PERFORMANCE OF SELECTED ORCHIDS UNDER VARYING LIGHT REGIMES, CULTURE METHODS AND NUTRITION

By

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DECLARATION

I hereby declare that this thesis entitled **"Performance of selected orchids under varying light regimes, culture methods and nutrition"** is a bonafide record of research done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Vellayani,
30.4.1996

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CERTIFICATE

Certified that this thesis entitled **"Performance of selected orchids under varying light regimes, culture methods and nutrition"** is a record of research work done independently by **Smt. Sabina George Thekkayam** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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INTRODUCTION

INTRODUCTION

The agricultural priorities of our country since independence have centered around the production of food and industrial crops. Cut-flowers like anthuriums, gladioli and orchids, having export potential, have been introduced into our cropping system only during the last decade. Among them, orchids are the most highly priced in international markets.

The increasing trends of global consumption, the leveling-off of production in the traditional producing countries and the declining trends in countries like Thailand due to industralization, have improved India's prospects in global trade. Side by side, the development of tourism and related industries has also increased the internal demand for these flowers. These factors point to an urgent need for promotion of orchid growing in the Country, especially the State of Kerala, the most ideal region for growing orchids. The optimum utilization of land, light, air, water and labour resources makes this crop well suited to our agro-ecosystem.

Research on cut-flower orchids has not been undertaken in India. The few orchid growers of Kerala have successfully adapted the cultural practices prevalent in Malaysia, Singapore and Thailand. Commercial production has thus preceded the development of indigenous technology for culture. In accordance with the competition faced in this field, successful growers are reticent in divulging to other growers the manurial dosages, details of cultural practices etc. This, together with the special requirements and input-intensive nature of culture, has limited the adoption of orchids as a major cut-flower crop in the State.

Inclusion of this crop in the existing cropping pattern and the need for production of quality sprays for export require that a package of technology relevant to our polycropped conditions is evolved urgently. This study formed a part of a programme designed to achieve this broad objective.

Orchids belonging to the genera *Arachnis, Aranda, Aranthera Dendrobium, Oncidium, Phalaenopsis* and *Vanda* are suited for large scale production in the tropics. These require varying light intensities, high temperatures and a high relative humidity in their micro-environment. Growth and flowering in orchids are subjected to regulation by biotic and abiotic factors as in other crops. The genotype, the environment and the culture conditions, in that order, exert immense influence on flower production. Modification of the culture environment and assessment of the impact of the modifications on crop performance formed the focus of the present investigation.

A cultivar each of proven commercial potential from representative monopodial and sympodial genera were chosen. The study aimed at assessing their performance under varying light and nutrient regimes and differing methods of cultivation.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

Information on the performance of temperate-zone orchids in varying cultural environments, growing media, light and temperature conditions as well as under different nutrition regimes is readily available. For example, the array of different substrates recommended for growing a single genus like *Cattleya* is truly impressive and in itself an indicator of the wide adaptability of these highly evolved group of plants to varying conditions. In the case of tropical orchids, the picture is slightly different in that, in situations ideal for their culture, research has been streamlined to increase production on commercial lines.

Experimental evidence accumulated over the years on the responses of monopodial and sympodial orchids to a variety of culture related treatments are reviewed in the following pages. An overall measure of these findings present inferences that are generally applicable to the groups they represent.

2.1 Methods of cultivation

One of the earliest reports on the cultivation practices prevalent in the tropics was that of Murashige and his co-workers in 1967. In Hawaii, they observed that monopodials like *Vanda* grew best in the open fields on vertical wooden supports. Purseglove (1975) detailed the cultivation of orchids in the humid tropics. He reported that climbing orchids like *Arachnis* were grown in beds and trailed up poles while epiphytes like *Dendrobium* were grown in pots with holes at their sides and bottom, for ventillation. Certain slow growing strap leaved monopodials like *Aranda* and *Vanda* were also reported to be grown in pots. In field culture, cuttings were planted in beds filled with broken tiles and surrounded by bricks. The cuttings were then tied to supporting poles and shaded with palm fronds until they were well established. Hagen (1976), outlining the cultivation of *Dendrobium* in Sri Lanka reported that pot culture was most ideal for the various types. Sheehan (1976; 1980) also specified the methods of cultivation in vogue in the tropics for cutflower orchids. He stated that in *Arachnis* and other monopodials, tip cuttings of 40 to 75cm length were planted 15 to 20cm apart in trenches of 15 to 20cm depth and width. *Dendrobium* and other sympodials were grown in containers, the most commonly used container being pots made of clay. Bose and Yadav (1986), Abraham and Vatsala (1981) and Yadav and Bose (1986) too confirmed the prevalance of outdoor cultivation for the high light intensity requiring monopodials and cultivation in pots under shade for the sympodials. In several terrestrials and epiphytes too, growing outdoors under partial shade was found to be satisfactory (Rao and Mohanan, 1986). Oszkinis (1992) found that in *Cymbidium* under greenhouse culture, growing in beds or baskets containing 40 dm^3 substrate resulted in good vegetative growth, but for obtaining a greater number of inflorescences growing in baskets of 10 dm^3 capacity was better. Basket cultured plants were found to need reconditioning in open beds after 2-3 years.

2.2 Growing media

From the time the wild tropical orchids reached the greenhouses of Europe, studies on their performance in different kinds of media were undertaken zealously. On the one hand, the growers concentrated on the use of substrates on which orchids were found growing in nature like different kinds of tree bark, fern roots, mosses and leaf mould. On the other hand, different indigenously available materials like cork-shreds, coconut husk, expanded clay, peat, pumice, sawdust and wood chips were tried. The surfeit of work done on this aspect prompted White (1986), to ponder, whether there existed a 'media mania' in the field of orchid growing. Even so, a greater understanding of the substrate preferences of orchids was gained by these investigations.

Davidson (1961) evaluated the suitability of a mixture containing equal parts of coarse peat moss, dried oak leaves and red wood bark fibre against shredded white fir (*Abies concolor*) bark and found the former to be superior with or without the addition of coarse sand. Sheehan (1966) assessed the relative merits of tree bark and osmunda fibre as media and found that the former needed supplements of nitrogen to compensate for the consumption by bark decomposing bacteria. Sander (1969) observed that materials like osmunda fibre sphagnum moss and peat were ideal for epiphytes including *Dendrobium*. The disadvantages of tree bark as a substrate was pointed out by Frei and Dodson (1972). They reported that seed germination and early development of protocorms were inhibited by the phenolic and gallic acid derived inhibitors present in the bark of thirty five species of *Quercus* (oak). Esser (1973) tested a range of substrates including perlite, peat, a mixture of fern fibre and sphagnum moss, and polystyrene chips. Peat had the highest water holding capacity. Peat containing media were reported to have the capacity to retain nutrients for longer periods, thus needing less frequent nutrient addition when compared to the others.

For the epiphytes grown in the tropics, Purseglove (1975) observed that fern roots, sphagnum moss, peat and other materials were not suitable. For *Dendrobium*, brick pieces, charcoal and coconut husk were found to be adequate. Addition of coconut husk was found to increase the moisture retention capacity of the medium. Sheehan (1980) also pointed out that in Thailand, Singapore and other tropical countries, field grown monopodials including *Arachnis* had coconut husk as a popular substrate while Dendrobiums were grown in a mixture of husks, bricks and charcoal. The use of charcoal alone or in combination with other materials was reported by several workers (Bhattacharjee, 1981; Abraham and Vatsala, 1981; Rao and Mohanan 1986; Yadav and Bose, 1986). Griffiths (1984) pointed out that for *Dendrobium phalaenopsis* in the U.K, osmunda fibre is the chief substrate used with sphagnum moss. Henderson (1985) reported that in the United States a mixture of charcoal, peat and styrofoam was a long-lasting medium used satisfactorily for almost all the genera grown. The unconventional media components used by growers include walnut and rice hulls and shredded coconut husk fibre. Sakai *et al.*, (1985) found that for *Dendrobium nobile* cultivars, a pumice-bark mixture containing 25-50 per cent by volume of bark was good for seedlings while for the flowering plants, 25 per cent bark was ideal in the mixture. Tanaka *et al.*, (1988a) found that in the *Phalaenopsis* hybrid (*Doritaenopsis* Red Lip x *Phalaenopsis* Red Eye) *Phalaenopsis* Culmination, growth and flowering was improved in a media mix containing pumice and peat moss in equal proportion followed by a medium of sphagnum moss. For the *Cattleya* hybrid *Laeliocattleya* Pacific South x *Brassocattleya* Deesse, the performance in different media such as sphagnum moss, hemlock (*Tsuga* sp) bark and a mixture of pumice and peat moss (1:1 V/V mix) depended on the additional nutrition given to the plants.

Seeni and Latha (1990) reported that broken tiles followed by charcoal pieces, cassava pith, rubber seed husk and coconut husk gave the highest per cent survival and growth. Koval'skaya and Zaimenko (1991) reported that for one year old seedlings of the cutflower varieties of *Dendrobium phalaenopsis* shredded sphagunum moss was the best medium while for 2 year old seedlings, forest top soil followed by forest top soil and shredded pine bark in equal proportion was good. Menezes (1992) found *Cattleya warneri* to be performing equally well in crushed rock, quartz chips and *Lantana camara* stakes (dried stalks). Suresh Kumar (1992) obtained maximum growth in one year old *Dendrobium* seedlings in charcoal followed by fern roots and rubber seed husk. Wang and Gregg (1994) observed in studies with a *Phalaenopsis* hybrid that the effect of the medium persisted for upto an year only and fertilizing the medium lowered its pH and increased its electrical conductivity.

2.3 Light regimes and effects

The light environment of plants, as a source of energy, has been observed to act in the four dimensions of quantity, quality, direction and periodicity (Hart, 1988). In the case of orchids, the most significant variables of light influencing the short term periodic functions of metabolsim and the longterm ones of vegetative growth and flowering, were observed to be the duration and intensity. In the natural stands of terrestrials like *Liparis lilifolia*, *Habenaria clavellata* and *Isotria medeoloides*, light was observed to be a critical factor with respect to flowering and seed production than vegetative growth (Stuckey, 1967). Together with moisture availability, light was reported to be responsible for the positioning of epiphytes in different vertical levels in the aerial environment (Sandford, 1974).

Though orchids are technically cosmopolitan, the present day cutflower varieties (with a few exceptions) are primarily tropical and native to the regions where daylength differences are slight. In most of these pantropical ones, light intensity has emerged as the single most influential photoeffect. Monopodials belonging to the genera *Arachnis, Aranda, Aranthera, Renanthera* and *Vanda* are grown in the tropics under partial to full sunlight while *Dendrobium* is grown under varying amounts of lath shade. In Sri Lanka, Hagen (1976) reported that *Dendrobium phalaenopsis*-types were grown under 40 per cent shade, *Ceratobium*-types in zero shade (full sunlight) and intermediate-types under 20 per cent shade.

Several workers have reported on the light requirement of the major genera. Skelsey (1978) included *Arachnis, Aerides* and *Renanthera* in the group requiring light above 3000 ft-c for growth. Sessler (1978) outlined the light needs of major orchid genera and pointed out that those that needed greater illumination for flowering were *Cattleya* and *Oncidium* (2000 to 4000 ft-c), *Cymbidium* and *Dendrobium* (3000 ft-c) and the *Miltonia* (2000 to 3000 ft-c). *Paphiopedilum* and *Phalaenopsis* had lower light requirements (600 to 700 ft-c) when compared to the others. Likewise, Bose and Yadav (1986) reported that illumination levels ranging from 2,400 to 3,600 ft-c were needed for *Arachnis* and its hybrids, *Dendrobium, Oncidium* and *Vanda* with a temperature of 18°C to 21°C and a relative humidity of 70 per cent. In temperate climates, supplementary illumination was found to be benefical for flowering. This led to the procedure of 'light gardening' using fluorescent and incandescent lamps. Use of a 3w fluorescent lamp to every 1w incandescent lamp was suggest ed by Walker and Abernathie (1964), while Powell (1964) recommended a 25w incandescent lamp for every 40w fluorescent lamp. Use of flourescent tubes for supplementary lighting for orchids grown in controlled environments was also reported by many (Baer, 1971; Keen,1972; Poole and Seely, 1978 and Van Acker, 1989).

The benefical effects of supplementary illumination prompted investigations on the manipulation of light intensity. Trials with the terete leaved *Vanda* Miss Joaquim in Hawaii showed that light intensity is the main determinant of earliness or lateness in the commencement of flowering (Murashige *et al.*, 1967). Flowering was the earlist under full exposure to sunlight. As available light was decreased, flowering was delayed. The delay observed was two, four, six and nine months respectively under 70,50,37 and 25 per cent light intensities. Krizek and Lawson (1974) found that in controlled environments, higher light intensity and elevated temperatures greatly accelerated vegetative growth (three to four times) of *Cattleya* and *Phalaenopsis*. At an intensity of 3000 ft-c, a day temparature 90°F and a night temperature of 85°F, increase in leaf area, leaf elongation, lateral shoot production and growth of aerial roots was observed.

Ding *et al.*,(1980) found that flower production in *Oncidium* Goldiana was negatively correlated with the sunshine hours received 15-60 days before harvesting. In *Cattleya,* Lacey (1981) reported that peak photosynthetic efficiency at 20°c was at 10,000 lux and that shading was necessary to maintain the illumination at 10,000 lux. Goh *et al.*, (1982) reviewed the light induced responses of flowering in orchids and classified cultivated species and varieties based on their response to light. Goh, (1985) reported that in the day neutral *Vanda*, peak and offseason flowerings are observed and that inflorescence production is dependent on the length of exposure to direct sunlight.

Gordon, (1989a, 1989b and 1989c) detailed the varying light conditions under which *Phalaenopsis* cultivars are grown. He observed that light intensity was the chief factor setting the pace of others such as nutrition, temperature and humidity. Advancement of flowering by five to seven days was obtained by Yoneda *et al.*, (1991) in three and six year old *Phalaenopsis* plants by exposing them to short days (8 hrs) for 55 days.

Johnson (1992) reported that in *Paphiopedilum malipoense* and *Paphiopedilum micranthum* a photon flux density (PFD) of 100 to 225M mol $m^{-2}s^{-1}$ (approximately 10 per cent of full sunlight) was favorable for photosynthetic saturation. Lim *et al.*, (1992) found that in *Dendrobium* plantlets, increasing the PFD from 45-90 E $m^{-2}s^{-1}$ increased the uptake of nitrate from the medium. Johnson (1993) found that in *Oeceolades maculata*, a shade tolerant herbaceous orchid in which photosynthetic saturation occured at 90 ± 10M mol $m^{-2}s^{-1}$, photo inhibition began at 120 ± 5M molm^{-2} s^{-1} with attendant damage to pigment systems. But it was observed that short term loss of pigments or structural damage to the leaves did not permanently damage the physiological processes or the overall reproductive effort of the plants. Increase in plant dry weight, sugar content, N absorption, the number of expanded leaves, root number and length were the effects reported in *Phalaenopsis* under higher light intensities (Kubota and Yoneda 1993).

2.4 Nutrition

Early investigations on the nutrition of epiphytes in their natural habitat prompted many workers to assume that cultivated orchids needed very little supplementary nutrition other than that provided by the growing medium (Sandford, 1974). Later on, the need for a good nutrient regime for balancing growth and flowering with environmental variables became apparent. Much of the work on the plant content of nutrients, their uptake, requirements, sources and application centered around a few commercally important genera. The trends and differences observed among the genera with respect to these aspects reveal their physiological dissmilarities and above all point to the characteristic differences between the orchids and other terrestrial ornamentals.

2.4.1 Nutrient uptake and composition of plants

The factors influencing the uptake of nutrients are different in the epiphytes when compared to the plants of a terrestrial environment. Moreover orchids have built-in mechanisms such as the velamen of the roots, additional path ways of photosynthesis (C.A.M) and a greater leaf longevity and leaf thickness as adaptations to overcome moisture fluctuations in the environment (Benzing, 1986). Mycorrhizal symbiosis is a trophic advantage of the naturalized orchids which may not be associated with the cultivated ones.

Orchids absorb nutrients through their foliage and roots. Sheehan (1966) reported that in *Cattleya*, phosphorus (like nitrogen, potassium and magnesium) was found to enter the plants through the foliage and that three-year old roots were able to absorb and translocate ^{32}P as actively as one-year old roots. Rahayu (1980) found that the absorption of P through the leaf was comparable to that through the root in *Phalaenopsis*. In *Cymbidium*, Hong *et al.*,(1991) found that the uptake of ^{32}P by the root was directly proportional and that of urea was inversely proportional to the relative humidity of the growing environment.

In cultivated orchids the efficiency of nutrient uptake over application was reported to be low when inorganic forms were used. Khaw and Chew (1980) found that in *Aranda* Noorah Alsagoff though the uptake of nutrients as well as growth and flower production increased with the frequency of fertilizer application, the efficiency of nutrient usage was 1.7, 0.2 and 2.0 per cent respectively for N,P and K. Tanaka *et al.*,(1989) found that in *Cattleya* plants potted in sphaghum moss, application of 2.5g of a mixture containing rape seed oil cake and bonemeal in equal proportion gave high ratios of uptake to application of N,P and K viz. 19.3, 2.7 and 149.7 per cent respectively. Hew *et al.*, (1993) reported that in *Cymbidium sinense* and *Dendrobium* White Fairy under solution culture, the uptake of nitrate-N was 0.3 and 0.9M $molg^{-1}$ $F.W.h^{-1}$ respectively, being considerably greater than most of the major crops. In orchids, the composition of nutrient elements in the plant parts was determined by the age of the plant material and the nutrient regime during the growth of the plant. In *Laeliocattleya* Culminant, Poole and Sheehan (1973) found that nitrogen and potassium levels in the leaves decreased with age while phosphorus levels increased.

An accumulation of nitrogen in the pseudobulbs was observed with aging. In *Phalaenopsis*, Poole and Sheehan (1974) found that levels of the three major nutrients in the leaves decreased with age. Calcium and manganese were preferentially accumulated in the mature leaves. Preferential uptake of manganese due to greater availability was also reported by Poole and Sheehan (1977) in a medium of fir bark. *Cattleya, Cymbidium* and *Phalaenopsis* were observed to absorb relatively higher levels of potassium, calcium and magnesium while maintaining relatively stable levels of iron, zinc and copper in their leaves (Poole and Sheehan 1982) In *Dendrobium nobile* tissues, Yamaguchi (1979) found that the levels of potassium, calcium, magnesium and manganese were relatively lower than those found in the other genera. With respect to the content of iron and zinc in the shoots, an increase with aging was observed. The importance of the culture environment as a whole is also signified by the finding of Carlucci *et al.*, (1980) that in *Cattleya* and *Laelia* plants under cultivation, the content of nitrogen, phosphorus and potassium were lower and that of the minor elements, higher than that in the plants grown on a host tree.

2.4.2 Nutrient regimes and effects

Reported effects of nitrogen, phosphorus and potassium on the growth and flowering of orchids conform to those obtained in other crops. Increasing the dosage of nitrogen was found to promote vegetative growth in most of them. Lunt and Kofranek (1961) observed this to occur at the expense of flowering in *Cymbidium*. The concentration of nutrients, observed to have promotive effects on both vegetative growth and flowering, differed with the genera grown. Increasing nitrogen levels from 50ppm to 1000ppm enhanced the leaf area, the length of the flowering spike and the diameter of the flowers in *Phalaenopsis* 'Pink Chiffon' (Sheehan 1966).

Vacharotayan and Kreetapirom (1975) found improvement in flowering of *Dendrobium* M.Pompadour with N,P and K in the ratio 3:3:2 or 5:5:2. For *Cymbidium* and *Phalaenopsis* seedlings, 100ppm N with 50 to 100ppm K and 25ppm Mg was found to be optimal by Poole and Seeley (1978). Khaw and Chew (1980) reported that for *Aranda* Noorah Alsagoff, the estimated nutrient requirement per week was 20.9 mg N, 5.0 mg P, 21.8 mg K and 3.4 mg Mg. Gomi *et al.*, (1980) found that for four-year old *Phalaenopsis* hybrids 200 ppm N was best for vegetative growth. A standard nutrient solution containing 77.0, 15.5, 39.1, 80.1 and 12.2 ppm respectively of N, P, K, Ca and Mg resulted in best growth at three times the standard level of application. In *Cymbidium* Pharoah Pathfinder, Nichols (1982) reported that liquid fertilizers containing 500 ppm ammonium nitrate, 500 ppm potassium nitrate and 100 ppm ammonium sulphate applied at weekly intervals resulted in a greater cumulative growth in seedlings over a period of 6 months. Johnson (1984a) observed that leaf drop in *Cymbidium* is due to excessive nutrition coupled with reduced watering of plants. As a modification of the recommendation of Poole and Seely (1978), Johnson (1984b) suggested the the use of a nutrient solution containing 100 ppm N, 20 ppm P, 75 ppm K and trace elements for *Cymbidium* and *Cattleya*. Bik and van den Berg, (1984) found that in *Cymbidium* Pendragon Sikkim plants receiving N at four, six and eight $mmoll^{-1}$, shoot formation increased and the spike to shoot ratio decreased with increase in the N applied. Spike length, spike fresh weight, flower/spike ratio and earliness in flowering were also affected by higher N doses.

Delay in flowering due to an increase in the dosage of nitrogen (60 mg/l to 240 mg/l) was found in *Phalaenopsis* (Schenk and Brundert, 1983). While, in *Dendrobium nobile*, Sakai *et al.*, (1982) obtained a greater number of flowers and longer pseudobulbs with nitrogen at 48 mg l^{-1}. Higher doses of nutrients were observed to be benefical under outdoor cultivation. Yadav and Bose (1986) found that 1000 ppm each of nitrogen, phosphorus and potassium enhanced the length and number of leaves, the number of spikes and the number of flowers per spike. Higaki and Imamura (1987) also obtained greater flower yield and an increase in the size of flowers, height of the plants and diameter of the stem in field grown *Vanda* Miss

Joaquim with 150 kg/ha of nitrogen, 200 kg/ha phosphorus and 275 kg/ha of potash. In *Dendrobium* Lim Hepa, Uesato *et al.*, (1987) found that increasing the nitrogen dosage from 50 ppm to 300 ppm and potassium from 25 ppm to 150 ppm showed few clear effects on vegetative growth and flowering. Nitrogen at 300 ppm delayed flowering and increased the length of the stem and its period of elongation. Tanaka *et al.*, (1981; 1988a, 1988b and 1989) obtained earlier flowering and increase in the fresh weight and the nitrogen and potassium contents of the leaves with incremental doses of nitrogen, phosphorus and potassium (77.00 ppm to 308.00 ppm, 15.50 ppm to 62.00 ppm and 39.10 ppm to 156.40 ppm, respectively) in *Cattleya* and *Phalaenopsis*.

Several workers have recommended the use of major nutrients as formulations of various salts in different proportions, as being optimal for growth and flowering. Sagarik and Siripong (1963) reported beneficial effects by the use of a solution containing potassium nitrate, ammonium sulphate and superphosphate as the major ingredients. Muir (1975) proposed that for fertilizing orchids, ammonium nitrate, ammonium sulphate or urea can be used as the source of nitrogen, single superphosphate as the source of phosphorus and potassium chloride or sulphate as the source of potassium. Schenk and Brundert (1983) recommended the use of the nitrate and ammoniacal forms of nitrogen in the proportion 2:1 for obtaining earlier flowering in *Phalaenopsis*. Singh (1986) found the Ohio W.P. solution to be satisfactory for the growth of most orchids, while Mukherjee (1990) suggested an elaborate formulation containing calcium nitrate, magnesium sulphate potassium nitrate and ammonium sulphate as major components in addition to trace elements as being ideal for pot grown orchids. Suggested ratios of major nutrients differed primarily with the kind of medium used for growing plants, the nature of the response desired and the genera grown. Sheehan (1966) recommended nitrogen, phosphorus and potassium in the propotion 1:1:1 for plants grown in osmunda fibre and in the proportion 3:1:1 for those grown in tree bark. For greenhouse culture, 453.514g of a mixture containing 18 per cent each of these nutrients diluted with 454.600l of water was recommended for 36.731 sq.m. of bench area.

Pradhan (1976) recommended an NPK mixture in the ratio of 2:1:1 during the vegetative period and 1:1:1 during the flowering season. Banfield (1981) recommended fertilizers containing high N doses for *Paphiopedilum spp* during the growing season followed by those containing high P and K during the flowering season with a resting period with no fertilizers and minimal watering during winter. Boon (1982) and Merriman (1987) recommended N, P and K in the ratio 11:13:6 at weekly intervals for increased flower production during summer and autumn in *Oncidicum* and *Cymbidium* respectively. Schum and Fischer (1985) obtained the greatest number of leaves and fresh weight in the plants receiving nitrogen and potassium in the ratio 1:1 and the greatest number of inflorescences,flowers and roots in those receiving the nutrients in a ratio of 1:3. Stewart (1988) recommended a combination containing a greater proportion of nitrogen (3:1:1) in the early summer for better vegetative growth followed by one containing a greater proportion of potassium (1:1:3) to encourage flowering and thereafter a balanced proportion of nutrients (1:1:1) for sustained growth.

2.4.3 The use of organic manures

Increased vegetative growth and yield of inflorescences were reported in *Arachnis* Maggie Oei, *Aranda* Deborah, *Aranda* Nancy and *Aranthera* James Storei by the application of chicken manure at 46.50 t ha^{-1} yr^{-1} (Wong and Chua, 1974). Avoiding organic manure application was reported by them to reduce the length of the inflorescences. An organic feed containing equal parts of cowdung and bonemeal was recommended by Pradhan (1976). Diluted pig manure was found to enhance the vegetative growth and flowering in *Oncidium* Caldwell (Koay and Chua, 1979). Abraham and Vatsala (1981) listed the various organic manures such as cowdung, dried leaves, fish manure, prawnmeal and bone meal applied to orchids and reported that these were immersed in water and their liquid extracts were diluted and applied. Rape seed oil cake and bonemeal in equal proportions were found to improve the uptake of nutrients by *Cattleya* plants grown in sphagnum moss (Tanaka *et al.*, 1989).

2.4.4 Nutrient application

Fortnightly application of fertilizers, with daily watering, was reported to produce maximum growth of plants in the ideal light environment (Sheehan,1980). Weekly application was reported to be more desirable for plants grown in neutral media such as charcoal or broken tiles. Application of nutrients in a trickle- drip system was found to be beneficial for increasing the fresh weight of *Phalaenopsis* seedlings (Campbell and Mathes, 1989).

2.5 The Vase life of inflorescences

The longevity of orchid blooms add to their ornamental value. In an orchid spray in which blooms open in an acropetal succession, correlative influences similar to that found in a vegetative shoot apex may be present (Nair, 1985). In detached flowers of *Dendrobium* Pompadour, the timing of senescence was found to be independent of the age of the flower. However, Ding *et al.*, (1980) reported that the age of the inflorescence was correlated with the time taken for 30 per cent drop of the blooms. The younger inflorescences had a greater longevity than the older ones and those having a smaller size had a greater longevity than the larger ones when cut at 30 per cent full bloom stage. In the inflorescences cut at 50 per cent full bloom stage size had no effect on the vase life.

One of the most important pre-harvest factors influencing the post harvest life of a cut-flower is light, the effect of which is largely related to the accumulation of respirable substrates, mainly carbohydrates (Halevy and Mayak, 1981). In *Dendrobium nobile* cultivars, Suto *et al.*, (1984) found that storage carobohydrates accumulated in the shoots after the emergence of the last leaf and during the elongation of the floral axis. Clifford *et al.*, (1992) reported that in *Aranda* Tay Swee Eng, assimilate supply to an inflorescence was not only from its subtending leaf but also from several leaves above and below it. The upper fully expanded leaves constituted the main additional source. Such an unrestricted assimilate supply was proposed to be indicative of minimal vascular restriction to assimilate movement.

In orchids, the effects of light as such on cut-flower longevity has not been reported. In other cut-flowers like carnations and chrysanthemums, a rapid aging in the flowers produced during periods of low light intensity has been reported (Lancaster, 1974; Kofranek *et al.* 1972). This was found to be directly related to their carbohydrate levels. Among the nutrients, N at higher doses given at the later part of the growing period was found to reduce the longevity of carnation flowers (Waters, 1967). In *Oncidium* Goldiana, Ong, (1982) reported that foliar sprays of aluminium chloride, (500ppm) ammonium molydate (100ppm) and boric acid (100ppm) increased the shelf of inflorescences.

MATERIALS AND METHODS

3. MATERIALS AND METHODS

The materials utilized and the methodology followed for the investigations are reported in this chapter.

3.1. Location

The studies were conducted at the College of Agriculture, Vellayani, Thiruvananthapuram. (Altitude 29m above M.S.L., Latitude 8°N., Longitude 76°E).

3.2. Soil

The soil of the site belonged to the fine kaolinitic iso-hyperthermic family of kandyustults and its chemical composition is given in Table 1. The soil pH was 5.5.

3.3. Climate

The site enjoyed a humid tropical climate with the maximum temperature ranging from 28.4°C to 33.3°C and the minimum temperature, from 20.4°C to 25.5°C during the period of investigations. The mean relative humidity varied from 72.4% to 88.8%. The mean monthly rainfall recorded was 145.71 mm. The weather parameters recorded (month-wise) during the period are presented in Table 3.

Table 1. Chemical composition of the soil

Particulars	Content (%)
Total nitrogen	0.014
Total phosphorus	0.049
Total potash	0.35

Table 2. Description of the varieties

Name	Parentage	Growth habit	Bloom colour
Arachnis Maggie Oei 'Red Ribbon'	*Arachnis hookeriana* var. *luteola* x *Arachnis flos-aeris*	Monopodial	Yellow with maroon markings and mauve-red lip
Dendrobium Sonia-16	*Dendrobium* Caesar x *Dendrobium* Tomie Drake	Sympodial	White and pink sepals and mauve red petals and lip with a white center

Table 3. Weather data recorded during the experimental period

Month		Temperature (°C) Max.	Temperature (°C) Min.	Rainfall (mm)	Mean R.H. (%)
1991	Nov.	30.20	23.20	247.10	82.60
	Dec.	30.40	21.90	20.20	75.70
1992	Jan.	30.40	20.40	0.00	73.20
	Feb.	30.10	21.80	0.00	74.90
	Mar.	32.20	22.20	0.00	72.40
	Apr.	33.30	25.50	1.50	75.70
	May.	32.10	24.70	90.90	77.80
	June.	29.60	24.20	402.60	88.80
	July.	28.40	23.20	260.30	86.40
	Aug.	28.90	22.30	67.80	83.89
	Sept.	29.30	23.20	76.30	81.72
	Oct.	28.90	22.70	412.00	85.23
	Nov.	29.17	23.00	281.00	83.18
	Dec.	30.34	21.48	15.10	78.66
1993	Jan.	30.30	20.56	0.00	75.15
	Feb.	31.20	21.30	2.80	76.46
	Mar.	32.39	23.10	36.30	75.55
	Apr.	32.50	24.60	31.60	83.12
	May.	32.09	25.00	223.20	88.00
	June.	29.97	24.12	391.30	86.80
	July.	28.75	22.47	224.20	87.24
	Aug.	29.80	23.30	33.20	84.62
	Sept.	32.72	22.87	78.80	81.33
	Oct.	29.85	23.35	312.20	83.79
	Nov.	28.79	22.39	434.30	87.07

3.4. Cropping duration

The field experiment on the monopodial orchid (Experiment 1) was conducted from November 1991 to May 1993, after which the plants were cut at a uniform height of 50cm from the base. The experiment on the sympodial orchid (Experiment 2) was carried out from October 1992 to December 1993.

3.5. Materials

3.5.1. Varieties

The monopodial orchid cultivar chosen for the Experiment 1 was *Arachnis* Maggie Oei 'Red Ribbon' and the sympodial variety chosen for the Experiment 2 was *Dendrobium* 'Sonia-16 . A description of the varieties and their lineage are presented in Table 2.

3.5.2. Planting material

Terminal cuttings of 45cm length, with a minimum of two aerial roots, were used for the Experiment 1 and plants with a minimum of two pseudobulbs or canes were used for the Experiment 2.

3.5.3. Culture medium

Coconut husk, charcoal and brick pieces were used in equal proportion as the medium for both the experiments, along with 0.5kg cowdung per plant for the Experiment 1.

3.5.4. Supports

Cuttings were supported vertically on split-bamboo reapers and horizontally on rope and wire terllis. *Dendrobium* plants were held in the pots strung with G.I. wire and hung from horizontal wooden poles.

3.5.5. Shading material

Black high density polyethylene net, fabricated for 50% and 75% light intensity, were used for the Experiment 1. For the Experiment 2, nets fabricated for 25%, 50% and 75% light intensity were used. The nets were spread at a height of 2.5m from the ground level and supported on G.I. pipes and teak wood poles of 6.5cm diameter.

3.5.6. Fertilizers and manure

Urea was used as the source of nitrogen, super phosphate as the source of phosphorus and muriate of potash as the source of potassium. The chemical composition of the fertilizers and cowdung used are given in Table 4.

3.6. Methods

3.6.1. Design and layout

The statistical design and the layout of the experiments are presented in Table 5 and Fig. 1 respectively.

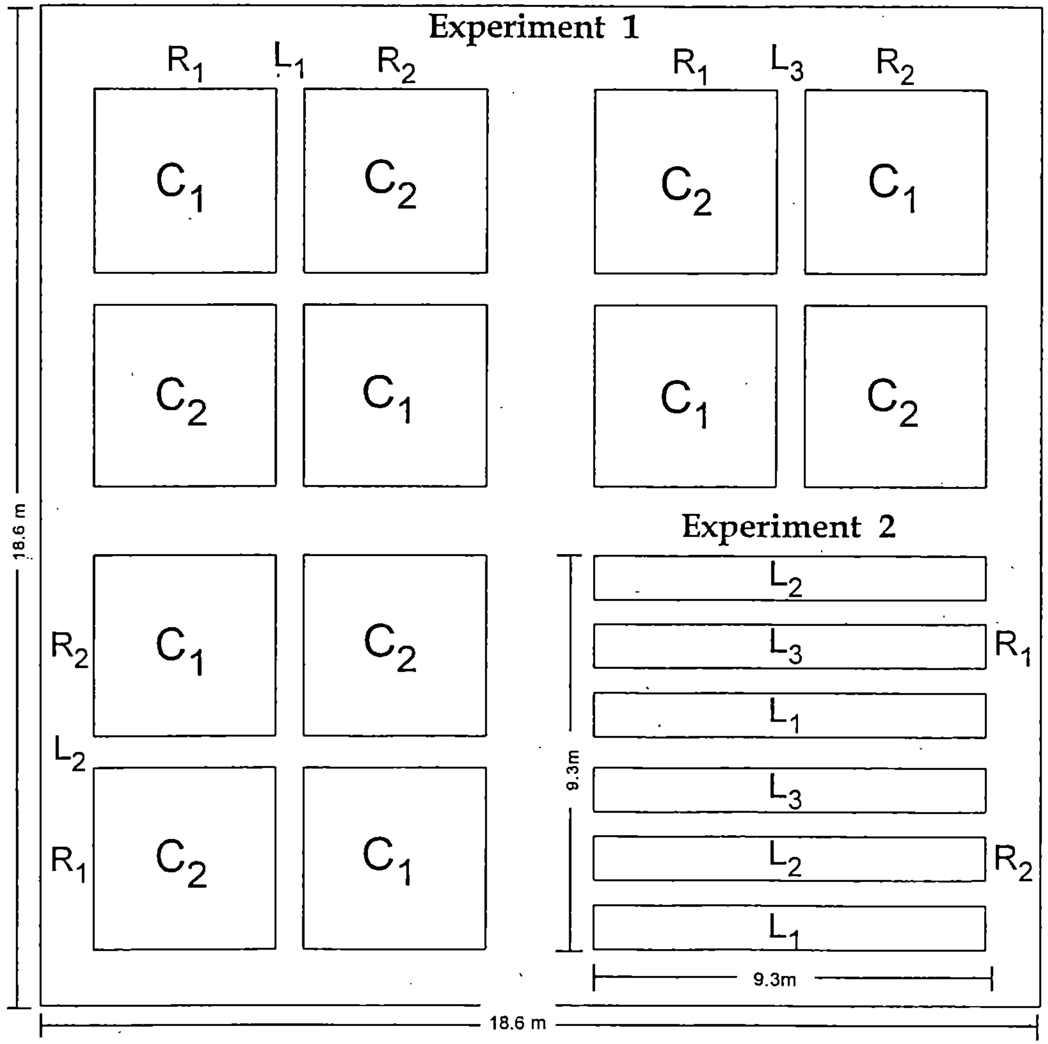
Table 4. Chemical composition of fertilizers and manures

Fertilizer/manure	N (%)	P (%)	K (%)
Urea	46	—	—
Superphosphate - single	—	16	—
Muriate of potash	—	—	60
Cowdung	0.4	0.3	0.2

Table 5. Details of the statistical design

Particulars	Experiment 1	Experiment 2
Design	Split-Split plot RBD	Split-plot RBD
Replications	Two	Two
Main plot treatments	100% light 75% light 50% light	75% light 50% light 25% light
Sub-plot treatments	Trench culture Pot culture	Nutrient treatments
Sub-sub-plot treatments	Nutrient treatments	—
Date of planting	30-10-1991	01-10-1992
Culture method	—	Pot culture

Fig. 1. Layout of the experiments



Experiment	Symbol	Key
1	L1	100% light
	L2	75% light
	L3	50% light
	C1	trench culture
	C2	pot culture
2	L1	25% light
	L2	50% light
	L3	75% light
1 & 2	R1	Replication 1
	R2	Replication 2

3.6.2. Plots

For the Experiment 1, three plants, spaced 15cm apart in brick-lined trenches of 30cm depth and 30cm width, formed a plot. The distance between the plots was kept at 30cm. In the Experiment 2, one pot (15cm top diameter and 15cm length) with one plant formed a plot.

3.6.3. Pre-treatment management

For the Experiment 1, cuttings were planted on 30-10-1991 and maintained under uniform shade (50%) and gradually hardened until the commencement of the treatments (light intensities) on 20-01-1995. For the Experiment 2 the plants were repotted and the treatments commenced from 01-10-1992.

3.6.4. Treatments

The nutrient treatments of the experiments are detailed in Table 6.

3.6.5. Nutrient application

Random numbers (Fisher and Yates, 1963) were allotted to the treatments and nutrient solutions were applied accordingly to the plots at fortnightly intervals from March, 1992 for the plants of the Experiment 1 and from October, 1992 for the plants of the Experiment 2.

Table 6. Nutrient treatments

N (ppm)	P (ppm)	K (ppm)	Notation
300	300	300	t1
300	300	400	t2
300	300	500	t3
300	400	300	t4
300	400	400	t5
300	400	500	t6
300	500	300	t7
300	500	400	t8
300	500	500	t9
400	300	300	t10
400	300	400	t11
400	300	500	t12
400	400	300	t13
400	400	400	t14
400	400	500	t15
400	500	300	t16
400	500	400	t17
400	500	500	t18
500	300	300	t19
500	300	400	t20
500	300	500	t21
500	400	300	t22
500	400	400	t23
500	400	500	t24
500	500	300	t25
500	500	400	t26
500	500	500	t27
0	0	0	t28

Stock solutions of the fertilizers were prepared and made upto the requirement ensuring the supply of 12, 16 and 20mg respectively for the 300, 400 and 500 ppm doses, per plant per application. The plots were shielded while spraying to avoid spray drift.

3.6.6. Irrigation

The plants were irrigated once a day with microsprinklers on all rainless days.

3.6.7. Plant protection

In the Experiment 1, as prophylaxis against termite infestation, B.H.C. 10% dust was applied into the medium before planting. In the Experiment 2, a pre-planting drench of media components in Dithane M-45 was given. Thereafter, prophylactic application of insecticides and fungicides were given as and when symptoms of pest/disease incidence was noticed. The details are given in the Appendix.

3.7. Observations

Observations were recorded from the middle plant of each plot in the Experiment 1 and from the entire clump in Experiment 2.

3.7.1. Growth observations

Observations on growth were recorded during the period of maximum vegetative growth until peak flowering, from March 1992 to January 1993 in Experiment 1 and from December 1992 to October 1993 in Experiment 2.

3.7.1.1. Plant height

In the Experiment 1, the height of the stem from the collar region upto the base of the emerging leaves was recorded at monthly intervals. In the Experiment 2, the length of the growing shoots from their point of origin to the base of the emerging bud was recorded at monthly intervals and the maximum height attained was recorded.

3.7.1.2. Number of leaves

The total number of green leaves present on the plants was recorded at monthly intervals.

3.7.1.3. Leaf area

The maximum length and breadth of all the leaves were recorded at monthly intervals. The total leaf area per plant was calculated using the formula $Y = Kx$ where Y is the total leaf area and x, the sum of the product of the length and breadth of all the leaves and K, a constant. The constant was derived separately for each variety from a sample of 40 stratified leaves and was found to be 0.7520 for the *Arachnis* cultivar and 0.7160 for the *Dendrobium* cultivar.

3.7.1.4. Number and length of aerial roots

In the Experiment 1, the total number of aerial roots produced was recorded at monthly intervals. Two actively growing roots were tagged and their length was recorded at monthly intervals for six months and the monthly increment worked out.

3.7.1.5. Number of pseudobulbs and shoots

The number of leafless pseudobulbs and growing shoots produced by the plants was recorded at monthly intervals from the Experiment 2.

3.7.2. Observations on flowering

3.7.2.1. Days to flower

The number of days taken from planting to the opening of the first flower in a plot was reckoned as the days taken for flowering in the Experiment 1.

3.7.2.2. Mean number of inflorescences per plant

The total number of inflorescences produced in a plot was recorded, averaged and expressed as the mean number.

3.7.2.3. Number of branched inflorescences per plot

The total number of branched inflorescences produced in a plot was recorded.

3.7.2.4. Mean length of inflorescences

The length of the inflorescences produced in a plot was recorded, averaged and expressed as the mean length of inflorescences.

3.7.2.5. Mean number of flowers per inflorescence

The total number of flowers produced in each inflorescence were recorded averaged and expressed as the mean number.

3.7.2.6. Span area per flower

The North-South and East-West span of two flowers from the middle portion of each inflorescence was recorded and the mean of their product was expressed as the span area per flower.

3.7.3. Post-harvest observations

3.7.3.1. Vase life of inflorescences

Vase life of the inflorescences in tap water as the holding solution was recorded in the Experiment 1. Symptoms of fading of the first flower was taken as the indication of cessation of vase life.

3.7.4. Dry matter production

In the Experiment 1, nineteen months after planting the terminal shoot was cut and the fresh weight and dry weight of the leaves and stems were recorded and the dry matter content estimated. In the Experiment 2, the fresh and dry weights of vegetative shoots were recorded and the dry matter content estimated.

3.7.5. Chemical analysis of leaf samples

Analysis of the nitrogen, phosphorus, potassium, magnesium, zinc and copper content of the leaf samples were done following the standard analytical procedures, as per Jackson (1973).

3.8. Statistical analysis

The experimental data were analysed employing the technique of analysis of variance for split-split-plot design (experiment 1) and split-plot design (experiment 2) as per Panse and Sukhatme (1967).

RESULTS

4. RESULTS

The salient results of the two experiments depicting effects on growth, flowering and nutrient content of the plants are presented in this chapter. They relate to the plants receiving nutrient treatments, unless otherwise stated.

4.1. Experiment 1 – Monopodials *Arachnis* Maggie Oei

4.1.1. Growth characters

4.1.1.1. Plant height

4.1.1.1.1. The effect of light intensities

The direct effect of the light treatments on the plant height observed from four to the fourteen months after planting (MAP) was not significant (Table 7).

4.1.1.1.2. The effect of LNP interaction

A significant interaction between the light intensities and NP combinations was observed from five MAP to 13 MAP (Table 8 and Table 9).

Table 7. The effect of light intensities and culture methods on the height (in cm) of *Arachnis* Maggie Oei plants

Treatment	Months after planting										
	4	5	6	7	8	9	10	11	12	13	14
L_1	49.806	53.361	57.102	61.157	65.463	70.315	75.250	80.537	84.250	89.537	93.972
L_2	51.759	55.657	59.500	64.306	70.176	76.185	83.537	90.509	97.194	104.519	110.926
L_3	51.444	56.407	61.120	67.056	74.056	81.898	90.519	99.333	108.574	119.731	134.756
F	2.153	3.979	7.237	7.492	18.712	10.956	15.059	10.605	9.212	9.382	14.433
CD (0.05)	—	—	—	—	—	—	—	—	—	—	—
C_1	53.895	59.006	64.247	70.160	76.858	84.401	92.531	100.969	108.457	117.901	127.617
C_2	48.111	51.278	54.235	58.185	62.938	67.864	73.673	79.284	84.889	91.290	98.821
F	48.771	224.591	394.494	236.258	130.156	128.259	129.852	121.050	153.816	168.912	113.299
CD (0.05)	2.635	1.641	1.604	2.479	3.882	4.646	5.266	6.272	6.047	6.515	8.608

Table 8. Interaction effects of light with NP on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after planting			
	5	6	7	8
$L_1N_1P_1$	53.083	56.250	61.000	65.417
$L_1N_1P_2$	53.417	57.333	61.167	66.000
$L_1N_1P_3$	53.500	57.667	62.333	66.333
$L_1N_2P_1$	53.250	56.750	60.833	66.750
$L_1N_2P_2$	55.250	60.000	63.750	69.083
$L_1N_2P_3$	54.917	58.583	61.917	66.250
$L_1N_3P_1$	54.417	58.917	63.667	68.167
$L_1N_3P_2$	51.833	55.417	59.083	61.417
$L_1N_3P_3$	50.583	53.000	56.667	59.750
$L_2N_1P_1$	55.000	57.750	62.667	67.333
$L_2N_1P_2$	58.333	62.583	67.667	73.750
$L_2N_1P_3$	55.750	59.667	63.667	68.583
$L_2N_2P_1$	56.333	60.500	65.667	71.583
$L_2N_2P_2$	53.750	58.000	61.917	68.250
$L_2N_2P_3$	55.417	58.750	63.750	70.250
$L_2N_3P_1$	53.000	56.833	62.000	67.583
$L_2N_3P_2$	54.083	58.417	62.583	68.500
$L_2N_3P_3$	59.250	63.000	68.833	75.750
$L_3N_1P_1$	55.500	60.333	67.167	74.500
$L_3N_1P_2$	57.333	61.833	67.167	73.667
$L_3N_1P_3$	55.250	59.500	63.583	69.833
$L_3N_2P_1$	60.083	65.667	71.583	82.083
$L_3N_2P_2$	55.083	59.667	65.333	70.917
$L_3N_2P_3$	52.167	55.333	62.583	70.000
$L_3N_3P_1$	54.833	59.167	64.583	70.333
$L_3N_3P_2$	60.083	65.833	72.250	79.750
$L_3N_3P_3$	57.333	62.750	69.250	75.417
F	2.185	2.488	2.489	2.527
CD (0.05)	4.888	5.816	6.525	7.962

Table 9. Interaction effects of light with NP on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after planting			
	9	10	11	13
$L_1N_1P_1$	69.833	76.083	81.667	89.250
$L_1N_1P_2$	71.083	75.417	80.667	87.750
$L_1N_1P_3$	71.667	75.833	80.250	88.333
$L_1N_2P_1$	71.917	76.917	82.250	92.500
$L_1N_2P_2$	74.750	81.083	88.167	99.000
$L_1N_2P_3$	70.250	74.917	79.417	87.417
$L_1N_3P_1$	73.333	77.583	82.583	93.083
$L_1N_3P_2$	66.583	71.750	78.000	87.583
$L_1N_3P_3$	63.417	67.667	71.833	80.917
$L_2N_1P_1$	72.333	78.500	84.250	94.833
$L_2N_1P_2$	79.917	87.500	95.250	107.833
$L_2N_1P_3$	72.333	81.833	88.500	104.000
$L_2N_2P_1$	78.167	85.333	94.333	113.583
$L_2N_2P_2$	74.833	81.750	87.750	103.583
$L_2N_2P_3$	75.917	82.833	89.583	101.833
$L_2N_3P_1$	73.750	79.333	85.417	97.167
$L_2N_3P_2$	74.417	83.917	91.500	105.917
$L_2N_3P_3$	84.000	90.833	98.000	111.917
$L_3N_1P_1$	81.917	89.500	97.500	116.333
$L_3N_1P_2$	82.083	91.250	100.250	120.750
$L_3N_1P_3$	76.333	83.667	92.833	112.583
$L_3N_2P_1$	90.917	100.833	110.583	134.833
$L_3N_2P_2$	78.333	87.000	96.667	117.583
$L_3N_2P_3$	78.667	87.583	96.333	115.333
$L_3N_3P_1$	77.417	85.250	93.250	111.667
$L_3N_3P_2$	87.833	94.750	102.667	122.000
$L_3N_3P_3$	83.583	94.833	103.917	126.500
F	2.879	2.288	2.107	2.064
CD (0.05)	8.706	9.812	11.018	13.501

At five MAP (April 1992) under L_1 and L_3 there was no significant difference in height between the plants receiving the various NP combinations. Under L_2 the plants receiving N_3P_3 had a greater height than those receiving N_2P_2, N_3P_1 and N_3P_2. Among the NP combinations, N_2P_1 resulted in a greater height under L_3 than under L_1, N_3P_2 resulted in a greater height under L_3 than under L_2 and L_1 and N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At six MAP (May 1992) (Table 8), the plants receiving N_2P_2 under L_1 had a greater height (60.000cm) than those receiving N_3P_3. Under L_2 the plants receiving N_3P_3 had a greater height (63.000cm) than those receiving N_3P_1. Under L_3 the plants receiving N_2P_1 or N_3P_2 had a greater height (65.667 and 65.833cm respectively) than those receiving N_1P_3, N_2P_2, N_2P_3 and N_3P_1. Among the NP combinations, N_2P_1 resulted a greater height under L_3 than under L_1 and N_3P_2 resulted in a greater height under L_3 than under L_1 or L_2 and N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At seven MAP (June 1992) (Table 8) under L_1 the plants receiving N_2P_2 and N_3P_1 had a greater height (63.750cm and 63.667cm respectively) than those receiving N_3P_3. Under L_2 the plants receiving N_3P_3 had a greater height (68.833cm) than those receiving N_2P_2 and N_3P_1. Under L_3 the plants receiving N_3P_2 had a greater height (72.250cm) than those receiving N_1P_3, N_2P_2, N_2P_3 and N_3P_1. The plants receiving N_2P_1 had a greater height than those receiving N_1P_3, N_2P_3 and N_3P_1. Among the NP combinations, N_2P_1 and N_3P_2 resulted in a greater height under L_3 than under L_1 and N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At eight MAP (July 1992) (Table 8) under L_1 the plants receiving N_2P_2 had a significantly greater height than those receiving N_3P_3. Under L_2 the plants receiving N_3P_3 had a greater height than those receiving N_1P_1 and N_3P_1. Under L_3, the plants receiving N_2P_1 had a greater height (72.250cm) than those receiving N_1P_2, N_1P_3, N_2P_2, N_2P_3 and N_3P_1. Among the NP combinations, N_1P_1 resulted in a greater height under L_3 than under L_1 and N_2P_1 and N_3P_2 resulted in a greater height under L_3 than under L_1 and L_2 and N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At nine MAP (August 1992) (Table 9) under L_1 the plants receiving N_2P_2 and N_3P_1 had a greater height than those receiving N_3P_3. Under L_2, the plants receiving N_3P_3 had a greater height than those receiving N_1P_1, N_1P_3, N_2P_2, N_3P_1 and N_3P_2. Under L_3, the plants receiving N_2P_1 had a greater height than those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_2, N_2P_3 and N_3P_1. Among the NP combinations, N_1P_1 and N_2P_1 resulted in a greater height under L_2 and L_3 than under L_1, N_3P_2 resulted in a greater height under L_3 than under L_1.

At 10 MAP (September 1992) (Table 9) under L_1 the plants receiving N_2P_2 had a greater height than those receiving N_3P_3. Under L_2, the plants receiving N_3P_3 had a greater height than those receiving N_1P_1 or N_3P_1. Under L_3, the plants receiving N_2P_1 had a greater height than those receiving N_1P_1, N_1P_3, N_2P_2, N_2P_3 and N_3P_1. Among the NP combinations, N_1P_1 and N_2P_1 resulted in a greater height under L_3 than under L_1 or L_2, N_1P_2 and N_2P_3 resulted in a greater height under L_3 than under L_1 and N_3P_2 resulted in a greater height under L_3 than under L_2 and a greater height under L_2 than under L_1. While N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At 11 MAP (October 1992) (Table 9) under L_1 the plants receiving N_2P_2 had a greater height than those receiving N_3P_3. Under L_2, the plants receiving N_3P_3 had a greater height than those receiving N_1P_1 and N_3P_1. Under L_3, the plants receiving N_2P_1 had a greater height (110.583cm) than those receiving N_1P_1, N_1P_3, N_2P_2, N_2P_3, and N_3P_1. Among the NP combinations, N_1P_1, N_1P_2, N_1P_3 and N_2P_3 resulted in a greater height under L_3 than under L_1, N_2P_1 resulted in a greater height under L_3 than under L_1 and L_2, N_3P_1 resulted in a greater height under L_3 than under L_2 and L_1 a greater height under L_2 than under L_1 and N_3P_3 resulted in a greater height under L_2 and L_3 than under L_1.

At 13 MAP (December 1992), under L_1 the plants receiving N_2P_2 had a greater height than those receiving N_3P_3. Under L_2; the plants receiving N_2P_1 had a greater height than those receiving N_1P_1 or N_3P_1. Under L_3 too, the plants receiving N_2P_1 had a greater height than those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_2, N_2P_3 and N_3P_1. Among the NP combinations, the plants receiving N_1P_1, N_2P_2, and N_3P_1 had a greater height under L_3 than under L_1 and L_2. The plants receiving N_1P_2 and N_1P_3 had a greater height under L_2 and L_3 than under L_1 and those receiving N_2P_1, N_2P_3, N_3P_2 and N_3P_3 had a greater height under L_3 than under L_2 and L_1 and a greater height under L_2 than under L_1.

4.1.1.1.3. The effect of LPK interaction

A significant interaction between the light intensities and the PK combinations influencing plant height was observed at six, seven, 10, 13 and 14 MAP (May, June, September and December 1992 and January 1993) (Table 10). At six MAP, under L_1 there was no significant difference in height between the plants receiving the various PK combinations.

Table 10. Interaction effects of light with PK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after Planting				
	6	7	10	13	14
$L_1P_1K_1$	55.083	59.083	74.750	90.750	95.917
$L_1P_1K_2$	58.583	63.333	75.417	89.917	94.667
$L_1P_1K_3$	58.250	63.083	80.417	94.167	99.083
$L_1P_2K_1$	57.417	59.750	76.167	91.917	96.583
$L_1P_2K_2$	57.750	62.333	75.333	89.583	93.333
$L_1P_2K_3$	57.583	61.917	76.750	92.833	97.417
$L_1P_3K_1$	58.333	62.833	76.750	88.333	92.667
$L_1P_3K_2$	57.917	61.333	74.333	87.333	90.333
$L_1P_3K_3$	53.000	56.750	67.333	81.000	85.750
$L_2P_1K_1$	60.583	66.167	83.500	108.417	111.583
$L_2P_1K_2$	57.667	63.500	80.333	100.500	107.000
$L_2P_1K_3$	56.833	60.667	79.333	96.667	102.167
$L_2P_2K_1$	60.500	65.500	86.417	109.333	117.250
$L_2P_2K_2$	59.750	64.333	84.833	106.833	112.667
$L_2P_2K_3$	58.750	62.333	81.917	101.167	108.083
$L_2P_3K_1$	61.500	66.917	89.083	114.833	122.833
$L_2P_3K_2$	56.667	61.667	78.083	95.417	102.250
$L_2P_3K_3$	63.250	67.667	88.333	107.500	114.500
$L_3P_1K_1$	61.917	68.083	93.417	124.000	138.500
$L_3P_1K_2$	58.917	64.333	86.333	111.583	125.167
$L_3P_1K_3$	64.333	70.917	95.833	127.250	138.500
$L_3P_2K_1$	68.417	74.167	100.083	132.917	153.250
$L_3P_2K_2$	60.083	65.417	85.250	112.833	129.750
$L_3P_2K_3$	58.833	65.167	87.667	114.583	128.750
$L_3P_3K_1$	57.500	64.583	86.333	114.167	128.333
$L_3P_3K_2$	59.667	65.000	89.083	118.500	134.833
$L_3P_3K_2$	60.417	65.833	90.667	121.750	135.750
F	2.391	2.117	2.038	2.024	2.129
CD (0.05)	5.816	6.525	9.812	13.501	14.462

Under L_2 the plants receiving P_3K_3 had a greater height than those receiving P_1K_3 or P_3K_2. Under L_3 the plants receiving P_1K_3 had a greater height than those receiving P_3K_1. Among the PK combinations, P_1K_3 was found to result in a greater height under L_3 than under L_2, P_2K_1 was found to result in a greater height under L_3 than under L_1 or L_2 and P_3K_3 was found to result in a greater height under L_2 and L_3 than under L_1.

At seven MAP (June 1992), under L_1 the plants receiving P_1K_2 had a greater height than those receiving P_3K_3. Under L_2, the plants receiving P_3K_3 had a greater height than those receiving P_1K_3. Under L_3, the plants receiving P_2K_1 had a greater height than those receiving P_1K_2, P_2K_2, P_2K_3, P_3K_1, P_3K_2 and P_3K_3. Among the PK combinations, P_1K_1, P_2K_1 and P_3K_3 resulted in a greater height under L_2 and L_3 than under L_1 while P_1K_3 resulted in a greater height under L_3 than under L_2.

At 10 MAP (Table 3) under L_1, the plants receiving P_1K_3 had a greater height than those receiving P_3K_3. Under L_2, the plants receiving P_3K_1 had a greater height than those receiving P_3K_2. Under L_3, the plants receiving P_2K_1 had a greater height than those receiving P_1K_2, P_2K_2, P_2K_3, P_3K_1 and P_3K_2.

At 13 MAP, under L_1, there was no significant difference in height between the plants receiving the various PK combinations. Under L_2 the plants receiving P_3K_1 had a greater height than those receiving P_1K_2, P_1K_3, P_2K_3 and P_3K_2. Under L_3, the plants receiving P_2K_1 had a greater height than those receiving P_1K_2, P_2K_2, P_2K_3, P_3K_1 and P_3K_2. Among the PK combinations, P_1K_1, P_2K_1 and P_3K_3 resulted in a greater height under L_3 than under L_2 and L_1 and a greater height under L_2 than under L_1. P_1K_2 and P_2K_3 resulted in a greater height under L_3 than under L_1, P_1K_3 and P_3K_2 resulted in a greater height under L_3 than under L_2 and L_1 and P_2K_2 and P_3K_1 resulted in a greater height under L_2 and L_3 than under L_1.

At 14 MAP (January 1993), (Table 3) under L_1, there was no significant difference in height between the plants receiving the various PK combinations. Under L_2 the plants receiving P_3K_1 had a greater height (122.833cm) than those receiving P_1K_2, P_1K_3, P_2K_3 and P_3K_2. Under L_3, the plants receiving P_2K_1 had a greater height (153.250cm) than those receiving the rest of the PK combinations. P_1K_1, P_2K_1, P_2K_2, P_2K_3, P_3K_1 and P_3K_3 resulted in a greater height under L_2 and L_3 than under L_1 and also a greater height under L_3 than under L_2.

4.1.1.1.4. The effect of LNPK interaction

A significant interaction between light intensities and the NPK combinations influencing the height of plants was observed at four MAP to 14 MAP (March 1992 to January 1993) (Table 11 to 16). At four MAP (March 1992) (Table 11) under L_1, the plants receiving $N_2P_3K_2$ had a greater height than those receiving $N_1P_1K_1$, $N_1P_3K_3$, $N_3P_2K_1$ $N_3P_2K_3$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_1P_3K_3$ were found to have grater height those receiving the rest of the NPK combinations except $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_3K_1$ and $N_3P_3K_1$.

Under L_3, the plants receiving $N_1P_3K_3$ had a greater height than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_3K_2$ and $N_3P_3K_3$. Among the NPK combinations $N_1P_1K_1$ resulted in a greater height under L_2 than under L_1.

Table 11. Interaction effects of light with NPK and culture methods with NP on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon' at four MAP

Treatment	L_1	L_2	L_3	Treatments	
$N_1P_1K_1$	45.250	53.500	49.000	$C_1N_1P_1$	53.278
$N_1P_1K_2$	53.750	49.500	41.250	$C_1N_1P_2$	56.111
$N_1P_1K_3$	51.500	51.500	59.750	$C_1N_1P_3$	53.333
$N_1P_2K_1$	49.500	56.250	52.750	$C_1N_2P_1$	55.333
$N_1P_2K_2$	47.500	55.250	54.750	$C_1N_2P_2$	53.611
$N_1P_2K_3$	53.500	45.250	50.000	$C_1N_2P_3$	51.056
$N_1P_3K_1$	52.000	53.500	51.000	$C_1N_3P_1$	52.167
$N_1P_3K_2$	52.000	51.750	52.500	$C_1N_3P_2$	53.833
$N_1P_3K_3$	46.500	51.750	48.000	$C_1N_3P_3$	56.333
$N_2P_1K_1$	50.250	54.250	53.250	$C_2N_1P_1$	47.833
$N_2P_1K_2$	48.000	48.250	55.000	$C_2N_1P_2$	47.167
$N_2P_1K_3$	48.500	53.000	54.000	$C_2N_1P_3$	48.667
$N_2P_2K_1$	53.250	50.500	56.250	$C_2N_2P_1$	47.889
$N_2P_2K_2$	52.250	51.000	50.500	$C_2N_2P_2$	48.500
$N_2P_2K_3$	48.250	51.250	46.250	$C_2N_2P_3$	50.000
$N_2P_3K_1$	52.250	55.750	49.000	$C_2N_3P_1$	47.667
$N_2P_3K_2$	54.750	49.500	43.750	$C_2N_3P_2$	47.944
$N_2P_3K_3$	47.750	50.750	51.250	$C_2N_3P_3$	47.333
$N_3P_1K_1$	48.500	50.250	49.500	F	3.021
$N_3P_1K_2$	51.000	51.750	51.250	CD(0.05)	3.447
$N_3P_1K_3$	50.250	47.250	49.500		
$N_3P_2K_1$	46.750	50.000	58.000		
$N_3P_2K_2$	51.500	49.500	49.250		
$N_3P_2K_3$	47.000	49.750	56.250		
$N_3P_3K_1$	48.250	55.500	54.000		
$N_3P_3K_2$	48.750	50.750	51.750		
$N_3P_3K_3$	46.000	60.250	51.250		
F	2.408	—	—		
CD (0.05)	7.312	—	—		

$N_1P_1K_2$ and $N_2P_3K_2$ resulted in a greater height under L_1 than under L_3, $N_1P_1K_3$ resulted in a greater height under L_3 than under L_1, $N_1P_2K_3$ resulted in a greater height under L_1 than under L_2 and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At five MAP (April 1992) (Table 12) under L_1 the plants receiving $N_2P_3K_2$ had a greater height than those receiving $N_1P_1K_1$, $N_3P_2K_1$ and $N_3P_3K_3$. Under L_2, the plants receiving $N_3P_3K_3$ had a greater height than those receiving the rest of the NPK combinations excepting $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_3K_1$ and $N_3P_3K_1$. Under L_3, the plants receiving $N_1P_1K_3$ had a greater height than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$. Among the NPK combinations, $N_1P_1K_1$ resulted in a greater height under L_2 than under L_1, $N_1P_1K_3$ and $N_3P_2K_1$ resulted in a greater height under L_2 or L_3 than under L_1 and $N_2P_1K_2$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1.

At six MAP (May 1992) (Table 12) under L_1, the plants receiving $N_2P_2K_1$ and $N_2P_3K_2$ had a greater height than those receiving $N_1P_1K_1$ and $N_3P_3K_3$. Under L_2, the plants receiving $N_3P_3K_3$ had a greater height than those receiving the rest of the NPK combinations excepting $N_1P_1K_1$, $N_1P_2K_2$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_3K_1$ and $N_3P_3K_1$. Under L_3, the plants receiving $N_3P_2K_1$ had a greater height than those receiving the other combinations excepting $N_1P_1K_1$, $N_1P_2K_2$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_3K_1$ and $N_3P_3K_1$. Under L_3, the plants receiving $N_3P_2K_1$ had a greater height than those receiving the other combinations excepting $N_1P_1K_3$, $N_1P_2K_2$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_2K_1$ and $N_3P_2K_3$.

Table 12. Interaction effects of light and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	5 MAP			6 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	48.250	58.250	53.750	51.500	61.500	59.750
$N_1P_1K_2$	56.750	53.250	46.750	60.000	56.250	49.500
$N_1P_1K_3$	54.250	53.500	66.000	57.250	55.500	71.750
$N_1P_2K_1$	52.500	60.500	58.000	56.000	65.500	62.750
$N_1P_2K_2$	50.500	59.500	60.500	54.250	63.000	65.500
$N_1P_2K_3$	57.250	55.000	53.500	61.750	59.250	57.250
$N_1P_3K_1$	54.250	56.000	56.250	57.000	59.750	60.000
$N_1P_3K_2$	55.500	54.750	57.250	59.000	58.750	61.750
$N_2P_3K_3$	50.750	56.500	52.250	57.000	60.500	56.750
$N_2P_1K_1$	53.000	57.750	59.750	56.750	61.500	63.500
$N_2P_1K_2$	53.000	53.250	61.500	57.500	58.000	69.000
$N_2P_1K_3$	53.750	58.000	59.000	56.000	62.000	64.500
$N_2P_2K_1$	57.000	52.500	62.000	62.250	57.500	69.000
$N_2P_2K_2$	56.000	54.500	53.500	61.250	59.250	57.000
$N_2P_2K_3$	52.750	54.250	49.750	56.500	57.250	53.000
$N_2P_3K_1$	55.250	59.500	51.000	59.500	60.750	49.500
$N_2P_3K_2$	58.500	53.000	49.500	62.250	56.250	54.000
$N_2P_3K_3$	51.000	53.750	56.000	54.000	59.250	62.500
$N_3P_1K_1$	52.750	54.250	56.500	57.000	58.750	62.500
$N_3P_1K_2$	53.750	54.750	55.000	58.250	58.750	58.250
$N_3P_1K_3$	56.750	50.000	53.000	61.500	53.000	56.750
$N_3P_2K_2$	50.000	54.000	65.750	54.000	58.500	73.500
$N_3P_2K_3$	54.500	52.750	53.000	57.750	57.000	57.750
$N_3P_2K_3$	51.000	55.500	61.500	54.500	59.750	66.250
$N_3P_3K_1$	52.000	59.250	58.500	58.500	64.000	63.000
$N_3P_3K_2$	50.750	54.000	56.750	52.500	55.000	63.250
$N_3P_3K_3$	49.000	64.500	56.750	48.000	70.000	62.000
F	2.233	—	—	2.175	—	—
CD (0.05)	8.467	—	—	10.074	—	—

Among the NPK combinations, $N_1P_1K_2$ resulted in a greater height under L_1 than under L_3, $N_1P_1K_3$ and $N_3P_2K_1$ resulted in a greater height under L_3 than under L_1 and L_2. $N_1P_2K_2$, $N_3P_2K_2$ and $N_3P_3K_2$ resulted in a greater height under L_3 than under L_1 and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At seven MAP (June 1992) (Table 13) under L_1, the plants receiving $N_2P_2K_2$ had a greater height than those receiving $N_1P_1K_1$, $N_3P_2K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_3K_3$ had a greater height than those receiving $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_3K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_2K_3$ and $N_3P_3K_2$. Under L_3, the plants receiving $N_1P_1K_3$ and $N_3P_2K_1$ had a greater height than those receiving the other combinations except $N_1P_2K_2$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_1$, $N_3P_2K_3$ and $N_3P_3K_2$. Among the combinations, $N_1P_1K_1$ and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1, $N_1P_1K_2$ resulted in a greater height under L_1 than under L_3, $N_1P_1K_3$ and $N_3P_2K_1$ resulted in a greater height under L_3 than under L_1 and L_2 and $N_1P_2K_2$, $N_2P_1K_2$, $N_2P_3K_3$, $N_3P_2K_3$ and $N_3P_3K_2$ resulted in a greater height under L_3 than under L_1.

At eight MAP (July 1992) (Table 13) under L_1 the plants receiving $N_2P_2K_1$ had a greater height than those receiving $N_1P_1K_1$, $N_3P_2K_1$ and $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_3K_3$ had a greater height than those receiving $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_2$, $N_2P_1K_2$, $N_2P_2K_3$, $N_2P_3K_2$, $N_3P_1K_3$, $N_3P_2K_2$ and $N_3P_2K_3$. Under L_3, the plants receiving $N_3P_2K_1$ had a greater height than those receiving $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_2K_1$, $N_3P_2K_2$ and $N_3P_1K_3$.

Table 13. Interaction effects of light and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	7 MAP			8 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	54.500	66.750	68.500	58.000	70.000	78.000
$N_1P_1K_2$	65.000	63.000	52.500	68.750	65.750	57.750
$N_1P_1K_3$	63.500	58.250	80.500	69.500	66.250	87.750
$N_1P_2K_1$	59.250	70.250	67.500	64.000	77.000	74.500
$N_1P_2K_2$	57.500	67.750	71.250	61.750	75.500	77.500
$N_1P_2K_3$	66.750	65.000	62.750	72.250	68.750	69.000
$N_1P_3K_1$	61.250	63.250	64.750	64.500	69.000	70.250
$N_1P_3K_2$	62.750	63.000	65.250	66.000	67.000	71.750
$N_1P_3K_3$	63.000	64.750	60.750	68.500	69.750	67.500
$N_2P_1K_1$	60.500	68.250	67.250	66.000	74.000	75.250
$N_2P_1K_2$	62.500	62.250	77.250	68.000	67.750	87.750
$N_2P_1K_3$	59.500	66.500	70.250	66.250	73.000	83.250
$N_2P_2K_1$	63.000	62.250	74.250	73.500	70.500	79.500
$N_2P_2K_2$	68.000	64.000	61.750	70.250	70.750	67.250
$N_2P_2K_3$	60.250	59.500	60.000	63.500	63.500	66.000
$N_2P_3K_1$	62.500	68.000	60.000	67.000	74.500	67.500
$N_2P_3K_2$	66.000	59.750	58.750	72.000	67.250	64.500
$N_2P_3K_3$	57.250	63.500	69.000	59.750	69.000	78.000
$N_3P_1K_1$	62.250	63.500	68.500	69.000	69.000	75.250
$N_3P_1K_2$	62.500	65.250	63.250	63.000	70.500	67.000
$N_3P_1K_3$	66.250	57.250	62.000	72.500	63.250	68.750
$N_3P_2K_1$	57.000	64.000	80.750	57.750	70.750	88.000
$N_3P_2K_2$	61.500	61.250	63.250	63.500	67.250	69.500
$N_3P_2K_3$	58.750	62.500	72.750	63.000	67.500	81.750
$N_3P_3K_1$	64.750	69.500	69.000	70.000	76.250	75.250
$N_3P_3K_2$	55.250	62.250	71.000	57.500	69.000	77.750
$N_3P_3K_3$	50.000	74.750	67.750	51.750	82.000	73.250
F	2.513	—	—	2.020	—	—
CD (0.05)	11.302	—	—	13.791	—	—

Among the combinations, $N_1P_1K_1$, $N_1P_2K_2$, $N_2P_1K_3$, $N_2P_3K_3$, $N_3P_2K_1$ and $N_3P_3K_2$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_2P_1K_2$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1 and L_2, $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1, $N_1P_1K_3$, $N_2P_1K_2$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1 and L_2 and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At nine MAP (August 1992) (Table 14) under L_1, the plants receiving $N_3P_1K_3$ had a greater height (80.250cm) than those receiving $N_1P_1K_1$, $N_2P_3K_3$, $N_3P_2K_1$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 those receiving $N_3P_3K_3$ had a greater height (90.750cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_2K_3$ $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_3$, $N_3P_2K_1$, $N_3P_2K_2$ and $N_3P_2K_3$. Under L_2, the plants receiving $N_2P_1K_2$ had a greater height than those receiving $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_2$, $N_3P_1K_3$ $N_3P_2K_2$, $N_3P_1K_1$ and $N_3P_3K_3$. Among the combinations, $N_1P_1K_1$ $N_1P_2K_1$, $N_1P_2K_2$, $N_2P_1K_2$, $N_2P_1K_3$ and $N_2P_3K_3$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_3P_2K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1 and L_2, $N_3P_3K_2$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_3P_2K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1 and L_2 and $N_3P_3K_2$ resulted in a greater height under L_3 than under L_2 and L_1 and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At 10 MAP (September 1992) (Table 14) under L_1, the plants receiving $N_2P_2K_1$ had a greater height (86.750cm) than those receiving $N_2P_3K_3$, $N_3P_2K_1$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 those receiving $N_3P_3K_3$ had a greater height (99.000cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_2$, $N_2P_2K_3$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_2$ $N_3P_1K_3$, and $N_3P_3K_2$.

Table 14. Interaction effects of light and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	9 MAP			10 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	61.750	74.500	85.250	70.250	79.750	92.500
$N_1P_1K_2$	72.750	71.500	62.500	77.750	78.500	67.500
$N_1P_1K_3$	75.000	71.000	98.000	80.250	77.250	108.500
$N_1P_2K_1$	69.750	84.250	84.750	73.500	90.000	95.500
$N_1P_2K_2$	66.250	79.750	85.250	71.000	85.750	94.250
$N_1P_2K_3$	77.250	75.750	76.250	81.750	86.750	84.000
$N_1P_3K_1$	69.250	74.000	77.750	72.750	83.500	85.750
$N_1P_3K_2$	70.250	72.250	78.000	75.250	77.000	86.500
$N_1P_3K_3$	75.500	70.750	73.250	79.500	85.000	78.750
$N_2P_1K_1$	72.500	80.750	85.000	78.000	86.250	96.750
$N_2P_1K_2$	72.500	71.750	98.750	77.000	80.500	109.500
$N_2P_1K_3$	70.750	82.000	89.000	75.750	89.250	96.250
$N_2P_2K_1$	79.250	77.500	89.750	86.750	85.500	100.250
$N_2P_2K_2$	77.500	78.000	73.000	83.750	85.750	80.250
$N_2P_2K_3$	67.500	69.000	72.250	72.750	74.000	80.500
$N_2P_3K_1$	72.000	82.000	74.750	76.750	90.250	81.000
$N_2P_3K_2$	76.750	72.000	72.500	83.750	77.250	81.000
$N_2P_3K_3$	62.000	73.750	88.750	64.250	81.000	100.750
$N_3P_1K_1$	72.250	78.250	84.500	76.000	84.500	91.000
$N_3P_1K_2$	67.500	76.500	72.500	71.500	82.000	82.000
$N_3P_1K_3$	80.250	66.500	75.250	85.250	71.500	82.750
$N_3P_2K_1$	63.250	75.000	96.500	68.250	83.750	104.500
$N_3P_2K_2$	66.250	73.500	76.000	71.250	83.000	81.250
$N_3P_2K_3$	70.250	74.750	91.000	75.750	85.000	98.500
$N_3P_3K_1$	75.750	85.000	81.500	80.750	93.500	92.250
$N_3P_3K_2$	60.500	76.250	87.000	64.000	80.000	99.750
$N_3P_3K_3$	54.000	90.750	82.250	58.250	99.000	92.500
F	2.502	—	—	2.568	—	—
CD (0.05)	15.079	—	—	16.995	—	—

Under L_3, the plants receiving $N_2P_1K_2$ had a greater height (109.500cm) than those receiving the NPK combinations except $N_1P_1K_3$, $N_1P_2K_1$, $N_1P_2K_2$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_2K_1$, $N_2P_3K_3$, $N_3P_2K_1$, $N_3P_2K_3$, and $N_3P_3K_2$. Among the combinations, $N_1P_1K_1$, $N_1P_2K_1$, $N_2P_1K_1$, $N_2P_1K_3$, $N_3P_2K_3$ and $N_3P_3K_2$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_2P_1K_2$, $N_2P_3K_3$ and $N_3P_2K_1$ resulted in a greater height under L_3 than under L_1 and L_2, $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At 11 MAP (October 1992) (Table 15) under L_1, the plants receiving $N_2P_2K_1$ had a greater height (94.000cm) than those receiving $N_2P_3K_3$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_3K_3$ had a greater height (106.750cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$, $N_1P_3K_2$, $N_2P_2K_3$, $N_2P_3K_2$, $N_3P_1K_3$, and $N_3P_3K_2$. Under L_3, the plants receiving $N_1P_1K_3$ and $N_2P_1K_2$ had a greater height (118.750cm) than those receiving $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_2$, $N_2P_1K_3$ and $N_3P_2K_2$. Among the NPK combinations, $N_1P_1K_1$ $N_1P_2K_1$, $N_1P_2K_2$, $N_2P_1K_1$, $N_2P_1K_3$, $N_3P_1K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_2P_1K_2$ $N_2P_3K_3$ and $N_3P_2K_1$ resulted in a greater height under L_3 than under L_2 or L_1, $N_2P_2K_1$ resulted in a greater height under L_3 than under L_2, $N_3P_3K_2$ resulted in a greater height under L_3 than under L_2 and L_1 and also a greater height under L_2 than under L_1 and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1.

At 12 MAP (November 1992) (Table 15) under L_1, the plants receiving $N_2P_2K_2$ had a greater height (98.500cm) than those receiving $N_2P_3K_3$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_3K_3$ had a greater height (113.000cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$, $N_1P_3K_2$, $N_2P_2K_3$, $N_2P_3K_2$ and $N_3P_1K_3$.

Table 15. Interaction effects of light and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	11 MAP			12 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	77.250	84.000	100.000	80.500	88.500	108.750
$N_1P_1K_2$	82.000	85.000	73.750	85.000	93.500	81.250
$N_1P_1K_3$	85.750	83.750	118.750	88.500	86.750	132.000
$N_1P_2K_1$	80.500	98.000	103.250	83.000	104.000	111.500
$N_1P_2K_2$7	75.500	95.000	105.250	80.000	100.000	117.750
$N_1P_2K_3$	86.000	92.750	92.250	88.500	99.250	103.250
$N_1P_3K_1$	76.750	91.500	93.750	79.750	102.000	104.750
$N_1P_3K_2$	79.500	81.500	97.500	81.500	87.500	107.250
$N_1P_3K_3$	84.500	92.500	87.250	87.000	99.250	95.500
$N_2P_1K_1$	84.000	95.000	106.500	88.250	104.750	119.000
$N_2P_1K_2$	81.750	89.000	118.750	88.750	94.000	115.000
$N_2P_1K_3$	81.000	99.000	106.500	863.500	107.750	117.500
$N_2P_2K_1$	94.000	92.500	113.250	98.000	101.750	125.500
$N_2P_2K_2$	92.000	90.250	87.750	98.500	100.250	98.000
$N_2P_2K_3$	78.500	80.500	89.000	81.500	87.000	98.250
$N_2P_3K_1$	80.000	97.000	87.000	82.500	103.250	93.000
$N_2P_3K_2$	89.250	83.000	89.250	94.000	88.500	96.000
$N_2P_3K_3$	69.000	88.750	112.750	72.250	94.250	123.000
$N_3P_1K_1$	80.250	91.000	100.250	84.250	99.000	110.250
$N_3P_1K_2$	76.750	88.500	88.750	80.000	94.000	97.250
$N_3P_1K_3$	90.750	76.750	90.750	95.500	81.750	98.500
$N_3P_2K_1$	74.500	91.750	113.750	79.250	98.500	126.250
$N_3P_2K_2$	76.000	90.000	87.750	77.750	95.750	95.250
$N_3P_2K_3$	83.500	92.750	106.500	90.750	98.500	114.250
$N_3P_3K_1$	84.750	100.500	103.500	88.000	109.500	114.000
$N_3P_3K_2$	66.250	86.750	106.750	69.000	92.000	118.500
$N_3P_3K_3$	64.500	106.750	101.500	69.250	113.000	110.000
F	2.346	—	—	2.013	—	—
CD (0.05)	19.086	—	—	21.222	—	—

Under L_3, the plants receiving $N_1P_1K_3$ had a greater height (132.000cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_1K_3$ $N_3P_2K_2$ and $N_3P_3K_3$. Among the combinations, $N_1P_1K_1$ $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_2$, $N_2P_1K_1$ $N_2P_1K_2$, $N_2P_1K_3$, $N_3P_1K_1$, $N_3P_2K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1, $N_1P_1K_3$, $N_2P_2K_1$ and $N_2P_3K_3$ resulted in a greater height under L_3 than under L_1 and L_2, $N_1P_3K_1$, $N_3P_3K_1$ and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1. $N_3P_3K_2$ resulted in a greater height under L_3 than under L_2 and L_1 and a greater height under L_2 than under L_1.

At 13 MAP (December 1992) (Table 16) under L_1, the plants receiving $N_2P_2K_2$ had a greater height (105.750cm) than those receiving $N_2P_3K_3$, $N_3P_2K_2$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_2P_1K_3$ had a greater height (127.250cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_2$, $N_2P_1K_2$, $N_2P_2K_3$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_1K_3$ and $N_3P_3K_2$. Under L_3, the plants receiving $N_1P_1K_3$ had a greater height (142.500cm) than those receiving $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_2$, $N_3P_1K_3$, and $N_3P_2K_2$. Among the combinations, $N_1P_1K_1$, $N_1P_1K_3$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_1$ $N_1P_3K_2$, $N_3P_1K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_3K_3$, $N_3P_2K_2$, $N_3P_3K_1$ and $N_3P_3K_2$ resulted in a greater height under L_2 and L_3 than under L_1, $N_2P_1K_2$, $N_2P_2K_1$ and $N_3P_2K_1$ resulted in a greater height under L_3 than under L_2 and L_1, $N_2P_2K_3$ resulted in a greater height under L_3 than under L_1 and $N_3P_3K_3$ resulted in a greater height under L_3 than under L_2 and L_1 and a greater height under L_2 than under L_1.

Table 16. Interaction effects of light and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	13 MAP			14 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	86.750	94.000	118.500	93.250	100.750	126.750
$N_1P_1K_2$	89.500	100.250	88.000	92.750	105.750	95.750
$N_1P_1K_3$	91.500	90.250	142.500	96.000	97.500	152.500
$N_1P_2K_1$	87.00	112.250	123.500	89.500	120.000	143.750
$N_1P_2K_2$	83.000	105.500	125.750	86.000	111.000	148.250
$N_1P_2K_3$	93.250	105.750	113.000	99.500	113.500	126.000
$N_1P_3K_1$	82.750	112.000	115.250	86.250	119.250	131.250
$N_1P_3K_2$	89.750	95.000	116.750	91.750	103.000	131.250
$N_2P_3K_3$	92.500	105.000	105.750	98.250	112.500	116.500
$N_2P_1K_1$	93.000	127.250	132.500	97.000	123.000	152.500
$N_2P_1K_2$	95.000	100.250	141.250	99.750	106.750	158.500
$N_2P_1K_3$	89.500	113.250	130.750	94.250	118.000	139.500
$N_2P_2K_1$	102.750	109.500	138.250	107.500	120.250	162.500
$N_2P_2K_2$	105.750	108.250	107.250	110.000	114.000	119.750
$N_2P_2K_3$	88.500	93.000	107.250	93.750	99.750	123.000
$N_2P_3K_1$	87.750	113.250	101.250	91.750	122.500	109.500
$N_2P_3K_2$	99.000	92.500	106.500	103.000	98.000	123.250
$N_2P_3K_3$	75.500	99.750	138.250	78.750	106.250	155.000
$N_3P_1K_1$	92.500	104.000	121.000	97.500	111.000	136.250
$N_3P_1K_2$	85.250	101.000	105.500	91.500	108.500	121.250
$N_3P_1K_3$	101.500	86.500	108.500	107.000	91.000	123.500
$N_3P_2K_1$	86.000	106.250	137.000	92.750	111.500	153.500
$N_3P_2K_2$	80.000	106.750	105.500	84.000	113.000	121.250
$N_3P_2K_3$	96.750	104.750	123.500	99.000	111.000	137.250
$N_3P_3K_1$	94.500	119.250	126.000	100.000	126.750	144.250
$N_3P_3K_2$	73.250	98.750	132.250	76.250	105.750	150.000
$N_3P_3K_3$	75.000	117.750	121.250	80.250	124.750	135.750
F	2.202	—	—	2.505	—	—
CD (0.05)	23.384	—	—	25.049	—	—

At 14 MAP (January 1993) (Table 16) under L_1, the plants receiving $N_2P_2K_2$ had a greater height (110.000cm) than those receiving $N_2P_3K_3$, $N_3P_2K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_3K_1$ had a greater height (126.750cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$, $N_2P_2K_3$, $N_2P_3K_2$ and $N_3P_1K_3$. Under L_3, the plants receiving $N_2P_2K_2$ had a greater height (162.500cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_1$, $N_3P_1K_2$ $N_3P_1K_3$ $N_3P_2K_2$ $N_3P_2K_3$ and $N_3P_3K_3$. Among the NPK combinations, $N_1P_1K_1$, $N_1P_2K_2$, $N_1P_3K_2$, $N_2P_1K_2$, $N_2P_1K_3$ $N_2P_2K_3$, $N_3P_1K_2$ $N_3P_2K_1$ and $N_3P_2K_3$ resulted in a greater height under L_3 than under L_1, $N_2P_1K_1$, $N_2P_2K_1$, $N_3P_2K_2$, $N_3P_3K_1$, and $N_3P_3K_3$ resulted in a greater height under L_2 and L_3 than under L_1, $N_1P_1K_3$ and $N_3P_1K_1$ resulted in a greater height under L_3 than under L_2 and L_1, $N_1P_3K_1$, $N_2P_3K_3$ and $N_3P_3K_2$ resulted in a greater height under L_2 than under L_1 and a greater height under L_3 than under L_2.

4.1.1.1.5. The effect of LCPK interaction

The effect of interaction between light intensities culture methods and the PK combinations was significant at five and seven MAP (April and June 1992) (Table 17).

During April 1992 under L_1C_1 the plants receiving P_2K_3 and P_3K_1 had a greater height than those receiving P_1K_1. Under L_1C_2 the plants receiving P_3K_2 had a greater height than those receiving P_2K_3. Under L_2C_1 the plants receiving P_3K_1 had a greater height than those receiving P_3K_2. Under L_3C_1 the plants receiving P_2K_1 had a greater height than those receiving the other combinations except P_1K_3. Under L_2C_2 and L_3C_2 there was no significant difference in height between the plants receiving the various PK combinations.

Table 17. 'Interaction effects of light with culture methods and PK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	5 MAP			7 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1P_1K_1$	51.667	60.667	60.000	59.833	71.333	73.500
$C_1P_1K_2$	57.000	58.667	59.333	70.000	70.500	70.833
$C_1P_1K_3$	57.167	58.333	66.167	69.000	66.333	81.500
$C_1P_2K_1$	54.667	60.000	72.000	61.833	73.000	87.500
$C_1P_2K_2$	58.000	61.333	57.500	69.167	73.000	68.000
$C_1P_2K_3$	59.333	58.500	56.833	71.167	67.500	67.500
$C_1P_3K_1$	59.000	64.500	60.167	71.333	75.500	72.167
$C_1P_3K_2$	54.333	56.500	58.167	62.500	66.667	69.500
$C_1P_3K_3$	53.167	61.667	58.500	60.667	74.000	70.500
$C_2P_1K_1$	51.000	52.833	53.333	58.333	61.000	62.667
$C_2P_1K_2$	52.000	48.833	49.500	56.667	56.500	57.833
$C_2P_1K_3$	52.667	49.333	52.500	57.167	55.000	60.333
$C_2P_2K_1$	51.667	51.333	51.833	57.667	58.000	60.833
$C_2P_2K_2$	49.333	49.833	53.833	55.500	55.667	62.833
$C_2P_3K_3$	48.000	51.333	53.000	52.667	57.167	62.833
$C_2P_3K_1$	48.667	52.000	50.333	54.333	58.333	57.000
$C_2P_3K_2$	55.500	51.333	50.833	60.167	56.667	60.500
$C_3P_3K_3$	47.333	54.833	51.500	52.833	61.333	61.167
F	1.986	—	—	2.020	—	—
CD (0.05)	6.913	—	—	9.228	—	—

At seven MAP (June 1992), under L_1C_1 the plants receiving P_3K_1 had a greater height (71.333cm) than those receiving P_1K_1, P_2K_1 and P_3K_3. Under L_3C_1 the plants receiving P_2K_1 had a greater height (87.500cm) than those receiving the other PK combinations except P_1K_3. Under L_1C_2, L_2C_1, L_2C_2 and L_3C_2 there was no significant difference in height between the plants receiving the various PK combinations. Under L_2C_1 and L_3C_1, P_1K_1 and P_3K_3 resulted in a greater height than under L_1C_1. Under L_3C_1, P_1K_3 and P_2K_1 resulted in a greater height than under L_1C_1 and L_2C_1. P_2K_1 too resulted in a greater height under L_2C_1 than under L_1C_1.

4.1.1.1.6. The effect of LCNPK interaction

A significant interaction between light intensities, culture methods and the NPK combinations influencing plant height was observed at four and five MAP (March and April 1992) (Table 18 and 19).

During March 1992 (Table 18) under L_1C_1, the plants receiving $N_1P_2K_3$ had a greater height (62.000cm) than those receiving the other combinations excepting $N_1P_1K_2$, $N_1P_3K_1$, $N_2P_2K_1$, $N_2P_2K_2$, $N_2P_3K_1$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$ and $N_3P_3K_2$.

Under L_1C_2 the plants receiving $N_2P_3K_2$ had a greater height (58.000cm) than those receiving $N_1P_1K_1$, $N_1P_2K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_3$, $N_3P_1K_3$, $N_3P_2K_1$, $N_3P_2K_2$, $N_3P_2K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$.

Under L_2C_1 the plants receiving $N_3P_3K_3$ had a greater height (67.500cm) than those receiving the other combinations excepting $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_1$, $N_2P_3K_1$ and $N_3P_1K_2$.

Table 18. Interaction effects of light with culture methods and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon' at four MAP

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	45.00	45.500	58.500	48.500	50.500	47.500
$N_1P_1K_2$	53.500	54.000	53.000	46.000	45.000	37.500
$N_1P_1K_3$	51.500	51.500	55.500	47.500	67.000	52.500
$N_1P_2K_1$	48.000	51.000	62.500	50.000	60.500	45.000
$N_1P_2K_2$	47.500	47.500	63.000	47.500	62.500	47.000
$N_1P_2K_3$	62.000	45.000	50.000	40.500	49.000	51.000
$N_1P_3K_1$	58.500	45.500	61.500	45.500	51.000	51.000
$N_1P_3K_2$	49.500	54.500	53.000	50.500	58.500	46.500
$N_2P_3K_3$	47.000	46.000	53.500	50.000	47.500	48.500
$N_2P_1K_1$	50.500	50.000	55.500	53.000	60.500	46.000
$N_2P_1K_2$	50.000	46.000	48.500	48.000	65.000	45.500
$N_2P_1K_3$	51.000	46.000	57.000	49.000	60.000	48.000
$N_2P_2K_1$	54.000	52.500	53.000	48.000	60.000	46.500
$N_2P_2K_2$	55.000	49.500	54.000	48.000	50.000	51.000
$N_2P_2K_3$	51.500	45.000	53.000	49.500	46.000	46.500
$N_2P_3K_1$	56.500	48.000	60.000	51.500	49.500	48.500
$N_2P_3K_2$	51.500	58.000	49.000	50.000	41.500	46.000
$N_2P_3K_3$	49.000	46.500	49.000	52.500	53.500	49.000
$N_3P_1K_1$	48.000	49.000	54.000	46.500	50.000	49.000
$N_3P_1K_2$	52.000	50.000	58.000	45.500	54.00	48.500
$N_3P_1K_3$	54.000	46.500	49.000	45.500	50.500	48.500
$N_3P_2K_1$	48.500	45.000	51.500	48.500	63.500	52.500
$N_3P_2K_2$	58.000	45.000	53.500	45.500	47.000	51.500
$N_3P_2K_3$	46.500	47.500	53.500	46.000	62.500	50.000
$N_3P_3K_1$	49.000	47.500	58.500	52.500	62.500	45.500
$N_3P_3K_2$	52.500	45.000	55.000	46.500	58.500	45.000
$N_3P_3K_3$	46.000	46.000	67.500	53.000	57.500	45.000
F	1.695	—	—	—	—	—
CD (0.05)	10.341	—	—	—	—	—

Table 19. Interaction effects of light with culture methods and NPK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon' at five MAP.

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	48.500	48.000	65.500	51.000	55.000	52.500
$N_1P_1K_2$	57.000	56.500	59.000	47.500	46.500	47.000
$N_1P_1K_3$	54.500	54.000	57.000	50.000	76.500	55.500
$N_1P_2K_1$	51.000	54.000	67.000	54.000	68.000	48.000
$N_1P_2K_2$	52.000	49.000	69.000	50.000	68.500	52.500
$N_1P_2K_3$	68.000	46.500	56.000	54.000	54.000	53.000
$N_1P_3K_1$	61.500	47.000	65.000	47.000	58.500	54.000
$N_1P_3K_2$	53.000	58.000	56.500	53.000	62.500	52.000
$N_1P_3K_3$	53.500	48.000	59.000	54.000	52.500	52.000
$N_2P_1K_1$	53.000	53.000	59.000	56.500	64.500	55.000
$N_2P_1K_2$	58.000	48.000	55.500	51.000	74.000	49.000
$N_2P_1K_3$	54.500	53.000	64.500	51.500	67.000	51.000
$N_2P_2K_1$	60.000	54.000	56.000	49.000	74.000	50.000
$N_2P_2K_2$	59.000	53.000	58.000	51.000	53.000	54.000
$N_2P_2K_3$	58.000	47.500	56.500	52.000	47.500	52.000
$N_2P_3K_1$	62.000	48.500	64.500	54.500	53.500	48.500
$N_2P_3K_2$	55.500	61.500	53.000	53.000	48.500	50.500
$N_2P_3K_3$	54.000	48.000	52.500	55.000	59.000	53.000
$N_3P_1K_1$	53.500	52.000	57.500	51.000	60.500	52.500
$N_3P_1K_2$	56.000	51.500	61.500	48.000	57.500	52.500
$N_3P_1K_3$	62.500	51.000	53.500	46.500	55.000	51.000
$N_3P_2K_1$	53.000	47.000	57.000	51.000	74.000	57.500
$N_3P_2K_2$	63.000	46.000	57.000	48.500	51.000	55.000
$N_3P_2K_3$	52.000	50.000	63.000	48.000	69.000	54.000
$N_3P_3K_1$	53.500	50.500	64.000	54.500	68.500	48.500
$N_3P_3K_2$	54.500	47.000	60.000	48.000	63.500	50.000
$N_3P_3K_3$	52.000	46.000	73.500	55.500	64.000	49.500
F	1.781	—	—	—	—	—
CD (0.05)	11.974	—	—	—	—	—

Under L_2C_2 the plants receiving $N_2P_1K_1$ and $N_3P_3K_3$ had a greater height (53.000cm) than those receiving $N_1P_2K_3$. Under L_3C_1, the plants receiving $N_1P_1K_3$ had a greater height (67.000cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$ and $N_3P_1K_3$. UnderL_3C_2 the plants receiving $N_1P_1K_3$ and $N_3P_2K_1$ had a greater height (52.500cm) than those receiving $N_1P_1K_1$.

At five MAP (April 1992) (Table 19) under L_1C_1 the plants receiving $N_1P_2K_3$ had a greater height (68.000cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_2K_1$, $N_3P_2K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2C_1 the plants receiving $N_3P_3K_3$ had a greater height (73.500cm) than those receiving $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_2K_3$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_1$, $N_3P_2K_2$ and $N_3P_3K_2$.

Among the L_3C_1 plants, those receiving $N_1P_1K_3$ had a greater height (76.500cm) than those receiving the other combinations except $N_1P_2K_1$, $N_1P_2K_2$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_1$, $N_3P_2K_1$, $N_3P_2K_3$, $N_3P_2K_3$ and $N_3P_3K_1$.

4.1.1.1.7. The effect of the culture method treatments

The effect of the culture method treatments on plant height was significant throughout the period under observation from four MAP to 14 MAP (March 1992 to January 1993) (Table 7). The C_1 plants recorded a greater height than the C_2 plants during the period. The difference in mean height between the two groups during March 1992 was 5.784cm and during January 1993 it was 28.796cm.

4.1.1.1.8. The effect of CNP interaction

A significant interaction between the culture method treatments and the NP combinations received by the plants was observed to influence plant height at four MAP (March 1992) (Table 11). Among the C_1 plants those receiving N_1P_2 and N_3P_3 had a greater height (56.111 and 56.333cm respectively) than those receiving N_2P_3 and N_3P_1. There was no significant difference in height between the C_2 plants receiving the various NP combinations. All the combinations except N_2P_2 resulted in a greater height under C_1 than under C_2. There was no significant difference in height between the C_1 and C_2 plants receiving N_2P_2.

4.1.1.1.9. The effect of CPK interaction

A significant interaction between the culture method treatments and the PK combinations was observed from 6 MAP and 10 MAP (May to September 1992) (Table 20).

During May 1992, the C_1 plants receiving P_2K_2 had a greater height (69.167cm) than those receiving P_1K_1, P_1K_2, P_2K_2 P_2K_3, P_3K_2 and P_3K_3. There was no significant difference in height between the C_2 plants receiving the various PK combinations. All the combinations except P_3K_3 resulted in a greater height under C_1 than under C_2. There was no significant difference in height between the C_1 and C_2 plants receiving P_3K_2.

During June 1992, the C_1 plants receiving P_2K_2 had a greater height (74.111cm) than those receiving P_1K_1, P_2K_3, P_3K_2 and P_3K_3. There was no significant difference in height between the C_2 plants receiving the various PK combinations. The C_1 plants receiving the various PK combinations had a greater height than the C_2 plants.

Table 20. Interaction effects of culture methods with PK on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	MAP				
	6	7	8	9	10
$C_1P_1K_1$	62.167	68.222	74.833	83.222	90.278
$C_1P_1K_2$	64.000	70.444	76.389	83.778	91.444
$C_1P_1K_3$	65.778	72.278	80.833	88.778	96.611
$C_1P_2K_1$	69.167	74.111	81.944	91.278	100.833
$C_1P_2K_2$	64.278	70.056	75.333	82.722	91.278
$C_1P_2K_3$	63.111	68.722	74.778	82.778	90.944
$C_1P_3K_1$	66.389	73.000	80.444	87.889	96.278
$C_1P_3K_2$	60.444	66.222	72.389	79.111	86.556
$C_1P_3K_3$	62.889	68.389	74.778	80.056	88.556
$C_2P_1K_1$	56.222	60.667	66.167	71.167	77.500
$C_2P_1K_2$	52.778	57.000	60.556	64.278	69.944
$C_2P_1K_3$	53.833	57.500	63.722	68.500	73.778
$C_2P_2K_1$	55.056	58.833	63.722	68.722	74.278
$C_2P_2K_2$	54.111	58.000	63.167	67.389	72.333
$C_2P_2K_3$	53.667	57.556	61.944	67.000	73.278
$C_2P_3K_1$	51.833	56.556	60.500	65.889	71.833
$C_3P_3K_2$	55.722	59.111	63.778	68.778	74.444
$C_2P_3K_3$	54.889	58.444	62.889	69.056	75.667
F	3.065	2.616	2.593	2.560	2.621
CD (0.05)	4.749	5.328	6.501	7.108	8.011

During July 1992 too, the C_1 plants receiving P_2K_1 had a greater height (81.944cm) than those receiving P_1K_1, P_2K_2, P_2K_3, P_3K_2 and P_3K_3. There was no significant difference in height between the C_2 plants receiving the various PK combinations. As in the previous month, the C_1 plants receiving the various PK combinations had a greater height than the C_2 plants.

During August 1992 (Table 20) the C_1 plants receiving P_2K_1 had a greater height (91.278cm) than those receiving P_1K_1, P_1K_2, P_2K_2, P_2K_3 and P_3K_2. The C_1 plants had a greater height than than C_2 plants as in the previous month and there was no significant difference in height between the C_2 plants receiving the various PK combinations.

During September 1992, among the C_1 plants, those receiving P_2K_1 had a greater height (100.833cm) than those receiving P_1K_1, P_1K_2, P_2K_2, P_2K_3, P_3K_2 and P_3K_3. There was no significant difference in height between the C_2 plants receiving the various PK combinations and all the combinations resulted in a greater height in the C_1 plants than in the C_2 plants.

4.1.1.1.10. The effect of nutrients and their interactions

The direct effect of the K doses on plant height was significant from nine MAP and 14 MAP (August 1992 to January1993) (Table 21). During the period, the plants receiving K_1 recorded a greater height than those receiving K_2. The height increment observed in the K_2 plants over the K_1 plants during August was 3.685cm and it was increased to 7.435cm during December. During January 1993, the K_1 plants were found to have a greater height than the K_2 and K_3 plants.

Table 21. Effect of K on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting					
	9	10	11	12	13	14
K_1	78.028	85.167	92.389	99.546	108.296	117.435
K_2	74.343	81.000	87.537	93.565	101.389	110.000
K_3	76.028	83.139	90.454	96.907	104.102	112.222
F	3.104	3.117	3.399	4.139	4.594	4.816
CD (0.05)	2.902	3.271	3.673	4.084	4.500	4.821

The effect of interaction between the NP combinations influenced plant height significantly at 13 MAP and 14 MAP (December 1992 and January 1993) (Table 22). During December, the plants receiving N_2P_1 had a greater height (113.639cm) than those receiving the rest of the NP combinations. During January the plants receiving N_2P_1 had a greater height than those receiving N_1P_1, N_1P_3, N_2P_3 and N_3P_1.

4.1.1.2. Number of leaves per plant

4.1.1.2.2 The effect of light intensities and their interaction with culture methods

The direct effect of light intensities on the number of leaves produced per plant was not significant. However, light interacted with the culture method treatments, influencing the number of leaves produced from four MAP to six MAP and nine MAP to 13 MAP (March to May and August to December 1992) (Table 23).

At four MAP (March 1992), under L_1 the C_1 plants had a greater number of leaves (15.185) than the C_2 plants. Under L_2 and L_3 too the C_1 plants had a greater number of leaves (15.630 and 14.481 respectively) than the C_2 plants. Among the C_1 plants those grown under L_2 had a greater number of leaves than those grown under L_3. The C_2 plants did not differ in their leaf number under L_1, L_2 or L_3.

At five MAP (April 1992) under L_1 L_2 and L_3 the C_1 plants had a greater number of leaves (16.519, 17.389 and 16.148 respectively) than the C_2 plants. The C_1 plants grown under L_2 had a greater number of leaves than those grown under L_3. There was no significant difference in the number of leaves produced by the C_2 plants under L_1, L_2 and L_3.

Table 22. The effect of NP interaction on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after Planting 13	14
N_1	102.407	110.685
N_2	107.296	115.843
N_3	104.083	113.130
F	2.341	2.201
CD (0.05)	—	—
P_1	104.806	112.509
P_2	105.778	115.231
P_3	103.204	111.917
F	0.641	1.033
CD (0.05)	—	—
N_1P_1	100.139	106.778
N_1P_2	105.444	115.278
N_1P_3	101.639	110.000
N_2P_1	113.639	121.028
N_2P_2	106.722	116.722
N_2P_3	101.528	109.778
N_3P_1	100.639	109.722
N_3P_2	105.167	113.694
N_3P_3	106.444	115.972
F	3.075	2.825
CD (0.05)	7.795	8.350

Table 23. Effects of light intensities culture methods and their interaction on the number of leaves produced by *Arachnis* Maggie oei 'Red Ribbon'

Treatment	Months after Planting										
	4	5	6	7	8	9	10	11	12	13	14
L_1	14.009	15.046	16.630	18.213	20.213	21.306	23.481	25.556	27.343	29.000	30.824
L_2	14.139	15.731	17.611	19.500	21.361	22.806	25.306	27.972	30.583	33.259	35.370
L_3	13.898	15.454	17.250	19.185	21.509	23.778	26.213	28.935	31.741	34.519	38.398
F	0.058	0.555	1.097	2.053	2.970	5.296	3.175	2.903	2.765	3.039	6.524
CD (0.05)	—	—	—	—	—	—	—	—	—	—	—
C_1	15.099	16.685	18.716	20.981	23.556	25.364	28.105	30.877	33.580	36.549	39.790
C_2	12.932	14.136	15.611	16.951	18.500	19.895	21.895	24.099	26.198	27.969	29.938
F	218.917	233.439	309.458	631.718	3397.333	2962.949	965.739	587.529	374.076	388.908	182.170
CD (0.05)	0.466	0.531	0.562	0.510	0.276	0.320	0.636	0.890	8.680	1.384	2.323
L_1C_1	15.185	16.519	18.556	20.685	23.259	24.574	27.333	29.852	32.093	34.556	37.056
L_1C_2	12.833	13.574	14.704	15.741	17.167	18.037	19.630	21.259	22.593	23.444	24.593
L_2C_1	15.630	17.839	19.519	21.926	24.185	25.704	28.426	31.407	34.074	37.481	40.204
L_2C_2	12.648	14.074	15.704	17.074	18.537	19.907	22.185	24.537	27.093	29.037	30.537
L_3C_1	14.481	16.148	18.074	20.333	23.222	25.816	28.556	31.370	34.574	37.611	42.111
L_3C_2	13.315	14.759	16.426	18.037	19.796	21.741	23.870	26.500	28.907	31.426	34.685
F	13.199	12.502	17.033	29.274	90.436	52.729	19.019	14.792	8.680	10.708	3.985
CD (0.05)	0.807	0.920	0.973	0.884	0.478	0.554	1.101	1.541	—	2.398	—

At six MAP similar effects were observed and the mean leaf number in the C_1 plants grown under L_1, L_2 and L_3 increased to 18.556, 19.519 and 18.074 respectively. At seven MAP (June 1992), under L_1 L_2 and L_3, the C_1 plants had a greater number of leaves (20.685, 21.926 and 20.333 respectively) than the C_2 plants. Among the C_1 plants the number of leaves was greater under L_2 than under L_1 or L_3. Among the C_2 plants, those grown under L_3 had a greater number of leaves than those grown under L_2 and L_1 and the plants grown under L_2 had a greater number than those grown under L_1.

At eight MAP (July 1992), under L_1, L_2 and L_3 the C_1 plants had a greater number of leaves (23.259, 24.185 and 23.222 respectively) than the C_2 plants. Among the C_1 plants, those grown under L_2 had a greater number of leaves than those grown under L_1 or L_3. The C_2 plants grown under L_3 had a greater number than those grown under L_2 and these in turn had a greater number than those grown under L_1.

At nine MAP, under L_1, L_2 and L_3 the C_1 plants had a greater number of leaves (24.574, 25.704 and and 25.815 respectively) than the C_2 plants. Among the C_1 plants those grown under L_2 or L_3 had a greater number of leaves than those grown under L_1. Among the C_2 plants those grown under L_3 had a greater number of leaves than those grown under L_2 and there in turn had a greater number than those grown under L_1.

At 10 MAP the effect of light intersities on the C_2 plants was similar to that of the previous month. Among the C_1 plants there was no significant difference in the number of leaves produced under L_1 L_2 and L_3.

At 11 MAP, under L_1, the C_1 plants had a greater number of leaves (29.8582) than the C_2 plants. Under L_2 and L_3 too they had a greater number of leaves (31.407 and 31.370 respectively) than the C_2 plants. Under L_2, the C_1 plants had a greater number of leaves than under L_1. The C_2 plants grown under L_3 had a greater number of leaves than those grown under L_2 and these in turn had a greater number than those grown under L_1.

At 13 MAP, under L_1, the C_1 plants had a greater number of leaves (34.550) than the C_2 plants. Under L_2 and L_3 too the C_1 plants had a greater number than the C_2 plants. The C_1 plants grown under L_2 or L_3 had a greater number of leaves (37.481 and 37.611 respectively) than those grown Under L_1. Among the C_2 plants, those grown under L_3 or L_2 had a greater number than those grown under L_1.

4.1.1.2.2 The effect of LCP interaction

A significant interaction between the light intensities culture methods and the P doses received by the plants was observed from eight MAP to 14 MAP (July 1992 to January 1993) (Table 24).

During July the L_1C_1 plants receiving P_2 had a greater number of leaves (25.056) than those receiving P_1 or P_3. Among the L_1C_2, L_2C_1 and L_2C_2 plants there was no significant difference in the number of leaves found on the plants receiving P_1, P_2 or P_3. Among the plants receiving P_1, the number of leaves was greater under L_1C_1, L_2C_1 and L_3C_1 than under L_1C_2, L_2C_2 and L_3C_2. Among those receiving P_2, the number was greater under L_1C_1, L_2C_1 and L_3C_1 than under L_1C_2, L_2C_2 and L_3C_2. Among the plants receiving P_3, the L_1C_1, the L_2C_1 and the L_3C_1 plants had a greater number of leaves than the L_1C_2 and L_3C_2 plants.

Table 24. Interaction effects of light intensities with culture methods and P on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting						
	8	9	10	11	12	13	14
$L_1C_1P_1$	22.500	23.556	26.389	29.056	31.278	33.444	35.778
$L_1C_1P_2$	25.056	26.833	29.556	32.778	34.944	37.556	40.389
$L_1C_1P_3$	22.222	23.333	26.056	27.722	30.056	32.667	35.000
$L_1C_2P_1$	17.167	18.278	20.000	22.111	23.500	24.389	25.333
$L_1C_2P_2$	16.500	17.333	18.833	20.611	21.833	22.722	23.500
$L_1C_2P_3$	17.833	18.500	20.056	21.056	22.444	23.222	24.944
$L_2C_1P_1$	23.833	25.167	27.556	30.833	33.667	36.167	39.056
$L_2C_1P_2$	25.389	27.278	30.500	33.167	36.056	40.389	42.444
$L_2C_1P_3$	23.333	24.667	27.222	30.222	32.500	35.889	39.111
$L_2C_2P_1$	18.278	19.444	21.611	23.889	26.222	28.000	29.056
$L_2C_2P_2$	17.889	19.111	21.556	24.000	26.167	28.111	29.444
$L_2C_2P_3$	19.444	21.167	23.389	25.722	28.889	31.000	33.111
$L_3C_1P_1$	23.778	26.556	29.444	32.222	35.333	38.778	43.611
$L_3C_1P_2$	22.611	25.167	28.000	30.833	33.833	36.111	41.000
$L_3C_1P_3$	23.278	25.722	28.222	31.056	34.556	37.944	41.722
$L_3C_2P_1$	19.111	21.278	23.222	25.722	28.111	30.111	32.944
$L_3C_2P_2$	20.889	22.667	25.056	27.667	29.833	32.722	36.222
$L_3C_2P_3$	19.389	21.278	23.333	26.111	28.778	31.444	34.889
F	2.465	2.832	2.895	2.696	2.725	3.642	3.066
CD(0.05)	2.450	2.547	2.701	2.920	3.147	3.511	3.864

At nine MAP (August 1992), among the L_1C_1 plants, those receiving P_2 had a greater number of leaves (26.833) than those receiving P_1 or P_3. Among the L_2C_2 plants there was no significant difference in the number of leaves produced by the plants receiving P_1, P_2 or P_3. Among the L_2C_1 plants those receiving P_2 had a greater number of leaves (27.278) than those receiving P_3. Among the L_2C_2 plants the L_3C_1 plants and the L_3C_2 plants there was no significant difference in the number of leaves found on those receiving P_1, P_2 or P_3 . Irrespective of the P dose received, the L_1C_1 plants had a greater number than the L_2C_2 plants and the L_3C_1 plants had a greater number than the L_3C_2 plants.

At 10 MAP (September 1992), among the L_1C_1 plants and the L_2C_1 plants those receiving P_2 had a greater number of leaves than those receiving P_1 or P_3. Among the L_2C_1 plants, the L_2C_2 plants the L_3C_1 plants and L_3C_2 plants, there was no significant difference in the number of leaves produced among those receiving P_1 P_2 or P_3. As in the previous month, among the plants receiving the P doses, the number of leaves was greater under L_1C_1, L_2C_1 and L_3C_1 than under L_1C_2, L_2C_2 and L_3C_2 respectively.

At 11 MAP, the L_1C_1 plants receiving P_2 had a greater number of leaves (32.778) than those receiving P_1 or P_3 and the L_2C_1 plants receiving P_2 had a greater number than those receiving P_3. Irrespective of the P dose received, there was no significant difference in the number of leaves produced under L_1C_2, L_2C_2 and L_3C_2 but it was greater under L_1C_1 than that under L_1C_2. So also under L_2C_2 the number was greater than that under L_3C_2.

At 12 MAP, among the L_1C_1 plants those receiving P_2 had greater number of leaves (34.944) than those receiving P_1 or P_3. Among the L_2C_1

plants, those receiving P_2 had a greater number of leaves (36.056) than those receiving P_3. Among the plants receiving, P_1, P_2 or P_3 there was no significant difference in the the number of leaves produced under L_1C_2, L_2C_2, L_3C_1 and L_3C_2. Under L_1C_1 the number of leaves produced was greater than that under L_1C_2 and under L_2C_2 and L_3C_1 the number was greater than that under L_3C_2.

At 13 MAP (December 1992), among the L_1C_1 plants and the L_2C_1 plants, those receiving P_2 had a greater number of leaves (37.556 and 40.389 respective by) than those receiving P_1 or P_3. Among the plants receiving P_1, P_2 or P_3 the L_1C_1 plants had a greater number of leaves than the L_1C_2 plants, the L_2C_1 plants had greater number than the L_2C_2 plants and the L_3C_1 plants had a greater number than the L_3C_2 plants. There was no significant difference between the L_1C_2 plants, the L_2C_2 plants the L_3C_1 plants and the L_3C_2 plants in the number of leaves produced.

At 14 MAP (January 1993), among the L_1C_1 plants, those receiving P_2 had greater number of leaves (40.389) than those receiving P_1 or P_3. Among the L_2C_2 plants, those receiving P_3 had a greater number of leaves (33.111) than those receiving P_1 and among the L_1C_2, L_2C_1 and the L_3C_1 plants, there was no significant difference in the number of leaves produced, irrespective of the P dose received.

4.1.1.2.3 The effect of LNP interaction

A significant interaction between light and the NP combinations received by the plants was observed to influence the number of leaves produced at eight MAP and 12 MAP (July and November 1992). (Table 25).

Table 25. Interaction effects of light intensity with NP on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after planting	
	8	12
$L_1N_1P_1$	19.500	26.417
$L_1N_1P_2$	21.750	28.417
$L_1N_1P_3$	20.917	28.333
$L_1N_2P_1$	18.833	27.917
$L_1N_2P_2$	20.500	29.250
$L_1N_2P_3$	20.250	26.583
$L_1N_3P_1$	21.167	27.833
$L_1N_3P_2$	20.083	27.500
$L_1N_3P_3$	18.917	23.833
$L_2N_1P_1$	20.000	26.917
$L_2N_1P_2$	22.667	32.167
$L_2N_1P_3$	20.583	30.000
$L_2N_2P_1$	22.917	33.417
$L_2N_2P_2$	22.583	32.083
$L_2N_2P_3$	20.667	29.667
$L_2N_3P_1$	20.250	29.500
$L_2N_3P_2$	19.667	29.083
$L_2N_3P_3$	22.917	32.417
$L_3N_1P_1$	22.500	32.000
$L_3N_1P_2$	21.500	30.083
$L_3N_1P_3$	19.417	29.750
$L_3N_2P_1$	20.167	31.167
$L_3N_2P_2$	21.917	32.500
$L_3N_2P_3$	21.333	31.167
$L_3N_3P_1$	21.667	32.000
$L_3N_3P_2$	21.833	32.917
$L_3N_3P_3$	23.250	34.083
F	1.989	2.114
CD(0.05)	3.001	3.854

During July, under L_1 there was no significant difference in the number of leaves produced by the plants receiving the different NP combinations. Under L_2 the plants receiving N_2P_1 or N_3P_3 had a greater number of leaves (22.917) than those receiving N_3P_2. Under L_3 the plants receiving N_3P_3 and N_1P_1 had a greater number (23.250 and 22.500 respectively) than those receiving N_1P_3. The plants receiving N_3P_3 had a greater number than those receiving N_2P_1 under L_3. The plants receiving N_2P_1 were found to have a greater number of leaves under L_2 than under L_1 and those receiving N_3 P_3 were found to have a greater number under L_2 and L_3 than under L_1.

At 12 MAP under L_1, the plants receiving N_3P_1 had a greater number of leaves (27.833) than those receiving N_3P_3. The N_1P_3 plants had greater number of leaves (28.333) than the N_3P_3 plants and there was no significant difference in the number of leaves produced by the plants receiving the rest of the NP combinations. Under L_2 the N_1P_2 plants had a greater number of leaves (32.167) than the N_1P_1 plants, the N_2P_1 plants had a greater number (33.417) than the N_1P_1 and N_3P_1 plants and those was no significant difference in the number of leaves produced by the plants receiving N_2P_1, N_2P_2, N_2P_3, N_3P_1, N_3P_2 and N_3P_3. Under L_3 the N_3P_3 plants had a greater number (34.083) than the N_1P_3 plants.

4.1.1.2.4 The effect of LNPK interaction

Interaction between the light intensities and the NPK combinations influenced the number of leaves produced at nine MAP (August 1992) (Table 26). Under L_1, the plants receiving N_1 P_2 K_3, $N_1P_3K_2$, $N_1P_3K_2$, $N_2P_2K_1$ and $N_3P_1K_3$ had a greater number of leaves than those receiving $N_1P_1K_1$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_3K_2$ and $N_3P_3K_3$.

Table 26. Interaction effects of light intensity with NPK on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon' at nine MAP

Treatment	L_1	L_2	L_3
$N_1P_1K_1$	19.000	20.250	25.000
$N_1P_1K_2$	22.500	21.250	21.500
$N_1P_1K_3$	20.250	21.500	28.000
$N_1P_2K_1$	20.000	28.500	23.000
$N_1P_2K_2$	21.500	26.250	25.000
$N_1P_2K_3$	26.500	18.500	22.500
$N_1P_3K_1$	21.000	24.500	22.000
$N_1P_3K_2$	24.500	20.500	21.750
$N_1P_3K_3$	21.750	20.750	20.500
$N_2P_1K_1$	20.500	24.750	21.750
$N_2P_1K_2$	21.500	24.000	22.750
$N_2P_1K_3$	20.000	24.250	23.500
$N_2P_2K_1$	24.750	23.750	27.000
$N_2P_2K_2$	23.000	25.250	24.500
$N_2P_2K_3$	19.750	22.500	21.250
$N_2P_3K_1$	22.750	23.250	22.500
$N_2P_3K_2$	22.250	24.000	23.500
$N_2P_3K_3$	18.250	19.000	24.000
$N_3P_1K_1$	22.250	21.000	25.250
$N_3P_1K_2$	17.500	22.000	22.500
$N_3P_1K_3$	24.750	21.750	25.000
$N_3P_2K_1$	21.000	21.250	27.250
$N_3P_2K_2$	21.250	22.250	20.750
$N_3P_2K_3$	21.000	20.500	24.000
$N_3P_3K_1$	23.750	23.750	25.250
$N_3P_3K_2$	17.250	24.250	27.250
$N_3P_3K_3$	17.000	26.250	24.750
F	1.714	—	—
CD (0.05)	5.402	—	—

Under L_2 the plants receiving $N_1P_2K_1$, $N_1P_2K_2$ $N_2P_2K_2$ and $N_3P_3K_3$ had a greater number of leaves than those receiving $N_1P_2K_3$ and $N_2P_3K_3$. Under L_3 the plants receiving $N_1P_1K_3$, $N_2P_2K_1$, $N_3P_2K_1$ and $N_3P_3K_2$ had greater number than those receiving $N_1P_3K_3$ and $N_3P_2K_2$.

4.1.1.2.5 The effect of the culture method treatments

The effect of the culture method treatments on the number of leaves produced per plant was significant from five MAP to 14 MAP (April 1992 to January 1993) (Table 23). The C_1 plants were found to have a greater number of leaves than the C_2 plants, during the period. In the C_1 plants the increase in leaf number over the C_2 plants was 2.594 during April 1992 and 9.825 during January 1993.

4.1.1.2.6 The effect of CP interaction

A significant interaction between the culture method treatments and the P doses received by the plants was observed during 12 MAP and 14 MAP (November 1992 and January 1993) (Table 27).

At 12 MAP the C_1 plants receiving P_2 had a greater number of leaves (34.944) than those receiving P_3. Among the C_2 plants, there was no significant difference in the number of leaves produced by the plants receiving P_1, P_2 or P_3. Among those receiving P_1 and P_2, the number of leaves was greater under C_1 than under C_2. Among those receiving P_3, there was no significant difference in the number of leaves produced under C_1 or C_2.

Table 27. Effects of P and interaction effects of culture methods and P on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting	
	12	14
P_1	29.685	34.296
P_2	30.444	35.500
P_3	29.537	34.796
F	1.103	1.130
CD (0.05)	—	—
C_1P_1	33.426	39.481
C_1P_2	34.944	41.278
C_1P_3	32.370	38.611
C_2P_1	25.944	29.111
C_2P_2	25.944	29.722
C_2P_3	26.704	30.981
F	3.241	3.131
CD (0.05)	1.817	2.231

During January, the C_1 plants receiving P_2 had a greater number of leaves (41.278) than those receiving P_3. Among the C_2 plants, there was no significant difference in the number of leaves produced by those receiving P_1, P_2, or P_3. Among the plants receiving P_1 P_2 or P_3, those grown under C_1 had a greater number of leaves than those grown under C_2.

4.1.1.2.7 The effect of CPK interaction

The effect of interaction between the culture method treatments and the PK combinations on the number of leaves produced by the plants was evident at four MAP to nine MAP (March to August 1992) (Table 28).

At four MAP under C_1, the plants receiving P_2K_1 had a greater number of leaves (17.056) than those receiving P_1K_1, P_1K_2, P_2K_3, P_3K_2 and P_3K_3. Under C_2 the plants receiving P_3K_2 had a greater number of leaves (14.167) than those receiving P_1K_2 or P_3K_3. This was however significantly lesser than the number of leaves produced by the plants receiving P_2K_1 under C_1. Among the PK combinations P_1K_2, P_1K_3, P_2K_1 and P_3K_1 resulted in a greater number of leaves under C_1 than under C_2.

At five MAP the C_1 plants receiving P_1K_3 or P_3K_1 had a greater number of leaves (17.667 and 18.667 respectively) than those receiving P_2K_3 and P_3K_2. Among the C_2 plants those receiving P_3K_2 had a greater number of leaves (15.333) than those receiving P_1K_2 or P_3K_3. This was however, significantly lesser than the number of leaves produced by the C_1 plants receiving P_2K_1.

At six MAP, the C_1 plants receiving P_2K_1 had a greater number of leaves (21.278) than those receiving P_1K_1, P_1K_2, P_2K_3, P_3K_2 and P_3K_3. Among the C_2 plants, those receiving P_3K_2 had a greater number (16.889) than those receiving P_3K_3. This was however significantly lesser than the number produced by the C_1 plants receiving P_2K_1.

Table 28. Interaction effects of culture methods with PK on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatement	Months after Planting 4	5	6	7	8	9
$C_1P_1K_1$	14.833	15.944	17.611	19.778	22.778	24.111
$C_1P_1K_2$	14.778	16.444	18.389	20.222	22.778	24.556
$C_1P_1K_3$	16.167	17.667	19.667	22.167	24.556	26.611
$C_1P_2K_1$	17.056	18.667	21.278	23.778	26.278	28.444
$C_1P_2K_2$	15.778	17.278	19.444	21.611	24.667	26.722
$C_1P_2K_3$	13.833	15.778	17.722	19.944	22.111	24.111
$C_1P_3K_1$	15.389	16.944	19.333	21.667	24.333	26.333
$C_1P_3K_2$	14.167	15.833	17.611	19.667	22.111	23.556
$C_1P_3K_3$	13.889	15.611	17.389	20.000	22.389	23.833
$C_2P_1K_1$	13.778	14.944	16.333	17.556	19.000	20.278
$C_2P_1K_2$	12.056	13.389	14.944	16.056	17.556	18.889
$C_2P_1K_3$	12.667	13.778	15.056	16.389	18.000	19.833
$C_2P_2K_1$	13.444	14.556	15.833	17.111	18.278	19.667
$C_2P_2K_2$	12.778	13.944	15.389	17.000	18.611	19.889
$C_2P_2K_3$	12.667	14.111	15.833	17.056	18.389	19.556
$C_2P_3K_1$	12.778	13.944	15.667	16.889	18.778	20.056
$C_2P_3K_2$	14.167	15.333	16.889	18.667	20.556	22.000
$C_2P_3K_3$	12.056	13.222	14.556	15.833	17.333	18.889
F	2.456	2.930	3.995	3.391	3.062	3.156
CD(0.05)	1.932	1.868	1.960	2.150	2.450	2.547

At seven MAP the C_1 plants receiving P_2K_1 and P_1K_3 had a greater number of leaves (23.778 and 22.167 respectively) than those receiving the other PK combinations. The C_2 plants receiving P_3K_2 had a greater number of leaves (18.667) than those receiving P_1K_2, P_1K_3 and P_3K_3. However, there had a lesser number than the C_1 plants receiving P_1K_3 and P_2K_1.

At eight MAP (July 1992) (Table 28), the C_1 plants receiving P_2K_1 had a greater number of leaves (26.278) than those receiving P_1K_1, P_1K_2, P_2K_3, P_3K_2 and P_3K_3. The plants receiving P_2K_2 had a greater number of leaves (24.667) than those receiving P_2K_3 or P_3K_2. The C_2 plants receiving P_3K_2 had a greater number of leaves (20.556) than those receiving P_3K_3, P_1K_2 and P_1K_3. The $C_2P_3K_2$ plants however had a lesser number of leaves than the $C_1P_1K_3$ plants, the $C_1P_2K_1$ plants, the $C_1P_2K_2$ plants and the $C_1P_3K_1$ plants.

At nine MAP, the C_1 plants receiving P_2K_1 and P_2K_2 had a greater number of leaves (28.444 and 26.722 respectively) than those receiving P_1K_1, P_2K_3, P_3K_2 and P_3K_3. The plants receiving P_1K_3 and P_3K_1 had a greater number than those receiving P_3K_2. The C_2 plants receiving P_3K_2 had a greater number of leaves (22.000) than those receiving P_1K_2 and P_3K_3. The plants receiving P_3K_2 were not significantly different in the number of leaves produced under C_1 and C_2.

4.1.1.2.8 The effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinations influencing the number of leaves produced per plant was observed during six and eight MAP (May and July 1992) (Table 29).

Table 29. Interaction effects of culture methods and NPK combinations on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting			
	6		8	
	C_1	C_2	C_1	C_2
$N_1P_1K_1$	16.833	16.500	21.333	19.000
$N_1P_1K_2$	18.667	15.333	23.167	17.500
$N_1P_1K_3$	20.333	14.500	24.667	18.333
$N_1P_2K_1$	21.333	15.167	26.333	17.667
$N_1P_2K_2$	20.667	15.500	27.333	17.833
$N_1P_2K_3$	19.667	15.333	24.333	18.333
$N_1P_3K_1$	19.333	14.333	24.500	16.833
$N_1P_3K_2$	17.000	17.000	21.833	19.833
$N_1P_3K_3$	15.500	15.500	20.500	18.333
$N_2P_1K_1$	18.500	15.500	22.833	18.500
$N_2P_1K_2$	20.333	13.500	25.500	15.833
$N_2P_1K_3$	18.167	15.833	23.000	18.167
$N_2P_2K_1$	22.000	15.833	27.333	18.333
$N_2P_2K_2$	18.500	16.667	23.833	20.500
$N_2P_2K_3$	16.667	16.333	21.500	18.500
$N_2P_3K_1$	18.500	16.167	22.833	19.833
$N_2P_3K_2$	17.000	17.500	21.000	22.833
$N_2P_3K_3$	17.667	13.500	22.000	16.000
$N_3P_1K_1$	17.500	17.000	24.167	19.500
$N_3P_1K_2$	16.167	16.000	19.667	19.333
$N_3P_1K_3$	20.500	14.833	26.000	17.500
$N_3P_2K_1$	20.500	16.500	25.167	18.833
$N_3P_2K_2$	19.167	14.000	22.833	17.500
$N_3P_2K_3$	16.833	15.833	20.500	18.333
$N_3P_3K_1$	20.167	16.500	25.667	19.667
$N_3P_3K_2$	18.833	16.167	23.500	19.000
$N_3P_3K_3$	19.000	14.667	24.667	17.667
F	2.052	—	2.071	—
CD (0.05)	3.394	—	4.244	—

At six MAP, the C_1 plants receiving $N_2P_2K_1$ had a greater number of leaves (22.000) than those receiving $N_1P_1K_1$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2N_3K_2$, $N_2P_3N_3$, $N_3P_1K_1$, $N_3P_1K_2$ and $N_2P_2K_3$. The C_2 plants receiving N_2 P_3 K_2 had a greater number of leaves (17.500) than those receiving $N_2P_1K_2$, $N_2P_3K_3$ and $N_3P_2K_2$.

At eight MAP the C_1 plants receiving $N_1P_2K_1$, $N_1P_2K_2$, $N_2P_2K_1$ and $N_3P_1K_3$ had a greater number of leaves than those receiving $N_1P_1K_1$, $N_1P_3K_3$, $N_2P_2K_3$, $N_2P_3K_2$, $N_3P_1K_2$ and $N_3P_2K_3$. The C_2 plants receiving $N_2P_2K_2$ and $N_3P_2K_2$ had a greater number of leaves than those receiving $N_2P_1K_2$ and $N_2P_3K_3$.

4.1.1.2.9 The effect of nutrients and their interactions

The direct effect of N and P and their interactions on the number of leaves produced during the period under observation was not significant. The K doses, directly and interacting with the N doses, significantly influenced the number of leaves produced at certain periods (Table 30).

At four MAP (March 1992), the plants receiving K_1 were found to have a greater number of leaves than those receiving K_3. AT 12 MAP too, the K_1 plants had a greater number than the K_3 plants.

The effect of NK interaction, influencing leaf number was observed at 12 MAP and 14 MAP (November and January 1992-1993) (Table 30).

At 12 MAP, the plants receiving N_2K_1 had a greater number of leaves than those receiving N_1K_2, N_1K_3, N_2K_3 and N_3K_2. Among the plants receiving K_1 or K_3 in combination with N_1 N_2 and N_3, there was no significant difference in the number of leaves produced.

Table 30. Effects of N, K and their interaction on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting		
	4	12	14
N_1	13.963	29.343	33.824
N_2	13.907	30.417	35.750
N_3	14.176	29.907	35.019
F	0.248	1.344	2.919
CD (0.05)	—	—	—
K_1	14.546	30.806	35.907
K_2	13.954	29.704	34.074
K_3	13.546	29.157	34.611
F	3.122	3.281	2.743
CD (0.05)	0.789	1.285	—
N_1K_1	14.167	29.722	34.111
N_1K_2	14.194	29.333	33.222
N_1K_3	13.528	28.972	34.139
N_2K_1	14.639	31.694	37.000
N_2K_2	13.889	31.278	36.361
N_2K_3	13.194	28.278	33.889
N_3K_1	14.833	28.278	33.889
N_3K_2	13.778	28.500	32.639
N_3K_3	13.917	30.222	35.806
F	0.482	2.435	2.427
CD (0.05)	—	2.225	2.732

At 14 MAP, the plants receiving N_2K_1 had a greater number of leaves (37.000) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_3 and N_3K_2. Among the plants receiving N_1 in combination K_1, K_2 or K_3 and those receiving K_3 in combination with N_1, N_2 or N_3 there was no significant difference in the number of leaves produced per plant.

4.1.1.3 Leaf area per plant

4.1.1.3.1 The effect of light intensities and their interaction with culture methods

The effect of the light intensity treatments on the leaf area of plants was significant at seven MAP (June 1992) (Table 31). The plants grown under L_2 were found to have a greater leaf area (385.884 sq. cm.) than those grown under L_1.

Interaction between light and the culture method treatments significantly influenced the leaf area of plants from six MAP to 10 MAP (May to September 1992) (Table 31).

At six MAP, under L_1L_2 and L_3 the C_1 plants had a greater leaf area than the C_2 plants. Among the C_1 plants, those grown under L_2 had a greater leaf area than those grown under L_1 or L_3. There was no significant difference in leaf area between the C_2 plants grown under L_1, L_2 or L_3.

At seven MAP, under L_1, L_2 and L_3 the C_1 plants had a greater leaf area than the C_2 plants (Table 25). The C_1 plants grown under L_2 had a greater leaf area than those grown under L_1 or L_3. Among the C_2 plants those grown under L_3 had a greater leaf area than those grown under L_1.

Table 31. Effect of light intensities and their interaction with culture methods on the leaf area (in sq.cm.) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting				
	6	7	8	9	10
L_1	315.906	350.182	389.932	418.182	465.519
L_2	346.470	385.884	425.277	456.969	509.674
L_3	330.109	369.559	415.078	461.478	513.554
F	17.544	23.891	7.212	10.432	4.030
CD (0.05)	—	22.251	41.223	44.848	80.884
L_1C_1	342.883	387.598	436.242	468.829	527.188
L_1C_2	288.930	312.767	343.622	367.535	403.851
L_2C_1	388.679	437.381	485.454	518.811	575.829
L_2C_2	304.261	334.386	365.099	395.127	443.520
L_3C_1	348.883	394.518	450.417	504.361	561.227
L_3C_2	311.335	344.601	379.739	418.596	465.881
F	11.045	9.985	142.568	17.761	23.098
CD (0.05)	22.771	26.740	6.633	14.388	12.767
L_1C_1 To	336.332	361.054	395.928	418.338	475.866
L_1C_2 To	291.306	312.738	346.014	390.288	444.150
L_2C_1 To	288.392	317.908	341.032	350.808	409.840
L_2C_2 To	356.260	386.152	425.068	436.442	467.556
L_3C_1 To	325.804	345.920	413.224	455.148	495.850
L_3C_2 To	264.892	276.736	297.040	308.884	365.660
F	0.618	0.668	0.857	0.969	0.621
CD (0.05)	—	—	—	—	—

At eight MAP the C_1 plants had a greater leaf area under L_1 L_2 and L_3 than the C_2 plants. Those grown under L_2 was found to have greater leaf area than those grown under L_1 or L_3 and those grown under L_3 had a greater leaf area than those grown under L_1. The C_2 plants grown under L_3 had a greater leaf area than those grown under L_1 or L_2 and the plants grown under L_2 had a significantly greater leaf area than those grown under L_1.

At nine MAP (Table 31) the C_1 plants grown under L_1 L_2 and L_3 had a greater leaf area than the C_2 plants. Those grown under L_2 and L_3 had a greater leaf area than those grown under L_1. The C_2 plants grown under L_2 and L_3 had a greater leaf area than those grown under L_1.

At 10 MAP, as in the previous months, the C_1 plants had a greater leaf area under L_1, L_2 and L_3 than the C_2 plants. The C_1 and C_2 plants grown under L_2 had a greater leaf area than those grown under L_3 and these in turn had a greater leaf area than those grown under L_3 and these in turn had a greater leaf area than those grown under L_1.

4.1.1.3.2 The effect of LCP interaction

The effect of interaction between light, culture methods and the P doses on the leaf area of plants was significant from eight to 11 MAP. At eight MAP, the L_1C_1 plants receiving P_2 had a greater leaf area than those receiving P_1 or P_3. The L_1C_2 plants the L_2C_2 plants L_3C_1 plants and the L_3C_2 plants receiving P_1, P_2 or P_3 were not significantly different in leaf area during the month.

At nine MAP, (Table 32) the L_1C_1 plants receiving P_2 had a greater leaf area than those receiving P_1 or P_3. The L_2C_1 plants receiving P_2 had a greater leaf area than those receiving P_1 or P_2. There was no significant difference in leaf area between the L_1C_2 plants receiving P_1, P_2 or P_3. Under L_1, L_2 and L_3, the C_1 P_1 plants had a greater leaf area than the C_2P_1 plants, the C_1P_2 plants had a greater leaf area than the C_2P_2 plants and the C_1P_3 plants had a greater leaf area than the C_2P_3 plants.

At 10 MAP (Table 32) the L_1 C_1 plants and the L_2 C_1 plants receiving P_2 had a greater leaf area than those receiving P_1 or P_3. Among the L_1C_2, L_2C_2, L_3C_1, and the L_3C_2 plants receiving P_1, P_2 or P_3 there was no significant difference in leaf area. Under L_1, L_2 and L_3 the C_1P_1 plants had a greater leaf area than the C_2P_1 plants, the C_1P_2 plants had a greater leaf area than the C_2P_2 plants, and the C_1P_3 plants had a greater leaf area than the C_2P_3 plants.

At 11 MAP, the L_1 C_1 plants and the L_2C_1 plants receiving P_2 had a greater leaf area (649.350 and 696.206 sq.cm respectively) than those receiving P_1 or P_3. Among the L_1C_2 plants, the L_3C_1 plants and the L_3C_2 plants receiving P_1, P_2 or P_3, there was no significant difference in leaf area. Under L_1, L_2 and L_3, the C_1 P_1 plants had a greater leaf area than the C_2P_1 plants, the C_1P_2 plants had a greater leaf area than the C_2 P_2 plants and the C_1P_3 plants had a greater leaf area than the C_2P_3 plants.

4.1.3.3 The effect of LN interaction

The effect of interaction between the light treatments and the N doses was significant from five MAP to seven MAP and from 10 MAP to 14 MAP (Table 33).

Table 32. Interaction effects of light with culture methods and P on the leaf area (in sq.cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting			
	8	9	10	11
$L_1C_1P_1$	389.202	429.117	485.226	545.474
$L_1C_1P_2$	485.761	518.034	586.299	649.350
$L_1C_1P_3$	433.764	459.336	510.038	565.285
$L_1C_2P_1$	336.601	360.277	399.926	446.007
$L_1C_2P_2$	333.961	353.465	387.531	429.020
$L_1C_2P_3$	360.302	388.863	424.097	451.054
$L_2C_1P_1$	468.066	497.582	549.735	620.507
$L_2C_1P_2$	521.199	560.846	623.042	696.206
$L_2C_1P_3$	467.096	498.006	554.709	620.404
$L_2C_2P_1$	353.847	378.622	423.982	474.249
$L_2C_2P_2$	362.537	389.484	439.481	496.999
$L_2C_2P_3$	378.914	417.276	467.096	520.374
$L_3C_1P_1$	461.561	517.230	570.329	628.672
$L_3C_1P_2$	436.745	490.081	550.126	612.646
$L_3C_1P_3$	452.944	505.772	563.227	626.782
$L_3C_2P_1$	361.984	407.156	445.560	493.709
$L_3C_2P_2$	397.651	433.685	484.777	540.479
$L_3C_2P_3$	379.582	414.947	467.305	521.146
F	2.942	2.779	2.891	2.566
CD (0.05)	49.536	51.857	56.353	62.804

Table 33. Interaction effects of light intensity with N on the leaf area (in sq.cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after Planting			
	5	6	7	10
L_1N_1	281.214	313.802	353.011	475.455
L_1N_2	280.611	312.606	346.869	465.997
L_1N_3	292.284	321.311	350.668	455.106
L_2N_1	321.573	355.481	394.261	508.995
L_2N_2	308.404	354.787	392.732	518.577
L_2N_3	285.567	329.141	370.658	501.450
L_3N_1	283.890	318.070	353.618	489.435
L_3N_2	281.399	317.213	360.260	504.044
L_3N_3	318.796	355.043	394.800	547.183
F	3.778	3.145	2.560	2.431
CD (0.05)	27.684	28.631	31.120	39.848
Treatment	11	12	13	14
L_1N_1	527.724	567.578	607.865	648.247
L_1N_2	512.883	554.559	598.681	644.309
L_1N_3	502.487	538.530	579.718	620.138
L_2N_1	565.698	617.531	672.192	730.702
L_2N_2	586.252	677.731	737.382	796.148
L_2N_3	562.419	645.826	704.737	765.608
L_3N_1	545.073	599.008	637.946	735.999
L_3N_2	559.196	626.620	691.939	783.687
L_3N_3	607.449	673.019	742.648	851.424
F	2.534	2.518	2.780	2.734
CD (0.05)	44.409	53.966	60.817	66.697

Under L_1 there was no significant difference in leaf area between the plants receiving N_1, N_2 or N_3. Under L_2 the plants receiving N_1 had a greater leaf area (321.573 sq.cm) than those receiving N_3. Under L_3 the plants receiving N_3 had a greater leaf area (318.796 sq.cm) than those receiving N_1 or N_2. Among the N_1 plants, those grown under L_2 had a greater leaf area than those grown under L_1 or L_3. Among the N_2 plants, those grown under L_2 had a greater leaf area than those grown under L_1 and among the N_3 plants, those grown under L_3 had a greater leaf area than those grown under L_2.

At six MAP, under L_1 and L_2 there was no significant difference in leaf area between the plants receiving N_1 N_2 and N_3. Under L_3 the plants receiving N_3 had a greater leafarea (355.043 sq.cm) than those receiving N_1 or N_2. Among the plants receiving N_1 or N_2, those grown under L_2 had a greater leaf area than those grown under L_1 or L_2. Among the plants receiving N_3 those grown under L_3 had a greater leaf area than those grown under L_1.

At seven MAP (June 1992), under L_1 and L_2 there was no significant difference in leaf area between the plants receiving N_1 N_2 and N_3. Under L_3 the plants receiving N_3 had a significantly greater leaf area (394.800 sq.cm) than those receiving N_1 or N_2. Among the N_1 and N_2 plants, those grown under L_2 had a significantly greater leaf area than those grown under L_1 or L_3. There was no significant difference in leaf area between the N_3 plants grown under L_1, L_2 or L_3.

At 10 MAP under L_1 and L_2 the plants receiving N_1, N_2 or N_3 had no significant difference in leaf area. Under L_3, N_3 resulted in a greater leaf area (547.183 sq.cm) than N_1 or N_2. There was no significant difference in leaf area between the N_1 plants under L_1, L_2 or L_3. The N_2 plants had a greater leaf area under L_2 (518.577 sq.cm) than under L_1 and the N_3 plants had a greater leaf area under L_3 (547.183 sq.cm) than under L_1 and L_2.

At 11 MAP, under L_1 and L_2 there was no significant difference in leaf area between the plants receiving N_1 N_2 or N_3. Under L_3 the plants receiving N_3 had a greater leaf area (607.449 sq.cm) than those receiving N_2 and N_1. Among the N doses N_1 did not result in significant difference in leaf area among the plants grown under L_1 L_2 and L_3, while N_2 resulted in a greater leaf area under L_2 than under L_1 and N_3 resulted in a greater leaf area under L_3 than under L_2 and L_1 and also a greater area under L_2 than under L_1.

At 12 MAP, under L_1 there was no significant difference in leaf area between the plants receiving N_1, N_2 or N_3. Under L_2, the N_2 plants had a greater leaf area (677.731 sq.cm) than the N_1 plants and under L_3 the N_3 plants had a greater leaf area (673.019 sq.cm) than those receiving N_1.

At 13 MAP, under L_1 there was no significant difference between the plants receiving N_1, N_2 or N_3. Under L_2, the N_2 plants had a greater leaf area (737.382 sq.cm) than the N_1 plants and under L_3 the N_3 plants had a significantly greater leaf area (742.648 sq. cm) than the N_1 plants. Among the N_1 and N_2 plants, those grown under L_2 had a greater leaf area than those grown under L_1. Among the N_3 plants, those grown under L_3 or L_2 had a greater leaf area than those grown under L_1.

At 14 MAP (January 1993), under L_1 and L_2 there was no significant difference in leaf area between the plants receiving N_1, N_2 or N_3. Under L_3, the N_3 plants had a greater leaf area (851.424 sq.cm) than the N_2 or N_1 plants. The plants receiving N_1, N_2 or N_3 had a significantly greater leaf area under L_2 than under L_1.

4.1.1.3.4 The effect of LNP interaction

A significant interaction between light and the NP combinations was observed at seven MAP to 10 MAP and at 12 MAP (June to September and during November 1992) (Table 34).

At seven MAP under L_1, the plants receiving $N_1 P_2$ had a greater leaf area (377.169 sq.cm) than those receiving $N_1 P_1$ and $N_2 P_1$. Under L_2 the plants receiving N_1P_2 had a greater leaf area (449.665 sq.cm) than those receiving N_1P_1, N_2P_3, N_3P_1 and N_3P_2. Under L_3, the plants receiving N_3P_3 had a greater leaf area (413.741 sq.cm) than those receiving N_1P_3 and N_2P_1. There was no significant difference in leaf area between the plants receiving N_2P_1, N_2P_2 and N_2P_3 and also between the N_3P_1, N_3P_2 and N_3P_3 plants under L_1, L_2 and L_3.

At nine MAP under L_1, the plants receiving N_1P_2 had a greater leaf area (426.190 sq. cm) than those receiving N_1P_1. The plants receiving N_2P_2 had a greater leaf area (406.870 sq.cm) than those receiving N_2P_1. The plants receiving N_3P_1, N_3P_2 and N_3P_3 were not significantly different in leaf area under L_1. Under L_2 the plants receiving N_1P_2 had a greater leaf area (482.972 sq.cm) than those receiving N_1P_1. The plants receiving N_2P_1, N_2P_2 and N_2P_3 were not significantly different in leaf area. The plants receiving N_3P_3 had a greater leaf area (452.375 sq.cm) than those receiving N_3P_2. Under L_3 there was no significant difference in leaf area between the plants receiving N_1P_1, N_1P_2 and N_1P_3, between those receiving N_2P_1, N_2P_2 and N_2P_3 and between those receiving N_3P_1, N_3P_2 and N_3P_3 under L_1, L_2 and L_3. Among the plants receiving P_1 in combination with N_1, N_2 or N_3 there was no significant difference in leaf area under L_3.

Table 34. Interaction effects of light with NP on the leaf area (in sq.cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting				
	7	8	9	10	12
$L_1N_1P_1$	309.812	350.701	382.157	432.616	521.734
$L_1N_1P_2$	377.169	426.190	446.212	491.742	579.908
$L_1N_1P_3$	372.052	409.198	452.547	502.007	601.092
$L_1N_2P_1$	313.453	345.241	383.593	437.282	531.185
$L_1N_2P_2$	363.905	406.870	439.243	499.112	585.858
$L_1N_2P_3$	363.247	402.492	419.911	461.596	546.635
$L_1N_3P_1$	351.231	392.763	418.341	457.830	538.119
$L_1N_3P_2$	362.558	396.523	421.794	469.890	571.006
$L_1N_3P_3$	338.215	379.409	399.842	437.598	506.466
$L_2N_1P_1$	365.657	391.507	415.430	452.435	541.609
$L_2N_1P_2$	449.665	482.972	517.815	577.458	699.595
$L_2N_1P_3$	367.462	406.017	435.743	497.094	611.389
$L_2N_2P_1$	399.406	445.294	474.590	533.763	671.536
$L_2N_2P_2$	407.224	451.263	480.356	536.207	727.541
$L_2N_2P_3$	371.566	410.623	443.304	485.761	634.115
$L_2N_3P_1$	356.229	396.069	424.285	474.377	597.264
$L_2N_3P_2$	355.978	391.369	427.324	480.121	602.853
$L_2N_3P_3$	399.766	452.375	493.876	549.853	737.360
$L_3N_1P_1$	378.162	423.689	470.376	512.112	614.525
$L_3N_1P_2$	360.925	411.360	451.601	496.580	593.807
$L_3N_1P_3$	321.762	364.109	404.028	459.613	588.691
$L_3N_2P_1$	345.105	380.653	433.324	482.988	601.318
$L_3N_2P_2$	370.141	410.122	462.934	519.366	645.733
$L_3N_2P_3$	365.535	420.603	457.169	509.778	632.808
$L_3N_3P_1$	386.074	430.974	482.878	528.734	639.654
$L_3N_3P_2$	384.585	424.112	471.112	536.408	665.771
$L_3N_3P_3$	413.741	464.078	519.883	576.408	713.632
F	2.165	2.081	2.301	2.371	2.248
CD (0.05)	53.901	60.669	63.511	69.018	93.472

At nine MAP (Table 34), under L_1 the plants receiving N_1P_2 and N_1P_3 had a greater leaf area (446.212 and 452.547 sq.cm respectively) than those receiving N_1P_1. There was no significant difference in leaf area between the plants receiving N_2P_1, N_2P_2 and N_2P_3 and between those receiving N_3P_1, N_3P_2 and N_3P_3.

Under L_2, the plants receiving N_1P_2 had a greater leaf area (517.815 sq.cm) than those receiving N_1P_1 or N_1P_3. There was no significant difference in leaf area between the plants receiving N_2P_1, N_2P_2 pr N_2P_3. The plants receiving N_3P_3 had a greater leaf area (493.876 sq.cm) than those receiving N_3P_1 and N_3P_2. Under L_3 there was no significant difference in leaf area between the plants receiving N_1P_1, N_1P_2 or N_1P_3 and between those receiving N_3P_1, N_3P_2 or N_3P_3. The N_3P_3 plants however had a greater leaf area than the N_1P_3 and N_2P_3 plants.

At 10 MAP, under L_1 there was no significant difference in leaf area between the plants receiving N_1P_1 or N_1P_3 and between those receiving N_2P_1, N_2P_2 or N_2P_3 and between those receiving N_3P_1, N_3P_2 and N_3P_3. Under L_2, the N_2P_1 plants had a greater leaf area (533.763 sq. cm) than the N_1P_1 plants, the N_1P_2 plants had a greater leaf area than the N_1P_1 plants, the N_1P_3 plants and the N_3P_2 plants. The N_3P_3 plants had a greater leaf area (549.853 sq.cm) than the N_3P_2 plants. Under L_3 the N_3P_3 plants had a greater leaf area than the N_1P_3 plants.

At 12 MAP (Table 34) under L_1, the plants receiving N_1P_3 had a greater leaf area (601.092 sq.cm) than those receiving N_3P_3 (506.466 sq.cm). There was no significant difference in leaf area between the plants receiving N_1P_2, N_2P_2 or N_3P_2 and between those receiving N_1P_1, N_2P_1 and N_3P_1.

Under L_2, the plants receiving N_1P_2 had a greater leaf area (671.536 sq.cm) than those receiving N_1P_1 and N_3P_2. The plants receiving N_2P_2 had a greater leaf area than those receiving N_3P_2 and the plants receiving N_3P_2 had a greater leaf area (737.360 sq.cm) than those receiving N_1P_1. N_1P_3, N_2P_3, N_3P_1 and N_3P_2.

Under L_3, the plants receiving N_3P_3 had a significantly greater leaf area (713.632 sq.cm) than those receiving N_1P_1, N_1P_2 N_1P_3 and N_2P_1.

4.1.1.3.5 The effect of the culture methods

The effect of the culture method treatments on the leaf area of the plants was significant throughout the period under observation from four to 14 MAP (March 1992 to January 1993) (Table 35). The C_1 plants were found to have a greater leaf area than the C_2 plants. The increase in leaf area observed in the C_1 plants was 38.175 sq.cm during March 1992 and during January 1993 it was 199.931 sq.cm.

4.1.1.3.6 Effect of CP interaction

A significant interaction between the culture method treatments and the P doses was observed at 10 MAP (September 1992) (Table 36). Under C_1, the plants receiving P_2 had a greater leaf area (586.489 sq.cm) than those receiving P_1 or P_3. Under C_2 there was no significant difference in leaf area between the plants receiving P_1, P_2 or P_3. The C_1 plants receiving P_1, P_2 or P_3 had a greater leaf area than the C_2 plants receiving the same doses of P.

Table 35. Effect of culture methods and P on the leaf area (in sq.cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting							
	4	5	6	7	8	9	13	14
C_1	284.695	319.297	360.148	406.499	457.371	497.334	750.952	830.661
C_2	246.520	294.695	301.508	330.585	362.820	393.753	576.405	630.730
F	79.547	50.722	201.443	244.8256	171.580	1574.384	58.490	52.841
CD (0.05)	13.620	21.837	13.147	15.438	3.830	8.307	72.623	87.518
Treatments	6	7	8	10	11	12	13	14
P_1	321.129	356.125	395.210	479.126	534.770	584.105	628.677	690.976
P_2	342.697	381.350	422.976	511.876	570.783	630.230	685.657	751.404
P_3	328.658	368.150	412.101	497.745	550.841	619.132	676.702	749.706
F	3.369	3.788	3.677	3.917	3.805	4.587	5.851	6.135
CD (0.05)	16.530	17.967	20.223	23.006	25.640	31.157	35.113	38.507

4.1.1.3.7 The effect of CNK interaction

The effect of interaction between the culture method treatments and the NK combinations received by the plants was observed at 13 and 14 MAP (December 1992 and January 1993) (Table 36).

At 13 MAP under C_1, the plants receiving N_3K_3 had a greater leaf area (818.416 sq.cm) than those receiving N_1K_3, N_2K_3 and N_3K_2. Under C_2 there was no significant difference in leaf area between the plants receiving the various NK combinations.

Table 36. Interaction effects of NK and culture methods with P and NK on the leaf area (in sq.cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	MAP		Treatments	MAP	
	13	14		12	13
$C_1N_1K_1$	765.225	849.829	N_1K_1	604.456	655.390
$C_1N_1K_2$	751.987	810.171	N_1K_2	588.923	636.599
$C_1N_1K_3$	673.007	793.930	N_1K_3	590.739	626.013
$C_1N_2K_1$	787.898	862.772	N_2K_1	635.552	690.956
$C_1N_2K_2$	797.450	874.286	N_2K_2	646.821	699.332
$C_1N_2K_3$	721.615	796.410	N_2K_3	576.535	637.715
$C_1N_3K_1$	778.899	869.556	N_3K_1	629.800	687.218
$C_1N_3K_2$	664.070	725.394	N_3K_2	581.799	631.897
$C_1N_3K_3$	818.416	893.602	N_3K_3	645.776	707.987
$C_2N_1K_1$	545.556	584.952	F	3.000	2.525
$C_2N_1K_2$	521.211	553.401	CD (0.05)	53.996	60.817
$C_2N_1K_3$	579.019	637.612		Treatment	9/92
$C_2N_2K_1$	594.013	655.922		C_1P_1	535.097
$C_2N_2K_2$	601.214	655.936		C_1P_2	586.489
$C_2N_2K_3$	553.815	602.962		C_1P_3	542.658
$C_2N_3K_1$	595.538	644.736		C_2P_1	423.156
$C_2N_3K_2$	599.724	683.497		C_2P_2	437.263
$C_2N_3K_3$	597.558	657.555		C_2P_3	452.833
F	2.947	2.798		F	3.271
CD (0.05)	86.008	94.323		CD (0.05)	32.535

At 14 MAP under C_1 the plants receiving N_3K_3 had a greater leaf area (893.602 sq.cm) than those receiving N_1K_3, N_2K_3 and N_3K_2. Under C_2 the plants receiving N_3K_2 had a greater leaf area than those receiving N_1K_1 and N_1K_2.

4.1.1.3.8 The effect of CPK interaction

The effect of interaction between the culture method treatments and the PK combinations was significant at five to nine MAP (April to August 1992). (Table 37).

At five MAP under C_1, the plants receiving P_2K_1 had a greater leaf area (359.978 sq.cm) than those receiving P_1K_1, P_1K_2 P_2K_3 and P_3K_3. Under C_2 there was no significant difference in leaf area between the plants receiving the various PK combinations.

At six MAP under C_1, the plants receiving P_2K_1 had a significantly greater leaf area (411.396 sq.cm) than those receiving P_1K_1, P_1K_2, P_2K_3, P_3K_2 and P_3K_3. Under C_2 the plants receiving P_3K_3 had a greater leaf area (335.862 sq.cm) than those receiving P_1K_3.

At seven MAP, under C_1 the plants receiving P_2K_1 had a greater leaf area (464.945 sq.cm) than those receiving P_1K_1, P_1K_2 P_1K_3, P_2K_3, P_3K_2 and P_3K_3. Under C_2 the plants receiving P_3K_2 had a greater leaf area (361.743 sq.cm) than those receiving P_1K_1, P_1K_2, P_1K_3, P_2K_2, P_2K_3, P_3K_2 and P_3K_3. Under C_2 the plants receiving P_3K_2 had a greater leaf area (402.592 sq.cm) than those receiving P_1K_2, P_1K_3 and P_3K_3.

Table 37. Interaction effects of culture methods with PK on the leaf area (in sq. cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting				
	5	6	7	8	9
$C_1P_1K_1$	295.076	326.228	372.612	421.085	460.924
$C_1P_1K_2$	302.396	340.261	377.454	430.470	466.002
$C_1P_1K_3$	334.421	371.582	420.859	467.274	517.002
$C_1P_2K_1$	359.978	411.396	464.954	518.692	556.350
$C_1P_2K_2$	331.768	377.159	422.029	483.630	527.152
$C_1P_2K_3$	314.587	352.949	396.868	441.382	485.458
$C_1P_3K_1$	327.778	372.741	421.903	479.661	524.290
$C_1P_3K_2$	305.241	342.267	386.655	438.126	470.905
$C_1P_3K_3$	302.429	346.749	395.166	436.018	467.919
$C_2P_1K_1$	280.538	312.884	338.348	367.885	395.400
$C_2P_1K_2$	258.740	285.426	309.448	338.275	367.373
$C_2P_1K_3$	253.986	290.395	318.031	346.273	383.282
$C_2P_2K_1$	278.543	301.886	330.671	358.875	386.766
$C_2P_2K_2$	268.767	297.218	330.525	364.281	393.505
$C_2P_2K_3$	280.983	315.575	343.065	370.993	396.363
$C_2P_3K_1$	264.286	300.758	329.418	368.365	398.230
$C_2P_3K_2$	291.724	325.569	361.743	402.592	436.854
$C_2P_3K_3$	256.234	335.862	314.012	347.842	386.004
F	2.684	3.703	3.561	3.264	2.962
CD (0.05)	39.151	40.490	44.010	49.536	51.857

At nine MAP, the plants receiving P_2K_1 had a greater leaf area (556.350 sq.cm) than those receiving P_1K_1, P_1K_2, P_2K_3, P_3K_2 and P_3K_3 under C_1. Under C_2, the plants receiving P_3K_2 had a greater leaf area (436.854 sq.cm) than those receiving P_1K_2 and P_1K_3.

4.1.1.3.9 The effect of nutrients and their interactions

The direct effect of N and K on the leaf area of plants was not significant. However, the effect of the P doses on leaf area was significant at six to eight MAP and from 10 MAP to 14 MAP (May to July 1992 and from September 1992to January 1993) (Table 35). The plants receiving P_2 had a greater leaf area than those receiving P_1 up to December 1992. During January 1993 the plants receiving P_2 and P_3 had a greater leaf area than those receiving P_1. The enhancement of leaf area in the P_2 plants over the P_1 plants was 21.568 sq.cm during May 1992 and 56.980 and 60.428 sq.cm respectively during December and January 1993.

Interaction between N and K was observed at 12 MAP and 13 MAP (November and December 1992) (Table 29). AT 12 MAP the plants receiving N_2K_2 and N_3K_3 had a greater leaf area than those receiving N_1K_2, N_1K_3, N_2K_3 and N_3K_2. At 13 MAP the plants receiving N_2K_2 and N_3K_3 had a greater leaf area (699.332 and 707.987 sq.cm respectively) than those receiving N_1K_2, N_1K_3, N_2K_3 and N_3K_2.

4.1.1.4 Number of aerial roots produced per plant

4.1.1.4.1 The effect of light intensities

The effect of the light intensity treatments on the number of aerial roots produced per plant was significant at seven MAP and nine to 13 MAP

(June 1992 and August to December 1992) (Table 38). Under L_2 and L_3, the number of aerial roots was greater than under L_1 during June, August, September, October and November. During December, the L_2 plants alone were found to have a greater number of aerial roots (9.259) than the L_1 plants.

4.1.1.4.2 The effect of LC interaction

The effect of interaction between the light treatments and the culture methods was significant during May 1992 and from 12 to 14 MAP (November 1992 to January 1993) (Table 38). During May,under L_1, L_2 and L_3 the C_1 plants had a greater number of aerial roots (4.500, 4.648 and 4.537 respectively) than the C_2 plants. The L_2C_1 plants had a greater number of roots than the L_1C_1, L_1C_2, L_2C_2 and L_3C_2 plants.

At 12 MAP under L_1 and L_2, the C_1 plants had a greater number of aerial roots (7.815 and 9.444 respectively) than the C_2 plants. Under L_3 there was no significant difference in the number of aerial roots between the C_1 and C_2 plants. Among the C_1 plants the number of aerial roots was greater under L_2 than under L_1 or L_3, and among the C_2 plants, the number was greater under L_3 and L_2 than under L_1. The number was greater than all the others in the L_2C_1 plants.

At 13 MAP, under L_1 and L_2 the C_1 plants had a greater number of aerial roots (8.481 and 10.222 respectively) than the C_2 plants. Under L_3 there was no significant difference between the C_1 and C_2 plants in the number of aerial roots. Among the C_1 plants the number was greater under L_2 than under L_1 or L_3 and among the C_2 plants, the number was greater under L_2 and L_3 than under L_1. As in the previous month the L_2C_1 plants had a greater number than all the others.

Table 38. Effects of light intensities culture methods and their interactions on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after planting								
	6	7	8	9	10	11	12	13	14
L_1	4.130	4.519	4.972	5.306	5.907	6.296	7.120	7.694	7.7991
L_2	4.519	5.611	5.787	6.019	7.361	8.019	8.380	9.259	9.454
L_3	40417	5.491	5.926	6.426	7.083	7.843	8.389	8.509	8.519
F	1.920	22.470	12.673	37.397	224.019	338.952	191.821	30.486	11.847
CD (0.05)	—	0.769	—	0.564	0.314	0.313	0.321	0.863	—
C_1	4.562	5.667	6.307	6.469	7.327	7.981	8.543	9.086	9.333
C_2	4.418	4.747	5.086	5.364	6.241	6.790	7.383	7.889	7.975
F	264.363	36.936	44.740	46.233	84.640	43.250	54.721	160.741	372.487
CD (0.05)	0.081	0.482	0.452	0.517	0.376	0.576	0.499	0.301	0.224
L_1C_1	4.500	4.852	5.389	5.796	6.593	7.019	7.815	8.481	8.481
L_1C_2	3.759	4.185	4.556	4.815	5.222	5.574	6.426	6.426	6.907
L_2C_1	4.648	6.278	6.519	6.741	8.056	9.000	9.444	9.446	10.222
L_2C_2	4.389	4.944	5.056	5.296	6.667	7.037	7.315	7.315	8.296
L_3C_1	4.537	5.870	6.204	6.870	7.333	7.926	8.370	8.370	8.556
L_3C_2	4.296	5.111	5.648	5.981	6.833	7.759	8.407	8.407	8.463
F	41.399	1.898	3.567	1.118	6.167	8.681	16.426	16.426	35.368
CD (0.05)	0.140	—	—	—	—	—	0.865	0.865	0.521

At 14 MAP, under L_1 and L_2 the C_1 plants had a greater number of aerial roots (8.963 and 10.463 respectively) than the C_2 plants. Under L_3 there was no significant difference between the C_1 and C_2 plants in the number of aerial roots. Among the C_1 plants those grown under L_2 had a greater number than those grown under L_1 and these in turn had a greater number than those grown under L_3. Among the C_2 plants those grown under L_3 or L_2 had a greater number than those grown under L_1. The L_2C_1 plants had a greater number (10.463) than all the others.

4.1.1.4.3 The effect of LCP interaction

Interaction between light intensities culture methods and the P doses was significant at four and five MAP (March and April 1992) (Table 39). During March, there was no significant difference in the number of aerial roots produced between the L_1C_1, L_1C_2 and L_3C_1 plants receiving P_1, P_2 and P_3. Among the L_2C_1 plants, those receiving P_1 or P_3 had a greater number of aerial roots (4.889 and 4.167 respectively) than those receiving P_2. Among the L_2C_2 plants those receiving P_3 had a greater number of aerial roots (4.167) than those receiving P_2. Among the L_3C_2 plants, those receiving P_2 had a significantly greater number of aerial roots (4.500) than those receiving P_1 or P_3.

At five MAP, under L_2C_1 the plants receiving P_1 had a significantly greater number of aerial roots (4.889) than those receiving P_2 or P_3. Under L_2C_2 the plants receiving P_3 had a greater number of aerial roots (4.167) than those receiving P_2. Under L_3C_2 the plants receiving P_2 had a greater number of aerial roots (4.500) than those receiving P_3. Under L_1C_1, L_1C_2 and L_3C_1 there was no significant difference in the number of aerial roots among the plants receiving P_1, P_2 or P_3.

Table 39. Interaction of culture methods with L and P and K on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	4 MAP	5 MAP	Treatment	6 MAP	9 MAP
$L_1C_1P_1$	3.556	3.722	$C_1P_1K_1$	4.833	6.389
$L_1C_1P_2$	4.222	4.278	$C_1P_1K_2$	4.222	6.333
$L_1C_1P_3$	3.667	3.722	$C_1P_1K_3$	4.611	6.778
$L_1C_2P_1$	3.389	3.611	$C_1P_2K_1$	4.889	6.833
$L_1C_2P_2$	3.389	3.556	$C_1P_2K_2$	4.444	6.944
$L_1C_2P_3$	3.667	3.556	$C_1P_2K_3$	4.111	6.500
$L_2C_1P_1$	4.889	4.889	$C_1P_3K_1$	4.556	5.889
$L_2C_1P_2$	3.944	3.944	$C_1P_3K_2$	4.278	6.056
$L_2C_1P_3$	4.167	4.167	$C_1P_3K_3$	5.111	6.500
$L_2C_2P_1$	3.722	3.722	$C_2P_1K_1$	4.056	5.611
$L_2C_2P_2$	3.444	3.444	$C_2P_1K_2$	4.278	5.222
$L_2C_2P_3$	4.167	4.167	$C_2P_1K_3$	4.222	5.389
$L_3C_1P_1$	4.222	4.222	$C_2P_2K_1$	3.944	5.056
$K_3C_1P_2$	3.778	3.778	$C_2P_2K_2$	3.944	5.111
$L_3C_1P_3$	4.111	4.111	$C_2P_2K_3$	4.333	5.889
$L_3C_2P_1$	3.667	3.833	$C_2P_3K_1$	4.333	5.333
$L_3C_2P_2$	4.500	4.500	$C_2P_3K_3$	4.222	5.556
$L_3C_2P_3$	3.500	3.500	$C_2P_3K_3$	4.000	5.111
F	3.474	3.402	F	2.691	2.412
CD (0.05)	0.715	0.690	CD (0.05)	0.691	0.802

4.1.1.4.4 The effect of LCNPK interaction

The effect of interaction between light intensities culture methods and the NPK combinations on the number of aerial roots found on the plants was significant during July and August 1992 (Table 40 and 41).

During July (Table 40) under L_1C_1, the plants receiving $N_1P_2K_3$ had a greater number of aerial roots (7.5) than those receiving $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_3$, $N_2P_3K_1$ and $N_3P_1K_2$.

Under L_1C_2, the plants receiving $N_3P_2K_3$ had a greater number of aerial roots (6.500) than those receiving $N_1P_2K_3$, $N_2P_2K_3$ and $N_2P_3K_3$. Under L_2 C_1 the plants receiving $N_1P_2K_1$, $N_2P_2K_3$ and $N_3P_1K_2$ had a greater number of aerial roots (8.000) than those receiving $N_2P_3K_3$ or $N_3P_3K_2$. Under L_2C_2 there was no significant difference between the plants receiving the various NPK combinations in the number of aerial roots produced. Under L_3C_1 the plants receiving $N_1P_2K_3$ had a greater number of aerial roots (8.000) than those receiving $N_1P_1K_2$, $N_3P_1K_3$, $N_3P_2K_1$ and $N_3P_2K_2$. Under L_3C_2 the plants receiving $N_1P_1K_1$ or $N_1P_2K_3$ had a greater number of aerial roots (7.500) than those receiving $N_1P_2K_1$ or $N_3P_1K_2$.

At nine MAP (Table 41) under L_1C_1, the plants receiving $N_1P_2K_3$ had a greater number of aerial roots (7.500) than those receiving $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_3K_1$, $N_3P_1K_1$, $N_3P_1K_2$ and $N_3P_3K_1$. Under L_1C_2 the plants receiving $N_1P_3K_1$ or $N_3P_2K_3$ had a greater number of aerial roots (6.500) than those receiving $N_1P_2K_3$, $N_2P_2K_1$ $N_2P_3K_3$, $N_3P_1K_3$, $N_3P_2K_2$, $N_2P_3K_3$, $N_1P_1K_3$ and $N_3P_2K_3$.

Table 40. Interaction effects of light and culture methods with NPK on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon' at eight MAP (July 1993)

Treatments	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	5.500	5.500	6.500	5.000	6.000	7.500
$N_1P_1K_2$	4.500	4.500	7.500	4.500	4.500	5.000
$N_1P_1K_3$	4.500	4.500	5.500	5.500	7.000	5.000
$N_1P_2K_1$	6.000	5.000	8.000	5.500	5.500	3.500
$N_1P_2K_2$	6.000	4.500	7.500	5.000	7.000	5.500
$N_1P_2K_3$	7.500	3.500	5.500	5.500	5.500	7.500
$N_1P_3K_1$	6.500	4.000	5.500	4.500	5.500	6.000
$N_1P_3K_2$	4.000	6.000	7.000	5.500	6.500	5.000
$N_1P_3K_3$	4.500	4.000	6.000	4.500	7.000	5.000
$N_2P_1K_1$	5.000	4.500	7.500	6.000	6.000	5.500
$N_2P_1K_2$	5.000	4.500	7.000	5.000	7.000	5.500
$N_2P_1K_3$	5.000	4.500	7.500	4.000	8.000	5.500
$N_2P_2K_1$	6.500	4.000	6.000	4.500	7.500	6.000
$N_2P_2K_2$	5.500	4.500	6.000	5.500	6.500	6.000
$N_2P_2K_3$	4.500	3.500	8.000	5.000	5.500	6.500
$N_2P_3K_1$	4.500	4.500	6.500	6.000	6.500	5.000
$N_2P_3K_2$	7.000	5.000	6.500	5.000	5.500	5.000
$N_2P_3K_3$	5.000	3.000	5.000	5.000	7.000	5.000
$N_3P_1K_1$	5.000	3.000	5.500	4.500	7.000	6.500
$N_3P_1K_2$	4.500	4.000	8.000	6.000	6.000	4.500
$N_3P_1K_3$	6.000	4.000	6.500	5.500	5.000	6.000
$N_3P_2K_1$	5.000	4.500	5.500	4.500	4.500	5.500
$N_3P_2K_2$	7.000	4.000	7.500	3.500	5.000	6.500
$N_3P_2K_3$	5.000	6.500	6.000	5.000	7.000	6.500
$N_3P_3K_1$	5.000	5.500	6.000	5.000	5.500	5.000
$N_3P_3K_2$	5.000	4.500	5.000	6.000	6.000	6.000
$N_3P_3K_3$	6.000	5.500	7.000	5.000	7.500	6.000
F	1.847	—	—	—	—	—
CD (0.05)	2.578	—	—	—	—	—

Table 41. Interaction effects of light and culture methods with NPK on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon' at nine MAP (August 1992)

Treatments	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	6.500	5.500	7.000	5.000	6.000	6.500
$N_1P_1K_2$	5.500	4.500	7.500	5.000	5.000	5.500
$N_1P_1K_3$	5.500	5.000	5.500	6.000	9.000	7.000
$N_1P_2K_1$	6.000	5.000	8.500	6.500	6.500	3.500
$N_1P_2K_2$	6.500	4.500	8.500	5.500	8.500	5.500
$N_1P_2K_3$	7.500	4.000	5.500	5.500	5.500	7.500
$N_1P_3K_1$	6.500	4.500	6.000	4.500	6.000	7.000
$N_1P_3K_2$	4.000	6.500	7.500	5.500	7.000	5.500
$N_1P_3K_3$	5.000	4.500	6.000	5.000	7.000	5.000
$N_2P_1K_1$	5.000	5.000	7.500	6.000	6.500	6.000
$N_2P_1K_2$	6.000	5.000	7.500	5.000	7.000	6.000
$N_2P_1K_3$	5.000	4.500	8.000	4.500	8.500	6.000
$N_2P_2K_1$	7.000	4.000	6.000	4.500	8.000	6.000
$N_2P_2K_2$	6.000	4.500	6.000	5.500	7.000	6.000
$N_2P_2K_3$	5.500	4.500	8.000	5.000	6.500	7.000
$N_2P_3K_1$	4.500	4.500	6.500	6.000	6.500	5.000
$N_2P_3K_2$	7.000	5.000	6.500	5.500	5.500	5.000
$N_2P_3K_3$	5.500	3.000	5.000	6.000	7.000	5.500
$N_3P_1K_1$	5.000	5.500	5.500	4.500	8.500	6.500
$N_3P_1K_2$	4.000	5.000	8.000	6.000	6.500	5.000
$N_3P_1K_3$	7.500	4.000	6.500	5.500	5.500	6.000
$N_3P_2K_1$	5.500	5.500	6.000	4.500	8.000	6.000
$N_3P_2K_2$	7.000	4.000	7.500	4.000	5.500	6.500
$N_3P_2K_3$	6.500	6.500	6.000	5.500	7.500	7.500
$N_3P_3K_1$	5.000	5.500	6.000	5.500	6.000	5.500
$N_3P_3K_2$	5.500	4.500	5.000	6.000	6.500	6.500
$N_3P_3K_3$	6.000	5.500	8.500	5.000	8.500	6.500
F	2.396	—	—	—	—	—
CD (0.05)	2.405	—	—	—	—	—

Under L_2C_1 the plants receiving $N_1P_2K_1$ or $N_1P_2K_2$ had a greater number of aerial roots (8.500) than those receiving $N_1P_1K_3$, $N_1P_2K_3$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_1$, $N_2P_2K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_2K_1$, $N_2P_2K_3$, $N_3P_3K_1$ and $N_3P_3K_2$. Under L_2 C_2 the plants receiving $N_1P_2K_1$ had a greater number of aerial roots (6.500) than those receiving $N_3P_2K_2$. Under L_3C_1 the plants receiving $N_1P_1K_3$ had a greater number of aerial roots (9.000) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_1$, $N_1P_2K_3$, $N_1P_3K_1$, $N_2P_1K_1$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$ $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_3K_1$ and $N_3P_3K_2$. Under L_3C_2 the plants receiving $N_3P_2K_3$ had a greater number of aerial roots (7.500) than those receiving $N_1P_2K_1$, $N_1P_3K_3$, $N_2P_3K_1$, $N_2P_3K_2$ and $N_3P_1K_2$. Among the NPK combinations, $N_1P_3K_2$ resulted in a greater number of aerial roots under L_1C_2 than under L_1C_1 while $N_2P_3K_3$, $N_3P_1K_3$ and $N_3P_2K_2$ resulted in a greater number under L_1C_1 than under L_1C_2. $N_1P_2K_2$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_3P_2K_3$ and $N_3P_3K_3$ resulted in a greater number under L_2C_1 than under L_2C_2. $N_1P_2K_1$ and $N_1P_2K_2$ resulted in a greater number under L_3C_1 than under L_3C_2.

4.1.1.4.5 The effect of LP interaction

Interaction between light and the P doses was significant at six MAP (May 1992) (Table 42). Under L_2 the plants receiving P_1 or P_3 had a greater number of aerial roots (4.800 and 4.667 respectively) than those receiving P_2. Under L_1 and L_2 there was no significant difference in the number of aerial roots between the plants receiving P_1, P_2 or P_3.

4.1.1.4.6 The effect of LNK interaction

Effect of interaction between light and the NK combinations was significant at five MAP (April 1992) (Table 43).

Table 42. Effect of light intensities, P and their interaction on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	6 MAP
L_1	4.130
L_2	4.519
L_3	4.417
F	1.920
CD (0.05)	—
P_1	4.370
P_2	4.278
P_3	4.417
F	0.483
CD (0.05)	—
L_1P_1	3.944
L_1P_2	4.222
L_1P_3	4.222
L_2P_1	4.806
L_2P_2	4.083
L_2P_3	4.667
L_3P_1	4.361
L_3P_2	4.528
L_3P_3	4.361
F	2.687
CD (0.05)	0.488

4.1.1.4.6 The effect of LNK interaction

Effect of interaction between light and the NK combinations was significant at five MAP (April 1992) (Table 43).

Table 43. Interaction effects of light with NK and NPK on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	5 MAP	Treatment	10 MAP		
			L_1	L_2	L_3
$L_1N_1K_1$	4.000	N_1P1K_1	6.250	7.000	6.500
$L_1N_1K_2$	3.417	N_1P1K_2	6.000	7.000	6.000
$L_1N_1K_3$	3.333	N_1P1K_3	5.500	6.000	8.000
$L_1N_2K_1$	3.667	N_1P2K_1	5.500	8.250	6.250
$L_1N_2K_2$	4.167	N_1P2K_2	5.500	7.000	7.750
$L_1N_2K_3$	3.667	N_1P2K_3	6.750	6.250	6.500
$L_1N_3K_1$	3.750	N_1P3K_1	6.000	7.000	7.750
$L_1N_3K_2$	3.750	N_1P3K_2	5.750	7.000	6.750
$L_1N_3K_3$	3.917	N_1P3K_3	5.250	7.750	6.750
$L_2N_1K_1$	4.250	N_2P1K_1	6.250	7.500	7.750
$L_2N_1K_2$	4.500	N_2P1K_2	5.750	7.000	7.000
$L_2N_1K_3$	3.250	N_2P1K_3	5.250	7.000	7.750
$L_2N_2K_1$	4.333	N_2P2K_1	8.000	6.750	7.250
$L_2N_2K_2$	4.000	N_2P2K_2	6.500	8.250	6.500
$L_2N_2K_3$	4.250	N_2P2K_3	5.000	8.000	8.250
$L_2N_3K_1$	3.750	N_2P3K_1	5.250	8.000	7.250
$L_2N_3K_2$	3.833	N_2P3K_2	6.500	6.750	6.250
$L_2N_3K_3$	4.333	N_2P3K_3	4.750	7.250	7.000
$L_3N_1K_1$	3.167	N_3P1K_1	5.500	6.000	8.250
$L_3N_1K_2$	4.167	N_3P1K_2	5.500	8.000	5.750
$L_3N_1K_3$	4.250	N_3P1K_3	6.750	9.000	6.250
$L_3N_2K_1$	4.083	N_3P2K_1	6.000	6.750	7.000
$L_3N_2K_2$	3.833	N_3P2K_2	5.750	7.250	6.250
$L_3N_2K_3$	4.000	N_2P3K_3	6.500	7.750	7.500
$L_3N_3K_1$	4.167	N_3P3K_1	6.750	7.750	7.250
$L_3N_3K_2$	3.917	N_3P3K_2	5.250	8.250	7.250
$L_3N_3K_3$	4.333	N_3P3K_3	5.750	8.250	8.500
F	2.713	F	2.041	—	—
CD (0.05)	0.845	CD (0.05)	2.002	—	—

Under L_1, there was no significant difference in the number of aerial roots produced by the plants receiving the different NK combinations. Under L_2, the plants receiving N_1K_1, N_1K_2, N_2K_1, N_2K_3 and N_3K_3 had a greater number of roots (4.250, 4.500, 4.333, 4.250 and 4.333 respectively) than those receiving N_1K_3. Under L_3, the plants receiving N_1K_2, N_1K_3, N_2K_1, N_3K_1 and N_3K_3 had a greater number of roots (4.250, 4.083, 4.107, and 4.333 respectively) than those receiving N_1K_1. Among the NK doses, N_1K_2 resulted in a greater number of roots under L_2 than under L_1 and N_1K_3 resulted in a greater number under L_3 than under L_1 or L_2.

4.1.1.4.7 The effect of LNPK interaction

Interaction between light intensities and the NPK combinations was observed during the 10th MAP (September 1992) (Table 43). Under L_1, the plants receiving $N_2P_2K_1$ had a greater number of aerial roots than those receiving $N_1P_1K_3$, $N_1P_2K_1$, $N_1P_1K_2$, $N_1P_3K_2$ $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_2K_2$ $N_3P_3K_2$ and $N_3P_3K_3$. Under L_2 the plants receiving $N_3P_1K_3$ had a greater number of aerial roots (9.000) than those receiving $N_1P_1K_3$, $N_1P_2K_3$, $N_2P_2K_1$, $N_2P_3K_2$, $N_3P_1K_1$ and $N_3P_2K_1$. Under L_3 the plants receiving $N_3P_3K_3$ had a greater number of aerial roots than those receiving $N_1P_1K_2$, $N_1P_2K_1$, $N_2P_3K_2$, $N_3P_1K_2$, $N_3P_1K_3$ and $N_3P_2K_2$. Among the combinations, $N_1P_2K_1$, $N_2P_3K_1$ and $N_3P_3K_2$ resulted in a greater number under L_2 than under L_1, $N_2P_2K_3$, $N_2P_3K_3$ and $N_3P_3K_3$ resulted in a greater number under L_2 and L_3 than under L_1 and $N_3P_1K_2$ and $N_3P_1K_3$ resulted in a greater number under L_2 than under L_1 or L_3.

4.1.1.4.8 The effect of the culture methods and their interactions

The culture method influenced the number of aerial roots produced at six to 14 MAP (May 1992 to January 1993) (Table 44). Throughout the period, the C_1 plants had a greater number of aerial roots than the C_2 plants. The difference between the two during the 6th MAP was 0.414 and during the 14th MAP, 1.358.

Table 44. Effect of culture methods, N and their interaction on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	10 MAP
C_1	7.327
C_2	6.241
F	84.640
CD (0.05)	0.376
N_1	6.593
N_2	6.843
N_3	6.917
F	1.492
CD (0.05)	—
C_1N_1	7.093
C_1N_2	7.648
C_1N_3	7.241
C_2N_1	6.093
C_2N_2	6.037
C_2N_3	6.593
F	3.072
CD (0.05)	0.545

4.1.1.4.9 The effect of CN interaction

The effect of interaction between the culture methods and the N doses was evident at 10 MAP (September 1992) (Table 44). Under C_1 the plants receiving N_2 had a greater number of aerial roots (7.648) than those receiving N_1 (7.093). The C_1N_2 plants and the C_1N_3 plants had a greater number of roots than the C_2N_1, C_2N_2 or C_2N_3 plants . Under C_2 the plants receiving N_3 had a greater number of roots (6.593) than those receiving N_2.

4.1.1.4.10 The effect of CPK interaction

Interaction between the culture methods and the PK combinations on the number of aerial roots found on the plants was significant at six and nine MAP (May and August 1992) (Table 39). Under C_1 the plants receiving P_3K_3 had a greater number of aerial roots (5.111) than those receiving P_1K_1, P_2K_3 and P_3K_2. Under C_2 there was no significant difference in the number of aerial roots among the plants receiving the various PK combinations. Among the combinations P_1K_1 P_2K_1 and P_3K_3 resulted in a greater number of aerial roots under C_1 than under C_2.

At nine MAP under C_1, the plants receiving P_2K_2 had a greater number of aerial roots (6.944) than those receiving P_3K_1 or P_3K_2. The plants receiving P_1K_3 or P_2K_1 too had a greater number of aerial roots (6.778 and 6.833 respectively) than P_3K_1. Under C_2, the plants receiving P_2K_3 had a greater number or aerial roots (5.889), than those receiving P_2K_1. Among the PK combinations P_1K_2, P_1K_3, P_2K_1, P_2K_2 and P_3K_2 resulted in a greater number of aerial roots under C_1 than under C_2.

4.1.1.5 Increase in the length of the aerial roots

4.1.1.5.1 The effect of light intensities

The effect of light intensities on the increase in the length of aerial roots was significant at seven, nine and 11 MAP (June, August and October 1992) (Table 39). At seven MAP, under L_2 and L_3 the root length increment was significantly greater (3.838 and 3.823 cm respectively) than under L_1. At nine MAP, the increment was greater under L_2 and L_3 (3.602 and 3.611 cm respectively) than under L_1. At 11 MAP, under a similar effect, the increase was respectively 3.711 and 3.640 cm in the L_2 and L_3 plants.

4.1.1.5.2 The effect of LC interaction

A significant interaction between light intensities and the culture methods was observed in the plants receiving nutrient treatments and in the control plants. In the treated plants the effects were significant throughout the period under observation, from seven to 11 MAP (June to October 1992) (Table 45).

At seven MAP under L_1, a greater increase in the length of the aerial roots was observed in the C_2 plants (4.007 cm) than in the C_1 plants (2.962cm). Under L_2 no significant difference was observed between the C_1 and C_2 plants in root length increment. Under L_3, the increase was greater in the C_1 plants (4.010cm) than in the C_2 plants (3.636cm). Among the C_1 plants, the increase was greater under L_2 and L_3 than under L_1. Among the C_2 plants the increase was greater under L_1 than under L_3.

Table 45. Effect of light intensities, culture methods and their interaction on the increase in the length of the aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	Months after Planting				
	7	8	9	10	11
L_1	3.485	3.544	3.256	3.326	3.365
L_2	3.838	3.705	3.602	3.571	3.711
L_3	3.823	3.789	3.611	3.510	3.646
F	92.461	2.091	39.084	0.017	27.506
CD (0.05)	0.126	—	0.197	—	0.213
C_1	3.610	3.539	3.397	3.332	3.473
C_2	3.821	3.820	3.583	3.606	3.674
F	10.185	13.372	3.635	13.154	2.902
CD (0.05)	0.211	0.244	—	0.240	—
L_1C_1	2.962	2.983	2.854	2.738	2.814
L_1C_2	4.007	4.106	3.659	3.914	3.917
L_2C_1	3.856	3.694	3.621	3.656	3.859
L_2C_2	3.819	3.716	3.583	3.486	3.562
L_3C_1	4.010	3.939	3.717	3.604	3.747
L_3C_2	3.636	3.639	3.506	3.417	3.544
F	41.777	31.594	10.419	35.921	14.666
CD (0.05)	0.3655	0.422	0.536	.415	0.650
L_1C_1 To	2.875	2.525	3.400	2.875	2.700
L_1C_2 To	3.700	3.550	3.825	4.250	3.875
L_2C_1 To	3.350	4.425	3.425	3.575	4.250
L_2C_2 To	3.450	3.725	4.050	3.450	4.125
L_3C_1 To	3.750	3.850	3.925	3.550	3.525
L_3C_2 To	3.400	3.900	3.850	3.525	3.050
F	0.779	2.953	0.517	1.371	2.928
CD(0.05)	—	1.016	—	—	0.996

At eight MAP under L_1, the increase in length of aerial roots was greater in the C_2 plants (4.106 cm) than in the C_1 plants. Under L_2 and L_3 there was no significant difference between the C_1 and C_2 plants in this aspect. The C_2 plants grown under L_1 recorded a greater increase than those grown under L_3 and the C_1 plants grown under L_2 or L_3 recorded a greater increase than those grown under L_1.

At nine MAP, under L_1 the C_2 plants had a greater increase (3.659cm) than the C_2 plants (2.854cm). Under L_2 and L_3 the increase was not significantly different in the C_1 and C_2 plants. The C_1 plants grown under L_2 were found to have a greater increase in root length (3.621cm) than those grown under L_1.

At 10 MAP the L_1C_1 plants recorded the lowest increase in root length among the treatments. The C_2 plants grown under L_1 recorded a greater increase (3.914cm) than those grown under L_2 or L_3.

At 11 MAP too the L_1C_1 plants recorded a lower increase in root length than the L_1C_2, L_2C_1, L_2C_2, L_3C_1 and the L_3C_2 plants. Under L_2 and L_3 the C_1 and C_2 plants did not record a significant difference in root length increase.

Among the control plants (Table 45) those grown under L_1C_1 recorded a lesser increase in root length than those grown under L_1C_2, L_2C_1 L_2C_2 L_3C_1 and L_3C_2 during July 1992. During October, the control plants grown under L_1C_2 L_2C_1 and L_2C_2 recorded a greater increase in root length (3.875, 4.250 and 4.125 cm respectively) than the L_1C_1 controls, which in turn recorded an increase of 2.700 cm. The control plants under L_2C_2 and L_2C_1 recorded a greater increase than the L_3C_2 controls too.

4.1.1.5.3 The effect of LCNPK interaction

The effect of interaction between light intensities, culture methods and the NPK combinations was significant at 10 MAP (September 1992) (Table 46). During the month, among the C_2 plants grown under L_1 those receiving $N_2P_1K_1$ had a greater increase in root length (4.900 cm) than those receiving $N_1P_2K_1$, $N_1P_2K_3$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_1$, $N_2P_2K_3$, $N_3P_1K_1$, $N_3P_2K_1$, $N_3P_2K_2$ and $N_3P_3K_3$.

Among the C_1 plants grown under L_2, those receiving $N_3P_1K_1$ had a greater increase (4.100 cm) than those receiving $N_3P_3K_1$. Among the C_2 plants grown under L_2 those receiving $N_1P_2K_1$ had a greater increase (4.400 cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$ $N_1P_3K_2$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_2$, $N_2P_2K_3$, $N_3P_1K_1$, $N_3P_2K_2$ and $N_3P_3K_2$. Among the C_1 plants grown under L_3 those receiving $N_3P_1K_3$ had a greater increase (4.575 cm) than those receiving $N_1P_1K_2$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_1$, $N_2P_2K_3$, $N_2P_3K_1$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_2K_1$ and $N_3P_3K_1$. Among the C_2 plants grown under L_3 those receiving $N_3P_2K_3$ had a greater increase (4.175 cm) than those receiving $N_2P_2K_1$, $N_2P_2K_2$ $N_2P_2K_3$, $N_3P_1K_2$, $N_3P_2K_2$ and $N_3P_3K_2$.

4.1.1.5.4 The effect of LP interaction

The effect of interaction between the light intensities and the P doses was significant at 11 MAP (October 1992) (Table 47). The P_1 plants grown under L_2 or L_3 had a greater increase in the root length (3.522 and 3.660 cm respectively) than those grown under L_1, the P_2 plants grown under L_2 or L_3 had a greater increase than under L_1 and the P_3 plants grown under L_2 had a significantly greater increase than those grown under L_1 or L_3.

Table 46. Interaction effects of light intensity and culture methods with NPK on the increase in the length of the aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon' at 10 MAP

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	2.800	4.325	3.250	2.925	3.550	3.300
$N_1P_1K_2$	2.625	4.700	3.800	3.625	3.375	3.775
$N_1P_1K_3$	2.800	3.900	3.900	3.075	3.550	3.300
$N_1P_2K_1$	2.225	3.750	3.325	4.400	3.950	3.825
$N_1P_2K_2$	2.225	4.325	3.900	3.700	3.875	3.550
$N_1P_2K_3$	2.925	3.625	3.650	3.725	3.650	3.550
$N_1P_3K_1$	2.400	3.875	3.775	3.475	2.800	3.700
$N_1P_3K_2$	2.770	4.100	3.825	3.200	3.925	3.525
$N_1P_3K_3$	2.900	3.675	3.175	4.075	3.200	3.475
$N_2P_1K_1$	2.825	4.900	3.625	3.275	3.900	3.800
$N_2P_1K_2$	2.425	3.725	4.075	2.550	4.125	3.950
$N_2P_1K_3$	3.125	3.425	3.775	3.925	3.550	3.325
$N_2P_2K_1$	2.825	3.750	3.300	3.800	3.525	2.800
$N_2P_2K_2$	2.625	3.975	3.425	2.675	4.050	2.725
$N_2P_2K_3$	2.650	3.175	3.775	2.825	2.775	2.525
$N_2P_3K_1$	2.700	4.125	3.725	2.475	3.400	3.475
$N_2P_3K_2$	3.100	3.925	3.475	4.225	3.750	3.600
$N_2P_3K_3$	3.000	3.950	3.800	4.125	3.600	3.150
$N_3P_1K_1$	2.425	2.900	4.100	3.150	3.425	3.350
$N_3P_1K_2$	2.500	3.900	3.500	3.700	3.200	2.925
$N_3P_1K_3$	2.750	4.275	3.875	3.425	4.575	3.225
$N_3P_2K_1$	2.450	3.850	3.950	3.925	3.350	4.125
$N_3P_2K_2$	2.825	3.575	3.550	3.300	4.250	2.750
$N_3P_2K_3$	2.850	3.650	3.700	4.375	3.875	4.175
$N_3P_3K_1$	2.675	3.975	2.800	3.700	3.300	3.450
$N_3P_3K_2$	2.875	4.125	3.800	3.000	3.800	3.025
$N_3P_3K_3$	3.125	4.200	3.850	3.475	2.975	3.875
F	1.953	—	—	—	—	—
CD(0.05)	1.035	—	—	—	—	—

Table 47. Effect of light intensities, culture methods, P and their interaction on the increase in the length of the aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	11 MAP
L_1	3.365
L_2	3.711
L_3	3.646
F	27.506
CD (0.05)	0.213
P_1	3.460
P_2	3.620
P_3	3.642
F	4.142
CD(0.05)	0.136
L_1P_1	3.197
L_1P_2	3.326
L_1P_3	3.572
L_2P_1	3.522
L_2P_2	3.775
L_2P_3	3.835
L_3P_1	3.660
L_3P_2	3.758
L_3P_3	3.519
F	3.380
CD(0.05)	0.235
C_1	3.473
C_2	3.674
F	2.902
CD(0.05)	—
C_1P_1	3.431
C_1P_2	3.565
C_1P_3	3.424
C_2P_1	3.488
C_2P_2	3.675
C_2P_3	3.860
F	4.411
CD(0.05)	0.192

Under L_1, the P_3 plants had a greater increase (3.572 cm) than the P_2 or P_1 plants, under L_2 the P_2 and P_3 plants had a greater increase (3.775 and 3.835 cm) than the P_1 plants and under L_3 the P_2 plants had a greater increase (3.758 cm) than the P_3 plants.

4.1.1.5.5 The effect of LNPK interaction

The effect of interaction between light and the NPK combinations was significant at eight MAP and 11 MAP (July and October 1992) (Table 48).

At eight MAP under L_1, the plants receiving $N_2P_3K_1$ had a greater root length increase (4.025 cm) than those receiving $N_1P_2K_2$, $N_3P_1K_2$, $N_3P_2K_3$ and $N_3P_3K_1$. Under L_2 the plants receiving $N_3P_3K_1$ had a greater increase (4.250 cm) than those receiving $N_1P_1K_2$, $N_1P_1K_3$, $N_2P_1K_2$, $N_2P_2K_2$, $N_2P_3K_2$ and $N_3P_3K_2$. Under L_3 the plants receiving $N_1P_1K_3$ had a greater increase (4.500 cm) than those receiving $N_1P_2K_3$; $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_2K_1$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$.

At 11 MAP (Table 48) under L_1, the plants receiving $N_2P_3K_2$ or $N_3P_2K_3$ recorded a greater increase in the length of aerial roots (3.863 cm) than those receiving $N_1P_1K_3$, $N_1P_2K_2$ $N_2P_1K_2$, $N_2P_2K_2$, $N_3P_1K_1$ and $N_3P_1K_3$. Under L_2 the plants receiving $N_1P_2K_1$ recorded a greater increase in root length (4.338 cm) than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_2$, $N_1P_2K_3$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_1$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$ and $N_3P_3K_1$. Under L_3 the plants receiving $N_3P_1K_3$ recorded a greater increase in root length (4.388 cm) than those receiving $N_1P_1K_1$, $N_1P_1K_3$, $N_1P_2K_2$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_3K_1$, $N_3P_1K_2$, $N_3P_2K_3$, $N_3P_3K_1$ and $N_3P_3K_3$.

Table 48. Interaction effects of light intensity with NPK on the increase in the length of the aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	8 MAP			11 MAP		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	3.925	3.888	3.863	3.313	3.375	3.313
$N_1P_1K_2$	3.500	3.888	3.925	3.313	3.525	3.863
$N_1P_1K_3$	3.450	3.275	4.500	2.750	3.763	3.075
$N_1P_2K_1$	3.588	3.663	4.175	3.363	4.338	3.725
$N_1P_2K_2$	2.738	3.913	3.800	3.125	3.525	3.450
$N_1P_2K_3$	3.750	3.738	3.288	3.388	3.400	3.950
$N_1P_3K_1$	3.725	3.900	3.800	3.313	3.938	3.463
$N_1P_3K_2$	3.700	3.850	3.688	3.588	3.963	3.800
$N_1P_3K_3$	3.575	3.637	3.700	3.738	4.325	3.137
$N_2P_1K_1$	3.800	3.762	3.613	3.388	3.563	3.963
$N_2P_1K_2$	3.338	3.475	3.713	3.125	3.513	3.588
$N_2P_1K_3$	3.613	3.675	3.250	3.213	3.038	3.650
$N_2P_2K_1$	3.563	3.738	4.012	3.475	3.213	3.913
$N_2P_2K_2$	3.513	3.500	3.850	3.038	3.650	3.638
$N_2P_2K_3$	3.688	3.850	3.788	3.238	3.925	3.850
$N_2P_3K_1$	4.025	3.962	3.950	3.588	4.125	3.238
$N_2P_3K_2$	3.725	3.525	3.300	3.863	3.538	3.788
$N_2P_3K_3$	3.313	3.762	3.450	3.638	3.563	3.375
$N_3P_1K_1$	3.700	3.638	4.188	3.100	3.575	3.600
$N_3P_1K_2$	3.200	3.638	3.988	3.525	3.587	3.500
$N_3P_1K_3$	3.387	3.515	3.950	3.050	3.763	4.388
$N_3P_2K_1$	3.763	3.515	3.725	3.225	4.050	3.938
$N_3P_2K_2$	3.788	3.875	3.962	3.225	4..050	3.975
$N_3P_2K_3$	2.975	3.975	4.113	3.863	3.825	3.388
$N_3P_3K_1$	3.263	4.250	3.513	3.513	3.375	3.450
$N_3P_3K_2$	3.538	3.363	3.775	3.350	3.800	3.775
$N_3P_3K_3$	3.563	3.650	3.425	3.563	3.887	3.650
F	1.765	—	—	2.223	—	—
CD(0.05)	0.718	—	—	0.704	—	—

4.1.1.5.6 The effect of culture methods

The effect of the culture method treatments on the increase in length of the aerial roots was significant at seven, eight and 10 MAP (June, July and September 1992) (Table 45).

The increase in length of the aerial roots was greater in the C_2 plants than in the C_1 plants during the months. The C_2 plants recorded an increase of 3.821, 3.820 and 3.606 cm respectively as against the C_1 plants, during the months.

4.1.1.5.7 The effect of CP interaction

A significant interaction between the culture methods and the P doses was observed at 11 MAP (October 1992) (Table 47). During the month, the C_2P_3 plants recorded a greater increase of 3.860 cm when compared to the C_2P_1 plants the C_1P_2 plants, the C_1P_3 plants and the C_2P_1 plants. Among the P_3 plants those grown under C_2 recorded a greater increase than those grown under C_1. There was no significant difference between the C_1 plants receiving P_1, P_2 or P_3.

4.1.1.5.8 Effect of the N,P and K doses.

The effect of the N doses on the increase in aerial root length was not significant during the period under observation. The P doses recorded a significant effect at 11 MAP (October 1992) (Table 49) and the K doses recorded a significant effect at eight MAP (July 1992) (Table 50).

Table 49. Effect of N,P and their interaction on the increase in the length of the aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after Planting	
	10	11
N_1	3.502	3.549
N_2	3.428	3.544
N_3	3.477	3.629
F	0.556	0.960
CD (0.05)	—	—
P_1	3.483	3.460
P_2	3.452	3.620
P_3	3.472	3.642
F	0.097	4.142
CD(0.05)	—	0.136
N_1P_1	3.476	3.365
N_1P_2	3.593	3.585
N_1P_3	3.437	3.696
N_2P_1	3.572	3.449
N_2P_2	3.178	3.549
N_2P_3	3.533	3.635
N_3P_1	3.400	3.565
N_3P_2	3.585	3.726
N_3P_3	3.446	3.596
F	4.023	1.016
CD(0.05)	0.244	—

Table 50. Effects of N, K and NK interaction on the increase in the length of aerial roots (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Months after Planting	
	8	10
N_1	3.701	3.502
N_2	3.657	3.428
N_3	3.680	3.477
F	0.195	0.556
CD(0.05)	—	—
K_1	3.779	3.422
K_2	3.613	3.487
K_3	3.626	3.498
F	4.297	0.657
CD(0.05)	0.138	—
N_1K_1	3.836	3.425
N_1K_2	3.611	3.629
N_1K_3	3.657	3.453
N_2K_1	3.825	3.457
N_2K_2	3.549	3.467
N_2K_3	3.599	3.360
N_3K_1	3.735	3.383
N_3K_2	3.681	3.367
N_3K_3	3.624	3.681
F	0.458	2.700
CD(0.05)	—	0.244

The plants receiving P_2 and P_3 recorded greater increase (3.620 and 3.642 cm respectively) than those receiving P_1.

The plants receiving K_1 recorded a greater increase (3.799cm) than those receiving K_2 and K_3.

4.1.1.5.9 Effect of NP and NK interactions

The effect of interaction between the NP doses on the increase in root length was significant during (September 1992) (Table 49). The increase was lower than all the others in the plants receiving N_2P_2 and the plants receiving N_1P_1, N_1P_2, N_1P_3, N_2P_1, N_2P_3, N_3P_2 and N_3P_3 were on par.

The effect of NK interaction was also significant at 10 MAP (September 1992) (Table 50). The plants receiving N_1K_2 had a greater increase (3.681 cm) than those receiving N_2K_3, N_3K_1 and N_3K_2. The plants receiving N_3K_3 had a greater increase than the above treatments and also N_1K_1.

4.1.6.1 Dry matter content of the leaves

The effect of light intensities, culture methods nutrients and their interactions on the dry matter content of the leaves was not significant.

Dry matter content of the stem

The effect of light intensities and culture methods on the dry matter content of the stem was not significant. Among the nutrients,the effect of the P doses was significant (Table 51) while that of the N and K doses and nutrient interactionswere not.

Table 51. Effect of N, P and K on the dry matter content of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	dm(%) of stem	dm(%)of shoot
N_1	41.566	27.229
N_2	42.890	28.154
N_3	43.656	28.562
F	2.464	2.793
CD (0.05)	—	—
P_1	41.806	27.505
P_2	41.004	27.253
P_3	45.302	29.188
F	11.513	6.626
CD (0.05)	1.867	1.133
K_1	41.810	27.849
K_2	43.482	28.425
K_3	42.819	27.671
F	1.562	0.931
CD(0.05)	—	—

The plants receiving 500 ppm P had a higher content of dry matter in the stem (45.302 per cent) than those receiving 300ppm (41.806 per cent) or 400ppm (41.004 per cent).

4.1.1.6.2 Dry matter content of the shoot

The effect of light intensities and culture methods on the dry matter content of the shoot was not significant. Among the nutrients, the effect of the P doses was significant (Table 51). The plants receiving P_3 had a higher dry matter content in the shoots (29.188 per cent) than those receiving P_1 or P_2. The effect of N and K doses and nutrient interactions were not significant.

4.1.2 Flowering and floral characters

4.1.2.1 Days to Flowering

The effect of the treatments on the days taken for the production of the first inflorescence was not significant.

4.1.2.2 Mean length of the inflorescences

4.1.2.2.1 The effect of light intensities and the response of the control plants

The direct effect of light intensities and the interaction of light intensities with culture methods on the mean length of the inflorescences was not significant (Table 52). However, among the control plants grown under the three light intensities and two culture methods, there was a significant effect on the mean length of their inflorescences (Table 52). The L_2C_1 controls had a greater mean length than the L_3C_1 and the L_3C_2 controls. So also, the L_1C_1, L_1C_2 and the L_2C_2 controls had a greater length than the L_3C_1 controls.

4.1.2.2.2 The effect of culture methods on the mean length of the inflorescences

The effect of the culture methods on the mean length of the inflorescences was significant (Table 52). The C_1 plants had a greater length (42.865 cm) than the C_2 plants (33.180 cm).

Table 52. Effect of light intensities, culture methods, the N doses and the response of the control plants on the floral characters of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Number of inflorescences per plant	Length of inflorescences (cm)	Number of branched inflorescences per plot	Vase life of inflorescences
L_1	2.293	42.438	1.398	7.287
L_2	1.957	53.247	2.778	7.833
L_3	0.209	18.382	0.000	0.713
F	62.911	7.718	59.057	489.252
CD (0.05)	0.858	—	1.100	1.090
C_1	1.850	42.865	2.272	5.877
C_2	1.123	33.180	0.512	4.679
F	42.692	10.379	21.829	22.061
CD (0.05)	0.354	1.565	1.198	0.811
L_1C_1To	3.000	42.275	1.000	7.000
L_1C_2To	2.670	42.400	1.000	6.500
L_2C_1To	2.835	62.500	4.000	8.000
L_2C_2To	1.330	44.075	1.000	6.500
L_3C_1To	0.165	17.000	0.000	0.000
L_3C_2To	0.335	20.250	0.000	3.000
F	5.912	3.504	2.338	7.335
CD (0.05)	0.847	25.050	2.640	3.116
N_1	1.414	36.901	1.241	4.889
N_2	1.599	39.877	1.657	5.546
N_3	1.447	37.290	1.278	5.398
F	1.878	1.732	3.165	5.083
CD (0.05)	—	—	0.359	0.424

The effect of nutrients and interactions between treatments did not affect the length of the inflorescences significantly.

4.1.2.3 Number of inflorescences produced per plant

4.1.2.3.1 The effect of light intensities

The effect of light intensities on the number of inflorescences produced per plant was significant (Table 52). The number was greater in the L_1 and L_2 plants than in the L_3 plants.

4.1.2.3.2 The effect of LC interaction

The effect of interaction between light intensities and culture methods on the number of inflorescences produced in the plants receiving nutrient treatments was significant (Table 53). Under L_1 and L_2, the C_1 plants had a greater number of inflorescences (2.679 and 2.636 respectively) than under L_3. The C_2 plants too had a greater number of inflorescences under L_1 and L_2 (1.908 and 1.278 respectively) than under L_3. Under these light intensities (L_1 and L_2) the number of inflorescences was greater in the C_1 plants than in the C_2 plants. There was no significant difference between the C_1 and C_2 plants in the number produced under L_3.

Under L_1 and L_3 there was no significant difference between the C_1 and C_2 controls in the number of inflorescences produced (Table 52). Under L_2 the C_1 controls had a greater number than the C_2 controls. The L_1C_1, L_1C_2 and L_2C_1 controls which were on par had a greater number of inflorescences than the L_2C_2,L_3C_2 and L_3C_1 controls.

Table 53. Effect of light intensities, culture methods and their interaction on the number of inflorescences produced per plant in *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Number of inflorescences
L_1	2.293
L_2	1.957
L_3	0.209
F	62.911
CD (0.05)	0.858
C_1	1.850
C_2	1.123
F	42.692
CD (0.05)	0.352
L_1C_1	2.679
L_1C_2	1.908
L_2C_1	2.636
L_2C_2	1.278
L_3C_1	0.238
L_3C_2	0.185
F	11.594
CD	0.613

4.1.2.3.3 The effect of LPK interaction

The effect of interaction between light intensities and the PK combinations on the number of inflorescences produced per plant was significant (Table 46). Under L_1, the plants receiving P_2K_3 had a greater number of inflorescences (2.722) than those receiving P_1K_1 and P_3K_3. The P_1K_2, P_2K_1 and the P_3K_2 plants had a greater number than the P_3K_3 plants.

Under L_2,the plants receiving P_1K_3 had a greater number than those receiving P_1K_1,P_1K_2,P_2K_3 and P_3K_2. The plants receiving P_2K_1 had a greater number than those receiving P_3K_2. Under L_3 the plants receiving the various PK combinations had a significantly lesser number of inflorescences than those grown under L_1 and L_2.

4.1.2.3.4 The effect of culture methods and their interactions

The effect of the culture methods on the number of inflorescences produced was significant (Table 52). Under C_1 the number was greater than under C_2.

Interactions between the culture methods and the N and K nutrients and their combinations was not significant. However the effect of interaction between culture methods and the P doses was significant (Table 55). The C_1 plants receiving P_2 had a greater number of inflorescences (2.031) than those receiving P_3. Among the C_2 plants there was no significant difference in the number of inflorescences produced by those receiving P_1, P_2 or P_3. Irrespective of the P dose received, the C_1 plants had a greater number of inflorescences than the C_2 plants.

4.1.2.4 Number of branched inflorescences per plot

4.1.2.4.1 The effect of light intensities and their interactions

The effect of light intensities on the number of branched inflorescences produced was significant (Table 52). The plants grown under L_2 had a greater number of branched inflorescences than those grown under L_1 and L_3.

Table 54. Interaction effects of light intensity with PK on the inflorescence characteristics of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Number of inflorescences per plant	Number of branched inflorescences per plot
$L_1P_1K_1$	2.057	1.333
$L_1P_1K_2$	2.332	1.583
$L_1P_1K_3$	2.139	1.083
$L_1P_2K_1$	2.529	1.333
$L_1P_2K_2$	2.169	1.083
$L_1P_2K_3$	2.722	2.083
$L_1P_3K_1$	2.305	1.333
$L_1P_3K_2$	2.668	2.000
$L_1P_3K_3$	1.723	0.750
$L_2P_1K_1$	1.860	3.000
$L_2P_1K_2$	1.890	2.917
$L_2P_1K_3$	2.501	3.417
$L_2P_2K_1$	2.166	3.750
$L_2P_2K_2$	2.110	3.583
$L_2P_2K_3$	1.556	1.333
$L_2P_3K_1$	1.944	2.250
$L_2P_3K_2$	1.556	2.583
$L_2P_3K_3$	2.028	2.167
$L_3P_1K_1$	0.222	0.000
$L_3P_1K_2$	0.194	0.000
$L_3P_1K_3$	0.305	0.000
$L_3P_2K_1$	0.222	0.000
$L_3P_2K_2$	0.249	0.000
$L_3P_2K_3$	0.194	0.000
$L_3P_3K_1$	0.248	0.000
$L_3P_3K_2$	0.138	0.000
$L_3P_3K_3$	0.111	0.000
F	2.564	3.099
CD (0.05)	0.599	1.078

Table 55. Effect of culture methods, P doses and their interaction on the number of inflorescences produced per plant in *Arachnis* Maggie Oei 'Red Ribbon' .

Treatment	Number of inflorescences
C_1	1.850
C_2	1.123
F	42.692
CD (0.05)	0.354
P_1	1.500
P_2	1.546
P_3	1.413
F	0.874
CD (0.050	—
C_1P_1	1.895
C_1P_2	2.031
C_1P_3	1.623
C_2P_1	1.105
C_2P_2	1.061
C_2P_3	1.204
F	3.791
CD (0.05)	0.282

Interactions between light intensities, culture methods and the N doses were not significant. However, light was found to interact with the PK combinations significantly (Table 46). Under L_1, the plots receiving P_2K_3 had a greater number of branched inflorescences (2.083) than those receiving P_3K_3. Under L_2, the plots receiving P_2K_1 had a greater number (3.750 cm) than those receiving P_2K_3, P_3K_1, P_3K_2 and P_3K_3. Under L_1 and L_2 there was no significant difference in the number of branched inflorescences produced by the plots receiving K_2 in combination with P_1, P_2 or P_3.

4.1.2.4.2 The effect of culture methods

The effect of the culture method treatments on the number of branched inflorescences produced was significant (Table 52). The C_1 plots were found to have a greater number (2.272) than the C_2 plots.

The effect of interactions between the culture method treatments and the various nutrient treatments was not significant.

4.1.2.4.3 The effect of nutrients

The effect of nitrogen on the number of branched inflorescences produced per plot was significant (Table 52). The plants receiving N_2 were found to have a greater number (1.657) than those receiving N_1 (1.241) or N_3 (1.278).

The effect of the P and K doses and also interaction between the nutrients was not significant.

4.1.2.5 Number of flowers per inflorescence

The effect of the treatments and their interactions on the number of flowers produced in an inflorescence was not significant.

4.1.2.6 Span area per flower

The effect of the treatments and their interactions on the span area per flower was not significant.

4.1.2.7 The vase life of inflorescences

4.1.2.7.1 The effect of LC interaction

The interaction effect of light intensities and culture methods on the vase life of the inflorescences of the treated plants was not significant. Among the control plants a significant effect on vase life was observed (Table 52). Inflorescences of the L_1C_1, L_1C_2, L_2C_1, and the L_2C_2 controls had a greater vase life (7.000, 6.500,8.000 and 6.500 days respectively) than those of the L_3C_1 and the L_3C_2 controls.

4.1.2.7.2 The effect of light intensities

The effect of light intensities on the vase life of the inflorescences was significant (Table 52). Inflorescences of the L_1 and L_2 plants had a greater vase life (7.287 and 7.833 days respectively) than those of the L_3 plants.

4.1.2.7.3 The effect of LCN interaction

The effect of interaction between light intensities,culture methods and the N doses was significant (Table 56). Under L_1C_1,L_1C_2 and L_2C_1 the vase life of the inflorescences of the plants receiving N_1, N_2 or N_3 was not significantly different. Under L_2C_2 the vase life was greater in the inflorescences of plants receiving N_2 or N_3 than in the inflorescences of those receiving N_1.

Among the N_1 plants, the vase life of inflorescences was greater under L_1C_1 than under L_1C_2. Among the N_2 plants the vase life of the inflorescences was not significantly different under L_1C_1 or L_1C_2.

Table 56. Interaction effects of light intensities and culture methods with N and on the vase life of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Days	Treatment	Days
$L_1C_1N_1$	7.722	$L_1C_1K_1$	8.111
$L_1C_1N_2$	7.833	$L_1C_1K_2$	7.778
$L_1C_1N_3$	7.944	$L_1C_1K_3$	7.611
$L_1C_2N_1$	6.389	$L_1C_2K_1$	7.000
$L_1C_2N_2$	6.833	$L_1C_2K_2$	6.889
$L_1C_2N_3$	7.000	$L_1C_2K_3$	6.333
$L_2C_1N_1$	8.889	$L_2C_1K_1$	8.556
$L_2C_1N_2$	8.333	$L_2C_2K_2$	9.111
$L_2C_1N_3$	8.611	$L_2C_1K_3$	8.167
$L_2C_2N_1$	5.833	$L_2C_2K_1$	7.444
$L_2C_2N_2$	7.611	$L_2C_2K_2$	6.500
$L_2C_2N_3$	7.722	$L_2C_2K_3$	7.222
$L_3C_1N_1$	0.500	$L_3C_1K_1$	1.833
$L_3C_1N_2$	1.944	$L_3C_1K_2$	0.389
$L_3C_1N_3$	1.111	$L_3C_1K_3$	1.333
$L_3C_2N_1$	0.000	$L_3C_2K_1$	0.000
$L_3C_2N_2$	0.722	$L_3C_2K_2$	0.722
$L_3C_2N_3$	0.000	$L_2C_3K_2$	0.000
F	2.618	F	3.743
CD (0.05)	1.039	CD (0.05)	1.039

4.1.2.7.4 The effect of LCK interaction

The effect of light intensities culture methods and the K doses on the vase life of the inflorescences was significant (Table 56). The inflorescences of the L_3C_1 and L_3C_2 plants receiving K_1, K_2 or K_3 had a lower vase life than those of the L_1C_1, L_1C_2, L_2C_1 and the L_2C_2 plants receiving K_1, K_2 or K_3.

4.1.2.7.5 The effect of culture methods

The effect of the culture methods on the vase life of the inflorescences' was significant (Table 52). Inflorescences of the C_1 plants were found to have a greater vase life (5.877 days) than the C_2 plants (4.679 days).

4.1.2.7.6 The effect of the N doses

The effect of the N doses received by plants on the vase life of inflorescences was significant (Table 52). Inflorescences of the plants receiving N_2 or N_3 had a greater vase life (5.546 amd 5.398 days respectively) than those of the plants receiving N_1.

The effect of the P and K doses and interaction between nutrients was not significant.

4.1.3 Nutrient composition of the leaves

4.1.3.1 The Nitrogen content

4.1.3.1.1 The effect of light intensities

The effect of light intensities on the N content of the leaves was significant (Table 57). Under L_3, the N content was greater (1.803 per cent) than under L_1 and L_2.

Table 57. Effect of light intensities, culture methods and their interaction on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N(%)	P(%)	K(%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
L_1	1.770	0.684	1.484	4.187	0.293	0.020
L_2	1.766	0.681	1.474	4.296	0.314	0.021
L_3	1.803	0.699	1.466	4.316	0.294	0.019
F	36.350	1.312	5.018	12.012	101.491	5.190
CD (0.05)	0.020	—	—	—	0.007	—
C_1	1.898	0.725	1.519	4.375	0.320	0.022
C_2	1.661	0.651	1.430	4.158	0.281	0.018
F	3866.897	26.839	209.400	82.964	82.918	37.931
CD (0.05)	0.012	0.045	0.020	0.076	0.014	0.002
L_1C_1	1.867	0.735	1.527	4.294	0.307	0.019
L_1C_2	1.672	0.634	1.441	4.080	0.280	0.020
L_2C_1	1.874	0.722	1.500	4.379	0.329	0.025
L_2C_2	1.657	0.640	1.449	4.213	0.300	0.017
L_3C_1	1.952	0.718	1.531	4.451	0.324	0.021
L_3C_2	1.653	0.680	1.401	4.182	0.263	0.016
F	69.155	1.702	13.560	1.564	6.456	16.928
CD (0.05)	0.021	—	0.034	—	—	0.004
L_1C_1 To	1.470	0.556	1.230	4.510	0.240	0.015
L_1C_2 To	1.260	0.653	1.410	3.802	0.454	0.035
L_2C_1 To	1.470	0.688	1.540	4.519	0.452	0.025
L_2C_2 To	1.260	0.729	1.360	4.115	0.359	0.015
L_3C_1 To	1.470	0.646	1.620	4.156	0.328	0.020
L_3C_2To	1.365	0.458	1.430	4.095	0.369	0.010
F	1.694	4.966	35.740	7.028	22.664	5.671
CD (0.05)	—	0.123	0.063	0.287	0.047	0.010

4.1.3.1.2 The effect of LC interaction

The effect of interaction between light intensities and culture methods was significant (Table 57). The C_1 plants had a higher content than the C_2 plants irrespective of the light intensity under which grown. The L_3C_1 plants had a greater N content (1.952 per cent) than the L_1C_1, L_1C_2, L_2C_1, L_2C_2 and L_3C_2 plants. The L_1C_1 and the L_2C_1, plants had a greater content (1.867 and 1.874 per cent respectively) than the L_1C_2, L_2C_2 and the L_3C_2 plants.

4.1.3.1.3 The effect of LCN interaction

The effect of interaction between light intensities culture methods and the N doses, on the N content of the leaves was significant (Table 58).

Among the L_1C_1 plants those receiving N_3 had a greater N content (2.205 per cent) than those receiving N_2 and these in turn had a greater content (1.890 per cent) than those receiving N_1. Among the L_1C_2, L_2C_1, L_2C_2 and the L_3C_1 plants, those receiving N_3 had a higher N content than those receiving N_2 and these in turn had a higher content than those receiving N_1 (Table 58).

4.1.3.1.4 The effect of LCP interaction

The effect of interaction between light intensities, culture methods and the P doses on the N content of the leaves was significant (Table 59). Under L_1, L_2 and L_3 among the plants receiving P_1, P_2 or P_3, the C_1 treatment resulted in a greater N content than the C_2 treatment. Among the L_1C_1, L_1C_2, L_2C_1, L_2C_2, L_3C_1 and L_3C_2 plants, those receiving P_3 had a greater N content than those receiving P_2 and these in turn had a greater content than those receiving P_1.

Table 58. Interaction effects of light, culture methods and N on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N(%)	K(%)	Mg(ppm)	Zn(ppm)	Cu(ppm)
$L_1C_1N_1$	1.506	1.467	4.258	0.332	0.019
$L_1C_1N_2$	1.890	1.628	4.321	0.262	0.017
$L_1C_1N_3$	2.205	1.477	4.304	0.329	0.022
$L_1C_2N_1$	1.528	1.413	4.194	0.258	0.024
$L_1C_2N_2$	1.657	1.442	4.088	0.285	0.018
$L_1C_2N_3$	1.832	1.467	3.959	0.296	0.018
$L_2C_1N_1$	1.598	1.437	4.336	0.316	0.030
$L_2C_1N_2$	1.948	1.624	4.417	0.297	0.022
$L_2C_1N_3$	2.077	1.439	4.384	0.375	0.023
$L_2C_2N_1$	1.482	1.566	4.320	0.334	0.019
$L_2C_2N_2$	1.668	1.371	4.124	0.283	0.018
$L_2C_2N_3$	1.820	1.410	4.195	0.281	0.014
$L_3C_1N_1$	1.657	1.563	4.482	0.361	0.020
$L_3C_1N_2$	1.983	1.486	4.411	0.287	0.023
$L_3C_1N_3$	2.217	1.543	4.460	0.326	0.021
$L_3C_2N_1$	1.482	1.371	4.026	0.245	0.017
$L_3C_2N_2$	1.622	1.417	4.305	0.255	0.014
$L_3C_2N_3$	1.855	1.417	4.214	0.289	0.017
F	3.418	146.643	13.775	44.065	6.263
CD (0.05)	0.073	0.021	0.096	0.016	0.003

Table 59. Interaction effects of light, culture methods and P on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N(%)	P(%)	K(%)	Mg(ppm)	Zn(ppm)	Cu(ppm)
$L_1C_1P_1$	1.540	0.701	1.527	4.136	0.296	0.017
$L_1C_1P_2$	1.983	0.731	1.496	4.312	0.356	0.020
$L_1C_1P_3$	2.078	0.772	1.558	4.435	0.269	0.020
$L_1C_2P_1$	1.458	0.587	1.379	3.924	0.273	0.023
$L_1C_2P_2$	1.703	0.668	1.418	4.056	0.292	0.014
$L_1C_2P_3$	1.855	0.646	1.526	4.261	0.274	0.023
$L_2C_1P_1$	1.657	0.734	1.486	4.229	0.323	0.024
$L_2C_1P_2$	1.855	0.709	1.550	4.497	0.345	0.028
$L_2C_1P_3$	2.112	0.723	1.464	4.411	0.320	0.022
$L_2C_2P_1$	1.435	0.629	1.487	4.171	0.266	0.015
$L_2C_2P_2$	1.680	0.663	1.477	4.420	0.383	0.020
$L_2C_2P_3$	1.855	0.627	1.383	4.048	0.250	0.016
$L_3C_1P_1$	1.680	0.681	1.497	4.423	0.310	0.018
$L_3C_1P_2$	1.972	0.746	1.576	4.327	0.371	0.017
$L_3C_1P_3$	2.205	0.728	1.520	4.603	0.293	0.029
$L_3C_2P_1$	1.458	0.688	1.457	4.244	0.240	0.012
$L_3C_2P_2$	1.692	0.695	1.382	4.096	0.292	0.017
$L_3C_2P_3$	1.808	0.656	1.364	4.205	0.256	0.019
F	3.450	2.619	41.681	4.728	37.956	9.249
CD (0.05)	0.073	0.041	0.021	0.096	0.016	0.003

4.1.3.1.5 The effect of LN interaction

The effect of interaction between light intensities and the N doses on the N content of the leaves was significant (Table 60). Under L_1,L_2 and L_3 the plants receiving N_3 had a higher N content (2.018,1.948 and 2.036 per cent respectively) than those receiving N_2 and these in turn had a greater content than those receiving N_1. There was no significant difference in the N content between the N_1 and N_2 plants grown under L_1, L_2 or L_3. Among the N_3 plants, the content was greater under L_1 and L_3 than under L_2.

4.1.3.1.6 The effect of LP interaction

The effect of interaction between the light intensities and the P doses on the N content of the leaves was significant (Table 60). Under L_1, L_2 and L_3 the plants receiving P_3 had a higher N content (1.966, 1.843 and 1.499 per cent respectively) than those receiving P_2 and these in turn had a greater content than those receiving P_1. There was no significant difference in the N content between the P_3 plants grown under L_1, L_2 or L_3. Among the P_2 plants, those grown under L_1 or L_3 had a higher N content (1.843 and 1.327 per cent respectively) than those grown under L_2. Among the P_1 plants, those grown under L_3 had a greater N content (1.569 per cent) than those grown under L_1.

4.1.3.1.7 The effect of LK interaction

The effect of interaction between light intensities and the K doses on the N content of the leaves was significant (Table 60).

Table 60. Interaction effects of light intensities with N,P and K on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
L_1N_1	1.517	0.648	1.444	4.226	0.295	0.022
L_1N_2	1.773	0.691	1.535	4.205	0.273	0.017
L_1N_3	2.018	0.715	1.472	4.131	0.313	0.020
L_2N_1	1.540	0.642	1.501	4.328	0.325	0.024
L_2N_2	1.808	0.665	1.498	4.271	0.290	0.020
L_2N_3	1.948	0.735	1.424	4.289	0.328	0.019
L_3N_1	1.569	0.683	1.467	4.254	0.303	0.019
L_3N_2	1.803	0.731	1.451	4.358	0.271	0.018
L_3N_3	2.036	0.682	1.480	4.337	0.307	0.019
F	2.778	9.515	55.857	4.905	1.172	4.359
CD (0.05)	0.052	0.029	0.015	0.068	—	0.002
L_1P_1	1.499	0.644	1.453	4.030	0.284	0.020
L_1P_2	1.843	0.700	1.457	4.184	0.324	0.017
L_1P_3	1.966	0.709	1.542	4.348	0.272	0.022
L_2P_1	1.546	0.681	1.486	4.200	0.294	0.019
L_2P_2	1.767	0.686	1.513	4.459	0.364	0.024
L_2P_3	1.983	0.675	1.424	4.229	0.285	0.019
L_3P_1	1.569	0.684	1.477	4.334	0.275	0.015
L_3P_2	1.832	0.720	1.479	4.212	0.332	0.017
L_3P_3	2.007	0.692	1.442	4.404	0.274	0.024
F	3.023	3.701	84.033	33.177	4.893	16.994
CD (0.05)	0.052	0.029	0.015	0.096	0.011	0.002
L_1K_1	1.716	0.693	1.509	4.165	0.273	0.021
L_1K_2	1.762	0.646	1.438	4.155	0.308	0.018
L_1K_3	1.832	0.715	1.504	4.242	0.300	0.020
L_2K_1	1.738	0.692	1.496	4.308	0.318	0.020
L_2K_2	1.762	0.644	1.451	4.313	0.324	0.019
L_2K_3	1.797	0.706	1.477	4.268	0.302	0.024
L_3K_1	1.779	0.735	1.451	4.354	0.312	0.021
L_3K_2	1.832	0.650	1.426	4.319	0.308	0.016
L_3K_3	1.797	0.712	1.522	4.276	0.261	0.019
F	2.647	1.563	23.480	3.539	24.755	3.440
CD (0.05)	0.052	—	0.015	0.068	0.011	0.002

Under L_1 the plants receiving K_3 had a greater N content (1.832 per cent) than those receiving K_1. Under L_2, there was no significant difference in the N content between the plants receiving K_1, K_2 or K_3. Under L_3, the plants receiving K_2 had a higher content (1.832 per cent) than those receiving K_3 or K_1. Among the K doses, K_2 and K_3 resulted in a greater N content under L_3 than under L_1 and L_2. The K_3 plants did not differ in their N content under L_1, L_2 or L_3.

4.1.3.1.8 The effect of LNP interaction

The effect of interaction between light intensities and the NP combinations on the N content of the leaves was significant (Table 61).

Under L_1, the N_3P_1 plants had a higher N content than the N_2P_1 plants and these in turn had a higher content than the N_1P_1 plants. So also, the N_3P_2 plants had a greater N content than the N_2P_2 plants and these in turn had a greater content than the N_1P_2 plants. The N_3P_3 plants had a greater content than the N_2P_3 plants and these in turn had a greater content than the N_1P_3 plants.

Under L_2 the N_3P_1 plants had a greater N content than the N_2P_1 plants and these in turn had a greater content than the N_1P_1 plants. The plants receiving N_2P_2 had a greater N content than those receiving N_3P_2 and these in turn had a greater content than those receiving N_1P_2. The N_3P_3 plants had a greater content than the N_2P_3 plants and these in turn had a greater content than the N_1P_3 plants.

Table 61. Interaction effects of light intensity with NP on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$L_1N_1P_1$	1.347	0.645	1.510	4.201	0.199	0.019
$L_1N_1P_2$	1.628	0.632	1.357	4.235	0.365	0.019
$L_1N_1P_3$	1.577	0.667	1.467	4.242	0.322	0.027
$L_1N_2P_1$	1.505	0.691	1.490	4.038	0.253	0.014
$L_1N_2P_2$	1.890	0.686	1.575	4.131	0.285	0.020
$L_1N_2P_3$	1.925	0.694	1.540	4.444	0.280	0.018
$L_1N_3P_1$	1.645	0.597	1.358	3.851	0.402	0.027
$L_1N_3P_2$	2.013	0.781	1.439	4.185	0.323	0.012
$L_1N_3P_3$	2.398	0.766	1.618	4.357	0.214	0.021
$L_2N_1P_1$	1.417	0.714	1.457	4.156	0.269	0.026
$L_2N_1P_2$	1.575	0.580	1.612	4.537	0.424	0.020
$L_2N_1P_3$	1.628	0.633	1.435	4.292	0.282	0.027
$L_2N_2P_1$	1.540	0.609	1.553	4.390	0.299	0.016
$L_2N_2P_2$	1.943	0.752	1.523	4.361	0.299	0.028
$L_2N_2P_3$	1.943	0.633	1.417	4.061	0.272	0.015
$L_2N_3P_1$	1.680	0.721	1.448	4.054	0.314	0.017
$L_2N_3P_2$	1.758	0.725	1.405	4.479	0.369	0.024
$L_2N_3P_3$	2.380	0.760	1.420	4.335	0.302	0.015
$L_3N_1P_1$	1.505	0.755	1.430	4.224	0.240	0.012
$L_3N_1P_2$	1.610	0.656	1.430	4.200	0.395	0.018
$L_3N_1P_3$	1.593	0.639	1.542	4.338	0.273	0.027
$L_3N_2P_1$	1.505	0.695	1.415	4.469	0.246	0.017
$L_3N_2P_2$	1.925	0.755	1.578	4.244	0.309	0.015
$L_3N_2P_3$	1.978	0.745	1.360	4.362	0.258	0.023
$L_3N_3P_1$	1.697	0.603	1.585	4.308	0.339	0.017
$L_3N_3P_2$	1.960	0.750	1.430	4.191	0.292	0.018
$L_3N_3P_3$	2.450	0.693	1.425	4.511	0.292	0.023
F	2.342	7.518	106.515	7.630	41.666	9.471
CD (0.05)	0.090	0.050	0.026	0.117	0.019	0.004

Under L_3 the N_3P_1 plants had a greater N content than the N_1P_1 and N_2P_1 plants, the N_2P_2 and N_3P_2 plants had a greater N content than the N_1P_2 plants, and the N_3P_3 plants had a greater content than those receiving N_2P_3 and these in turn had a greater content than the N_1P_3 plants.

Under L_1, in combination with N_1 or N_2, P_2 or P_3 resulted in a greater N content than P_1. In combination with N_3, P_3 resulted in a greater N content than P_2 and P_1 was found to result in a lower N content in combination with N_3 than P_2.

Under L_2, in combination with N_1 or N_2, P_2 or P_3 resulted in a greater N content than P_1. In combination with N_3, P_3 resulted in a greater content than P_2. P_1 was found to result in a lower content in combination with N_3, than P_2.

Under L_3, in combination with N_1 or N_2, P_2 or P_3 resulted in a greater N content than P_1. In combination with N_3, P_3 resulted in a greater content than P_2 and P_2 in turn resulted in a greater content in combination with N_3, than P_1.

4.1.3.1.9 The effect of culture methods

The effect of the culture methods on the N content of the leaves was significant (Table 57). The C_1 plants were found to have a greater N content (1.898 per cent) than the C_2 plants.

4.1.3.1.10 The effect of CN interaction

The effect of interaction between the culture methods and the N doses on the N content of the leaves was significant (Table 62).

Table 62. Interaction effects of culture methods with N,P and K on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatments	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)
C_1N_1	1.587	0.711	1.492	4.359	0.336
C_1N_2	1.941	0.733	1.579	4.383	0.281
C_1N_3	2.166	0.731	1.486	4.382	0.343
C_2N_1	1.497	0.604	1.450	4.180	0.279
C_2N_2	1.649	0.658	1.410	4.173	0.274
C_2N_3	1.836	0.691	1.431	4.123	0.289
F	35.845	7.878	126.415	2.071	37.298
CD (0.05)	0.042	0.024	0.012	—	0.009
C_1P_1	1.626	0.705	1.503	4.263	0.310
C_1P_2	1.937	0.729	1.541	4.379	0.357
C_1P_3	2.131	0.741	1.514	4.483	0.294
C_2P_1	1.451	0.635	1.441	4.113	0.259
C_2P_2	1.692	0.675	1.426	4.191	0.322
C_2P_3	1.839	0.643	1.424	4.171	0.260
F	7.443	3.518	17.793	9.001	4.015
CD (0.05)	0.042	0.024	0.012	0.055	0.009
C_1K_1	1.859	0.760	1.511	4.356	0.314
C_1K_2	1.898	0.687	1.485	4.427	0.340
C_1K_3	1.937	0.728	1.562	4.342	0.307
C_2K_1	1.629	0.653	1.460	4.195	0.287
C_2K_2	1.672	0.607	1.391	4.098	0.287
C_2K_3	1.680	0.693	1.440	4.182	0.269
F	0.606	9.363	32.873	11.835	9.057
CD (0.05)	—	0.024	0.012	0.055	0.009

Under C_1 and C_2, the N_3 plants had a greater N content than the N_2 plants and these in turn had a greater N content than the N_1 plants. The C_1 plants receiving N_1, N_2 or N_3 had a higher content than the C_2 plants receiving the respective N doses.

4.1.3.1.11 The effect of CP interaction

The effect of interaction between the culture method treatments and the P doses on the N content of the leaves was significant (Table 62).

Under C_1 and C_2 the P_3 plants had a greater N content than the P_2 plants and these in turn had a greater N content than the P_1 plants. The plants receiving P_1, P_2 or P_3 under C_1 had a greater N content than those grown under C_2.

4.1.3.1.12 The effect of CNP interaction

The effect of interaction between the culture methods and the NP combinations received by the plants on the N content of the leaves was significant (Table 63).

Under C_1, the plants receiving N_3P_3 had a higher N content than those receiving the other NP combinations. N_2P_2, N_2P_3 and N_3P_2 resulted in a greater N content than N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_3P_1.

Under C_2 too, the plants receiving N_3P_3 had a higher N content than those receiving the other NP combinations. N_2P_2, N_2P_3 and N_3P_2 resulted in a greater content than N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_3P_1.

Table 63. Interaction effects of culture methods with NP on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)
$C_1N_1P_1$	1.470	0.771	1.526	4.210	0.247
$C_1N_1P_2$	1.622	0.643	1.454	4.399	0.423
$C_1N_1P_3$	1.669	0.720	1.496	4.468	0.338
$C_1N_1P_1$	1.622	0.677	1.492	4.463	0.295
$C_1N_2P_2$	2.123	0.776	1.706	4.289	0.297
$C_1N_2P_3$	2.077	0.746	1.540	4.397	0.252
$C_1N_3P_1$	1.785	0.667	1.491	4.116	0.387
$C_1N_3P_2$	2.065	0.767	1.462	4.448	0.353
$C_1N_3P_3$	2.648	0.758	1.507	4.583	0.291
$C_2N_1P_1$	1.377	0.638	1.406	4.178	0.225
$C_2N_1P_2$	1.587	0.602	1.478	4.249	0.366
$C_2N_1P_3$	1.528	0.573	1.467	4.113	0.246
$C_2N_2P_1$	1.412	0.652	1.480	4.135	0.237
$C_2N_2P_2$	1.715	0.686	1.412	4.201	0.298
$C_2N_2P_3$	1.820	0.636	1.338	4.181	0.288
$C_2N_3P_1$	1.563	0.613	1.437	4.026	0.316
$C_2N_3P_2$	1.773	0.738	1.388	4.122	0.304
$C_2N_3P_3$	2.170	0.721	1.469	4.219	0.248
F	7.430	4.496	103.605	8.762	26.528
CD (0.05)	0.073	0.041	0.021	0.096	0.016

4.1.3.1.13 The effect of the nitrogen doses

The effect of the N doses on the N content of the leaves was significant (Table 64). The plants receiving N_3 had a higher N content (2.001 per cent) than those receiving N_2, and the plants receiving N_2 had a higher N content (1.795 per cent) than those receiving N_1.

4.1.3.1.14 The effect of the P doses

The effect of the P doses on the N content of the leaves was significant (Table 64). The plants receiving P_3 had a higher N content (1.985 per cent) than those receiving P_2 and the plants receiving P_2 had a higher content (1.814 per cent) than those receiving P_1.

4.1.3.1.15 The effect of the K doses

The plants receiving K_2 or K_3 had a greater N content than those receiving K_1 (Table 65).

4.1.3.1.16 The effect of NP interaction

The effect of interaction between the N and P doses on the N content of the leaves was significant (Table 64). The plants receiving N_3P_3 had a higher content than those receiving the other NP combinations. The content was lower in the plants receiving N_1P_1 than all the others. N_2P_2, N_2P_3 and N_3P_2 resulted in a greater N content than N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_3P_1.

Table 64. Effect of N, P and their interaction on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
N_1	1.542	0.658	1.471	4.269	0.308	0.022
N_2	1.795	0.696	1.495	4.278	0.278	0.018
N_3	2.001	0.711	1.459	4.252	0.316	0.019
F	453.144	20.624	34.273	0.831	76.605	10.185
CD (0.05)	0.030	0.017	0.009	—	0.006	0.001
P_1	1.538	0.670	1.472	4.188	0.284	0.018
P_2	1.814	0.702	1.483	4.285	0.340	0.019
P_3	1.985	0.695	1.469	4.327	0.277	0.022
F	437.492	7.481	5.629	25.604	222.163	11.694
CD (0.05)	0.030	0.017	0.009	0.039	0.006	0.001
N_1P_1	1.423	0.705	1.466	4.194	0.236	0.019
N_1P_2	1.604	0.623	1.466	4.324	0.394	0.019
N_1P_3	1.599	0.646	1.481	4.291	0.292	0.027
N_2P_1	1.517	0.665	1.486	4.299	0.266	0.016
N_2P_2	1.919	0.731	1.559	4.245	0.297	0.021
N_3P_3	1.948	0.691	1.439	4.289	0.270	0.018
N_3P_1	1.674	0.640	1.464	4.071	0.351	0.020
N_3P_2	1.919	0.752	1.425	4.285	0.328	0.018
N_3P_3	2.409	0.740	1.488	4.401	0.269	0.020
F	80.085	26.910	78.812	15.288	156.576	13.105
CD (0.05)	0.052	0.029	0.015	0.068	0.011	0.002

Table 65. Effect of K and its interaction with N and P on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	N (%)	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
K_1	1.744	0.706	1.485	4.275	0.301	0.021
K_2	1.785	0.647	1.438	4.262	0.313	0.018
K_3	1.808	0.711	1.501	4.262	0.288	0.021
F	9.005	35.234	111.131	0.307	29.693	11.234
CD (0.05)	0.030	0.017	0.009	—	0.006	0.001
N_1K_1	1.511	0.660	1.463	4.267	0.297	0.018
N_1K_2	1.552	0.641	0.391	4.280	0.313	0.022
N_1K_3	1.563	0.672	1.559	4.262	0.312	0.025
N_2K_1	1.773	0.717	1.478	4.325	0.288	0.019
N_2K_2	1.791	0.625	1.520	4.276	0.286	0.015
N_2K_3	1.820	0.745	1.480	4.232	0.259	0.022
N_3K_1	1.948	0.743	1.515	4.235	0.318	0.025
N_3K_2	2.012	0.674	1.403	4.231	0.340	0.017
N_3K_3	2.042	0.715	1.458	4.291	0.292	0.016
F	0.619	7.112	129.317	2.680	13.972	28.792
CD (0.05)	—	0.029	0.015	0.068	0.011	0.02
P_1K_1	1.522	0.707	1.511	4.231	0.284	0.021
P_1K_2	1.528	0.623	1.482	4.212	0.295	0.014
P_1K_3	1.563	0.679	1.422	4.121	0.274	0.019
P_2K_1	1.762	0.697	1.450	4.270	0.337	0.020
P_2K_2	1.838	0.633	1.424	4.277	0.383	0.018
P_2K_3	1.843	0.776	1.576	4.301	0.300	0.020
P_3K_1	1.949	0.715	1.496	4.325	0.281	0.021
P_3K_2	1.989	0.685	1.408	4.299	0.261	0.021
P_3K_3	2.018	0.677	1.504	4.358	0.289	0.023
F	0.905	16.428	143.128	3.767	48.117	3.867
CD (0.05)	—	0.029	0.015	0.068	0.011	0.002

4.1.3.2 The phosphorus content

4.1.3.2.1 Effect of light intensities

The direct effect of light intensity treatments on the phosphorus content of the leaves was not significant (Table 57). However, light interacted with the culture method treatments and nutrients and their combinations, influencing the P content.

4.1.3.2.2 Effect of LC interaction and the response of the control plants

The effect of interaction between the light intensities and culture methods was not significant. However among the control plants grown under the three light intensities and two culture methods,there was a significant difference in the P content (Table 57).

The L_2C_1 and L_2C_2 controls had a higher P content (0.688 and 0.729 per cent respectively) than the L_1C_1 and L_3C_2 controls. The L_1C_2, L_2C_1, L_2C_2 and L_3C_1 controls had a greater P content than the L_3C_2 controls.

4.1.3.2.3 Effect of LCP interaction

The effect of interaction between light intensities culture methods and the P doses on the P content of the leaves was significant (Table 59).

The L_1C_1 and L_2C_1 plants receiving P_1, P_2 or P_3 had a greater P content than the L_1C_2 and L_2C_2 plants receiving the same doses of P. The L_3C_1 plants receiving P_2 and P_3 had a greater P content than the L_3C_2 plants. There was no significant difference in the P content between the L_3C_1 and L_3C_2 plants receiving P_1.

Among the L_1C_1 plants those receiving P_3 had a higher content than those receiving P_1 or P_2. Among the L_1C_2 plants those receiving P_2 or P_3 had a higher content than those receiving P_1. Among the L_3C_1 plants those receiving P_2 had a higher P content than those receiving P_1. Among the L_2C_1, L_2C_2 and L_3C_2 plants there was no significant difference in the content between those receiving P_1, P_2 or P_3.

4.1.3.2.4 Effect of LCK interaction

The effect of interaction between light intensities culture methods and the K doses on the P content of the leaves was significant (Table 66).

Among the L_1C_1, L_2C_1 and the L_3C_1 plants those receiving K_1 had a higher P content (0.773, 0.762 and 0.746 per cent respectively) than those receiving K_2. Among the L_1C_2 and the L_2C_2 plants those receiving K_3 had a higher P content (0.681 and 0.704 per cent respectively) than those receiving K_1 or K_2. Among the L_3C_2 plants those receiving K_1 had a higher P content (0.723 per cent) than those receiving K_2.

4.1.3.2.5 Effect of LCNP interaction

The effect of interaction between light intensities culture methods and the NP combinations on the P content of the leaves was significant (Table 67).

Under L_1C_1,the plants receiving N_3P_2 had a higher P content (0.799 per cent) than those receiving N_1P_1, N_1P_2, N_2P_1 and N_3P_1. Under L_1C_2, the plants receiving N_3P_2 and those receiving N_3P_3 had a higher content (0.764, and 0.762 per cent respectively) than those receiving the rest of the NP combinations.

Table 66. Interaction effects of light, culture methods and K on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)
$L_1C_1K_1$	0.733	1.599	4.293	0.280
$L_1C_1K_2$	0.684	1.488	4.304	0.323
$L_1C_1K_3$	0.748	1.493	4.286	0.319
$L_1C_2K_1$	0.612	1.419	4.037	0.265
$L_1C_2K_2$	0.608	1.388	4.006	0.292
$L_1C_2K_3$	0.681	1.516	4.198	0.282
$L_2C_1K_1$	0.762	1.466	4.306	0.319
$L_2C_1K_2$	0.697	1.469	4.413	0.351
$L_2C_1K_3$	0.708	1.566	4.418	0.318
$L_2C_2K_1$	0.623	1.527	4.309	0.317
$L_2C_2K_2$	0.592	1.432	4.214	0.296
$L_2C_2K_3$	0.704	1.388	4.117	0.286
$L_3C_1K_1$	0.746	1.468	4.468	0.344
$L_3C_2K_2$	0.679	1.498	4.563	0.346
$L_3C_1K_3$	0.729	1.627	4.322	0.283
$L_3C_2K_1$	0.723	1.434	4.240	0.281
$L_3C_2K_2$	0.621	1.353	4.075	0.269
$L_3C_2K_3$	0.696	1.417	4.230	0.239
F	4.459	124.738	10.202	4.079
CD (0.05)	0.041	0.021	0.096	0.016

Table 67. Interaction effects of light and culture methods with NP on the phosphorus status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)		
	L_1	L_2	L_3
$C_1N_1P_1$	0.720	0.875	0.718
$C_1N_1P_2$	0.640	0.579	0.711
$C_1N_1P_3$	0.797	0.676	0.690
$C_1N_2P_1$	0.727	0.586	0.720
$C_1N_2P_2$	0.755	0.787	0.787
$C_1N_2P_3$	0.752	0.706	0.780
$C_1N_3P_1$	0.657	0.741	0.604
$C_1N_3P_2$	0.799	0.762	0.739
$C_1N_3P_3$	0.771	0.788	0.715
$C_2N_1P_1$	0.569	0.553	0.793
$C_2N_1P_2$	0.623	0.581	0.602
$C_2N_1P_3$	0.593	0.590	0.588
$C_2N_2P_1$	0.655	0.632	0.669
$C_2N_2P_2$	0.618	0.718	0.722
$C_2N_2P_3$	0.637	0.561	0.710
$C_2N_3P_1$	0.537	0.701	0.602
$C_2N_3P_2$	0.764	0.689	0.762
$C_2N_3P_3$	0.762	0.731	0.671
F	8.693	—	—
CD (0.05)	0.071	—	—

Under L_2C_1, the plants receiving N_1P_1 had a greater P content (0.875 per cent) than those receiving the other NP combinations. Under L_2C_2, the plants receiving N_3P_3 had a higher content (0.731 per cent) than those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_2P_3.

Under L_3C_1, the plants receiving N_2P_2 had a greater P content (0.787 per cent) than those receiving N_1P_2, N_1P_3, N_3P_1 and N_3P_3. Under L_3C_2 the plants receiving N_1P_1 had a greater content (0.793 per cent) than those receiving the other NP combinations excepting N_3P_2.

Among the NP doses, N_1P_1, N_1P_3, N_2P_1, N_2P_2, N_2P_3 and N_3P_1 resulted in a higher P content under L_1C_1 than under L_1C_2, N_1P_1, N_1P_3, N_2P_3 and N_3P_2 resulted in a higher content under L_2C_1 than under L_2C_2 and N_1P_2 and N_1P_3 resulted in a higher content under L_3C_1 than under L_3C_2.

4.1.3.2.6 Effect of LCNK interaction

The effect of interaction between light intensities culture methods and the NK combinations on the P content of the leaves was significant (Table 68).

Under L_1C_1, the plants receiving N_2K_1, had a higher P content (0.840 per cent) than those receiving N_1K_1, N_1K_2, N_2K_2, N_3K_2 and N_3K_3. Under L_1C_2, the plants receiving N_3K_3 had a higher P content (0.706 per cent) than those receiving N_1K_1, N_1K_2 and N_2K_2. Under L_2C_1 the plants receiving N_3K_1 had a greater content (0.838 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2, N_2K_3, N_3K_2 and N_3K_3. Under L_2C_2, the plants receiving N_2K_3 had a greater content (0.799 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2 and N_3K_2.

Table 68. Interaction effects of light and culture methods with NK on the phosphorus status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)		
	L_1	L_2	L_3
$C_1N_1K_1$	0.669	0.729	0.762
$C_1N_1K_2$	0.675	0.706	0.674
$C_1N_1K_3$	0.810	0.694	0.683
$C_1N_2K_1$	0.840	0.718	0.808
$C_1N_2K_2$	0.618	0.683	0.722
$C_1N_2K_3$	0.775	0.678	0.757
$C_1N_3K_1$	0.810	0.838	0.669
$C_1N_3K_2$	0.759	0.702	0.642
$C_1N_3K_3$	0.657	0.750	0.748
$C_2N_1K_1$	0.525	0.588	0.685
$C_2N_1K_2$	0.539	0.574	0.681
$C_2N_1K_3$	0.667	0.562	0.617
$C_2N_2K_1$	0.641	0.544	0.750
$C_2N_2K_2$	0.597	0.567	0.563
$C_2N_2K_3$	0.671	0.799	0.789
$C_2N_3K_1$	0.669	0.738	0.734
$C_2N_3K_2$	0.706	0.750	0.681
F	4.678	—	—
CD (0.05)	0.071	—	—

Under L_3C_1, the plants receiving N_2K_1 had a greater content (0.808 per cent) than those receiving N_1K_2, N_1K_3, N_2K_2, N_3K_1 and N_3K_2. Under L_3C_1, the plants receiving N_2K_3 had a greater content (0.789 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_2, N_3K_2 and N_3K_3. Under L_1 and L_2, the C_1 plants receiving N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2 and N_3K_1 had a greater P content than the C_2 plants.

4.1.3.2.7 Effect of LCPK interaction

The effect of interaction between light intensities,culture methods and the PK combinations on the P content of the leaves was significant (Table 69).

Under L_1C_1, the plants receiving P_2K_3 had a greater P content (0.840 per cent) than those receiving P_1K_2, P_1K_3, P_2K_1, P_2K_2, P_3K_2 and P_3K_3. Under L_1C_2, the plants receiving P_2K_3 had a higher P content (0.803 per cent) than those receiving the other PK combinations. Under L_2C_1 the plants receiving P_1K_1 had a higher P content (0.838 per cent) than those receiving the other PK combinations. Under L_2C_2 the plants receiving P_1K_3 had a higher P content (0.782 per cent) than those receiving the rest of the combinations excepting P_2K_3. Under L_3C_1, the P_2K_1 plants had a higher P content (0.799 per cent) than the P_1K_1, P_1K_2, P_2K_2, P_2K_3 and P_3K_2 plants.

Among the PK combinations P_1K_1, P_2K_2, P_3K_1 and P_3K_3 resulted in a higher P content under L_1C_1 than under L_1C_2, P_1K_1, P_1K_2, P_2K_2; P_3K_1, P_3K_2 and P_3K_3 resulted in a higher P content under L_2C_1 than under L_2C_2 and P_1K_3, P_2K_1, P_2K_2 and P_3K_3 resulted in a higher P content under L_3C_1 than under L_3C_2. P_1K_1 and P_2K_3 resulted in a higher content under L_3C_2 than under L_3C_1.

Table 69. Interaction effects of light and culture methods with PK on the phosphorus status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P(%)		
	L_1	L_2	L_3
$C_1P_1K_1$	0.817	0.838	0.681
$C_1P_1K_2$	0.646	0.667	0.616
$C_1P_1K_3$	0.641	0.697	0.745
$C_1P_2K_1$	0.690	0.711	0.797
$C_1P_2K_2$	0.664	0.697	0.725
$C_1P_2K_3$	0.840	0.720	0.713
$C_1P_3K_1$	0.813	0.736	0.759
$C_1P_3K_2$	0.743	0.728	0.697
$C_1P_3K_3$	0.762	0.706	0.729
$C_2P_1K_1$	0.565	0.542	0.801
$C_2P_1K_2$	0.586	0.563	0.664
$C_2P_1K_3$	0.611	0.782	0.598
$C_2P_2K_1$	0.646	0.680	0.657
$C_2P_2K_2$	0.556	0.572	0.583
$C_2P_2K_3$	0.803	0.736	0.845
$C_2P_3K_1$	0.625	0.649	0.710
$C_2P_3K_2$	0.683	0.641	0.616
$C_2P_3K_3$	0.630	0.593	0.644
F	11.803	—	—
CD (0.05)	0.071	—	—

4.1.3.2.8. Effect of LCNPK interaction

The effect of interaction between light intensities culture methods and the NPK combinations on the P content of the leaves was significant (Table 70).

Under L_1C_1, the plants receiving $N_1P_3K_3$ or $N_2P_3K_3$ had a greater P content (1.049 per cent) than all the others except those receiving $N_2P_1K_1$ and $N_2P_3K_1$. Under L_1C_2 the plants receiving $N_3P_2K_3$ had a greater P content (0.931 per cent) than all the others except those receiving $N_2P_1K_1$ and $N_3P_3K_2$.

Under L_2C_1, the plants receiving $N_1P_1K_1$ had a greater P content (0.979 per cent) than those receiving the other combinations excepting $N_3P_3K_2$. Under L_2C_2 the plants receiving $N_3P_1K_3$ had a greater P content (0.986 per cent) than all the othersexcept those receiving $N_2P_2K_3$.

Under L_3C_1 the plants receiving $N_3P_3K_3$ had a greater P content (0.938 per cent) than those receiving the other combinations except $N_2P_1K_3$. Under L_3C_2, the plants receiving $N_2P_2K_3$ and $N_3P_2K_3$ had a greater P content (0.965 per cent) than all the others except those receiving $N_1P_1K_1$, $N_2P_1K_1$ and $N_3P_3K_1$.

4.1.3.2.9 Effect of LN interaction

The effect of interaction between light intensities and the N doses on the P content of the leaves was significant (Table 60). Under L_1, the plants receiving N_3 had a higher P content (0.715 per cent) than those receiving N_1. Under L_2, the plants receiving N_3 had a higher content (0.735 per cent) than those receiving N_1 or N_2 and under L_3 the plants receiving N_2 had a higher content (0.731 per cent) than those receiving N_1 or N_3.

Table 70. Interaction effects of light and culture methods with NPK on the phosphorus status (%) of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	0.667	0.313	0.979	0.458	0.674	0.875
$N_1P_1K_2$	0.743	0.667	0.875	0.618	0.653	0.813
$N_1P_1K_3$	0.750	0.729	0.771	0.582	0.826	0.690
$N_1P_2K_1$	0.688	0.729	0.382	0.604	0.785	0.632
$N_1P_2K_2$	0.602	0.465	0.764	0.563	0.701	0.569
$N_1P_2K_3$	0.632	0.674	0.590	0.576	0.646	0.604
$N_1P_3K_1$	0.653	0.535	0.826	0.701	0.826	0.549
$N_1P_3K_2$	0.681	0.486	0.479	0.542	0.667	0.660
$N_1P_3K_3$	1.049	0.597	0.722	0.528	0.576	0.556
$N_2P_1K_1$	0.931	0.847	0.653	0.597	0.701	0.896
$N_2P_1K_2$	0.646	0.549	0.563	0.521	0.549	0.507
$N_2P_1K_3$	0.604	0.569	0.542	0.778	0.910	0.604
$N_2P_2K_1$	0.639	0.521	0.875	0.618	0.875	0.667
$N_2P_2K_2$	0.576	0.528	0.743	0.632	0.799	0.535
$N_2P_2K_3$	1.049	0.806	0.743	0.903	0.688	0.965
$N_2P_3K_1$	0.951	0.556	0.625	0.418	0.847	0.686
$N_2P_3K_2$	0.632	0.715	0.743	0.549	0.819	0.646
$N_2P_3K_3$	0.674	0.639	0.750	0.715	0.674	0.799
$N_3P_1K_1$	0.854	0.535	0.882	0.569	0.667	0.632
$N_3P_1K_2$	0.549	0.542	0.563	0.549	0.646	0.674
$N_3P_1K_3$	0.569	0.535	0.778	0.986	0.500	0.500
$N_3P_2K_1$	0.743	0.688	0.875	0.817	0.736	0.674
$N_3P_2K_2$	0.813	0.674	0.583	0.521	0.676	0.646
$N_3P_2K_3$	0.840	0.931	0.826	0.729	0.806	0.965
$N_3P_3K_1$	0.833	0.785	0.757	0.826	0.604	0.896
$N_3P_3K_2$	0.917	0.847	0.961	0.833	0.604	0.542
$N_3P_3K_3$	0.563	0.653	0.646	0.535	0.938	0.576
F	6.433	—	—	—	—	—
CD (0.05)	0.123	—	—	—	—	—

Among the N doses, N_1 resulted in a greater P content under L_3 than under L_2, N_2 resulted in a greater P content under L_3 than under L_1 or L_2 and N_3 resulted in a greater P content under L_1 and L_2 than under L_3.

4.1.3.2.10 Effect of LP interaction

The effect of interaction between light intensities and the P doses on the P content of the leaves was significant (Table 60.)

Under L_1, the plants receiving P_3 had a greater P content (0.709 per cent) than those receiving P_1. Under L_2, there was no significant difference in the content between the plants receiving P_1, P_2 or P_3. Under L_3, the plants receiving P_2 had a greater P content (0.720 per cent) than those receiving P_1. Among the P doses, P_1 resulted in a greater P content under L_2 and L_3 than under L_1, P_2 resulted in a greater content under L_3 than under L_2 and P_3 resulted in a greater content under L_1 than under L_2.

4.1.3.2.11 Effect LNP interaction

The effect of interaction between light intensities and the NP combinations on the P content of the leaves was significant (Table 61).

Under L_1, the plants receiving N_3P_2 had a greater content (0.781 per cent) than those receiving the other combinationsexcept N_3P_3. Under L_2, the plants receiving N_1P_1, N_2P_2, N_3P_1, N_3P_2 and N_3P_3 had a higher P content (0.714,0.752,0.721, 0.725 and 0.760 per cent respectively) than those receiving N_1P_2, N_1P_3, N_2P_1 and N_2P_3. Under L_3 the plants receiving N_1P_1, N_2P_2, N_2P_3 and N_3P_2 had a higher P content (0.755, 0.755, 0.745 and 0.750 per cent respectively) than those receiving N_1P_2, N_1P_3, N_2P_1, N_3P_1 and N_3P_3.

4.1.3.2.12 Effect of LNK interaction

The effect of interaction between light intensities and the NK combinations was significant (Table 71). Under L_1 the plants receiving N_1K_3, N_2K_1 and N_3K_1 had a higher P content (0.738, 0.741 and 0.740 per cent respectively) than those receiving N_1K_1, N_1K_2, N_2K_2 and N_3K_3. Under L_2, the plants receiving N_3K_1 had a higher P content (0.788 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2 and N_3K_2. Under L_3, the plants receiving N_2K_1 and N_2K_3 had a greater P content (0.799 and 0.773 per cent respectively) than those receiving the other NK combinations.

Among the combinations, N_1K_1 resulted in a greater P content under L_3 than under L_1 or L_2, N_1K_3 and N_3K_2 resulted in a greater P content under L_1 than under L_2 or L_3, N_2K_1 resulted in a greater content under L_1 or L_3 than under L_2, N_3K_1 resulted in a greater content under L_2 than under L_3 and N_3K_3 resulted in a greater P content under L_2 than under L_1. The plants receiving N_1K_2, N_2K_2 or N_2K_3 did not differ significantly in their P content under L_1, L_2 or L_3.

4.1.3.2.13 Effect of LPK interaction

The effect of interaction between light intensities and the PK doses on the P content of the leaves was significant (Table 72).

Under L_1, the P_2K_3 plants had a higher P content (0.822 per cent) than those receiving the rest of the PK combinations. Under L_2, the plants receiving P_1K_3 had a greater P content (0.739 per cent) than those receiving P_1K_2, P_2K_2, P_3K_2 and P_3K_3.

Table 71. Interaction effects of light intensity with NK on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$L_1N_1K_1$	0.597	1.487	4.240	0.248	0.013
$L_1N_1K_2$	0.607	1.337	4.190	0.330	0.027
$L_1N_1K_3$	0.738	1.510	4.248	0.307	0.024
$L_1N_2K_1$	0.741	1.517	4.189	0.238	0.018
$L_1N_2K_2$	0.608	1.538	4.233	0.270	0.013
$L_1N_2K_3$	0.723	1.550	4.192	0.309	0.021
$L_1N_3K_1$	0.740	1.524	4.065	0.331	0.030
$L_1N_3K_2$	0.723	1.438	4.043	0.323	0.015
$L_1N_3K_3$	0.682	1.453	4.286	0.285	0.015
$L_2N_1K_1$	0.659	1.488	4.395	0.344	0.024
$L_2N_1K_2$	0.640	1.440	4.351	0.312	0.019
$L_2N_1K_3$	0.628	1.575	4.238	0.319	0.030
$L_2N_2K_1$	0.631	1.542	4.269	0.305	0.017
$L_2N_2K_2$	0.625	1.553	4.266	0.302	0.017
$L_2N_2K_3$	0.738	1.398	4.277	0.262	0.026
$L_2N_3K_1$	0.788	1.458	4.258	0.304	0.020
$L_2N_3K_2$	0.668	1.358	4.322	0.357	0.020
$L_2N_3K_3$	0.750	1.457	4.288	0.324	0.016
$L_3N_1K_1$	0.723	1.413	4.165	0.299	0.016
$L_3N_1K_2$	0.677	1.397	4.299	0.298	0.018
$L_3N_1K_3$	0.650	1.592	4.299	0.311	0.022
$L_3N_2K_1$	0.779	1.377	4.517	0.321	0.022
$L_3N_2K_2$	0.642	1.468	4.329	0.285	0.015
$L_3N_2K_3$	0.773	1.508	4.228	0.207	0.018
$L_3N_3K_1$	0.701	1.563	4.381	0.317	0.026
$L_3N_3K_2$	0.631	1.412	4.329	0.339	0.016
$L_3N_3K_3$	0.714	1.465	4.301	0.266	0.016
F	9.663	35.746	4.697	26.035	9.183
CD (0.05)	0.050	0.026	0.117	0.019	0.004

Table 72. Interaction effects of light intensity with PK on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$L_1P_1K_1$	0.691	1.418	4.059	0.286	0.025
$L_1P_1K_2$	0.616	1.515	3.963	0.262	0.012
$L_1P_1K_3$	0.626	1.425	4.069	0.305	0.023
$L_1P_2K_1$	0.668	1.513	4.091	0.289	0.018
$L_1P_2K_2$	0.610	1.315	4.225	0.385	0.018
$L_1P_2K_3$	0.822	1.543	4.236	0.298	0.015
$L_1P_3K_1$	0.719	1.597	4.344	0.243	0.018
$L_1P_3K_2$	0.713	1.483	4.277	0.275	0.025
$L_1P_3K_3$	0.696	1.545	4.422	0.298	0.022
$L_2P_1K_1$	0.690	1.590	4.258	0.265	0.020
$L_2P_1K_2$	0.615	1.515	4.307	0.319	0.016
$L_2P_1K_3$	0.739	1.353	4.035	0.299	0.023
$L_2P_2K_1$	0.695	1.467	4.476	0.382	0.024
$L_2P_2K_2$	0.634	1.492	4.431	0.392	0.020
$L_2P_2K_3$	0.728	1.582	4.469	0.318	0.028
$L_2P_3K_1$	0.692	1.432	4.188	0.306	0.017
$L_2P_3K_2$	0.684	1.345	4.201	0.260	0.020
$L_2P_3K_3$	0.649	1.495	4.299	0.289	0.021
$L_3P_1K_1$	0.741	1.525	4.376	0.302	0.018
$L_3P_1K_2$	0.640	1.417	4.364	0.304	0.016
$L_3P_1K_3$	0.672	1.488	4.261	0.220	0.012
$L_3P_2K_1$	0.728	1.370	4.244	0.340	0.018
$L_3P_2K_2$	0.654	1.465	4.175	0.370	0.014
$L_3P_2K_3$	0.779	1.603	4.215	0.285	0.018
$L_3P_3K_1$	0.735	1.458	4.442	0.295	0.027
$L_3P_3K_2$	0.656	1.395	4.418	0.249	0.019
$L_3P_3K_3$	0.686	1.473	4.352	0.279	0.026
F	4.228	72.344	2.959	17.154	7.567
CD (0.05)	0.050	0.026	0.117	0.019	0.004

Under L_3 the plants receiving P_2K_3 had greater P content (0.779 per cent) than those receiving P_1K_2, P_1K_3,P_2K_1, P_2K_2, P_3K_2 and P_3K_3. Among the PK doses, P_1K_1 resulted in a higher P content under L_3 than under L_1 or L_2, P_1K_3 resulted in a higher P content under L_2 than under L_1 or L_3, P_2K_1 resulted in a higher P content under L_3 than under L_1, P_2K_3 resulted in a higher P content under L_1 than under L_2 and P_3K_2 resulted in a higher P content under L_1 than under L_3.

4.1.3.2.14 Effect of LNPK interaction

The effect of interaction between light intensities and the NPK combinations on the P content of the leaves was significant (Table 73).

Under L_1, the the plants receiving $N_2P_1K_1$, $N_2P_2K_3$, $N_3P_2K_3$ and $N_3P_3K_2$, had a greater P content (0.889, 0.927, 0.885 and 0.882 per cent respectively) than those receiving the other NPK combinations, excepting $N_1P_3K_3$ and $N_3P_3K_1$.

Under L_2 the plants receiving $N_3P_1K_3$ and $N_3P_3K_2$ had a greater P content (0.882 and 0.897 per cent respectively) than those receiving the other combinations excepting $N_2P_2K_3$ and $N_3P_2K_1$. Under L_3,the plants receiving $N_3P_2K_3$ had a greater P content (0.885 per cent) than those receiving the other NPK combinations except $N_2P_1K_1$ and $N_2P_2K_3$.

4.1.3.2.15 Effect of culture methods

The effect of culture methods on the P content of the leaves was significant (Table 57). The C_1 plants were found to have a greater P content (0.725 per cent) than the C_2 plants (0.651 per cent)

Table 73. Interaction effects of light with NPK on the phosphorus status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P(%)		
	L_1	L_2	L_3
$N_1P_1K_1$	0.490	0.719	0.774
$N_1P_1K_2$	0.705	0.747	0.733
$N_1P_1K_3$	0.740	0.676	0.758
$N_1P_2K_1$	0.708	0.493	0.708
$N_1P_2K_2$	0.543	0.663	0.635
$N_1P_2K_3$	0.653	0.583	0.625
$N_1P_3K_1$	0.594	0.764	0.688
$N_1P_3K_2$	0.583	0.510	0.663
$N_1P_3K_3$	0.823	0.625	0.566
$N_2P_1K_1$	0.889	0.625	0.799
$N_2P_1K_2$	0.597	0.542	0.528
$N_2P_1K_3$	0.587	0.660	0.757
$N_2P_2K_1$	0.580	0.747	0.771
$N_2P_2K_2$	0.552	0.688	0.667
$N_2P_2K_3$	0.927	0.823	0.826
$N_2P_3K_1$	0.753	0.521	0.767
$N_2P_3K_2$	0.674	0.646	0.733
$N_2P_3K_3$	0.656	0.733	0.736
$N_3P_1K_1$	0.694	0.726	0.649
$N_3P_1K_2$	0.545	0.556	0.660
$N_3P_1K_3$	0.552	0.882	0.500
$N_3P_2K_1$	0.715	0.846	0.705
$N_3P_2K_2$	0.743	0.552	0.661
$N_3P_2K_3$	0.885	0.778	0.885
$N_3P_3K_1$	0.809	0.792	0.750
$N_3P_3K_2$	0.882	0.897	0.573
$N_3P_3K_3$	0.608	0.590	0.757
F	18.200	—	—
CD (0.05)	0.087	—	—

4.1.3.2.16 Effect of CN interaction

The effect of interaction between the culture methods and the N doses on the P content was significant (Table 62). Under C_1 there was no significant difference in the P content of the plants receiving N_1, N_2 or N_3. Under C_2, the N_3 plants had a higher P content (0.691 per cent) than the N_1 and N_2 plants. Irrespective of the N dose received the C_1 plants had a higher P content than the C_2 plants.

4.1.3.2.17 Effect of CP interaction

The effect of interaction between culture methods and the P doses on the P content of the leaves was significant (Table 62). Under C_1 the plants receiving P_2 or P_3 had a greater P content (0.729 and 0.741 per cent respectively) than those receiving P_1.

Under C_2, the plants receiving P_2 had a greater P content (0.675 per cent) than those receiving P_1 or P_3. The plants receiving P_1, P_2 or P_3 had a higher P content under C_1 than under C_2.

4.1.3.2.18 Effect of CK interaction

The effect of interaction between culture methods and the K doses on the P content of the leaves was significant (Table 62). Under C_1 the plants receiving K_1 had a greater P content (0.760 per cent) than those receiving K_2 or K_3. The K_3 plants had a higher content (0.728 per cent) than the K_2 plants. Under C_2, the K_3 plants had a higher P content than the K_1 and K_2 plants. The K_1 plants had a higher content (0.653 per cent) than the K_2 plants. K_1, K_2 and K_3 resulted in a higher P content under C_1 than under C_2. The P content was higher in the C_1K_1 plants (0.760 per cent) than in the others.

4.1.3.2.19 Effect of CNP interaction

The effect of interaction between the culture methods and the NP combinationson the P content was significant (Table 63). Under C_1 the plants receiving N_2P_1, N_2P_2 and N_3P_2 had a higher P content (0.771, 0.776 and 0.767 per cent respectively) than those receiving N_1P_2, N_2P_1 and N_3P_1. Under C_2 the plants receiving N_3P_2 had a greater P content (0.738 per cent) than those receiving the other NP combinations except N_3P_3. Among the combinations, N_1P_1, N_1P_2, N_1P_3, N_2P_2 and N_2P_3 resulted in a greater P content under C_1 than under C_2.

4.1.3.2.20 Effect of CNK interaction

The effect of interaction between culture methods and the NK combinations on the P content of the leaves was significant (Table 74). Under C_1, the plants receiving N_2K_1 had a higher P content (0.789 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_2, N_2K_3, N_3K_2 and N_3K_3. Under C_2, the plants receiving N_2K_3 had a higher P content (0.753 per cent) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2 and N_3K_2. Among the NK doses, N_1K_1, N_1K_2, N_1K_3, N_2K_1, N_2K_2, N_3K_1 and N_3K_2 resulted in a greater P content under C_1 than under C_2.

4.1.3.2.21 Effect of CPK interaction

The effect of interaction between culture methods and the PK combinations on the P content of the leaves was significant (Table 75). Under C_1 the plants receiving P_1K_1 had a greater P content (0.779 per cent) than those receiving P_1K_2, P_1K_3, P_2K_1, P_2K_2, P_3K_2 and P_3K_3.

Table 74. Interaction effects of culture methods with NK on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$C_1N_1K_1$	0.720	1.449	4.365	0.319	0.021
$C_1N_1K_2$	0.685	1.424	4.478	0.338	0.021
$C_1N_1K_3$	0.729	1.602	4.243	0.351	0.027
$C_1N_2K_1$	0.789	1.560	4.378	0.289	0.021
$C_1N_2K_2$	0.674	1.613	4.438	0.315	0.017
$C_1N_2K_3$	0.737	1.564	4.333	0.241	0.023
$C_1N_3K_1$	0.772	1.524	4.333	0.334	0.026
$C_1N_3K_2$	0.701	1.417	4.364	0.368	0.021
$C_1N_3K_3$	0.718	1.519	4.450	0.328	0.019
$C_2N_1K_1$	0.600	1.477	4.178	0.274	0.015
$C_2N_1K_2$	0.598	1.358	4.082	0.289	0.022
$C_2N_1K_3$	0.615	1.516	4.281	0.274	0.023
$C_2N_2K_1$	0.645	1.397	4.272	0.287	0.017
$C_2N_2K_2$	0.576	1.427	4.114	0.257	0.012
$C_2N_2K_3$	0.753	1.407	4.131	0.278	0.020
$C_2N_3K_1$	0.713	1.507	4.136	0.301	0.024
$C_2N_3K_2$	0.647	1.389	4.098	0.311	0.013
$C_2N_3K_3$	0.647	1.389	4.133	0.255	0.012
F	4.474	14.715	7.203	19.036	3.391
CD (0.05)	0.041	0.021	0.096	0.016	0.003

Table 75. Interaction effects of culture methods with PK on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$C_1P_1K_1$	0.779	1.540	4.336	0.305	0.021
$C_1P_1K_2$	0.643	1.548	4.313	0.319	0.016
$C_1P_1K_3$	0.694	1.421	4.139	0.305	0.022
$C_1P_2K_1$	0.733	1.536	4.251	0.335	0.022
$C_1P_2K_2$	0.695	1.443	4.457	0.424	0.021
$C_1P_2K_3$	0.758	1.642	4.428	0.313	0.023
$C_1P_3K_1$	0.769	1.457	4.480	0.303	0.024
$C_1P_3K_2$	0.722	1.463	4.510	0.277	0.022
$C_1P_3K_3$	0.732	1.622	4.459	0.302	0.024
$C_2P_1K_1$	0.636	1.482	4.126	0.264	0.021
$C_2P_1K_2$	0.604	1.417	4.110	0.271	0.013
$C_2P_1K_3$	0.664	1.423	4.104	0.244	0.017
$C_2P_2K_1$	0.661	1.363	4.290	0.338	0.019
$C_2P_2K_2$	0.570	1.404	4.097	0.341	0.014
$C_2P_2K_3$	0.795	1.510	4.185	0.288	0.018
$C_2P_3K_1$	0.661	1.534	4.170	0.260	0.017
$C_2P_3K_2$	0.647	1.352	4.087	0.246	0.021
$C_2P_3K_3$	0.622	1.387	4.256	0.275	0.021
F	8.119	130.017	7.459	12.003	2.587
CD (0.05)	0.041	0.021	0.096	0.016	0.003

Under C_2, the plants receiving P_2K_3 had a greater P content (0.795 per cent) than those receiving the other PK combinations. Among the combinations, P_1K_1, P_2K_1, P_2K_2, P_3K_1, P_3K_2 and P_3K_3 resulted in a greater P content under C_1 than under C_2.

4.1.3.2.22 Effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinationson the P content of the leaves was significant (Table 76).

Under C_1, the plants receiving $N_2P_2K_3$, $N_3P_2K_3$ and $N_3P_3K_2$ had a greater P content (0.826, 0.824 and 0.827 per cent respectively) than those receiving $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_2K_3$, $N_1P_3K_2$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_3K_1$ and $N_3P_3K_3$. Under C_2, the plants receiving $N_2P_2K_3$ and $N_3P_2K_3$ had a greater P content (0.891 and 0.875 per cent respectively) than those receiving the other combinations except $N_3P_3K_1$.

4.1.3.2.23 Effect of N doses

The effect of the N doses on the P content of the leaves was significant (Table 64). The plants receiving N_2 or N_3 had a greater P content (0.696 and 0.711 per cent respectively) than those receiving N_1.

4.1.3.2.24 Effect of the P doses

The effect of the P doses received by the plants influenced the P content of the leaves significantly (Table 64). The plants receiving P_2 or P_3 had a higher P content (0.702 and 0.692 per cent respectively) than those receiving P_1.

Table 76. Interaction effects of culture methods with NPK on the phosphorus and potassium status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)		K (%)	
	C_1	C_2	C_1	C_2
$N_1P_1K_1$	0.733	0.549	1.433	1.447
$N_1P_1K_2$	0.757	0.699	1.570	1.327
$N_1P_1K_3$	0.782	0.667	1.573	1.443
$N_1P_2K_1$	0.618	0.655	1.453	1.387
$N_1P_2K_2$	0.689	0.532	1.307	1.313
$N_1P_2K_3$	0.623	0.618	1.603	1.733
$N_1P_3K_1$	0.769	0.595	1.460	1.597
$N_1P_3K_2$	0.609	0.563	1.397	1.433
$N_1P_3K_3$	0.782	0.560	1.630	1.370
$N_2P_1K_1$	0.762	0.780	1.577	1.457
$N_2P_1K_2$	0.586	0.525	1.563	1.530
$N_2P_1K_3$	0.685	0.651	1.337	1.453
$N_2P_2K_1$	0.796	0.602	1.607	1.307
$N_2P_2K_2$	0.706	0.565	1.757	1.517
$N_2P_2K_3$	0.826	0.891	1.753	1.413
$N_2P_3K_1$	0.808	0.553	1.497	1.427
$N_2P_3K_2$	0.731	0.637	1.520	1.233
$N_2P_3K_3$	0.699	0.718	1.603	1.353
$N_3P_1K_1$	0.801	0.579	1.610	1.543
$N_3P_1K_2$	0.586	0.588	1.510	1.393
$N_3P_1K_3$	0.616	0.674	1.353	1.373
$N_3P_2K_1$	0.785	0.726	1.548	1.397
$N_3P_2K_2$	0.691	0.613	1.267	1.383
$N_3P_2K_3$	0.824	0.875	1.570	1.383
$N_3P_3K_1$	0.731	0.836	1.413	1.580
$N_3P_3K_2$	0.827	0.741	1.473	1.390
$N_3P_3K_3$	0.715	0.588	1.633	1.437
F	11.916	—	38.546	—
CD (0.05)	0.071	—	0.037	—

4.1.3.2.25 Effect of the K doses

The effect of the K doses received by the plants influenced the P content of the leaves significantly (Table 65). The plants receiving K_1 or K_3 had a greater P content (0.706 and 0.711 per cent respectively) than those receiving K_1.

4.1.3.2.26 Effect of NP interaction

The effect of interaction between the N and P doses on the P content of the leaves was significant (Table 64). N_3P_2 and N_3P_3 resulted in a greater P content than N_1P_1, N_1P_2, N_1P_3, N_2P_1, N_2P_3 and N_3P_1, whereas N_2P_2 resulted in a greater content than N_1P_2, N_1P_3, N_2P_1, N_2P_3 and N_3P_1.

4.1.3.2.27 Effect of NK interaction

The effect of interaction between the N and K doses on the P content of the leaves was significant (Table 65). The plants receiving N_2K_1, N_2K_3, N_3K_1 and N_3K_3 had a higher P content (0.717, 0.745, 0.743 and 0.715 per cent respectively) than those receiving N_1K_1, N_1K_2, N_1K_3, N_2K_2 and N_3K_2. N_2K_3 was found to result in a greater content than N_3K_3 too.

4.1.3.2.28 Effect of PK interaction

The effect of interaction between the P and K doses on the P content of the leaves was significant (Table 65). The plants receiving P_2K_3 had a greater P content (0.776 per cent) than those receiving the other PK combinations, P_1K_2 and P_2K_2 resulted in a significantly lower P content (0.623 and 0.633 per cent respectively) than the other PK combinations.

4.1.3.2.29 Effect of NPK interaction

The effect of interaction between the NPK combinations on the P content of the leaves was significant (Table 77).

Among the combinations containing N_1, $N_1P_1K_2$ resulted in a greater P content (0.728 per cent) than $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_2K_3$, $N_1P_3K_2$ and $N_1P_3K_3$. Among the combinations containing N_2, $N_2P_1K_1$ and $N_2P_2K_3$ resulted in a greater P content (0.771 and 0.895 per cent respectively) than the other combinations. $N_2P_2K_3$ resulted in a higher content than $N_2P_1K_1$ too. Among the combinations containing N_3, $N_3P_2K_1$, $N_3P_2K_3$, $N_3P_3K_1$ and $N_3P_3K_2$ resulted in a greater P content (0.755, 0.850, 0.784 and 0.784 per cent respectively) than the other combinations. $N_3P_2K_3$ resulted in a greater P content than $N_3P_2K_1$, $N_3P_3K_1$ and $N_3P_3K_2$ too. The P content was the greatest among the treatments in the plants receiving $N_2P_2K_3$ (0.859 per cent) and $N_3P_2K_3$ (0.850 per cent).

4.1.3.3 The Potassium content

4.1.3.3.1 Effect of light intensities

The effect of light intensities on the K content of the leaves was not significant (Table 57).

4.1.3.3.2 Effect of LC interaction and the response of the control plants

The effect of interaction between light intensities and the culture methods on the K content of the leaves was significant (Table 57). The C_2 plants grown under L_1 and L_2 had a higher K content in the leaves than those grown under L_3. There was no significant difference in the K content between the C_1 plants grown under L_1, L_2 and L_3 and their K content was greater than that of the C_2 plants grown under the respective light intensities.

Table 77. Interaction effects of NPK on the nutrient status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	P (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
$N_1P_1K_1$	0.661	1.440	4.080	0.208	0.012
$N_1P_1K_2$	0.728	1.448	4.285	0.239	0.016
$N_1P_1K_3$	0.725	1.508	4.216	0.261	0.028
$N_1P_2K_1$	0.637	1.420	4.268	0.404	0.021
$N_1P_2K_2$	0.611	1.310	4.371	0.440	0.018
$N_1P_2K_3$	0.620	1.668	4.333	0.339	0.018
$N_1P_3K_1$	0.682	1.528	4.452	0.278	0.020
$N_1P_3K_2$	0.586	1.415	4.183	0.261	0.031
$N_1P_3K_3$	0.671	1.500	4.237	0.337	0.030
$N_2P_1K_1$	0.771	1.517	4.402	0.297	0.022
$N_2P_1K_2$	0.556	1.547	4.369	0.282	0.013
$N_2P_1K_3$	0.668	1.395	4.126	0.224	0.013
$N_2P_2K_1$	0.699	1.457	4.336	0.286	0.018
$N_2P_2K_2$	0.635	1.637	4.131	0.319	0.016
$N_2P_2K_3$	0.859	1.583	4.268	0.287	0.029
$N_2P_3K_1$	0.681	1.462	4.236	0.286	0.017
$N_2P_3K_2$	0.684	1.377	4.328	0.256	0.016
$N_2P_3K_3$	0.708	1.478	4.303	0.268	0.023
$N_3P_1K_1$	0.690	1.577	4.210	0.352	0.028
$N_3P_1K_2$	0.587	1.452	3.981	0.364	0.015
$N_3P_1K_3$	0.645	1.363	4.022	0.338	0.017
$N_3P_2K_1$	0,755	1.472	4.208	0.320	0.022
$N_3P_2K_2$	0.652	1.325	4.329	0.389	0.018
$N_3P_2K_3$	0.850	1.477	4.320	0.276	0.014
$N_3P_3K_1$	0.784	1.497	4.286	0.281	0.026
$N_3P_3K_2$	0.784	1.432	4.385	0.267	0.018
$N_3P_3K_3$	0.652	1.535	4.533	0.261	0.016
F	16.032	60.269	11.331	15.875	12.096
CD (0.05)	0.052	0.026	0.117	0.009	0.004

Apart from the plants receiving the nutrient treatments, there was a significant difference in the K content of the leaves of the control plants (Table 57). The L_1C_1 controls had a lower K content (1.230 per cent) than the other controls while the L_3C_1 controls had a greater K content than the others. The L_2C_1 controls had a greater content than the L_1C_1, L_1C_2, L_2C_2 and L_3C_2 controls. The L_3C_2 controls had a greater K content than the L_1C_1 and L_2C_2 controls. The L_1C_2 controls had a greater K content than the L_1C_1 controls.

4.1.3.3.3 Effect of LCN interaction

The effect of interaction between light intensities, culture methods and the N doses was significant (Table 58).

Among the L_1C_1 plants, those receiving N_2 had a greater K content than those receiving N_1 and N_3. Among the L_1C_2 plants those receiving N_3 had a greater K content than those receiving N_2 and these in turn had a greater K content than those receiving N_1. Among the L_2C_1 plants those receiving N_2 had a greater K content than those receiving N_1 or N_3. Among the L_2C_2 plants, those receiving N_1 had a greater K content than those receiving N_2 or N_3. The N_2 plants had a lower K content than the N_3 plants. Among the L_3C_1 plants, those receiving N_1 or N_3 had a greater K content than those receiving N_2. Among the L_3C_2 plants those receiving N_2 or N_3 had a greater K content than those receiving N_1.

4.1.3.3.4 Effect of LCP interaction

The effect of interaction between light intensities culture methods and the P doses received by the plants on the K content of the leaves was significant (Table 59).

Among the L_1C_1 plants those receiving P_3 had a greater K content than those receiving P_1 or P_2 and those receiving P_1 had a greater content than those receiving P_2.

The L_1C_2 plants receiving P_3 had a greater K content than those receiving P_2 and these in turn had a greater K content than those receiving P_1. The L_2C_1 plants receiving P_2 had a greater K content than those receiving P_1 and these in turn had a greater K content than those receiving P_3. The L_2C_2 plants receiving P_1 or P_2 had a greater K content than those receiving P_3. The L_3C_1 plants receiving P_2 had a greater K content than those receiving P_3 and these in turn had a greater content than those receiving P_1. The L_3C_2 plants receiving P_1 had a greater K content than those receiving P_2 or P_3.

4.1.3.3.5 Effect of LCK interaction

The effect of interaction between the light intensities culture methods and the K doses on the K content of the leaves was significant (Table 66). Under L_1C_1, the plants receiving K_1 had a greater K content than those receiving K_2 or K_3. Under L_1C_2, L_2C_1 and L_3C_1, the plants receiving K_3 had a greater K content than those receiving K_1 or K_2. Under L_2C_2 the plants receiving K_1 had a greater K content than those receiving K_2 and these in turn had a greater K content than those receiving K_3. Under L_3C_2 the plants receiving K_1 or K_3 had a greater K content than those receiving K_2.

4.1.3.3.6 Effect of LCNP interaction

The effect of interaction between light intensities culture methods and the NP combinations on the K content of the leaves was significant (Table 78).

Table 78. Interaction effects of light and culture methods with NP on the potassium and magnesium status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	K (%)			Mg (ppm)		
	L_1	L_2	L_1	L_2	L_1	L_2
$C_1N_1P_1$	1.630	1.363	1.583	4.186	4.048	4.395
$C_1N_1P_2$	1.337	1.590	1.437	4.189	4.531	4.478
$C_1N_1P_3$	1.460	1.357	1.670	4.401	4.430	4.574
$C_1N_2P_1$	1.553	1.613	1.310	4.262	4.545	4.582
$C_1N_2P_2$	1.767	1.597	1.753	4.250	4.440	4.177
$C_1N_2P_3$	1.563	1.663	1.393	4.451	4.266	4.475
$C_1N_3P_1$	1.397	1.480	1.597	3.961	4.093	4.294
$C_1N_3P_2$	1.385	1.463	1.537	4.497	4.521	4.326
$C_1N_3P_3$	1.650	1.373	1.497	4.454	4.538	4.759
$C_2N_1P_1$	1.390	1.550	1.277	4.217	4.264	4.053
$C_2N_1P_2$	1.377	1.633	1.423	4.281	4.542	3.923
$C_2N_1P_3$	1.473	1.513	1.413	4.084	4.155	4.102
$C_2N_2P_1$	1.427	1.493	1.520	3.815	4.235	4.356
$C_2N_2P_2$	1.383	1.450	1.403	4.013	4.281	4.310
$C_2N_2P_3$	1.517	1.170	1.327	4.438	3.856	4.249
$C_2N_3P_1$	1.320	1.417	1.573	3.741	4.015	4.322
$C_2N_3P_2$	1.493	1.347	1.323	3.874	4.438	4.056
$C_2N_3P_3$	1.587	1.467	1.353	4.261	4.132	4.264
F	94.024	—	—	4.629	—	—
CD (0.05)	0.037	—	—	0.166	—	—

Under L_1C_1 the plants receiving N_2P_2 had a greater K content than those receiving the other NP combinations. Under L_1C_2 the N_3P_3 plants had a greater K content than the others and the N_3P_1 plants had a lesser content than the others. Under L_2C_1 the plants receiving N_2P_3 had a greater K content than the others and the N_1P_3 plants had a lower K content than the N_1P_2, N_2P_1, N_2P_2, N_2P_3, N_3P_1 and the N_3P_2 plants. Under L_2C_2 the N_1P_2 plants had a greater K content than the others and the N_2P_3 plants had a lesser K content than the others. Under L_3C_1, the N_2P_2 plants had a greater K content than the others and the N_2P_1 plants had a lesser K content than the others. Under L_3C_2, the N_2P_1 and N_3P_1 plants had a greater K content than the others and the N_1P_1 plants had a lower K content than the others.

4.1.3.3.7 Effect of LCNK interaction

The effect of interaction between light intensities culture methods and the NK combinations on the K content of the leaves was significant (Table 79). Under L_1C_1, L_1C_2, L_2C_1, L_2C_2, L_3C_1 and L_3C_2 a higher K content was found in the plants receiving respectively N_2K_1, N_2K_2, N_1K_3, N_1K_1, N_1K_3 and N_3K_1 than in the others.

4.1.3.3.8 Effect of LCPK interaction

The effect of interaction between light intensities, culture methods and the PK doses was significant (Table 80). Among the L_1C_1, L_2C_2, L_3C_1 and L_3C_2 plants, a higher K content was observed in those receiving respectively P_2K_1, P_1K_1, P_2K_3 and P_1K_1 than in the others. Under L_1C_2 the plants receiving P_2K_3 or P_3K_1 had a greater K content than the others while under L_2C_1 those receiving P_2K_3 or P_3K_3 had a greater K content than the others.

Table 79. Interaction effects of light and culture methods with NK on the potassium and magnesium status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	K (%)			Mg (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1N_1K_1$	1.567	1.323	1.457	4.320	4.362	4.385
$C_1N_1K_2$	1.420	1.383	1.470	4.325	4.355	4.754
$C_1N_1K_3$	1.440	1.603	1.763	4.130	4.292	4.308
$C_1N_2K_1$	1.683	1.633	1.363	4.327	4.257	4.549
$C_1N_2K_2$	1.567	1.760	1.513	4.322	4.490	4.501
$C_1N_2K_3$	1.633	1.480	1.580	4.313	4.504	4.183
$C_1N_3K_1$	1.548	1.440	1.583	4.231	4.300	4.469
$C_1N_3K_2$	1.477	1.263	1.510	4.266	4.393	4.434
$C_1N_3K_3$	1.407	1.613	1.537	4.416	4.459	4.475
$C_2N_1K_1$	1.407	1.653	1.370	4.160	4.429	3.944
$C_2N_1K_2$	1.253	1.497	1.323	4.055	4.348	3.843
$C_2N_1K_3$	1.580	1.547	1.420	4.367	4.184	4.291
$C_2N_2K_1$	1.350	1.450	1.390	4.050	4.281	4.485
$C_2N_2K_2$	1.510	1.347	1.423	4.145	4.041	4.157
$C_2N_2K_3$	1.467	1.317	1.437	4.071	4.050	4.274
$C_2N_3K_1$	1.500	1.477	1.543	3.900	4.217	4.292
$C_2N_3K_2$	1.400	1.453	1.313	3.820	4.252	4.224
$C_2N_3K_3$	1.500	1.300	1.393	4.156	4.117	4.126
F	75.261	—	—	3.772	—	—
CD (0.05)	0.037	—	—	0.166	—	—

Table 80. Interaction effects of light and culture methods with PK on the potassium and magnesium status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	K (%)			Mg (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1P_1K_1$	1.560	1.543	1.517	4.209	4.303	4.497
$C_1P_1K_2$	1.610	1.587	1.447	4.053	4.311	4.576
$C_1P_1K_3$	1.410	1.327	1.527	4.147	4.073	4.197
$C_1P_2K_1$	1.675	1.507	1.427	4.142	4.269	4.342
$C_1P_2K_2$	1.327	1.450	1.553	4.463	4.520	4.387
$C_1P_2K_3$	1.481	1.693	1.747	4.331	4.703	4.251
$C_1P_3K_1$	1.563	1.347	1.460	4.527	4.348	4.564
$C_1P_3K_2$	1.527	1.370	1.493	4.397	4.407	4.726
$C_1P_3K_3$	1.583	1.677	1.607	4.381	4.479	4.517
$C_2P_1K_1$	1.277	1.637	1.533	3.908	4.214	4.255
$C_2P_1K_2$	1.420	1.443	1.387	3.874	4.303	4.152
$C_2P_1K_3$	1.440	1.380	1.450	3.990	3.997	4.324
$C_2P_2K_1$	1.350	1.427	1.313	4.040	4.683	4.146
$C_2P_2K_2$	1.303	1.533	1.377	3.987	4.342	3.963
$C_2P_2K_3$	1.600	1.470	1.460	4.140	4.236	4.180
$C_2P_3K_1$	1.630	1.517	1.457	4.162	4.029	4.319
$C_2P_3K_2$	1.440	1.320	1.297	4.158	3.995	4.109
$C_2P_3K_3$	1.507	1.313	1.340	4.463	4.119	4.187
F	24.786	—	—	7.459	—	—
CD (0.05)	0.037	—	—	0.096	—	—

4.1.3.3.9 Effect of LCNPK

The effect of interaction between light intensities, culture methods and the NPK combinations on the K content of the leaves was significant (Table 81).

Among the L_1C_1, L_1C_2, L_2C_2 and L_3C_2 plants, a greater K content was found in those receiving respectively $N_2P_2K_3$, $N_1P_2K_3$, $N_1P_1K_1$ and $N_3P_1K_1$ than in the others. Under L_2C_1, the $N_1P_2K_3$ plants and the $N_2P_2K_2$ plants had a greater K content than the others. Under L_3C_1, the $N_2P_2K_3$ plants had a greater K content than those receiving the other NPK combinations excepting $N_1P_1K_3$ and $N_1P_3K_3$.

4.1.3.3.10 Effect of LN interaction

The effect of interaction between light intensities and the N doses on the K content of the leaves was significant (Table 60). Under L_1, the plants receiving N_2 had a greater K content (1.538 per cent) than those receiving N_1 or N_2. Under L_2, the plants receiving N_1 had a greater K content than those receiving N_3. Under L_3 the plants receiving N_3 or N_1 had a greater K content (1.480 and 1.467 per cent respectively) than those receiving N_2.

4.1.3.3.11 Effect of LP interaction

The effect of interaction between light intensities and the P doses on the K content of the leaves was significant (Table 60). Under L_1, the P_3 plants had a greater K content (1.542 per cent) than the P_1 and P_2 plants. Under C_2, the P_2 plants had a greater K content (1.513 per cent) than the P_1 or P_3 plants. The P_1 plants were found to have a greater K content (1.486 per cent) than the P_3 plants. Under L_3, the P_1 and P_2 plants had a greater K content (1.477 and 1.479 per cent respectively) than the P_3 plants.

Table 81. Interaction effects of light and culture methods with NPK on the potassium status (%) of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	1.620	1.250	1.160	1.920	1.520	1.170
$N_1P_1K_2$	1.720	1.360	1.610	1.380	1.380	1.240
$N_1P_1K_3$	1.550	1.560	1.320	1.350	1.850	1.420
$N_1P_2K_1$	1.550	1.240	1.460	1.510	1.350	1.410
$N_1P_2K_2$	1.090	1.070	1.440	1.550	1.390	1.320
$N_1P_2K_3$	1.370	1.820	1.870	1.840	1.570	1.540
$N_1P_3K_1$	1.530	1.730	1.350	1.530	1.500	1.530
$N_1P_3K_2$	1.450	1.330	1.100	1.560	1.640	1.410
$N_1P_3K_3$	1.400	1.360	1.620	1.450	1.870	1.300
$N_2P_1K_1$	1.730	1.260	1.790	1.490	1.210	1.620
$N_2P_1K_2$	1.580	1.570	1.720	1.620	1.390	1.400
$N_2P_1K_3$	1.350	1.450	1.330	1.370	1.330	1.540
$N_2P_2K_1$	1.770	1.310	1.420	1.350	1.630	1.260
$N_2P_2K_2$	1.640	1.510	1.890	1.490	1.740	1.550
$N_2P_2K_3$	1.890	1.330	1.480	1.510	1.890	1.400
$N_2P_3K_1$	1.550	1.480	1.690	1.510	1.250	1.290
$N_2P_3K_2$	1.480	1.450	1.670	0.930	1.410	1.320
$N_2P_3K_3$	1.660	1.620	1.630	1.070	1.520	1.370
$N_3P_1K_1$	1.330	1.320	1.680	1.500	1.820	1.810
$N_3P_1K_2$	1.530	1.330	1.430	1.330	1.570	1.520
$N_3P_1K_3$	1.330	1.310	1.330	1.420	1.400	1.390
$N_3P_2K_1$	1.705	1.500	1.640	1.420	1.300	1.270
$N_3P_2K_2$	1.205	1.330	1.020	1.560	1.530	1.260
$N_3P_2K_3$	1.200	1.650	1.730	1.060	1.780	1.440
$N_3P_3K_1$	1.610	1.680	1.000	1.510	1.630	1.550
$N_3P_3K_2$	1.650	1.540	1.340	1.470	1.430	1.160
$N_3P_3K_3$	1.690	1.540	1.780	1.420	1.430	1.350
F	78.929	—	—	—	—	—
CD (0.05)	0.063	—	—	—	—	—

Among the P doses, P_1 resulted in a greater K content in the leaves under L_2 and L_3 than under L_1, P_2 resulted in a greater K content under L_2 than under L_3 and a greater content under L_3 than under L_1. So also, P_3 resulted in a greater K content under L_1 than under L_2 and a greater content under L_2 than under L_3.

4.1.3.3.12 Effect of LK interaction

The effect of interaction between light intensities and the K doses on the K content of the leaves was significant (Table 60).

Under L_1, the K_1 and K_3 plants had a greater K content than the K_2 plants. Under L_2, the K_1 plants had a greater K content than the K_2 and K_3 plants and the K_3 plants had a greater K content than the K_2 plants. Under L_3 the K_3 plants had a greater K content than the K_1 and K_2 plants and the K_1 plants had a greater K content than the K_2 plants. The K_1 plants had a greater K content under L_1 and L_2 than under L_3, the K_2 plants had a greater K content under L_2 than under L_3 and the K_3 plants had a greater K content under L_3 than under L_2 and L_1 and a greater content under L_1 than under L_2.

4.1.3.3.13 Effect of LNP interaction

The effect of interaction between light intensities and the NP combinations on the K content of the leaves was significant (Table 61).

Under L_1, the N_3P_3 plants had a greater K content than those receiving the other NP combinations. The N_1P_2 and the N_3P_1 plants had a lower K content than the others.

Under L_2, the N_1P_2 plants had a greater K content than those receiving the other NP combinations. The N_3P_2 plants had a greater K content than the N_1P_1, N_1P_2, N_1P_3, N_2P_1, N_2P_2 and N_3P_1 plants. Under L_3, the N_3P_1 plants had a greater K content than those receiving the other combinations. N_2P_3 resulted in a lower K than all the other combinations.

4.1.3.3.14 Effect of LNK interaction

The effect of interaction between light intensities and the NK combinations on the K content of the leaves was significant (Table 71).

Under L_1, the plants receiving N_2K_3 had a greater K content than those receiving the other combinations. The plants receiving N_1K_2 had a lower content than all the others. Under L_2, the plants receiving N_1K_3 had a greater K content than those receiving N_1K_1, N_1K_2, N_2K_1, N_2K_3, N_3K_1, N_3K_2 and N_3K_3. Under L_3, the plants receiving N_1K_3 had a greater K content than those receiving the other combinations and the plants receiving N_2K_1 had a lower K content than those receiving the other NK combinations.

4.1.3.3.15 Effect of LPK interaction

The effect of interaction between the light intensities and the PK combinations on the K content of the leaves was significant (Table 72).

Under L_1, the plants receiving P_3K_1 had a greater K content than those receiving the other PK combinations. Those receiving P_2K_2 were found to have a lower K content than all the others. Under L_2, the plants receiving P_1K_1 and P_2K_3 had a greater K content than those receiving the other PK combinations. Those receiving P_1K_3 and P_3K_2 had a lower K content than the others. Under L_3, the plants receiving P_2K_3 had a greater K content than those receiving the other PK combinations. The plants receiving P_2K_1 had a lower K content than those receiving P_1K_1, P_1K_2, P_1K_3, P_2K_2 P_2K_3, P_3K_1 and P_3K_3.

Among the combinations, P_1K_1 and P_2K_2 resulted in a greater K content under L_2 than under L_1 and L_3 and a greater content under L_3 than under L_1. P_1K_2 resulted in a greater K content under L_1 and L_2 than under L_3. P_1K_3 resulted in a greater K content under L_3 than under L_1 or L_2 and a greater content under L_1 than under L_2. P_2K_1 resulted in a greater K content under L_1 than under L_2 or L_3 and a greater content under L_2 than under L_3. P_2K_3 resulted in a greater K content under L_3 than under L_1 and L_2. P_3K_1 and P_3K_2 resulted in a greater K content under L_1 than under L_3 and a greater content under L_3 than under L_2.

4.1.3.3.16 Effect of LNPK interaction

The effect of interaction between light intensities and the NPK combinations on the K content of the leaves was significant (Table 83).

Under L_1, the plants receiving $N_1P_3K_1$ had a greater K content than those receiving the other NPK combinations, excepting $N_2P_2K_3$, $N_2P_3K_3$, $N_3P_2K_1$, $N_3P_3K_1$ and $N_3P_3K_3$. Under L_2, the plants receiving $N_1P_2K_3$ had a greater K content than those receiving the other NPK combinations, and under L_3, the plants receiving $N_3P_1K_3$ had a greater K content than those receiving the other NPK combinations.

Table 82. Interaction effects of light and culture methods with NPK on the magnesium status (ppm) of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	4.189	4.060	4.210	4.124	4.080	3.818
$N_1P_1K_2$	4.262	4.010	4.240	4.470	4.768	3.964
$N_1P_1K_3$	4.106	4.580	3.695	4.198	4.336	4.379
$N_1P_2K_1$	4.180	4.203	4.088	4.909	4.612	3.616
$N_1P_2K_2$	4.322	4.236	4.746	4.535	4.738	3.650
$N_1P_2K_3$	4.065	4.405	4.760	4.182	4.084	4.502
$N_1P_3K_1$	4.592	4.217	4.789	4.254	4.464	4.400
$N_1P_3K_2$	4.391	3.918	4.080	4.038	4.757	3.915
$N_1P_3K_3$	4.219	4.116	4.421	4.172	4.503	3.993
$N_2P_1K_1$	4.276	3.738	4.569	4.458	4.926	4.446
$N_2P_1K_2$	4.218	4.039	4.628	4.374	4.750	4.203
$N_2P_1K_3$	4.292	3.668	4.439	3.873	4.068	4.420
$N_2P_2K_1$	4.036	4.228	4.285	4.644	4.175	4.650
$N_2P_2K_2$	4.287	4.033	4.226	4.009	4.159	4.075
$N_2P_2K_3$	4.426	3.778	4.810	4.190	4.196	4.207
$N_2P_3K_1$	4.669	4.186	3.917	3.741	4.545	4.359
$N_2P_3K_2$	4.461	4.362	4.618	3.741	4.594	4.194
$N_2P_3K_3$	4.223	4.767	4.263	4.087	4.285	4.195
$N_3P_1K_1$	4.161	3.927	4.129	4.061	4.484	4.502
$N_3P_1K_2$	3.679	3.573	4.066	4.066	4.211	4.290
$N_3P_1K_3$	4.044	3.723	4.084	3.919	4.188	4.174
$N_3P_2K_1$	4.211	3.691	4.434	4.497	4.240	4.174
$N_3P_2K_2$	4.781	3.691	4.590	4.483	4.264	4.163
$N_3P_2K_3$	4.500	4.239	4.539	4.335	4.474	3.831
$N_3P_3K_1$	4.321	4.083	4.337	4.092	4.684	4.200
$N_3P_3K_2$	4.338	4.195	4.522	4.207	4.828	4.219
$N_3P_3K_3$	4.703	4.506	4.754	4.097	4.764	4.374
F	7.082	—	—	—	—	—
CD (0.05)	0.287	—	—	—	—	—

Table 83. Interaction effects of light with NPK on the potassium and magnesium status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	K (%)			Mg (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	1.435	1.540	1.345	4.125	4.167	3.949
$N_1P_1K_2$	1.540	1.495	1.310	4.136	4.355	4.366
$N_1P_1K_3$	1.555	1.335	1.635	4.343	3.946	4.358
$N_1P_2K_1$	1.395	1.485	1.380	4.191	4.498	4.114
$N_1P_2K_2$	1.080	1.495	1.355	4.279	4.640	4.194
$N_1P_2K_3$	1.595	1.855	1.555	4.235	4.471	4.293
$N_1P_3K_1$	1.630	1.440	1.515	4.404	4.521	4.432
$N_1P_3K_2$	1.390	1.330	1.525	4.155	4.059	4.336
$N_1P_3K_3$	1.380	1.535	1.585	4.167	4.296	4.248
$N_2P_1K_1$	1.495	1.640	1.415	4.007	4.514	4.686
$N_2P_1K_2$	1.575	1.670	1.395	4.129	4.501	4.476
$N_2P_1K_3$	1.400	1.350	1.435	3.980	4.156	4.244
$N_2P_2K_1$	1.540	1.385	1.445	4.132	4.465	4.412
$N_2P_2K_2$	1.575	1.690	1.645	4.160	4.117	4.117
$N_2P_2K_3$	1.610	1.495	1.645	4.102	4.500	4.201
$N_2P_3K_1$	1.515	1.600	1.270	4.427	3.829	4.452
$N_2P_3K_2$	1.465	1.300	1.365	4.411	4.179	4.394
$N_2P_3K_3$	1.640	1.350	1.445	4.495	4.175	4.240
$N_3P_1K_1$	1.325	1.590	1.815	4.044	4.095	4.493
$N_3P_1K_2$	1.430	1.380	1.545	3.626	4.066	4.250
$N_3P_1K_3$	1.320	1.375	1.395	3.883	4.002	4.181
$N_3P_2K_1$	1.603	1.530	1.285	3.951	4.465	4.207
$N_3P_2K_2$	1.290	1.290	1.395	4.236	4.537	4.214
$N_3P_2K_3$	1.425	1.395	1.610	4.370	4.437	4.152
$N_3P_3K_1$	1.645	1.255	1.590	4.202	4.215	4.442
$N_3P_3K_2$	1.595	1.405	1.295	4.266	4.365	4.523
$N_3P_3K_3$	1.615	1.600	1.390	4.604	4.426	4.569
F	70.044	—	—	2.391	—	—
CD (0.05)	0.045	—	—	0.203	—	—

Among the combinations $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_2$ and $N_1P_2K_3$ resulted in a greater K content in the leaves under L_2 than under L_1 or L_3, $N_1P_1K_2$, $N_3P_2K_1$ and $N_3P_3K_2$ resulted in a greater K content under L_1 than under L_2 and L_3 and also a greater K content under L_2 than under L_3. $N_1P_1K_3$ resulted in a greater K content under L_1 and L_3 than under L_2 and a greater content under L_3 than under L_1. $N_1P_3K_1$, $N_2P_2K_1$, $N_2P_3K_2$ and $N_2P_3K_3$ resulted in a greater K content under L_1 than under L_2 and a greater K content under L_3 than under L_2. $N_1P_3K_2$ and $N_3P_1K_2$ resulted in a greater content under L_3 than under L_1 and L_2 and a greater content under L_1 than under L_2. $N_1P_3K_3$ resulted in a greater K content under L_2 and L_3 than under L_1, and also a greater content under L_3 than under L_1.

$N_2P_1K_3$ and $N_2P_2K_3$ were found to result in a greater K content under L_1 and L_3 than under L_2. $N_2P_1K_1$, $N_2P_1K_2$ and $N_2P_3K_1$ resulted in a greater K content under L_2 than under L_1 and L_3 and also a greater K content under L_1 than under L_3. $N_2P_2K_2$ resulted in a greater K content under L_2 than under L_1 and L_3. $N_3P_1K_1$ resulted in a greater K content under L_3 than under L_1 and L_2 and also a greater content under L_2 than under L_1. $N_3P_1K_3$ and $N_3P_3K_3$ resulted in a greater K content under L_1 and L_2 than under L_3.

4.1.3.3.17 Effect of culture methods

The effect of the culture method treatments on the K content of the leaves was significant (Table 57). Under C_1 the plants had a greater K content (1.519 per cent) than under C_2.

4.1.3.3.18 Effect of CN interaction

The effect of interaction between culture methods and the N doses on the K content of the leaves was significant (Table 62).

Under C_1, the N_2 plants had a greater K content than the N_1 and N_3 plants. Under C_2, the N_1 and N_3 plants had a greater K content than the N_2 plants. The plants receiving N_1, N_2 or N_3 were found to have a greater K content under C_1 than under C_2.

4.1.3.3.19 Effect of CP interaction

The effect of interaction between culture methods and the P doses on the K content of the leaves was significant (Table 62).

The C_1 plants receiving P_1, P_2 or P_3 were found to have a greater K content than the C_2 plants receiving the corresponding doses of P. Among the C_1 plants those receiving P_2 had a greater K content than those receiving P_1 or P_3. Among the C_2 plants those receiving P_1 had a greater K content than those receiving P_2 or P_3.

4.1.3.3.20 Effect of CK interaction

The effect of interaction between the culture methods and the K doses on the K content of the leaves was significant (Table 62). The C_1 plants receiving K_3 had a greater K content than those receiving K_1 or K_2, and those receiving K_1 were found to have a greater content than those receiving K_2. The C_2 plants receiving K_1 had a greater K content than those receiving K_2 or K_3. The K_3 plants were also found to have a greater K content than the K_2 plants. The C_1 plants receiving K_1, K_2 or K_3 were found to have a greater K content than the C_2 plants receiving the corresponding K doses.

4.1.3.3.21 Effect of CNP interaction

The effect of interaction between culture methods and the NP combinations received by the plants on the K content of the leaves was significant (Table 63).

The C_1 plants receiving N_2P_2 had a greater K content than those receiving the other NP combinations. The N_1P_2 and N_3P_2 plants had a lesser K content than the others. Under C_2, the N_2P_1 plants had a greater K content than the N_1P_1, N_2P_2, N_2P_3, N_3P_1 and N_3P_2 plants. The N_2P_3 plants had a lesser K content than the others.

The N_1P_1 and N_1P_3 plants grown under C_1 had a greater K content than those grown under C_2, while the N_1P_2 plants grown under C_2 had a greater K content than those grown under C_1. The N_2P_2 and N_2P_3 plants grown under C_1 had a greater K content than those grown under C_2 while the N_2P_1 plants grown under C_1 and C_2 were not significantly different in their K content. The N_3P_1, N_3P_2 and N_3P_3 plants grown under C_1 had a greater K content than those grown under C_2.

4.1.3.3.22 Effect of CNK interaction

The effect of interaction between culture methods and the NK combinations on the K content of the leaves was significant (Table 74).

Under C_1, the N_2K_2 and N_1K_3 plants had a greater K content than those receiving the other NK combinations. The plants receiving N_1K_2 and N_3K_2 had a lower K content than the others. Under C_2 the N_1K_3 and N_3K_1 plants had a greater K content than those receiving the other NK combinations and the plants receiving N_1K_2 had a lower K content than the others.

The N_1K_2 and N_1K_3 plants had a greater K content under C_1 than under C_2. The N_1K_1 plants had a greater K content under C_2 than under C_1. The N_2K_1, N_2K_2 and N_2K_3 plants had a greater K content under C_1 than under C_2. The N_3K_2 and N_3K_3 plants too had a greater K content under C_1 than under C_2. The N_3K_1 plants were not significantly different in their K content under C_1 and C_2.

4.1.3.3.23 Effect of CPK interaction

The effect of interaction between culture methods and the PK combinations on the K content of the leaves was significant (Table 75).

The plants receiving the various PK combinations excepting P_1K_3 had a higher K content under C_1 than under C_2. Under C_1, P_2K_3 had a greater K content than all the others and under C_1, P_3K_1 had a greater K content than all the others.

4.1.3.3.24 Effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinations on the K content of the leaves was significant (Table 76).

Under C_1 the plants receiving $N_2P_2K_2$ had a greater K content than those receiving the other NPK combinations excepting $N_2P_2K_3$. Under C_2, the plants receiving $N_1P_2K_3$ had a greater K content than those receiving the other NPK combinations. Among the combinations, $N_1P_1K_1$, $N_1P_2K_2$, $N_2P_1K_2$ and $N_3P_1K_3$ were not significantly different in their K content under C_1 and C_2. The rest of the combinations resulted in a greater K content under C_1 than under C_2.

4.1.3.3.25 Effect of the N doses

The effect of the N doses on the K content of the leaves was significant (Table 64). The plants receiving N_2 had a greater K content than those receiving N_1 or N_3. The N_1 plants had a greater K content than the N_3 plants.

4.1.3.3.26 Effect of the P doses

The effect of the P doses on the K content of the leaves was significant (Table 64). The plants receiving P_2 had a greater K content than those receiving P_1 or P_3. The P_3 plants had a greater K content than the P_1 plants.

4.1.3.3.27 Effect of the K doses

The effect of the K doses on the K content of the plants was significant (Table 65). The plants receiving K_3 had a greater K content than those receiving K_2 or K_1 and those receiving K_1 had a greater K content than those receiving K_2.

4.1.3.3.28 Effect of NP interaction

The effect of interaction between the N and P doses on the K content of the leaves was significant (Table 64). The N_2P_2 plants had a greater K content than those receiving the other NP combinations. The plants receiving N_1P_3, N_2P_1 and N_3P_3 had a greater K content than those receiving N_1P_1, N_1P_2, N_3P_1, N_3P_2 and N_2P_3. The plants receiving N_3P_2 had a lower K content than those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_1, N_3P_1 and N_3P_3.

4.1.3.3.29 Effect of NK interaction

The effect of interaction between the N and K doses on the K content of the leaves was significant (Table 65). The N_1K_3, N_2K_2 and N_3K_1 plants had a greater K content than those receiving the other NK combinations and among these, N_1K_3 had a higher K content than N_3K_1. N_1K_2 and N_3K_2 resulted in a lower K content than the other NK combinations.

4.1.3.3.30 Effect of PK interaction

The effect of interaction between the P and K doses on the K content of the leaves was significant (Table 65).

The plants receiving P_2K_3 had a greater K content than those receiving the rest of the PK combinations. The plants receiving P_1K_1 and P_3K_1 had a greater K content than those receiving P_1K_2, P_1K_3, P_2K_1, P_2K_2 and P_3K_2. The plants receiving P_3K_2 had a lower K content than those receiving P_1K_1, P_1K_2, P_2K_1, P_2K_2, P_2K_3, P_3K_1 and P_3K_3.

4.1.3.3.31 Effect of NPK interaction

The effect of interaction between the N, P and K doses on the K content of the leaves was significant (Table 77).

Among the combinations, $N_1P_2K_3$ resulted in a higher K content than the others. Among the combinations containing N_2, $N_2P_2K_2$ resulted in a greater K content than the others and among the combinations containing N_3, $N_3P_1K_1$ resulted in a greater K content than the others.

4.1.3.4 The Magnesium content

4.1.3.4.1 The effect of light intensities and the response of the control plants

The direct effect of light intensities on the Mg content of the leaves of the plants receiving nutrient treatments was not significant (Table 57). Among the control plants grown under L_1, L_2 and L_3 and under the culture methods C_1 and C_2, there was a significant difference in the K content of the leaves.

The L_1C_1 and the L_2C_1 controls had a greater Mg content than the L_1C_2, L_2C_2, L_3C_1, L_3C_2 controls. The L_1C_2 controls had a lower Mg content than the others. The L_2C_2, L_3C_1 and L_3C_2 controls were not significantly different in the Mg content of their leaves.

4.1.3.4.2 Effect of LCN Interaction

The effect of interaction between light intensities culture methods and the N doses on the Mg content of the leaves was significant (Table 58).

Under L_1C_1, L_2C_1 and L_3C_1 the plants receiving N_1, N_2 or N_3 did not differ in their Mg content. Under L_2C_2 and L_3C_2 the N_1 plants had a lower Mg content than the N_2 and N_3 plants. Among the N_1 plants, those grown under L_3C_1 had a greater Mg content than those grown under L_2C_1 and L_1C_1. Among the plants receiving N_2 and N_3, those grown respectively under L_2C_1 and L_3C_1 had a greater Mg content than those grown under L_1C_1.

4.1.3.4.3 Effect of LCP interaction

The effect of interaction between light intensities, culture methods and the P doses on the Mg content of the leaves was significant (Table 59).

Under L_1C_1 the plants receiving P_3 had a greater Mg content than those receiving P_2 or P_1 and those receiving P_2 had a greater Mg content than those receiving P_1 . Under L_1C_2 the plants receiving P_3 had a greater Mg content than those receiving P_2 or P_1 and those receiving P_2 had a greater Mg content than those receiving P_1.

Under L_2C_1, the plants receiving P_2 or P_3 had a greater Mg content than those receiving P_1. Under L_2C_2, the plants receiving P_2 had a greater Mg content than those receiving P_1 or P_3 and those receiving P_1 had a greater Mg content than those receiving P_3.

Under L_3C_1 the plants receiving P_3 had a greater Mg content than those receiving P_1 or P_2 and those receiving P_1 had a greater content than those receiving P_2.Under L_3C_2 the plants receiving P_1 or P_3 had a greater Mg content than those receiving P_2.

The P_1 plants grown under L_3C_1 had a greater Mg content than those grown under L_1C_1 and L_2C_1 and those grown under L_3C_2 and L_2C_2 had a greater Mg content than those grown under L_1C_2 .

The P_2 plants grown under L_2C_1 had a greater Mg content than those grown under L_1C_1 and L_3C_1 and those grown under L_2C_2 had a greater Mg content than those grown under L_1C_2 or L_3C_2.

The P_3 plants grown under L_3C_1 had a greater Mg content than those grown under L_1C_1 or L_2C_1 and the plants grown under L_1C_2 and L_3C_2 had a greater Mg content than those grown under L_2C_2.

4.1.3.4.4 Effect of LCK interaction

The effect of interaction between light intensities culture methods and the K doses on the Mg content of the leaves was significant (Table 66). Under L_1C_1, there was no significant difference in the Mg content between the plants receiving K_1, K_2 or K_3. Under L_1C_2 the plants receiving K_3 had a greater Mg content than those receiving K_1 and K_2.

Under L_2C_1 the plants receiving K_3 or K_2 had a greater Mg content than those receiving K_1. Under L_2C_2 and L_3C_1 the plants receiving K_1 or K_2 had a greater Mg content than those receiving K_3. Under L_3C_2 the plants receiving k_3 had a greater Mg content than those receiving K_1 or K_2.

The K_1 and K_2 plants grown under L_3C_1 had a greater Mg content than those grown under L_2C_1 and L_1C_1. The K_2 plants grown under L_2C_1 had a greater Mg content than those grown under L_1C_1. The K_3 plants grown under L_2C_1 had a greater Mg content than those grown under L_1C_1 and L_3C_1 and the plants grown under L_3C_2 had a greater content than those grown under L_2C_2.

4.1.3.4.5 Effect of LCNP interaction

The effect of light intensities, culture methods and the NP combinations on the Mg content of the leaves was significant (Table 78).

Under L_1C_1 the plants receiving N_3P_2 had a greater Mg content than those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_2 and N_3P_1. Under L_1C_2 the plants receiving N_2P_3 had a greater Mg content than those receiving N_1P_1, N_1P_3, N_2P_1, N_2P_2, N_3P_1, N_3P_2 and N_3P_3.

Under L_2C_1 the plants receiving N_2P_1 had a greater Mg content than those receiving N_1P_1, N_2P_3 and N_3P_1. Under L_2C_2, the plants receiving N_1P_2 had a greater Mg content than those receiving N_1P_1, N_1P_3, N_2P_1, N_2P_2, N_2P_3 and N_3P_1.

Under L_3C_1 the plants receiving N_3P_3 had a greater Mg content than those receiving the other NP combinations. Under L_3C_2 the plants receiving N_2P_1 had a greater Mg content than those receiving N_1P_1, N_1P_2, N_1P_3 and N_3P_2.

4.1.3.4.6 Effect of LCNK interaction

The effect of interaction between light intensities culture methods and the NK combinations on the Mg content of the leaves was significant (Table 79).

Under L_1C_1 the plants receiving N_3K_3 had a greater Mg content than those receiving N_1K_3 or N_3K_1. Under L_1C_2 the plants receiving N_1K_3 had a greater Mg content than those receiving the other NK combinations. Under L_2C_1 the plants receiving N_2K_3 had a greater Mg content than those receiving N_1K_3, N_2K_1 and N_3K_1. Under L_2C_2 the plants receiving N_1K_1 had a greater Mg content than those receiving N_1K_3, N_2K_2, N_2K_3, N_3K_1, N_3K_2 and N_3K_3. Under L_3C_1 the plants receiving N_1K_2 had a greater Mg content than those receiving the other NK combinations. Under L_3C_2 the plants receiving N_2K_1 had a greater Mg content than those receiving the other NK combinations.

4.1.3.4.7 Effect of LCPK interaction

The effect of interaction between light intensities culture methods and the PK combinations on the Mg content of the leaves was significant (Table 80).

Under L_1C_1 the plants receiving P_3K_1 had a greater Mg content than those receiving P_1K_1, P_1K_2, P_1K_3, P_2K_1 and P_2K_3. Under L_2C_1 the plants receiving P_2K_3 had a greater Mg content than those receiving P_1K_1, P_1K_2, P_1K_3, P_2K_1, P_2K_2, P_3K_1, P_3K_2 and P_3K_3. Under L_3C_1 the plants receiving P_3K_2 had a greater Mg content than those receiving P_1K_1, P_1K_2 , P_1K_3, P_2K_1, P_2K_2, P_2K_3 and P_3K_3. Under L_1C_2, the plants receiving P_3K_3 had a greater Mg content than those receiving the other PK combinations. Under L_2C_2 the plants receiving P_2K_1 had a greater Mg content than those receiving the other PK combinations. Under L_3C_2, the plants receiving P_1K_3 had a greater Mg content than those receiving P_1K_2, P_2K_1, P_2K_3 and P_3K_2.

4.1.3.4.8 Effect of LCNPK interaction

The effect of interaction between light intensities culture methods and the NPK combinations on the Mg content of the leaves was significant (Table 63).

Under L_1C_1 the plants receiving $N_3P_2K_2$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_3K_1$, $N_2P_3K_1$, $N_3P_2K_3$ and $N_3P_3K_3$. Under L_1C_2 the plants receiving $N_2P_3K_3$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_1K_3$ and $N_3P_3K_3$.

Under L_2C_1 the plants receiving $N_2P_2K_2$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_2K_2$, $N_1P_2K_3$, $N_1P_3K_1$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_3K_2$, $N_3P_2K_2$, $N_3P_2K_3$ and $N_3P_3K_3$.

Under L_2C_2 the plants receiving $N_1P_2K_1$ had a greater Mg content than those receiving the other NPK combinations excepting $N_2P_2K_1$. Under L_3C_1 the plants receiving $N_2P_1K_1$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_1K_2$, $N_1P_2K_2$, $N_1P_3K_2$, $N_2P_1K_2$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$. Under L_3C_2, the plants receiving $N_2P_2K_1$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_1K_3$, $N_1P_2K_3$, $N_1P_3K_1$, $N_2P_1K_1$, $N_2P_1K_3$ and $N_3P_3K_3$.

4.1.3.4.9 Effect of LN interaction

The effect of interaction between light intensities and the N doses on the Mg content of the leaves was significant (Table 60).

Under L_1, the plants receiving N_1 or N_2 had a greater Mg content than those receiving N_3. Under C_2 the plants receiving N_1 had a greater Mg content than those receiving N_2. Under L_3, the plants receiving N_2 or N_3 had a greater Mg content than those receiving N_1. Among the N doses, N_1 resulted in a greater Mg content under L_2 than under L_1 and L_3, N_2 resulted in a greater Mg content under L_3 than under L_1 and L_2 and N_3 resulted than greater content under L_2 and L_3 than under L_1.

4.1.3.4.10 Effect of LP interaction

The effect of light intensities and the P doses on the Mg content of the leaves was significant (Table 60). Under L_1, the plants receiving P_3 had a greater Mg content than those receiving P_2 and P_1 and those receiving P_2 had a greater content than those receiving P_1. Under L_2, the plants receiving P_2 had a greater Mg content than those receiving P_1 or P_3. Under L_3, the plants receiving P_3 had a greater Mg content than those receiving P_1 or P_2, and those receiving P_1 had a greater content than those receiving P_2.

The P_1 plants had a greater Mg content under L_3 than under L_1 and L_2, the P_2 plants had a greater Mg content under L_2 than under L_1 L_3 and the P_3 plants had a greater Mg content under L_3 than under L_1 and L_2 and those grown under L_1 had a greater content than those grown under L_2.

4.1.3.4.11 Effect of LK interaction

The effect of interaction between light intensities and the K doses on the Mg content of the leaves was significant (Table 60). Under L_1 the plants receiving K_3 had a greater Mg content than those receiving K_1 or K_2. Under L_2, the plants receiving K_1, K_2 or K_3 were not significantly different in the Mg content of their leaves. Under L_3, the plants receiving K_1 had a greater Mg content than those receiving K_3.

4.1.3.4.12 Effect of LNP interaction

The effect of interaction between light intensities and the NP combinations on the Mg content of the leaves was significant (Table 61). Under L_1, the plants receiving N_2P_3 had a greater Mg content than those receiving

N_1P_1, N_1P_2, N_1P_3, N_2P_1, N_2P_2, N_3P_1 and N_3P_2. The plants receiving N_3P_1 had a lower Mg content than those receiving the other NP combinations.

Under L_2, the plants receiving N_1P_2 had a greater Mg content than those receiving N_1P_1, N_1P_3, N_2P_1, N_2P_2, N_2P_3, N_3P_1 and N_3P_3. Under L_3, the plants receiving N_3P_3 had a greater Mg content that those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_2, N_2P_3, N_3P_1 and N_3P_2.

Among the NP doses, N_1P_2, N_2P_2 and N_3P_2 resulted in a greater Mg content under L_2 than under L_1 and L_3. N_2P_1 resulted in a greater Mg content under L_2 and L_3 than under L_1, N_2P_3 resulted in a greater Mg content under L_1 and L_3 than under L_2, N_3P_1 resulted in a greater Mg content under L_3 than under L_2 and a greater content under L_2 than under L_1 and N_3P_3 resulted a greater Mg content under L_3 than under L_1 and L_2. There was no significant difference in the Mg content among the plants receiving N_1P_1 or N_1P_3 under L_1, L_2 and L_3.

4.1.3.4.13 Effect of LNK interaction

The effect of interaction between light intensities and the NK combinations on the Mg content of the leaves was significant (Table 71).

Under L_1, the plants receiving N_3P_3 had a greater Mg content than those receiving N_3K_1 and N_3K_2. Under L_2, the plants receiving N_1K_1 had a greater Mg content than those receiving N_1K_3, N_2K_1, N_2K_2, N_2K_3 and N_3K_1. Under L_3 the plants receiving N_2K_1 had a greater Mg content than those receiving the other NK combinations.

Among the combinations, N_1K_1 resulted in a greater Mg content under L_2 than under L_1 and L_3, N_2K_2 resulted in a greater Mg content under L_2 than under L_1, N_2K_1 and N_3K_1 resulted in a greater Mg content under L_3 than under L_1 and L_2 and N_3K_2 resulted in a greater Mg content under L_3 and L_2 than under L_1. The plants receiving N_1K_3, N_2K_2, N_2K_3 or N_3K_3 did not differ significantly in their Mg content under L_1, L_2 and L_3.

4.1.3.4.14 Effect of LPK interaction

The effect of interaction between light intensities and the PK combinations on the Mg content of the leaves was significant (Table 72).

Under L_1, the plants receiving P_3K_3 had a greater Mg content than those receiving P_1K_2, P_1K_3, P_2K_1, P_2K_2, P_2K_3, and P_3K_2. Under L_2 the plants receiving P_2K_3 had a greater Mg content than those receiving P_1K_2, P_1K_3, P_3K_1, P_3K_2 and P_3K_3. Under L_3, the plants receiving P_3K_1 had a greater Mg content than those receiving P_1K_3, P_2K_1, P_2K_2 and P_2K_3.

Among the combinations, P_1K_1 and P_1K_2 resulted in a greater Mg content under L_3 than under L_2 and a greater content under L_2 than under L_1. P_1K_3 resulted in a greater Mg content under L_3 than under L_1 and L_2. P_2K_1 resulted in a greater Mg content under L_2 than under L_3 and a greater content under L_3 than under L_1. P_2K_2 and P_2K_3 resulted in a greater Mg content under L_2 than under L_1 and L_3. P_3K_1 resulted in a greater Mg content under L_3 and L_1 than under L_2. P_3K_2 resulted in a greater content under L_1 and L_2 than under L_3 and P_3K_3 resulted in a greater content under L_1 than under L_2 and L_3.

4.1.3.4.15 Effect of LNPK interaction

The effect of interaction between light intensities and the NPK combinations on the Mg content of the leaves was significant (Table 83).

Under L_1, the plants receiving $N_3P_3K_3$ had a greater Mg content than those receiving the other combinations except $N_1P_3K_1$, $N_2P_3K_1$, $N_2P_3K_2$ and $N_2P_3K_3$.

Under L_2, the plants receiving $N_1P_2K_2$ had a greater Mg content than those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_3K_1$, $N_2P_3K_2$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$.

Under L_3, the plants receiving $N_2P_1K_1$ had a greater Mg content than those receiving the other NPK combinations except $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$.

Among the NPK combinations; $N_1P_1K_1$ resulted in a greater Mg content under L_2 than under L_3. $N_1P_1K_2$, $N_2P_1K_2$, $N_3P_1K_2$ and $N_3P_1K_3$ resulted in a greater Mg content under L_2 and L_3 than under L_1. $N_1P_1K_3$, $N_2P_2K_3$ and $N_2P_3K_1$ resulted in a greater Mg content under L_1 and L_3 than under L_2. $N_1P_2K_1$ and $N_1P_2K_2$ resulted in a greater Mg content under L_2 than under L_1 and L_3. $N_1P_2K_3$ and $N_2P_2K_1$ resulted in a greater Mg content under L_2 than under L_1.

$N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_2$ and $N_3P_3K_3$ had no significant difference in their Mg content under L_1, L_2 and L_3. $N_1P_3K_2$ resulted in a greater Mg content under L_3 than under L_2. $N_2P_1K_1$, $N_2P_1K_2$, $N_3P_1K_2$ and $N_3P_1K_3$

resulted in a greater Mg content under L_2 and L_3 than under L_1. $N_2P_1K_3$ and $N_3P_3K_3$ resulted in a greater Mg content under L_3 than under L_1. $N_2P_3K_2$ and $N_2P_3K_3$ resulted in a greater Mg content under L_1 than under L_2. $N_2P_3K_2$ also had a greater content under L_3 than under L_2. $N_3P_1K_1$ and $N_3P_3K_1$ resulted in a greater Mg content under L_3 than under L_1 and L_2. $N_3P_2K_1$ and $N_3P_2K_2$ resulted in a greater Mg content under L_2 than under L_1 and L_3. $N_3P_2K_1$ also resulted in a greater content under L_3 than under L_1.

4.1.3.4.16 Effect of culture methods

The direct effect of culture methods on the Mg content of the leaves was not significant. However, interactions between culture methods and the nutrients received by the plants was observed (Tables 62, 63, 74, 75 and 84).

4.1.3.4.17 Effect of CP interaction

The effect of interaction between culture methods and the P doses on the Mg content of the leaves was significant (Table 62). Under C_1, the plants receiving P_3 had a greater Mg content than those receiving P_1 or P_2. The plants receiving P_2 had a greater content than those receiving P_1. Under C_2, the P_2 and P_3 plants had a greater Mg content than the P_1 plants. The C_1 plants receiving P_1, P_2 or P_3 had a greater Mg content than the C_2 plants receiving the same doses.

4.1.3.4.18 Effect of CK interaction

The effect of interaction between culture methods and the K doses on the Mg content of the leaves was significant (Table 62). Under C_1, the plants receiving K_2 had a greater Mg content than those receiving K_1 and K_3.

Table 84. Interaction effects of culture methods with NPK on the magnesium, zinc and copper status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Mg (ppm)		Zn (ppm)		Cu (ppm)	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	4.160	4.001	0.220	0.197	0.015	0.010
$N_1P_1K_2$	4.423	4.148	0.235	0.242	0.015	0.017
$N_1P_1K_3$	4.046	4.385	0.287	0.235	0.032	0.025
$N_1P_2K_1$	4.293	4.242	0.417	0.392	0.025	0.017
$N_1P_2K_2$	4.602	4.140	0.516	0.364	0.020	0.017
$N_1P_2K_3$	4.303	4.363	0.335	0.343	0.017	0.018
$N_1P_3K_1$	4.615	4.290	0.322	0.233	0.022	0.018
$N_1P_3K_2$	4.409	3.957	0.262	0.260	0.028	0.033
$N_1P_3K_3$	4.381	4.094	0.432	0.243	0.033	0.027
$N_2P_1K_1$	4.591	4.214	0.329	0.255	0.022	0.022
$N_2P_1K_2$	4.532	4.204	0.322	0.242	0.017	0.008
$N_2P_1K_3$	4.266	3.987	0.232	0.216	0.017	0.010
$N_2P_2K_1$	4.165	4.507	0.259	0.313	0.020	0.017
$N_2P_2K_2$	4.224	4.039	0.335	0.303	0.017	0.015
$N_2P_2K_3$	4.477	4.058	0.296	0.277	0.033	0.025
$N_2P_3K_1$	4.377	4.095	0.278	0.294	0.020	0.013
$N_2P_3K_2$	4.558	4.099	0.286	0.226	0.018	0.013
$N_2P_3K_3$	4.257	4.349	0.193	0.343	0.020	0.025
$N_3P_1K_1$	4.258	4.163	0.365	0.339	0.027	0.030
$N_3P_1K_2$	3.958	3.976	0.400	0.327	0.017	0.013
$N_3P_1K_3$	4.105	3.939	0.395	0.281	0.018	0.015
$N_3P_2K_1$	4.295	4.120	0.329	0.311	0.020	0.023
$N_3P_2K_2$	4.545	4.112	0.421	0.356	0.025	0.012
$N_3P_2K_3$	4.504	4.135	0.308	0.244	0.018	0.010
$N_3P_3K_1$	4.447	4.125	0.309	0.253	0.032	0.020
$N_3P_3K_2$	4.562	4.207	0.283	0.250	0.020	0.015
$N_3P_3K_3$	4.741	4.326	0.281	0.240	0.020	0.012
F	5.434	—	27.102	—	3.596	—
CD (0.05)	0.166	—	0.027	—	0.006	—

Under C_2, the plants receiving K_1 had a greater Mg content than those receiving K_2. The plants receiving K_1, K_2 and K_3 had a greater Mg content under C_1 than under C_2.

4.1.3.4.19 Effect of CNP interaction

The effect of interaction between culture methods and the NP combinations on the Mg content of the leaves was significant (Table 63).

Under C_1, the plants receiving N_3P_3 had a greater Mg content than the rest and the plants receiving N_3P_1 had the lowest content among the treatments. Under C_2,the plants receiving N_1P_2 had a greater Mg content than those receiving N_1P_3, N_2P_1, N_3P_1 and N_3P_2 and the plants receiving N_3P_1 had a lower content than those receiving N_1P_1, N_1P_2,N_2P_1, N_2P_2, N_2P_3, N_3P_2 and N_3P_3.

4.1.3.4.20 Effect of CNK interaction

The effect of interaction between culture methods and the NK doses on the Mg content of the leaves was significant (Table 74). Under C_1 the plants receiving N_1K_2 had a higher Mg content than those receiving N_1K_1, N_1K_3, N_2K_1, N_2K_3, N_3K_1 and N_3K_2. Under C_2 the plants receiving N_1K_3 had a greater Mg content than those receiving N_1K_1, N_1K_2, N_2K_2, N_2K_3, N_3K_1, N_3K_2 and N_3K_3. All the NK combinations except N_1K_3 resulted in a greater Mg content under C_1 than under C_2. The plants receiving N_1K_3 were not significantly different in their Mg content under C_1 and C_2.

4.1.3.4.21 Effect of CPK interaction

The effect of interaction between culture methods and the PK combinations on the Mg content of the leaves was significant (Table 75).

Under C_1, the plants receiving P_3K_2 had a greater Mg content than those receiving P_1K_1, P_1K_2, P_1K_3 and P_2K_1. Under C_2 the plants receiving P_2K_1 had a greater Mg content than those receiving P_1K_1, P_1K_2, P_1K_3,P_2K_2, P_2K_3, P_3K_1 and P_3K_2. Among the combinations, P_1K_1, P_1K_2, P_2K_2, P_2K_3, P_3K_1, P_3K_2 and P_3K_3 resulted in a greater Mg content under C_1 than under C_2.

4.1.3.4.22 Effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinations on the Mg content of the leaves was significant (Table 84).

Under C_1, $N_3P_3K_3$ resulted in a greater Mg content than the others excepting $N_1P_2K_2$, $N_1P_3K_1$ and $N_2P_1K_1$. Under C_2, $N_2P_2K_2$ resulted in a greater Mg content than the others excepting $N_1P_1K_3$ and $N_2P_3K_3$. There was no significant difference in the Mg content between the plants receiving $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_3$, $N_1P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_1K_2$ and $N_3P_1K_3$, under C_1 and C_2. The plants receiving $N_1P_1K_3$ and $N_2P_2K_1$ had a greater Mg content under C_2 than under C_1 while those receiving the other NPK combinations had a greater content under C_1 than under C_2.

4.1.3.4.23 Effect of the N doses

The effect of the N doses on the Mg content of the leaves was not significant (Table 64).

4.1.3.4.24 Effect of the P doses

The effect of the P doses received by the plants on the Mg content of the leaves was significant (Table 64). The plants receiving P_3 had a greater Mg content than those receiving P_2 and those receiving P_2 had a greater Mg content than the plants receiving P_1.

4.1.3.4.25 Effect of NP interaction

The effect of interaction between the N and P doses on the Mg content of the leaves was significant (Table 64). The N_3P_3 plants had a greater Mg content than those receiving the other NP combinations. The plants receiving N_3P_1 had a lower Mg content than those receiving the other combinations. The N_1P_2 plants had a greater content than the N_1P_1, N_2P_2 and N_3P_1 plants.

4.1.3.4.26 Effect of NK interaction

The effect of interaction between the NK doses on the Mg content of the leaves was significant (Table 65). The N_2K_1 plants had a greater Mg content than those receiving N_2K_3, N_3K_1 and N_3K_2.

4.1.3.4.27 Effect of PK interaction

The effect of interaction between the P and K doses on the Mg content of the leaves was significant (Table 65). The P_3K_3 plants had a greater Mg content than the P_1K_1, P_1K_2, P_1K_3, P_2K_1 and P_2K_2 plants. The P_2K_3 plants had a greater Mg content than the P_1K_1, P_1K_2 and P_1K_3 plants. The P_1K_3 plants had a lower Mg content than the others.

4.1.3.4.28 Effect of NPK interaction

The effect of interaction between the N, P and K doses on the Mg content of the leaves was significant (Table 77).

The plants receiving $N_3P_3K_3$ had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_3K_1$ and these had a greater Mg content than those receiving the other NPK combinations excepting $N_1P_2K_2$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_1$ and $N_3P_3K_2$. The plants receiving $N_3P_1K_2$ had a lower Mg content than the others excepting $N_1P_1K_1$ and $N_3P_1K_3$.

Among the NPK combinations containing N_1, $N_1P_3K_1$ resulted in a greater Mg content than the others excepting $N_1P_2K_2$. Among the combinations containing N_2, $N_2P_1K_1$ resulted, in a greater Mg content than $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_2K_3$ and $N_2P_3K_1$. Among the combinations containing N_3, $N_3P_3K_3$ had a greater Mg content than the others.

4.1.3.5 The zinc content

4.1.3.5.1 The effect of light intensities and the response of the control plants

The effect of light intensities on the zinc content of the leaves of the plants given nutrient treatments was significant (Table 57). The zinc content of the leaves was greater in the L_2 plants (0.314ppm) than in the L_1 or L_3 plants. The content in the latter two were on par.Among the control plants grown under L_1, L_2 and L_3 and under the culture methods C_1 and C_2, there was a significant difference in the zinc content of the leaves (Table 57).

The L_1C_2 and the L_2C_2 controls had a greater zinc content (0.454 and 0.452 ppm respectively) than the L_1C_1, L_2C_2, L_3C_1 and the L_3C_2 controls. The L_1C_1 controls had a lower zinc content than the others.

4.1.3.5.2 Effect of LCN interaction

The effect of interaction between light intensities culture methods and the N doses on the zinc content of the leaves was significant (Table 58).

Under L_1C_1 the N_1 plants had a greater zinc content than the N_2 plants and under L_1C_2 the N_3 plants had a greater zinc content than the N_1 plants. Under L_2C_1 and L_3C_2 the N_3 plants had a greater zinc content than the N_1 and N_2 plants. The N_1 plants were greater in zinc content than the N_2 plants under L_2C_1. Under L_2C_2 and L_3C_1 the N_1 plants had a greater zinc content than the N_2 and N_3 plants. Under L_3C_1 the N_3 plants had a greater content than the N_2 plants. The $L_2C_1N_3$ plants and the $L_3C_1N_1$ plants had a greater zinc content than the others.

4.1.3.5.3 Effect of LCP interaction

The effect of interaction between light intensities culture methods and the P doses on the zinc content of the leaves was significant (Table 59).

Under L_1C_1, L_2C_1, L_2C_2 and L_3C_1, the plants receiving P_2 had a greater zinc content than those receiving P_1 or P_3. Under L_3C_2 the P_2 and P_3 plants had a greater zinc content than the P_1 plants.

4.1.3.5.4 Effect of LCK interaction

The effect of interaction between light intensities culture methods and the K doses on the zinc content of the leaves was significant (Table 66).

Under L_1C_1 and L_1C_2 the K_2 and K_3 plants had a greater zinc content than the K_1 plants. Under L_2C_1, the K_2 plants had a greater zinc content than the K_1 and K_3 plants. Under L_2C_2, the K_1 plants had a greater zinc content than the K_2 and K_3 plants. Under L_3C_1 and L_3C_2, the K_1 and K_2 plants had a greater zinc content than the K_3 plants.

4.1.3.5.5 Effect of LCNP interaction

The effect of interaction between light intensities culture methods and the NP combinations on the zinc content of the leaves was significant (Table 85).

Under L_1C_1, L_1C_2, L_2C_2 and L_3C_1, the N_1P_2, N_3P_1, N_1P_2 and N_1P_2 plants respectively had a greater zinc content than the others. Under L_2C_1 the N_3P_2 plants had a greater zinc content than the others except N_3P_1. Under L_3C_2 the N_1P_2 plants had a greater zinc content than the others except N_3P_1 and N_3P_3.

Among the CNP combinations, the $C_1N_1P_1$ and $C_1N_2P_3$ plants had a greater zinc content under L_2 and L_3 than under L_1.

The $C_1N_1P_2$ plants had a greater zinc content under L_1 and L_3 than under L_2.

The $C_1N_2P_1$ and $C_2N_1P_2$ plants had a greater content under L_2 than under L_1 and L_3.

Table 85. Interaction effects of light and culture methods with NP on the zinc and copper status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Zn(ppm)			Cu(ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1N_1P_1$	0.196	0.266	0.280	0.012	0.035	0.015
$C_1N_1P_2$	0.461	0.352	0.455	0.025	0.023	0.013
$C_1N_1P_3$	0.339	0.330	0.347	0.020	0.032	0.032
$C_1N_2P_1$	0.283	0.321	0.280	0.015	0.018	0.022
$C_1N_2P_2$	0.274	0.291	0.327	0.020	0.032	0.018
$C_1N_2P_3$	0.225	0.278	0.255	0.015	0.015	0.028
$C_1N_3P_1$	0.409	0.382	0.370	0.025	0.018	0.018
$C_1N_3P_2$	0.334	0.393	0.331	0.015	0.030	0.018
$C_1N_3P_3$	0.245	0.351	0.277	0.025	0.020	0.027
$C_2N_1P_1$	0.202	0.273	0.200	0.027	0.017	0.008
$C_2N_1P_2$	0.268	0.496	0.334	0.013	0.017	0.022
$C_2N_1P_3$	0.304	0.234	0.199	0.033	0.023	0.022
$C_2N_2P_1$	0.223	0.278	0.212	0.013	0.013	0.013
$C_2N_2P_2$	0.295	0.306	0.291	0.020	0.025	0.012
$C_2N_2P_3$	0.336	0.265	0.261	0.020	0.015	0.017
$C_2N_3P_1$	0.394	0.246	0.308	0.028	0.015	0.015
$C_2N_3P_2$	0.313	0.346	0.252	0.010	0.018	0.017
$C_2N_3P_3$	0.183	0.252	0.308	0.017	0.010	0.020
F	22.284	—	—	6.024	—	—
CD (0.05)	0.027	—	—	0.006	—	—

The $C_1N_2P_2$ and the $C_1N_3P_2$ plants had a greater zinc content under L_3 than under L_1 and L_2. The $C_1N_3P_1$ and $C_2N_2P_3$ plants had a greater zinc content under L_1 than under L_2 and L_3.

The $C_1N_3P_3$ plants had a greater zinc content under L_2 than under L_1 and L_3 and also a greater content under L_3 than under L_1.

The $C_2N_1P_3$ plants had a greater zinc content under L_1 than under L_2 and L_3 and also a greater content under L_2 than under L_3. The $C_2N_2P_1$ plants had a greater zinc content under L_2 than under L_1. The $C_2N_3P_1$ plants had a greater zinc content under L_1 than under L_2 and L_3 and a greater content under L_3 than under L_2. The $C_2N_3P_2$ plants had a greater zinc content under L_2 than under L_1 and L_3 and also a greater content under L_1 than under L_3. The $C_2N_3P_3$ plants had a greater content under L_3 than under L_1 and L_2 and 'a greater content under L_2 than under L_1.

4.1.3.5.6 Effect of LCNK interaction

The effect of interaction between light intensities culture methods and the NK combinations on the zinc content of the leaves as significant (Table 86).

Under L_1C_1 the N_1K_2 plants had a greater zinc content than the others excepting the N_3K_1 plants. Under L_1C_2, the N_3P_2 plants had a greater zinc content than the others excepting the N_2K_3 and the N_3K_1 plants.

Under L_2C_1, the N_3K_2 plants had a greater zinc content than the others and the N_3K_3 plants had a greater content than the others excepting the N_3K_2 plants. Under L_2C_2 the N_1K_1 plants had a greater zinc content than the others.

Table 86. Interaction effects of light and culture methods with NK on the zinc and copper status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Zn (ppm)			Cu (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1N_1K_1$	0.283	0.310	0.365	0.013	0.030	0.018
$C_1N_1K_2$	0.370	0.291	0.352	0.022	0.022	0.020
$C_1N_1K_3$	0.342	0.346	0.365	0.022	0.038	0.022
$C_1N_2K_1$	0.205	0.322	0.339	0.017	0.018	0.027
$C_1N_2K_2$	0.279	0.347	0.317	0.017	0.017	0.018
$C_1N_2K_3$	0.297	0.220	0.205	0.017	0.030	0.023
$C_1N_3K_1$	0.352	0.323	0.327	0.030	0.022	0.027
$C_1N_3K_2$	0.319	0.415	0.370	0.017	0.028	0.017
$C_1N_3K_3$	0.316	0.387	0.281	0.018	0.018	0.020
$C_2N_1K_1$	0.213	0.377	0.232	0.013	0.018	0.013
$C_2N_1K_2$	0.289	0.333	0.245	0.033	0.017	0.017
$C_2N_1K_3$	0.272	0.293	0.257	0.027	0.022	0.022
$C_2N_2K_1$	0.271	0.288	0.302	0.020	0.015	0.017
$C_2N_2K_2$	0.261	0.257	0.253	0.008	0.017	0.012
$C_2N_2K_3$	0.322	0.305	0.209	0.025	0.022	0.013
$C_2N_3K_1$	0.310	0.286	0.307	0.030	0.018	0.025
$C_2N_3K_2$	0.326	0.299	0.309	0.013	0.012	0.015
$C_2N_3K_3$	0.253	0.260	0.252	0.012	0.013	0.012
F	11.381	—	—	4.375	—	—
CD (0.05)	0.027	—	—	0.006	—	—

Under L_3C_1 the N_3K_2 plants had a greater zinc content than the N_2K_1, N_2K_2, N_2K_3, N_3K_1 and the N_3K_3 plants.

Under L_3C_2 the N_3P_2 plants had a greater zinc content than the others excepting the N_2K_1 and the N_3K_1 plants.

4.1.3.5.7 Effect of LCPK interaction

The effect of interaction between light intensities culture methods and the PK combinations on the zinc content of the leaves was significant (Table 87).

Under L_1C_1, the P_2K_1 plants had a greater zinc content than those receiving the other PK combinations. Under L_2C_1, the P_2K_2 plants had a greater zinc content than those receiving the other PK combinations. Under L_3C_1, L_1C_2 and L_3C_2 too, the P_2K_2 plants had a greater zinc content than those receiving the other PK combinations. Under L_2C_2, the P_2K_1 plants has a greater zinc content than those receiving the other PK combinations.

4.1.3.5.8 Effect of LCNPK interaction

The effect of interaction between light intensities, culture methods and the NPK combinations on the zinc content of the leaves was significant (Table 88).

Under L_1C_1, L_2C_2 and L_3C_2 the plants receiving respectively $N_1P_2K_2$, $N_1P_2K_1$ and $N_1P_2K_3$ had a greater zinc content in the leaves than those receiving the other NPK combinations.

Table 87. Interaction effects of light and culture methods with PK on the zinc and copper status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Zn (ppm)			Cu (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$C_1P_1K_1$	0.296	0.280	0.339	0.018	0.023	0.022
$C_1P_1K_2$	0.271	0.323	0.364	0.015	0.017	0.017
$C_1P_1K_3$	0.321	0.365	0.228	0.018	0.032	0.017
$C_1P_2K_1$	0.300	0.316	0.389	0.020	0.027	0.018
$C_1P_2K_2$	0.430	0.431	0.411	0.023	0.023	0.015
$C_1P_2K_3$	0.338	0.288	0.313	0.017	0.035	0.017
$C_1P_3K_1$	0.245	0.360	0.304	0.022	0.020	0.032
$C_1P_3K_2$	0.268	0.299	0.264	0.017	0.027	0.023
$C_1P_3K_3$	0.296	0.300	0.310	0.022	0.020	0.032
$C_2P_1K_1$	0.276	0.251	0.265	0.032	0.017	0.013
$C_2P_1K_2$	0.254	0.314	0.244	0.008	0.015	0.015
$C_2P_1K_3$	0.288	0.232	0.211	0.028	0.013	0.008
$C_2P_2K_1$	0.277	0.447	0.291	0.017	0.022	0.018
$C_2P_2K_2$	0.341	0.353	0.330	0.013	0.017	0.013
$C_2P_2K_3$	0.258	0.348	0.257	0.013	0.022	0.018
$C_2P_3K_1$	0.241	0.252	0.287	0.015	0.013	0.023
$C_2P_3K_2$	0.281	0.222	0.233	0.033	0.013	0.015
$C_2P_3K_3$	0.300	0.278	0.249	0.022	0.022	0.020
F	19.341	—	—	9.995	—	—
CD (0.05)	0.027	—	—	0.006	—	—

Table 88. Interaction effects of light and culture methods with NPK on the zinc status (ppm) of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	0.151	0.171	0.214	0.193	0.295	0.229
$N_1P_1K_2$	0.169	0.182	0.197	0.355	0.339	0.190
$N_1P_1K_3$	0.267	0.252	0.386	0.272	0.208	0.182
$N_1P_2K_1$	0.370	0.197	0.355	0.708	0.525	0.272
$N_1P_2K_2$	0.643	0.355	0.433	0.414	0.473	0.323
$N_1P_2K_3$	0.369	0.253	0.268	0.366	0.368	0.409
$N_1P_3K_1$	0.327	0.272	0.362	0.231	0.276	0.197
$N_1P_3K_2$	0.299	0.331	0.243	0.230	0.244	0.221
$N_1P_3K_3$	0.391	0.309	0.384	0.241	0.520	0.180
$N_2P_1K_1$	0.270	0.201	0.376	0.308	0.343	0.256
$N_2P_1K_2$	0.251	0.197	0.363	0.328	0.353	0.202
$N_2P_1K_3$	0.329	0.270	0.223	0.197	0.145	0.180
$N_2P_2K_1$	0.197	0.331	0.252	0.267	0.330	0.341
$N_2P_2K_2$	0.309	0.312	0.377	0.266	0.321	0.332
$N_2P_2K_3$	0.316	0.244	0.245	0.387	0.329	0.200
$N_2P_3K_1$	0.150	0.281	0.340	0.289	0.345	0.312
$N_2P_3K_2$	0.278	0.274	0.303	0.178	0.278	0.226
$N_2P_3K_3$	0.246	0.453	0.193	0.330	0.141	0.246
$N_3P_1K_1$	0.468	0.457	0.250	0.252	0.379	0.309
$N_3P_1K_2$	0.393	0.382	0.409	0.260	0.399	0.341
$N_3P_1K_3$	0.368	0.343	0.487	0.227	0.331	0.273
$N_3P_2K_1$	0.334	0.304	0.342	0.368	0.311	0.260
$N_3P_2K_2$	0.339	0.356	0.485	0.379	0.439	0.334
$N_3P_2K_3$	0.330	0.279	0.353	0.290	0.243	0.163
$N_3P_3K_1$	0.257	0.170	0.378	0.237	0.291	0.351
$N_3P_3K_2$	0.227	0.240	0.352	0.258	0.271	0.253
$N_3P_3K_3$	0.252	0.139	0.324	0.262	0.268	0.320
F	13.162	—	—	—	—	—
CD (0.05)	0.047	—	—	—	—	—

Under L_1C_2 the plants receiving $N_3P_1K_1$ had a greater zinc content than the others excepting those receiving $N_2P_3K_3$. Under L_2C_1 the plants receiving $N_3P_1K_3$ had a greater zinc content than the others excepting those receiving $N_3P_2K_3$. Under L_3C_1, the plants receiving $N_1P_2K_1$ had a greater zinc content than the others excepting those receiving $N_1P_3K_3$.

4.1.3.5.9 Effect of LP interaction

The effect of interaction between light intensities and the P doses on the zinc content of the leaves was significant (Table 60). Under L_1, L_2 and L_3, the plants receiving P_2 had a greater zinc content than those receiving P_1 or P_3. The P_1 plants had a greater zinc content under L_2 than under L_3. The P_2 and P_3 plants had a greater zinc content under L_2 than under L_1 or L_3.

4.1.3.5.10 Effect of LK interaction

The effect of interaction between light intensities and the K doses on the zinc content of the leaves was significant (Table 60) Under L_1, the plants receiving K_2 or K_3 had a greater zinc content than those receiving K_1. Under L_2 and L_3 the plants receiving K_1 or K_2 had a greater zinc content than those receiving K_3. The K_1 plants had a greater zinc content under L_2 and L_3 than under L_1. The K_2 plants had a greater zinc content under L_2 than under L_1 and L_3 and the K_3 plants had a greater zinc content under L_1 and L_2 than under L_3.

4.1.3.5.11 Effect of LNP interaction

The effect of interaction between light intensities and the NP combinations on the zinc content of the leaves was significant (Table 61).

Under L_1, the plants receiving N_3P_1, had a greater zinc content than those receiving the other NP combinations. Under L_2 and L_3 the plants receiving N_1P_2 had a greater zinc content than those receiving the other NP combinations.

Among the combinations, N_1P_1, and N_1P_2 resulted in a greater zinc content under L_2 than under L_3 and L_1 and a greater content under L_3 than under L_1. N_1P_3 resulted in a greater zinc content under L_1 than under L_2 or L_3. N_2P_1 resulted in a greater zinc content under L_2 than under L_1 and L_3. N_2P_2 resulted in a greater zinc content under L_3 than under L_1 and N_2P_3 resulted in a greater zinc content under L_1 than under L_3. N_3P_1 resulted in a greater zinc content under L_1 than under L_2 and L_3 and a greater content under L_3 than under L_1. N_3P_2 resulted in a greater zinc content under L_2 than under L_1 and L_3 and a greater content under L_1 than under L_3, and N_3P_3 resulted in a greater zinc content under L_2 and L_3 than under L_1.

4.1.3.5.12 Effect of LNK interaction

The effect of interaction between light intensities and the NK combinations on the zinc content of the leaves was significant (Table 71).

Under L_1 the plants receiving N_3K_1 had a greater zinc content than those receiving N_1K_1, N_1K_3, N_2K_1, N_2K_2, N_2K_3 and N_3K_3. Under L_2 and L_3, the plants receiving N_3K_2 had a greater zinc content than those receiving N_1K_1 under L_2 and N_2K_1 under L_3.

4.1.3.5.13 Effect of LPK interaction

The effect of light intensities and the PK combinations on the zinc content of the leaves was significant (Table 72). Under L_1 and L_3 the plants receiving P_2K_2 had a greater zinc content than those receiving the other PK combinations. Under L_2, the plants receiving P_2K_1 and P_2K_2 had a greater zinc content than those receiving the other PK combinations.

Among the combinations, P_1K_1 resulted in a greater zinc content under L_3 and L_1 than under L_2. P_1K_2 and P_2K_1 resulted in a greater zinc content under L_2 than under L_3 and L_1 and a greater content under L_3 than under L_1. P_1K_3 resulted in a greater content under L_1 and L_2 than under L_3 and P_2K_2 resulted in a greater zinc content under L_2 than under L_3. P_2K_3 resulted in a' greater content under L_2 than under L_1 and L_3.

P_3K_1 resulted in a greater zinc content under L_2 and L_3 than under L_1. P_3K_2 and P_3K_3 resulted in a greater zinc content under L_1 than under L_3.

4.1.3.5.14 Effect of LNPK interaction

The effect of interaction between the light intensities and the NPK combinations on the zinc content of the leaves was significant (Table 90).

Under L_1, the plants receiving $N_2P_2K_2$ and $N_3P_1K_1$ had a greater zinc content than those receiving the other NPK combinations.

Under L_2, the plants receiving $N_1P_2K_1$, $N_1P_2K_2$ and $N_3P_2K_2$ had a greater zinc content than those receiving the other combinations.

Under L_3, the plants receiving $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_2K_3$ and $N_3P_2K_2$ had a greater zinc content than those receiving the other NPK combinations excepting $N_3P_1K_2$. However the L_2, $N_1P_2K_1$ plants had a greater zinc content than all the others.

Table 89. Interaction effects of light and culture methods with NPK on the copper status (ppm) of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	L_1		L_2		L_3	
	C_1	C_2	C_1	C_2	C_1	C_2
$N_1P_1K_1$	0.010	0.015	0.020	0.010	0.015	0.005
$N_1P_1K_2$	0.010	0.010	0.020	0.025	0.015	0.015
$N_1P_1K_3$	0.015	0.055	0.065	0.015	0.015	0.005
$N_1P_2K_1$	0.020	0.015	0.045	0.025	0.010	0.010
$N_1P_2K_2$	0.035	0.020	0.010	0.010	0.015	0.020
$N_1P_2K_3$	0.020	0.005	0.015	0.015	0.015	0.035
$N_1P_3K_1$	0.010	0.010	0.025	0.020	0.030	0.25
$N_1P_3K_2$	0.020	0.070	0.035	0.015	0.030	0.015
$N_1P_3K_3$	0.030	0.020	0.035	0.035	0.035	0.025
$N_2P_1K_1$	0.015	0.025	0.025	0.020	0.025	0.020
$N_2P_1K_2$	0.015	0.005	0.015	0.010	0.020	0.010
$N_2P_1K_3$	0.015	0.010	0.015	0.010	0.020	0.010
$N_2P_2K_1$	0.025	0.020	0.010	0.015	0.025	0.015
$N_2P_2K_2$	0.020	0.010	0.015	0.025	0.015	0.010
$N_2P_2K_3$	0.015	0.030	0.070	0.035	0.015	0.010
$N_2P_3K_1$	0.010	0.015	0.020	0.010	0.030	0.015
$N_2P_3K_2$	0.015	0.010	0.020	0.015	0.020	0.015
$N_2P_3K_3$	0.020	0.035	0.005	0.020	0.035	0.020
$N_3P_1K_1$	0.030	0.055	0.025	0.020	0.025	0.015
$N_3P_1K_2$	0.020	0.010	0.015	0.010	0.015	0.020
$N_3P_1K_3$	0.025	0.020	0.015	0.0015	0.015	0.010
$N_3P_2K_1$	0.015	0.015	0.025	0.025	0.020	0.030
$N_3P_2K_2$	0.015	0.010	0.045	0.015	0.015	00.10
$N_3P_2K_3$	0.015	0.005	0.020	0.015	0.020	0.010
$N_3P_3K_1$	0.045	0.020	0.015	0.010	0.035	0.030
$N_3P_3K_2$	0.015	0.020	0.025	0.010	0.020	0.015
$N_3P_3K_3$	0.015	0.010	0.020	0.010	0.025	0.015
F	—	11.670	—	—	—	—
CD (0.05)	—	0.010	—	—	—	—

Table 90. Interaction effects of light with NPK on the zinc and copper status of the leaves of *Arachnis* Maggie Oei 'Red Ribbon'

Treatment	Zn (ppm)			Cu (ppm)		
	L_1	L_2	L_3	L_1	L_2	L_3
$N_1P_1K_1$	0.161	0.203	0.262	0.012	0.015	0.010
$N_1P_1K_2$	0.176	0.276	0.264	0.010	0.023	0.015
$N_1P_1K_3$	0.260	0.329	0.195	0.035	0.040	0.010
$N_1P_2K_1$	0.284	0.532	0.398	0.018	0.035	0.010
$N_1P_2K_2$	0.499	0.424	0.398	0.028	0.010	0.018
$N_1P_2K_3$	0.311	0.317	0.388	0.012	0.015	0.025
$N_1P_3K_1$	0.300	0.296	0.237	0.010	0.023	0.028
$N_1P_3K_2$	0.315	0.236	0.232	0.045	0.025	0.023
$N_1P_3K_3$	0.350	0.312	0.350	0.025	0.035	0.030
$N_2P_1K_1$	0.235	0.342	0.299	0.020	0.023	0.023
$N_2P_1K_2$	0.224	0.345	0.277	0.010	0.012	0.015
$N_2P_1K_3$	0.299	0.210	0.162	0.012	0.012	0.015
$N_2P_2K_1$	0.264	0.259	0.335	0.023	0.012	0.020
$N_2P_2K_2$	0.310	0.321	0.327	0.015	0.020	0.012
$N_2P_2K_3$	0.280	0.316	0.264	0.023	0.053	0.012
$N_2P_3K_1$	0.216	0.314	0.328	0.012	0.015	0.023
$N_2P_3K_2$	0.276	0.240	0.252	0.012	0.018	0.018
$N_2P_3K_3$	0.349	0.261	0.194	0.028	0.012	0.028
$N_3P_1K_1$	0.462	0.251	0.344	0.042	0.023	0.020
$N_3P_1K_2$	0.388	0.334	0.370	0.015	0.012	0.018
$N_3P_1K_3$	0.355	0.357	0.302	0.023	0.015	0.012
$N_3P_2K_1$	0.319	0.355	0.285	0.015	0.025	0.025
$N_3P_2K_2$	0.347	0.432	0.387	0.012	0.030	0.012
$N_3P_2K_3$	0.304	0.322	0.203	0.010	0.018	0.015
$N_3P_3K_1$	0.213	0.308	0.321	0.033	0.012	0.033
$N_3P_3K_2$	0.233	0.305	0.262	0.018	0.018	0.018
$N_3P_3K_3$	0.195	0.293	0.294	0.012	0.015	0.020
F	21.731	—	—	14.254	—	—
CD (0.05)	0.033	—	—	0.007	—	—

4.1.3.5.15 Effect of culture methods

The effect of the culture methods on the zinc content of the leaves was significant (Table 57). Under C_1 the plants had a greater zinc content in the leaves than under C_2.

4.1.3.5.16 Effect of CN interaction

The effect of interaction between the culture methods and the N doses on the zinc content of the leaves was significant (Table 62).

Under C_1, the N_3 plants had a greater zinc content than the N_1 plants. Under C_2, the N_3 plants had a greater zinc content than the N_1 and N_2 plants. The N_1 and N_3 plants had a greater zinc content under C_1 than under C_2. There was no significant difference in the zinc content between the N_2 plants under C_1 and C_2.

4.1.3.5.17 Effect of CP interaction

The effect of interaction between the culture method treatments and the P doses on the zinc content of the leaves was significant.

Under C_1 the plants receiving P_1, P_2 or P_3 had a greater zinc content than those receiving the corresponding P doses under C_2 (Table 62).

Under C_1 and C_2 the P_2 plants had a greater zinc content than the P_1 and P_3 plants. The C_1P_2 plants had a greater zinc content than all the others.

4.1.3.5.18 Effect of CK interaction

The effect of interaction between the culture method treatments and the K doses on the zinc content of the leaves was significant (Table 62).

Under C_1, the K_2 plants had a greater zinc content than the K_1 and K_3 plants. Under C_2 the K_1 plants had a greater zinc content than the K_2 and K_3 plants. The K_2 plants had a greater zinc content than the K_3 plants under C_2.

The plants receiving K_1, K_2 or K_3 had a greater zinc`content under`C_1 than`under`C_r. The C_1K_2`plants had a greater zinc`content than all the othersn

4.1.3.5.19 Effect of CNP interaction

The effect of interaction between culture methods and the NP combinations on the zinc content of the leaves was significant (Table 63).

The plants receiving the various'NP combinations excepting N_2P_2 had a greater zinc content under C_1 than under C_2. The N_2P_2 plants had no significant difference in their zinc content under C_2 and C_1.

Under C_1, the N_1P_2 plants had a greater zinc content than those receiving the other combinations and the N_3P_1 plants hàd a greater zinc content than those receiving the other combinations excepting N_1P_2. Under C_2 too the N_1P_2 plants had a greater zinc content than those receiving the other combinations.

4.1.3.5.20 Effect of CNK interaction

The effect of interaction between culture methods and the NK combinations on the zinc content of the leaves was significant (Table 74).

Under C_1, the plants receiving N_3K_2 had a greater zinc content than those receiving the other NK combinations. Under C_2, the plants receiving N_3K_2 had a greater zinc content than those receiving the other combinations excepting N_3K_1.

Among the combinations, the N_1K_1, N_1K_2, N_1K_3, N_2K_2, N_3K_1, N_3K_2 and N_3K_3 plants had a greater zinc content in the leaves under C_1 than under C_2, while the N_2K_3 plants had a greater zinc content under C_2 than under C_1 and the N_2K_1 plants were not significantly different in the zinc content of the leaves under C_1 and C_2.

4.1.3.5.21 Effect of CPK interaction

The effect of interaction between culture methods and the PK combinations on the zinc content of the leaves was significant (Table 75).

All the PK combinations excepting P_2K_1 resulted in a greater zinc content under C_1 than under C_2. There was no significant difference in the zinc content between the P_2K_1 plants, under C_1 and C_2 . Under C_1 the P_2K_2 plants had a greater zinc content than those receiving the other PK combinations.` the P_1K_2 plants had a greater zinc content than the others excepting the P_2K_2 plants.

Under C_2, the P_2K_1 and P_2K_2 plants had a greater zinc content than those receiving the other PK combinations.

4.1.3.5.22 Effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinations on the zinc content of the leaves was significant (Table 84).

Under C_1 the plants receiving $N_1P_2K_2$ had a greater zinc content than those receiving the other NPK combinations. The $N_1P_3K_3$ plants too, had a greater zinc content than the others excepting the $N_1P_2K_2$ plants. Under C_2, the plants receiving $N_1P_2K_1$ had a greater zinc content than those receiving the other combinations.

Among the combinations, $N_1P_1K_3$, $N_1P_2K_2$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_2K_2$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_2K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$ resulted in a greater zinc content under C_1 than under C_2. Whereas the $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_1$, $N_1P_2K_3$, $N_1P_3K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_1$, $N_3P_1K_1$ and $N_3P_2K_1$ plants had no significant difference in their zinc content under C_1 and C_2.

4.1.3.5.23 Effect of the N doses

The effect of the N doses on the zinc content of the leaves was significant (Table 64). The plants receiving N_3 had a greater zinc content than those receiving N_1 or N_2. The plants receiving N_1 had a greater zinc content than those receiving N_2.

4.1.3.5.24 Effect of the P doses

The effect of the P doses received by the plants on the zinc content of the leaves was significant (Table 64). The plants receiving P_2 had a greater zinc content than those receiving P_1 and P_3 and those receiving P_1 had a greater content than those receiving P_3.

4.1.3.5.25 Effect of the K doses

The effect of the K doses on the zinc content of the leaves was significant (Table 65). The plants receiving K_2 had a greater zinc content than those receiving K_1 and K_3 and those receiving K_1 had a greater content than those receiving K_3.

4.1.3.5.26 Effect of NP interaction

The effect of the interaction between the NP doses on the zinc content of the leaves was significant (Table 64). The plants receiving N_1P_2 had a greater zinc content than those receiving the other NP combinations. The N_3P_1 plants had a greater zinc content than the N_1P_1, N_1P_3, N_2P_1, N_2P_2, N_2P_3, N_3P_2 and N_3P_3 plants and the N_3P_2 plants had a greater zinc content than the N_1P_1, N_1P_3 N_2P_1, N_2P_2, N_2P_3 and N_3P_3 plants.

4.1.3.5.27 Effect of NK interaction

The effect of interaction between the NK doses received by the plants on the zinc content of the leaves was significant (Table 65). The plants receiving N_3K_2 had a greater zinc content than those receiving the other NK combinations. The plants receiving N_2K_2, N_2K_3 and N_3K_1 had a greater zinc content than those receiving N_1K_1, N_2K_1, N_2K_2, N_2K_3 and N_3K_3.

4.1.3.5.28 Effect of Pk interaction

The effect of interaction between the PK combinations on the zinc content of the leaves was significant (Table 65). The plants receiving P_2K_2 had a greater zinc content than those receiving the other PK combinations. The P_2K_1 plants had a greater zinc content than the P_1K_1, P_1K_2, P_1K_3, P_2K_3, P_3K_1, P_3K_2 and P_3K_3 plants. The P_1K_2 plants had a greater zinc content than the P_1K_1 and P_1K_3 plants.

4.1.3.5.29 Effect of NPK interaction

The effect of interaction between the NPK combinations on the zinc content of the leaves was significant (Table 77).

Among the plants receiving the NPK combinations containing N_1, P_2K_2 resulted in a greater zinc content than the others. Among the plants receiving the combinations containing N_2 too, P_2K_2 resulted in a greater zinc content than the others. Among the plants receiving the combinations containing N_3, P_2K_2 resulted in a greater zinc content than the others. The plants receiving $N_1P_2K_2$ had a significantly greater zinc content than the others.

4.1.3.6 The copper content

4.1.3.6.1 The effect of light intensities

The effect of light intensities on the copper content of the leaves was not significant (Table 57).

4.1.3.6.2 Effect of LC interaction

The effect of interaction between light intensities and culture methods on the Cu content of the leaves was significant (Table 57). The L_2C_1 plants had a greater Cu content than the L_1C_1, L_1C_2, L_2C_2, L_3C_1, and the L_3C_2 plants. Under L_2 and L_3, the C_1 plants had a greater content of Cu than the C_2 plants. Under L_1 there was no significant difference between the C_1 and C_2 plants in the Cu content of the leaves.

Among the control plants there was a significant difference in the Cu content of the leaves (Table 57). The L_1C_2 controls had a greater content of Cu than the L_1C_1, L_2C_1, L_2C_2, L_3C_1 and the L_3C_2 controls.

4.1.3.6.3 Effect of LCN interaction

The effect of interaction between light intensities, culture methods and the N doses on the Cu the content of the leaves was significant (Table 58).

The Cu content was greater in the $L_2C_1N_1$ plants than in the others.

Under L_1C_1 the plants receiving N_3 had a greater Cu content than those receiving N_1 and N_2. Under L_1C_2 the plants receiving N_1 had a greater Cu content than those receiving N_2 and N_3. Under L_2C_1 the plants receiving N_1 had a greater Cu content than those receiving N_2 and N_3. Under L_2C_2, the plants receiving N_1 and N_2 had a greater Cu content than those receiving N_3. Under L_3C_1 the plants receiving N_2 had a greater Cu content than those receiving N_1 and N_3. Under L_3C_2 the plants receiving N_1 or N_3 had a greater Cu content than those receiving N_2.

4.1.3.6.4 Effect of LCP interaction

The effect of interaction between light intensities,culture methods and the P doses on the Cu content of the leaves was significant (Table 59).

Under L_1C_1 and L_3C_2, the plants receiving P_2 or P_3 had a greater Cu content than those receiving P_1. Under L_1C_2 the plants receiving P_1 or P_3 had a greater Cu content than those receiving P_2. Under L_2C_1 and L_2C_2 the plants receiving P_2 had a greater Cu content than those receiving P_1 or P_3. Under L_3C_1 the plants receiving P_3 had a greater Cu content than those receiving P_1 or P_2.

and the NP combinations on the Cu content of the leaves was significant (Table 85).

Under L_1C_1, the plants receiving N_1P_2 or N_3P_3 had a greater Cu content than those receiving N_1P_1, N_2P_1, N_2P_3, and N_3P_2. Under L_2C_1 the plants receiving N_1P_1 had a greater Cu content than those receiving N_1P_2, N_2P_1, N_2P_3, N_3P_1 and N_3P_3. Under L_3C_1 the plants receiving N_1P_3 had a greater Cu content than those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_2 and N_3P_1. Under L_1C_2 the plants receiving N_1P_3 had a greater Cu content than those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_2, N_2P_3, N_3P_2 and N_3P_3. Under L_2C_2 the plants receiving N_2P_2 had a greater Cu content than those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_3, N_3P_1, N_3P_2 and N_3P_3. Under L_3C_3 the plants receiving N_1P_1 and N_1P_3 had a greater Cu content than those receiving N_1P_1, N_2P_1, N_2P_2 and N_3P_1.

4.1.3.6.6 Effect of LCNK interaction

The effect of interaction between light intensities culture methods and the NK combinations on the Cu content of the leaves was significant (Table 86).

Under L_1C_1 the plants receiving N_3K_1 had a greater Cu content than those receiving the other NK combinations. Under L_2C_1, the plants receiving N_1K_3 had a greater Cu content than those receiving the other combinations. Under L_3C_1 the plants receiving N_2K_1 had a greater Cu content than those receiving N_1K_1, N_1K_2, N_2K_2, N_3K_2, and N_3K_3.

Under L_1C_2 the plants receiving N_1K_2 had a greater Cu content than those receiving the other NK combinations excepting N_3K_1. Under L_2C_2, the plants receiving N_1K_3 and N_2K_3 had a greater Cu content than those receiving N_2K_1, N_3K_2 and N_3K_3. Under L_3C_2, the plants receiving N_3K_1 had a greater Cu content than the others excepting N_1K_3.

4.1.3.6.7 Effect of LCPK interaction

Under L_1C_1 the plants receiving P_2K_2 had a greater Cu content than those receiving P_1K_2, P_2K_3 and P_3K_2 (Table 87). Under L_2C_1 the plants receiving P_2k_3 had a greater Cu content than those receiving P_1K_1, P_1K_2, P_2K_1, P_2K_2, P_3K_1, P_3K_2 and P_3K_3. Under L_3C_1 the plants receiving P_3K_1 and P_3K_3 had a greater Cu content than those receiving the other PK combinations. Under L_1C_2 the plants receiving P_3K_2 had a greater Cu content than those receiving P_1K_2, P_2K_1, P_2K_2, P_2k_3, P_3K_1, and P_3K_3.

Under L_2C_2 the plants receiving P_2K_1, P_2K_3 and P_3K_3 had a greater Cu content than those receiving P_1K_2, P_1K_3, P_3K_1 and P_3K_2.. Under L_3C_2 the plants receiving P_3K_1 had a greater Cu content than those receiving P_1K_1, P_1K_2 ,P_1K_3, P_2K_2 and P_3K_2

4.1.3.6.8 Effect of LCNPK interaction

The effect of interaction between light intensities culture methods and the NPK combinations on the Cu content of the leaves was significant (Table 89).

Under L_1C_1 the plants receiving $N_3P_3K_1$ had a greater Cu content than those receiving the other NPK combinations excepting $N_1P_2K_2$. Under

L_1C_2 the plants receiving $N_1P_3K_2$ had a greater Cu content than those receiving the other NPK combinations.

Under L_2C_1 the plants receiving $N_2P_2K_3$ had a greater Cu content than those receiving the other NPK combinations excepting $N_1P_1K_3$. Under L_2C_2 the plants receiving $N_1P_3K_3$ and $N_2P_2K_3$ had a greater Cu content than those receiving the other NPK combinations.

Under L_3C_1 the plants receiving $N_1P_2K_2$ had a greater Cu content than those receiving the other NPK combinations. Under L_3C_2 the plants receiving $N_1P_2K_3$ had a greater Cu content than those receiving the other NPK combinations excepting $N_3P_3K_1$.

4.1.3.6.9 Effect of LN interaction

The effect of interaction between light intensities and the N doses on the Cu content of the leaves was significant (Table 60).

Under L_1, the plants receiving N_1 or N_3 had a greater Cu content than those receiving N_2. Under L_2, the plants receiving N_1 or N_2 had a greater Cu content than those receiving N_3. Under L_3, there was no significant difference in the Cu content between the plants receiving N_1, N_2 or N_3. Among the N_1 plants, the Cu content was greater under L_2 than under L_1 and L_3 and greater under L_1 than under L_3. Among the N_2 plants the Cu content was greater under L_2 than under L_1 and L_3. Among the N_3 plants, there was no significant difference in the Cu content between the plants grown under L_1, L_2 and L_3.

4.1.3.6.10 Effect of LP interaction

The effect of interaction between the light intensities and the P doses on the Cu content of the leaves was significant (Table 60). Under L_1 the P_3 plants had a greater Cu content than the P_1 and P_2 plants and the P_1 plants had a greater Cu content than the P_2 plants. Under L_2, the P_2 plants had a greater Cu content than the P_1 and P_3 plants and under L_3, the P_3 plants had a greater Cu content than the P_1 and P_2 plants. The P_2 plants had a greater Cu content than the P_1 plants under L_3.

Among the P_1 plants the Cu content of the leaves was greater under L_1 and L_2 than under L_3. Among the P_2 plants, the content was greater under L_2 than under L_1 and L_3. Among the P_3 plants the Cu content was greater under L_3 than under L_1 and L_2 and also greater under L_1 than under L_2.

4.1.3.6.11 Effect of LK interaction

The effect of interaction between light intensities and the K doses on the Cu content of the leaves was significant (Table 60). Under L_1 the K_1 and K_3 plants had a greater Cu content than the K_2 plants. Under L_2, the K_3 plants had a greater Cu content than the K_1 and K_2 plants. Under L_3,the K_1 plants had a greater Cu content than the K_2 and K_3 plants and the K_3 plants had a greater content than the K_2 plants.

Among the K_1 plants the Cu content of the leaves was not significantly different under L_1, L_2 and L_3. In the K_2 plants, the content was greater under L_1 and L_2 than under L_3. In the K_3. plants the Cu content was greater under L_2 than under L_1 and L_3.

4.1.3.6.12 Effect of LNP interaction

The effect of interaction between light intensities and the NP combinations on the Cu content of the leaves was significant (Table 61).

Under L_1 the plants receiving N_1P_3 and N_3P_1 had a greater Cu content than those receiving the other NP combinations. Under L_2, the plants receiving N_2P_2 had a greater Cu content than those receiving N_1P_2, N_2P_1, N_2P_3, N_3P_1, N_3P_2 and N_3P_3. Under L_3, the plants receiving N_1P_3 had a greater Cu content than those receiving the other NP combinations.

Among the combinations, N_1P_1 and N_2P_2 resulted in a greater Cu content under L_2 than under L_1 and L_3. A greater Cu content was found under L_1 than under L_3, too. The N_2P_3 plants resulted in a greater Cu content under L_3 than under L_1 and L_2. The N_3P_1 plants had a greater Cu content under L_1 than under L_2 and L_3. The N_3P_2 plants had a greater Cu content under L_2 than under L_1 and L_3 and a greater content under L_3 than under L_1. The N_3P_3 plants had a greater Cu content under L_1 and L_3 than under L_2.

The N_2P_1, N_1P_3 and N_1P_2 plants had no significant difference in their Cu content under L_1, L_2 and L_3.

4.1.3.6.13 Effect of LNK interaction

The effect of interaction between light intensities and the Nk combinations on the Cu content of the leaves was significant (Table 71).

Under L_1 the plants receiving N_3K_1 had a greater Cu content than those receiving the other NK combinations excepting N_1K_2. Under L_2 the plants receiving N_1k3 had a greater Cu content than those receiving the other NK combinations. So also under L_3, the plants receiving N_3K_1 had a greater Cu content than those receiving the other Nk combinations.

The N_1K_1 plants had a greater Cu content under L_2 than under L_1 and L_3, the N_1K_2 plants had a greater Cu content under L_1 than under L_2 and L_3, the N_1K_3, N_2K_3 and N_3K_2 plants had a greater Cu content under L_2 than under L_1 and L_3, the N_2K_1 plants had a greater Cu content under L_3 than under L_1 and L_2 the N_2K_2 plants had a greater Cu content under L_2 than under L_1, the N_3K_1 plants had a greater Cu content under L_1 and L_3 than under L_2 and the N_3K_3 plants were not significantly different in their Cu content under L_1, L_2 and L_3.

4.1.3.6.14 Effect of LPK interaction

The effect of interaction between light intensities and the PK combinations on the Cu content of the leaves was significant (Table 72).

Under L_1 the plants receiving P_1K_1 and P_3K_2 had a greater Cu content than those receiving P_1K_2, P_2K_1, P_2K_2, P_2K_3 and P_3K_1. Under L_2, the plants receiving P_2K_3 had a greater Cu content than those receiving P_1K_1, P_1K_2, P_1K_3, P_2K_1, P_2K_2, P_3K_1, P_3K_2 and P_3K_3. Under L_3, the plants receiving P_3K_1 had P_3K_3, had a greater Cu content than those receiving the other PK combinations.

Among the combinations, the P_1K_1 plants and the P_3K_2 plants had a greater Cu content under L_1 than under L_2 and L_3. The P_1K_2 plants had a greater Cu content under L_2 and L_3 than under L_1. The P_1K_3 and P_2K_2 plants had a greater Cu content under L_1 and L_2 than under L_3. The P_2K_1 and P_2K_3 plants had a greater Cu content under L_2 than under L_1 and L_3. The P_3K_1 and P_3K_3 plants had a greater Cu content under L_3 than under L_1 and L_2.

4.1.3.6.15 Effect of LNPK interaction

The effect of interaction between light intensities and the NPK combinations on the Cu content of the leaves was significant (Table 90).

Under L_1, the plants receiving $N_1P_3K_2$ had a greater Cu content than those receiving the other NPK combinations except $N_3P_1K_1$. Under L_2, the plants receiving $N_2P_2K_3$ had a greater Cu content than the rest. Under L_3, $N_3P_3K_1$, resulted in a greater Cu content than the others, excepting $N_1P_3K_1$, $N_1P_3K_3$ and $N_2P_3K_3$.

4.1.3.6.16 The effect of culture methods

The effect of the culture methods on the Cu content of the leaves was significant (Table 57). The C_1 plants had a greater Cu content than the C_2 plants.

4.1.3.6.17 Effect of CNK interaction

The effect of interaction between culture methods and the NK combinations on the Cu content of the leaves was significant (Table 74).

Under C_1, the plants receiving N_1K_3 and N_3K_1 had a greater Cu content than those receiving the other combinations. Under C_2 the plants receiving N_1K_3 and N_3K_1 had a greater Cu content than those receiving the other combinations except N_1K_2.

Among the NK combinations all except N_1K_2 and N_3K_1 resulted in a greater Cu content under C_1 than under C_2. There was no significant difference in Cu content between the plants receiving N_1K_2 and N_3K_1 under C_1 and C_2.

4.1.3.6.18 Effect of CPK interaction

The effect of interaction between culture methods and the PK combinations on the Cu content of the leaves was significant (Table 75).

Under C_1, the plants receiving P_3K_1 or P_3K_3 had a greater Cu content than those receiving P_1K_1, P_1K_2 and P_2K_2. Under C_2, the plants receiving P_1K_1, P_3K_2 and P_3K_3 had a greater Cu content than those receiving P_1K_2, P_1K_3, P_2K_2, P_2K_3 and P_3K_1.

Among the combinations, all except P_1K_1 and P_3K_2 resulted in a greater Cu content under C_1 than under C_2. There was no significant difference in the Cu content among the plants receiving P_1K_1 and P_3K_2 under C_1 or C_2.

4.1.3.6.19 Effect of CNPK interaction

The effect of interaction between culture methods and the NPK combinations on the Cu content of the leaves was significant (Table 84).

Under C_1, the plants receiving $N_1P_1K_3$, $N_1P_3K_3$, $N_2P_2K_3$ and $N_3P_3K_1$, had a greater Cu content than those receiving the other NPK combinations, excepting $N_1P_3K_2$ and $N_3P_1K_1$. Under C_2, the plants receiving $N_1P_3K_2$ had a greater Cu content than those receiving the other combinations.

Among the combinations, $N_1P_1K_3$, $N_1P_2K_1$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_1$, $N_3P_2K_2$, $N_3P_2K_3$, $N_3P_3K_1$ and $N_3P_3K_3$ resulted in a greater Cu content under C_1 than under C_2 and there was no significant difference in Cu content between the plants receiving the other combinations, under C_1 and C_2.

4.1.3.6.20 Effect of the N doses

The effect of the N doses on the Cu content of the leaves was significant (Table 64). The Cu content was greater in the N_1 plants than in the N_2 and N_3 plants and greater in the N_3 plants than in the N_2 plants.

4.1.3.6.21 Effect of the P doses

The effect of the P doses on the Cu content of the leaves was significant (Table 64). The P_3 plants had a greater Cu content than the P_2 and P_1 plants. The P_2 plants had a greater Cu content than the P_1 plants

4.1.3.6.22 Effect of the K doses

The effect of the K doses on The Cu content of the leaves was significant (Table 65). The K_1 and K_3 plants had a greater Cu content than the K_2 plants.

4.1.3.6.23 Effect of NP interaction

The effect of interaction between the N and P doses on the Cu content of the leaves was significant (Table 64) The N_1P_3 plants had a greater Cu content and the N_2P_1 plants had a lesser content than those receiving the other NP combinations. The N_2P_2 plants had a greater Cu content than the N_1P_1, N_1P_2, N_2P_1, N_2P_3 and N_3P_2 plants. The N_3P_1 and N_3P_3 plants had a greater Cu content than the N_2P_1, N_2P_3 and the N_3P_2 plants.

4.1.3.6.24 Effect of NK Interaction

The effect of interaction between the N and K doses on the Cu content of the leaves was significant (Table 65). The N_1K_3 plants and the N_3K_2 plants had a greater Cu content than the others. The N_1K_2 and N_2K_3 plants had a greater Cu content than the N_1K_1, N_2K_1, N_2K_2, N_3K_2 and the N_3K_3 plants.

4.1.3.6.25 Effect of PK interaction

The effect of interaction between the P and K doses on the Cu content of the leaves was significant (Table 65). The plants receiving P_3K_2 had a greater Cu content than those receiving the other PK treatments. The P_1K_1, P_3K_1 and the P_3K_2 plants had a greater Cu content than the P_1K_2, P_1K_3 and P_2K_2 plants. So also the P_2K_1 and P_2K_3 plants had a greater Cu content than the P_1K_2 and P_2K_2 plants.

4.1.3.6.26 Effect of NPK interaction

The effect of interaction between the N,P and K doses on the Cu content of the leaves was significant (Table 77). The plants receiving $N_1P_1K_3$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_2K_3$ and $N_3P_1K_1$ had a greater Cu content than those receiving the other NPK combinations excepting $N_3P_3K_1$.

Among the combinations containing N_1, $N_1P_3K_2$ and $N_1P_3K_3$ resulted in a greater Cu content than $N_1P_1K_1$, $N_1P_1K_2$,$N_1P_2K_1$, $N_1P_2K_2$, $N_1P_2K_3$ and $N_1P_3K_1$. Among the combinations containing N_2, $N_2P_2K_3$ resulted in a greater Cu content than the others. Among those containing N_3, $N_3P_1K_1$ and $N_3P_3K_1$ resulted in a greater Cu content than the others.

4.2 Experiment 2 Sympodials *Dendrobium* Sonia-16

4.2.1 Growth characters

4.2.1.1 The length of the shoots

The effect of the P doses on the maximum length attained by the shoots was significant (Table 91). Plants receiving 400 or 500 ppm P attained a greater length (17.902 and 17.774 cm respectively) than those receiving 300 ppm (16.163 cm).

Table 91. Effect of P and its interaction with light intensities on the length and dry matter content of the shoots of *Dendrobium* Sonia - 16

Treatment	Length (cm)	dm (%)
P_1	16.163	9.513
P_2	17.902	9.450
P_3	17.774	9.705
F	3.451	7.184
CD (0.05)	1.468	0.139
L_1P_1	16.167	9.639
L_1P_2	18.633	9.756
L_1P_3	19.083	9.775
L_2P_1	16.956	9.414
L_2P_2	17.456	9.236
L_2P_3	17.667	9.780
L_3P_1	15.417	9.487
L_3P_2	17.617	9.358
L_3P_3	16.572	9.559
F	0.663	2.719
CD (0.05)	—	0.241

The direct effect of N, P and light intensities and their interaction effects on the length of the shoots were not significant.

4.2.1.2 The number of leaves per clump

4.2.1.2.1 The effect of P

The P doses were found to influence the total number of leaves produced in a clump at 10 and 11 MAP (August and September 1993)

(Table 92). During the period, plants receiving 400 and 500 ppm P had a greater number of leaves than those receiving 300 ppm. The increase recorded was 0.685 and 0.815 per cent respectively during August 1993 and 0.556 and 0.815 per cent respectively, during September 1993.

4.2.1.2.2 The effect of NP interaction

Interaction between the N and P doses was significant at 9 MAP (July 1993) (Table 92). Plants receiving N_2P_3 or N_3P_2 had a greater leaf number (5.222 and 5.278 respectively) than those receiving N_1P_2 or N_3P_3 (4.000). Among the N doses, N_2 resulted in a greater number of leaves in combination with P_3 than with P_1 and N_3 resulted in a greater number of leaves in combination with P_2 than with P_1 or P_3.

Table 92. Effect of P and interaction effects of NP and PK on the number of leaves produced by *Dendrobium* Sonia - 16

Treatment	10 MAP	Treatment	9 MAP	Treatment	3 MAP
P_1	4.000	N_1P_1	4.056	P_1K_1	1.833
P_2	4.685	N_1P_2	4.000	P_1K_2	2.722
P_3	4.815	N_1P_3	4.389	P_1K_3	2.278
F	5.327	N_2P_1	4.111	P_2K_1	2.500
CD (0.05)	0.534	N_2P_2	4.333	P_2K_2	1.944
Treatment	11 MAP	N_2P_3	5.222	P_2K_3	2.833
P_1	4.000	N_3P_1	4.278	P_3K_1	2.944
P_2	4.556	N_3P_2	5.278	P_3K_2	2.000
P_3	4.815	N_3P_3	4.000	P_3K_3	3.056
F	5.010	F	3.137	F	3.227
CD (0.05)	0.523	CD (0.05)	0.933	CD (0.05)	0.819

4.2.1.2.3 The effect of PK interaction

Interaction between the P and K doses was significant at 3 MAP (January 1993) (Table 92). Plants receiving P_1K_2, P_2K_3, P_3K_1 and P_3K_3 had a greater number of leaves (2.722, 2.833, 2.944 and 3.056 respectively) than those receiving P_1K_1. Among the P doses, P_1 resulted in a greater number of leaves in combination with K_2 than with K_1, P_2 resulted in a greater number of leaves in combination with K_3 than with K_2 and P_3 resulted in a greater number of leaves in combination with K_3 than with K_2.

4.2.1.2.4 The effect of NPK interaction

Interaction between the NPK combinations was significant at 11 and 12 MAP (September and October 1993) (Table 93). During September 1993, among the PK combinations with N_1, $N_1P_3K_2$ resulted in a greater number of leaves (5.167) than $N_1P_1K_1$. Among the combinations with N_2, $N_2P_3K_1$, $N_2P_2K_1$ and $N_2P_3K_3$ resulted in a greater number of leaves (5.500, 5.333 and 5.167 respectively) than $N_2P_1K_3$ (3.500). Among the PK combinations with N_3, $N_3P_1K_1$, $N_3P_2K_2$, $N_3P_2K_3$ and $N_3P_3K_3$ resulted in a greater number of leaves (5.333, 5.000, 5.167 and 6.167 respectively) than $N_3P_1K_2$ (3.167).

At 12 MAP, (October 1993) among the PK combinations with N_1,it was found that $N_1P_2K_2$ and $N_1P_3K_2$ had a greater number of leaves (5.000) than $N_1P_1K_1$ (3.000). Among the PK combinations with N_2, $N_2P_3K_3$ resulted in a greater number of leaves (5.333) than $N_2P_2K_2$ (3.5000) and among the combinations with N_3, $N_3P_3K_3$ and $N_3P_1K_1$ resulted in a greater number (6.000 and 5.667 respectively) than $N_3P_1K_3$ or $N_3P_3K_1$ (3.500 and 3.667 respectively).

Table 93. Interaction effects of NPK combinations on the number of leaves produced by *Dendrobium* Sonia - 16

Treatment	11 MAP	12 MAP
$N_1P_1K_1$	3.167	3.000
$N_1P_1K_2$	3.333	3.500
$N_1P_1K_3$	4.500	4.000
$N_1P_2K_1$	4.167	4.333
$N_1P_2K_2$	4.667	5.000
$N_1P_2K_3$	3.667	4.167
$N_1P_3K_1$	4.667	4.333
$N_1P_3K_2$	5.167	5.000
$N_1P_3K_3$	4.000	4.333
$N_2P_1K_1$	4.667	4.500
$N_2P_1K_2$	4.667	4.833
$N_2P_1K_3$	3.500	3.667
$N_2P_2K_1$	5.333	5.000
$N_2P_2K_2$	4.000	3.500
$N_2P_2K_3$	4:667	4.167
$N_2P_3K_1$	5.500	4.667
$N_2P_3K_2$	4.667	4.333
$N_2P_3K_3$	5.167	5.333
$N_3P_1K_1$	5.333	5.667
$N_3P_1K_2$	3.167	3.833
$N_3P_1K_3$	3.667	3.500
$N_3P_2K_1$	4.333	4.000
$N_3P_2K_2$	5.000	4.667
$N_3P_2K_3$	5.167	4.667
$N_3P_3K_1$	4.333	3.667
$N_3P_3K_2$	3.667	4.000
$N_3P_3K_3$	6.617	6.000
F	2.782	2.096
CD (0.05)	1.570	1.695

4.2.1.2.5 The effect of LN interaction

The direct effect of the light treatments on the number of leaves produced was not significant. However, a significant interaction between light and the N doses was observed at 11 MAP (Table 94). During this month, it was observed that among the plants grown under 25 per cent light, N_3 resulted in a greater number of leaves (4.611) than N_1 (3.444). Under 50 per cent light, there was no significant difference in the number of leaves produced by the plants receiving N_1 or N_2, N_3. Under 75 per cent light, N_2 resulted in a greater number of leaves (5.000) than N_3 (3.833).

4.2.1.2.6 The effect of LP interaction

Interaction between light intensities and the P doses was significant at three to five MAP and at 12 MAP (January to March 1993 and October 1993) (Table 94). Plants receiving 500 ppm P under 25 per cent light had a greater number of leaves (3.833) than the others, during January 1993. There was no significant difference in the number of leaves produced by the plants receiving the rest of the interacting treatments.

At four and five MAP (February and March 1993), plants receiving 500 ppm P under 25 per cent light had a greater number of leaves (4.278 and 4.389 respectively) than the others. During February 1993 there was no significant difference in the number of leaves among the rest of the interacting treatments. During March 1993, among the plants grown under 50 per cent light, those receiving 400 ppm P had a greater number of leaves than those receiving 500 ppm.

Table 94. Interaction effects of light intensity and the N and P doses on the number of leaves produced by *Dendrobium* Sonia -16

Treatment	11 MAP	Treatment	3 MAP	4MAP	5 MAP	12 MAP
L_1N_1	3.444	L_1P_1	2.160	2.722	3.444	3.444
L_1N_2	4.333	L_1P_2	2.556	2.889	3.444	3.722
L_1N_3	4.611	L_1P_3	3.833	4.278	4.389	5.059
L_2N_1	4.611	L_2P_1	2.556	2.833	3.500	4.722
L_2N_2	4.722	L_2P_2	2.389	3.000	3.667	4.778
L_2N_3	5.167	L_2P_3	1.778	2.111	2.611	4.611
L_3N_1	4.389	L_3P_1	2.111	2.222	2.833	4.000
L_3N_2	5.000	L_3P_2	2.333	2.389	2.944	4.667
L_3N_3	3.833	L_3P_3	2.389	2.778	3.222	4.222
F	2.735	F	4.930	4.160	3.129	2.543
CD (0.05)	0.907	CD (0.05)	0.819	0.910	0.902	0.979
L_1T_0	4.000	L_1T_0	2.000	1.500	2.500	3.500
L_2T_0	3.500	L_2T_0	3.000	2.500	3.000	3.500
L_3T_0	3.000	L_3T_0	2.500	3.500	3.500	2.500
F	0.268	F	0.328	1.064	0.270	0.306
CD (0.05)	-	CD (0.05)	-	-	-	-

Thereafter, interaction between light intensities and the P doses was not significant till 12 MAP (October 1993). During this month, the L_1P_3 plants and the L_2P_1, L_2P_2, L_2P_3 and L_3P_2 plants had a greater number of leaves (5.056, 4.722, 4.778, 4.611 and 4.667 respectively) than the L_1P_1 plants. The L_1P_3 plants had a greater number of leaves than the L_3P_3 plants too. There was no significant difference in the number of leaves produced by the plants receiving P_3 under the three light intensities.

4.2.1.2.7 The effect of LNP interaction

Interaction between light intensities and the NP doses was significant at four MAP (February 1993) (Table 95). Under 25 per cent light, plants receiving N_2P_3, N_3P_3, N_1P_3, N_1P_2 had a greater number of leaves (4.500, 4.333, 4.000, 3.667 and 3.500 respectively) than N_3P_2 (1.500). The others which recorded a lesser leaf number than N_2P_3 were N_1P_1 (2.667) and N_2P_1 (2.500).

Under 50 per cent light, there was no significant difference between the NP combinations in the number of leaves produced. Under 75 per cent light N_1P_3 resulted in a greater number of leaves (3.667) when compared to N_1P_2, N_2P_3 and N_3P_1. N_1P_2 resulted in a greater number of leaves under L_3 and N_1P_3 resulted in a greater number of leaves under L_1 than under L_3. Under 25 per cent light, N_2P_3 resulted in a greater number than under 50 or 75 per cent light and N_3P_3 resulted in a greater number under 25 per cent light than under 50 per cent light. So also, N_3P_1resulted in a greater number under L_2 than under L_3.

4.2.1.2.8 The effect of LNPK interaction

Interaction between the light treatments and the NPK combinations was significant at 11 MAP (Table 95). Under 25 per cent light, $N_1P_3K_2$, $N_2P_2K_1$, $N_2P_3K_1$, $N_2P_3K_3$, $N_3P_1K_1$, $N_3P_2K_1$, $N_3P_2K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$ resulted in a greater number of leaves than $N_1P_3K_3$ and $N_2P_2K_3$. Under 50 per cent light, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_2K_3$, $N_3P_2K_2$ and $N_3P_3K_3$ resulted in a greater number of leaves than $N_2P_1K_3$ or $N_3P_3K_2$. Under 75 per cent light $N_1P_2K_2$, $N_1P_3K_1$, $N_1P_3K_2$ $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_2K_3$, $N_2P_3K_2$, $N_2P_3K_3$, $N_3P_1K_1$ and $N_3P_2K_2$ resulted in a greater number than $N_1P_1K_1$, $N_3P_1K_2$, $N_3P_3K_1$ or $N_3P_3K_2$.

Table 95. Interaction effects of light with NP and NPK combinations on the number of leaves produced by *Dendrobium* Sonia - 16

Treatment	4 MAP	Treatment	L_1	L_2	L_3
$L_1N_1P_1$	2.667	$N_1P_1K_1$	3.000	4.000	2.500
$L_1N_1P_2$	3.500	$N_1P_1K_2$	3.000	3.500	3.500
$L_1N_1P_3$	4.000	$N_1P_1K_3$	4.000	5.000	4.500
$L_1N_2P_1$	2.500	$N_1P_2K_1$	4.000	4.500	4.000
$L_1N_2P_2$	3.667	$N_1P_2K_2$	2.500	5.000	6.500
$L_1N_2P_3$	4.500	$N_1P_2K_3$	4.000	4.000	3.000
$L_1N_3P_1$	3.000	$N_1P_3K_1$	3.500	4.500	6.000
$L_1N_3P_2$	1.500	$N_1P_3K_2$	5.000	5.000	5.500
$L_1N_3P_3$	4.333	$N_1P_3K_3$	2.000	6.000	4.000
$L_2N_1P_1$	2.333	$N_2P_1K_1$	3.500	6.000	4.500
$L_2N_1P_2$	3.167	$N_2P_1K_2$	4.500	4.000	5.500
$L_2N_1P_3$	1.667	$N_2P_1K_3$	3.500	3.000	4.000
$L_2N_2P_1$	3.000	$N_2P_2K_1$	6.000	4.000	6.000
$L_2N_2P_2$	3.167	$N_2P_2K_2$	4.000	4.500	3.500
$L_2N_2P_3$	2.167	$N_2P_2K_3$	2.000	6.000	6.000
$L_2N_3P_1$	3.167	$N_2P_3K_1$	6.500	5.500	4.500
$L_2N_3P_2$	2.667	$N_2P_3K_2$	4.000	4.500	5.500
$L_2N_3P_3$	2.500	$N_2P_3K_3$	5.000	5.000	5.500
$L_3N_1P_1$	2.000	$N_3P_1K_1$	5.000	5.500	5.500
$L_3N_1P_2$	1.833	$N_3P_1K_2$	2.500	4.500	2.500
$L_3N_1P_3$	3.667	$N_3P_1K_3$	3.000	5.000	3.000
$L_3N_2P_1$	3.000	$N_3P_2K_1$	5.000	4.500	3.500
$L_3N_2P_2$	2.500	$N_3P_2K_2$	4.000	7.000	4.000
$L_3N_2P_3$	1.667	$N_3P_2K_3$	5.000	4.500	6.000
$L_3N_3P_1$	1.667	$N_3P_3K_1$	6.500	4.000	2.500
$L_3N_3P_2$	2.833	$N_3P_3K_2$	5.500	3.000	2.500
$L_3N_3P_3$	3.000	$N_3P_3K_3$	5.000	8.500	5.000
F	2.057	F	1.980	—	—
CD (0.05)	1.575	CD (0.05)	2.720	—	—

4.2.1.3 The leaf area per clump

4.2.1.3.1 The effect of P

The P doses influenced the leaf area from 10 MAP to 12 MAP (Table 96). At 10 MAP, 400 or 500 ppm P resulted in a greater leaf area (66.980 and 73.035 sq.cm. respectively) when compared to 300 ppm P (57.178 sq.cm). During September too 400 or 500 ppm P resulted in a greater leaf area (64.860 and 73.878 sq.cm. respectively) than 300 ppm P (57.953 sq.cm). But during October, 500 ppm P resulted in greater leaf area (72.328 sq.cm) than 300 or 400 ppm P.

4.2.1.3.2 The effect of NPK interaction

Interaction between the NPK combinations was significant at 11 and 12 MAP (Table 97). Among the NPK combinations containing N_1, $N_1P_3K_2$, $N_1P_3K_1$, $N_1P_1K_3$ and $N_1P_2K_2$ resulted in a greater leaf area (76.161, 75.278, 70.093 and 69.627 sq.cm respectively) than $N_1P_1K_1$ (39.823 sq.cm) at 11 MAP. Among the NPK combinations containing N_2, $N_2P_3K_1$ resulted in a greater leaf area (95.893 sq.cm) than $N_2P_1K_3$ (54.711 sq.cm). Among the combinations containing N_3, $N_3P_3K_3$, $N_3P_1K_1$, $N_3P_2K_2$ and $N_3P_3K_1$ resulted in a greater leaf area when compared to $N_3P_1K_2$ (42.271 sq.cm). At 12 MAP, among the NPK combinations containing N_1, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_1$, and $N_1P_3K_2$ resulted in a greater leaf area (67.032, 74.221, 73.694 and 74.519 sq.cm respectively) than $N_1P_1K_1$ (38.811 sq.cm). Among the combinations containing N_2, $N_2P_3K_1$ had a greater leaf area (82.215 sq.cm) than $N_2P_2K_2$ (54.973 sq.cm) and among the combinations containing N_3, $N_3P_3K_3$ resulted in a greater leaf area (95.140 sq.cm) than $N_3P_1K_2$ (51.375 sq.cm).

Table 96. Effect of phosphorus and interaction of light intensities with N on the leaf area (in sq. cm.) of *Dendrobium* Sonia - 16

Treatment	Months after planting		
	10	11	12
P_1	57.178	57.953	59.080
P_2	66.980	64.860	62.601
P_3	73.035	73.878	72.328
F	6.883	7.535	4.754
CD (0.05)	8.584	8.187	8.857
L_1N_1	55.696	50.918	50.148
L_1N_2	63.918	67.133	63.472
L_1N_3	69.461	72.734	74.719
L_2N_1	64.311	66.320	67.507
L_2N_2	70.516	70.287	69.543
L_2N_3	76.255	73.960	71.175
L_3N_1	65.073	67.216	68.843
L_3N_2	68.089	71.917	65.493
L_3N_3	58.260	49.588	51.131
F	1.293	4.528	3.852
CD (0.05)	—	14.180	15.341
L_1 To	54.584	55.930	49.841
L_2 To	46.314	46.314	46.314
L_3 To	41.814	46.837	36.230
F	0.167	0.128	0.373
CD (0.05)	—	—	—

Table 97. Interaction effects of NPK combinations on the leaf area (in sq.cm) of *Dendrobium* Sonia - 16

Treatment	Months after planting	
	11	12
$N_1P_1K_1$	39.823	38.811
$N_1P_1K_2$	47.198	49.516
$N_1P_1K_3$	70.093	64.648
$N_1P_2K_1$	63.498	67.032
$N_1P_2K_2$	69.627	74.221
$N_1P_2K_3$	53.797	55.935
$N_1P_3K_1$	75.218	73.694
$N_1P_3K_2$	76.161	74.519
$N_1P_3K_3$	57.947	61.119
$N_1P_1K_1$	68.851	67.253
$N_2P_1K_2$	70.726	71.439
$N_2P_1K_3$	54.711	56.879
$N_2P_2K_1$	75.366	72.001
$N_2P_2K_2$	61.276	54.973
$N_2P_2K_3$	62.329	56.262
$N_2P_3K_1$	95.893	82.215
$N_2P_3K_2$	68.934	65.948
$N_2P_3K_3$	69.923	68.555
$N_3P_1K_1$	72.857	77.733
$N_3P_1K_2$	41.271	51.375
$N_3P_1K_3$	56.052	54.071
$N_3P_2K_1$	63.223	59.124
$N_3P_2K_2$	70.043	65.751
$N_3P_2K_3$	64.576	58.114
$N_3P_3K_1$	68.668	59.654
$N_3P_3K_2$	63.135	70.113
$N_3P_3K_3$	89.021	95.140
F	2.462	2.236
CD (0.05)	24.560	26.571

4.2.1.3.3 The effect of light intensities

The effect of the light treatments on the leaf area of the plants was significant at three and four MAP (Table 98). The leaf area was greater in the plants grown under 25 per cent light (36.740 sq.cm) than under 50 per cent light (24.480 sq.cm) at three MAP. At four MAP the leaf area was greater under 25 per cent light (43.404 sq.cm) than under 50 per cent light (36.990 sq.cm) or 75 per cent light (32.499 sq.cm).

4.2.1.3.4 The effect of LN interaction

Interaction between the light treatments and the N doses was significant at 11 and 12 MAP (Table 96). Under 25 per cent light, N_2 and N_3 resulted in a greater leaf area (67.133 and 72.734 sq.cm respectively). Under 50 per cent light there was no significant difference in leaf area between the plants receiving N_1, N_2 or N_3. Under 75 per cent light N_1 and N_2 resulted in a greater leaf area (67.216 and 71.917 sq.cm respectively) than N_3. The plants receiving N_2 or N_3 under 25 per cent light, those receiving N_1, N_2 or N_3 under 50 per cent light and N_1 or N_2 under 75 per cent light had a greater leaf area than those receiving N_1 under 25 per cent light or N_3 under 75 per cent light.

At 12 MAP, it was observed that under 25 per cent light, N_3 resulted in a greater leaf area (74.719 sq.cm) than N_1 (50.148 sq.cm). Under 50 per cent light there was no significant difference in the leaf area of plants receiving N_1, N_2 or N_3. Under 75 per cent light N_1 resulted in a greater leaf area (68.843 sq.cm) than N_3 (51.131 sq.cm).

Table 98. Effect of the light treatments and their interaction with P doses on the leaf area (in sq.cm) of *Dendrobium* Sonia - 16

Treatment	Months after planting		
	3	4	12
L_1	36.735	43.404	62.780
L_2	24.476	30.990	69.408
L_3	30.229	32.499	61.822
F	31.152	416.247	0.169
CD (0.05)	6.687	2.021	—
L_1P_1	27.461	33.790	50.588
L_1P_2	31.147	37.789	56.986
L_1P_3	51.598	58.635	80.765
L_2P_1	27.885	33.467	71.095
L_2P_2	25.037	34.484	65.091
L_2P_3	20.505	25.020	72.040
L_3P_1	27.807	29.765	55.559
L_3P_2	31.053	30.889	65.727
L_3P_3	31.827	36.842	64.181
F	3.645	3.631	2.622
CD (0.05)	12.641	13.617	15.341
L_1To	23.571	19.719	49.841
L_2To	34.107	47.961	46.314
L_3To	30.212	46.837	36.230
F	0.156	1.214	0.373
CD (0.05)	—	—	—

4.2.1.3.5 The effect of LP interaction

Interaction between the light intensities and the P doses was significant at three, four and 12 MAP. (Table 98). Plants grown under 25 per cent light and receiving 500 ppm P had a greater leaf area at three and four MAP (51.598 and 58.635 sq.cm respectively) than the other treatments which were not significantly different from each other in the total leaf area.

At 12 MAP, L_1P_3, L_2P_1 and L_2P_3 resulted in a greater leaf area (80.765, 71.095 and 72.040 sq.cm respectively) than L_1P_1 or L_3P_1 which recorded respectively 50.588 and 55.559 sq.cm respectively. L_1P_3 also resulted in a greater leaf area than L_1P_2, L_2P_2 or L_3P_3. Under L_2 and L_3 there was no significant difference in the leaf area between plants receiving P_1, P_2 or P_3.

4.2.1.3.6 The effect of LNP interaction

Interaction between the light treatments and the NP doses was significant at four, five and 12 MAP (Table 99). Under 25 per cent light, plants receiving N_1P_2, N_1P_3, N_2P_2, N_2P_3 and N_3P_3 had a greater leaf area than those receiving N_3P_2. Under 50 per cent light, there was no significant difference in the leaf area between plants receiving the different NP combinations. Under 75 per cent light, plants receiving N_1P_3 had a greater leaf area (52.614 sq.cm) than those receiving N_1P_1 (18.763 sq.cm).

Among the NP combinations, N_1P_3 resulted in a greater leaf area under 75 or 25 per cent light (48.221 and 52.614 sq.cm respectively) than under 50 per cent light and N_2P_3 and N_3P_3 resulted in a greater leaf area (64.102 and 63.581 sq.cm respectively) under 25 per cent light. The rest of the combinations did not result in significant differences in the leaf area under the three light intensities.

Table 99. Interaction effects of light with the N and P doses on the leaf area (in sq.cm.) of *Dendrobium* Sonia - 16

Treatment	Months after planting			
	4	5	6	12
$L_1N_1P_1$	34.237	52.507	60.329	44.656
$L_1N_1P_2$	46.181	60.074	66.182	51.496
$L_1N_1P_3$	48.221	49.291	49.356	54.292
$L_1N_2P_1$	31.246	40.139	45.119	54.916
$L_1N_2P_2$	48.548	48.806	54.599	50.692
$L_1N_2P_3$	64.102	71.816	79.976	84.809
$L_1N_3P_1$	35.887	42.652	57.877	52.192
$L_1N_3P_2$	18.636	31.745	49.402	68.772
$L_1N_3P_3$	63.581	61.708	62.440	103.195
$L_2N_1P_1$	29.027	40.491	53.426	68.521
$L_2N_1P_2$	36.886	47.281	55.806	67.148
$L_2N_1P_3$	19.783	32.318	42.558	66.853
$L_2N_2P_1$	35.743	45.459	51.636	67.206
$L_2N_2P_2$	36.833	46.954	54.046	65.125
$L_2N_2P_3$	24.931	37.294	49.587	76.298
$L_2N_3P_1$	35.631	46.737	60.683	77.557
$L_2N_3P_2$	29.732	41.628	53.553	63.000
$L_2N_3P_3$	30.345	29.783	41.310	72.968
$L_3N_1P_1$	18.763	27.519	31.004	39.798
$L_3N_1P_2$	24.759	29.332	45.040	78.544
$L_3N_1P_3$	52.614	60.050	58.198	88.187
$L_3N_2P_1$	46.674	53.161	61.909	73.448
$L_3N_2P_2$	32.841	41.910	45.970	67.420
$L_3N_2P_3$	21.970	37.312	37.353	55.611
$L_3N_3P_1$	23.860	28.589	33.777	53.430
$L_3N_3P_2$	35.066	43.416	51.540	51.218
$L_3N_3P_3$	35.941	40.616	48.084	48.744
F	2.336	2.122	2.137	2.333
CD (0.05)	23.585	25.373	26.586	26.571

At five MAP (March 1993), under 25 per cent light, plants receiving N_2P_3 or N_3P_3 had a greater leaf area (71.816 and 61.708 sq.cm) than those receiving N_3P_2 (31.745 sq.cm). Under 50 per cent light, there was no significant difference between the plants receiving the different NP combinations in their total leaf area. Under 75 per cent light, plants receiving N_2P_1 or N_1P_3 had a greater leaf area (53.161 and 60.050 sq.cm) than those receiving N_1P_1 (27.519 sq.cm).

Among the NP combinations, N_1P_2 was found to result in a greater leaf area (60.074 sq.cm) under 25 per cent than under 75 per cent light, N_1P_3 was found to result in a greater leaf area (60.050 sq.cm) under 25 per cent than under 75 per cent light, N_2P_3 was found to result in a greater leaf area (71.816 sq.cm) under 25 per cent than under 50 or 75 per cent light and N_3P_3 was found to result in a greater leaf area under 25 per cent light (61.708 sq.cm) than under 50 per cent light.

At six MAP (April 1993), plants receiving N_2P_3 had a greater leaf area (79.976 sq.cm) than those receiving N_1P_3, N_2P_1 or N_3P_2. Under 50 per cent light, there was no significant difference between the plants receiving the different NP combinations in their total leaf area. Under 75 per cent light, plants receiving N_2P_1 had a greater leaf area (61.909 sq.cm) than those receiving N_1P_1 or N_3P_1.

Among the NP combinations, N_1P_1 and N_2P_3 resulted in a greater leaf area under 25 per cent light (60.329 and 79.976 sq.cm respectively) than under 75 per cent light, while N_3P_1 resulted in a great leaf area under 50 per cent light than under 75 per cent light.

At 12 MAP (October 1993) under 25 per cent light, plants receiving N_3P_3 or N_2P_3 had a greater leaf area (103.195 and 84.809 sq.cm respectively) than those receiving N_1P_1. Under 50 per cent light there was no significant difference in the leaf area between the plants receiving the different NP combinations. Under 75 per cent light, plants receiving N_1P_3, N_1P_2, N_2P_1 and N_2P_2 had a greater leaf area (88.187), 78.544, 73.448 and 67.420 sq.cm respectively) than those receiving N_1P_1 (39.798 sq.cm).

Among the NP combinations, N_1P_1 was found to result in a greater leaf area under 50 per cent than under 75 per cent light, N_1P_2 and N_1P_3 were found to result in a greater leaf area under L_3 than under L_1 and N_2P_3 was found to result in a greater leaf area under L_1 than under L_3.

4.2.1.3.7 The effect of LNPK interaction

Interaction between the light treatments and the NPK combinations was significant at 11 MAP (September 1993) (Table 100). Under 25 per cent light, the leaf area was higher in the plants receiving $N_2P_3K_1$, $N_3P_3K_1$ and $N_3P_3K_2$ (130.523, 104.618 and 91.433 sq.cm respectively) than in those receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_2$, $N_1P_3K_1$, $N_1P_3K_3$, $N_2P_2K_3$, $N_3P_1K_2$, or $N_3P_1K_3$.

Under 50 per cent light, plants receiving $N_3P_2K_2$ or $N_3P_3K_3$ had a greater leaf area (123.700 and 91.745 sq.cm respectively) than those receiving $N_2P_1K_3$ (47.553 sq.cm). Under 75 per cent light, the plants receiving $N_1P_1K_3$, $N_1P_2K_2$, $N_1P_3K_2$, $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_2K_3$, $N_2P_3K_1$, and $N_2P_3K_2$ had a greater leaf area than those receiving $N_1P_1K_1$ or $N_3P_1K_2$ (19.432 and 19.246 sq.cm respectively).

Table 100. Interaction effects of light with the NPK combinations on the leaf area (in sq.cm.) of *Dendrobium* Sonia - 16 at 11 MAP

Treatment	L_1	L_2	L_3
$N_1P_1K_1$	40.454	59.582	19.432
$N_1P_1K_2$	46.196	55.164	40.232
$N_1P_1K_3$	58.272	80.675	71.332
$N_1P_2K_1$	63.012	60.191	67.293
$N_1P_2K_2$	35.753	66.305	106.824
$N_1P_2K_3$	60.276	59.027	42.086
$N_1P_3K_1$	47.843	64.644	113.167
$N_1P_3K_2$	80.027	66.402	82.054
$N_1P_3K_3$	26.424	84.893	62.525
$N_2P_1K_1$	57.019	78.237	71.296
$N_2P_1K_2$	62.736	63.520	85.924
$N_2P_1K_3$	53.453	47.553	63.126
$N_2P_2K_1$	77.335	52.383	96.381
$N_2P_2K_2$	63.563	65.339	54.928
$N_2P_2K_3$	29.542	83.976	73.469
$N_2P_3K_1$	130.523	83.614	73.540
$N_2P_3K_2$	55.791	73.769	77.242
$N_2P_3K_3$	74.231	84.191	51.348
$N_3P_1K_1$	71.131	77.962	69.477
$N_3P_1K_2$	42.452	62.117	19.246
$N_3P_1K_3$	41.055	77.947	49.153
$N_3P_2K_1$	70.769	63.527	55.372
$N_3P_2K_2$	62.285	91.745	56.099
$N_3P_2K_3$	87.739	56.557	49.433
$N_3P_3K_1$	104.618	62.249	39.137
$N_3P_3K_2$	91.433	49.834	48.137
$N_3P_3K_3$	83.128	123.700	60.237
F	2.222	—	—
CD (0.05)	42.540	—	—

Among the combinations of NPK, $N_1P_2K_2$ resulted in a greater leaf area under 75 per cent light (106.824 sq.cm) than under 25 per cent light, $N_1P_3K_1$ resulted in a greater leaf area under 75 per cent light (113.167 sq.cm) than under 25 per cent or 50 per cent light, $N_1P_3K_3$ resulted in a greater leaf area under 25 per cent light (84.893 sq.cm) than under 50 per cent light, $N_2P_2K_1$ resulted in a greater leaf area under 50 per cent light (96.381 sq.cm) than under 75 per cent light, $N_2P_2K_3$ resulted in a greater leaf area under 50 per cent light (83.976 sq.cm) than under 25 per cent light, $N_2P_3K_1$ resulted in a greater leaf area under 25 per cent light (130.523 sq.cm) than under 50 or 75 per cent light, $N_3P_1K_2$ resulted in a greater leaf area under 50 per cent light (62.117 sq.cm) than under 75 per cent light (19.246 sq.cm), $N_3P_3K_1$ and $N_3P_3K_2$ resulted in a greater leaf area under 25 per cent light (104.618 and 91.433 sq.cm respectively) than under 75 per cent light and $N_3P_3K_3$ resulted in a greater leaf area under 50 per cent light (123.700 sq.cm) than under 75 per cent light.

4.2.1.4 The number of back bulbs produced per clump

4.2.1.4.1 The effect of NPK interaction

The effect of N, P and K on the number of back bulbs produced per clump was not significant. The interaction effect of the NPK combinations was significant at two MAP and from four to 12 MAP (Tables 101 and 102).

At two MAP (December 1992) among the plants receiving the NPK combinations containing 300 ppm N there was no significant difference in the number of back bulbs produced. Among those containing 400 ppm N, $N_2P_3K_1$, and $N_2P_3K_3$ resulted in a greater number (4.333) when compared to $N_2P_1K_3$ and $N_2P_3K_3$ (2.000 and 2.833 respectively).

Table 101. Interaction effect of NPK combinations on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting				
	2	4	5	6	7
$N_1P_1K_1$	2.833	3.500	3.667	3.667	3.833
$N_1P_1K_2$	2.667	2.833	3.000	3.167	4.000
$N_1P_1K_3$	3.000	3.500	3.500	3.667	3.667
$N_1P_2K_1$	3.167	3.500	3.830	3.833	3.833
$N_1P_2K_2$	3.167	3.667	4.000	4.000	4.000
$N_1P_2K_3$	3.500	4.000	4.000	4.000	4.000
$N_1P_3K_1$	3.333	3.667	3.830	3.833	4.000
$N_1P_3K_2$	3.333	4.000	4.167	4.167	4.333
$N_1P_3K_3$	3.500	3.833	3.830	3.833	3.833
$N_2P_1K_1$	4.167	4.333	4.500	4.667	4.833
$N_2P_1K_2$	3.167	3.667	3.667	3.667	3.667
$N_2P_1K_3$	2.000	2.667	2.833	2.833	3.333
$N_2P_2K_1$	3.500	3.667	3.667	4.000	4.167
$N_2P_2K_2$	3.833	4.167	4.000	4.333	4.500
$N_2P_2K_3$	3.833	3.833	4.000	3.833	4.000
$N_2P_3K_1$	4.333	4.500	4.667	4.667	4.667
$N_2P_3K_2$	2.833	3.333	3.333	3.667	3.667
$N_2P_3K_3$	4.333	4.500	5.000	5.500	5.833
$N_3P_1K_1$	3.167	3.500	4.000	4.167	4.167
$N_3P_1K_2$	2.667	3.000	3.500	3.500	3.667
$N_3P_1K_3$	3.833	4.500	4.667	4.667	4.667
$N_3P_2K_1$	3.333	4.167	4.167	4.333	4.333
$N_3P_2K_2$	3.000	3.333	3.667	4.000	4.000
$N_3P_2K_3$	4.500	4.500	4.833	4.833	5.167
$N_3P_3K_1$	4.000	4.000	4.500	4.500	4.167
$N_3P_3K_2$	3.667	3.833	4.167	4.500	4.500
$N_3P_3K_3$	2.667	2.667	2.667	3.333	3.333
F	2.098	2.164	2.449	2.561	2.633
CD (0.05)	1.435	1.389	1.415	1.319	1.353

Table 102. Interaction effects of NPK combinations on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting				
	8	9	10	11	12
$N_1P_1K_1$	3.833	3.833	3.833	3.833	3.833
$N_1P_1K_2$	3.500	3.500	3.500	3.500	3.500
$N_1P_1K_3$	3.833	3.667	3.667	3.667	3.833
$N_1P_2K_1$	3.833	3.833	3.833	3.833	3.833
$N_1P_2K_2$	4.000	4.000	4.167	4.167	4.167
$N_1P_2K_3$	4.167	4.333	4.500	4.500	4.500
$N_1P_3K_1$	4.167	4.167	4.000	4.333	4.333
$N_1P_3K_2$	4.333	4.333	4.500	4.333	4.500
$N_1P_3K_3$	3.833	4.000	4.000	4.167	4.500
$N_2P_1K_1$	5.167	5.167	5.167	5.000	5.167
$N_2P_1K_2$	3.667	3.667	3.667	3.667	3.833
$N_2P_1K_3$	3.167	3.167	3.167	3.333	3.333
$N_2P_2K_1$	4.167	4.167	4.167	4.000	4.167
$N_2P_2K_2$	4.500	4.667	4.667	4.833	4.500
$N_2P_2K_3$	3.833	4.000	4.000	4.000	4.000
$N_2P_3K_1$	4.667	4.667	4.667	4.667	4.667
$N_2P_3K_2$	3.667	3.667	3.667	3.500	3.667
$N_2P_3K_3$	6.000	6.000	6.000	6.000	6.000
$N_3P_1K_1$	4.167	4.167	4.167	4.167	4.167
$N_3P_1K_2$	3.667	3.167	3.667	3.667	3.667
$N_3P_1K_3$	4.833	4.833	4.833	4.833	4.833
$N_3P_2K_1$	4.333	4.333	4.333	4.333	4.333
$N_3P_2K_2$	4.000	4.000	4.000	4.000	4.000
$N_3P_2K_3$	5.167	5.167	5.167	5.167	5.167
$N_3P_3K_1$	4.667	4.833	4.833	4.833	5.000
$N_3P_3K_2$	4.500	4.500	4.167	4.667	4.667
$N_3P_3K_3$	3.500	3.500	3.667	3.667	3.667
F	3.205	3.154	2.807	2.831	2.606
CD(0.05)	1.347	1.365	1.380	1.428	1.442

Among the combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number of back bulbs (4.500) than $N_3P_1K_2$, $N_3P_2K_2$ or $N_3P_3K_3$ which had respectively 2.667, 3.000 and 2.667 back bulbs.

At four MAP (February 1992) too, the plants receiving the combinations containing 300 ppm N were not significantly different in the number of back bulbs produced. Among the combinations containing 400 ppm N, $N_2P_1K_1$, $N_2P_2K_2$, $N_2P_3K_1$ and $N_2P_3K_3$ resulted in a greater number of back bulbs (4.333, 4.167, 4.500 and 4.500 respectively) than $N_2P_1K_3$ (2.667). Among those containing 500 ppm N, $N_3P_1K_3$ and $N_3P_2K_3$ resulted in a greater number of back bulbs (4.500) than $N_3P_3K_3$ and $N_3P_1K_2$ (2.667 and 3.000 respectively) and $N_3P_2K_1$ resulted in a greater number (4.167) than $N_3P_3K_3$.

At five MAP (March 1993) too there was no significant difference in the number of back bulbs produced by the plants which received NPK combinations containing 300 ppm N. Among the combinations containing 400 ppm N, $N_2P_1K_3$ and $N_2P_3K_2$ resulted in a greater number of back bulbs (5.000) than $N_2P_1K_3$ or $N_2P_3K_2$ (2.833 and 3.333 respectively) while $N_2P_1K_1$ and $N_2P_3K_1$ resulted in a greater number (4.500 and 4.667 respectively) than $N_2P_1K_3$. Among the combinations containing 500 ppm N, $N_3P_1K_3$ resulted in a greater number (4.667) when compared to $N_3P_3K_3$ (2.667).

At six MAP, the plants which received combinations containing 300 ppm N did not differ in the number of back bulbs produced. Among the combinations containing 400 ppm N, $N_2P_1K_1$, $N_2P_2K_2$, $N_2P_3K_1$ and $N_2P_3K_3$ resulted in a greater number of back bulbs than $N_2P_1K_3$ (2.833). Among the combinations containing 500 ppm N, $N_3P_2K_3$ and $N_3P_1K_3$ resulted in a greater number of back bulbs (4.833 and 4.677 respectively) than $N_3P_3K_3$ (3.333).

At seven MAP, the plants which received combinations containing 300 ppm N did not differ in the number of back bulbs produced. Among the combinations containing 400 ppm N, $N_2P_3K_3$ and $N_2P_1K_1$ resulted in a greater number of back bulbs (5.833 and 4.833 respectively) than $N_2P_1K_3$ (3.333). Among those receiving combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number (5.167) than $N_3P_3K_3$ (3.333).

At eight MAP (June 1993) too, the plants which received combinations containing 300 ppm N retained their similarity in the number of back bulbs produced. Among the combinations containing 400 ppm N, $N_2P_1K_1$, $N_2P_3K_1$ and $N_2P_3K_3$ resulted in a greater number of back bulbs (5.167, 4.667 and 6.000 respectively) than $N_2P_1K_3$ (3.167). $N_2P_3K_3$ was also observed to result in a greater number of back bulbs than $N_2P_1K_2$, $N_2P_2K_1$, $N_2P_2K_2$, $N_2P_2K_3$ and $N_2P_3K_2$. Among the combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number of back bulbs (5.167) than $N_3P_3K_3$ (3.500).

At nine MAP (July 1993), plants receiving combinations containing 300 ppm N retained their similarity in the number of back bulbs produced. Among the combinations containing 400 ppm N, $N_2P_1K_1$, $N_2P_2K_2$, $N_2P_3K_1$ and $N_2P_3K_3$ resulted in a greater number of back bulbs (5.167, 4.667, 4.667 and 6.000 respectively) than $N_2P_1K_3$ (3.167). Among the combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number of back bulbs (5.167) than $N_3P_3K_3$ and $N_3P_1K_2$ (3.500 and 3.667 respectively).

At 10 MAP, the plants receiving NPK combinations containing 300 ppm N did not differ in the number of back bulbs produced. Among those containing 400 ppm N, $N_2P_1K_1$, $N_2P_2K_2$, $N_2P_3K_1$ and $N_2P_3K_3$ resulted in a greater number (5.167, 4.167, 4.667 and 4.667 respectively) than $N_2P_1K_3$ (3.167). Among the combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number of back bulbs (5.167) than $N_3P_3K_3$ (3.667).

At 11 MAP, the plants receiving combinations containing 300 ppm N did not differ in the number of back bulbs produced. Among those containing 400 ppm N, $N_2P_1K_1$ and $N_2P_3K_3$ resulted in a greater number of back bulbs (5.000, and 6.000 respectively) than $N_2P_1K_3$ (3.333). With respect to the combinations containing 500 ppm N, $N_3P_2K_3$ resulted in a greater number of back bulbs (5.167) when compared to $N_3P_1K_2$ and $N_3P_3K_3$ (3.667).

4.2.1.4.2 The effect of LP interaction

The direct effect of L_1, L_2 and L_3 on the number of back bulbs produced was not significant. However, a significant interaction between the light treatment and the P doses was observed at six MAP to 12 MAP (Table 103).

At six MAP, under 25 per cent light, an increase of 19.45 per cent was observed in the number of back bulbs with 500 ppm P when compared to 300 ppm P. Under 50 per cent light, the P doses did not significantly influence the number of back bulbs. Under 75 per cent light, P at 400 ppm resulted in a greater number of back bulbs than P at 300 and 500 ppm. Among the interacting LP treatments, L_3P_1 resulted in the lowest number of back bulbs (3.444) and L_2P_3, L_3P_2, L_1P_2 and L_1P_3 had greater numbers than it.

Table 103. Interaction effects of light intensities and P doses on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting						
	6	7	8	9	10	11	12
L_1P_1	4.000	4.111	4.167	4.167	4.167	4.167	4.333
L_1P_2	4.222	4.222	4.222	4.278	4.389	4.389	4.333
L_1P_3	4.778	4.944	5.000	5.056	5.111	5.167	5.389
L_2P_1	3.889	4.111	4.056	4.056	4.056	4.056	4.056
L_2P_2	3.722	3.944	3.889	3.889	3.889	3.889	3.889
L_2P_3	4.333	4.389	4.389	4.389	4.222	4.389	4.389
L_3P_1	3.444	3.722	3.722	3.667	3.667	3.667	3.667
L_3P_2	4.444	4.500	4.557	4.667	4.667	4.667	4.667
L_3P_3	3.556	3.611	3.722	3.778	3.833	3.833	3.889
F	2.702	2.602	2.606	2.826	2.515	2.504	2.832
CD (0.05)	0.762	0.781	0.778	0.788	0.797	0.824	0.832
L_1To	4.000	4.000	4.000	4.000	4.000	4.000	4.000
L_2To	4.000	4.500	4.500	4.500	4.500	4.500	4.500
L_3To	4.000	4.000	4.000	4.000	4.000	4.000	4.000
F	0.000	0.120	0.121	0.118	0.115	0.108	0.106
CD (0.05)	—	—	—	—	—	—	—

At seven MAP, P_1 or P_2 did not significantly influence the number of back bulbs, under the three light intensities. P_3 resulted in a greater number of back bulbs under 25 per cent light (4.944) than under 75 per cent light (3.611). Under 75 per cent light, P_2 resulted in a greater number of back bulbs (4.500) than P_3 (3.611).

At eight MAP, P_3 resulted in more back bulbs than P_1 or P_2 under 25 per cent light. Under 50 per cent light, the number of back bulbs was not affected by the P doses and under 75 per cent light, the plants receiving 400 ppm P had a greater number of back bulbs than those receiving 300 or 500 ppm.

At nine MAP, under 25 per cent light, plants receiving 500 ppm P had a greater number of back bulbs than those receiving 300 ppm P. Under 50 per cent light, plants receiving P_1 P_2 or P_3 did not differ significantly in the number of back bulbs produced. Under 75 per cent light, plants receiving P_2 had a greater number of back bulbs than those receiving P_1 or P_3. Among the plants receiving 500 ppm P, the number was greater under 25 per cent light (5.056) than under 75 per cent light (3.778). Under the three light intensities there was no significant difference between the plants receiving P_1 or P_2 in the number of back bulbs produced.

At 10 MAP under 25 per cent light, the plants receiving 500 ppm P had a greater number of back bulbs (5.111) than those receiving 300 ppm P. Under 50 per cent light, the number of back bulbs was not influenced by the P doses given. Under 75 per cent light, the plants receiving 500 ppm P had a greater number of back bulbs than those receiving 400 ppm and these in turn had greater numbers than those receiving 300 ppm. P_3 was found to result in a greater number of back bulbs under 25 per cent light (5.111) than under 50 or 75 per cent light. Under the three light intensities there was no significant difference between the plants receiving 300 or 400 ppm P in the number of back bulbs produced.

At 11 MAP under 25 per cent light, the plants receiving 500 ppm P maintained a greater number of back bulbs (5.167) than those receiving 300 ppm P (4.167). Under 50 and 75 per cent light,the number of back bulbs was not influenced by the P doses. Plants receiving 500 ppm P were found to have a greater number of back bulbs under 25 per cent light (5.167) than under 75 per cent light (3.833).

At 12 MAP (October 1993) as in the previous month, under 25 per cent light, P_3 resulted in a greater number of back bulbs (5.389) than P_1 or P_2. Under 50 and 75 per cent light, the number of back bulbs was not influenced by the P doses.

4.2.1.4.3 The effect of LNK interaction

Interaction between the light treatments and the NK doses was significant at nine and 10 MAP (July and August 1993) (Table 104). During July, under 25 per cent light, the number of back bulbs was greater in the plants receiving N_2K_3 (5.500) than in these receiving N_1K_3 or N_3K_3 (3.833). Under 50 per cent light, plants receiving N_3K_3 and N_2K_1, had a greater number of back bulbs (5.333 and 5.167 respectively) than those receiving N_3K_2 (3.333). Under 75 per cent light, there was no significant difference in the number of back bulbs produced by the plants receiving the various NK combinations. Among the treatments, $L_2N_3K_2$ resulted in the lowest number of back bulbs (3.333) and greater numbers than this was recorded by $L_1N_2K_3$, $L_1N_3K_1$, $L_1N_3K_2$, $L_2N_2K_1$ and $L_2N_3K_3$.

During August, under 25 per cent light, the number of back bulbs was greater in the plants receiving N_2K_3 (5.500) than in those receiving N_1K_3 or N_3K_3 (3.833). Under 50 per cent light, the number of back bulbs was the lowest in the plants receiving N_3K_2 (3.333) and the plants receiving N_2K_1 and N_3K_3 had greater numbers (5.167 and 5.333 respectively) than these.

Table 104. Interaction effects of light intensities and NK combinations on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting	
	9	10
$L_1N_1K_1$	4.000	4.000
$L_1N_1K_2$	4.667	4.667
$L_1N_1K_3$	3.833	3.833
$L_1N_2K_1$	4.500	4.500
$L_1N_2K_2$	4.667	4.667
$L_1N_2K_3$	5.500	5.500
$L_1N_3K_1$	5.167	5.167
$L_1N_3K_2$	4.833	4.833
$L_1N_3K_3$	3.833	3.833
$L_2N_1K_1$	4.000	4.000
$L_2N_1K_2$	3.833	3.833
$L_2N_1K_3$	3.667	3.667
$L_2N_2K_1$	5.167	5.167
$L_2N_2K_2$	3.500	3.500
$L_2N_2K_3$	3.667	3.667
$L_2N_3K_1$	4.000	4.000
$L_2N_3K_2$	3.333	3.333
$L_2N_3K_3$	5.333	5.333
$L_3N_1K_1$	3.667	3.667
$L_3N_1K_2$	3.667	3.667
$L_3N_1K_3$	4.667	4.667
$L_3N_2K_1$	4.333	4.333
$L_3N_2K_2$	3.833	3.833
$L_3N_2K_3$	4.000	4.000
$L_3N_3K_1$	4.167	4.167
$L_3N_3K_2$	3.667	3.667
$L_3N_3K_3$	4.500	4.500
F	2.178	2.178
CD(0.05)	1.380	1.380

Under 75 per cent light, as in the previous month, there was no significant difference in the number of back bulbs produced by the plants receiving the various NK combinations. While N_2K_3 resulted in a greater number of back bulbs under 25 per cent light (5.500) than under 50 or 75 per cent light (3.667 and 4.000 respectively), N_3K_2 resulted in a greater number under 25 per cent than under 50 per cent light and N_3K_3 resulted in a greater number under 50 per cent than under 25 per cent light.

4.2.1.4.4 The effect of LPK interaction

Interaction between the light treatments and the PK doses was significant during the period under observation (Tables 105 and 106). During December 1992 (two MAP) under 25 per cent light, the plants receiving P_3K_1 had a greater number of back bulbs (4.833) than those receiving P_1K_1, P_1K_3 or P_2K_3. Under 50 per cent light, P_1K_1 and P_3K_3 resulted in a greater number of back bulbs(4.167 and 3.667 respectively) when compared to P_1K_2 . Under 75 per cent light, plants receiving P_2K_3 had a greater number of back bulbs (5.500) than those receiving the rest of the PK combinations. Among the combinations, P_1K_2 resulted in a greater number of back bulbs under 25 per cent light (4.000) than under 50 or 75 per cent light, P_2K_3 resulted in a greater number under 75 per cent light (5.500) than under 25 or 50 per cent light, P_3K_1 resulted in a greater number of back bulbs under 25 per cent light (4.833) than under 50 per cent light, and P_3K_3 brought about a similar effect (4.333) under 25 per cent light.

At three MAP (January 1993) under 25 per cent light, the plants receiving P_3K_1 or P_3K_3 had a greater number of back bulbs (4.833 and 4.333 respectively) than those receiving P_1K_3 (2.833).

Table 105. Interaction effects of light with the PK combinations on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting			
	2	3	4	5
$L_1P_1K_1$	3.117	3.167	3.333	3.833
$L_1P_1K_2$	4.000	4.000	4.167	4.500
$L_1P_1K_3$	2.500	2.833	3.500	3.500
$L_1P_2K_1$	3.667	3.667	4.167	4.167
$L_1P_2K_2$	3.833	3.833	4.000	4.167
$L_1P_2K_3$	3.333	3.333	3.500	3.833
$L_1P_3K_1$	4.833	4.833	5.000	5.000
$L_1P_3K_2$	3.833	3.667	4.167	4.333
$L_1P_3K_3$	4.333	4.333	4.000	4.333
$L_2P_1K_1$	4.167	4.167	4.667	4.667
$L_2P_1K_2$	2.167	2.167	2.333	2.667
$L_2P_1K_3$	3.333	3.667	3.833	4.000
$L_2P_2K_1$	3.500	3.500	3.667	3.833
$L_2P_2K_2$	3.500	3.500	3.833	4.000
$L_2P_2K_3$	3.000	3.000	3.167	3.333
$L_2P_3K_1$	3.333	3.333	3.667	4.000
$L_2P_3K_2$	3.167	3.333	3.500	3:667
$L_2P_3K_3$	3.667	3.667	4.000	4.167
$L_3P_1K_1$	2.833	2.833	3.333	3.667
$L_3P_1K_2$	2.333	2.500	3.000	3.000
$L_3P_1K_3$	3.000	3.000	3.333	3.500
$L_3P_2K_1$	2.833	3.333	3.500	3.667
$L_3P_2K_2$	2.667	2.667	3.333	3.500
$L_3P_2K_3$	5.500	5.667	5.667	5.667
$L_3P_3K_1$	3.500	3.500	3.500	4.000
$L_3P_3K_2$	2.833	2.833	3.500	3.667
$L_3P_3K_3$	2.500	2.500	3.000	3.000
F	2.810	2.963	2.671	2.147
CD (0.05)	1.435	1.445	1.389	1.415

Table 106. Interaction effects of light intensities and PK combinations on the number of back bulbs produced by *Dendrobium* Sonia - 16

Treatment	Months after planting						
	6	7	8	9	10	11	12
$L_1P_1K_1$	3.833	4.000	4.167	4.167	4.167	4.167	4.333
$L_1P_1K_2$	4.500	4.667	4.667	4.667	4.667	4.667	4.883
$K_1P_1K_3$	3.667	3.667	3.667	3.667	3.667	3.667	3.833
$L_1P_2K_1$	4.333	4.333	4.333	4.333	4.333	4.333	4.500
$L_1P_2K_2$	4.500	4.500	4.500	4.500	4.667	4.667	4.333
$L_1P_2K_3$	3.833	3.833	3.833	4.000	4.167	4.167	4.167
$L_1P_3K_1$	5.000	5.167	5.167	5.333	5.167	5.500	5.667
$L_1P_3K_2$	4.333	4.500	4.500	4.500	4.833	4.500	4.833
$L_1P_3K_3$	5.000	5.167	5.333	5.333	5.333	5.500	5.667
$L_2P_1K_1$	4.833	5.000	5.000	5.000	5.000	5.000	5.000
$L_2P_1K_2$	2.833	2.833	2.833	2.833	2.833	2.833	2.833
$L_2P_1K_3$	4.000	4.500	4.333	4.333	4.333	4.333	4.333
$L_2P_2K_1$	3.833	4.000	4.000	4.000	4.000	4.000	4.000
$L_2P_2K_2$	4.167	4.167	4.167	4.167	4.167	4.167	4.167
$L_2P_2K_3$	3.167	3.667	3.500	3.500	3.500	3.500	3.500
$L_2P_3K_1$	4.167	4.167	4.167	4.167	4.167	4.167	4.167
$L_2P_3K_2$	4.167	4.167	4.167	4.167	3.667	4.167	4.167
$L_2P_3K_3$	4.667	4.833	4.833	4.833	4.833	4.833	4.833
$L_3P_1K_1$	3.833	3.833	4.000	4.000	4.000	3.833	3.833
$L_3P_1K_2$	3.000	3.833	3.333	3.333	3.333	3.333	3.333
$L_3P_1K_3$	3.500	3.500	3.833	3.667	3.667	3.833	3.833
$L_3P_2K_1$	4.000	4.000	4.000	4.000	4.000	3.833	3.833
$L_3P_2K_2$	3.667	3.833	3.833	4.000	4.000	4.166	4.167
$L_3P_2K_3$	5.667	5.667	5.833	6.000	6.000	6.000	6.000
$L_3P_3K_1$	3.833	4.000	4.167	4.167	4.167	4.167	4.167
$L_3P_3K_2$	3.833	3.833	3.833	3.833	3.833	3.833	3.833
$L_3P_3K_3$	3.000	3.000	3.167	3.333	3.500	3.500	3.667
F	2.923	2.860	2.885	2.724	2.255	2.394	2.206
CD(0.05)	1.319	1.353	1.347	1.365	1.380	1.428	1.442

Under 50 per cent light, P_1K_1, P_1K_3 and P_3K_3 resulted in a greater number of back bulbs than P_1K_2 and under 75 per cent light P_2K_3 resulted in a greater number (5.667) than the other combinations.

At four MAP, under 25 per cent light, the plants receiving P_3K_1 had a greater number of back bulbs (5.000) than those receiving P_1K_1, P_1K_3 or P_2K_3. Under 50 per cent light, the plants receiving P_1K_1 had a greater number (4.667) than those receiving P_1K_2 or P_2K_3 and under 75 per cent light plants receiving P_2K_3 had a greater number (5.667) than those receiving the rest of the PK combinations.

At fiveMAP, under 25 per cent light, P_3K_1 resulted in a greater number of back bulbs (5.000) than P_1K_3 (3.500). Under 50 per cent light, plants receiving P_1K_1 or P_1K_3 had a greater number (4.667 and 4.167 respectively) than those receiving P_1K_2 (2.667). Under 75 per cent light, plants receiving P_2K_3 had a greater number of back bulbs (5.667) than those receiving the other PK combinations.

At six MAP (Table 106), under 25 per cent light, plants receiving P_3K_1 and P_3K_3 had a greater number of back bulbs (5.000) than those receiving P_1K_3 (3.667). Under 50 per cent, light plants receiving P_1K_1, P_2K_2, P_3K_1 P_3K_2 and P_3K_3 had a greater number of back bulbs (4.833, 4.167, 4.167, 4.167 and 4.667 respectively) than those receiving P_1K_2. Under 75 per cent light plants receiving P_2K_3 had a greater number of back bulbs (5.667) than those receiving the rest of the PK combinations.

At seven MAP, under 25 per cent light, P_3K_1 and P_3K_3 resulted in a greater number of back bulbs (5.167) than P_1K_3 (3.667).

Under 50 per cent light, plants receiving P_1K_1 or P_1K_3 and P_3K_3 resulted in a greater number (5.000, 4.500 and 4.833 respectively) than P_1K_2 and under 75 per cent light, P_2K_3 resulted in a greater number (5.667) when compared to P_3K_3 (3.000). P_1K_2 resulted in a greater number of back bulbs under 25 per cent light (4.667) than under 50 per cent light. P_3K_3 resulted in a greater number under 50 per cent light (4.833) and 75 per cent light (5.167) than under 25 per cent light. With the rest of the combinations, no significant difference in the number of back bulbs was found under the three light intensities.

At eight MAP, under 25 per cent light, the number of back bulbs was greater in the plants receiving P_3K_3 and P_3K_1 (5.333) and 5.167 respectively) than in those receiving P_1K_3 (3.667). Under 50 per cent light, P_1K_1 P_1K_3 and P_3K_3 resulted in a greater number of back bulbs than P_1K_2 (2.833). Under 75 per cent light, P_2K_3 resulted in a greater number of back bulbs (5.833) than P_3K_3 (3.167), P_1K_2 resulted in a greater number (4.667) under 25 per cent light than under 50 per cent (2.833), P_2K_3 resulted in a greater number under 75 per cent light (5.833) than under 25 or 50 per cent light (3.833 and 3.500 respectively) and P_3K_3 resulted in a greater number of back bulbs under 25 and 50 per cent (5.333 and 4.833 respectively) than under 75 per cent light.

At nine MAP, under 25 per cent light, plants receiving P_3K_1 or P_3K_3 had a greater number of back bulbs (5.333) than those receiving P_1K_3 (3.667). Under 50 per cent light, P_1K_3, P_3K_3 and P_1K_1 resulted in a greater number of back bulbs than P_1K_2. Under 75 per cent light, the plants receiving P_2K_3 had a greater number of back bulbs than those receiving the other combinations.

At 10 MAP, under 25 per cent light, plants receiving P_3K_3 or P_3K_1 had a greater number of back bulbs (5.333 and 5.167 respectively) than those receiving P_1K_3 (3.667). Under 50 per cent light, plants receiving P_1K_1, P_3K_3 and P_1K_3 had a greater number (5.000, 4.833 and 4.333 respectively) than those receiving P_1K_2. Under 75 per cent light, P_2K_3 resulted in a greater number of back bulbs than the other PK combinations.

At 11 MAP, among the plants grown under 25 per cent light, those receiving P_3K_1 and P_3K_3 had a greater number of back bulbs (5.500) than those receiving P_1K_3 (3.667). Under 50 per cent light, plants receiving P_1K_1, P_1K_3 and P_3K_3 had a greater number of back bulbs (5.000, 4.333 and 4.833 respectively) than those receiving P_1K_2. Under 75 per cent light, plants receiving P_2K_3 had a greater number of back bulbs (6.000) than those receiving the other combinations.

At 12 MAP (October 1993), P_3K_1 and P_3K_3 resulted in a greater number of back bulbs (5.667) than P_1K_3 (3.833) under 25 per cent light. Under 50 per cent light, P_1K_1, P_3K_3 and P_1K_3 resulted in greater numbers (5,000, 4.833 and 4.333 respectively) than P_1K_2 (2.833). Under 75 per cent light, plants receiving P_2K_3 had a greater number of back bulbs (6.000) than those receiving the other PK combinations.

4.2.1.5 The number of shoots per clump

4.2.1.5.1 The effect of N

The effect of the N doses on the number of shoots produced per clump was significant at four MAP (Table 107). Plants receiving 500 ppm N had a greater number of shoots (1.574) when compared to those receiving 300 ppm (1.278).

Table 107. Effect of the N, P and K doses and NP interaction on the number of shoots produced by *Dendrobium* Sonia - 16

Treatment	Months after planting		
	4	7	8
N_1	1.278	1.241	1.426
N_2	1.352	1.278	1.407
N_3	1.574	1.185	1.278
F	4.486	0.575	1.815
CD (0.05)	0.205	—	—
P_1	1.370	1.204	1.278
P_2	1.333	1.241	1.333
P_3	1.500	1.259	1.500
F	1.445	0.212	3.725
CD (0.05)	—	—	0.169
K_1	1.333	1.222	1.278
K_2	1.426	1.130	1.370
K_3	1.444	1.352	1.468
F	0.668	3.299	2.388
CD (0.05)	—	0.173	—
N_1P_1	1.389	1.667	1.278
N_1P_2	1.222	1.222	1.278
N_1P_3	1.222	1.333	1.722
N_2P_1	1.278	1.278	1.389
N_2P_2	1.333	1.389	1.500
N_2P_3	1.444	1.167	1.333
N_3P_1	1.444	1.167	1.167
N_3P_2	1.444	1.111	1.222
N_3P_3	1.833	1.278	1.444
F	1.380	1.075	2.531
CD (0.05)	—	—	0.292

Table 108. Interaction effects of NPK combinations and light intensities with PK doses on the number of shoots produced by *Dendrobium* Sonia - 16

Treatment	Months after planting		Treatment	Months after planting	
	4	9		10	11
$N_1P_1K_1$	1.167	1.000	$L_1P_1K_1$	1.167	1.333
$N_1P_1K_2$	1.667	1.333	$L_1P_1K_2$	1.500	1.667
$N_1P_1K_3$	1.333	1.667	$L_1P_1K_3$	1.333	1.667
$N_1P_2K_1$	1.167	1.167	$L_1P_2K_1$	1.667	1.667
$N_1P_2K_2$	1.167	1.333	$L_1P_2K_2$	1.000	1.333
$N_1P_2K_3$	1.333	1.333	$L_1P_2K_3$	1.000	1.333
$N_1P_3K_1$	1.333	1.833	$L_1P_3K_1$	2.167	2.000
$N_1P_3K_2$	1.500	1.667	$L_1P_3K_2$	1.500	1.500
$N_1P_3K_3$	0.833	1.667	$L_1P_3K_3$	1.667	1.833
$N_2P_1K_1$	1.333	1.167	$L_2P_1K_1$	1.833	2.000
$N_2P_1K_2$	1.000	1.833	$L_2P_1K_2$	1.333	1.500
$N_2P_1K_3$	1.500	1.333	$L_2P_1K_3$	1.500	1.500
$N_2P_2K_1$	1.333	1.667	$L_2P_2K_1$	1.500	1.500
$N_2P_2K_2$	1.500	1.333	$L_2P_2K_2$	1.833	1.833
$N_2P_2K_3$	1.167	1.667	$L_2P_2K_3$	1.333	1.500
$N_2P_3K_1$	1.167	1.500	$L_2P_3K_1$	1.167	1.167
$N_2P_3K_2$	1.333	1.167	$L_2P_3K_2$	1.333	1.333
$N_2P_3K_3$	1.833	1.667	$L_2P_3K_3$	1.667	1.667
$N_3P_1K_1$	1.500	1.333	$L_3P_1K_1$	1.500	1.667
$N_3P_1K_2$	1.667	1.167	$L_3P_1K_2$	1.500	1.667
$N_3P_1K_3$	1.167	1.333	$L_3P_1K_3$	1.500	1.333
$N_3P_2K_1$	1.167	1.500	$L_3P_2K_1$	1.167	1.333
$N_3P_2K_2$	1.333	1.500	$L_3P_2K_2$	1.333	1.667
$N_3P_2K_3$	1.833	1.167	$L_3P_2K_3$	1.667	2.000
$N_3P_3K_1$	1.833	1.000	$L_3P_3K_1$	1.500	1.500
$N_3P_3K_2$	1.667	1.333	$L_3P_3K_2$	1.333	1.833
$N_3P_3K_3$	2.000	1.833	$L_3P_3K_3$	1.667	1.833
F	2.399	2.701	F	2.512	2.512
CD (0.05)	0.615	0.536	CD (0.05)	0.543	0.577

4.2.1.5.2 The effect of P

The effect of the P doses on number of shoots produced was significant at eight MAP (Table 107). ·ınts receiving 500 ppm P had a greater number of shoots (1.500) than those receiving 300 ppm P (1.278)

4.2.1.5.3 The effect of K

With respect to the K doses, their effect on the number of shoots produced was significant at seven MAP (Table 107). Plants receiving 500 ppm K had a greater number of shoots (1.352) than those receiving 400 ppm K (1.130).

4.2.1.5.4 The effect of NP interaction

A significant interaction between the N and P doses was observed at eight MAP (Table 107). Plants receiving N_1P_3 had a greater number of shoots (1.722) than those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_3, N_3P_1 or N_3P_2 and the plants receiving N_2P_2 had a greater number (1.500) than those receiving N_2P_1 (1.389).

4.2.1.5.5 The effect of NPK interaction

The interaction effects of the NPK combinations on the number of shoots produced was significant at four and nine MAP (Table 108). At four MAP, among the NPK combinations containing N_1, $N_1P_1K_2$ and $N_1P_3K_2$ resulted in a greater number of shoots (1.667 and 1.500 respectively) than $N_1P_3K_3$ (0.833). Among the combinations containing N_2, $N_2P_3K_3$ resulted in a greater number of shoots (1.667 and 1.500 respectively) than $N_1P_3K_3$ (0.833). Among the combinations containing N_2, $N_2P_3K_3$ ·esulted in a greater number of shoots (1.833) than $N_1P_1K_2$ (1.000).

Among the combinations containing N_3, $N_3P_2K_3$, $N_3P_3K_1$ and $N_3P_3K_3$ resulted in a greater number of shoots (1.833, 1.833 and 2.000 respectively) than $N_3P_1K_3$ or $N_3P_2K_1$ (1.167).

At nine MAP, among the NPK combinations containing N_1, $N_1P_1K_3$, $N_1P_3K_1$, $N_1P_3K_2$ and $N_1P_3K_3$ resulted in a greater number of shoots (1.667, 1.833, 1.667 and 1.667 respectively) than $N_1P_1K_1$ (1.000). Among the combinations containing N_2, $N_2P_1K_2$ resulted in a greater number of shoots (1.833) than $N_2P_1K_1$ or $N_2P_3K_2$. Among the combinations containing N_3, $N_3P_3K_2$ resulted in a greater number of shoots (1.833) than $N_3P_3K_1$ (1.000).

4.2.1.5.6 The effect of LN interaction

The direct effect of the light treatments on the number of shoots produced was not significant during the period under observation. However, interaction between light and the N doses was significant at 10 to 12 MAP (August to October 1993) (Table 109).

During August, L_3N_2 and L_2N_1 resulted in a greater number of shoots (1.667) than L_1N_1, L_2N_2 and L_3N_3 (1.333, 1.333 and 1.278 respectively). During September, plants receiving L_1N_2, L_1N_3, L_2N_1 L_3N_1 and L_3N_2 were found to have a greater number of shoots (1.778, 1.722, 1.833, 1.778 and 1.611 respectively) than those receiving L_1N_1 or L_1N_2 (1.278).

During October, the plants receiving L_1N_2, L_1N_3, L_2N_1, L_2N_3, L_3N_1, L_3N_2 and L_3N_3 had a greater number of shoots (1.778, 1.667 1.833, 1.722, 1.722, 1.667 and 1.556 respectively) than those receiving L_1N_1. The plants receiving L_2N_1 had a greater number (1.833) than those receiving L_2N_2 (1.444) too.

Table 109. Interaction effects of light intensities with the N and P doses on the number of shoots produced by *Dendrobium* Sonia - 16

Treatment	Months after planting		
	10	11	12
L_1N_1	1.333	1.278	1.167
L_1N_2	1.556	1.778	1.778
L_1N_3	1.444	1.722	1.667
L_2N_1	1.667	1.833	1.833
L_2N_2	1.333	1.278	1.444
L_2N_3	1.500	1.556	1.722
L_3N_1	1.444	1.778	1.722
L_3N_2	1.667	1.611	1.667
L_3N_3	1.278	1.556	1.556
F	2.761	5.747	4.613
CD (0.05)	0.314	0.333	0.357
L_1P_1	1.333	1.556	1.444
L_1P_2	1.222	1.444	1.444
L_1P_3	1.778	1.778	1.722
L_2P_1	1.556	1.667	1.833
L_2P_2	1.556	1.611	1.722
L_2P_3	1.389	1.389	1.444
L_3P_1	1.500	1.556	1.611
L_3P_2	1.389	1.667	1.667
L_3P_3	1.500	1.722	1.667
F	3.175	1.969	2.062
CD (0.05)	0.314	—	—
L_1 To	1.500	1.500	1.500
L_2 To	1.500	1.500	2.000
L_3 To	1.000	1.500	1.500
F	0.745	0.000	0.574
CD (0.05)	—	—	—

4.2.1.5.7 The effect of LP interaction

Interaction effects of the light treatments and P doses was significant at 10 MAP (August 1993) (Table 109). During the month, plants receiving L_1P_3, L_2P_1 and L_2P_2 had a greater number of shoots (1.778, 1.556 and 1.556 respectively) than those receiving L_1P_2 (1.222). Under 25 per cent light P_3 resulted in a greater number of shoots (1.778) than P_1 or P_2. Under 50 or 75 per cent light, there was no significant difference between the plants receiving P_1, P_2 or P_3 in the number of shoots produced.

4.2.1.5.8 The effect of LK interaction

Interaction between light intensities and the K doses was significant at six, seven and eight MAP (April, May and June 1993) (Table 110). During April, the plants receiving L_3K_3 had a greater number of shoots (1.611) than those receiving L_1K_3 or L_2K_2 (1.111). Under 25 or 50 per cent light, there was no significant difference in the number of shoots between the plants receiving K_1, K_2 or K_3. Under 75 per cent light, K_3 resulted in a greater number of shoots (1.611) than K_1 or K_2 (1.167 and 1.278 respectively).

During May (seven MAP) plants receiving L_3K_3 had a greater number of shoots (1.667) than the other treatments, which were not significantly different from each other.

During June (eight MAP) the plants receiving L_3K_3 had a greater number of shoots (1.722) than those receiving L_1K_1, L_1K_2, L_1K_3, L_2K_1, L_2K_2 and L_3K_1.

Table 110. Interaction effects of light intensities and K doses on the number of shoots produced by *Dendrobium* Sonia - 16

Treatment	Months after planting		
	6	7	8
L_1K_1	1.389	1.333	1.389
L_1K_2	1.167	1.056	1.278
L_1K_3	1.111	1.111	1.222
L_2K_1	1.167	1.056	1.222
L_2K_2	1.111	1.111	1.389
L_2K_3	1.333	1.278	1.444
L_3K_1	1.167	1.278	1.222
L_3K_2	1.278	1.222	1.444
L_3K_3	1.611	1.667	1.722
F	2.919	2.482	2.675
CD (0.05)	0.301	0.300	0.292
L_1To	1.000	1.000	1.500
L_2To	1.500	1.000	1.500
L_3To	1.000	1.000	1.000
F	0.808	0.000	0.860
CD (0.05)	—	—	—

4.2.1.5.9 The effect of LPK interaction

The interaction effect of light intensities and the PK combinations was significant at 10 and 11 MAP (August and September 1993) (Table 108). During August (10 MAP) under 25 per cent light, plants receiving P_3K_1, P_2K_1 or P_3K_3 had a greater number of shoots (2.167, 1.667 and 1.667 respectively) than the rest of the PK combinations, which were on par.

Under 50 per cent light, the plants receiving P_1K_1 or P_2K_2 had a greater number of shoots (1.833) than those receiving P_3K_1 (1.167). Under 75 per cent light, there was no significant difference between the different PK combinations in the number of shoots produced.

During September (11 MAP) under 25 per cent light, plants receiving P_3K_1 had a greater number of shoots (2.000) than those receiving P_1K_1, P_2K_2 or P_2K_3 (1.333). Under 50 per cent light, plants receiving P_1K_1 or P_2K_2 had a greater number of shoots (2.000 and 1.833 respectively) than those receiving P_3K_1 (1.167) and under 75 per cent light, plants receiving P_2K_3 had a greater number of shoots (2.000) than those receiving P_1K_3 or P_2K_1 (1.333).

4.2.1.6 The dry matter content of the shoots

4.2.1.6.1 The effect of P

The effect of the P doses on the dry matter content of the shoots was significant (Table 91). The plants receiving 500 ppm P had a greater dry matter content (9.075 per cent) than those receiving 400 ppm (9.450 per cent) or 300 ppm (9.513 per cent). Interaction between the nutrient doses did not significantly influence the dry matter content.

4.2.1.6.2 The effect of LP interaction

The direct effect of the light treatments on the dry matter content was not significant. However, the light intensities interacted with the P doses (Table 91). Under 25 and 75 per cent light, there was no significant difference between the plants receiving P_1, P_2 or P_3 in their dry matter content. Under 50 per cent light plants receiving 500 ppm P had a greater dry matter content

(9.775 per cent) than those receiving 300 or 400 ppm P. Plants receiving 400 ppm P had a greater dry matter content under 25 per cent light (9.756 per cent) than under 50 or 75 per cent light, while those receiving 300 or 500 ppm P did not differ in their dry matter content under the three light intensities.

4.2.2 Floral characters

4.2.2.1 Mean length of the inflorescences

4.2.2.1.1 The effects of N, P and K

The effect of the N and P doses on the mean length of the inflorescences was significant (Table 111). Plants receiving 500 ppm N had inflorescences of a greater length (13.907 cm) than those receiving 400 ppm N (10.980cm) and the plants receiving 300 ppm N has a lesser mean length (6.035cm) than the above two. Plants receiving 500 ppm P had inflorescences of a greater mean length (13.752cm) than those receiving 400 ppm (10.581cm). Plants receiving 300 ppm P had a lower mean length of the inflorescence (6.589cm) than those receiving the 400 or 500 ppm doses. The effect of the K doses on the mean length of the inflorescences was not significant.

4.2.2.1.2 The effect of light intensities

The effect of the light treatments on the mean length of the inflorescences was significant (Table 111). Plants grown under 75 per cent light had inflorescences of a greater mean length (13.846cm) than those grown under 25 per cent light.

Table 111. Effect of the N, P and K doses, light intensities and LN interaction on the flower characteristics of *Dendrobium* Sonia - 16

Treatment	Number of inflorescences per plant	Number of flowers per inflorescence	Length of the inflorescences (cm)	Span area per flower (sq.cm)
N_1	0.135	1.130	6.035	18.685
N_2	0.574	1.944	10.980	33.597
N_3	0.759	2.500	13.907	43.217
F	19.235	13.748	16.318	16.174
CD (0.05)	0.143	0.523	2.772	8.650
P_1	0.370	1.300	6.589	21.607
P_2	0.556	1.981	10.581	32.367
P_3	0.722	2.463	13.752	41.526
F	11.956	13.192	13.279	10.523
CD (0.05)	0.143	0.523	2.772	8.650
K_1	0.444	1.500	8.476	25.596
K_2	0.593	1.926	10.761	33.841
K_3	0.611	2.148	11.685	36.062
F	3.221	3.198	2.813	3.219
CD (0.05)	0.143	0.523	2.772	8.650
L_1	0.333	1.204	6.343	19.358
L_2	0.574	2.093	10.733	33.999
L_3	0.741	2.278	13.846	42.143
F	336.926	16.767	19.108	146.269
CD (0.05)	0.065	—	5.248	5.809

4.2.2.1.3 The effect of LN interaction

Interaction between the light treatments and the N doses was significant (Table 112). Under 25 per cent light, there was no significant difference in the mean length of the inflorescences between the plants receiving 300, 400 or 500 ppm N. Under 50 per cent light, plants receiving 400 or 500 ppm N had inflorescences of a greater length (12.728 and 14.017cm respectively) than those receiving 300 ppm N (5.456cm).

Under 75 per cent light, plants receiving 400 or 500 ppm N had inflorescences of a greater length (15.750cm and 18.556cm respectively) than those receiving 300 ppm (7.233cm).

4.2.2.1.4 The effect of LNP interaction

The interaction effect of light intensities and the NP combinations was significant (Table 113). Under 25 per cent light, plants receiving N_2P_3, N_3P_3, N_3P_2 and N_2P_2 had inflorescences of a greater length (5.350, 17.450, 6.800 and 8.033 respectively) than those receiving N_1P_2. Among the NP combinations, N_1P_2, N_3P_1 and N_3P_2 resulted in inflorescences having a greater length under 75 per cent light than under 25 or 50 per cent light. N_2P_1 resulted in inflorescences having a greater length under 75 per cent light than under 50 per cent light and N_2P_3 resulted in inflorescences having a greater length under 50 or 75 per cent light than under 25 per cent. There was no significant difference in the length of the inflorescences produced by the plants receiving N_3P_3, N_2P_2 or N_1P_3 under the three light intensities.

Table 112. Interaction effects of light intensities with the nitrogen doses on the flower characteristics of *Dendrobium* Sonia - 16

Treatment	Number of inflorescences per plant	Number of flowers per inflorescence	Length of the inflorescences (cm)	Span area per flower (sq.cm)
L_1N_1	0.278	1.056	5.417	16.655
L_1N_2	0.222	0.833	4.461	12.515
L_1N_3	0.500	1.722	9.150	28.905
L_2N_1	0.278	1.000	5.456	16.553
L_2N_2	0.667	2.500	12.728	39.860
L_2N_3	0.778	2.778	14.017	45.582
L_3N_1	0.389	1.333	7.233	22.848
L_3N_2	0.833	2.500	15.750	48.415
L_3N_3	1.000	3.000	18.556	55.165
F	2.625	2.097	2.528	2.493
CD (0.05)	0.248	—	4.801	14.982
L_1 To	0.000	0.000	0.000	0.000
L_2 To	0.000	0.000	0.000	0.000
L_3 To	0.000	0.000	0.000	0.000
F	0.000	0.000	0.000	0.000
CD (0.05)	—	—	—	—

Table 113. Interaction effects of light intensities with NP on the flower characteristics of *Dendrobium* Sonia - 16

Treatment	Number of inflorescences per plant	Number of flowers per inflorescence	Length of the inflorescences (cm)	Span area per flower (sq.cm)
$L_1N_1P_1$	0.167	0.500	3.050	10.180
$L_1N_1P_2$	0.676	0.667	2.950	9.425
$L_1N_1P_3$	0.500	2.000	10.250	30.360
$L_1N_2P_1$	0.000	0.000	0.000	0.000
$L_1N_2P_2$	0.333	1.500	8.033	18.860
$L_1N_2P_3$	0.333	1.000	5.350	18.685
$L_1N_3P_1$	0.167	0.667	3.200	8.633
$L_1N_3P_2$	0.333	1.333	6.800	19.447
$L_1N_3P_3$	1.000	3.167	17.450	58.635
$L_2N_1P_1$	0.333	1.167	6.067	20.800
$L_2N_1P_2$	0.167	0.500	3.117	10.305
$L_2N_1P_3$	0.333	1.333	7.183	18.555
$L_2N_2P_1$	0.333	1.000	5.483	20.402
$L_2N_2P_2$	0.667	2.333	12.867	40.925
$L_2N_2P_3$	1.000	4.167	19.833	58.253
$L_2N_3P_1$	0.500	1.167	8.100	30.525
$L_2N_3P_2$	0.833	3.333	16.017	45.773
$L_2N_3P_3$	1.000	3.333	17.933	60.448
$L_3N_1P_1$	0.000	0.000	0.000	0.000
$L_3N_1P_2$	0.667	2.167	11.200	39.530
$L_3N_1P_3$	0.500	1.833	10.500	29.013
$L_3N_2P_1$	0.833	2.500	16.633	46.870
$L_3N_2P_2$	0.833	2.500	15.400	49.142
$L_3N_2P_3$	0.833	2.500	15.217	49.233
$L_3N_3P_1$	1.000	2.667	16.767	57.052
$L_3N_3P_2$	1.000	3.500	18.850	57.895
$L_3N_3P_3$	1.000	2.833	20.050	50.548
F	2.228	2.479	2.232	2.182
CD (0.05)	0.430	1.569	8.316	25.949

4.2.2.2 The number of inflorescences produced per plant

4.2.2.2.1 The effects of N, P and K

The effect of the N, P and K doses on the number of inflorescences produced per plant was significant (Table 111). Plants receiving 500 or 400 ppm N had a greater number of inflorescences than those receiving 300 ppm. The increase recorded by 500 ppm P and the 400 and 300 ppm doses was respectively 32.230 and 95.140 per cent. So also, plants receiving 400 or 500 ppm K had a greater number of inflorescences than those given 300 ppm.

4.2.2.2.2 The effect of light intensities and LN interaction

The direct effect of the light treatments on the number of inflorescences produced was significant (Table 111). The number was greater under L_3 than under L_2 and greater under L_2 than under L_1. The interaction between light intensities and the N doses on the number of inflorescences produced was significant (Table 112). The plants receiving L_1N_3, L_2N_2, L_2N_3, L_3N_2 and L_3N_3 had a greater number of inflorescence than those receiving L_1N_1, L_1N_2, L_2N_1 and L_3N_1. Among the plants receiving 400 ppm N, there was no significant difference in the number of inflorescences produced between those grown under 50 or 75 per cent light. Among those receiving 500 ppm N, the number was greater under 50 and 75 per cent light (0.778 and 1.000 respectively) than under 25 per cent light.

4.2.2.2.3 The effect of LNP interaction

Interaction between the light treatments and the NP combinations was significant (Table 113). Plants receiving combinations such as N_3P_2 or N_3P_1

under 75 per cent light, N_2P_2 under 50 per cent light or N_3P_3 under 25, 50 or 75 per cent light had the highest number. Under 25 per cent light, plants receiving N_3P_3 had a greater number than the others. Under 50 per cent light, N_3P_3, N_3P_2, N_2P_3 and N_2P_2 resulted in a greater number of inflorescences (1.000, 1.000 and 0.667 respectively) than N_1P_2. Under 25 per cent light, the N_2P_1 plants and under 75 per cent light the N_1P_1 plants did not flower. The control plants too did not flower.

4.2.2.3 Mean number of flowers produced per inflorescence

4.2.2.3.1 The effects of N, P and K

The effect of the N, P and K doses on the mean number of flowers produced in an inflorescence was significant (Table 111). The plants receiving 500 ppm N had a greater number of flowers (2.500) than those receiving 400 ppm (1.944) or 300 ppm (1.130). Among the P doses, 400 and 500 ppm P resulted in a greater number of flowers (1.981 and 2.463 respectively) than 300 ppm. Among the K doses, 500 ppm resulted in a greater number (2.148) than 300 ppm.

4.2.2.3.2 The effect of LNP interaction

Interaction between light intensities and the NP combinations was observed (Table 113).

Under 25 per cent light, the number of flowers was greater in the plants receiving N_3P_3 (3.167) than in those receiving N_1P_1, N_1P_2, N_2P_1, N_2P_2, N_2P_3, N_3P_1 an N_3P_2. Under 50 per cent light the plants receiving N_2P_3 had a greater number of inflorescences (4.167) than those receiving N_1P_1, N_1P_2, N_1P_3 and N_3P_1 and the plants receiving N_3P_2 and N_3P_3 had greater numbers (3.333) than those receiving N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_3P_1.

Under 75 per cent light, plants receiving N_1P_1 failed to flower and those receiving N_3P_2 had a greater number of flowers (3.500) than those receiving N_1P_3 (1.833).

4.2.2.4 Span area per flower

4.2.2.4.1 The effects of N, P and K

The effects of the N, P and K doses on the span area per flower was significant (Table 111). Plants receiving 500 ppm N had a greater span area per flower (43.217 sq.cm) than those receiving 400 ppm and these in turn had a greater span area per flower (33.597 sq.cm) than those receiving 300 ppm (18.685 sq.cm). So also, the plants receiving 500 ppm P had a greater span area per flower (41.526 sq.cm) than those receiving 400ppm and the plants receiving 300 ppm P had a lesser span area per flower (21.607 sq.cm) than the latter group. With respect to the K doses, the plants receiving 500 ppm K had a greater span area (36.062 sq.cm) than those receiving 300 ppm (25.596 sq.cm).

4.2.2.4.2 The effect of light intensities

The effect of the light treatments on the span area per flower was significant (Table 111). In the plants grown under 50 or 75 per cent light, the span area of the flowers was greater (42.143 and 33.999 sq.cm respectively) than in those grown under 25 per cent light (19.358 sq.cm).

4.2.2.4.3 The effect of LN interaction

The interaction effect of light intensities and the N doses was significant (Table 112). Under 25 per cent light, the span area of flowers was greater (28.905 sq.cm) in the plants receiving 500 ppm N than in those receiving 400 ppm (12.515 sq.cm). Under 50 per cent light, in the plants receiving 500 ppm N the span area of flowers was greater (45.582 sq.cm) than in those receiving 300 ppm N. Under 75 per cent light, those receiving 500 or 400 ppm N had flowers having a greater span area (55.165 and 48.415 sq.cm respectively) than those receiving 300 ppm N (22.848 sq.cm). In the plants receiving N_1, the span area per flower was significantly different under the three light intensities. In those receiving N_2 or N_3, the span area of flowers was greater under 75 or 50 per cent light than under 25 per cent.

4.2.2.4.4 The effect of LNP interaction

The interaction effect of light and the NP combinations was significant (Table 113). Under L_1, N_3P_3 resulted in a greater span area (58.635 sq.cm) than the other combinations. Under L_2, N_3P_3 resulted in a greater span area of flowers (60.448 sq.cm) than N_1P_1, N_1P_2, N_1P_3, N_2P_1 and N_3P_1, which had 20.800, 10.305, 18.555, 20.402 and 30.525 sq.cm respectively. Under L_3, N_3P_3, N_3P_2, N_3P_1, N_2P_3 and N_2P_2 resulted in flowers having a greater span area (50.548, 57.895, 57.052, 49.233 and 49.142 sq.cm respectively) than N_1P_3.

4.2.3 Nutrient composition of the leaves

4.2.3.1 The Nitrogen content

4.2.3.1.1 The effect of N, P and K

The effect of the N, P and K doses received by the plants on the N content of the leaves was significant (Table 114). The content was higher in the plants receiving 400 or 500 ppm N (2.170 and 3.059 per cent respectively) than in those receiving 300 ppm (1.535 per cent). In the plants receiving 400 ppm P the content of N was greater (2.356 per cent) than in those receiving 300 ppm (2.069 per cent). Among the K doses, 400 ppm K resulted in a higher content of N in the leaves (2.314 per cent) than 300 ppm (2.103 per cent).

Table 114. Effect of the N, P and K doses on the nutrient status of the leaves of *Dendrobium* Sonia - 16

Treatment	N(%)	P(%)	K(%)	Mg(ppm)	Zn(ppm)	Cu(ppm)
N_1	1.535	0.928	1.040	2.316	0.223	0.019
N_2	2.170	0.978	1.061	2.339	0.227	0.021
N_3	3.059	0.941	1.060	2.348	0.195	0.018
F	1435.471	2.045	1.701	1.699	38.594	2.808
CD (0.05)	0.057	—	—	—	0.008	—
P_1	2.069	0.765	1.037	2.375	0.241	0.019
P_2	2.356	0.887	1.071	2.276	0.190	0.022
P_3	2.340	1.195	1.051	2.351	0.214	0.017
F	63.619	149.019	3.469	16.186	77.792	6.997
CD (0.05)	0.057	0.051	0.026	0.036	0.008	0.002
K_1	2.103	0.952	0.943	2.370	0.208	0.021
K_2	2.314	0.923	1.066	2.332	0.233	0.020
K_3	2.348	0.973	1.151	2.300	0.204	0.017
F	43.145	1.905	129.536	7.528	30.656	4.248
CD (0.05)	0.057	—	0.026	0.036	0.008	0.002

4.2.3.1.2 The effect of NP interaction

The effect of interaction between the N and the P doses on the N content of the leaves was significant (Table 115). The plants receiving N_2P_1 or N_3P_1 had a higher content of N (1.878 and 2.893 per cent respectively) than those receiving N_1P_1 (1.435 per cent). The plants receiving N_2P_2 or N_3P_2 had a higher content of N (2.357 and 3.065 per cent respectively) than those receiving N_1P_2 (1.645 per cent). Plants receiving N_2P_3 or N_3P_3 had a higher content (2.275 and 3.220 per cent) than those receiving N_1P_3 (1.525 per cent).

4.2.3.1.3 The effect of NK interaction

The interaction effect of the NK combinations on the N content of the leaves was significant (Table 115). Plants receiving N_1K_1 or N_1K_2 had a higher N content (1.572 and 1.575 per cent respectively) than those receiving N_1K_3. The plants receiving N_2K_2 or N_2K_3 had a higher N content (2.170 and 2.368 per cent respectively) than those receiving N_2K_1 (1.972 per cent). The plants receiving N_3K_2 or N_3K_3 had a higher N content (3.197 and 3.217 per cent respectively) than those receiving N_3K_1 (2.765 per cent).

4.2.3.1.4 The effect of PK interaction

The interaction effect of the PK combinations on the N content of the leaves was significant (Table 115). P_2K_1 and P_3K_1 resulted in a higher N content (2.275 and 2.202 per cent respectively) than P_1K_1 (1.832 per cent). The plants receiving P_2K_2 or P_3K_2 had a higher N content than those receiving P_1K_2. The plants receiving P_2K_3 or P_3K_3 had a higher N content (2.388 and 2.392 per cent respectively) than those receiving P_1K_3 (2.263 per cent)

Table 115. Interaction effects of NP, NK and PK on the nutrient status of the leaves of *Dendrobium* Sonia - 16

Treatment	N (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
N_1P_1	1.435	1.010	2.418	0.253	0.016
N_1P_2	1.645	1.111	2.224	0.216	0.024
N_1P_3	1.525	0.998	2.305	0.199	0.018
N_2P_1	1.878	1.060	2.321	0.268	0.021
N_2P_2	2.357	1.043	2.292	0.186	0.024
N_2P_3	2.275	1.080	2.403	0.228	0.017
N_3P_1	2.893	1.042	2.385	0.201	0.019
N_3P_2	3.065	1.060	2.312	0.168	0.017
N_3P_3	3.220	1.077	2.347	0.214	0.017
F	10.325	7.152	6.300	22.190	3.462
CD (0.05)	0.099	0.045	0.062	0.014	0.004
N_1K_1	1.527	0.936	2.335	0.235	0.024
N_1K_2	1.575	1.033	2.305	0.229	0.020
N_1K_3	1.458	1.150	2.306	0.204	0.014
N_2K_1	1.972	0.950	2.367	0.203	0.024
N_2K_2	2.170	1.077	2.331	0.241	0.021
N_2K_3	2.368	1.157	2.318	0.238	0.017
N_3K_1	2.765	0.944	2.408	0.185	0.013
N_3K_2	3.197	1.087	2.361	0.229	0.019
N_3K_3	3.217	1.148	2.275	0.170	0.021
F	22.847	0.882	1.816	18.650	9.092
CD (0.05)	0.099	—	—	0.014	0.004
P_1K_1	1.832	0.941	2.333	0.220	0.019
P_1K_2	2.112	1.024	2.478	0.269	0.021
P_1K_3	2.263	1.117	2.312	0.233	0.017
P_2K_1	2.275	0.933	2.319	0.164	0.024
P_2K_2	2.403	1.083	2.189	0.204	0.023
P_2K_3	2.388	1.198	2.320	0.203	0.018
P_3K_1	2.202	0.956	2.458	0.239	0.018
P_3K_2	2.427	1.059	2.329	0.226	0.017
P_3K_3	2.392	1.140	2.267	0.176	0.017
F	5.984	2.433	19.936	31.285	0.909
CD (0.05)	0.099	–	0.062	0.014	0.004

4.2.3.1.5 The effect of NPK interaction

The interaction effect of the NPK combinations on the N content of the leaves was significant (Table 116). Among the NPK combinations containing N_1, $N_1P_2K_1$ and $N_1P_3K_2$ resulted in a higher N content (1.785 and 1.680 per cent respectively) than $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_1$ and $N_1P_3K_3$. Among the combinations containing N_2, $N_2P_2K_2$, $N_2P_2K_3$, $N_2P_3K_2$ and $N_2P_3K_3$ resulted in a higher N content (2.415, 2.485, 2.345 and 2.415 per cent respectively) than $N_2P_1K_1$, $N_2P_1K_2$, $N_2P_2K_1$ and $N_2P_3K_1$. Among the combinations containing N_3, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_2K_3$, $N_3P_3K_1$, $N_3P_3K_2$ and $N_3P_3K_3$ had a higher N content (3.150, 3.150, 3.185, 3.140, 3.045, 3.225 and 3.360 per cent respectively) than $N_3P_1K_1$ (2.380 per cent) and $N_3P_2K_1$ (2.870 per cent).

4.2.3.1.6 The effect of LK interaction

Interaction between the light treatments and the K does was significant (Table 117).

Under 25 per cent light, plants receiving 400 or 500 ppm K had a higher N content (2.298 and 2.368 per cent respectively) than those receiving 300 ppm. Under 50 and 75 per cent light, plants receiving K_2 or K_3 had a higher N content than those receiving K_1. Under the three light intensities, plants receiving K_3 did not differ in their N content.

4.2.3.1.7 The effect of LPK interaction

The interaction effect of light and the PK combinations on the N content of the leaves was significant (Table 118).

Table 116. Interaction effects of NPK combinations on the nutrient status of the leaves of *Dendrobium* Sonia - 16

Treatment	N (%)	K (%)	Mg (ppm)	Cu (ppm)
$N_1P_1K_1$	1.435	0.960	2.343	0.017
$N_1P_1K_2$	1.435	0.973	2.529	0.018
$N_1P_1K_3$	1.435	1.097	2.382	0.013
$N_1P_2K_1$	1.785	0.933	2.132	0.033
$N_1P_2K_2$	1.610	1.097	2.164	0.022
$N_1P_2K_3$	1.540	1.303	2.375	0.018
$N_1P_3K_1$	1.495	0.913	2.531	0.022
$N_1P_3K_2$	1.680	1.030	2.221	0.020
$N_1P_3K_3$	1.400	1.050	2.162	0.017
$N_2P_1K_1$	1.680	0.937	2.309	0.028
$N_2P_1K_2$	1.750	1.087	2.460	0.020
$N_2P_1K_3$	2.205	1.157	2.193	0.015
$N_2P_2K_1$	2.170	0.943	2.277	0.027
$N_2P_2K_2$	2.415	1.057	2.203	0.030
$N_2P_2K_3$	2.485	1.130	2.396	0.015
$N_2P_3K_1$	2.065	0.970	2.514	0.018
$N_2P_3K_2$	2.345	1.087	2.330	0.013
$N_2P_3K_3$	2.415	1.183	2.366	0.020
$N_3P_1K_1$	2.380	0.927	2.347	0.013
$N_3P_1K_2$	3.150	1.103	2.448	0.023
$N_3P_1K_3$	3.150	1.097	2.362	0.022
$N_3P_2K_1$	2.870	0.923	2.548	0.013
$N_3P_2K_2$	3.185	1.097	2.200	0.017
$N_3P_2K_3$	3.140	1.160	2.190	0.022
$N_3P_3K_1$	3.045	0.983	2.329	0.013
$N_3P_3K_2$	3.255	1.060	2.438	0.018
$N_3P_3K_3$	3.360	1.187	2.274	0.018
F	4.141	3.443	13.453	3.528
CD (0.05)	0.171	0.078	0.108	0.007

Table 117. Interaction effects of light with N,P and K doses on the nutrient status of the leaves of *Dendrobium* Sonia - 16

Treatment	Mg (ppm)	Zn (ppm)	Treatment	Mg (ppm)	Zn (ppm)
L_1N_1	2.273	0.189	L_1P_1	2.382	0.227
L_1N_2	2.400	0.222	L_1P_2	2.346	0.118
L_1N_3	2.443	0.209	L_1P_3	2.389	0.205
L_2N_1	2.345	0.262	L_2P_1	2.409	0.260
L_2N_2	2.309	0.226	L_2P_2	2.272	0.207
L_2N_3	2.354	0.199	L_2P_3	2.327	0.219
L_3N_1	2.309	0.218	L_3P_1	2.334	0.235
L_3N_2	2.306	0.234	L_3P_2	2.210	0.176
L_3N_3	2.247	0.176	L_3P_3	2.338	0.217
F	9.495	24.787	F	2.624	3.290
CD (0.05)	0.062	0.014	CD (0.05)	0.062	0.014
	N (%)	K (%)	Mg (ppm)	Zn (ppm)	Cu (ppm)
L_1K_1	2.038	0.976	2.405	0.188	0.021
L_1K_2	2.298	1.059	2.338	0.230	0.022
L_1K_3	2.368	1.154	2.373	0.202	0.019
L_2K_1	2.112	0.932	2.414	0.234	0.023
L_2K_2	2.380	1.062	2.335	0.238	0.019
L_2K_3	2.322	1.187	2.259	0.214	0.013
L_3K_1	2.158	0.922	2.291	0.201	0.018
L_3K_2	2.263	1.076	2.324	0.203	0.019
L_3K_3	2.353	1.113	2.267	0.196	0.019
F	2.774	3.199	4.296	4.350	3.331
CD (0.05)	0.099	0.045	0.062	0.014	0.004
L_1To	1.575	0.900	2.288	0.167	0.015
L_2To	1.365	0.910	2.143	0.138	0.015
L_3To	1.350	0.900	2.207	0.108	0.015
F	1.435	0.015	1.200	3.961	0.000
CD (0.05)	—	—	—	0.042	—

Under 25 per cent light, P_1K_3, P_2K_2, P_3K_2 and P_3K_3 had a higher N content (2.450, 2.450, 2.380 and 2.415 per cent respectively) than those receiving P_1K_1, P_1K_2 and P_3K_1. Among the treatments, P_1K_1 resulted in the lowest N content (1.715 per cent).

Under 50 per cent light, P_1K_1 resulted in a significantly lower N content (1.925 per cent) than the other treatments. The plants receiving P_2K_2, P_2K_3, P_3K_2 and P_3K_3 had a higher N content (2.415, 2.380, 2.520 and 2.415 per cent respectively) than those receiving P_1K_1 or P_1K_3. The plants receiving P_3K_3 had a higher N content than those receiving P_1K_2, P_2K_1 and P_3K_1 too.

Under 75 per cent light, the plants receiving P_1K_1 had a lower N content (1.855 per cent) than the other treatments. The plants receiving P_2K_1, P_2K_2, P_2K_3, P_3K_2 or P_3K_3 had a higher N content (2.380, 2.345, 2.545, 2.380 and 2.345 per cent respectively) than those receiving P_1K_1, P_1K_2 and P_1K_3. The plants receiving P_2K_3 had a greater N content than those receiving P_2K_2, P_3K_1 and P_3K_3.

4.2.3.2 The Phosphorus content

The effect of the N and K doses on the phosphorus content of the leaves was not significant. However, the effect of the P doses was significant (Table 114). Plants receiving 500 ppm P had a higher P content (1.195 per cent) than those receiving 400 or 300 ppm and those receiving 400 ppm and a higher content (0.887 per cent) than those receiving 300 ppm, (0.765 per cent).

Table 118. Interaction effects of light, NP and PK on the nutrient status of the leaves of *Dendrobium* Sonia - 16

Treatment	Cu (ppm)	Treatment	Cu (ppm)	N (%)	Zn (ppm)
$L_1N_1P_1$	0.015	$L_1P_1K_1$	0.023	1.715	0.194
$L_1N_1P_2$	0.028	$L_1P_1K_2$	0.020	2.065	0.263
$L_1N_1P_3$	0.017	$L_1P_1K_3$	0.015	2.450	0.224
$L_1N_2P_1$	0.027	$L_1P_2K_1$	0.017	2.240	0.143
$L_1N_2P_2$	0.022	$L_1P_2K_2$	0.030	2.450	0.216
$L_1N_2P_3$	0.022	$L_1P_2K_3$	0.020	2.240	0.207
$L_1N_3P_1$	0.017	$L_1P_3K_1$	0.022	2.160	0.229
$L_1N_3P_2$	0.017	$L_1P_3K_2$	0.017	2.380	0.212
$L_1N_3P_3$	0.022	$L_1P_3K_3$	0.022	2.415	0.174
$L_2N_1P_1$	0.018	$L_2P_1K_1$	0.020	1.925	0.271
$L_2N_1P_2$	0.022	$L_2P_1K_2$	0.022	2.205	0.267
$L_2N_1P_3$	0.015	$L_2P_1K_3$	0.015	2.170	0.244
$L_2N_2P_1$	0.018	$L_2P_2K_1$	0.030	2.205	0.189
$L_2N_2P_2$	0.025	$L_2P_2K_2$	0.020	2.415	0.202
$L_2N_2P_3$	0.015	$L_2P_2K_3$	0.013	2.380	0.229
$L_2N_3P_1$	0.020	$L_2P_3K_1$	0.018	2.205	0.241
$L_2N_3P_2$	0.017	$L_2P_3K_2$	0.015	2.520	0.248
$L_2N_3P_3$	0.015	$L_2P_3K_3$	0.012	2.415	0.169
$L_3N_1P_1$	0.015	$L_3P_1K_1$	0.015	1.855	0.196
$L_3N_1P_2$	0.023	$L_3P_1K_2$	0.020	2.065	0.278
$L_3N_1P_3$	0.022	$L_3P_1K_3$	0.020	2.170	0.230
$L_3N_2P_1$	0.018	$L_3P_2K_1$	0.027	2.380	0.160
$L_3N_2P_2$	0.025	$L_3P_2K_2$	0.018	2.345	0.194
$L_3N_2P_3$	0.015	$L_3P_2K_3$	0.022	2.545	0.175
$L_3N_3P_1$	0.022	$L_3P_3K_1$	0.013	2.240	0.247
$L_3N_3P_2$	0.018	$L_3P_3K_2$	0.020	2.380	0.218
$L_3N_3P_3$	0.013	$L_3P_3K_3$	0.017	2.345	0.184
F	2.382	F	4.051	3.404	5.403
CD (0.05)	0.007	CD (0.05)	0.007	0.171	0.024

Interaction between the nutrients had no significant effect on the P content of the leaves. So also, the light treatments and their interaction with the nutrients had no significant effect on the P content of the leaves.

4.2.3.3 The Potassium content

4.2.3.3.1 The effect of P and K

The effect of the P and K doses given to the plants on the K content of the leaves was significant (Table 114). Plants receiving 400 ppm P had a higher K content (1.071 per cent) than those receiving 300 ppm P (1.037 per cent). Plants receiving 400 or 500 ppm K had a higher K content (1.066 and 1.151 per cent respectively) than those receiving 300 ppm (0.943 per cent).

4.2.3.3.2 The effect of NP interaction

Interaction between the N and P doses significantly affected the K content of the leaves (Table 115). The plants receiving N_1P_2 had a higher K content (1.111) than those receiving N_1P_1 (1.010 per cent) or N_1P_3 (0.998 per cent). The plants receiving N_2P_1 ,N_2P_2, or N_2P_3 did not differ significantly in their K content. So also, there was no significant difference in the K content between the plants receiving N_3P_1, N_3P_2, or N_3P_3.

Among the P doses, P_1 in combination with N_2 resulted in a higher K content (1.060 per cent) than in combination with N_1. P_2 in combination with N_1 resulted in higher K content (1.111 per cent) than in combination with N_2 (1.043 per cent) or with N_3 (1.060 per cent). P_3 in combination with N_2 or N_3 resulted in a higher K content (1.080 and 1.077 per cent respectively) than with N_1.

4.2.3.3.3 The effect of NPK interaction

The effect of interaction between the NPK combinations on the K content of the leaves was significant (Table 116). Among the combinations containing N_1, $N_1P_2K_3$ resulted in higher K content (1.303 per cent) than the others. So also, $N_1P_1K_3$ and $N_1P_2K_2$ had a higher K content (1.097 per cent) than $N_1P_1K_1$,$N_1P_1K_2$, $N_1P_2K_1$ and $N_1P_3K_1$.

Among the combinations containing N_2, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_2K_3$ and $N_2P_3K_3$ resulted in a higher K content (1.087, 1.157, 1.057, 1.130, 1.087 and 1.183 per cent respectively) than $N_2P_1K_1$ $N_2P_2K_1$ and $N_2P_3K_1$. Among the combinations containing N_3, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_2K_3$ and $N_3P_3K_3$ resulted in a higher K content (1.103, 1.097, 1.097, 1.160 and 1.187 per cent respectively) than $N_3P_1K_1$, $N_3P_2K_1$ and $N_3P_3K_1$. Plants receiving $N_3P_3K_3$ had a higher K content than those receiving $N_3P_1K_2$ $N_3P_1K_3$ $N_3P_2K_2$ and $N_3P_3K_2$ too.

4.2.3.3.4 The effect of LK interaction

The direct effect of light intensities on the K content of the leaves was not significant. However, light interacted with the K doses received by the plants and influenced the K content of the leaves (Table 117). Under 25 per cent light, plants receiving K_3 had a higher K content (1.154 per cent) than those receiving K_2 or K_3 and those receiving K_2 had a higher content (1.059 per cent) than those receiving K_1 (0.976 per cent).

Under 50 per cent light, plants receiving K_3 had a higher K content (1.187 per cent) than those receiving K_2 (1.062 per cent) and the plants receiving K_2 had a higher content than those receiving K_1 (0.932 per cent). Under 75 per cent light, plants receiving K_2 or K_3 had a higher content (1.076

and 1.113 per cent respectively) than those receiving K_1 (0.922 per cent). Under L_1, L_2 or L_3,there was no significant difference in the K content of leaves between the plants receiving K_1 or K_2.

4.2.3.4 The Magnesium content

4.2.3.4.1 The effects of P and K

The effect of the P and K doses on the Mg content of the leaves was significant (Table 114). Plants receiving 300 or 500 ppm P had a higher content of Mg in the leaves (2.375 and 2.351 ppm respectively) than those receiving 400 ppm. The plants receiving K_1 had a higher content of magnesium (2.370 ppm) than these receiving K_2 or K_3 (2.332 and 2.300 ppm respectively).

4.2.3.4.2 The effect of NP interaction

The interaction effect of the N and P doses on the Mg content of the leaves was significant (Table 115). Plants receiving N_1P_1 had a higher content of Mg in the leaves (2.418 ppm) than those receiving N_1P_3 (2.035 ppm), and the plants receiving N_1P_3 had a higher content than those receiving N_1P_2 (2.224 ppm). The plants receiving N_2P_3 had a higher content (2.403 ppm) than those receiving N_2P_1 (2.321 ppm) or N_2P_2 (2.292 ppm) and the plants receiving N_3P_1, N_3P_2 or N_3P_3 had no significant difference in the Mg content of their leaves.

4.2.3.4.3 The effect of PK interaction

The interaction effect of the PK doses on the Mg content of the leaves was significant (Table 115). The plants receiving P_1K_2 had a higher Mg content (2.478 ppm) than those receiving P_1K_1 (2.333 ppm) or P_1K_3 (2.312

ppm). Plants receiving P_2K_1 or P_2K_3 had a higher Mg content (2.319 and 2.320 ppm respectively) than those receiving P_2K_2. The plants receiving P_3K_1 had a higher Mg content (2.458 ppm) than those receiving P_3K_2 (2.329 ppm) and these in turn had a higher content than those receiving P_3K_3 (2.267 ppm).

4.2.3.4.4 The effect of NPK interaction

The interaction effect of the NPK combinations on the Mg content of the leaves was significant (Table 116). Among the combinations containing N_1, $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_2K_3$ and $N_1P_3K_1$ had a higher Mg content (2.343, 2.529, 2.382 2.375 and 2.531 ppm respectively) than $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_2$ and $N_1P_3K_3$. Among the combinations containing N_2, $N_2P_1K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$ and $N_2P_3K_3$ resulted in a higher Mg content (2.460, 2.396, 2.514, 2.330 and 2.360 ppm respectively) than $N_2P_1K_3$ and $N_2P_2K_2$. Among the combinations containing N_3, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_1$, $N_3P_3K_1$ and $N_3P_3K_2$ resulted in a higher Mg content (2.347, 2.445, 2.362, 2.548, 2.329 and 2.438 ppm respectively) than $N_3P_2K_2$ and $N_3P_2K_3$.

4.2.3.4.5 The effect of LN interaction

The direct effect of the light treatments on the Mg content of the leaves was not significant. However, interactions of light with the N doses was significant (Table 117). Under 25 per cent light, plants receiving N_2 or N_3 had a higher Mg content (2.400 and 2.443 ppm respectively) than those receiving 300 ppm (2.273 ppm). Under 50 per cent light, the plants receiving N_1, N_2 or N_3 did not differ significantly in their Mg content. Under 75 per cent light, the plants receiving N_1 had a higher Mg content (2.329 ppm) than those receiving N_3 (2.247 ppm).

4.2.3.4.6 The effect of LP interaction

Interaction effects of light intensities and the P doses (Table 117) revealed that under 25 per cent light, there was no significant difference between the plats receiving P_1, P_2 or P_3 in their Mg content. Under 50 per cent light, the plants receiving P_1 had a higher content (2.409 ppm) than those receiving P_2 or P_3 (2.272 and 2.327 ppm respectively). Under 75 per cent light, the plants receiving P_1 or P_3 had a higher content (2.334 and 2.338 ppm respectively) than those receiving P_2 (2.210 ppm).

4.2.3.4.7 The effect of LK interaction

The interaction effect of the light treatments with the K doses was significant (Table 117). Under 25 per cent light, the plants receiving K_1 had a higher Mg content (2.405 ppm) than those receiving K_2. Under 50 per cent light, the plants receiving K_1 or K_2 had a higher Mg content(2.414 and 2.335 ppm respectively) than those receiving K_3. Under 75 per cent light the plants receiving K_1,K_2 or K_3 did not differ significantly in the Mg content of their leaves.

4.2.3.4.8 The effect of LNPK interaction

The interaction effect of the light treatments and the NPK combinations was significant (Table 119). Under 25 per cent light, the plants receiving $N_1P_2K_3$, $N_1P_3K_1$, $N_2P_1K_1$ $N_2P_1K_2$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_3$, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_1$ and $N_3P_3K_2$ had a higher Mg content (2.478, 2.682, 2.491, 2.492, 2.591, 2.501, 2.527, 2.600, 2.486, 2.686 and 2.547 ppm respectively) than those receiving $N_1P_1K_1$, $N_1P_2K_1$, $N_1P_2K_2$, $N_1P_3K_2$, $N_1P_3K_3$, $N_2P_1K_3$, $N_2P_2K_1$, $N_2P_3K_2$, $N_3P_2K_2$ and $N_3P_2K_3$.

Table 119. Interaction effects of light intensities with NPK combinations on the magnesium content (ppm) of the leaves of *Dendrobium* Sonia - 16

Treatment	Light Intensity		
	L_1	L_2	L_3
$N_1P_1K_1$	2.155	2.452	2.424
$N_1P_1K_2$	2.332	2.614	2.642
$N_1P_1K_3$	2.306	2.377	2.465
$N_1P_2K_1$	2.100	2.217	2.080
$N_1P_2K_2$	2.172	2.161	2.160
$N_1P_2K_3$	2.478	2.282	2.366
$N_1P_3K_1$	2.682	2.517	2.396
$N_1P_3K_2$	2.122	2.279	2.262
$N_1P_3K_3$	2.114	2.205	2.166
$N_2P_1K_1$	2.491	2.214	2.224
$N_2P_1K_2$	2.492	2.310	2.579
$N_2P_1K_3$	2.231	2.207	2.142
$N_2P_2K_1$	2.255	2.364	2.213
$N_2P_2K_2$	2.321	2.166	2.122
$N_2P_2K_3$	2.591	2.418	2.179
$N_2P_3K_1$	2.501	2.610	2.431
$N_2P_3K_2$	2.206	2.314	2.469
$N_2P_3K_3$	2.517	2.182	2.400
$N_3P_1K_1$	2.344	2.594	2.104
$N_3P_1K_2$	2.600	2.544	2.193
$N_3P_1K_3$	2.486	2.369	2.231
$N_3P_2K_1$	2.686	2.533	2.426
$N_3P_2K_2$	2.254	2.166	2.180
$N_3P_2K_3$	2.260	2.144	2.165
$N_3P_3K_1$	2.434	2.230	2.324
$N_3P_3K_2$	2.547	2.459	2.308
$N_3P_3K_3$	2.379	2.150	2.293
F	2.866	—	—
CD (0.05)	0.187	—	—

Under L_2, the plants receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_3K_1$, $N_2P_2K_3$, $N_2P_3K_1$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_2K_1$ and $N_3P_3K_2$ had a higher Mg content (2.452, 2.614, 2.517, 2.418, 2.610, 2.594,2.544, 2.533 and 2.459 ppm respectively) than those receiving $N_1P_2K_1$, $N_1P_3K_3$, $N_2P_1K_1$, $N_2P_1K_3$, $N_2P_2K_2$, $N_2P_3K_3$, $N_3P_2K_3$ and $N_3P_3K_3$. Under L_3, the plants receiving $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_1K_3$, $N_1P_3K_3$, $N_2P_1K_2$, $N_2P_3K_1$, $N_2P_3K_2$, $N_2P_3K_3$ and $N_3P_2K_1$ had a higher Mg content (2.424, 2.642, 2.465, 2.396, 2.579, 2.431, 2.469, 2.400 and 2.426 ppm respectively than those receiving $N_1P_2K_1$, $N_2P_2K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_3P_1K_1$, $N_3P_1K_2$, $N_3P_2K_2$ and $N_3P_2K_3$.

4.2.3.5 The zinc content

4.2.3.5.1 The effect of N, P and K

The effect of the N, P and K does on the zinc content of the leaves was significant (Table 114). Plants receiving 300 or 400 ppm N had a higher zinc content (0.223 ppm and 0.227 ppm respectively) than those receiving 500 ppm (0.195 ppm).

The plants receiving 300 or 500 ppm P had a higher zinc content (0.241 and 0.214 ppm) respectively than those receiving 400 ppm P. Plant receiving 300 ppm had a higher Mg content than those receiving 500 ppm P.

Among the K doses, 400 ppm resulted in a higher zinc content (0.233 ppm) than 300 or 500 ppm (0.208 and 0.204 ppm respectively)

4.2.3.5.2 The effect of NP interaction

The effect of the NP doses on the zinc content of the leaves was significant (Table 115). The plants receiving N_2P_1, had a higher zinc content

(0.208 ppm) than those receiving N_1P_1 or N_1P_3. The plants receiving N_1P_1 had a higher content (0.253 ppm) than those receiving N_3P_1 (0.201 ppm). So also the plants receiving N_1P_2 had a higher zinc content (0.216 ppm) than those receiving N_2P_2 or N_3P_2. The plants receiving N_2P_2 had a higher content (0.186 ppm) than those receiving N_3P_2 (0.168 ppm). The plants receiving N_2P_3 had a higher content (0.228 ppm) than those receiving N_3P_3 (0.214 ppm) or N_1P_3 (0.199 ppm).

4.2.3.5.3 The effect of NK interaction

The effect of interaction between the NK doses on the zinc content of the leaves was significant (Table 115). the plants receiving N_1K_1 had a higher zinc content (0.235 ppm) than those receiving N_2K_1 and these in turn had a higher content(0.203 ppm)than those receiving N_3K_1. The plants receiving N_1K_2,N_2K_2 or N_3K_2 did not differ significantly in the zinc content of their leaves. the plants receiving N_1K_2, had a higher content than those receiving N_1K_3 and these in turn had a higher content than those receiving N_3K_3 (0.170 ppm).

4.2.3.5.4 The effect of PK interaction

The effect of interaction between the PK combinations on the zinc content of the leaves was significant (Table 115). The plants receiving P_3K_1 had a higher zinc content (0.239 ppm) than those receiving P_1K_1 and these in turn had a higher content (0.220 ppm) than those receiving P_2K_1 (0.164 ppm). The plants receiving P_1K_2 had a higher content (0.269 ppm) than those receiving P_3K_2 and these in turn had a higher content (0.226 ppm) than those receiving P_2K_2 (0.204 ppm). The plants receiving P_1K_3 had a higher zinc content (0.233 ppm) than those receiving P_2K_3 and these in turn had a higher content (0.203 ppm) than those receiving P_3K_3 (0.176 ppm).

4.2.3.5.5 The effect of NPK interaction

The interaction effect of the NPK combinations on the zinc content of the leaves was significant (Table 116). The plants receiving $N_2P_1K_2$ had a higher zinc content (0.328 ppm) than those receiving the other combinations. The plants receiving $N_1P_2K_2$ or $N_3P_2K_2$ had higher contents (0.227 and 0.214 ppm respectively) than those receiving $N_2P_2K_2$.

Among the combinations containing N_1, $N_1P_1K_1$, $N_1P_1K_2$, $N_1P_2K_2$, $N_1P_2K_3$ and $N_1P_3K_1$ resulted in a higher zinc content (0.289, 0.254, 0.227, 0.228 and 0.222 ppm respectively) than $N_1P_2K_1$ and $N_1P_3K_3$. Among the combinations containing N_2, $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_1$ and $N_2P_3K_2$ resulted in a higher zinc content (0.328, 0.279, 0.228, 0.251 and 0.226 ppm respectively) than $N_2P_1K_1$, $N_2P_2K_1$ and $N_2P_2K_2$. Among the combinations containing N_3, $N_3P_1K_2$, $N_3P_1K_3$, $N_3P_2K_2$, $N_3P_3K_1$ and $N_3P_3K_2$ resulted in a higher zinc content (0.225, 0.002, 0.214, 0.243 and 0.247 ppm respectively) than $N_3P_1K_1$, $N_3P_2K_1$, $N_3P_2K_3$ and $N_3P_3K_3$.

4.2.3.5.6 The effect of light intensities

The direct effect of the light treatments on the zinc content of the leaves of the plants which received the various NPK nutrients was not significant. However in the control plants the effect of the light treatments on the zinc content of the leaves was significant (Table 117). The control plants grown under 25 per cent light had a higher zinc content (0.167 ppm) than those grown under 75 per cent light (0.108 ppm).

4.2.3.5.7 The effect of LN interaction

The interaction effect of the light treatments and the N doses on the zinc content of the leaves was significant (Table 117). Plants receiving 300 ppm N had a higher zinc content (0.262 ppm) under 50 per cent light than under 25 or 75 per cent light. The plants receiving 400 ppm N had no significant difference in their zinc content under L_1, L_2 or L_3. The plants receiving 500 ppm N under L_1 or L_2 had a higher zinc content (0.209 and 0.199 ppm respectively) than those grown under L_3.

4.2.3.5.8 The effect of LP interaction

The interaction effects of the light treatments and P doses (Table 117) revealed that under 25 per cent light, the plants receiving P_1 had a higher zinc content (0.227 ppm) than those receiving P_2 (0.118 ppm) or P_3 (0.205 ppm). Under 50 per cent light, those receiving P_1 had a higher zinc content (0.260 ppm) than those receiving P_2 (0.207 ppm) or P_3 (0.219 ppm). Under 75 per cent light, plants receiving P_1 had a higher zinc content (0.235 ppm) than those receiving P_2 or P_3.

4.2.3.5.9 The effect of LK interaction

Interaction effects of light and the K doses (Table 117) revealed that under 25 per cent light, plants receiving K_2 and K_3 had a higher zinc content (0.230 and 0.202 ppm respectively) than those receiving K_1 (0.188 ppm). Under 50 per cent light, plants receiving K_1 or K_2 had a higher zinc content (0.234 and 0.238 ppm respectively) than those receiving K_3 (0.214 ppm). Under 75 per cent light, plants receiving K_2 had a higher zinc content (0.230 ppm) than those receiving K_1 (0.201 ppm) or K_3 (0.196 ppm).

4.2.3.5.10 The effect of NPK interaction

Interaction effects between the light treatments and the PK combinations significantly influenced the zinc content of the leaves (Tables 118). Under L_1, plants receiving P_1K_2, P_1K_3 and P_3K_1 had a higher zinc content (0.263, 0.224 and 0.229 ppm respectively) than those receiving P_1K_1, P_2K_1 and P_3K_3. Under L_2, the plants receiving P_1K_1, P_1K_2, P_1K_3, P_2K_3, P_3K_1 and P_3K_2 had a higher zinc content (0.271, 0.267, 0.244, 0.229, 0.241 and 0.248 ppm respectively) than P_2K_1 or P_3K_3. Under L_3, plants receiving P_1K_2, P_1K_3 and P_3K_1 had a higher content (0.278, 0.230, and 0.247 ppm respectively) than those receiving P_1K_1, P_2K_1, P_2K_2 and P_2K_3. The plants receiving P_1K_2, P_1K_3, P_2K_2, P_3K_1 and P_3K_3 had no significant difference in the zinc content under L_1, L_2 or L_3.

4.2.3.6 The copper content

4.2.3.6.1 The effects of P and K

The effect of the P and K doses on the Cu content of the leaves was significant (Table 114). The plants receiving 400 ppm P had a higher Cu content (0.022 ppm) than those receiving 300 or 500 ppm. The plants receiving K_1 had a higher Cu content (0.021 ppm) than those receiving K_3 (0.017 ppm).

4.2.3.6.2 The effect of NP interaction

The interaction effects of the N and P doses on the Cu content of the leaves was significant (Table 115). The plants receiving N_1P_2 had a higher Cu content (0.024 ppm) than those receiving N_1P_1 or N_1P_3. The plants receiving N_2P_2 had a higher Cu content (0.024 ppm) than those receiving N_2P_3 (0.017 ppm). The plants receiving N_3P_1, N_3P_2 or N_3P_3 were not significant different in the Cu content of their leaves.

4.2.3.6.3 The effect of NK interaction

The interaction effects of the N and K doses (Table 115) revealed that plants receiving N_1K_1 or N_1K_2 had a higher Cu content (0.024 and 0.020 ppm respectively)than those receiving N_1K_3 (0.021 ppm). The plants receiving N_2K_1 or N_2K_2 had a higher Cu content (0.024 and 0.021 ppm respectively) than those receiving N_2K_3 (0.017 ppm). The plants receiving N_3K_2 or N_3K_3 had a higher Cu content (0.019 and 0.012 ppm respectively) than those receiving N_3K_1 (0.013 ppm).

4.2.3.6.4 The effect of NPK interaction

The interaction effects of the NPK combinations on the Cu content of the leaves was significant (Table 116). Among the combinations containing N_1, plants the receiving $N_1P_2K_1$ had a higher Cu content (0.033 ppm) than those receiving the other combinations. The plants receiving $N_1P_2K_2$, $N_1P_3K_1$ and $N_1P_3K_2$ had a higher Cu content (0.022,0.022 and 0.020 ppm respectively) than those receiving $N_1P_1K_3$ (0.013 ppm). Among the combinations containing N_2, $N_2P_1K_1$ $N_2P_2K_1$ and $N_2P_2K_2$ resulted in a higher Cu content (0.028,0.027 and 0.030 ppm respectively) than $N_2P_1K_2$, $N_2P_1K_3$, $N_2P_2K_3$, $N_2P_3K_1$, $N_2P_3K_2$ and $N_2P_3K_3$. Among the combinations containing N_3, $N_3P_1K_2$, $N_3P_1K_3$ and $N_3P_2K_3$ resulted in a higher Cu content (0.023, 0.022 and 0.022 ppm respectively) than $N_3P_1K_1$, $N_3P_2K_1$ and $N_3P_3K_1$.

4.2.3.6.5 The effect of LK interaction

The direct effect of the light treatments on the Cu content of the leaves was not significant. However the effect of interaction between light and the

K doses was significant (Table 117). Under 25 and 75 per cent light, the plants receiving K_1, K_2 or K_3 did not differ significantly in the K content of the leaves. Under 50 per cent light, the plants receiving 300 ppm, K had a higher Cu content (0.023 ppm) than those receiving K_2 (0.019 ppm) or K_3 (0.013 ppm).

4.2.3.6.6 The effect of LNP interaction

The interaction effects of light and the NP combinations was significant (Table 118). Under 25 per cent light, the plants receiving N_1P_2 or N_2P_1 had a higher Cu content (0.028 and 0.027 ppm respectively) than those receiving N_1P_1, N_1P_3, N_3P_1 and N_3P_2. Under 50 per cent light, the plants receiving N_1P_2 or N_2P_2 had a higher Cu content (0.022 and 0.255 ppm respectively) than those receiving N_1P_3, N_2P_3 or N_3P_3. Under 75 per cent light, N_1P_2, N_1P_3, N_2P_2 and N_3P_1 resulted in a higher Cu content (0.023, 0.022, 0.025 and 0.022 ppm respectively) than N_1P_1, N_2P_3 or N_3P_3.

4.2.3.6.7 The effect of LPK interaction

The interaction effect of light and the PK combinations revealed that under 25 per cent light (Table 118) plants receiving P_1K_1, P_2K_2, P_3K_1 or P_3K_3 had a higher Cu content (0.023, 0.030, 0.022 and 0.022 ppm respectively) than those receiving P_1K_3. The plants receiving P_2K_2 also had a higher Cu content than those receiving P_1K_2, P_2K_1, P_2K_3 and P_3K_2. Under 50 per cent light the plants receiving P_1K_2 and P_2K_1 had a greater Cu content (0.022 and 0.030 ppm respectively) than those receiving P_1K_3, P_2K_3,P_3K_2 and P_3K_3. Under 75 per cent light, the plants receiving P_2K_1 or P_2K_3 had a higher Cu content (0.027 and 0.022 ppm respectively) than those receiving P_1K_1 or P_3K_1.

PLATE 1 *Arachnis* Maggie Oei 'Red Ribbon'

PLATE 2 *Dendrobium* Sonia - 16

LATE 3

Pot grown plants in full sunlight have not flowered. A few trench grown plants seen in the rear are in flower (Expt.1)

PLATE 4

Trench grown plants under full sunlight in full bloom (Expt.1)

PLATE 5

Trench grown plants under 75 per cent light in full bloom (Expt.1)

PLATE 6

Trench grown plants under 50 per cent light, initiating inflorescences in the upper nodes of the shoots (Expt.1)

PLATE 7

Roots of the pot grown plants showing extensive ramification outside the pots (Expt.1)

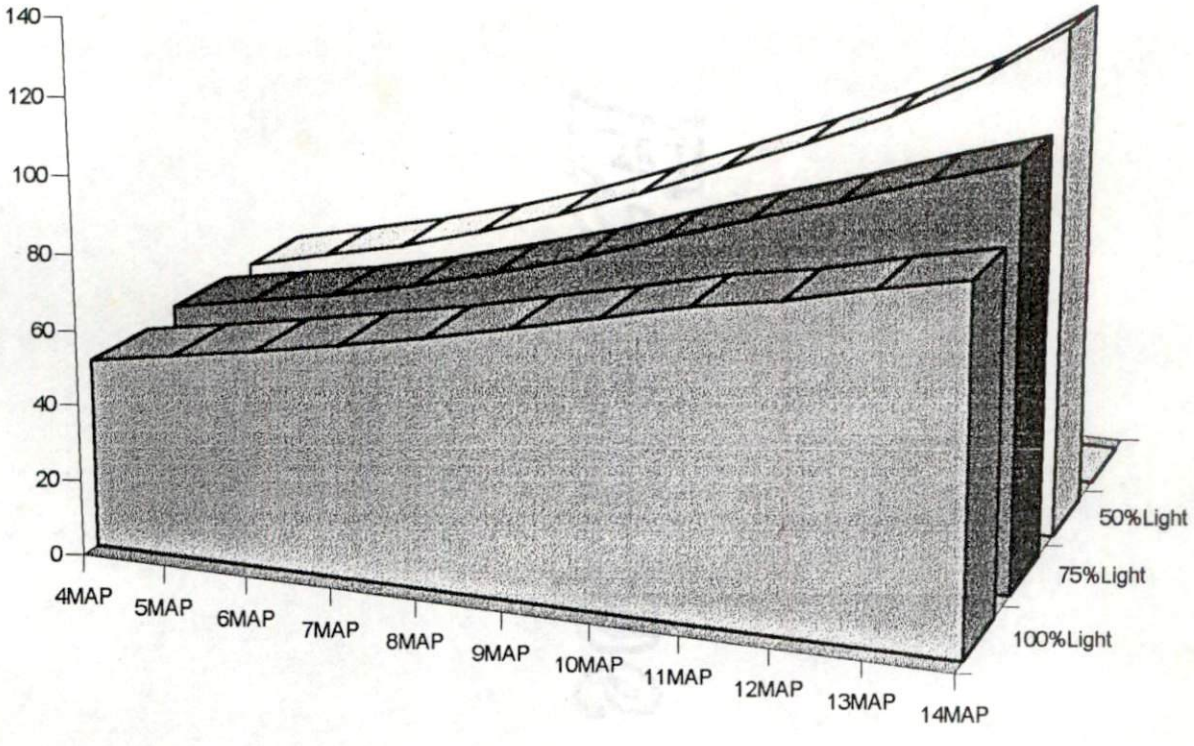
PLATE 8

A view of the experimental plots of *Dendrobium* Sonia - 16 (Expt.2)

DISCUSSION

Figure - 2

Effect of light intensities on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'



DISCUSSION

Export oriented production of cut-flowers requires precise manipulation of the culture environment. In the tropics where plant growth is sufficiently rapid and continuous throughout the year, controlling the culture environment is not as input-intensive as in the temperate regions, where production on an equivalent scale is costlier. Modification of the culture environment and assessment of its impact on the performance of representative monopodial and sympodial cultivars were the foci of this study.

Two popular cut-flower varieties grown in the State, namely *Arachnis* Magggie Oei 'Red Ribbon' and *Dendrobium* Sonia-16 were chosen as the experimental genotypes.

Arachnis Maggie Oei, commonly called the 'Scorpion' or 'Spider' orchid is a climber with indeterminate apical growth, producing side shoots when apical dominance is lost. The inflorescences are axillary and occasionally branched (Purseglove, 1975).

Dendrobium Sonia-16 is one among the progeny of a cross (Table 2) which has given rise to several prominent cultivars such as Sonia-17 and Sonia-28. This epiphyte produces few to many noded, fleshy cane-like leafy stems called pseudobulbs. Inflorescences (one to three) are produced in the axils of the terminal fully opened leaves of the pseudobulbs. The latter then gradually shed their leaves and remain as 'back bulbs'. The back bulbs and the leafy shoots occasionally produce off-shoots.

In *Arachnis* Maggie Oei, 'Red Ribbon', the effect of reducing the light intensity in the growing environment from 100 to 75 and 50 per cent, and the relative merits of two methods of cultivation viz. trench and pot culture were assessed under varying nutrient levels (Experiment 1).

In the *Dendrobium* Sonia-16, the performance under 25, 50 and 75 per cent light intensity was evaluated under varying nutrient levels. (Experiment 2).

The salient results of the experiments covering the effects of the treatments and their interactions on plant growth,flowering, floral characters and the nutrient composition of the leaves are discussed in this chapter.

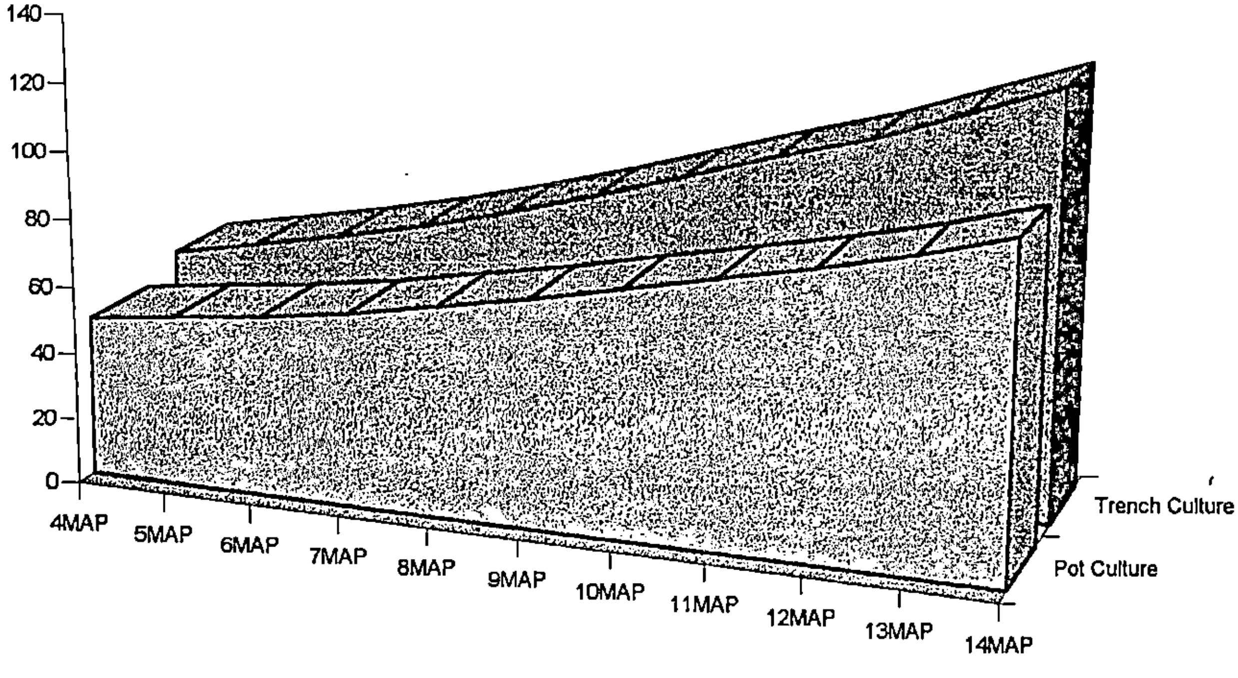
Arachnis Maggie Oei 'Red Ribbon', maintained a greater height, more number of leaves and a greater leaf area under trench cultivation from four months after planting (MAP) to 14 MAP, (Figures 3, 4 and 5 and Tables 7, 23 and 35 respectively).

The light intensities did not directly influence plant height (Figure 2), number of leaves and leaf area. However, interaction between light intensities and the culture methods influenced the number of leaves retained by the plants and their area.

The number of leaves retained on the plants was greater in the trench cultured plants under 75 per cent light at five MAP to 11 MAP and at 13 MAP (Table 23). The leaf area was also greater in the trench cultured plants under 75 per cent light at six MAP to 10 MAP (Table 31). During these months, the trench cultured plants retained a greater number of leaves and supported greater leaf area than the pot cultured plants, under the three light intensities.

Figure- 3

Effect of culture methods on the height (in cm) of *Arachnis* Maggie Oei 'Red Ribbon'



Beneficial results similar to the present findings were obtained by Rao and Mohanan (1986) by out-door bed cultivation of orchid species. Oszkinis (1992), testing different cultivation methods for growing *Cymbidium lowianum* in the green house, found that growing in beds enhanced their vegetative growth.

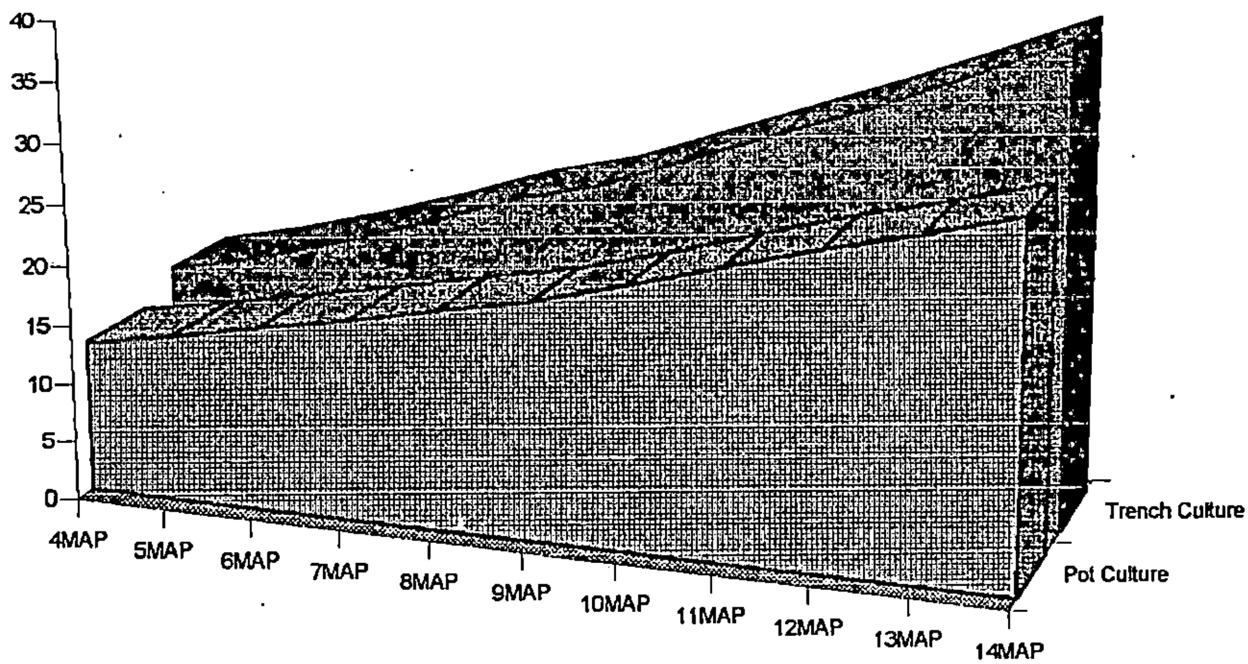
The favourable effects of trench cultivation on growth indicate an advantage which may be trophic or due to an overall micro-environmental effect or both, derived from the soil surrounding the trenches. On the other hand, the disadvantage of pot culture may also be nutritional, in the light of the findings of Kubota *et al.* (1993) in a nutritional experiment in *Phalaenopsis*, that porous clay pots absorbed a considerable portion of the nutrients applied to the plants (upto 80 per cent of the nitrates), reducing the amount available for plant growth. Evaporation of moisture through the porous walls was postulated as a cause for the constant removal of nutrients from the medium.

The beneficial effect of 75 per cent light intensity in combination with trench culture, in enhancing the number of leaves and leaf area may be resulting from the modified environment created by their combination. A similar favourable influence under a modified environment, when compared to the natural environment, was obtained in the leaf size and relative leaf area of *Phalaenopsis* by controlling the light intensity and day and night temperatures (Krizek and Lawson, 1974).

Plant height in *Arachnis* Maggie Oei 'Red Ribbon' was influenced by light intensities and the N and P doses, through their interactions. The plants grown under 100 per cent light, irrespective of the N and P doses received,

Figure 4

Effect of culture methods on the number of leaves produced by *Arachnis* Maggie Oei 'Red Ribbon'



were shorter in stature (Table 21). Though this is an advantage in cultivation, these plants had a lesser number of leaves (Table 25) and a lower leaf area (Table 34).

Apart from trench culture and 300 ppm K, the treatments which had a considerable influence on the enhancement of plant height through interactions were a combination of 50 per cent light 400 ppm N and 300 ppm P.

This response to light (enhanced axis elongation), though observed as a result of interaction, is suggestive of a characteristic response of shade-avoiding plant species described by Hart (1988). The strong apical dominance and the limited branching of this cultivar being the other characteristic responses of such species, endorses this suggestion.

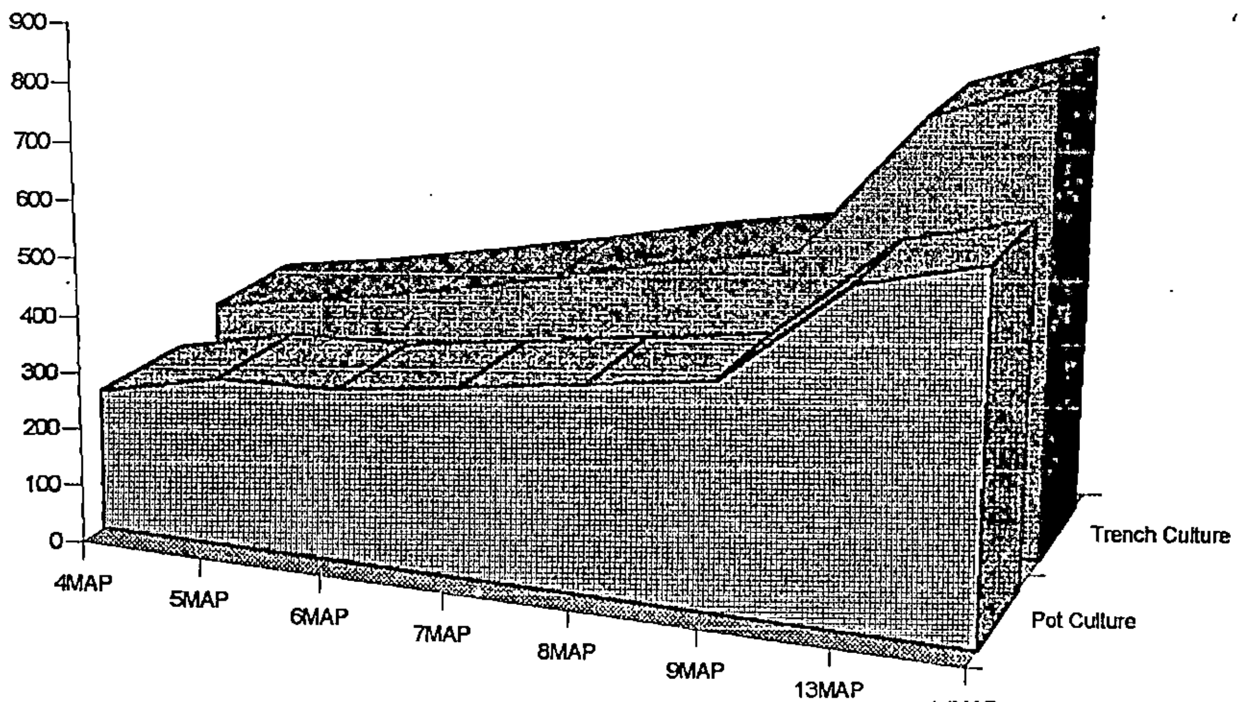
The classic auxin-regulated photo response of monocotyledons (stem elongation) is also indicated as Goh (1983 and 1984) had pointed out that the monopodial orchid shoot is the seat of production of auxins.

The number of leaves retained by the plants was not directly influenced by the N and P doses. K at 300 ppm was found to enhance the number of leaves at four MAP and 12 MAP (Table 30). NK interaction at 12 MAP and 14 MAP resulted in a greater number of leaves in the plants receiving 400 ppm N and 300 ppm K. Interaction between culture methods and the P doses during the same period, resulted in a similar effect in the trench grown plants receiving 400 ppm P (Table 27).

These results reveal that apart from trench culture and a light intensity of 75 per cent, the treatments which could considerably influence the number of leaves retained by the plants were 400 ppm N in combination with 400 ppm P and 300 ppm K.

Figure 5

Effect of culture methods on the leaf area (in sq cm) of *Arachnis* Maggie Oei 'Red Ribbon'



The leaf area of plants was not directly influenced by N and K. But P was influential. Phosphorus at 400 ppm enhanced the leaf area of the plants at six MAP to 14 MAP and 500 ppm P proved to be equally effective from 12 to 14 MAP (Table 35).

For enhancing the leaf area, the N requirement was found to vary with light intensity. Under 75 per cent light, 400 ppm N and under 50 per cent light, 500 ppm N were beneficial from six MAP to 13 MAP (Table 33). However, interaction between light intensities and the NP combinations observed from seven to 10 MAP and at 12 MAP (Table 34) showed that under 75 per cent light, 300 ppm N with 400 ppm P and under 50 per cent light, 500 ppm of both N and P were beneficial. This suggests that while plants were satisfied with lower doses of N and P under 75 per cent light, for a comparable enhancement of leaf area under 50 per cent light, higher doses were needed.

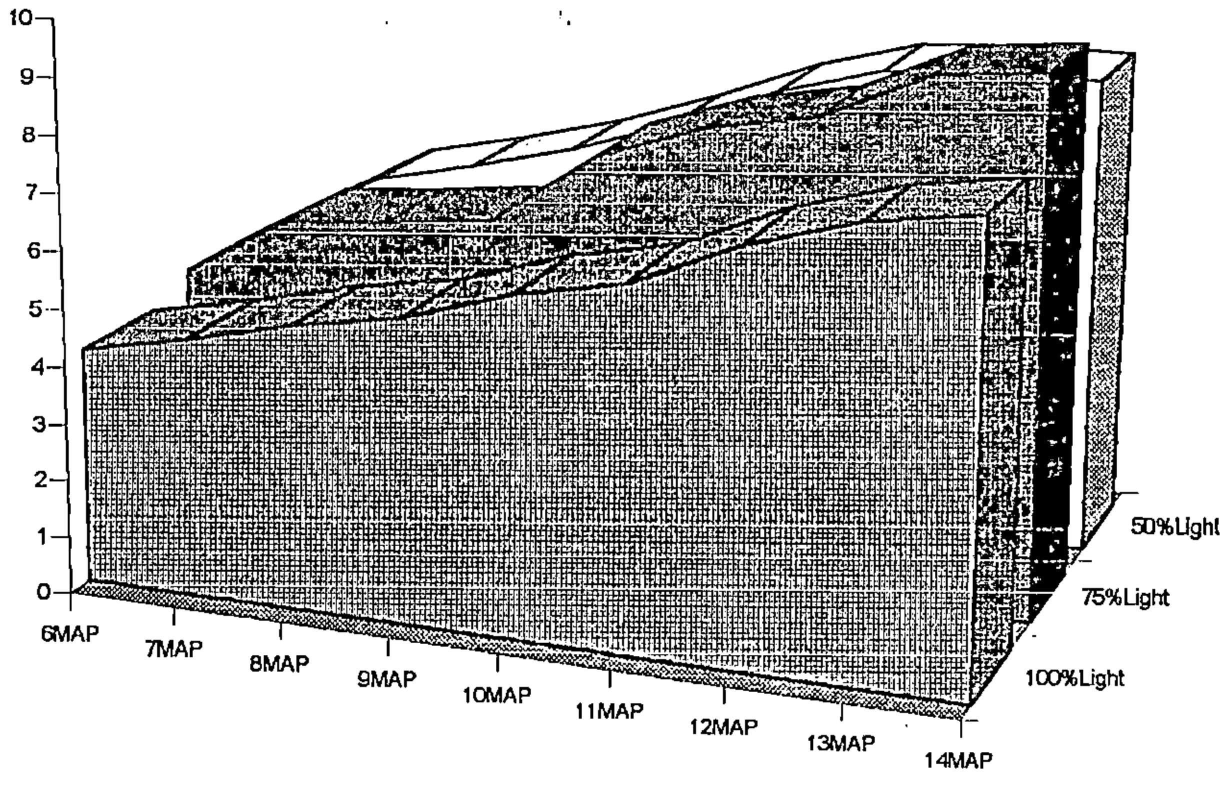
Interaction of N and K resulted in a greater leaf area in the plants receiving 400 or 500 ppm N and K at 12 MAP and 13 MAP (Table 36). These results show that apart from trench culture of plants, a combination of 75 per cent light, 300 or 400 ppm N and 400 ppm K and a combination of 50 per cent light, 500 ppm N 400 or 500 ppm P and 400 or 500 ppm K could result in leaf area enhancement in *Arachnis* Maggie Oei 'Red Ribbon'

Enhancement of growth was thus dependent on the interaction between nutrients, light intensities and culture methods. The nutrient doses found effective for maintaining a greater leaf area and leaf number varied with the stage of growth of the plants.

The number of aerial roots found on the plants, an imporatnt criterion of productivity, was influenced by light intensities (Figure 6) culture methods

Figure 6

Effect of light intensities on the number of aerial roots produced by *Arachnis* Maggie Oei 'Red Ribbon'



and their interaction. A greater number of aerial roots was found in the trench grown plants throughout the period under observation from four to 14 MAP (Table 38). The number was also greater in the plants grown under 50 and 75 per cent light during seven to 12 MAP (Table 38).

Interaction effects of culture methods and light intensities (Table 38) showed that root production was greater in the trench grown plants under 100, 75 and 50 per cent light at six MAP. From 12 MAP onwards, this favourable interaction was restricted to the trench grown plants under 100 and 75 per cent light. During this period, under 50 per cent light, the pot and trench grown plants had a lesser number of roots.

The influence of N and P on aerial root production was chiefly observed through their short-term interactions with culture methods and light intensities. LP interaction at six MAP resulted in a greater number of aerial roots in the plants receiving 300 or 500 ppm P under 75 per cent light (Table 42). Interaction between the culture methods and the N doses resulted in a greater number of aerial roots at 10 MAP in the trench grown plants receiving 400 or 500 ppm N (Table 44).

The production of aerial roots in monopodial orchids was reported to be regulated by the auxin gradient along the stem axis (Goh, 1983). Aerial root production is generally restricted to the third or fourth visible node from the apex and new roots are produced upwards on alternate nodes or on every third node (Goh, 1984). The present findings indicate that the greater the height of the plants, the greater would be the number of leaves produced by them. The resultant greater number of nodes under trench culture and lowered light intensities, together with auxin mc lateral root out growth, resulted in greater aerial root production.

Aerial root growth, observed from seven to 11 MAP as increase in the length of the roots, was influenced by light intensities, culture methods and their interaction. Root growth was enhanced at seven, nine and 11 MAP in the plants grown under 50 and 75 per cent light (Table 45).

The effect of the culture methods was observed at seven, eight and 10 MAP, when the pot grown plants recorded greater increases than the trench grown plants (Table 45).

Aerial root growth was also influenced by interaction between light intensities and culture methods throughout the period under observation (Table 45). Under full sunlight, root growth was faster in the pot grown plants than in the trench grown plants. But at eight and 11 MAP (July and October 1992) under 50 and 75 per cent light, the pot and trench grown plants were on par.

The influence of pot culture on enhancing root growth may be due to the nutritional disadvantage of the pots tending to flush out nutrients and thus imparting a greater need to expand the area of absorption of the roots. Chinn (1966) reported on such a need-based growth enhancement in orchid roots grown in nutrient deficient media. Interaction effects of a similar nature found in the control plants at eight and 11 MAP too support this (Table 45).

The dry matter content of the stem and apical shoot was enhanced by 500 ppm P (Table 51). The vegetative apical shoot and the stem internodes of monopodial orchids have been reported to have considerable sink activity (Clifford *et al.*, 1992). The high[illegible]se of P applied may have helped to promote this through its major fu[illegible]n energy transfer.

In Maggie Oei 'Red Ribbon', flowering and the flower characters were influenced by the light intensities (Figure 7), culture methods and their interaction. Full sunlight was more conducive to flowering (Table 52) than the lower levels of light. Trench cultivation resulted in a greater number of inflorescences. The interaction effects of light intensities and culture methods too endorsed the superiority of trench cultivation under 100 or 75 per cent light (Table 53).

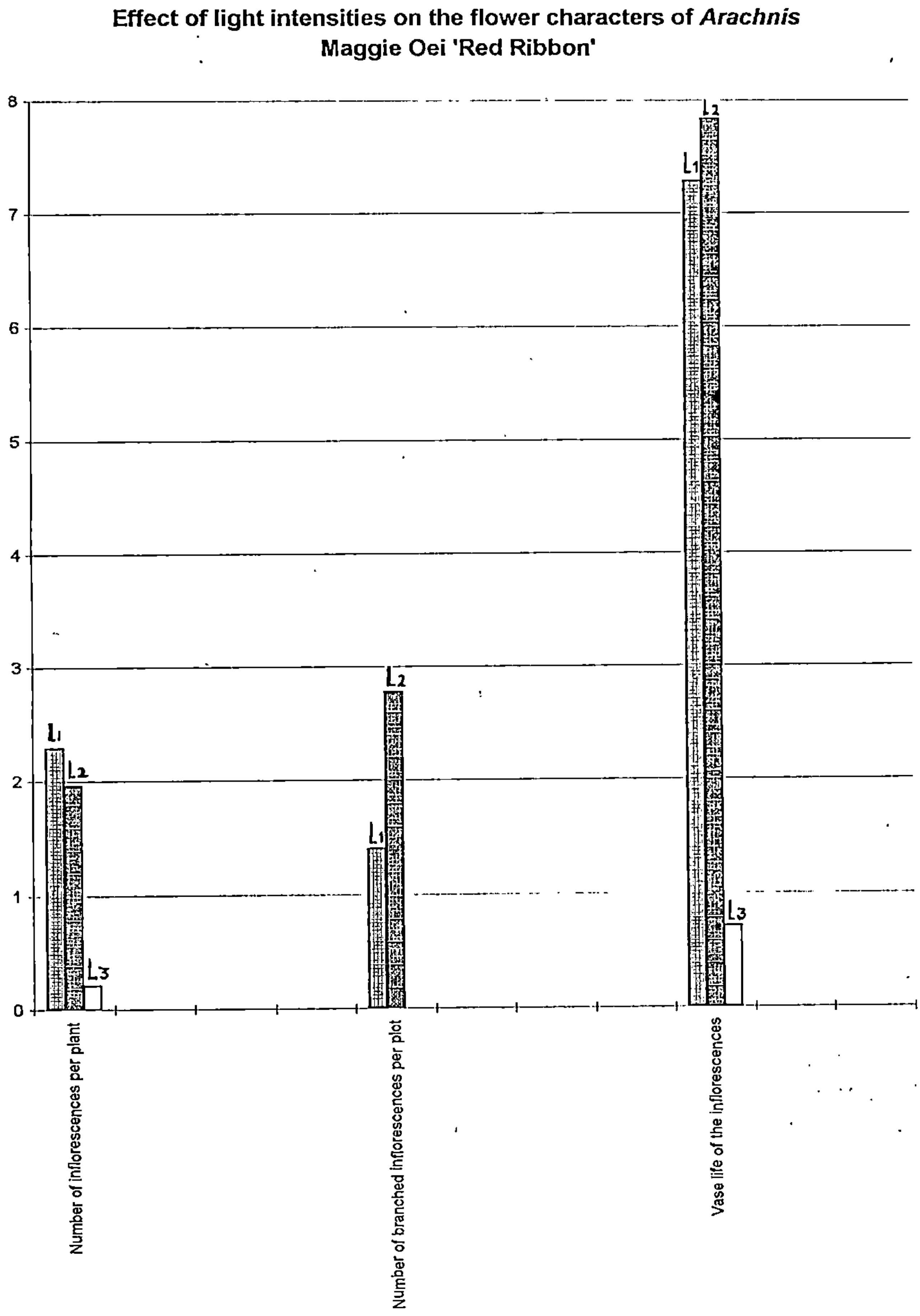
A similar trend in inflorescence production was seen in the control plants (Table 52). The number of inflorescences produced was the lowest in the pot and trench grown controls under 50 per cent light. The pot and trench grown controls under 100 per cent light and the trench grown controls under 75 per cent light were comparable to the treated plants in inflorescence production, indicating a greater involvement of light intensity and culture method and a lesser role of applied nutrients, on this character.

The effects of nutrient doses observed in this study confirm this, being evidenced through interactions with culture methods and light intensities (CP, LPK; Tables 55 and 54, respectively).

The flowering responses observed in this study endorse the beneficial effect of higher light intensities on the flowering of tropical species reported by Murashige *et al.* (1967) and Goh and Arditti (1981).

The length of the inflorescences was influenced by the method of cultivation. Trench culture favoured the production of inflorescencesof a greater length (Table 52). The trench grown control plants under 75 per cent light had inflorescences of a greater length than those grown under 50 per cent light.

Figure 7


Effect of light intensities on the flower characters of *Arachnis* Maggie Oei 'Red Ribbon'
8
7
6
5
4
3
2
1
0
L1
L2
L3
L1
L2
L1
L2
L3
Number of inflorescences per plant
Number of branched inflorescences per plot
Vase life of the inflorescences

The production of branched inflorescences was influenced by light intensities and culture methods (Table 52). A light intensity of 75 per cent was conducive to the production of a greater number of branched inflorescences and under 50 per cent light, branching was absent. Trench culture was found to result in a greater number of branched inflorescences than pot culture. The effect of nutrients on this character revealed that 400 ppm N (Table 52) and also the combination of 400 ppm P and 300 ppm K under 75 per cent light, promoted branching (Table 54).

Several workers (Banfield, 1981; Boon, 1982; Stewart, 1988) have recommended the use of higher doses of P and K for the promotion of flowering in orchids. However, in the present study the effects of these nutrients were influenced by their interactions with light.

The vase life of inflorescences was influenced by the light intensities and culture methods under which the plants were grown. Trench culture and both 100 and 75 per cent light were conducive to a greater vase life (Table 52). Nitrogen at 400 or 500 ppm and trench culture under 75 per cent light with 400 ppm N enhanced the vase life of the inflorescences.

In other cut-flowers like carnations and chysanthemums, aging was reported to be influenced by the pre-harvest light conditions (Lancaster, 1974; Kofranek *et al.*, 1972) and the N nutrition of the plants (Waters, 1967) through their effect on carbohydrate accumulation. The effect of 75 per cent light and 400 ppm N on the vase life of the flowers, observed in the present studies, may be due to a similar influence.

The effects of the treatments on the nutrient composition of the plants revealed that the N content of the leaves was enhanced under 50 per cent light and the trench culture of plants (Table 57) and by the applied nutrients.

A greater N content of the leaves resulted from the treatment 500 ppm N, 500 ppm P (Table 64) and 500 ppm K (Table 65).

The interaction effects of nutrients and culture methods (Table 62) confirmed the influence of trench culture.

The P content of the leaves was enhanced by trench culture (Table 57), 400 or 500 ppm N, 400 or 500 ppm P (Table 64) and 300 or 500 ppm K (Table 65).

Interaction between light intensities and N doses revealed that the plants receiving 400 ppm N under 50 per cent light maintained a higher P content in their leaves. Phosphorus status on par with this was found in the plants receiving 500 ppm N under 75 per cent light. These observations indicate that under 50 per cent light, a higher content of P could be maintained in the leaves at lower levels of application.

In the trench cultured plants, irrespective of the N or P nutrition received, a greater P content was found. With respect to K nutrition, 300 and 500 ppm K could maintain a greater P content in the plants (Table 62). The control plants grown under 50 per cent light in pots and under 100 per cent light in trenches had lower P contents (Table 57).

The K content of the leaves was enhanced by trench culture (Table 57). Among the nutrient doses, 400 and 500 ppm N, 400 and 500 ppm P (Table 64) and 500 and 300 ppm K enhanced the K status (Table 65). Interactions between the nutrients also revealed the favourable effects of these doses (NP, NK and PK; Table 64 and 65, respectively). Interactions of nutrients and light intensities too showed that these N, P and K doses under 100 per cent light could enhance the K content of the leaves (Table 60). Interactions with culture methods showed that the trench cultured plants receiving 500 ppm K maintained a higher K content in their leaves.

Several workers (Gomi *et al.*, 1980; Khaw and Chew, 1980 and Tanaka *et al.*, 1988b) have reported that increased application of nutrients in orchids result in greater uptake and higher contents of the respective nutrients in plant parts. In the present study, the higher doses of N, P and K enhanced their respective contents in the leaves of *Arachnis* Maggie Oei 'Red Ribbon'. The content of N, P and K in the leaves was not very different from that recommended for monopodial orchids (Khaw and Chew, 1980; Wang and Gregg, 1994). But the dosages found effective in this experiment were lower than that observed by them.

The Mg, Zn and Cu contents of the leaves were found to be generally lower than the standard levels suggested (Poole and Sheehan, 1982). In the present investigation, as these nutrient doses were not supplied directly, their major sources were evidently the cowdung applied at the beginning of the experiment and the decomposable component of the medium namely, coconut husk.

The Mg content of the leaves was directly influenced by P. At 500 ppm P, the content was greater and a progressive reduction in the content was observed with decreasing P doses. Interaction effects showed that the plants receiving 400 ppm N under 50 per cent light, 400 ppm P under 75 per cent light and 300 ppm K under 50 per cent light (Table 60) had a greater Mg content.

The Zn content of the leaves was found to be greater under 75 per cent light and trench culture (Table 57). The pot and trench grown plants under 100 and 75 per cent light respectively, had a greater Zn content in their leaves while the content was lowest in the trench grown plants under 100 per cent light.

Among the nutrient doses, 500 ppm N and 400 ppm P (Table 64) and 400 ppm K (Table 65) enhanced the Zn content of the leaves. Interaction effects of light intensities and the nutrients resulted in a greater Zn content in the plants receiving 400 ppm P under 75 per cent light and 300 or 400 ppm K under 75 per cent light (Table 60). The plants receiving 300 ppm N with 400 ppm P (Table 64), 500 ppm N with 400 ppm K and 400 ppm P with 400 ppm K (Table 65) also had greater Zn contents.

The Cu content of the leaves was greater under trench culture (Table 57) and when 75 per cent light was combined with trench culture.

The effects of nutrients revealed that 300 ppm N, 500 ppm P and 300 or 500 ppm K (Tables 64 and 65 respectively) enhanced the Cu content of the leaves. Interaction effects too showed that combinations of these doses (NP, NK and PK) maintained a greater Cu content (Tables 64 and 65, respectively) by themselves and also in combination with 75 per cent light (Table 60).

The results of Experiment 2 revealed that in *Dendrobium* Sonia-16, the light intensity treatments had a direct influence on the leaf area at three and four MAP (Table 98). The plants grown under 25 per cent light had a greater leaf area than those under 75 per cent light during these months.

Nitrogen and K influenced the number of shoots produced by the plants (Table 107). The plants receiving 500 ppm N had a greater number of shoots at four MAP and those receiving 500 ppm K had a greater number at seven MAP.

The P nutrition given to the plants was found to influence their growth. Shoot length was greater in the plants receiving 400 or 500 ppm P (Table 91). These plants also had a greater number of leaves per clump at 10 and 11 MAP (Table 92). The plants receiving 500 ppm P had a greater number of shoots at eight MAP (Table 107) and also a greater leaf area at 10 to 12 MAP (Table 96).

Interactions between nutrients and light intensities also influenced growth. With respect to LN interaction, a lesser number of leaves and leaf area were found in the plants receiving 300 ppm N and 25 per cent light and 500 ppm N and 75 per cent light at respectively 11 and 12 MAP (Tables 94 and 96, respectively).

The number of shoots produced was the lowest in the plants receiving 300 ppm N under 25 per cent light, 400 ppm N under 50 per cent light and 500 ppm N under 75 per cent light at 10 MAP. At 11 MAP, the number was lower in the plants receiving 300 ppm P under 25 per cent light and 400 ppm N under 50 per cent light. But at 12 MAP this effect persisted only in the former group (Table 109).

The plants receiving 400 or 500 ppm N under 25 per cent light and those receiving 300 ppm N under 50 and 75 per cent light had a greater leaf area at 11 MAP and 12 MAP and those receiving 300 ppm N under 50 per cent light and 400 ppm N under 75 per cent light had a similar effect at 10 MAP (Table 96).

LP interaction resulted in a greater number of leaves and a greater leaf area in the plants receiving 500 ppm P under 25 per cent light at three, four and five MAP and at three and four MAP respectively (Tables 94 and 98). These plants along with those receiving 400 ppm P under 75 per cent light and 300, 400 or 500 ppm P under 50 per cent light had a greater leaf area at six to 12 MAP (Table 98).

The number of shoots produced was also influenced by LP interaction. At 10 MAP, the plants receiving 500 ppm P under 25 per cent light followed by those receiving 300 and 400 ppm P under 50 per cent light had a greater leaf area. As a result of LK interaction, the plants receiving 500 ppm K under 75 per cent light had a greater number of shoots and those receiving the same dose under 25 per cent light had a lesser number of shoots at six, seven and eight MAP (Table 110). The number of shoots was also lesser in the plants receiving 400 ppm K under 50 per cent light at six and seven MAP and in those receiving 300 ppm K under 50 per cent and 75 per cent light at eight MAP.

Interaction between the N and P doses was also observed. The plants receiving 300 or 400 ppm N with 500 ppm P and 500 ppm N with 400 ppm P had a greater number of leaves at nine MAP (Table 92). So also, the plants receiving 300 ppm N with 500 ppm P had a greater number of shoots at eight MAP (Table 108).

Under PK interaction, the plants receiving 500 ppm P with 300 or 500 ppm K, 300 ppm P with 400 ppm K and 400 ppm P with 500 ppm K recorded a greater number of leaves at three MAP.

The main effects of the nutrients and the nutrient-light interaction effects were not found to influence plant growth consistently for more than one to three months in *Dendrobium* Sonia-16.

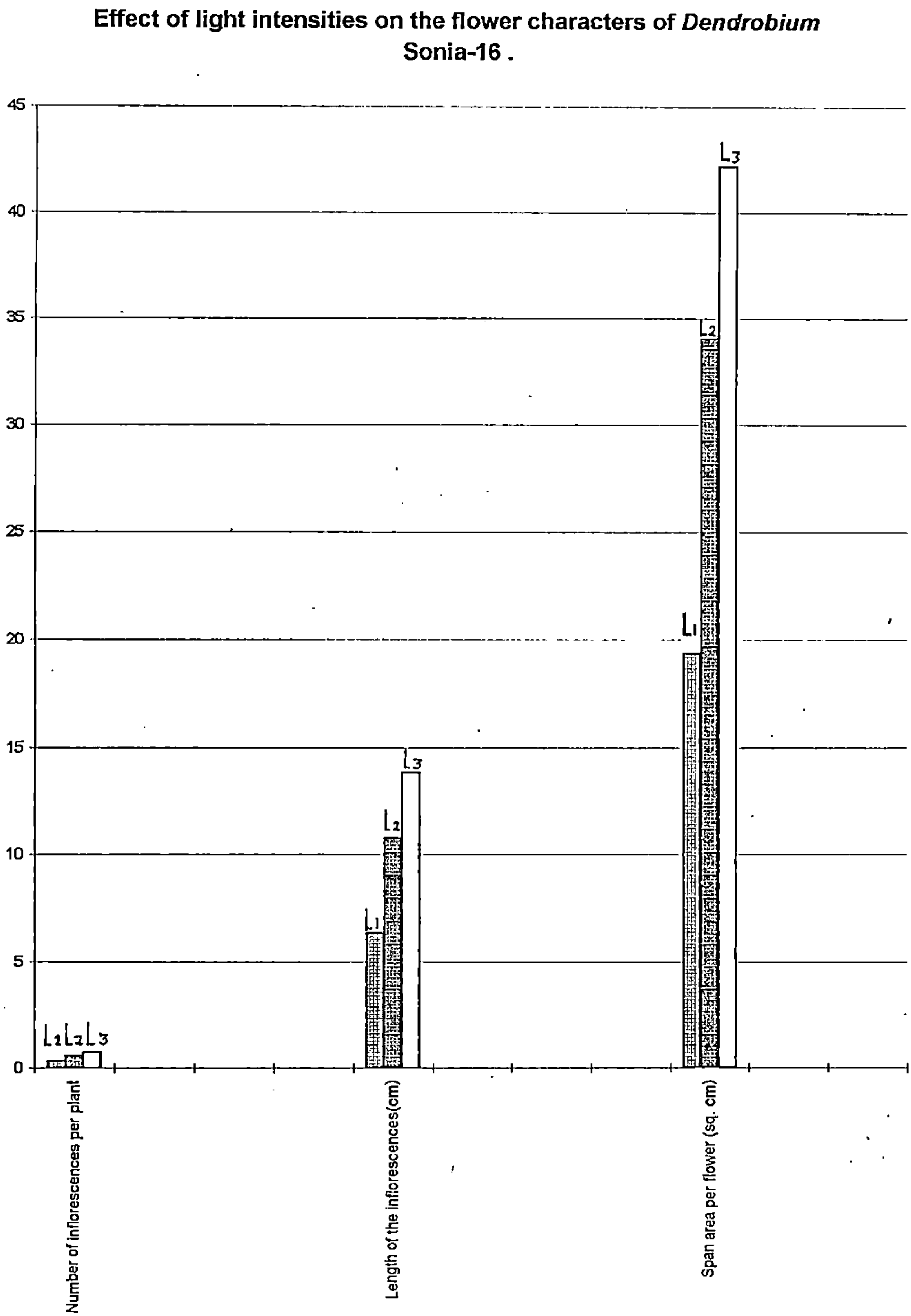
Flowering and floral characters of *Dendrobium* Sonia-16, were influenced by the light intensities (Figure 8). The number of inflorescences produced and the span area of the flowers were found to increase with increase in the light intensity under which the plants were grown (Table 111), 75 per cent light being most favourable. The mean length of the inflorescences was also greater under this light intensity. An increase in the flowering response with increase in the exposure to higher light intensities, has been reported in shade grown *Oncidium* Goldiana by Ding *et al.* (1980).

The effect of N, P and K nutrition revealed that 500 ppm N, increased the number of inflorescences produced by the plants, the number of blooms per inflorescence, the length of the inflorescences and the span area of the flowers.

Among the P doses, 400 or 500 ppm P enhanced the number of flowers produced in an inflorescence. Other floral characters namely the number and length of the inflorescences and the span area of the flowers were influenced by 500 ppm P (Table 111).

Among the K doses, 400 and 500 ppm K enhanced the number of inflorescences. Potassium at 500 ppm increased the number of flowers per inflorescence and their span area (Table 111).

Figure 8


Effect of light intensities on the flower characters of *Dendrobium* Sonia-16 .
45
40
35
30
25
20
15
10
5
0
L1 L2 L3
Number of inflorescences per plant
Length of the inflorescences(cm)
Span area per flower (sq. cm)

The span area of the flowers and the number of inflorescences produced per plant were greater in the plants receiving 500 ppm N under 50 per cent light and in those receiving 400 or 500 ppm N under 75 per cent light (Table 112). The plants receiving 300 ppm N under 25, 50 and 75 per cent light and also those receiving 400 ppm N under 25 per cent light had a lower span area. These indicated the requirement of higher doses of N under higher light intensities for maintaining a greater flower size.

The number of inflorescences produced was greater in the plants receiving 400 or 500 ppm N under 75 per cent light and 500 ppm N under 50 per cent light (Table 112). The length of the inflorescences was greater in the plants receiving 500 ppm N under 75 per cent light (Table 112).

The interaction effects of light and the NP combinations on the number of inflorescences, the length of the inflorescences and the span area of the flowers revealed that under 25 per cent light, 500 ppm of both N and P; under 50 per cent light, 400 or 500 ppm of both N and P and under 75 per cent light, 400 or 500 ppm N with 300, 400 or 500 ppm P could enhance these characters (Table 113).

Interaction effects of light and the NP combinations on the number of flowers produced per inflorescence (Table 113) revealed that under 25 per cent light 500 ppm of N and P; under 50 per cent light, 400 ppm N with 500 ppm P and also 500 ppm N with 400 or 500 ppm P were effective in increasing the number of flowers. Thus, with N at 500 ppm the requirement of P for enhancing floral characters was lowered with increase in the light intensity.

Differences in the nutrient doses recommended for *Dendrobiums* (Vacharotayan and Kreetapirom 1975; Sakai *et al.*, 1982 and Koval'skaya and

Zaimenko, 1991) in different media and culture conditions, also point to a need to streamline specific dosages for the most ideal light environment.

The nutrient composition of the leaves was influenced by the applied doses and their interactions with light intensities.

The N content was increased by 500 ppm N, 400 ppm P and 400 ppm K (Table 114). Interaction effects revealed that greater contents were found in the plants receiving 500 ppm of N with 400 or 500 ppm P, 300 ppm N with 400 or 500 ppm K, 400 or 500 ppm P and K and in those receiving 400 or 500 ppm K under 25, 50 and 75 per cent light (Table 117).

The P content of the leaves was increased by 500 ppm P (Table 114). Interaction as well as the direct effect of the other nutrients did not influence the P content of the leaves.

The K content was greater in the plants receiving 400 ppm P and 500 ppm K (Table 114). Interaction effects showed that the K contents were greater in the plants receiving 300 ppm N with 500 ppm P (Table 115). Under 25 and 50 per cent light, 500 ppm K resulted in greater K content, as a result of LK interaction (Table 117).

The Mg content of the leaves was influenced by the P and K nutrition of the plants. A greater content was obtained in the plants receiving 300 or 500 ppm P and in those receiving 300 ppm K. The Mg content in the leaves was lower under the higher levels (400 and 500 ppm) of K application. Such a depressive effect was reported by Poole and Seeley (1978) in *Phalaenopsis* and *Cymbidium* by increasing the supply of K or Mg on the accumulation of one another.

Interaction effects showed that 400 or 500 ppm N under 25 per cent light (Table 117), 300 ppm P under 50 per cent light and 300 ppm K under 50 per cent light resulted in greater Mg content, and 500 ppm K under 50 per cent light reduced the content (Table 117).

The Zn content of the leaves was increased by 300 or 400 ppm N, 300 ppm P and 400 ppm K (Table 114).

Interaction effects showed that the plants receiving 300 or 400 ppm N with 300 ppm P (Table 115), 400 ppm of N and K and 300 ppm P with 400 ppm K (Table 115) had greater Zn contents. Interaction between light intensities and nutrients showed greater Zn content in the plants receiving 300 ppm N under 50 per cent light, 300 ppm P under 50 per cent light and 300 or 400 ppm K under 50 per cent light (Table 117). The content was low in-the plants receiving 300 ppm N, 400 ppm P and 300 or 500 ppm K under 25 per cent light.

Among the control plants, those grown under 25 per cent light (Table 117) had a greater Zn content than those grown under 75 per cent light. These indicate the influence of the lower light intensity in maintaining a higher Zn content under restricted nutrition.

Among the treated plants, 50 per cent light was better than 75 per cent light in maintaining greater Zn contents in the leaves (Table 117).

The Cu content of the leaves was influenced by the P and K doses. Phosphorus at 400 ppm and 300 ppm K maintained comparatively greater Cu contents in the leaves (Table 114). Interaction effects enhanced the Cu levels in the plants receiving 400 ppm P with 300 or 400 ppm N (Table 115), 300 ppm K with 300 or 400 ppm N and 300 ppm K under 50 per cent light (Table 117). The content was lower in the plants receiving 500 ppm K under 50 per cent light.

As in *Arachnis* Maggie Oei 'Red Ribbon', in *Dendrobium* Sonia-16, the application of higher doses of N, P and K was found to enhance the concentration of the respective nutrients in the plants. In *Cymbidium* and *Phalaenopsis*, increasing the substrate levels of major nutrients has been observed to increase their uptake and concentration in the plants (Poole and Seeley, 1978).

The present findings reveal that for the *Dendrobium* cultivar a light intensity of 50 per cent and higher levels of nutrition and for the *Arachnis* cultivar, this combined with trench cultivation could enhance vegetative growth and at the same time maintain greater content of nutrients in the leaves, which was indicative of a low C/N ratio. However, this was not adequately utilized for reproductive growth, apparently due to lack of sufficient exposure to light. The production of inflorescences in the *Arachnis* cultivar under 50 per cent light, in the axils of the upper leaves, when the shoot had nearly touched the overhead shade net (Plate 6) endorses this.

In *Arachnis* Maggie Oei 'Red Ribbon', the flowering response and the vase life of the inflorescences under 75 and 100 per cent light were on par and greater than that under 50 per cent light. Trench culture could enhance the vegetative and floral attributes. The nutrient doses found effective for enhancing growth were acted upon by light intensities and culture methods and these interaction effects varied with the stage of growth of the plants.

This indication of differences in growth response to nutrients under varying light intensities and culture methods as a result of interaction, points to the need for standardisation of nutrient doses under trench culture at 75 to 100 per cent light intensity at the pre-flowering and post-flowering stages, for optimisation of growth and flower production.

In *Dendrobium* Sonia-16, the flowering response under the three light intensities was linear (Table 111). The most responsive combinations of light and nutrient doses for flowering were 75 per cent light and 400 to 500 ppm of N, P and K.

Based on the present findings, for *Arachnis* Maggie Oei 'Red Ribbon' 75 to 100 per cent light intensity, trench cultivation and a dosage of 300 ppm N, 400 ppm, P and 300 ppm K upto nine MAP and thereafter 400 to 500 ppm N, 400 ppm P ad 500 ppm K can be recommended and for *Dendrobium* Sonia-16,75 per cent light intensity and 400 to 500 ppm of N, P and K can be recommended.

SUMMARY

SUMMARY

For evolving agrotechniques for cut-flower orchid production in Kerala, two experiments were laid out in 1991 and 1992 at the College of Agriculture, Vellayani. Two popular cut-flower varieties, namely *Arachnis* Maggie Oei 'Red Ribbon' and *Dendrobium* Sonia-16 were selected for study. In the *Arachnis* cultivar, the effect of varying light intensities viz. 100, 75 and 50 per cent light, two methods of cultivation viz. trench and pot culture and differing nutrient doses were assessed (Experiment 1). In the *Dendrobium* cultivar, the performance under varying light intensities viz. 25,50 and 75 per cent light and nutrition levels was evaluated (Experiment 2).

In *Arachnis* Maggie Oei 'Red Ribbon' the method of culture influenced growth. The trench grown plants had a greater height, number of leaves, leaf area and a greater number of aerial roots than the pot grown plants throughout the period under experimentation. The light intensities directly influenced the growth of aerial roots. At seven, eight and ten months after planting (MAP) the plants grown under 100 and 75 per cent light recorded a greater increase in the length of the aerial roots than those grown under 100 per cent light.

Interaction between light intensities and culture methods resulted in a greater number of aerial roots in the trench grown plants under 100 and 75 per cent light than in the pot grown plants. Aerial root growth was on par in the pot and trench grown plants under 75 per cent light while the trench grown plants under 100 per cent light recorded the lowest increase at eight and 11 MAP.

The direct effects and interactions of nutrients on growth were observed at certain months during the experimental period. The plants receiving 400 ppm K had a lower height than those receiving 300 ppm K at nine MAP to 14 MAP. The plants receiving 300 ppm K had a greater number of leaves than those receiving 500ppm, at four and 12 MAP. The leaf area was greater in the plants receiving 400 ppm P than in those receiving 300 ppm from six to 14 MAP. The dry matter content of the stem and apical shoot were greater in the plants receiving 500 ppm P than in those receiving 400 or 300 ppm. At 12 and 14 MAP, as a result of interaction, 400 ppm N with 300 ppm K resulted in a greater number of leaves. Enhancement of leaf area was found at 12 and 13 MAP in the plants receiving 400 ppm of N and K or 500 ppm of N and K.

Interaction between the nutrients and the culture methods was also observed. The number of leaves was greater in the trench grown plants receiving 400 ppm P than in those receiving 500 ppm P at 12 and 14 MAP. At 10 MAP these plants recorded a greater leaf area. At 11 MAP, the pot grown plants receiving 500 ppm P recorded a greater increase in the length of aerial roots than those receiving 300 ppm P and the trench grown plants receiving 300, 400 or 500 ppm P. Irrespective of the P and K dose received, the pot grown plants had a lesser height than the trench grown plants at six MAP to 10 MAP.

The number of leaves was greater in the trench grown plants receiving 400 ppm P and 300 ppm K at four MAP and at six to nine MAP and the leaf area was greater at five to seven and at nine MAP.

Interaction between light intensities and nutrients resulted in a greater leaf area in the plants receiving 500 ppm N under 50 per cent light at five to seven and at 10 to 14 MAP. The number of aerial roots was greater in the plants receiving 300 or 500 ppm P under 75 per cent light at six MAP. Increase in the length of aerial roots was greatest in the plants grown under 75 per cent light receiving 500 or 400 ppm P and in those grown under 50 per cent light receiving 400 ppm P.

The plants grown under 100 per cent light receiving N_3P_3 were shorter at five to 11 and at 13 MAP while the plants receiving N_3P_2 under 50 per cent light (six, 11 and 13 MAP) and N_2P_1 under 75 per cent light (six to 10 MAP) had a greater height.

The number of leaves was greater in the plants grown under 50 and 75 per cent light, receiving 400 ppm of N and P. The leaf area was greater under 75 per cent light in the plants receiving the various NP combinations at eight MAP. Under L_1, N_1 P_1 resulted in a lower leaf area. At nine and 10 MAP, the plants receiving 500 ppm of N and P under 50 per cent light and 300 ppm N and 400 ppm P under 75 per cent light recorded a greater leaf area. At 11 MAP a greater leaf area was recorded by the plants receiving 400 ppm of N and P under 75 per cent light and 500 ppm of N and P under 50 and 75 per cent light.

Flowering and the floral characters were influenced by the method of culture. The number of inflorescences produced by the plants, the number of branched inflorescences per plot, the length of the inflorescences and their vase life were enhanced under trench culture when compared to pot culture. Inflorescence production was greater under 100 and 75 per cent light than under 50 per cent light. Branching of inflorescences was greater under 75 per cent light than under 100 per cent light. Under 50 per cent light, branching was absent.

The vase life of inflorescences was greater under 100 and 75 per cent light than under 50 per cent light. Interaction between light intensities and culture methods resulted in a greater number of inflorescences in the trench grown plants under 100 and 75 per cent light. Though flowering was poor in the pot grown plants the number inflorescences produced by them was greater under 75 per cent light than under 100 per cent light. The length of the inflorescences was not directly influenced by the light intensities. However the trench grown control plants under 75 per cent light had longer inflorescences than the pot and trench grown control plants under 50 per cent light.

The vase life of the inflorescences was greater in the trench and pot grown plants under 100 and 75 per cent light and in the trench grown plants receiving 300 ppm N under 75 per cent light and in those receiving 500 ppm N under 100 per cent light. Nitrogen was found to promote branching of the inflorescences at 400 ppm and the vase life of the inflorescences at 400 and 500 ppm.

The culture methods interacted with the P doses resulting in a greater number of inflorescences in the trench grown plants receiving 400 ppm P.

The nutrient composition of the leaves was influenced by the N,P and K doses and their interactions. Nitrogen at 500 ppm increased the N content and the Zn content of the leaves while 400 and 500 ppm N enhanced the P content and 400 ppm N enhanced the K content of the leaves.

The N, Mg and Cu contents of the leaves were increased by 500 ppm P while 400 and 500 ppm P enhanced the P content and 400 ppm P enhanced the K and Zn content of the leaves.

Interaction between the N and P doses resulted in a greater N and K content in the plants receiving 400 ppm each of N and P. A greater P and Mg content was observed in the plants receiving 500 ppm each of N and P, a greater Zn content was found in the plants receiving 300 ppm N with 400 ppm P and a greater Cu content in those receiving 300 ppm N with 500 ppm P.

Interaction between the N and K doses resulted in a greater P and Mg content in the plants receiving 400 ppm N with 300 ppm K, a greater K and Cu content in the plants receiving 300 ppm N with 500 ppm K and greater Zn content in those receiving 500 ppm N with 400 ppm K.

Interaction between the P and K doses resulted in a greater P and K content in the plants receiving 400 ppm P and 500 ppm K, a greater Mg and Cu content in the plants receiving 500 ppm each of P and K and a greater Zn content in the plants receiving 400 ppm each of P and K.

Interaction between the light intensities and the applied nutrients influenced the nutrient composition of the leaves. The N content was greater in the plants grown under 100 and 50 per cent light receiving 500 ppm N. The P content was greater in the plants grown under 75 per cent light receiving 500 ppm N and in those grown under 50 per cent light receiving 400 ppm N. The K content was greater in the plants grown under 100 per cent light receiving 400 ppm N. The Mg content was greater in the plants grown under 50 per cent light receiving 400 ppm N and the Cu content was greater in the plants grown under 75 per cent light receiving 300 ppm N.

Interaction between light intensities and the P doses resulted in a greater N content in the plants receiving 500 ppm P under 100, 75 and 50 per cent light, a greater P content in the plants receiving 400 ppm P under 50 per cent light, a greater K content in the plants receiving 500 ppm P under 100 per cent light and a greater Mg, Zn and Cu content in the plants receiving 400 ppm P under 75 per cent light.

Interaction between the light intensities and the K doses resulted in a greater N content in the plants receiving 500 ppm K under L_1, L_2 and L_3 and in those receiving 400 ppm K under L_3. The K content was greater in the plants receiving 500 ppm K under 50 per cent light. The Mg content was greater in those receiving 300 ppm K under 50 per cent light and in those receiving 500 ppm K under 75 per cent light. The Zn content was greater in the plants receiving 300 or 400 ppm K under L_2.

Interaction between the culture methods and the applied nutrients influenced the nutrient status of the leaves. The N and Zn content was greater in the trench grown plants receiving 500 ppm N. The P content was greater in the trench grown plants receiving 400 or 500 ppm N and the K content was greater in the trench grown plants receiving 400 ppm N.

The N content was greater in the pot and trench grown plants receiving 500 ppm P and the P and K contents were greater in the trench grown plants receiving 400 ppm P.

As a result of interaction between the culture methods and the K doses, the P and K contents were greater in the trench grown plants receiving 500 ppm K and the Mg and Zn contents were greater in the trench grown plants receiving 400 ppm K.

Interaction between culture methods and the NP combinations resulted in a greater N content in the trench grown plants receiving 500 ppm of N and

P, a greater P content in the trench grown plants receiving N_2P_1, N_2P_2 and N_3P_2 and in the pot grown plants receiving N_3P_2. A greater K content was found in the trench grown plants receiving 400 ppm of N and P and in the pot grown plants receiving 400 ppm N and 300 ppm P.

Interaction between culture methods and the NK combinations resulted in a greater P content in the plants receiving N_2K_1 under trench culture and N_2K_3 under pot culture. The K content was greater in the plants receiving 400 ppm N and K or 300 ppm N and 500 ppm K under trench culture and in the pot grown plants receiving 300 ppm N with 500 ppm K or 500 ppm N with 300 ppm K.

Interaction between culture methods and the PK combinations resulted in a greater P content in the trench grown plants receiving 300 ppm of P and K and in the pot grown plants receiving 400 ppm P and 500 ppm K. The K content was greater in the trench grown plants receiving 500 ppm K with 400 or 500 ppm P.

In *Dendrobium* Sonia -16 plant growth was directly influenced by P among the nutrients. The number of leaves produced and leaf the area per clump was greater in the plants receiving 400 or 500 ppm P at 10 and 11 MAP. At 12 MAP, the plants receiving 500 ppm P recorded a greater leaf area. The number of shoots produced per clump was greater in the plants receiving 500 ppm N, 500 ppm P and in those receiving 500 ppm K at four, eight and seven MAP respectively. Shoot length was greatest in the plants receiving 400 or 500 ppm P and the dry matter content of the shoots was greater in the plants receiving 500 ppm P.

NP interaction resulted in a greater number of leaves in the plants receiving 500 ppm N with 400 ppm P or 400 ppm N with 500 ppm P at nine MAP. At eight MAP, the number of shoots produced per clump was greater in the plants receiving 300 ppm N with 500 ppm P.

The direct effect of light intensities was observed on the leaf area of plants at three and four MAP. During these months, the plants grown under 25 per cent light recorded a greater leaf area.

Light intensities interacted with the nutrients influencing plant growth. Under LN interaction, the plants receiving 500 ppm N under 25 per cent light and those receiving 400 ppm N under 75 per cent light had a greater number of leaves. The plants receiving 400 or 500 ppm N under 25 per cent light and those receiving 300 or 400 ppm N under 75 per cent light had a greater leaf area at 11 MAP. At 12 MAP, the plants receiving 500 ppm N under 25 per cent light and 300 ppm N under 75 per cent light had a greater leaf area.

The number of shoots was greater in the plants receiving 300 ppm N under 50 per cent light and in those receiving 400 ppm N under 75 per cent light at 10 MAP. At 11 MAP, the plants receiving 400 or 500 ppm N under 25 per cent light, 300 ppm N under 50 per cent light and 300 or 400 ppm N under 75 per cent light had a greater number of shoots and at 12 MAP along with these plants, those receiving 500 ppm N under 50 and 75 per cent light too had a greater number.

Interaction between the light intensities and the P doses resulted in a greater number of leaves in the plants receiving 500 ppm P under 25 per cent light at three, four and five MAP. At 12 MAP, the plant receiving 300, 400 or 500 ppm P under 50 per cent light and those receiving 400 ppm P under 75 per cent light too had a greater number. The leaf area was greater in the plants receiving 500 ppm P under 25 per cent light at three and four MAP. At 12 MAP, the plants receiving 300 or 500 ppm under 50 per cent light too recorded a greater leaf area.

The number of back bulbs produced per clump was greater in the plants receiving 500 ppm P under 25 per cent light at six to 12 MAP and in those receiving the same P dose under 50 per cent light at six to nine MAP.

The plants receiving 500 ppm P under 25 per cent light and 300 or 400 ppm P under 50 per cent light had a greater number of shoots at 10 MAP. The dry matter content of the shoots was also greater in the plants receiving 400 ppm P under 25 per cent light. Under LK interaction, a greater number of shoots was produced in the plants receiving 500 ppm K under 75 per cent light at six, seven and eight MAP.

Flowering in *Dendrobium* Sonia - 16 was influenced by the light intensities received by the plants. A progressive increase in the number of inflorescences produced was observed with increase in the light intensity. The number of inflorescences was greater under 75 per cent light than under 25 per cent light. The span area of the flowers was greater under 50 and 75 per cent light.

N at 500 ppm increased the length of the inflorescences,the number of flowers in an inflorescence and the span area of the flowers. The number of inflorescences were greater in the plants receiving 400 or 500 ppm N.

The number of inflorescences produced, the length of inflorescences and the span area of the flowers were greater in the plants receiving 500 ppm

P. Those receiving 400 or 500 ppm P had a greater number of flowers in the inflorescences.

The number of inflorescences produced was greater in the plants receiving 400 or 500 ppm K and the number of flowers in an inflorescence and their span area were greater in the plants receiving 500 ppm K.

Interaction between light intensities and the N doses also influenced the floral characters. The number of inflorescences produced was greater in the plants receiving 500 ppm N under 25 per cent light and 400 or 500 ppm N under 50 per cent light. The length of the inflorescences was greater in the plants receiving 400 or 500 ppm N under 50 and 75 per cent light. The span area of the flowers was greater in the plants receiving 500 ppm N under 50 per cent light and in those receiving 400 or 500 ppm N under 75 per cent light.

The nutrient composition of the leaves of *Dendrobium* Sonia - 16 was influenced by the nutrient treatments and their interactions.

The N content of the leaves was greater in the plants receiving 400 or 500 ppm N and the Zn content was greater in the plants receiving 300 or 400 ppm N.

The N, K and Cu content of the leaves was greater in the plants receiving 400 ppm P. The plants receiving 500 ppm P had a greater P content, those receiving 300 ppm P had a greater Zn content and those receiving 300 or 400 ppm P had a greater Mg content.

The Mg and Cu content of the leaves was greater in the plants receiving 300 ppm K, the N and Zn content were greater in the plants receiving 400 ppm K and the K content was greater in the plants receiving 400 or 500 ppm K.

Interaction between the N and P doses resulted in a greater N content in the plants receiving 400 or 500 ppm N with 300, 400 or 500 ppm P. The K content was greater in the plants receiving 400 ppm P with 300 ppm N. The Mg content was greater in the plants receiving 300 ppm N with 300 ppm P and 400 ppm N with 500 ppm P. The Zn content was greater in the plants receiving 400 ppm N with 300 ppm P or 300 ppm N with 400 or 300 ppm P. The Cu content of the leaves was greater in the plants receiving 300 or 400 ppm N with 400 ppm P.

Interaction between N and K resulted in a greater N content in the plants receiving 400 or 500 ppm of N and K. PK interactions resulted in a greater N content in the plants receiving 400 or 500 ppm P with 300, 400 or 500 ppm K. The N content was lower in the plants receiving 300 ppm P with 300, 400 or 500 ppm K.

Interaction between light intensities and the nutrient treatments influenced the nutrient composition of the leaves. The Mg content was greater in the plants receiving 400 or 500 ppm N under 25 per cent light and 300 ppm N under 75 per cent light. The content was also greater in the plants receiving 300 ppm P under 25, 50 and 75 per cent light. The N content of the leaves was greater in the plants receiving 400 or 500 ppm K under 50 and 75 per cent light. The K content was greater in the plants receiving 500 ppm K under 25, 50 and 75 per cent light. The Mg content of the leaves was greater in the plants receiving 300 ppm K under 25 per cent light, 300 or 400 ppm K under 50 per cent light and 300, 400 or 500 ppm K under 75 per cent light.

In *Arachnis* Maggie Oei 'Red Ribbon' trench cultivation of plants under 75 to 100 per cent light enhanced flowering and improved the floral characters. Growing under full sunlight with 500 ppm of N and P resulted in shorter plants. Interaction between nutrients and light intensities could also influence the number of leaves, aerial roots and the leaf area of plants. The nutrient composition of the leaves was generally enhanced by the 400 and 500 ppm doses of N and P and 500 ppm K in both the cultivars.

In *Dendrobium* Sonia - 16 the most responsive combinations of light and nutrients for flowering ie, 75 per cent light with 400 to 500 ppm of N, P and K and in *Arachnis* Maggie Oei 'Red Ribbon', 75 to 100 per cent light intensity, trench culture and 300 ppm N, 400 ppm P and 300 ppm K from planting until nine MAP and thereafter, 400 to 500 ppm N, 400 ppm P and 500 ppm K can be recommended. Standardisation of the nutrient dosage for the pre and post flowering stages under 75 to 100 per cent light intensity, followed by on-farm trials are the future lines of work indicated.

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* Originals not seen

APPENDIX

APPENDIX

DETAILS OF PLANT PROTECTION GIVEN TO THE EXPERIMENTAL PLANTS

Sl. No.	Name of chemical and concentration	Time of application and dosage
1.	B.H.C. 10 per cent dust	At planting and at six MAP @ 12g per sq.m* of net plot in Experiment 1
2.	Dimethoate 30 EC	At 12 MAP in Experiment 1 and at planting and at four and eight MAP @ 0.030 per cent in Experiment 2.
3.	Mancozeb	At planting and thereafter at bimonthly intervals @ 0.400 per cent in Experiment 2.

* Kerala Agricultural University (1989)

PERFORMANCE OF SELECTED ORCHIDS UNDER VARYING LIGHT REGIMES, CULTURE METHODS AND NUTRITION

By

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ABSTRACT OF A THESIS
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ABSTRACT

The present study was undertaken to evolve agrotechniques for cut-flower orchid production in Kerala. Two experiments were conducted at the College of Agriculture, Vellayani in 1991 and 1992 with two popular cut-flower varieties namely *Arachnis* Maggie Oei 'Red Ribbon' and *Dendrobium* Sonia-16. The effects of varying light intensities and nutrient regimes under two methods of cultivation were assessed in *Arachnis* Maggie Oei 'Red Ribbon' (Experiment 1) and in *Dendrobium* Sonia-16, the performance under varying light intensities and nutrient regimes was evaluated (Experiment 2).

In *Arachnis* Maggie Oei 'Red Ribbon', trench culture was found to promote growth, flowering and the floral attributes. The number of leaves, aerial roots, leaf area and plant height were greater in the trench grown plants. The number of inflorescences produced, their branching, length and vase life were also enhanced under trench culture.

The effect of light intensities on growth was mediated through interactions with culture methods and nutrients. The trench grown plants under 50 and 75 per cent light had a greater number of leaves and leaf area. The plants receiving 500 ppm of P and K under 100 per cent light had a shorter stature. The direct effect and interactions of nutrients on growth were observed at certain months during the experimental period which was indicative of differences in the requirement at different stages of growth. The

dry matter content of the stem and apical shoot was greater in the plants receiving 500 ppm P.

Inflorescence production and the vase life of inflorescences was greater under 100 and 75 per cent light. Branching of inflorescences was greater under 75 per cent light.

In *Dendrobium* Sonia-16 the number of inflorescences produced was greatest under 75 per cent light. The length of the inflorescences was greater under 75 per cent light and the span area of the flowers was greater under 50 and 75 per cent light. Nitrogen at 500 ppm increased the length of the inflorescences, the number of flowers in an inflorescence, and the span area of the flowers. The number of inflorescences produced was also greater in the plants receiving 400 or 500 ppm N, 400 or 500 ppm K and in those receiving 500 ppm P.

Interactions between the nutrients and between light intensities and the nutrients were also observed.

The nutrient composition of the leaves in both the cultivars were enhanced by the 400 and 500 ppm doses of N and P and 500 ppm K.

Based on the observed effects, in *Arachnis* Maggie Oei 'Red Ribbon', trench culture of plants under 75 to 100 per cent light and a nutrient dosage of 300 ppm N, 400 ppm P and 300-ppm K from planting till nine MAP and thereafter a dosage of 400 to 500 ppm N, 400 ppm, P and 500 ppm K can be recommended. In *Dendrobium* Sonia - 16 growing in pots under 75 per cent light with 400 to 500 ppm of N, P and K can be recommended.