GROWTH PATTERN FLOWERING AND YIELD POTENTIAL OF TISSUE-CULTURED PLANTS OF BANANA " *MUSA* (AAB GROUP) NENDRAN" AND STANDARDISATION OF FERTILIZER SCHEDULE

By

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THESIS
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Dedicated

to

my

Beloved Husband

DECLARATION

I hereby declare that this thesis entitled **Growth pattern flowering and yield potential of tissue-cultured plants of banana 'Musa (AAB group) Nendran' and standardisation of fertilizer schedule** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar title of any other University or Society

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20-01-1995

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CERTIFICATE

Certified that this thesis entitled 'Growth pattern flowering and yield potential of tissue-cultured plants of banana 'Musa (AAB group) Nendran' and standardisation of fertilizer schedule' is a record of research work done independently by Smt Sheela V.L. 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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Hewitt and Osborne (1962) working on lacatan variety of banana observed that for securing high yields the leaf tissue should have 2 6 per cent nitrogen o 40 per cent P_2O_5 and 4 0 per cent K_2O respectively Potash application rapidly increased leaf potash and heavy application decreased leaf nitrogen Ho (1969) established significant correlation between K concentrations in third leaf in one hand and the height and girth of pseudostem, number of fingers and yield on the other hand Iacoevilho and Martin-prevel (1971) analysed banana leaves for potassium concentration in third and fourth leaves (combined) and expressed as percentage of drymatter during flowering stage During flowering and harvest stages the levels of K_2O were 4 3 and 8 5 per cent respectively, whereas potassium defecient plants showed 2.65 and 1 8 per cent during the same stage

Ramaswamy (1971) observed leaf nutrient levels of 3 29 per cent N, 0 44 per cent P_2O_5 3 11 K_2O, 2 12 per cent Ca and 6 24 per cent Mg as optimum for increased yield in 'Robusta' banana sunder Singh (1972) reported that leaf nutrient content of 3 13 per cent N, 0 44 per cent P_2O_5, and 3 89 per cent K_2O in the fifth month and 3 37 per cent N, 0 51 per cent P_2O_5 and 4 36 per cent K_2O in the seventh month

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3.8.2. Duration of the crop

3.8.2 1. Date of shooting

The date of shooting of plants in each treatment was observed, based on which the number of days taken from planting to shooting was worked out

3.8.2.2. Date of harvest

The date of harvest of plants in each treatment was observed, based on which number of days taken from planting to harvest was worked out

3.9. Post Harvest Observations

3.9.1.Bunch characters

Bunches were harvested when fully mature as indicated by the disappearance of angles from fingers (Simmonds, 1959) The following observations were made on the bunch characters

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Weight of bunch including the portion of the peduncle upto the first scar (exposed outside the plant) was recorded in Kilograms

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LIST OF ABBREVIATIONS USED IN THE TEXT

m	-	metre
cm	-	centimetre
mm	-	millimetre
g	-	gram
kg	-	kilogram
%	-	per cent
lb	-	pound
N	-	Nitrogen
P, P_2O_5	-	Phosphorus
K, K_2O	-	Potassium
Ca	-	Calcium
Mg	-	Magnesium
Fe	-	Iron
Zn	-	Zinc

INTRODUCTION

INTRODUCTION

Banana is the leading tropical fruit in the world It is one of the oldest fruit plants cultivated by man from prehistoric times Banana culture in India is as old as Indian civilization Reference to this fruit occurs in Vedic literature The country produces 11 per cent of world's bananas It is the second largest producer of banana after Brazil In Kerala, this crop occupies an area of 22,600 hectare with a production of 3,10,000 tonnes and is the most important fruit crop of the state 'Nendran' belonging to French plantain group is the leading commercial variety, fetching a premium price both as green and ripe fruit

The area under cultivation of banana is fast dwindling in Kerala due to the high pressure on land by more remunerative crops Historical, commercial and to some extend religious involvement in its cultivation enable to ward off to some extend its replacement by other crops Under such a situation, the better solution would be to increase its productivity per unit area Any technology change conducive to optimising resources for production and increasing productivity merits serious attention

The in vitro propagation of banana is gaining importance throughout the world The use of tissue cultured plants offers certain advantages namely that a large quantity of uniform disease free plants can be produced rapidly from a single plant showing good genetic potential

The commercial application of tissue culture technology has been widely recognised in this crop The technique has great potential for rapid large scale and true to type multiplication of elite genotypes. But the large scale use of tissue cultured plants will depend on its commercial viability The micro propagated plants have been promoted by commercial tissue culture laboratories as having four important advantages over conventional planting material These are, the plants could be rapidly multiplied from a mother plant of known superior characteristics Secondly tissue cultured plants could be provided to the growers free of virus diseases Thirdly the material produced would be true to type and conform with the characteristics of the mother plant Finally 100 per cent establishment of plants could be easily achieved.

One important problem facing banana growers is variability in the flowering (staggered flowering) and yield The tissue cultured plants are expected to be true to type and of uniform nature besides having higher yield potential In a leading commercial variety like Nendran whose cultivation and consumption is concentrated at certain peak seasons, uniformity in flowering and harvest are of great economic importance The development, growth and physiology of tissue cultured bananas differ from that of plants produced from suckers especially at different developmental stages It is thus essential to make a critical evaluation of such plants especially of a leading commercial variety like 'Nendran' under field conditions Studies have been undertaken in important banana growing countries throughout the world regarding the use of tissue cultured bananas as a possible replacement to conventional suckers Such studies conducted in Australia and Taiwan to assess the field performance of tissue cultured bananas have been in cultivars of commercial importance such as the 'Cavendish' bananas popular in these countries.

Banana is a heavy feeder of nutrients and manuring is indispensible A survey of literature shows that the choice and dosage of nutrients to be applied depends on the cultivar, initial soil fertility, stage of plant growth, climate etc , A judicious use of fertilizers not only gives high yield but also improves the quality of the produce

The nutrient requirements of tissue cultured plants are also probably different from that of the conventionally propagated plants Further, these plants expected to have a higher yield potential, probably also have a much higher nutrient requirement No work has been done regarding the nutrient requirement of such plants or the split applications of nutrients

The present study was, therefore, under taken with two main objectives

1 To compare the growth, flowering and yield potential of tissue cultured banana plants "Musa (AAB group) 'Nendran'" with those propagated from conventional suckers

2 To standardise a suitable fertilizer schedule for tissue cultured banana

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Banana is conventionally propagated by suckers which develop at the base of the mother plant Propagation through tissue culture can produce disease free apparently true to type planting material in large numbers from selected clones In order to ascertain the feasibility of large scale commercial adoption of tissue culture plants, their field performance is to be assessed in comparison with that of the conventional propagating materials under similar situations Studies undertaken in some of the important banana growing regions of the world with reference to tissue cultured plants are reviewed in the first part of this chapter The second part includes a review of studies conducted in nutrition and fertilization of banana under different soil and agroclimatic conditions with different clones

2.1. Initial Establishment in the field

The morphological characters of tissue cultured banana plantlets ready for transplanting to the field after hardening are entirely different from the conventional suckers They are comparatively smaller but will have four orfive small functional leaves but a well developed pseudostem and root system, However, they lack a good corm, in contrast to the conventional suckers which have a well developed corm with sufficient stored food but lack functional leaves and roots It is of interest therefore, to make an assessment of the problems in initial establishment of these plantlets in the field

In Bangalore, Swamy et al (1983) produced plantlets of cv Robusta from 2 types of explants, (a) shoot tip with the youngest leaves (b) shoot tips with several older leafing sheaths The plantlets obtained from both types of explants were successfully transplanted to soil and grown to maturity

Plantlets of Musa textilis (1) Bungalanon when transfered to a soil medium, recorded 91 per cent survival according to Hwang et al (1984) Robinson and Nel (1989) obtained 100 per cent survival on transplanting tissue cultured plants of Cv. Williams, Grandnain and Dwarf Cavendish According to Robinson and Anderson (1992) the first three months after field establishment of the plantlets are critical In south Eastern Queens land tissue cultured banana established more quickly than conventional suckers in the field (Drew and Smith, 1990) Pradeep et al (1992) gave shade for plantlets of 'Nendran' on transplanting to field, as a precaution for protection from sun scorching and excess evaporation

2.2. Growth and development

Robinson (1989b) made a comparison between different types of planting materials such as conventional 2 kg pared suckers and 200 mm and 500 mm tall tissue cultured plants The cultivars tried were Williams, Dwarf Cavendish and Grand nain Six weeks after planting there were 14 leaves on tissue cultured plants but only 4 on newly emerged suckers Tissue cultured plants were upto 300 mm taller at the flowering stage This difference was attributed to the greater number of leaves produced by tissue cultured plants They produced six to seven more leaves before flower emergence compared to the plants from suckers

Plants produced through tissue culture from the Giant Cavendish were as high or higher than the same cultivars propagated by traditional methods But cv Grandnain plants were shorter (Kwa and Ganry, 1990) They also reported that trials in Taiwan, Costa Rica, Israel, Ivory Coast, Cameroon and the French West Indies had the benefits of in vitro propagation compared with that of the traditional methods of plant propagation namely increased plant vigour and more homogeneous plants Plant height at flowering of in vitro derived material varied with the cultivar Drew and Smith (1990) recorded greater heights in tissue cultured plants compared to conventional planting materials

Novak et al (1990) observed vigorous growth in micro-propagated plants of Grandnain At Buegershall Research station, Robinson et al (1992) obtained greater heights in tissue cultured plants of Williams, Dwarf Cavendish and Grand nain compared to conventional suckers in the first crop cycle

According to Pradeep et al. (1992), the tissue cultured plants of 'Nendran' recorded relative growth rates during the vegetative phase which was significantly higher than that of the sword sucker plants They also produced more number of leaves Till the sixth month after planting the tissue cultured plants produced 29 7 leaves whereas the sword sucker plants produced 24 8 leaves which was significantly lower. But at flowering stage both type of plants were almost similar in height

2.3. Flowering

Novak et al (1990) reported early flowering among the population of Grandnain regenerated from shoot tips and irradiated with gamma rays The true-to type tissue cultured plants of cv. Williams took about three weeks more than suckers for bunch emergence in North Queensland (Daniells, 1988) According to Robinson (1989) plantlets of Williams and Dwarf Cavendish reached flowering stage 15 and 24 days sooner than the suckers of same varieties In south Eastern Queensland Drew and Smith (1990) observed that tissue cultured banana took a shorter time for bunch emergence and harvest, compared to the conventional planting material In Nendran the days taken by tissue cultured plants from planting to flowering and maturity was higher than the days taken by sword suckers The tissue cultured plants flowered 268 days after planting whereas the sword sucker plants flowered 240 days after planting The days taken to attain maturity was 346 days and 314 days respectively (Pradeep et al , 1992)

2.4. Yield

In North Queensland, Daniells (1988) observed that tissue cultured plants of cv Williams produced bunches about seven per cent heavier than plants grown from suckers The greater bunch weight was due to more number of fingers/bunch

Robinson and Anderson (1992) carried out three separate experiments in Dwarf Cavendish banana with suckers and tissue cultured plants during the three different planting dates (January, 1988, December, 1988 and November 1989) Tissue cultured plants out yielded suckers in all the three experiments The increase was 28 6, 26 3 and 19 5 per cent respectively In all cases tissue cultured plants grew taller and thicker than suckers which in turn gave rise to potential for carrying larger bunches According to Kwa and Ganry (1990) the advantages of in vitro propagated plants include higher bunch weight, more fingers and hands and less variability in fruit size and shape thus increasing the percentage of exportable fruits In south Eastern Queensland Drew and Smith (1990) recorded significantly higher yields in terms of bunch weight for tissue cultured banana which was a function of greater number of fingers and hands In Kannara tissue cultured plants of Nendran recorded 39 per cent increase in yield over sword sucker plants (Pradeep et al., 1992)

2.5. Sucker production, Ratoon crops

Daniells (1988) reported that tissue cultured plants produced many more suckers than the conventional material and these suckers were uniform in nature. According to Drew and Smith (1990) sucker production on tissue cultured plants was significantly higher upto eight months after planting, similar to conventional material. But the advantages of plant crop did not extend to the ratoon crop.

Trials with cv. Williams, Grandnain and Dwarf Cavendish by Robinson and Anderson (1992) showed that some of the advantages of using tissue cultured plants were carried over to the ratoon crop. The follower suckers from first ratoon were larger and healthier in tissue cultured mother plants than in conventional mother plants. Ratoon crop from tissue cultured plants recorded 18.5 per cent increase in yield over the ratoon crop from suckers.

Hwang (1984) reported that tissue cultured plants of Musa textilis cv. Bungalanon produced on an average one and six suckers within 3.5 and 5.5 months respectively from the date of transplanting.

Israeli and Nameri (1988) reported that plantlets of cv. Williams could be successfully utilized for high density planting for a single cycle banana crop .

2.6 Variations in tissue cultured plants

In North Queensland Daniells (1988) observed 50 per cent off types in tissue cultured plants mainly dwarfs which is a serious problem for the establishment of field plantings from tissue cultured plants. Ventura et al (1988) evaluated micro-propagated clone of genome group AAB. The results indicated that 10.4 of the population showed somaclonal variation in bunch characters (hands/bunch, length of fruits, increased fruits/ bunch and atrophied fruits) and 19.6 per cent showed variations in plant height. Plants derived from a clone of American group (AAA) included variants which ranged in height between Dwarf Cavendish and Grandnain, Hwang (1984) reported five per cent somaclonal variants by using in vitro propagated banana plants

In cultivar New Guinea Cavendish as a result of callus tissue culture, 22 per cent of derived plants were off types compared with three per cent in the line produced by axillary bud proliferation No off types were observed in conventional planting material (Drew and Smith, 1990)

Vuylsteke and Swennen (1990) assessed levels of somaclonal variation in seven shoot tip micro-propagated plantains Levels of somaclonal variation ranged from 0 to 69 1 per cent (Bobby Tannap and Bis Egome respectively) indicating cultivar differences in stability of micro propagated plants The plants displayed variation in inflorescence types and associated degrees of female fertility, pseudostem, petiole and bract colour and growth habit Much of this somaclonal variation corresponded to natural phenotypic variation which was enhanced in-vitro

According to Robinson and Nel (1989) the highest mutation percentage (3 33%) was obtained in Dwarf Cavendish and the lowest in Grandnain (0 63%) when Dwarf Cavendish, Williams and Grandnain were compared The average rate of variation was 1 76 per cent (Robinson et al, 1993) In another study using the same cultivars 30 distinct somaclonal variants were observed in 1700 plants in second crop cycle

Vuylsteke et al (1988) reported five forms of phenotypic variation at a frequency of six per cent in cv. Agbaga (AAB) in the plant crop and successive ratoon Novak et al (1990) observed considerable variation among plants regenerated from in vitro shoot tips after mutagenic treatment

Daniells and Bryde (1991) had reported an off type from tissue cultured plants of 'Monsmarie' from Queensland with longer fingers and higher bunch weight and named it J D. special

Tissue cultured plantlets of two clones designated 'Maricongo' and Dwarf respectively were introduced into the U S Virgin Islands The clones exhibited considerable variability By the second harvest 21 per cent of Maricongo had reverted to tall French types and 38 per cent of the Dwarf had reverted to Dwarf French types The characters of the planting and first ratoon crops were similar The dwarf French variant produced high yield (46 t/ha), was tolerant to alkaline soils with Fe and K deficiency and was resistant to pseudostem soft rot and to wind damage, (Ramcharan et al , 1987)

2.7. Role of major nutrients in banana

Detailed studies have been conducted in nutrition and fertilization of banana in different parts of the world under different soil and agroclimatic conditions and with different clones of banana Banana is a soil exhausting crop and hence sound fertilizer programme is essential to increase the yield by increasing bunch weight and to improve the production of marketable fruits with attractive finger characters It is observed that banana requires larger quantities of K, moderate quantities of N and relatively lower doses of P_2O_5

The requirement of nitrogen and potassium for banana in high amounts was reported as early as 1921 by Fawcett (1921), and later confirmed by Norris and Ayyar (1942)

Banana responds well to the application of nitrogen Studies in Poona region by Gandhi (1951) indicated that nitrogen application was highly beneficial but application of phosphorus and potash was not found to be effective Gopalan Nair (1953) reported good response to nitrogen application in 'Poovan' in heavy clayey soils but application of phosphorus and potash did not give any response

According to Srivastava (1961) larger fingers, heavier bunches and earlier flowering was obtained in banana by using a mixture of 1 5 lb ammonium sulphate, 30 lb farmyard manure and 3 5 lb castor cake

Madhava Rao (1974) recommended 225 g of nitrogen per clump in two doses as groundnut cake and ammonium sulphate for deltaic areas of West Godavari district Chathopadhyay et al (1980) found that in Giant Govenor banana, the yield rose to 31200 and 30,800 kg/ ha for the plant and ratoon crops respectively by increasing N dose upto 240 g/plant annually Mustaffa (1983) reported that 150 g N/plant applied to hill banana gave the highest yield Langenegger (1984) found that 240 g of Calcium Ammonium

Nitrate per plant was the most economical application for Cavendish and William cultivars Kohli et al (1985) reported that the highest yield was obtained in Robusta banana by application of 150 g nitrogen per plant

The importance of nitrogen on growth and yield of banana has been further confirmed by Martin-Prevel (1969) Venketesan et al (1965), Ramaswamy and Muthukrishnan (1974), Arunachalam (1972), Valsamma Mathew (1980), Dave et al (1990) and Mustaffa(1988)

Langenegger and Smith (1988) reported that for Dwarf Cavendish and Williams bananas in light sandy soils of south coast Natal and in heavy soils at Burgeashall the optimum rate of N was 56-67 g N/ Plant and higher rates of nitrogen were uneconomic

Nanjan et al (1981) reported that in Periyar river command area 100 g N, 40 g P_2O_5 and 350 g K_2O/ plant was found optimum for cv. Poovan plant crop, and 200 g N, 40 g P_2O_5 and 350 g K_2O for ratoon crop and 100 40 350 g of N, P_2O_5 and K_2O/plant optimum for Vayal vazhai for getting good yields

According to Decunha and Fraga (1963) in sandy soils marked increases in production was obtained by potash application and slight increases by nitrogen and phosphorus. For these soils 60g N, 40g P_2O_5 and 325 g K_2O/ plant was recommended for getting increased yields. Hernandez et al (1981) reported that nitrogen significantly increased yield, hands and fruits number upto 150 g/plant.

The influence of nitrogen on quality attributes, time of shooting and period of maturity of the crop besides yield has been reported by many workers (Croucher and Mitchell, 1940, SteinHausen, 1957, Butler 1960, Jagirdar et al., 1963, Kohli et al., 1989).

Importance of potassium in banana nutrition has been emphasized by many scientists.

Wood (1939) recorded an increase in yield in banana by the application of farmyard manure and potash. Increase in bunch weight has been reported by application of potassium (Hewitt and Osborne, 1962). According to Twyford (1967) the amount of potash was always the highest among the nutrients analysed. The potash content was 2.2 to 4.6 times higher than nitrogen content and critical manuring could be done on 4.1 14 ratio of N, P and K Marked increase in bunch weight and its positive influence on quality has been further stressed by Vadivel (1976) and Sheela et al (1990)

In Taiwan Chu (1961) stated that K application greatly increased pseudostem growth and fruit yield, improved fruit quality and storage life and promoted disease resistance Katyal and Chadha (1961) reported that under North Indian conditions 1 8 to 2 3 kg K_2OS_4 plant^{-1} was found essential

There are reports on combined effect of N, P and K in banana

In Queensland having red basaltic soils Summerville (1944) found that there was considerable response to nitrogen and potassium when applied together than when these were supplied separately Application of P to these soils has no effect on growth Figueroa Escobar (1962) reported remarkable yield improvement in bananas by application N and K_2O in the ratio of 1 2 The results of a study in Robusta banana indicated that application of 160 g nitrogen in combination with 240 g K_2O plant^{-1} gave an additional yield of 35.2 t ha^{-1} (Champion et al, 1958)

Twyford and Walmsely (1973) recommended a ratio of 9:9.35 of NPK which should be applied at the rate of 6 2 t ha^{-1} and for the ratoon crop 0 65 t ha^{-1}. Optimum K_2O rates recommended by Samuel et al (1977) for increased number and weight of plantains were 420 and 405 kg ha^{-1} respectively Investigation by Koen et al (1976) in Levebu area revealed that an annual application of 230-450 g of potassium ammonium nitrate and 110 to 230 g of super phosphate and 130 to 350 g of potassium chloride was adequate for optimum yields and good quality fruits

For the conditions in New South Whales an annual dose of 225 kg N, 55-110, kg P_2O_5 and 500 kg K_2O ha^{-1} was recommended by Turner and Bull (1970). Lin et al. (1962) reported that individual application of N, P and K failed to influence growth and yields, while N P K at the rate of 200 100.300 kg/acre helped to maximise the yield

Shanmughqm and Velayudham (1972) reviewed the fertilizer recommendations of banana in different states of

India and found that a dose of 225 g each of N and K plant^{-1} year^{-1} was the best recommendation for Kerala Soils Tandon (1987) also reported the manurial schedule adopted in different banana growing states in India The amount of N, P_2O_5 and K_2O recommended for irrigated 'Nendran' bananas in Kerala are 190 115·300 g plant^{-1} respectively and for rainfed Palayankodan it is 100 200 400g plant^{-1} of N, P_2O_5 and K_2O, for other varieties in general 160 g each of N P_2O_5 and 320 g of K_2O are recommended to be applied per plant Studies by Pillai et al (1977) in Nendran banana at BRS Kannara indicated that Nendran banana required 191 g N and 301 g P_2O_5 and 300g K_2O respectively for maximum yields In studies conducted by Geetha V Nair (1988) in Nendran banana in rice fallows a linear increase in yield was obtained upto 400 g N and 600 g K_2O plant^{-1}

2.8. Nutrients on growth and development

The corelation between bunch weight and leaf area and height and girth of pseudostem at shooting was reported by several workers, (Croucher and Mitchell, 1940; Krishnan and Shanmughavelu, 1983; Kothavade et al, 1985; Holder and Gumbs, 1982)

Summerville (1944) showed whilst in the very early stages of growth significant increases were associated with the presence of added potash, no difference was found later According to Stein Hausen (1957) nitrogen promoted vegetative growth including longitudinal growth of petiole Promotive effects were noticed on the sprouting of cormlets also Reduction in the rate of leaf production and size of leaves produced were noted in bananas due to deficiency of nitrogen (Murray 1959)

Low rate of leaf production was noticed by Butler (1960) in bananas with reduction in levels of nitrogen This was further proved by Battikah and Khalidy (1962), Arunachalam (1972), Shanmugham and Velayudham (1972) Height and girth of pseudostem was significantly increased with higher levels of nitrogen (Ashok Kumar, 1977, Valsamma Mathew, 1980) Anjorin and Obigesan (1982) reported that application of N at higher levels retarded the plant height and girth in bananas This was later confirmed by Singh and Kashyap (1992) according to whom the highest yield, Pseudostem circumference, number of leaves per plant, number of hands per bunch and number of fingers/bunch were obtained with 400g N/plant In a nutritional trial on Robusta by Kohli et al., (1984) with six levels of nitrogen at Bangalore plant height and Pseudostem girth were significantly increased by application of nitrogen. Suckering was also reduced by low levels of nitrogen. Baruah and Mohan (1985) reported highest rate of suckering with 330g N per plant and lowest rate with zero nitrogen.

Phosphorous requirement of banana was much less compared to N and K as reported by Norris & Ayyar (1942), Martin-Prevel (1964), Turner (1969), Jauhari et al.,(1974) and Vadivel (1976), Jagirdar and Ansari (1966) found that in Basrai variety of banana stem girth was increased when P was applied alone or with K at the rate of 48 and 96 lb/acre respectively.

Effect of K_2O on Fairyman banana as reported by Yang and Pao (1962) showed that leaf areas, length, width and number of leaves was not affected significantly by potassium. According to HO (1968) the application of potash in the early stages gave the largest height and girth of stem, number of leaves and increase in growth of sucker. His study revealed a close relationship between girth and height of Pseudostem and yield.

In a green house study with Grosmichel bananas, Hernadez Medina and Iugo Lopez (1967) found that high K favoured better plant development Potassium starvation significantly reduced the leaf size, longetivity, total leaf area, pseudostem height and girth in bananas (Lahav, 1973) Lacoevilhe (1973) clearly indicated that K application influenced the number of functional leaves.

Pseudostem growth was greatly increased by potassium as reported by Chu (1961) and sheela (1982) According to Yang and Pao (1962) height of plant was not significantly influenced by increased doses of potash Jambulingam et al (1975) reported that in Robusta banana higher rates of K_2O significantly increased pseudostem height, girth, leaf area and sucker production Similar results were obtained in Jahaji' banana in Assam by Baruah and Mohan (1985) and also by Oubahou and Dafiri (1987)

In Robusta banana under rainfed conditions Mustaffa (1988) reported that application of Muriate of Potash at 400 g $plant^{-1}$ significantly increased the height and girth of pseudostem, number of leaves and leaf area Oubaheou and Dafiri (1987) reported that potassium increases height and girth of pseudostem

In a trial on Dwarf Cavendish banana by Khoreby and Salem (1991) the height and basal circumference responded positively to the highest K application rate (500 g K_2O plant^{-1}) At this rate the plants were more vigorous and there was a greater leaf surface area

Chattopadhyaya and Bose (1986) observed that application of nutrients significantly increased plant height, girth, leaf number and sucker production over control Dagado (1986) recommended application of 100 g N, 40 g P_2O_5 and 100g K_2O plant^{-1}

2.9. Nutrients on flowering and yield

That application of nitrogen can reduce cropping period was first reported by Croucher and Mitchell (1940). According to him earliness in flowering by two months was observed due to the effect of nitrogen Shooting was hastened upto 20 per cent by nitrogen The same was later confirmed by Stein Hausen (1957) Simmonds (1959) and Kohli et al (1984) Singh et al (1977) observed that higher levels of N P K (150 g N, 90 g P_2O_5 170 g K_2O plant^{-1} year^{-1}) significantly shortened the time taken to flowering In rainfed 'Palayankodan' the duration of the crop was significantly increased by nitrogen (Valsmma Mathew, 1980)

A positive correlation exists between the applied nutrients and yield as reported by many workers Bowman and Eastwood (1940) obtained increased yields due to application of nitrogen This was later on supported by Bhan and Majumdar (1956), simmonds (1959), Butler (1960) and Jagirdar (1963) All the yield attributing characters and ultimately the yield were improved in bananas by the application of nitrogen (Venketesan et al , 1965)

Arunachalam et al (1976) reported the promotive effect of N on Dwarf Cavendish, Gaint Cavendish, Robusta and Lacatan bananas on yield 170 g N was the optimum level in these varieties Ramanathan et al (1973) found that 55 g N plant^{-1} as ammonium chloride or ammonium sulphate was sufficient to get profitable yield in Poovan Ramaswamy and Muthukrishnan (1974) got the highest response in terms of number of hands and flowers, weight of hands and fruits with 170 g N plant^{-1}

Singh et al (1974) reported that number of hands and fingers were increased by application of nitrogen while the response to potassium was due to increased weight, volume and density of fruit Gopimony et al (1979) found that in 'Zanzibar' variety of Nendran an additional dose of 500 g urea in five equal split doses of 100 g each at one week interval during the fifth month of planting resulted in an increase in bunch weight and number of fingers per bunch Split application of nitrogen at 30 and 50 days after planting recorded maximum bunch weight (Nambiar et al 1979) In rainfed palayankodan the optimum dose of nitrogen was found to be 204 69 g $plant^{-1}$ by Valsamma Mathew (1980)

Chattopadhyay et al (1980) found that in Giant Governor banana the yield rose to 31200 and 30880 kg ha^{-1} for the plant and ratoon crop respectively by increasing nitrogen dose upto 240 g $plant^{-1}$ annually Mustaffa (1983) reported that 150 g N $plant^{-1}$ applied to Hill bananas gave the highest yield Langenegger (1984) found that 240 g Calcium Ammonium Nitrate $plant^{-1}$ was the most economical application for Cavendish, Eilliam cultivars Kohli et al (1984) reported that the highest yield was obtained in robusta banana by application of 150 g nitrogen $plant^{-1}$

Foliar application of nitrogen enhanced the yield in bananas as reported by Ashok kumar (1977) and sharma (1984)

Bhan and Majumdar (1958) and Bhan (1967) reported that P_2O_5 and K_2O did not show show any significant effect on yield and maturity of banana According to Valmayer et al (1965) and Nambisan et al (1981) individual effect of phosphorous in improving the yield of bananas was not much significant

Number of hands/bunch, bunch weight and fruit size and volume increased upto 60 g P_2O_5 $plant^{-1}$ according to Ramaswamy (1974)

Beneficial effect of potassium on yield of bunches has been reported by many workers (Osborne and Hewitt, 1963, Moreau and Robin, 1972, Sheela, 1982, Turner and Barkus, 1982, Langenegger and Smith, 1986) According to Jagirdar and Ansari (1966) in 'Basrai' variety of banana receiving 96 lb/acre of K_2SO_4 alone gave the highest yield in terms of bunch weight, number of fingers per unit area and highest monetary returns per lb of fertilizer applied

Increased dose of potassium exerted a favourable effect on nearly every feature of fruit growth and quality as reported by Yang and Pao (1962) Average weight of fingers increased due to potash application by 15-25 per cent during the first year and by 27-48 per cent in second year Thickness and weight of peel length and girth of fruits etc were also increased

In Taiwan Leigh (1969) reported that increasing supplies of potassium increased bunch, hand and finger weights, rind thickness, finger length and circumference Application of 204 kg K_2O/acre/annum in three to four splits was recommended

Garita and Jarmillo (1984) found that 750 kg K_2O ha^{-1} $year^{-1}$ resulted in highest yield Yadav et al (1988) recommended application of K in 3 split doses at the rate of 300 g $plant^{-1}$ to get the best results in Dwarf Cavendish

In a trial conducted by Venkatarayappa et al (1978) fruit volume and weight were remarkably increased by spraying potassium dihydrogen phosphate

Increased yields were obtained by application of N, P and K in combination in bananas Bhangoo et al (1962) found out that a 350, 160, 180 formulation of N, P_2O_5 and K_2O greatly increased yields bunch weight and number of hands per bunch According to Veeraraghavan (1972) significant increase in the number and weight of fruits in 'Nendran' bananas was obtained with 228 g N, 228 g P_2O_5 and 456 g K_2O plant^{-1} year^{-1}.

Teaotia et al (1972) found that application of 300 g ammonium sulphate 600 g superphosphate and 300 g potassium sulphate gave the highest yield in Cavendish banana Randhawa and Iyer (1978) found that a fruit yield of 45 t ha^{-1} could be obtained by the application of 180 g N in combination with 100 g P_2O_5 and 225 g K_2O plant^{-1} in Robusta banana Sharma and Roy (1973) found that 320 kg P_2O_5 ha^{-1} gave the greatest profit when applied in combination with 600 kg N and 320 kg K_2O Chattopadhyaya and Bose (1986) reported that the N P K at 240 g N 90 g P_2O_5 and 480 g K_2O plant^{-1} gave the maximum fruit yield (58 5 t ha^{-1}) in the plant and ratoon crop

According to Oberifuna and Onyele (1987) demand for K is double that of N An annual application of 200 g N and

500 g K produced the heaviest bunch weight and was the most economic

Pillai and Khador (1981) reported that application of 100 kg N, 40 kg P_2O_5 and 400 kg K_2O per acre produced the heaviest bunches (about 20 kg $bunch^{-1}$) in Robusta banana Chundawat et al (1982) recommended the application of a fertilizer dose of 100 g N, 180 g P_2O_5 and 180 g K_2O in three split doses within six months after planting for Basrai bananas Kohli et al (1985) reported that 50 g P_2O_5 $plant^{-1}$ in combination with 150 g N and 25 g K_2O per plant gave the highest yield in Robusta banana Bellie (1987) found that a fertilizer dose of 150 g N, 90 g P_2O_5 and 300 g K_2O $plant^{-1}$ applied in three splits during third, fifth and seventh month increased the net income per hectare from Nendran banana

Dave et al (1990) recommended application of N, P, K at the rate of 180 180 180 g $plant^{-1}$ for Basrai banana in south Gujarath Nair et al (1990) obtained the highest yield by the application of N and K in six splits at the rate of 400 g N and 600 g K_2O $plant^{-1}$ along with a basal dose at 100 g P_2O_5 in Nendran grown in rice fallows

2.10. Nutrients on fruit quality

Mineral nutrition reflects significantly on the quality of final product in all crops In banana the reducing sugar content of fruits was increased significantly by nitrogen application (Chattopadhyay et al 1980) Similar results were obtained in rainfed 'Palayankodan' banana by Valsamma Mathew, (1980)

In an experiment by Ho (1968) in Taiwan increasing supplies of K_2O improved the fruit conditions as observed after 20 days of storage According to Koen (1976) optimum yield of high quality fruits were obtained with an annual application of 370 g potassium ammonium nitrate along with 450 g KCl $plant^{-1}$ Yield and fruit quality was lowest with higher rate of application or when the latter was supplemented with 250 g magnesium sulphate

Studies conducted by Venkatarayappa et al (1978) on the effect of post shooting application of potassium dihydragen phosphate revealed that the treatments significantly increased the volume and weight of fruits Total soluble solids content of Robusta increased with an increase in level of K_2O application (upto 300 g $plant^{-1}$) Reducing non reducing and total sugar content also increased with increasing doses of K_2O While acidity was reduced sugar/acid ratio increased, ascorbic acid content also increased with higher levels of potash (Vadivel and Shanmughavelu, 1988) Sheela et al (1990) also obtained beneficial effects on TSS, reducing sugar, total sugars, sugar/acid ratio and acidity with higher doses of potash

Singh et al (1974) studied the effect of nutrients on fruit quality of Robusta banana and reported an appreciable improvement in fruit qualities with different potassium combinations But Teotia et al (1972) failed to get any marked effect on the quality of fruits as effected by different levels of N, P and K in banana variety Cavendish

According to Chu (1961) K fertilizing greatly improved fruit quality and storage life Rama and Prasad (1988) obtained the maximum TSS when N P K was applied in three split doses at 300 120 100 g $plant^{-1}$

According to Von Vexkull (1970) potassium improved the sugar/acid ratio and the keeping quality by increasing the thickness and firmness of rind. Mustaffa (1987) reported that potassium improved the quality of fruits by raising the TSS (Brix) and ascorbic acid content and reducing the acidity. This is confirmed by Tandon and Sekhon (1988) according to whom potash improves the quality flavour, sweetness and keeping quality of fruits. Acidity of fruits decreased with increasing levels of potassium (Chattopadhyay and Bose 1986). Hedge and Srinivas (1992) reported that increasing levels of potassium increased TSS but decreased pulp/peel ratio.

2.11. Deficiency of nutrients

The growth and development of banana is seriously impaired, if any of the three major nutrients are deficient. There is an ultimate reduction in the yield of bunches.

Murray (1959) and Wardlaw (1961) reported that characteristic symptoms of nitrogen deficiency were slow growth, development of yellowish green colour of lamina and deep reddish pigmentation in petiole. Total deficiency of nitrogen would affect the growth beyond flowering (Charpentier and Martinprevel, 1965). A considerable reduction in yield and quality invariably occured if differentiation coincided with a period of nitrogen deficiency

Pale green leaves and pink petioles were produced by nitrogen deficiency in 'Williams' bananas (Iahav et al, 1981)

Severe phosphate deficiency has been tentatively identified in Dominica (Simmonds, 1952) Bananas planted on a highly phosphate deficient soil stopped growing after satisfactory establishment This was followed by bad leaf colour, coupled with severe marginal scroching, shrinkage of old leaves, poor root development, rotting of base of cormland occurrence of stained vasculars in the centre of the corm There was a high incidence of mortality of plants

Simmonds and Hutchinson (1953) reported a similar situation with respect to potash deficiency There was satisfactory early growth, but afterwards the older leaves turned yellow at tip and distal margins and yellowing rapidly spread in proximal direction until the whole leaf withered

Occurrence of premature yellowing was reported in 8-10 month old 'Lacatan' bananas due to low potassium supply in dry soils (Hasselo, 1961) On chinchina series soil, K_2O at 200 or 400 kg/ha controlled premature yellowing (Garcia et al 1981) Murray (1960) observed that visual deficiency symptoms of potassium appeared at levels considerably lower than those at which growth was reduced According to Cassidy (1960) in declining banana plantations the first defeciency to appear was that of potassium

The defeciency symptoms of the major nutrients was described by Singh and Srivastava (1962) and also by Lahav and Turner (1983) Defeciency of nitrogen results in uniform paleness of leaves of all ages and the petioles develop a pink colour Phosphorous defeciency leads to saw toothed marginal chlorosis of old leaves followed by petiole breaking and blueish bronze colour of young leaves Yellow orange chlorosis of old leaves is observed in case of potassium defeciency leading to leaf bending and quick leaf dessication

2.12. Split application of nutrients

Summerville (1944) observed that time of application of fertilizer is important in determining the yield of banana According to him the early stages of growth were critical and fertilizers should be applied during the early stages of growth Alexandrovitz (1955) Dugain (1959), HO (1968) and Leigh (1969) had pointed out the importance of split application in banana Dugain applied nitrogenous fertilizers in 2-12 instalments

Osborne and Hewitt (1963) found no significant difference in yield by application of fertilizers either once in a year or three times a year In Puerto Rico fertilizers were applied in three split doses (Champion, 1970) In Mozambique 200 kg N, 50-150 kg P_2O_5 and 100-600 kg K_2O/ ha are applied in three to four splits, (Marques and Monterio, 1971) Shanmughom and Velayaudham (1972) stated that potassium could be applied along with nitrogen in three split doses viz one, three and five months after planting in Robusta Lahav (1974) followed four splits $year^{-1}$ in the northern coastal plains Veerararaghavan (1972) recommended 228 g N, 228 g P_2O_5 and 456 g K_2O / year after planting in two equal split doses

Veerannah et al (1976) studied the nutrient uptake in poovan and robusta bananas reported that nitrogen and phosphorous were absorbed more in preflowering stage in Robusta, but in equal quantities before and after flowering in Poovan In Assam three split applications of fertilizers are given to Dwarf Cavendish (Jahajee) (Sharma and Roy, 1973) Ramaswamy and Muthukrishnan (1974) recommended two split applications of fertilizers in the third and fifth months after planting in Robusta Nambiar et al (1979) recommended application of fertilizers in three equal splits at 30, 60 and 150 days after planting for 'Zanzibar' type of Nendran

Different levels of split application were recommended for different nutrients by HO (1968) He recommended five split applications of nitrogen, two split applications of phosphorus and three split applications of potassium for the maximisation of yield

Studies by Obeifuna (1984) revealed that the highest yield of plantain associated with heavy application of K_2O, two to three times after planting could be achieved by timely application of K_2O at the 19th/20th leaf stage when it requires more potassium for its floral initiation

Gopimony et al (1979) recommended application of an additional application of an additional dose of 500 g urea in five equal split doses at one week interval during the fifth month of planting for obtaining high yields Chundawat et al (1982) recommended three split doses within six months of planting Basrai banana Kotur and Mustaffa (1984) reported the application of nitrogen in two split doses, fifth and eighth month after planting in Robusta banana

According to Rajeevan (1985) yield could be improved by 17 per cent in Palayankodan variety by suitably spliting the recommended dose of fertilizers Yadav et al (1988) recommended application of potassium in three split at 300 g $plant^{-1}$ to get best results In Kerala it is recommended to apply fertilizers in six splits for 'Nendran' banana to improve finger size and increase bunch weight (Anon 1989)

Sharma and Yadav (1987) recommended application of fertilizers in two split doses Beena Natesh et al (1993) reported that application of fertilizers for Nendran banana in four splits resulted in better yields than applying in two split doses

2 13. Leaf nutrient levels

Based on N P K concentration of third, fifth and seventh leaf Hewitt (1955) suggested that third leaf should be sampled to estimate nutrient status He found that 2 6 per cent N, 0 45 per cent P_2O_5 and 3 3 per cent K_2O were the critical concentrations and that no increase in yield could be obtained by additional application of P_2O_5 and K_2O over and above their critical levels Murray (1960) observed that K_2O content in leaves increased with increasing age and in K defecient plants this increase was at a much lower rate Boland (1960) reported the optimum levels of N, P_2O_5 and K_2O as 2 8 -3 0% 0 4-0 55 per cent and 3 8 to 4 0 per cent Hagin et al (1964) recommended addition of nutrients when the leaf content fell below 0 19 per cent for P, 3 3 per cent of K_2O and 3 2 per cent for nitrogen Twyford (1967) standardised the fourth youngest leaf to assess the critical level of nutrients The critical level for nitrogen was shown to be 2 9 per cent in the most soils and 2 6 per cent in very light soils For P_2O_5 it was 0 29 per cent to 0 48 por cent and for K_2O it was 3 8 per cent The concentration for nitrogen and potassium were constant and were recommended for wide adoption

Hewitt and Osborne (1962) working on lacatan variety of banana observed that for securing high yields the leaf tissue should have 2 6 per cent nitrogen o 40 per cent P_2O_5 and 4 0 per cent K_2O respectively Potash application rapidly increased leaf potash and heavy application decreased leaf nitrogen Ho (1969) established significant correlation between K concentrations in third leaf in one hand and the height and girth of pseudostem, number of fingers and yield on the other hand Iacoevilho and Martin-prevel (1971) analysed banana leaves for potassium concentration in third and fourth leaves (combined) and expressed as percentage of drymatter during flowering stage During flowering and harvest stages the levels of K_2O were 4 3 and 8 5 per cent respectively, whereas potassium defecient plants showed 2.65 and 1 8 per cent during the same stage

Ramaswamy (1971) observed leaf nutrient levels of 3 29 per cent N, 0 44 per cent P_2O_5 3 11 K_2O, 2 12 per cent Ca and 6 24 per cent Mg as optimum for increased yield in 'Robusta' banana sunder Singh (1972) reported that leaf nutrient content of 3 13 per cent N, 0 44 per cent P_2O_5, and 3 89 per cent K_2O in the fifth month and 3 37 per cent N, 0 51 per cent P_2O_5 and 4 36 per cent K_2O in the seventh month as optimum for variety Robusta for high yield. Almost similar level of NPK was reported for Robusta banana by Vadivel and Shanmughavelu (1988) and Ashok kumar (1977)

In Vayal Vazhai the N content at shooting was 1 93 per cent. The P content of plants was generally low the highest being at shooting (0.13 per cent) Banana plant contained a higher amount of K than any other nutrient (2.99 per cent at shooting). (Buragohain and Shanmughavelu, 1990). The Calcium of the banana plant increased with age, 0 43 per cent at sucker stage to 1 158 per cent at harvest The Mg content also increased with age, 0.254 per cent at the sucker stage to 0 574 per cent at the shot stage and 1 045 per cent at harvest, Buragohain and Shanmughavelu (1990) Vadivel and Shanmughavelu (1991) reported a Ca and Mg content of 0.68 per cent and 0 35 per cent at shooting respectively.

Ray et al (1988) observed that increased doses of applied nutrient were reflected in increased contents of these elements in the leaves A leaf content of 2 8 per cent N, 0.52 per cent P and 3 8 per cent K at shooting were considered a good indicator of satisfactory subsequent productivity

According to Warner and Fox (1977) leaf N levels were associated with yield which approached a maximum at about 2 6 per cent N Plants adequatley supplied with K content about 4 5 - 5 per cent K in the third fully unfurled leaf as reported by Vonwexkull (1970)

2.14. Interaction between nutrients

Antagonism or Synergism between nutrient elements reported in banana is observed to affect the growth and development of banana plant considerably

Hewitt and Osborne (1962) reported that increased doses of K increased the leaf K content and high dressings brought about depression of leaf N. Murray (1960) expressed the view that antagonism existed between K and Mg, and K and Ca, stronger antagonism being between the latter two Ho (1969) also reported a similar trend besides the antagonism between K and N. According to Labav (1973) antagonism exists between K and Mg, K and Ca, K and N and also K and Na But a synergestic relationship was observed between K and P. Antagonism between K and Ca and Mg is further confirmed by Childers (1966), Barber (1986), Garcia and Gu[illegible]ro (1981), Turner and Barkus (1984) Dumas and Martinprevel (1958) reported that yields depended largely on the balance between K and N, Ca and Mg

In studies with William banana by Lahav (1977) no antagonism was observed between N and K Synergestic relationship was noticed between K and P. There was antagonism between K and Ca, and K and Mg K supply had the greatest influence on Ca and Mg levels (Lahav, 1977 (b)) An increase in K content in petiole and leaf blade coincided with a decrease in Ca and Mg content (Iahav 1977). Turner (1983) reported that high Mn depressed Mg and Ca uptake and increased Mn uptake seven folds

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation on tissue cultured Nendran Banana was carried out as two separate experiments The first experiment was aimed at making a critical comparison of the growth pattern, flowering and yield potential of tissue cultured plants of banana var Nendran with those of conventional propagating material, (Suckers) grown under similar conditions The second experiment was undertaken with the intention of formulating an appropriate fertilizer schedule for tissue cultured banana The plantlets of banana var Nendran was supplied by M/S A V. Thomas & Co, Kochi The experiments were laid out in the rice fallows attached to the Instructional Farm, Vellayani. The materials and methods used for the study are detailed below

3.1. Location

The field experiments were conducted in the rice fallows of the Instructional Farm attached to the College of Agriculture, Vellayani, with an assured water supply throughout the period of growth of the crop The experiment site was located at an altitude of 29 M above the mean sea level, and at a latitude of 8 5^{o} N and longitute of 76 9^{o} E The soil of the experimental field was clay loam kaolinitic isohypothermic family of Rhodic Haplustox

3.2 Climate

The experimental site enjoys a humid tropical climate There were abudant rains during the cropping period from the two monsoons The data on various weather parameters (monthly rainfall, mean maximum and minimum temperatures relative humidity and sunshine) during the period (March 91 and January 93) are presented in Appendix 1 The mean maximum and minimum temperatures during the cropping period were 32 55^{o}C and 23 18^{o}C respectively Total rainfall received during the period was 4241 6 mm Maximum rainfall was received during the month of June 1991 During the dry spells irrigation was given to the crop at fortnightly intervals with 200 litres of water per plant

3 3 Cultivar

Tissue cultured plantlets and suckers of the variety 'Nendran' the most popular duel purpose commercial cultivar of Kerala was used There is wide spread cultivation of Nendran banana in the rice fallows of the State

3.4 Planting material

Experiment I Two groups of tissue cultured plants of age 2 5 months and 3 5 months respectively supplied by M/S A V Thomas & Co, Kochi and suckers of the same age groups were used for the study.

Experiment II Three month old tissue cultured plants were used for the study

3.5. Field preparation and planting

Raised beds were prepared with proper drainage and pits were made at a size of 50 cm^3 and at a spacing of 2m x 2m Woodash at the rate of 2 kg/pit, Farmyard manure at 10 kg/pit and green manure at 10 kg/pit were applied as basal dressing (as per farmers practise). 25 g of phorate containing 10% active ingredient was applied to each pit before planting as a prophylatic measure against rhizome weevils and aphids.

3.6 Planting

Experiment I A handful of sand was incorporated in each pit prior to planting to encircle the root zone of both the tissue cultured plants and suckers They were then planted upright in the pit

Experiment II The plants were planted upright in the pit after mixing a handful of sand with the clayey soil in the pit

3.7. Experiment design and layout

3.7.1. Experiment I

The experiment was laid out in Split Split Plot in Randomised Block Design

The details of the layout are as follows

Total number of treatments	-	24 (2×2×3×2 - T1 to T24)
Number of replications	-	2
Main plot treatments	-	Combination of age groups and mode of sucker retention
Age group	-	2 (2 5 months old and 3 5 months old)

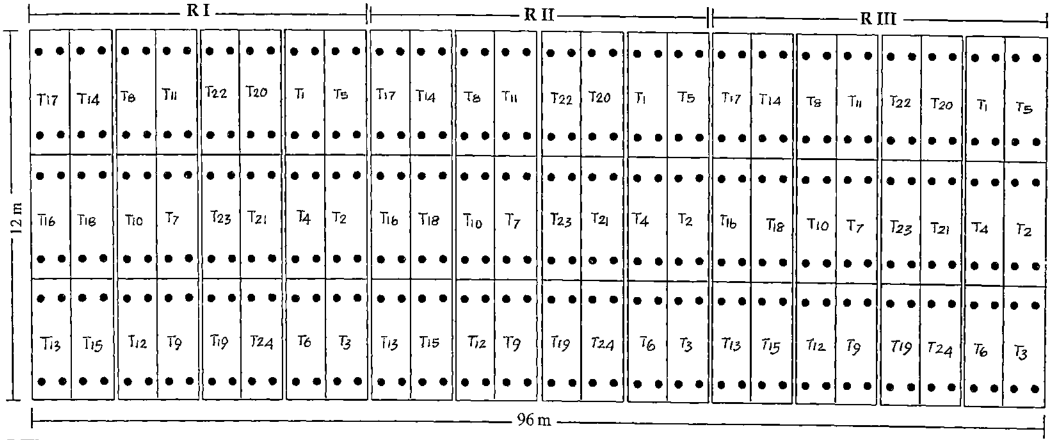
Ex. I. Growth pattern flowering and yield potential of tissue cultured plants vis a vis suckers

Sl No	Treatment code	Treatment details
1	T_1	$a_1b_1c_1d_1$
2	T_2	$a_1b_1c_1d_2$
3	T_3	$a_1b_1c_2d_1$
4	T_4	$a_1b_1c_2d_2$
5	T_5	$a_1b_1c3d_1$
6	T_6	$a_1b_1c3d_2$
7	T_7	$a_1b_2c_1d_1$
8	T_8	$a_1b_2c_1d_2$
9	T_9	$a_1b_2c_2d_1$
10	T_{10}	$a_1b_2c_2d_1$
11	T_{11}	$a_1b_2c3d_1$
12	T_{12}	$a_1b_2c3d_2$
13	T_{13}	$a_2b_1c_1d_1$
14	T_{14}	$a_2b_1c_1d_2$
15	T_{15}	$a_2b_1c_2d_1$
16	T_{16}	$a_2b_1c_2d_2$
17	T_{17}	$a_2b_1c3d_1$
18	T_{18}	$a_2b_1c3d_2$
19	T_{19}	$a_2b_2c_1d_1$
20	T_{20}	$a_2b_2c_1d_2$
21	T_{21}	$a_2b_2c_2d_1$
22	T_{22}	$a_2b_2c_2d_2$
23	T_{23}	$a_2b_2c3d_1$
24	T_{24}	$a_2b_2c_2d_2$

a - Age of planting material
b - Made of sucker retention
c - Split application of fertilizers
d - Type of planting material

Fig. 1. Layout plan of Experiment No. I

Growth pattern, flowering and yield potential of tissue cultured plants vs. suckers



Main plot
Split plot
Split split plot

Number of main plots = 12
(4 per replication)
Number of split plots = 36
Number of split split plots = 72
Design Split split plot in RBD

Area of plot = 4m x 4m
Plants / plot = 4
Number of replications = 3

Main plot = 2 x 2
(Age and mode of sucker retention)
Sub plot = Split application of fertilizer (3)
Sub sub plot = 2 Type of planting material

Mode of sucker retention	-	2 (retaining 2 suckers per plant after bunch emergence and not retaining any sucker till harvest)
Split-plot treatments	-	3 (levels of split applications of fertilizer)

Details of split application of fertilizer is given in the Appendix 2

Split split plot treatment	-	2(Types of planting material tissue cultured plants and conventional suckers)
No of replications	-	3
No of blocks/replication	-	4
No. of plots/block	-	6
No of plants/plot	-	4
Spacing	-	2m x2m

3.7.2. Experiment II

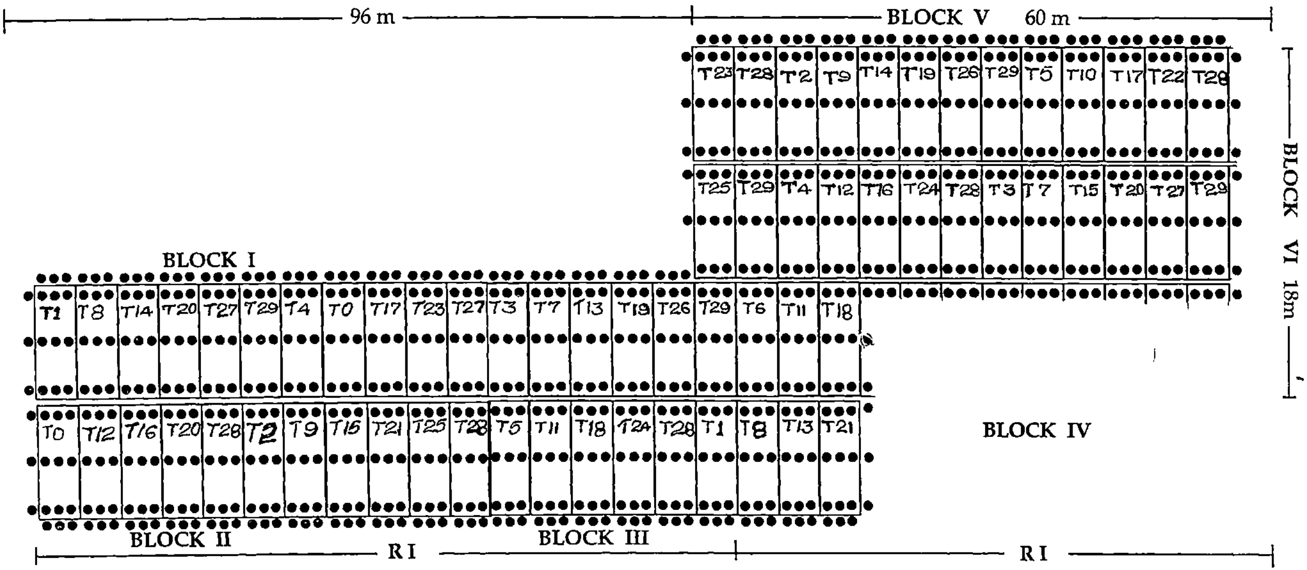
The experiment was laid out in 3^3 Partially Confounded Design in Randomised Block, confounding the higher order interactions, NKT in replication I and $NK^2 T^2$ in replication II respectively The details of layout are as follows

Ex. II. Standardisation of fertilizer schedule for tissue cultured plants of banana — Treatment details

Sl No	Treatment code	Treatment details
1	T_1	$N_1K_2S_1$
2	T_2	$N_1K_2S_2$
3	T_3	$N_1K_2S_3$
4	T_4	$N_1K_2S_1$
5	T_5	$N_1K_2S_2$
6	T_6	$N_1K_2S_3$
7	T_7	$N_1K_3S_1$
8	T_8	$N_1K_3S_2$
9	T_9	$N_1K_3S_3$
10	T_{10}	$N_2K_2S_1$
11	T_{11}	$N_2K_2S_2$
12	T_{12}	$N_2K_2S_3$
13	T_{13}	$N_2K_2S_1$
14	T_{14}	$N_2K_2S_2$
15	T_{15}	$N_2K_2S_3$
16	T_{16}	$N_2K_3S_1$
17	T_{17}	$N_2K_3S_2$
18	T_{18}	$N_2K_3S_3$
19	T_{19}	$N_3K_2S_1$
20	T_{20}	$N_3K_2S_2$
21	T_{21}	$N_3K_2S_2$
22	T_{22}	$N_3K_2S_1$
23	T_{23}	$N_3K_2S_2$
24	T_{24}	$N_3K_2S_3$
25	T_{25}	$N_3K_3S_1$
26	T_{26}	$N_3K_3S_2$
27	T_{27}	$N_3K_3S_3$
28	PP	Package of practices recommendation
29	AC	Absolute control

Fig. 2. Layout plan of Experiment No. II

Standardisation of fertilizer schedule for tissue cultured plants of banana



Design - Partially confounded factorial in Randomised Block Design
Confounded effects - NKS in R1 NK^2S^2 in R11

No of blocks = 6
No of plots/block = 11
Area of individual plot = 6m x 6m

Total no of treatments - 27

Number of controls - 2

Number of replications - 2

Number of blocks - 6

Number of plots/block - 11 (9 treatments + 2 controls)

Spacing - 2m x 2m

No of plants/plot - 9

Treatments- Treatments consisted of combinations of three levels of nitrogen and three levels of potassium and three levels of split application

Levels of nitrogen

1 N_1 - 200 grams/plant/year

2 N_2 - 300 grams/plant/year

3 N_3 - 400 grams/plant/year

Levels of potassium

1 K_1 - 300 grams/plant/year

2 K_2 - 450 grams/plant/year

3 K_3 - 600 grams/plant/year

Levels of split application

T_1 - 30,60,90,120 and 150 days after planting and just after complete emergence of bunch (Six split applications)

T_2 - 15,30,45,60,90,120 and 150 days after planting and just after complete emergence of bunch (eight split applications)

T_3 - 20,40,60,90,120 and 150 days after planting and just after complete emergence of bunch (seven split applications)

The details of split application of fertilizers are given in Appendix 2

P_2O_5 was applied uniformly in all plots as single super phosphate as per package of practices recommendations

Control

1. Package of practices recommendations of Kerala Agricultural University (190,115,300 g/plant NPK/year in six split doses) (Anonymous, 1989)

2 Absolute control - No fertilizer application

3.8. Observations

3.8.1. Morphological Characters

3.8.1.1. Weight of planting material

Weight of each tissue cultured plant and sucker were recorded at the time of planting

3.8.1.2. Height of plants at planting

The height of pseudostem was measured from the base of the plant to the tip of the youngest leaf and recorded in centimetres

3.8 1 3 No of leaves at planting

The total number of leaves on the plant at the time of planting was recorded

3.8.1.4. Girth of pseudostem

Experiment I The girth of pseudostem at 10 cm above ground level was measured at weekly intervals upto 12 weeks after planting and thereafter at monthly intervals and recorded in centimetres

Experiment II The girth of pseudostem was measured at 10 cm above ground level at monthly intervals and expressed in centimetres

3.8.1.5. Height of pseudostem

Experiment I The height of pseudostem was measured from the base of the plant to the axil of the youngest leaf at weekly intervals upto 12 weeks after planting and thereafter at monthly intervals and recorded in centimetres

Experiment II The height of pseudostem was measured from the base of the plant to the axil of the youngest leaf and recorded in centimetres

3.8.1.6. Number of leaves produced

Total number of leaves produced by the plant at monthly intervals till shooting was recorded

3.8.1.7. Number of leaves retained

The total number of fully opened functional leaves retained by the plant at monthly intervals was recorded

3.8.1.8. Progressive/Cumulative total number of leaves

The total number of leaves produced by the plant in its life time was computed by progressively counting the total number of leaves produced in each month till shooting

3.8.1.9. Total leaf area

This was computed using the formula

Leaf area of index leaf = Length of lamina x width of lamina x 0 8

Total leaf area = Leaf number x leaf area of index leaf

3.8.1.10. Number of functional leaves at shooting

The total number of fully opened functional leaves at the time of shooting was recorded

3.8.2. Duration of the crop

3.8.2 1. Date of shooting

The date of shooting of plants in each treatment was observed, based on which the number of days taken from planting to shooting was worked out

3.8.2.2. Date of harvest

The date of harvest of plants in each treatment was observed, based on which number of days taken from planting to harvest was worked out

3.9. Post Harvest Observations

3.9.1. Bunch characters

Bunches were harvested when fully mature as indicated by the disappearance of angles from fingers (Simmonds, 1959) The following observations were made on the bunch characters

3.9.1.1. Weight of bunch

Weight of bunch including the portion of the peduncle upto the first scar (exposed outside the plant) was recorded in Kilograms

3.9.1.2. Length of bunch

This was measured from the point of attachment of first hand to that of the last hand and expressed in centimetres

3.9.1.3. Internodal length

The distance between each hand on the peduncle was measured and expressed in centimetres

3.9.1.4. Number of hands/bunch

The number of fingers in each hand was noted

3.9 1.5. Number of fingers

The number of fingers in each the bunches was counted and the values recorded.

3.9.1.6. Weight of fingers

The middle fruit in the top row of the second hand (from the base of the bunch) was selected as the representative finger (Gottreich et al 1964) for finding out the mean finger weight, girth and length of finger The weight of this representative finger was recorded as the mean finger weight

3.9.1.7. Girth and length of finger

Girth was measured at the middle portion and length from the portion of attachment to the top using fine thread and scale

3.9.1.8. Pulp/peel ratio

The weight of peel and pulp of ripe fruits were taken separately and the ratio worked out

3.9.2. Qualitative analysis

The fruits collected from well ripe bunches were used for quality analysis The middle fruit in the top row of the second hand was selected as the representative sample Samples were taken from each fruit from three portions viz top, middle and bottom These samples were used for analysis as detailed below

3.9.2.1. Total soluble solids (TSS)

The samples as mentioned above were used for the analysis of total soluble solids (TSS) which was found out using a pocket refractometer and expressed as percentage

3.9.2.2. Total sugar

The total sugar of the samples were determined as per the method described by AOAC (1977)

3.9.2.3. Reducing sugars

This was estimated as per the method described by AOAC (1977)

3.9.2.4. Non-reducing sugars

The content of non-reducing sugars were computed from the values estimated for total sugars and reducing sugars (Ranganna, 1977)

3.9.2.5. Acidity

Acidity of fruit pulp was estimated as per the method described by AOAC (1977) and expressed as percentage of citric acid.

3.9.2.6. Sugar/Acid ratio

This was arrived at by dividing the total sugars with titrable acidity

3.10. Nutrient content of leaves

The nutrient content of 3rd leaf was estimated by the following methods

Nitrogen was estimated by the micro kjeldahl digestion distillation method (A.O A C, 1977) and phosphrous by the Vanadomolybdophosphoric yellow colour method and potassium by the flame photometer method (Jackson, 1973). An atomic absorption spectrophotometer (Perkin Elmermake) was used for determing Calcium, Magnesium and Zinc content The content of nutrients was expressed as percentage. Iron was estimated by the thiocyanate method and the colour read in spectro photmeter (Spectronic 20) at a wave length fo 490 nm (Jackson, 1973).

3.11. Other observations

3.11.1. Benefit/ cost ratio

Benefit / cost ratio of various treatments were worked out, considering all aspects of cost of cultivation and the income derived from the plant. It was calculated as per the norms and rates fixed by the instructional farm, College of Agriculture, Vellayani, Thiruvananthapuram

3.11.2. Incidence of pests and diseases

The various diseases and pests observed in the plant were recorded as and when they appeared. Disease scoring was carried out as per the method suggested by Suherban (1977)

3.11.3. Soil nutrient status

Soil samples were collected from the plot before planting and after harvest and were analysed for available nitrogen, phosphorus and potassium following the method of Jackson (1973)

3.11.4. Statistical analysis

The experimental data were analysed statistically by applying the technique of analysis of variance as per the layout of the experiments (Panse and Sukhatme 1967) pooled analysis was conducted for yield The physical and economic optimum for nitrogen and potassium were worked out separately for each crop fitting quadratic response surface function for nitrogen and potassium using the formula $y = b_0 + b_1 N + b_2 K + b_{11} N^2 + b_{22} K_2{}^2 + b_{12} NK$ (Das & Giri, 1979)

3.11.5. Variations in morphological characters of tissue cultured plants.

The crop was watched regularly to note any variation from the confirmed morphological features of the cultivar [Musa (AAB group) 'Nendran'], in the tissue cultured plants Any peculiarity in growth and development of morphological features was taken note of

RESULTS

RESULTS

Experimental results

The present study was undertaken with the objective of comparing the growth pattern, flowering and yield potential of tissue cultured plants of 'Nendran' banana with those of the plants produced from suckers and to standardise a suitable fertilizer schedule for the tissue cultured plants Two separate experiments were conducted from March 1991 to February 1993 for two seasons in the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram The salient results are presented below

4.1 Experiment I: Growth pattern, flowering and yield potential of tissue cultured plants vis-a-vis suckers

4.1.1 Weight, height and number of leaves per plant at the time of planting

At the time of planting in the 2 5 month age group, the weight of tissue cultured plants ranged from 95 to 123 g and that of the 3 5 month age group ranged from 118 to

Plate 1. Tissue cultured plants at planting

Plate 2. A view of the experimental field (Experiment I)

134 g The average weight of suckers used for planting ranged from 1 085 kg to 1 206 kg (2 5 month old) and from 1 423 to 1 516 kg (3 5 month old)

The number of leaves in tissue cultured plants were three to five in 2 5 month old groups and four to seven in 3 5 month old group The average height of 2 5 months old tissue cultured plants 23 8 to 27 6 cm and that of 3 5 month old plants were 28 8 to 34 7 cm

4 1 2 Vegetative characters

4 1 2 1 Height of the pseudostem

4 1 2 1 1 Main effect of the factors on the height of the pseudostem

Weekly observations were made on the height of pseudostem from two weeks after planting upto three months and there after at monthly intervals The age of plants used had a significant effect on the height of pseudostem in the early stages of growth (three to four weeks after planting

Table 1 Effect of age split application of fertilizers and type of planting material on height of pseuiostem

He ght of pseudostem (cm)

Ma n effect	3	4	5	6	7	8	9	0	11	2	4	5	6		Shoot ng
	Weeks afte plant ng										Month after plant ng				
a1	21 08	28 4	35 87	43 29	51 24	63 33	85 41	101 08	107 62	117 62	138 54	88 63	212 00	240 6	286 05
a2	23 51	32 48	38 35	45 00	52 74	65 74	86 27	02 03	07 39	119 85	3 78	192 09	209 08	23 33	28 9
	*														
f 1 2	9 65	6 42	14 58	4 86	10 06	4 80	11	4 1	2 4		0 94	17 43	6 58	9	
cd	2 353	2 284													
c	22 35	30 03	34 65	40 66	49 00	62 07	84 83	00 03	06 70	11 45	36 86	87 3	2 3	236 00	281 6
c2	22 10	29 81	36 90	43 79	51 28	64 3	85 58	102 03	0 29	20 90	138 42	91 55	209 60	240	288 04
c3	22 43	3 09	39 9	47 99	55 68	66 39	8 13	02 35	0 2	7 85	39 2	92 22	2 0 50	240 21	29 9
				*											
f 2 4	0 11	1 5	32 4	45 58	29 34	48 84	1 22	9			7 38	16 53	4 32	2 84	
cd			82	2 14	2 463	222					733	2 574			
d1	22 40	30 45	3 93	45 75	53 20	66 85	8 44	03 34	109 9	122 72	40 68	93 36	2 6 00	244 36	295 86
d2	22 19	30 17	36 29	42 54	50 78	6 7	84 24	99 78	04 75	114 74	135 65	187 37	205 00	233 58	278 42
															*
f 1 16	1		35 09	79 32	5 69	72 25	22 82	28 59	233 5	11 061	345 94	0 13	12 65	68 90	20 62
cd			0 583	0 61	0 3	0 834	42	4	0 23	5 09	0 572		2 34	2 65	6 3

The 3 5 month old plants had greater height than the 2 5 month old plants This difference levelled off with the further growth of plants and both age groups recorded heights statistically on par during the later stages (Table 1)

The height of plants was influenced by the different levels of split application of fertilizers During the initial periods of growth five six seven and eight weeks after planting higher levels of split application resulted in greater heights (Table 1) During the fifth and sixth month after planting the same trend continued However the total height of plants at the time of shooting was not influenced by the different levels of split application

During the initial stages upto the fourth week after planting the height of tissue cultured plants and suckers did not show any significant difference But from fifth week onwards the tissue cultured plants had greater height (Table 1) than the plants from suckers The total height of plants at the time of shooting was 295 56 cm for tissue cultured plants and 278 42 cm for the sucker derived plants

4 1 2 1 2 Interaction effect of the factors on the height of pseudostem

There was no difference in the height of plants due to the interaction between age and split application of fertilizers

The interaction between age and planting material did not significantly affect the height of plants at various stages of growth

Six and seven weeks after planting the tissue cultured plants in combination with the highest level of split application resulted in significantly greater heights (Table 2)

4 1 2 2 Girth of pseudostem

Weekly observations were taken on the girth of pseudostem from the second week after planting upto four months and thereafter at monthly intervals

Table 2 Interaction effect of the age split application of fertilizers and type of planting material on height of pseudostem

Height of pseudostem (cm)

Interaction effect	3	4	5	6	7	8	9	10	11	12	4	5	6	7	Shooting
	Weeks after planting										Month after planting				
a1c1	21 42	27 79	33 14	39 15	47 21	60 90	84 15	99 13	106 33	117 02	136 58	185 24	212 00	234 33	279 08
a1c2	20 46	27 15	35 22	42 55	50 62	63 42	84 58	101 92	107 34	118 10	139 34	189 74	214 00	244 25	288 25
a1c3	21 36	29 48	39 26	48 17	55 87	65 64	87 49	102 19	108 12	117 73	139 72	190 92	215 00	243 25	290 83
a2c1	23 29	32 27	36 16	42 16	50 79	63 24	85 50	100 93	107 08	117 88	137 15	189 38	214 34	237 67	284 83
a2c2	23 74	32 48	38 57	45 03	51 94	65 33	86 58	102 68	107 79	123 70	137 49	193 38	218 65	237 17	287 83
a2c3	23 50	32 70	40 32	47 80	55 50	67 15	86 76	102 50	107 33	117 53	138 70	195 53	220 21	237 17	291 75
$f_{2\ 4}$	<1	<1	1 86	2 76	2 49	1	1	<1	<1	<1	1 95	<1	1	3 51	<1
cd															
a1d1	21 17	28 29	36 50	44 82	52 66	65 97	87 20	102 47	109 61	120 97	141 37	191 69	216 50	246 94	294 56
a1d2	20 99	27 98	35 25	41 77	49 81	60 67	83 61	99 69	104 91	114 26	135 72	185 57	212 21	234 28	277 56
a2d1	23 62	32 61	39 37	46 68	53 73	60 72	87 69	104 21	110 21	124 47	140 00	195 02	220 21	241 78	296 56
a2d2	23 40	32 35	37 33	43 31	51 75	62 76	84 87	99 86	104 59	115 23	135 57	189 17	214 30	232 89	279 30
$f_{1\ 16}$	<1	3 43	1 96	<1	1 60	<1	1	1 40	1 92	<1	4 92	6 13	4 56	2 12	<1
cd															
c1d1	21 83	29 90	35 18	42 17	50 40	63 21	87 26	102 42	109 19	119 34	138 36	189 98	214 21	240 83	289 58
c1d2	22 88	30 15	34 12	39 15	47 60	60 71	82 39	97 64	104 21	115 55	135 13	184 65	208 58	231 17	273 87
c2d1	22 68	30 06	37 96	45 57	52 40	65 94	87 78	104 44	110 23	127 81	141 17	194 22	218 61	246 17	294 50
c2d2	21 56	29 56	35 83	42 08	50 16	63 41	83 42	100 15	104 90	113 99	135 67	188 90	212 58	235 25	281 58
c3d1	22 68	31 39	40 66	49 51	56 79	68 20	87 34	103 16	110 30	121 02	142 28	195 88	220 26	246 08	302 58
c3d2	22 18	30 79	38 93	46 46	54 58	64 18	86 91	101 53	105 15	114 68	136 14*	188 56	213 56	234 33	280 00
$f_{2\ 16}$	2 86	<1	1 28	<1	<1	<1	4 33	2 16	<1	1 57	8 67	<1	<1	<1	<1
cd															

4 1 2 2 1 Main effects of the factors on the girth of pseudostem

There was no significant difference between different age groups on the girth of the pseudostem at the different stages of growth

The different levels of split application had no significant effect on the girth of pseudostem

There was significant difference between tissue cultured plants and conventional suckers in the girth of the pseudostem At planting suckers had a higher girth and maintained superiority in the initial stages of growth From the tenth week tissue cultured plants had a significantly higher girth of pseudostem than plants derived from suckers At this stage the tissue cultured plants had a girth of 24 24 cm and the plants derived from suckers 21 33 cm At the time of shooting the former had a girth of 66 78 cm and the latter 59 67 cm (Table 3)

4 1 2 2 2 Interaction effect of the factors on the girth of the pseudostem

There was no difference between treatments on the girth of the pseudostem due to the interaction between age and split application of fertilizers (Table 4)

Table 3 Effect of the age split application of fertilizers and type of planting material on girth of the pseudostem

Girth of the pseudostem (cm)

Main effect	3	4	5	6	7	8	9	10	11	12	4	5	6	7	Shoot ng
				Week after planting								Month after planting			
a1	7 09	9 18	10 94	12 48	14 23	16 68	19 20	22 73	25 43	29 19	38 98	49 50	53 20	58 09	62 55
a2	7 27	9 29	11 16	12 68	14 65	17 08	19 33	22 84	25 66	28 90	38 13	49 10	53 45	58 67	63 91
f1 2	<1	2 16	4 09	6 58	12 43	12 14	<1	<1	1 19	<1	1 73	0 57	0 42	1 69	3 57
CD															
c1	6 90	9 01	10 85	12 42	14 19	16 58	19 12	22 61	25 15	28 88	38 47	48 73	53 23	57 93	62 45
c2	7 00	9 32	11 15	12 66	14 57	17 00	19 30	22 68	25 72	28 94	38 58	49 65	55 16	59 23	63 87
c3	7 65	9 38	11 15	12 65	14 55	17 07	19 38	23 08	25 76	29 33	38 60	49 51	53 18	57 99	63 37
f2 4	17 01*	2 35	2 25	1 40	12 89	6 39	3 08	1 78	5 75	<1	<1	<1	<1	1 60	2 17
CD	0 389														
d1**	6 44	8 96	11 00	12 86	15 01	18 18	20 40	24 24	26 89	29 54	41 02	51 98	57 23	62 28	66 78
d2	7 93	9 51	11 11	12 29	13 86	15 59	18 13	21 33	24 20	28 56	36 09	46 62	50 15	54 48	59 67
f1 16	363 60**	92 58**	2 50**	60 76	210 19**	1118 09**	467 05**	400 24**	393 26**	5 52**	183 76**	201 25**	18 26**	373 21**	213 08**
cd	0 165	0 121		0 157	0 168	0 164	0 223	0 308	0 288	0 885	0 771	0 801	0 820	0 857	1 032

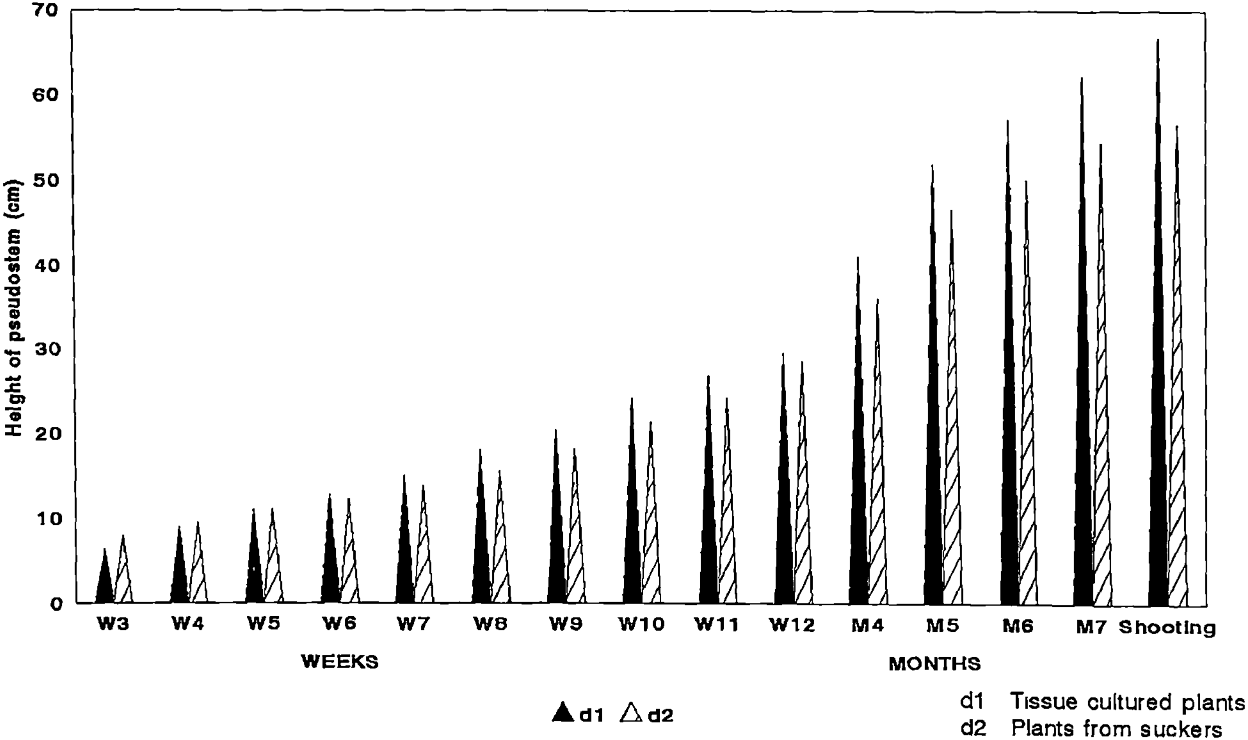


Fig. 3. Effect of type of planting material on girth of pseudostem

Table 4 Interaction effects of age split application of fertilizers and type of planting material on girth of pseudostem

Girth of the pseudostem (cm)

Interaction effect	3	4	5	6	7	8	9	10	11	12	4	5	6	7	Shooting
	Weeks after planting										Month after planting				
a1c1	6 97	8 99	10 82	12 32	14 04	16 45	19 18	22 55	25 25	28 80	38 94	49 13	53 26	57 98	61 64
a1c2	6 96	9 24	11 03	12 56	14 27	16 83	19 27	22 73	25 66	28 97	38 81	49 64	53 54	58 66	63 21
a1c3	7 34	9 30	10 78	12 56	14 36	16 75	19 17	22 92	25 38	29 82	39 18	49 71	53 08	57 64	62 80
a2c1	6 81	9 03	10 99	12 53	14 34	16 70	19 06	22 66	25 05	28 95	38 00	48 34	52 15	57 87	63 27
a2c2	7 04	9 39	11 27	12 78	14 86	17 17	19 34	22 61	25 79	28 93	38 36	49 65	53 67	59 80	64 53
a2c3	7 95	9 45	11 32	12 75	14 73	17 39	19 58	23 25	26 15	28 85	38 01	49 32	53 58	58 34	63 94
f2 4	4 00	<1	<1	<1	1 64	<1	3 14	1	3 00	6 23	<1	<1	<1	<1	<1
cd															
a1d1*	6 10	8 91	10 88	12 71	14 85	17 97	20 32	24 18	26 71	29 47	41 38	52 04	56 68	61 37	65 23
a1d2	8 08	9 45	11 00	12 25	13 60	15 38	18 08	21 28	24 15	28 92	36 57	46 94	52 33	54 81	59 87
a2d1	6 70	9 02	11 11	13 03	15 17	18 30	20 49	24 30	27 07	29 61	40 66	51 91	55 58	63 19	68 33
a2d2	7 77	9 57	11 21	12 33	14 12	15 79	18 17	21 38	24 25	28 20	35 60	46 29	52 66	54 15	59 48
f1 16	40 71**	<1	<1	2 35	1 55	<1	<1	<1	<1	1 076	<1	<1	<1	9 316*	12 728**
cd	0 234													1 218	1 460
c1d1	6 19	8 76	10 74	12 62	14 89	17 89	20 23	24 03	26 45	29 65	40 64	51 17	57 16	61 58	65 80
c1d2	7 60	9 27	10 97	12 23	13 49	15 26	18 00	21 20	23 85	28 10	36 29	46 30	50 53	54 27	59 11
c2d1	6 15	9 09	11 15	12 99	15 05	18 39	20 51	24 19	27 23	29 63	40 83	52 35	55 23	63 00	67 52
c2d2	7 85	9 54	11 15	12 34	14 09	15 60	18 10	21 16	24 23	28 26	36 34	46 94	51 20	55 45	60 23
c3d1	6 98	9 04	11 10	13 00	15 09	18 24	20 48	24 52	27 00	29 35	41 58	52 42	56 63	62 27	67 04
c3d2	8 32	9 72	11 19	12 32	14 00	15 90	18 28	21 65	24 53	29 32	35 63	46 61	52 23	53 72	59 70
f2 16	1 93	1 50	0 13	0 55	2 07	<1	<1	<1	1 44	1 31	1 99	<1	<1	<1	0 190
cd															

In the initial stages (three weeks after planting) plants derived from 3 5 month old suckers had a significantly higher girth (8 08 cm) due to the interaction between age and type of planting material This interaction effect was evident seven and eight months after planting also During this stage plants that developed from 3 5 month old tissue cultured plants had the highest girth (63 19 and 68 33 cm) followed by plants from 2 5 month old tissue cultured plants (61 37 and 65 24 cm) Plants derived from suckers of both age groups had a lower girth and were on par with each other (Table 4)

4 1 2 3 Number of leaves produced at monthly intervals

4 1 2 3 1 Main effect of the factors on the number of leaves produced at monthly intervals

After five months of planting there was difference between the two age groups The 3 5 month old plants produced 5 16 leaves during the fifth month which was higher than the average leaf production of 4 16 by the 2 5 month old plants (Table 5)

Table 5 Effect of age split application of fertilizers and type of planting material on number of leaves produced at monthly intervals

Number of leaves produced

Main effect	1	2	3	4	5	6	7	8
				Month after planting				
a1	3 18	3 18	3 63	4 65	4 79	4 80	4 52	3 62
a2	3 21	3 25	3 73	4 77	5 16	4 90	4 87	3 50
f 1 2	<1	<1	4 56	<1	3 182	1 545	4 61	1 27
cd	–	–	–	–	–	–	–	–
c1	3 06	3 12	3 54	4 37	4 79	4 66	4 37	3 25
c2	3 27	3 26	3 78	4 82	5 03	4 89	4 78	3 69
c3	3 26	3 26	3 72	4 94	5 10	5 01	4 93	3 73
f 2 4	1 93	0 42	3 33	6 11	2 65	8 06	7 84	5 68
cd	–	–	–	–	–	–	–	–
d1	3 38	3 38	4 21	5 32	5 44	5 63	5 53	3 73
d2	3 09	3 05	3 14	4 10	4 52	4 03	3 85	3 39
f 1 16	26 52**	12 35**	575 13**	238 68**	228 62**	690 25**	607 29**	29 45**
cd	0 155	0 195	0 0096	0 168	0 129	0 125	0 144	0 134

There was no significant difference in the average number of leaves produced at monthly intervals due to the effect of split application of fertilizers (Table 5)

The tissue cultured plants produced higher number of leaves compared to the plants from suckers throughout the growing period The average leaf production in tissue cultured plants was 4 57 per month and that of plants from suckers only 3 72 per month The maximum difference in leaf production was observed at seven months after planting

4 1 2 3 2 Interaction effect of the factors on the number of leaves produced at monthly intervals

No significant difference was observed due to interaction of the age and split application of fertilizers

Interaction between age and nature of planting material was not significant

There was a significant effect due to the interaction between the two factors split application of fertilizers and nature of planting material three and four months after planting and also at shooting Application of

Table 6 Interaction effect of age split application of fertilizers and type of planting material on number of leaves produced at monthly intervals

Number of leaves produced

Interaction effect	1	2	3	4	5	6	7	8
				Month after planting				
a1c1	3 03	3 17	3 47	4 23	4 61	4 55	4 30	3 28
a1c2	3 25	3 22	3 75	4 83	4 88	4 83	4 44	3 81
a1c3	3 28	3 17	3 67	4 87	4 88	5 02	4 83	3 78
a2c1	3 08	3 08	3 61	4 47	4 97	4 78	4 44	3 22
a2c2	3 28	3 30	3 80	4 80	5 19	4 94	5 14	3 58
a2c3	3 28	3 36	3 78	5 05	5 33	4 99	5 02	3 69
f 2 4	<1	<1	<1	<1	<1	1 02	2 17	<1
cd	-	-	-	-	-	-	-	-
a1d1	3 35	3 33	4 14	5 31	5 26	5 55	5 31	3 76
a1d2	3 02	3 04	3 11	3 98	4 33	4 05	3 74	3 47
a2d1	3 42	3 42	4 29	5 33	5 62	5 69	5 76	3 70
a2d2	3 00	3 07	3 17	4 22	4 70	4 11	3 98	3 29
f 1 16	<1	<1	1 07	1 97	<1	<1	2 23	1 03
cd	-	-		-		-	-	-
c1d1	3 11	3 19	3 99	5 22	5 27	5 41	5 19	3 41
c1d2	3 00	3 055	3 08	3 52	4 30	3 91	3 55	3 08
c2d1	3 52	3 49	4 39	5 33	5 55	5 63	5 66	3 74
c2d2	3 00	3 03	3 17	4 30	4 53	4 14	3 91	3 63
c3d1	3 53	3 44	4 28	5 41	5 50	5 83	5 75	4 03
c3d2	3 03	3 08	3 17	4 47	4 72	4 19	4 11	3 44
f 2 16	3 33	1 12	3 91*	9 05**	1 47	<1	<1	4 69
cd	-	-	0 166	0 290	-	-	-	-

fertilizers in seven and eight split doses for the tissue cultured plants recorded an average leaf production of 4 39 and 4 28 numbers three months after planting which was significantly higher than that (3 99) for the same type of plants but with six split fertilizer doses On the other hand the plants from suckers receiving fertilizers in seven and eight splits produced only 3 17 leaves each not significantly different from the lowest number of leaves (3 0) produced by those receiving six split fertilizer applications

The same trend was observed during the fourth month after planting Tissue cultured plants given fertilizers in seven and eight splits produced 5 33 and 5 44 leaves which was higher than the leaf production (5 22) observed in tissue cultured plants receiving fertilizers in six splits

Further the leaf production in tissue cultured plants given six split fertilizer application was found to be superior to the leaf production in suckers given both seven and eight split applications (4 30 and 4 7) The average leaf production observed in plants from sucker with six split doses was only 3 52 numbers

Tissue cultured plants receiving fertilizers in eight splits produced 4 03 leaves during the month just prior to shooting which was significantly higher than all other treatments Tissue cultured plants and plants from suckers receiving fertilizers in eight and seven splits gave similar performance (3 41 3 14 3 63 and 3 44 number of leaves respectively) Plants from suckers receiving fertilizers in six split doses however produced only 3 08 number of leaves (Table 6)

4 1 2 4 Number of leaves retained at monthly intervals

4 1 2 4 1 Main effect of the factors on the number of leaves retained at monthly intervals

Age of planting material had no significant effect on the number of leaves retained by the plant at any stage except at the early stage of the observation namely two months after planting (Table 7)

One month after planting plants receiving fertilizers in seven and eight split doses retained 6 11 and

Table 7 Effect of age split application of fertilizers and type of planting material on number of leaves retained at monthly intervals

Number of leaves retained

Main effect	1	2	3	4	5	6	7	8
				Month after planting				
a1	5 87	6 85	7 51	7 47	9 32	10 76	12 30	11 62
a2	6 04	7 47	7 37	7 71	9 52	10 74	12 23	12 38
f1 2	2 50	76 18**	6 39	11 78	10 13	<1	<1	16 03
cd	—	0 313	—	—	—	—	—	—
c1	5 43	6 49	6 92	7 08	9 01	10 47	11 44	11 30
c2	6 11	7 03	7 60	7 75	9 68	10 95	12 11	12 24
c3	6 34	7 97	7 81	7 93	9 57	10 83	13 25	12 47
f2 4	35 58**	50 12**	20 99**	20 10**	6 79	4 30	0 93	9 72
cd	0 312	0 416	0 398	0 391	— —	—	—	
d1	b 53	8 20	8 63	8 66	10 60	12 03	13 17	13 31
d2	5 39	6 13	6 24	6 52	8 24	9 47	11 36	10 69
f1 16	238 33**	1582 40**	2148 93**	815 03**	1184 52**	627 37**	4 12**	918 70**
cd	0 156	0 110	0 110	0 159	0 145	0 217	1 189	0 183

6 34 leaves respectively which was significantly higher than the number of leaves retained in plants given six split applications (5 43)

Two months after planting the same trend as above was observed The number of leaves retained by the three groups being 7 97 7 03 and 6 49 respectively

Higher number of split applications retained more number of leaves three months after planting Plants receiving seven and eight splits had 7 8 and 7 6 functional leaves which was significantly higher compared to the number of leaves on plants receiving fertilizers in six split doses (6 92 leaves) The same trend continued during the fourth month after planting also Plants receiving the two higher levels of split applications were on par (7 75 and 7 93 leaves) compared to the lower number (7 08) of leaves retained by the plants which were supplied with fertilizers in six split doses During shooting the two higher split applications resulted in 12 24 and 12 47 leaves respectively whereas the lowest number of split applications resulted in 11 30 leaves only

There was significant difference between the tissue cultured plants and plants from suckers throughout the period of growth of the plants (Table 7) At all stages the tissue cultured plants had significantly higher numbers of leaves than the plants propagated from suckers

4 1 2 4 2 Interaction effect of the factors on the number of leaves retained at monthly intervals

Two months after planting the 3 5 month old plants receiving fertilizers in eight splits had the highest number of leaves (8 75) followed by the 3 5 month old plants receiving fertilizers in seven splits and the 2 5 month old plants receiving fertilizers in eight split doses

Two months after planting the tissue cultured plants in both the age groups (2 5 and 3 5 month old) were statistically on par (8 09 and 8 29 leaves respectively) The plants from suckers in the 3 5 month old group had 6 65 leaves which was higher than those in 2 5 month old group (5 61 leaves) Three and six months after planting tissue cultured plants in both age group were again statistically on par (8 65 and 13 79 and 8 63 and 12 65 leaves respectively) The plants from suckers in the two age groups had however

Table 8 Interaction effect of age split application of fertilizers and type of planting material on number of leaves retained at monthly intervals

Number of leaves retained

Interaction effect	1	2	3	4	5	6	7	8
				Month after planting				
a1c1	5 33	6 39	6 88	6 81	8 92	10 36	11 11	10 89
a1c2	5 99	6 97	7 64	7 58	9 56	11 05	11 86	11 81
a1c3	6 28	7 19	8 00	8 02	9 5	10 88	13 94	12 17
a2c1	5 52	6 58	6 95	7 36	9 11	10 58	11 78	11 72
a2c2	6 22	7 08	7 55	7 93	9 80	10 86	12 36	12 67
a2c3	6 39	8 75	7 61	7 84	9 64	10 77	12 56	12 78
f	<1	14 68*	1 27	3 68	<1	<1	<1	<1
cd	—	0 501	—	—	—	—	—	—
a1d1	6 46	8 09	8 65	8 59	10 44	11 87	13 79	13 24
a1d2	5 28	5 61	6 37	6 35	8 20	9 66	10 82	10 00
a2d1	6 59	8 29	8 63	8 72	10 76	12 20	12 55	13 39
a2d2	5 49	6 65	6 11	6 69	8 23	9 27	11 91	11 39
f	<1	64 70**	5 48*	2 06	3 07	12 42**	1 69	51 49**
cd	—	0 156	0 155	—	—	0 309	—	0 260
c1d1	5 72	7 47	7 89	7 92	9 81	11 72	12 44	12 78
c1d2	5 14	5 5	5 94	6 25	8 22	9 22	10 44	9 83
c2d1	5 44	8 44	9	9	10 97	12 16	12 72	13 5
c2d2	6 80	5 61	6 19	6 51	8 39	9 74	11 50	10 97
c3d1	5 4	8 66	9 03	9 06	11 28	12 22	14 36	13 67
c3d2	7 05	7 28	6 58	6 81	8 11	9 44	12 14	11 28
f	5 62	65 38**	23 21**	10 78**	34 04**	1 13	1 03	3 72
cd	—	0 191	0 190	0 275	0 252	—	—	—

lower number of leaves (6 37 and 9 66 and 6 11 and 9 27 respectively) At shooting the tissue cultured plants in the 2 5 month age group had significantly higher number of leaves (13 24) than other treatments Tissue cultured plants in the 3 5 month age group had 11 39 leaves which was higher than that of the plants from suckers (10 and 11 5 leaves)

A significant difference was noticed between treatments two three four and five months after planting and at shooting due to interaction of split application of fertilizers and planting materials During the second third fourth and fifth months after planting and at shooting the tissue cultured plants receiving the two higher levels of split application had higher number of leaves (8 44 and 8 66 9 03 and 9 06 and 9 11 28 and 10 97 13 67 and 13 5 leaves) than other treatments

4 1 2 5 Total number of leaves produced

4 1 2 5 1 Main effect of the factors on the total number of leaves produced

Significant difference was observed in the total number of leaves produced by the plants five months after

Table 9 Effect of age split application of fertilizers and type of planting material on total number of leaves produced

Total number of leaves produced

Main effect	1	2	3	4	5	6	7	8
				Month after planting				
a1	5 11	8 26	11 88	16 53	21 33	26 12	30 67	34 46
a2	5 29	8 51	12 26	17 05	22 24	27 16	31 84	35 10
f1 2	3 96	2 23	3 70	9 74	22 12 *	17 85	9 22	1 68
cd	—	—	—	—	0 834	—	—	—
c1	5 04	8 17	11 71	16 09	20 95	25 66	29 99	33 31
c2	5 30	8 52	12 30	17 16	22 20	27 08	31 70	35 60
c3	5 20	8 47	12 20	17 71	22 20	27 19	32 09	35 43
f2 4	2 96	1 37	3 34	4 63	6 18	7 01 *	9 88 *	4 50
cd	—	—	—	-	—	0 323	0 391	—
d1	7 40	10 71	14 91	20 27	25 76	33 35	36 78	40 33
d2	3 00	6 06	9 230	13 29	17 81	21 93	25 74	29 23
f1 16	6270 **	1983 **	1838 **	2420 **	2296 **	2760 **	3150 **	478 54 **
cd	0 116	0 223	0 284	0 303	0 352	0 384	0 413	1 074

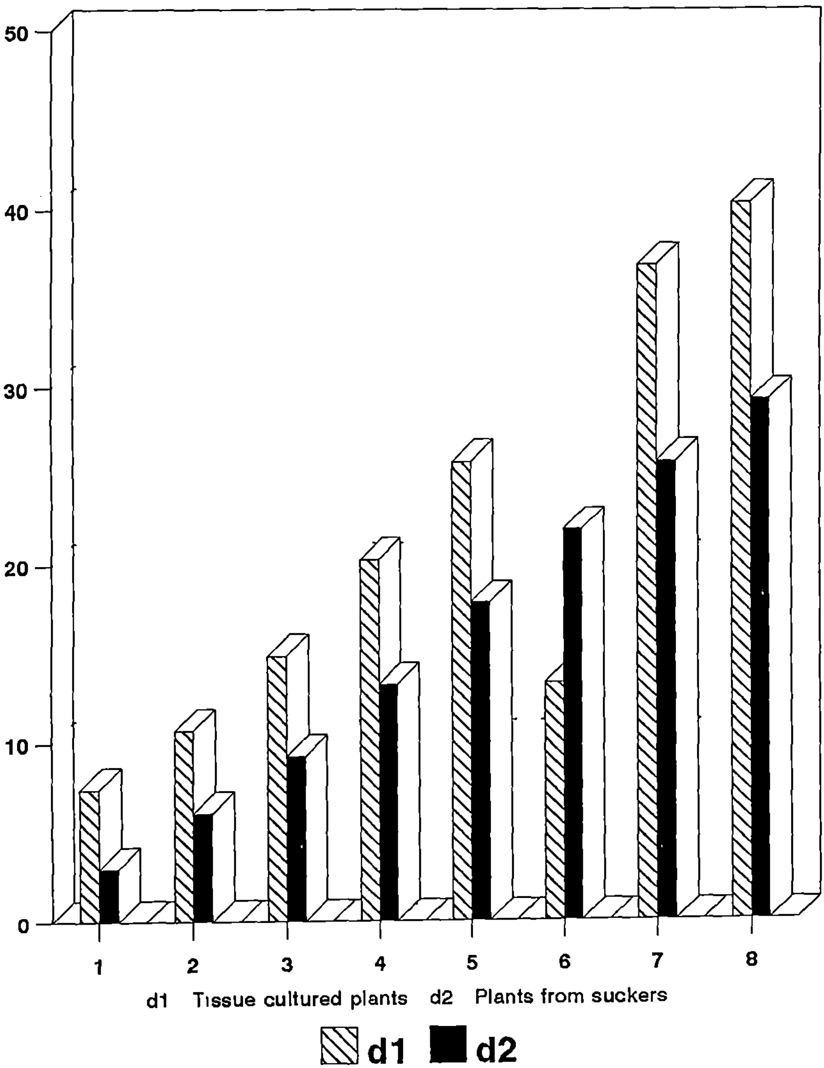


Fig. 4. Effects of type of planting material on total number of leaves produced

planting The 3 5 month old plants had produced significantly higher number of leaves than the 2 5 month old plants (Table 9)

The different levels of split application had a significant influence on the total number of leaves produced six and seven months after planting The two higher levels of split application produced significantly higher number of leaves compared to the lowest level (Table 9) However there was no significant difference in the total number of leaves produced at shooting between the different levels of split application

The total number of leaves produced by tissue cultured plants was significantly higher than that of plants from suckers throughout the period of growth (Table 9)

4 1 2 5 2 Interaction effect of the factors on the total number of leaves produced

Interaction between age and split application of fertilizers was not significant with reference to the number of leaves produced

Table 10 Interaction effect of age split application of fertilizers and type of planting material on total number of leaves produced

Total number of leaves produced

Interaction effect	1	2	3	4	5	6	7	8
	Month after planting							
a1c1	4 91	8 10	11 58	15 85	20 46	25 08	29 41	32 68
a1c2	5 24	8 38	12 13	16 96	21 85	26 66	31 10	35 24
a1c3	5 19	8 30	11 94	16 77	21 66	26 63	31 52	35 46
a2c1	5 16	8 24	11 85	16 32	21 44	26 24	30 57	33 94
a2c2	5 35	8 66	12 46	17 35	22 55	27 49	32 30	35 96
a2c3	5 35	8 63	12 46	17 41	22 75	27 74	32 66	35 41
f 2 4	<1	<1	<1	<1	<1	<1	<1	<1
cd	-	-	-		-	-	-	-
a1d1	7 21	10 47	14 66	19 99	25 25	13 72	36 06	39 95
a1d2	3 01	6 05	9 10	13 07	17 40	21 53	25 29	28 97
a2d1	7 58	10 95	15 16	20 55	26 27	31 99	37 49	40 71
a2d2	3 00	6 07	9 36	13 51	18 21	22 32	26 20	24 49
f 1 16	12 24**	4 89*	0 83	0 16	0 39	1 75	1 75	0 05
cd	0 164	0 317	—	—	—	—	—	—
c1d1	7 08	10 27	14 32	19 55	24 96	30 36	35 46	38 88
c1d2	3 00	6 08	9 10	12 63	16 94	20 96	24 52	27 74
c2d1	7 60	11 02	15 41	20 82	26 88	31 99	37 35	41 18
c2d2	3 00	b 02	9 19	13 49	18 02	22 16	26 05	30 02
c3d1	7 52	10 85	14 99	20 43	25 94	31 72	37 52	40 94
c3d2	3 02	6 08	9 41	13 75	18 46	22 66	26 66	29 93
f 2 16	8 32**	5 27*	8 89*	1 76	2 43	1 53	0 48	0 01
cd	0 201	0 383	0 165	-				-

The interaction between age and type of planting material significantly influenced the total number of leaves produced in the early stages (one and two months after planting) Thus one month after planting the 3 5 month old tissue cultured plants produced 7 58 leaves and 2 5 months old plants 7 21 leaves This was significantly higher compared to the total number of leaves produced by the plants from suckers (3 00 and 3 01 respectively) Two months after planting the tissue cultured plants in both age groups had produced significantly higher number of leaves (10 47 and 10 95) compared to plants from suckers (6 07 and 6 05)

Significant difference was observed due to interaction of direct type of planting material and split application of fertilizers in the early stages of growth (Table 10) Thus one month after planting the highest number of leaves were produced by tissue cultured plants receiving the two higher levels of split application (seven and eight splits producing 7 60 and 7 52 leaves) This trend continued upto three and four months after planting after which there was no difference between the various interaction effects

4 1 2 6 Leaf area

4 1 2 6 1 Main effect of the factors on leaf area

In the early stages of growth two three and four months after planting the total leaf area per plant was significantly influenced by age (Table 11) Thus 3 5 month old plants had significantly higher leaf area than 2 5 month old plants

Higher levels of split application resulted in increased leaf area and the effect was significant at three and six months after planting (Table 11)

The tissue cultured plants had higher leaf area throughout the growth period of the plant (Table 11)

4 1 2 6 2 Interaction effect of the factors on leaf area

Interaction between age and split application of fertilizers did not have any effect on the leaf area

There was significant difference due to interaction of age and nature of planting material Thus tissue cultured

Table 11 Effect of age split application of fertilizers and type of planting material on leaf area

Leaf area m^2

Main effect	1	2	3	4	5	6	7	Shooting	Harvest
	Month after planting								
a1	0 09	0 24	0 75	1 60	3 40	5 91	8 51	11 43	4 18
a2	0 10	0 25	0 80	1 73	3 49	5 90	8 37	11 85	4 29
f 1 2	6 62	44 76**	62 69*	19 00*	<1	<1	1 34	6 25	<1
cd	-	0 007	0 350	0 133	-	-	-	-	-
c1	0 10	0 24	0 74	1 64	3 31	5 71	8 20	11 37	4 26
c2	0 10	0 25	0 78	1 67	3 52	6 00	8 59	11 62	4 25
c3	0 10	0 25	0 79	1 67	3 51	6 00	8 52	11 93	4 20
f 1 4	<1	1 86	19 76**	1 90	2 13	13 48*	3 07	2 16	<1
cd	-	-	0 023	-	-	0 180	-	-	
d1	0 11	0 28	0 83	1 82	3 72	6 55	9 33	13 49	5 23
d2	0 08	0 22	0 71	1 50	3 17	5 25	7 56	9 79	3 25
f 1 16	73 50**	1024 20**	546 13**	852 31**	124 57**	1209 95**	507 98**	1745 00**	770 29**
cd	0 008	0 004	0 011	0 023	0 106	0 079	0 165	0 188	0 151

Table 12 Interaction effect of age split application of fertilizers and type of planting material on leaf area

Main effect	Leaf area m^2								
	1	2	3	4	5	6	7	Shooting	Harvest
	Month after planting								
a1c1	0 09	0 24	0 71	1 57	3 18	5 69	8 17	11 09	4 17
a1c2	0 09	0 24	0 74	1 61	3 53	6 02	8 75	11 38	4 17
a1c3	0 10	0 25	0 75	1 60	3 50	6 02	8 60	11 81	4 22
a2c1	0 10	0 25	0 76	1 71	3 43	5 73	8 24	11 65	4 35
a2c2	0 10	0 25	0 81	1 74	3 51	5 97	8 44	11 85	4 34
a2c3	0 10	0 26	0 82	1 74	3 52	5 99	8 44	12 04	4 19
f2 4	<1	<1	<1	<1	<1	<1	<1	<1	<1
cd	—	—	—	—	—	—	—	—	—
a1d1	0 11	0 27	0 79	1 77	3 63	6 56	9 21	13 38	5 24
a1d2	0 08	0 21	0 68	1 42	3 18	5 26	7 81	9 48	3 13
a2d1	0 12	0 29	0 87	1 87	3 82	6 55	9 43	13 60	5 22
a2d2	0 09	0 22	0 73	1 59	3 15	5 24	7 31	10 10	3 37
f 1 16	<1	4 76*	9 47**	12 13**	4 67*	<1	21 00**	5 08*	3 09
cd	—	0 006	0 016	0 033	0 149	—	0 234	0 265	—
c1d1	0 11	0 27	0 78	1 80	3 61	6 23	8 89	13 30	5 27
c1d2	0 08	0 21	0 70	1 48	3 00	5 19	7 52	9 44	3 24
c2d1	0 11	0 28	0 08	1 83	3 78	6 69	9 53	13 51	5 24
c2d2	0 08	0 22	0 71	1 53	3 25	5 30	7 65	9 73	5 26
c3d1	0 12	0 29	0 86	1 83	3 77	6 74	9 53	13 65	5 17
c3d2	0 08	0 22	0 73	1 51	3 25	5 27	7 50	13 65	3 240
f 2 16	<1	3 34	10 31**	<1	<1	12 69**	6 44**	12 20**	<1
cd	—	—	0 019	—	—	0 137	0 287	0 108	—

plants in the 3 5 month age group recorded significantly higher leaf area than others at the different stages of growth from the second month after planting up to shooting (Table 12) The lowest values were observed in plants derived from suckers of 2 5 month age group However at the time of shooting there was no significant difference in leaf area between plants from suckers of the two age groups

Interaction between split application of fertilizers and type of planting material on leaf area was not significant

4 1 2 7 Duration of the crop

4 1 2 7 1 Main effect of the factors on the duration of the crop

The age of the plants at planting had a significant effect on the duration of the crop The total number of days taken from planting to shooting and planting to harvest were significantly influenced by the age (Table 13) The 3 5 month old plants took significantly less time than the 2 5 month old plants for shooting and harvest

Table 13 Effect of age mode of sucker retention split application of fertilizers and type of planting material on duration of the crop

Main effect	No of days taken from planting to shooting	No of days taken from shooting to harvest
a1	241 36	336 40
a2	225 75	320 94
f1 2	113 20**	100 18**
cd	6 312	6 651
b1	-	335 27
b2	---	322 08
f1 2	-	72 860*
cd	---	6 651
c1	232 54	328 00
c2	232 71	327 79
c3	235 42	330 25
f2 4	0 35	0 29
cd	---	---
d1	232 97	328 44
d2	234 14	328 91
f1 16	0 37	0 08
cd	---	---

o

There was a difference of 15 61 days in the number of days taken for shooting and 15 46 days in the number of days taken for harvest between the two age groups

Plants in which suckers were not retained took 13 19 days less to harvest than the plants in which two suckers were retained

The total duration of the crop was not significantly influenced by the different levels of split application of fertilizers

There was no significant difference (Table 19) between the tissue cultured plants and plants from suckers in the duration of the crop

4 1 2 7 2 Interaction effect of the factors on the duration of the crop

None of the interaction effects significantly influenced the duration of the crop

Table 14 Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on duration of the crop

Interaction effect	No of days taken for shooting	No of days taken for harvest
a1b1	249 00	342 78
a1b2	233 72	330 05
a2b1	232 17	327 77
a2b2	219 33	314 11
f1 2	91 77*	<1
cd	6 63	---
a1c1	241 08	335 75
a1c2	240 17	335 50
a1c3	242 83	338 00
a2c1	224 00	320 25
a2c2	225 25	320 08
a2c3	228 00	322 50
f2 4	<1	<1
cd	--	---
a1d1	240 44	336 05
a1d2	242 27	336 77
a2d1	225 50	320 83
a2d2	226 00	321 05
f1 16	<1	<1
cd	--	---
b1c1	239 75	334 91
b1c2	239 00	334 33
b1c3	243 00	336 58
b2c1	225 33	321 08
b2c2	226 42	321 25
b2c3	227 83	321 91
f2 4	<1	<1
cd	---	---
b1d1	239 39	334 77
b1d2	241 78	335 77
b2d1	226 56	322 11
b2d2	226 50	322 05
f1 16	<1	<1
cd	---	---
c1d1	230 92	326 58
c1d2	234 17	329 41
c2d1	231 92	328 05
c2d2	233 50	327 50
c3d1	236 08	330 66
c3d2	234 75	329 82
f2 16	<1	<1
cd	---	- -

4 1 3 Bunch characters

There was no significant effect on any of the bunch characters by either retaining two suckers per plant after bunch emergence and not retaining any suckers

The different levels of split application of fertilizers had no significant effect on various bunch characters including weight of bunch

There was significant difference between tissue cultured plants and plants from conventional suckers in all the bunch characters namely weight of bunch length of bunch numbers of hands and fingers and the weight length and girth of fingers (Table 15)

The tissue cultured plants recorded significantly higher values for all the above characters than the plants produced from suckers

4 1 3 2 Interaction effect of the factors on bunch characters

The interaction effect did not significantly influence bunch characters (Table 16)

Table 15 Effect of age mode of suoker retentıon splıt applıcatıon of fertılızers of type of plantıng materıal on bunoh characters

Maın effect	Weıght of bunch kg	Length of bunch cm	No of hands	No of fıngers	Length of fınger cm	Gırth of fınger cm	Weıght of fınger g
a1	10 82	34 67	4 75	41 67	28 27	16 03	250 08
a2	11 04	35 31	4 83	43 47	28 16	15 82	244 69
f 1 2	8 79	1 37	3 51	13 33	<1	1 056	1 02
cd	–	–	–	–	–	–	–
b1	10 50	34 50	4 82	42 25	27 89	15 78	243 67
b2	11 06	35 47	4 77	42 89	28 54	16 06	251 11
f 1 2	10 24	3 91	0 11	1 67	1 71	1 94	1 95
cd	–	–	–	–	–	–	–
c1	10 55	34 58	4 78	42 38	27 97	15 68	245 71
c2	10 83	35 29	4 85	42 92	28 57	16 00	250 21
c3	10 96	35 08	4 75	42 42	28 10	16 10	246 25
f 2 4	1 61	<1	<1	<1	1 93	1 07	0 73
cd	–	–	–	–	–	–	–
d1	12 01	37 28	5 02	49 78	30 05	16 91	268 19
d2	9 56	32 69	4 57	39 36	26 38	14 94	226 58
f 1 6	405 61 **	518 38 **	29 91 **	275 81 **	196 00 **	151 65 **	391 27 **
cd	0 259	0 427	0 176	0 819	0 557	0 340	4 460

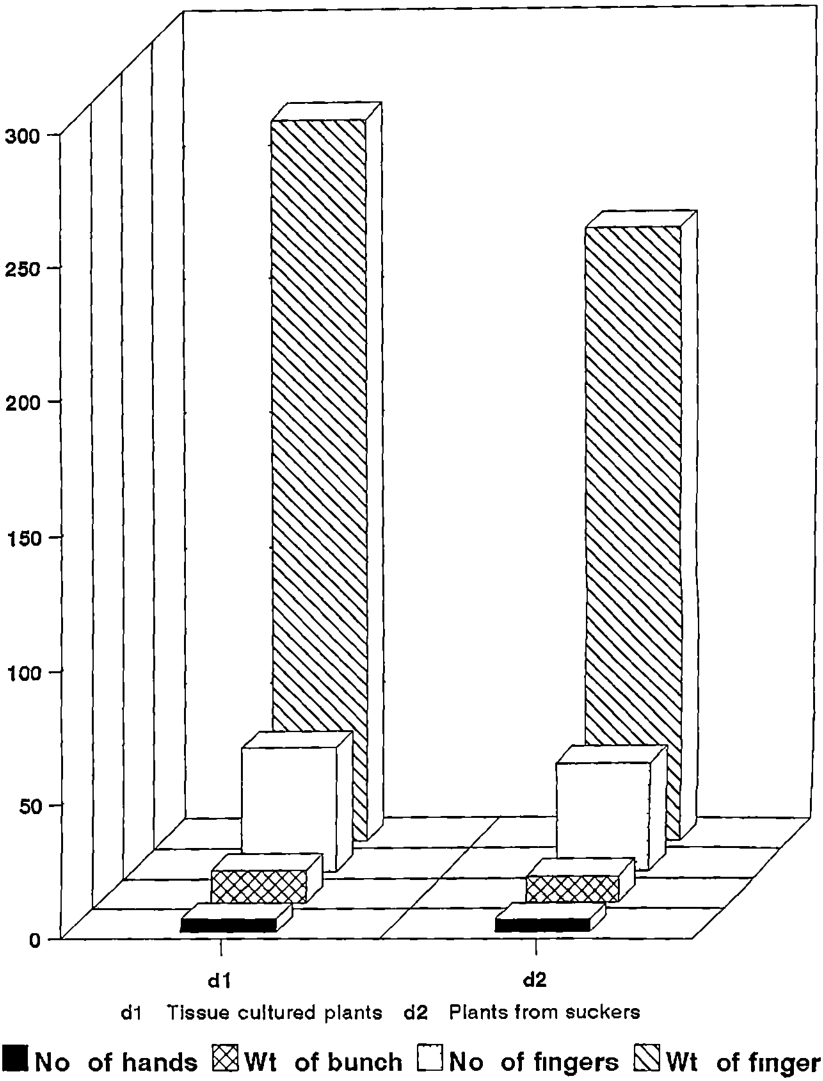


Fig. 5. Effect of type of planting material on bunch characters

Plate 3 Plants from suckers (left) and tissue cultured plants (right) - 2 months after planting

Plate 4 Bunches of plants from suckers (left) and tissue cultured plants (right) given fertilizers in eight split doses in which two suckers were retained per plant and no suckers were retained

Plate 5 Bunches of tissue cultured plants with three levels of split application of fertilizers

Plate 6 Bunches of plants from suckers (left) and tissue cultured plants (right) given fertilizers in six split doses in which two suckers were retained per plant and no suckers were retained

Table 16 Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on bunch characters

Interaction effect	Bunch weight kg	Length of bunch cm	No of hands	No of fingers	Length of finger cm	Girth of finger cm	Weight of fingers g
a1b1	10 31	34 28	4 85	43 38	27 63	15 57	246 83
a1b2	10 73	35 06	4 65	43 94	28 92	16 49	253 33
a2b1	10 69	34 73	4 78	44 11	28 16	16 00	240 50
a2b2	11 40	35 88	4 88	45 83	28 17	15 64	248 89
f 1 2	<1	<1	1 39	<1	1 68	10 10	<1
cd							
a1c1	10 33	34 50	4 75	43 58	27 50	15 43	245 17
a1c2	10 61	34 83	4 78	44 00	28 35	16 28	253 00
a1c3	10 61	34 67	4 72	43 42	28 67	16 37	252 08
a2c1	10 77	34 67	4 81	45 17	28 44	15 89	246 25
a2c2	11 06	35 75	4 92	45 83	28 50	15 72	247 42
a2c3	11 32	35 50	4 78	45 42	27 55	15 85	240 42
f 2 4	<1	<1	<1	<1	5 105	1 62	1 22
cd	-						
b1c1	10 31	34 33	4 72	44 42	27 78	15 512	242 32
b1c2	10 45	34 42	4 88	44 33	28 11	15 74	245 75
b1c3	10 73	34 75	4 83	44 00	27 80	16 09	242 33
b2c1	10 79	34 83	4 83	44 33	28 17	15 81	248 55
b2c2	11 20	36 17	4 81	45 50	27 04	16 27	254 67
b2c3	11 20	35 42	4 67	44 83	28 40	16 12	250 17
f 2 4	0 21	0 79	0 50	0 67	0 35	0 31	0 08
cd							

Contd

Table 16 contd Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on bunch characters

Interaction effect	Bunch weight kg	Length of bunch cm	No of hands	No of fingers	Length of finger cm	Girth of finger cm	Weight of fingers g
a1d1	11 80	36 83	5 00	44 94	30 18	16 99	271 56
a1d2	9 23	32 50	4 50	38 68	26 37	15 05	228 62
a2d1	12 22	37 72	5 04	46 61	29 94	16 82	284 83
a2d2	9 88	32 88	4 63	40 33	26 38	14 81	224 56
f 1 2	<1	1 54	<1	<1	<1	<1	<1
cd	-	-	-				
b1d1	11 75	36 72	5 00	45 78	29 63	16 77	264 50
b1d2	9 25	32 27	4 63	38 72	26 17	14 79	222 83
b2d1	12 28	37 83	5 03	45 77	30 94	17 04	71 893
b2d2	9 86	33 11	4 50	40 00	26 59	15 08	230 33
f 1 2	<1	<1	1 00	2 73	0 68	<1	<1
cd	-	-	-	-	-	-	-
c1d1	11 79	36 67	5 00	45 58	29 61	16 92	267 42
c1d2	9 31	32 50	4 56	39 16	26 33	14 40	224 00
c1d3	12 17	37 92	5 00	46 25	30 51	16 97	270 25
c2d1	9 50	32 66	4 69	39 58	26 64	15 03	230 17
c2d2	12 08	37 25	5 06	45 50	30 05	16 85	266 92
c2d3	9 85	32 92	4 44	39 33	26 17	15 37	225 58
f 2 16	1 07	2 80	1 10	0 13	0 57	3 53	0 20
cd	-	-	-	-	-	-	-

4 1 3 3 Correlation of yield with other important characters

Correlation of the following factors with yield was worked out Girth and height of pseudostem total leaf production leaf area (at shooting and harvest) number of leaves (at shooting) content of N P and K in the index leaf (at shooting) length of bunch number of hands fingers length girth and weight of fingers (Table 17) All the factors are seen to be significantly correlated with yield

4 1 4 Quality of fruits

4 1 4 1 Main effect of the factors on the quality of fruits

There was no significant difference in the quality of the fruits due to the age of plants used for planting Quality of fruits was not influenced by the mode of sucker retention Split application of fertilizers did not affect the quality of fruits

The fruits from tissue cultured plants had a higher TSS more total reducing and non reducing sugars lower acidity higher sugar acid and pulp peel ratios than those from plants from suckers (Table 18)

Table 17 Corelation values of various characters with yield

Sl No	Characters	Correlation co-efficient
1	Girth pseudostem at shooting	0 8764
2	Height of pseudostem at shooting	0 5600
3	Total leaf production	0 8021
4	Leaf area of shooting	0 8764
5	Leaf area at harvest	0 8738
6	No of leaves at shooting	0 8215
7	Content of N in leaves at shooting	0 7302
8	Content of P in leaves at shooting	0 8977
9	Content of K in leaves at shooting	0 8689
10	Length of bunch	0 9031
11	Number of hands	0 5859
12	Number of fingers	0 9398
13	Length of finger	0 7865
14	Girth of finger	0 6837
15	Weight of finger	0 7980

Table 18 Effect of age mode of sucker retention split application of fertilizers and type of planting material on quality of fruits

Main effect	TSS brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acids ratio	Pulp/ peel ratio
a1	22 18	21 05	6 77	14 28	0 403	53 96	3 64
a2	21 96	21 19	6 68	14 66	0 415	52 91	3 59
f	3 48	<1	<1	<1	<1	<1	1 74
cd	—	—	—	—	—	—	—
b1	22 07	21 24	6 79	14 47	0 406	53 99	3 56
b2	22 07	21 005	6 65	14 46	0 413	52 87	3 67
f	<1	<1	<1	<1	<1	<1	8 34
cd	—	—	—	—	—	—	—
c1	21 97	021 12	6 73	14 63	0 409	53 16	3 60
c2	22 08	21 19	6 65	14 57	0 411	53 83	3 58
c3	22 17	21 07	6 79	14 39	0 408	53 31	3 66
f	<1	<1	<1	<1	<1	<1	<1
cd	—	—	—	—	—	—	—
d1	23 58	23 74	7 68	16 03	0 358	66 79	3 88
d2	20 56	18 51	5 76	12 91	0 460	40 07	3 34
f	165 80 **	273 29 *	240 55 **	70 19 **	<1	364 58 *	208 53 *
cd	0 498	0 670	0 263	0 793	—	2 967	0 679

4 1 4 2 Interaction effect of the factors on quality of the fruits

The quality of fruits was not altered by the interaction effects (Table 19)

4 1 5 Nutrient content on index leaf

4 1 5 1 Nitrogen

4 1 5 1 1 Main effect of the factors on content of nitrogen in index leaf

Two months after planting the age of plants used had an effect on the content of nitrogen The 3 5 month old plants had a signifi antly higher nitrogen content than the younger group of plants (Table 20)

There was significant difference due to the different levels of split application of fertilizers in the nitrogen content of index leaf of various treatments (Table 20) The two higher levels of split applications were on par and resulted in higher levels of nitrogen compared to the application of fertilizers at the lowest level

Table 19 Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on quality of fruits

Interaction effect	TSS brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acids ratio	Pulp/ peel ratio
a1b1	22 09	21 22	6 86	14 35	0 394	55 69	3 57
a1b2	22 27	20 89	6 67	14 2	0 413	52 23	3 70
a2b1	22 05	21 27	6 73	14 59	0 418	52 28	3 54
a2b2	21 87	21 12	6 64	14 72	0 412	53 52	3 63
f2 12	2 28	<1	<1	<1	1 29	1 12	<1
cd	—	—	—	—	—	—	—
a1c1	22 07	20 87	6 74	14 12	0 396	53 98	3 59
a1c2	22 33	21 48	6 65	14 80	0 404	56 10	3 63
a1c3	22 15	20 80	6 9	13 90	0 411	51 82	3 70
a2c1	21 88	21 37	6 71	14 75	0 422	52 33	3 61
a2c2	21 88	20 88	6 65	14 35	0 418	51 57	3 54
a2c3	22 18	21 33	6 69	14 87	0 406	54 52	3 61
f2 4	<1	<1	<1	<1	<1	1 55	<1
cd	—	-	—	—	—	—	—
b1c1	22 13	21 31	6 78	14 53	0 41	53 55	3 55
b1c2	21 78	21 48	6 80	14 79	0 406	55 01	3 53
b1c3	22 31	20 94	6 80	14 08	0 403	53 41	3 58
b2c1	21 82	20 93	6 67	14 33	0 408	52 76	3 64
b2c2	22 37	20 90	6 50	14 36	0 416	52 65	3 63
b2c3	22 03	21 19	6 78	14 69	0 414	53 22	3 73
f2 4	<1	<1	<1	<1	<1	1 55	<1
cd	—	—	—	—	—	—	—

contd

Table 19 contd Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on quality of fruits

Interaction t	TSS brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acids ratio	Pulp/ peel ratio
	23 75	23 73	7 84	15 89	0 356	67 53	3 89
	20 62	18 37	5 69	12 66	0 451	40 40	3 38
	23 48	23 74	7 54	16 17	0 361	66 06	3 87
a2d2	20 50	18 65	5 83	13 15	0 469	39 74	3 31
f 1 16	<1	<1	3 02	<1	<1	<1	<1
cd	-	-	-	-		-	-
b1d1	23 67	23 76	7 82	15 89	0 356	66 67	3 83
b1d2	20 47	18 73	5 77	13 04	0 469	41 31	3 28
b2d1	23 49	23 71	7 55	16 15	0 361	66 92	3 93
b2d2	20 64	18 30	5 75	12 27	0 451	38 84	3 41
f 1 16	<1	<1	1 03	<1	1 98	<1	<1
cd	-	-	-	-	-	-	-
c1d1	23 41	23 74	7 81	15 94	0 362	65 92	3 89
c1d2	20 53	18 49	5 64	12 93	0 458	40 39	3 31
c2d1	23 54	23 88	7 58	16 23	0 361	67 26	3 84
c2d2	20 60	18 50	5 72	12 91	0 461	40 41	3 32
c3d1	23 80	23 58	7 68	15 91	0 353	67 20	3 92
c3d2	20 53	18 55	5 92	12 88	0 464	39 42	3 40
f 2 16	<1	<1	<1	<1	<1	<1	<1
cd	-	-		-	-	-	-

Table 20 Effect of age split application of fertilizers and type of planting material on the N content of index leaf

Main effect	N content (per cent) 2 MAP	4MAP	Shooting	Harvest
a1	0 96	1 14	3 44	1 91
a2	1 03	1 19	3 45	1 92
f 1 2	19 40*	17 62	7 50	<1
cd	0 06	-	-	-
c1	0 93	1 14	3 36	1 87
c2	1 03	1 17	3 49	1 95
c3	1 03	1 18	3 49	1 94
f 2 4	16 60*	2 57	17 44*	7 39*
cd	0 056	-	0 068	0 065
d1	1 10	1 21	3 62	2 04
d2	0 89	1 11	3 27	1 79
f 1 16	197 47*	168 26**	287 50**	55 28**
cd	0 032	0 016	0 044	0 070

The tissue cultured plants had a higher nitrogen content in their index leaf than the plants from suckers at all the four stages studied namely two months and four months after planting at the time of shooting and harvest

4 1 5 1 2 Interaction effect of the factors on content of nitrogen in index leaf

Among the interaction effects only that due to split application of fertilizers and type of planting material influenced the nitrogen content of the index leaf The tissue cultured plants receiving the two higher levels of split applications had higher levels of nitrogen in their index leaf two months after planting

4 1 5 2 Phosphorous

4 1 5 2 1 Main effect of the factors on the content of phosphorus in index leaf

Two and four months after planting the 3 5 month old plants had a higher content of phosphorus in the index leaf (Table 22)

Table 21 Interaction effect of age split application of fertilizers and type of planting material on N content of index leaf

Interaction effect	N content (per cent) 2 MAP	4MAP	Shooting	Harvest
a1c1	0 89	1 11	3 35	1 89
a1c2	0 99	1 15	3 49	1 91
a1c3	1 00	1 16	3 48	1 93
a2c1	0 96	1 17	3 38	1 84
a2c2	1 06	1 20	3 49	1 98
a2c3	1 06	1 20	3 50	1 94
f 2 4	<1	<1	<1	3 14
cd	-	-	-	-
a1d1	1 06	1 19	3 62	2 05
a1d2	0 86	1 09	3 26	1 77
a2d1	1 14	1 24	3 62	2 02
a2d2	0 91	1 14	3 29	1 89
f 1 16	2 00	<1	<1	1 50
cd	-	-	-	-
c1d1	1 00	1 19	3 54	2 02
c1d2	0 86	1 08	3 19	1 71
c2d1	1 15	1 23	3 67	2 05
c2d2	0 89	1 12	3 31	1 85
c3d1	1 15	1 22	3 67	2 04
c3d2	0 91	1 14	3 32	1 83
f 2 4	6 07*	2 57	<1	1 21
cd	0 056	-	-	-

Table 22 Effect of age split application of fertilizers and type of planting material on the P content of index leaf

Interaction effect	P content (per cent) 2 MAP	4MAP	Shooting	Harvest
a1	0 10	0 09	0 46	0 44
a2	0 11	0 10	0 47	0 44
f 1 2	68 33*	259 80**	0 96	0 04
cd	0 00	0 00	-	-
c1	0 10	0 09	0 45	0 43
c2	0 10	0 10	0 47	0 44
c3	0 11	0 10	0 48	0 44
f 2 4	24 60**	30 23**	7 76*	0 95
cd	0 003	0 004	0 0012	---
d1	0 11	0 11	0 53	0 51
d2	0 09	0 09	0 39	0 37
f 1 16	1036 43**	170 42**	948 87**	619 19**
cd	0 001	0 003	0 010	0 012

Split application of nitrogen and potash significantly influenced the content of phosphorus in the index leaf at two and four months after planting and at shooting (Table 23) At harvest however the three levels of split application did not result in a difference in the content of phosphorus in the index leaf

At all the stages of sampling the index leaf of tissue cultured plants had a significantly higher content of phosphorus than the plants from suckers

4 1 5 2 2 **Interaction effect of the factors on the content of phosphorus in index leaf**

The interaction between age and type of planting material influenced the content of phosphorus in index leaf At shooting the tissue cultured plants in both age groups had a significantly higher content of phosphorus than the plants from suckers in both the age groups (Table 23)

At shooting the tissue cultured plants receiving the highest level of split application recorded the maximum

Table 23 Interaction effect of age split application of fertilizers and type of planting material on P content of index leaf

Interaction effect	P content (per cent)			
	2 MAP	4MAP	Shooting	Harvest
a1c1	0 10	0 90	0 44	0 42
a1c2	0 10	0 09	0 46	0 43
a1c3	0 10	0 09	0 47	0 45
a2c1	0 10	0 04	0 45	0 43
a2c2	0 11	0 11	0 47	0 45
a2c3	0 11	0 11	0 48	0 44
f 2 4	1 76	3 76	0 67	0 26
cd	-	-	-	-
a1d1	0 11	0 10	0 54	0 51
a1d2	0 09	0 08	0 38	0 36
a2d1	0 12	0 11	0 53	0 50
a2d2	0 10	0 09	0 40	0 37
f 1 16	3 14	1 00	6 93	4 43
cd	-	-	-	-
c1d1	0 11	0 10	0 53	0 50
c1d2	0 09	0 08	0 37	0 35
c2d1	0 11	0 11	0 53	0 50
c2d2	0 09	0 09	0 40	0 38
c3d1	0 12	0 11	0 55	0 52
c3d2	0 10	0 09	0 40	0 37
f 2 16	<1	1 53	4 86*	3 12
cd	-	-	0 01	-

content of phosphorus which was superior to all other treatments (Table 23) The lowest level of phosphorus was observed in the plants from suckers receiving the lowest level of split application of fertilizers

4 1 5 3 Potassium

4 1 5 3 1 Main effect of the factors on the content of potassium in index leaf

There was no difference in the content of potassium in the index leaf between different age groups

Split application of fertilizers at various levels had a significant effect on the content of potassium in the index leaf (Table 24) The two higher levels of split application were significantly superior to the lower level and at the same time on par with each other

The tissue cultured plants had a higher content of potassium at all the four stages sampled (two and four months after planting at shooting and harvest) (Table 24)

Table 24 Effect of age mode of sucker retention split application of fertilizers and type of planting material on K content of index leaf

Main effect	K content (per cent) 2 MAP	4MAP	Shooting	Harvest
a1	1 18	0 45	2 13	2 02
a2	1 22	0 48	2 17	2 04
f 1 2	<1	13 48	1 42	<1
cd	-	-	-	-
c1	1 11	0 44	1 98	1 87
c2	1 24	0 50	2 26	2 13
c3	1 24	0 47	2 21	2 08
f 2 4	9 56*	11 72**	16 92*	13 29
cd	0 094	0 033	0 143	0 037
d1	1 31	0 59	2 49	2 37
d2	1 09	0 35	1 81	1 69
f 1 16	101 70**	997 72**	945 33**	572 06**
cd	0 047	0 005	0 016	0 061

4 1 5 3 2 Interaction effect of the factors on the content of potassium in index leaf

The two higher levels of split application in combination with the 3 5 month old plants had higher content of potassium in the index leaf four months after planting Interaction between any of the other factors did not result in difference in the potassium content of leaves

4 1 5 4 Calcium Magnesium Iron and zinc

4 1 5 4 1 Main effect of the factors on the content of Calcium Magnesium Iron and Zinc in index leaf

No difference was observed in the content of calcium magnesium iron and zinc in the index leaf of plants between the different age groups (Table 26)

A higher content of calcium was observed in the index leaf at shooting with the higher levels of split applications The tissue cultured plants had higher levels of Magnesiun Iron and Zinc in the index leaf compared to the plants propagated from suckers (Table 26)

Table 25   Interaction effect of age mode of sucker retention split application of fertilizers and type of planting material on K content of index leaf

Interaction effect	K content (per cent)			
	2MAP	4MAP	Shooting	Harvest
a1c1	1 07	0 41	1 96	1 86
a1c2	1 24	0 49	2 24	2 05
a1c3	1 23	0 46	2 24	2 05
a2c1	1 15	0 46	2 19	2 12
a2c2	1 25	0 51	2 00	2 10
a2c3	1 25	0 49	2 29	0 34
$F_{2\ 4}$	0 60	11 72	2 23	<1
a1d1	1 11	0 49	1 93	2 05
a1d2	1 04	0 45	1 53	1 84
a2d1	1 24	0 49	1 88	2 16
a2d2	1 12	0 46	1 41	1 81
$F_{1,16}$	0 51	0 62	<1	<1
c1d1	1 29	0 58	2 45	2 34
c1d2	1 08	0 33	1 82	1 65
c2d1	1 33	0 60	2 53	2 40
c2d2	1 11	0 37	1 81	1 72
c3d1	1 25	0 52	2 30	2 51
c3d2	1 12	0 38	1 71	1 81
$F_{2\ 16}$	<1	<1	<1	0 02

Table 26 Effect of age split application of fertilizers and type of planting material on Ca Mg Fe and Zn content of index leaf at shooting stage

Interaction effect	Ca per cent	Mg per cent	Fe ppm	Zn per cent
a1	0 34	0 04	163 42	0 32
a2	0 33	0 04	161 42	0 31
f 1 2	5 28	0 70	1 67	0 02
cd	-	-	-	-
c1	0 31	0 04	165 45	0 32
c2	0 34	0 04	161 67	0 32
c3	0 34	0 04	160 13	0 31
f 2 4	17 61	0 98	<1	0 02
cd	0 015	-	-	-
d1	0 35	0 05	169 33	0 37
d2	0 31	0 04	155 50	0 26
f 1 16	137 49**	617 88**	140 31**	61 04**
cd	0 007	0 001	2 476	0 027

4 1 5 4 2 Interaction effect of the factors on the content of Calcium Magnesium Iron and Zinc in index leaf

No significant difference was observed in the content of Calcium Magnesium Iron and Zinc due to this interaction (Table 27) The 2 5 and 3 5 month aged tissue cultured plants had higher levels of Zinc in the index leaf (Table 27) at shooting

The tissue cultured plants receiving all three levels of split applications had higher content of zinc in the index leaf at shooting time

4 1 6 Other observations

4 1 6 1 Effect of treatments on incidence of pests and diseases in banana

Incidence of bunchy top was negligible in the crop None of the tissue cultured plants were removed even due to suspected symptoms of bunchy top Out of a total population of 144 suckers planted only four plants were uprooted and

Table 27 Interaction effect of age split application of fertilizers and type of planting material on Ca Mg Fe and Zn content of index leaf at shooting stage

Interaction effect	Ca per cent	Mg per cent	Fe ppm	Zn per cent
a1c1	0 32	0 048	165 67	0 29
a1c2	0 35	0 050	164 08	0 33
a1c3	0 34	0 049	160 50	0 33
a2c1	0 31	0 048	165 25	0 34
a2c2	0 34	0 492	159 25	0 31
a2c3	0 33	0 047	159 75	0 29
f 2 4	<1	<1	1 73	3 24
cd	-		-	-
a1d1	0 35	0 055	171 00	0 38
a1d2	0 32	0 043	155 83	0 25
a2d1	0 35	0 054	167 67	0 35
a2d2	0 30	0 042	155 17	0 28
f 1 16	1 10	<1	1 304	6 41
cd	-	-	-	-
c1d1	0 33	0 054	173 75	0 38
c1d2	0 29	0 042	15 17	0 25
c2d1	0 36	0 055	167 00	0 36
c2d2	0 32	0 044	156 33	0 27
c3d1	0 36	0 055	167 25	0 36
c3d2	0 32	0 041	153 00	0 27
f 2 4	<1	4 59	2 17	4 79
cd	-	-	-	

Table 28 Effect of treatments on incidence of pests and diseases in banana

Treatment	No of rhizome weevils/plant	Sigatoka leaf spot disease index	Disease incidence Leaf area infested (percentage)
t_1	3 25	2	13
t_2	3 50	2	18
t_3	3 30	2	14
t_4	3 15	2	16
t_5	3 35	2	15
t_6	3 45	2	11
t_7	3 25	2	19
t_8	3 36	2	20
t_9	3 25	2	17
t_{10}	3 30	2	18
t_{11}	3 41	2	16
t_{12}	3 56	2	15
t_{13}	3 38	2	13
t_{14}	3 51	2	12
t_{15}	3 25	2	11
t_{16}	3 15	2	15
t_{17}	3 15	2	14
t_{18}	3 30	2	13
t_{19}	3 36	2	16
t_{20}	3 26	2	17
t_{21}	3 30	2	15
t_{22}	3 15	2	14
t_{23}	3 30	2	13
t_{24}	3 15	2	12

Note

Disease index	Leaf area infested	
negligible	0-5	5-41-50
1	6-10	6-51-75
2	11-25	7-76-and above
3	26 30	
4	31-40	
5	41-50	

Table 29 Effect of treatments on soil nutrient status after harvest of banana

Treatment	Soil nutrient status after harvest kg/ha N	P	K	Per cent increase/decrease of nutrient N	P	K
t_1	73 23	37 33	108 56	3 78	3 69	-3 92
t_2	78 45	40 63	115 13	3 12	12 86	1 88
t_3	72 89	36 25	102 45	4 09	0 69	-9 33
t_4	76 33	41 62	114 26	0 43	15 61	1 11
t_5	74 52	38 58	103 45	-1 9	7 16	-8 45
t_6	78 24	42 23	112 67	2 95	17 30	-0 29
t_7	73 22	36 77	107 52	-3 66	2 13	-4 84
t_8	77 38	40 55	114 52	1 82	12 63	1 34
t_9	72 15	38 88	104 52	-5 06	8 00	-7 50
t_{10}	79 11	41 87	113 33	4 09	16 30	0 29
t_{11}	70 68	33 53	106 55	7 00	7 02	-5 70
t_{12}	80 33	42 33	116 33	5 69	17 58	2 94
t_{13}	72 25	36 51	105 52	-4 93	1 4	-6 67
t_{14}	78 25	40 56	117 75	2 96	12 66	4 20
t_{15}	73 33	33 23	108 88	-3 51	6 19	3 64
t_{16}	79 66	41 73	118 92	4 81	15 91	5 23
t_{17}	72 26	36 18	105 56	-4 92	0 5	-6 58
t_{18}	78 52	42 11	114 45	3 31	16 97	1 28
t_{19}	73 55	37 56	104 45	-3 22	4 33	-7 56
t_{20}	79 67	40 77	117 77	4 82	13 25	4 22
t_{21}	72 67	36 53	105 52	-4 38	1 47	-6 67
t_{22}	80 23	40 87	118 85	5 56	13 52	5 17
t_{23}	72 52	36 18	103 52	-4 57	0 5	-8 38
t_{24}	78 55	40 58	116 62	3 35	12 72	3 20

Note Pre-harvest values for composite soil sample
Levels N 76 kg ha^{-1} (Low) P_2O_5 36 kg ha^{-1} (High) K_2O 113 kg ha^{-1} (Medium)

removed from the field suspecting the infection of bunchy top virus

The data on the incidence of sigatoka leaf spot disease and banana rhizome weevil are presented in Table 29 It can be seen from the data that the crop in general did not suffer from any serious attack of pests or diseases in any of the treatments

4 1 6 2 Effect of treatments on soil nutrient status after harvest of the crop

Table 23 shows the status of major nutrient (N P and K) in soil before and after taking the crop Before planting analysis of a composite soil samples revealed that the nitrogen content of soil to be 76 kg ha^{-1} and that of phosphoros 36 kg ha^{-1} and potassium 113 kg ha^{-1} The availabl nitrogen content after harvest exhibited a declining trend in the plots occupied by tissue cultured plants whereas the plots where suckers were planted showed a slight increase in nitrogen content after harvest

The lowest nitrogen levels were recorded in T_{13} (72 25 kg ha^{-1}) T_{17} (72 26 kg ha^{-1}) T_{21} (72 67 kg ha^{-1}) and T_{23} (72 52 kg ha^{-1}) T_{12} (80 33 kg ha^{-1}) and T_{22} (80 23 kg ha^{-1}) recorded the highest values

The available phosphorus content of soil showed an increase after harvest of the crop The increase was higher in suckers T_{12} recorded the highest increase (17 58 per cent) and the lowest increase was in T_3 (0 69 per cent)

The available potassium in the soil after harvest of the crop showed variation in different treatments A slight increase in potassium content was recorded in the case of plants from suckers The highest values being in T_{18} (5 23 per cent) and T_{22} (5 17 per cent) In treatments including tissue cultured plants there was a decline in potassium content after harvest ranging from -3 92 per cent in T_1 to 8 45 in T_5

The removal of three major nutrients (N P and K) from soil were higher in the case of tissue cultured plants compared to the plants propagated from suckers

4 1 6 3 Effect of treatments on the cost of cultivation net profit and benefit/cost ratio of banana

The detailed cost of cultivation in Appendix 24 (a b) and the Table 30 showing cost of cultivation net profit and benefit/cost ratio showed that the cost of cultivation ranged from Rs 82530 in T_2 T_8 T_{14} and T_{20} to Rs 95202 in T_5 T_{11} T_{17} and T_{23} The income per hectare ranged from Rs 147000 in T_8 to Rs 213832 in T_{15} The net profit per hectare ranged from Rs 64470 in T_8 to Rs 119202 in T_{15} The highest benefit cost ratio was also observed in T_{15} and the lowest benefit cost ratio was obtained in T_8 The results indicated that for highest benefits and net profit the 3 5 months old tissue cultured plants supplied with fertilizers in seven splits and two suckers retained per plant gave best results

4 1 6 4 Variations in morphological characters of tissue cultured plants

No significant variations from the confined morphological features of the cultivar [Musa (AAB group) Nendran] was observed in the tissue cultured plants

Table 30 Effect of treatments on cost of cultivation net profit and benefit cost ratio of nendran banana

Treatment	Yield/ha	Income (bunches) Rs 8/kg	Income suckers	Total income Rs	Total expenditure	Net profit	Benefit cost ratio
	24304	94432	9600	204032	94057	109975	2 17
	18792	150336	9600	159936	82530	77406	1 94
	25309	202468	9600	212069	94630	117438	2 24
T_4	18179	145432	9600	155032	83102	71930	1 87
T_5	24696	197568	9600	207168	95202	111966	2 18
T_6	18179	145432	9600	155032	83674	71358	1 85
T_7	25113	200904		200904	94057	106847	2 13
T_8	18375	147000		147000	82530	64470	1 78
T_9	24892	199136		199136	94630	104506	2 10
T_{10}	19600	156800		156800	83102	73698	1 88
T_{11}	25921	207368		207368	95202	112166	2 18
T_{12}	20629	165032		165032	83674	81358	1 97
T_{13}	24500	19600	9600	205600	94057	111543	2 18
T_{14}	18792	150336	9600	159936	82530	76806	1 93
T_{15}	25529	204232	9600	213832	94630	119202	2 26
T_{16}	18792	150336	9600	159936	83102	76834	1 92
T_{17}	25113	200904	9600	210504	95202	115302	2 21
T_{18}	21242	169936	9600	179536	83674	95862	2 15
T_{19}	25725	205800		205800	94057	111743	2 19
T_{20}	20629	165032		165032	82530	82502	2 00
T_{21}	26338	210704		210764	94630	116074	2 23
T_{22}	21854	174832		174832	83102	91730	2 10
T_{23}	25529	204232		204232	95202	109030	2 15
T_{24}	21854	174832		174832	83674	91158	2 09

Plate 7 Individual fingers from bunches of tissue cultured plants (left) and plants from suckers (right) given fertilizers in seven split doses in which two suckers were retained per plant and no suckers were retained

Plate 8 A view of the experimental field (Fxperiment II)

4 2 Ex II Standardisation of fertiliser schedule for tissue cultured plants of banana

4 2 1 Height Weight and number of leaves per plant at the time of planting

Thr e month old tissue cultured plants of uniform growth were used in the study There was only negligible variation in the height weight and number of leaves of the tissue cultured plants used The height of plants ranged from 25 6 to 30 8 cm the weight from 112 to 124 g and the number of leaves per plant from four to six

4 2 2 Vegetative characters

4 2 2 1 Height of pseudostem

4 2 2 1 1 Effect of N K and their split applications on the height of pseudostem

A significant difference in the height of pseudostem was noticed under different levels of nitrogen application f ve months after planting in the first crop At this stage N 400 recorded a height of 141 69 cm which was significantly higher than N 200 (12 38 cm) and N 300 (126 65

Table 31a Effect of N K and their split application (s) on height of pseudostem

Height of pseudostem(cm)

Effect	Month after planting 1	2	3	4	5	6	7	8
n1	27 88	39 26	53 13	71 13	127 38	188 75	267 43	299 00
n2	26 53	35 73	48 88	65 05	126 65	192 45	260 88	299 67
n3	27 63	34 57	48 17	66 59	141 69	198 92	259 22	303 88
F2 22	<1	1 80	2 96	2 88	4 83*	1 26	1 98	0 36
CD	—	—	—	—	11 324	—	—	—
k1	26 19	36 05	47 35	67 69	120 81	182 93	266 64	295 28
k2	26 53	35 42	50 21	64 55	134 04	191 47	255 39	299 94
k3	27 63	38 09	52 62	70 53	140 89	205 72	265 50	307 33
F	0 51	0 59	2 86	2 58	6 99**	6 31	4 06	1 92
CD	—	—	—	—	11 32	13 44	8 015	—
s1	26 29	35 70	49 10	68 40	128 27	187 32	256 98	299 22
s2	26 44	35 77	48 85	66 73	136 43	199 59	265 50	300 61
s3	27 62	38 09	52 23	67 64	131 03	193 19	265 05	302 72
F2 22	0 47	0 56	1 46	<1	1 15	1 79	2 43	<1

Table 31b Effect of N K and their split application (s) on height of pseudostem

Height of pseudostem (cm)

Effect	Month after planting 1	2	3	4	5	6	7	8
n_1	28 74	36 21	48 23	65 96	116 37	211 03	256 77	279 61
n_2	30 53	38 71	55 62	77 72	129 10	225 95	255 77	292 38
n_3	28 88	36 73	49 36	72 10	120 20	223 33	254 83	296 22
$F_{2\ 22}$	<1	<1	3 14	3 33	1 367	<1	<1	<1
CD	–	—	—	–	—	—	—	—
k_1	29 29	37 16	52 52	72 31	122 97	219 21	251 83	288 11
k_2	29 63	37 88	51 39	74 46	122 17	222 43	256 33	294 44
k_3	29 22	36 61	49 29	69 025	120 52	218 67	253 22	285 68
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
CD	—	—	—	—	—	—	—	—
s_1	29 15	37 41	50 75	72 09	121 85	219 81	254 11	289 38
s_2	29 69	37 50	51 45	71 82	122 27	220 65	254 22	291 11
s_3	29 30	36 74	51 00	71 88	121 56	219 85	253 05	287 72
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1

cm) At all other stages of growth in both the seasons the level of nitrogen did not influence the height of the plant (Table 31a and b) In both seasons the maximum height at shooting was observed in N 400 (303 88 cm and 296 22 cm in the first and second crop respectively)

During the first season levels of potassium significantly influenced the height of pseudostem at five six and seven months after planting Six hundred grams of potassium recorded heights of 140 89 cm 205 72 cm and 265 5 cm which was higher than the values recorded in K 300 and K 450 At shooting the height of pseudostem was not influenced by the level of K_2O in both the crops

The height of pseudostem was not influenced by the different levels of split applications

4 2 2 1 2 Interaction effect of N K and their split applications the height of pseudostem

At any stage in either crop NK interaction effect could not be noticed with respect to plant height (Table 32a and b) The height of pseudostem was not influenced by NS

Table 32a Interaction effect of N K and their split application(s) on height of pseudostem

Interaction Effect	Height of pseudostem (cm) — Month after planting 1	2	3	4	5	6	7	8
n_1k_1	27 64	39 38	54 05	73 22	121 33	184 33	266 44	293 67
n_1k_2	26 05	36 56	52 00	69 05	131 83	186 58	266 83	298 33
n_1k_3	29 97	41 83	53 33	71 10	129 00	195 33	269 00	305 00
n_2k_1	25 61	35 36	42 83	66 11	119 17	185 17	271 00	293 17
n_2k_2	27 39	35 53	50 38	62 83	120 20	187 03	248 00	297 17
n_2k_3	26 58	36 31	53 44	66 22	140 58	205 17	263 00	308 67
n_3k_1	25 33	33 42	45 16	63 75	121 92	179 30	282 50	299 00
n_3k_2	26 17	34 17	48 25	61 78	150 08	200 78	251 00	304 33
n_3k_3	26 33	36 14	51 08	74 25	153 08	216 67	264 00	308 33
$F_{4,22}$	0 49	0 16	1 29	1 26	1 77	<1	1 25	<1
n_1s_1	26 14	36 67	50 72	72 11	119 00	184 33	263 61	299 33
n_1s_2	28 58	39 67	54 11	71 16	131 83	195 17	272 73	299 67
n_1s_3	28 94	41 44	54 55	70 11	131 33	186 75	266 33	298 00
n_2s_1	26 92	36 94	47 50	67 17	120 41	183 77	255 33	298 00
n_2s_2	25 50	33 75	43 77	62 11	136 04	200 10	257 67	294 80
n_2s_3	27 17	36 50	55 38	65 88	123 50	193 50	269 67	305 33
n_3s_1	25 83	33 50	49 08	65 94	145 42	193 88	252 00	299 50
n_3s_2	25 25	33 89	48 67	66 92	141 42	203 53	266 50	307 33
n_3s_3	26 75	36 33	46 75	66 92	138 25	199 33	259 17	304 83
$F_{4,22}$	0 32	0 28	2 09	0 29	0 92	<1	1 10	0 30
k_1s_1	26 42	36 42	49 83	68 42	107 62	175 55	260 11	287 33
k_1s_2	24 61	34 19	46 67	72 55	136 50	193 25	268 50	295 50
k_1s_3	27 55	37 55	45 55	62 11	118 50	180 00	271 33	303 00
k_2s_1	24 83	32 97	48 17	63 77	135 28	186 93	251 33	301 67
k_2s_2	27 31	36 22	50 33	64 47	142 52	204 54	259 67	303 67
k_2s_3	27 47	37 05	52 13	65 42	124 33	182 92	255 17	294 50
k_3s_1	27 64	37 72	49 30	73 02	142 14	199 50	259 50	308 67
k_3s_2	27 42	36 88	49 55	63 17	130 28	201 00	268 33	302 67
k_3s_3	27 83	39 67	59 00	75 38	150 25	216 67	268 68	310 67
$F_{4,22}$	0 43	0 20	1 98	3 29	3 90	1 54	0 16	<1

Table 32b Interaction effect of N K and their split application(s) on height of pseudostem

Height of Pseudostem (cm)

Interaction Effect	1	2	3	4	5	6	7	8
				Month after planting				
n_1k_1	28 18	35 92	47 99	64 60	115 63	210 33	249 16	281 50
n_1k_2	28 85	36 93	47 35	66 31	117 54	211 45	253 16	282 00
n_1k_3	29 19	35 80	49 37	66 98	115 95	211 31	250 00	275 33
n_2k_1	29 71	36 98	56 24	77 54	126 13	220 58	251 00	279 00
n_2k_2	31 49	40 00	56 68	80 48	131 17	228 90	264 50	305 50
n_2k_3	30 40	39 15	53 95	75 15	129 99	228 32	251 83	292 66
n_3k_1	29 98	38 58	53 35	74 79	127 16	226 72	255 33	303 83
n_3k_2	28 56	36 73	50 17	76 59	117 80	226 92	251 33	295 83
n_3k_3	28 08	34 88	44 58	64 93	115 63	216 37	257 83	289 00
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
n_1s_1	28 37	36 17	47 366	65 48	115 10	209 00	252 66	280 16
n_1s_2	28 88	36 25	48 081	65 61	115 99	212 65	251 50	281 66
n_1s_3	28 96	36 29	49 27	65 80	118 03	211 45	248 11	277 00
n_2s_1	30 12	39 83	55 83	78 65	129 51	227 78	256 00	293 16
n_2s_2	31 16	39 49	56 89	77 26	129 13	225 67	256 83	290 83
n_2s_3	30 30	36 82	54 14	77 27	128 65	224 40	254 50	293 16
n_3s_1	28 96	36 31	49 08	72 15	120 93	222 67	253 66	290 60
n_3s_2	29 03	36 77	49 41	71 59	121 68	223 63	254 33	300 83
n_3s_3	28 63	37 13	49 61	72 56	117 99	223 71	256 50	293 00
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	28 30	37 03	51 61	71 73	124 10	215 68	252 00	288 83
k_1s_2	30 36	37 18	52 47	72 85	122 03	220 03	253 50	292 00
k_1s_3	29 20	37 27	53 50	72 35	122 89	221 92	250 00	283 33
k_2s_1	30 18	38 39	51 69	75 72	122 21	222 34	255 83	294 66
k_2s_2	29 71	38 07	51 74	74 16	123 14	222 91	255 33	296 17
k_2s_3	29 00	37 22	50 75	73 51	121 16	222 09	257 83	292 56
k_3s_1	28 97	36 84	48 97	68 84	119 32	221 43	254 50	284 66
k_3s_2	29 00	37 25	50 17	68 45	121 62	218 99	253 83	285 00
k_3s_3	29 70	35 75	48 76	69 77	120 63	215 59	251 33	287 33
$F_{4\ 22}$	1 00	<1	<1	<1	<1	<1	<1	<1

interaction During the first season significant difference in the height of pseudostem was recorded four and five months after planting due to KS interaction Potassium at 600 g per plant applied in eight splits recorded a height of 70 02 cm four months after planting and 150 25 cm five months after planting which was higher than that recorded in all other combinations The height of plants at shooting was not influenced by the KS interaction (Table 32a and b)

4 2 2 2 Girth of pseudostem

4 2 2 2 1 Effect of N K and their split applications on girth of pseudostem

Significant difference was observed in the girth of pseudostem due to the different levels of nitrogen only at the early stages of growth in both the seasons In the first crop two months after planting N 200 recorded a girth of 14 59 cm and N 300 13 79 cm which was higher than the girth at N 400 (12 19 cm) In the second season three months after planting N 300 recorded a pseudostem girth 25 15 cm which was higher than the girth at N 200 and N 400 levels (21 81 cm and 20 18 cm respectively) The girth of plant

Table 33a Effect of N K and their split application(s) on girth of pseudostem

Girth of pseudostem (cm)

Effect	Month after planting 1	2	3	4	5	6	7	8
n_1	10 16	14 59	21 23	29 02	44 40	55 20	62 53	71 25
n_2	10 05	13 79	19 81	26 79	40 94	57 48	64 65	70 35
n_3	8 90	12 19	19 97	27 30	41 23	57 04	63 09	69 55
$F_{2\ 22}$	3 00	7 62**	2 65	1 59	2 41	1 32	1 20	1 04
CD	—	1 29	—	-	—	—	—	—
k_0	10 02	13 70	20 39	27 23	41 23	54 77	62 63	69 28
k_1	9 21	13 03	19 55	27 53	41 44	55 82	62 29	70 68
k_2	9 92	13 85	21 06	28 37	43 89	59 13	65 39	71 19
$F_{2\ 22}$	1 25	<1	1 85	<1	1 43	4 63	2 79	1 40
CD	-	-	-	—	—	3 092	—	—
s_1	9 78	13 51	20 56	26 85	42 14	56 08	63 92	71 44
s_2	9 09	13 01	20 08	28 37	42 29	56 82	63 36	69 77
s_3	10 26	14 07	20 37	27 91	42 13	56 82	62 99	69 94
$F_{2\ 22}$	2 28	1 45	1 76	<1	<1	<1	<1	1 21
CD	—	—	-	—	—	—	—	—

Table 33b Effect of N K and their split application(s) on girth of pseudostem

Girth of pseudostem (cm)

Effect	Month after planting 1	2	3	4	5	6	7	8
n_1	10 31	14 64	21 81	30 35	39 71	53 63	60 70	69 31
n_2	9 93	14 34	25 15	33 23	44 21	56 82	64 74	71 71
n_3	10 02	12 60	20 18	27 88	38 71	51 32	59 39	67 46
$F_{2\ 22}$	0 11	2 83	4 89*	2 98	2 39	1 00	<1	<1
CD	—	—	3 365	—	—	—	-	—
k_0	9 69	14 43	22 44	30 60	41 19	54 32	61 82	68 80
k_1	10 15	13 04	22 75	30 75	41 33	54 63	62 47	71 00
k_2	10 42	14 11	21 95	30 11	41 00	52 83	65 40	68 62
$F_{2\ 22}$	0 40	1 25	0 12	<1	0 12	0 12	0 10	0 14
CD	—	-	—	—	-	—	—	—
s_1	10 21	14 15	22 01	30 51	48 90	54 27	61 95	69 79
s_2	9 96	13 60	22 52	30 27	41 00	53 91	61 72	69 43
s_3	10 04	13 83	22 60	30 69	40 74	53 53	61 16	69 28
$F_{2\ 22}$	0 02	0 17	<1	<1	4 66*	<1	<1	0 03
CD	—	—	—	—	5 552	—	—	—

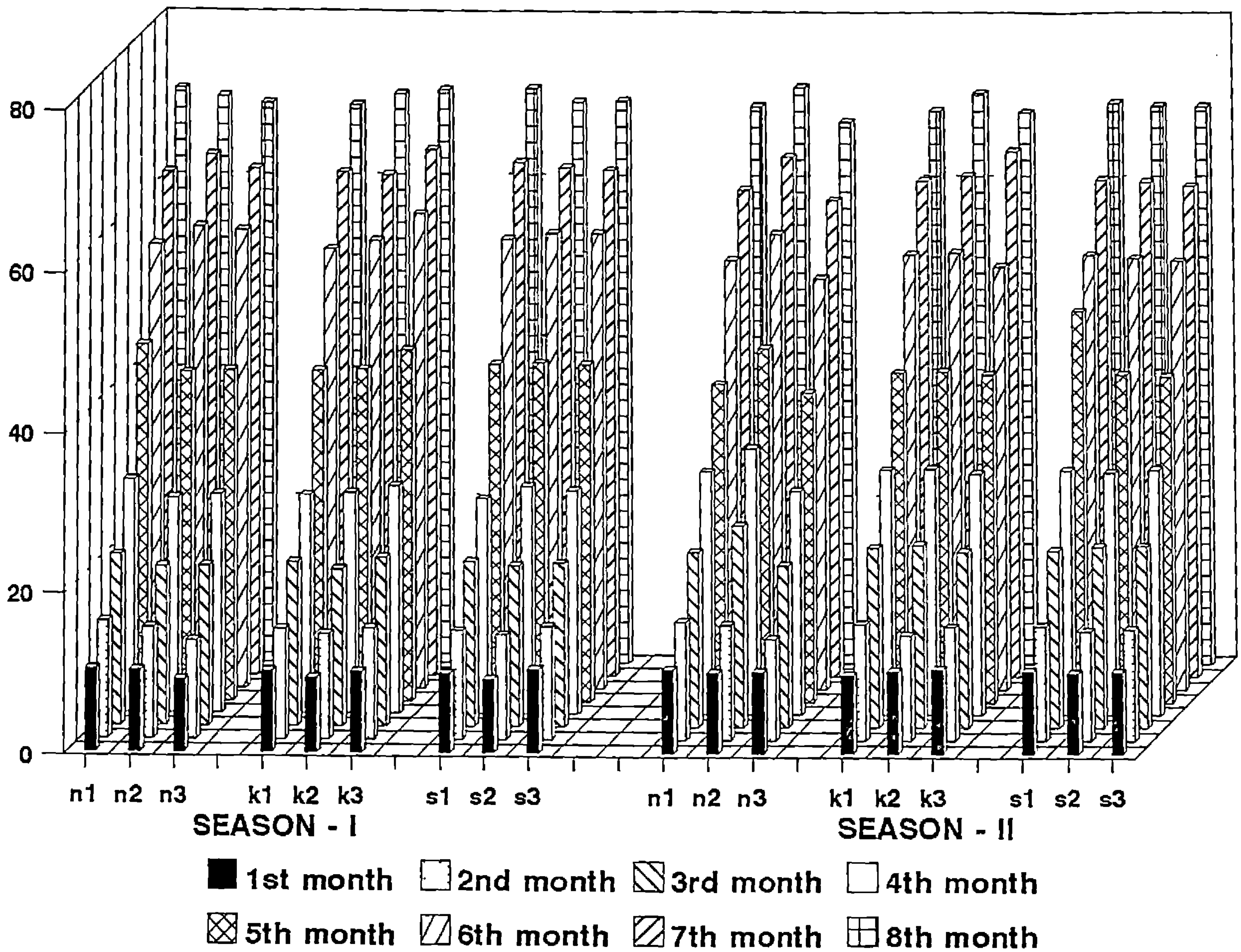


Fig. 6 Effect of N, K and their split on girth of pseudostem

during the later stages was not influenced by the level of N At shooting the girth of plants for N 200 N 300 and N 400 were 71 25 and 69 31 70 35 and 71 72 and 69 55 and 67 46 cm respectively for the two seasons (Table 33a and b)

Different levels of potassium influenced the girth of pseudostem six monnths after planting During the first crop at this stage K 600 recorded a significantly higher girth of pseudostem compared to other treatments (59 13 cm) At shooting the girth of pseudostem between different levels of potassium did not show significant difference (Table 33a and b)

The girth of pseudostem at the different stages of growth was not influenced by the level of split applications

4 2 2 2 2 Interaction effect of N K and their split applications on the girth of pseudostem

In the first crop seven months after planting NK interaction exerted a significant influence on the girth of pseudostem N300 K450 (66 03 cm) N300 K600 (64 83 cm) and N450 K600 (69 22 cm) recorded greater girth of pseudostem

Table 34a Interaction effect of N K and their split application(s) on girth of psedostem

Effect	Girth of pseudostem (cm)							
	Month after planting							
	1	2	3	4	5	6	7	8
n_1k_1	10 49	14 22	21 53	29 54	46 80	56 61	66 11	72 33
n_1k_2	9 08	13 50	20 55	30 25	43 02	51 99	59 47	69 77
n_1k_3	10 88	16 05	21 61	27 27	43 38	57 00	62 00	71 67
n_2k_1	10 88	14 16	20 17	26 47	38 72	55 44	63 10	69 00
n_2k_2	10 38	13 58	18 61	26 89	41 03	58 22	66 03	72 22
n_2k_3	9 75	13 63	20 67	27 03	43 07	56 17	64 83	69 83
n_3k_1	10 03	12 72	19 49	25 67	38 19	52 27	58 67	66 50
n_3k_2	9 17	12 02	19 49	25 44	40 28	57 24	61 38	70 06
n_3k_3	8 80	11 85	20 92	30 80	45 22	61 62	69 22	72 08
$F_{4\ 22}$	0 51	1 27	<1	2 07	1 69	2 58	5 78*	2 27
n_1s_1	10 19	14 28	21 83	29 35	43 13	56 33	63 11	73 45
n_1s_2	9 33	14 05	20 92	29 14	40 74	54 27	62 17	69 33
n_1s_3	10 94	15 44	20 94	28 58	39 83	55 00	62 31	71 00
n_2s_1	10 44	14 28	20 28	25 95	40 29	56 47	65 61	72 00
n_2s_2	9 36	13 14	19 44	26 64	42 88	57 47	64 75	69 56
n_2s_3	9 36	13 97	19 72	27 81	41 14	58 50	63 60	69 50
n_3s_1	10 36	11 97	19 58	25 25	43 00	55 45	63 05	68 88
n_3s_2	8 72	11 83	19 89	29 33	43 25	58 72	63 17	70 42
n_3s_3	8 58	12 79	20 44	27 33	45 43	50 97	63 05	69 33
$F_{4\ 22}$	<1	<1	<1	<1	1 43	<1	<1	1 04
k_1s_1	10 44	14 17	21 39	27 57	43 14	55 05	64 11	72 17
k_1s_2	9 33	12 67	19 19	28 36	40 75	54 88	61 17	66 50
k_1s_3	10 27	14 27	20 60	25 75	39 83	54 38	62 60	69 17
k_2s_1	8 47	12 19	19 50	26 28	40 30	52 77	62 17	70 67
k_2s_2	8 47	11 99	19 44	26 78	42 89	59 00	64 02	72 05
k_2s_3	10 69	14 32	19 72	29 53	41 14	55 69	60 64	69 33
k_3s_1	10 44	14 17	20 80	26 69	43 00	60 42	65 50	71 50
k_3s_2	9 47	14 36	21 62	29 97	43 25	56 58	64 83	70 75
k_3s_3	9 83	13 02	20 78	28 44	45 44	60 39	65 13	71 33
$F_{4\ 22}$	1 30	2 69	<1	1 11	<1	2 11	<1	1 78

Table 34b Interaction effect of N K and their split application(s) on girth of pseudostem

Effect	Girth of pseudostem (cm)							
	Month after planting							
	1	2	3	4	5	6	7	8
n_1k_1	9 86	15 17	21 81	29 93	39 41	53 04	59 96	68 03
n_1k_2	10 48	12 49	21 85	30 68	39 35	53 92	60 79	69 81
n_1k_3	10 58	16 25	21 7	34 30	40 39	53 94	61 35	70 09
n_2k_1	9 40	14 81	24 99	32 88	43 75	56 32	63 74	71 16
n_2k_2	9 84	14 25	26 29	33 98	45 61	58 03	65 87	74 14
n_2k_3	10 55	13 98	24 60	32 83	43 27	56 12	64 62	70 87
n_3k_1	9 81	13 32	25 10	28 98	40 61	53 59	61 75	68 43
n_3k_2	10 14	12 37	21 00	27 60	39 03	51 94	60 76	69 04
n_3k_3	10 14	12 12	19 91	27 06	36 68	48 43	55 65	64 90
$F_{4\ 22}$	<1	1 05	<1	<1	<1	<1	<1	<1
n_1s_1	9 97	16 07	21 47	33 70	39 53	53 55	62 55	69 49
n_1s_2	10 78	14 58	22 02	29 99	40 04	53 75	61 14	68 71
n_1s_3	10 18	14 26	21 98	30 68	39 57	53 60	60 42	69 73
n_2s_1	10 07	14 50	24 52	33 12	44 55	53 06	60 55	71 60
n_2s_2	9 21	13 992	25 02	33 36	44 60	56 74	64 81	71 87
n_2s_3	10 51	14 31	25 90	33 21	43 48	56 68	64 87	71 71
n_3s_1	10 61	12 56	20 10	28 02	38 60	52 21	60 75	68 27
n_3s_2	9 88	12 31	20 51	27 45	38 35	51 42	59 20	67 70
n_3s_3	9 57	12 93	19 93	28 17	39 17	50 33	58 21	66 40
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	10 28	14 81	22 18	31 06	40 38	54 98	62 02	68 80
k_1s_2	9 69	13 64	22 18	30 05	41 80	54 20	61 50	68 83
k_1s_3	9 12	14 84	22 95	36 90	41 38	53 77	61 93	68 99
k_2s_1	9 68	13 41	22 03	33 40	42 22	55 21	62 70	71 15
k_2s_2	10 28	12 43	23 25	37 80	41 04	54 60	63 18	71 58
k_2s_3	10 50	13 27	22 96	31 14	47 30	54 08	61 55	70 25
k_3s_1	10 68	14 22	21 83	30 11	40 08	52 62	61 14	69 41
k_3s_2	9 93	14 74	22 12	29 98	40 15	53 11	60 46	67 88
k_3s_3	10 64	13 38	21 90	30 23	41 11	52 76	60 01	68 57
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1

compared to the other treatments The girth of pseudostem at shooting in both seasons was highest at N300 K450 being 72 42 cm and 74 14 cm respectively (Table 34a and b)

The girth of pseudostem was not influenced by NS interaction at any stage of growth in both the seasons

KS interaction also did not influence the girth of pseudostem In both seasons at shooting the highest girth was recorded in K450S8 (72 05 cm and 71 58 cm respectively)

4 2 2 3 Number of leaves produced at monthly intervals

4 2 2 3 1 The effect of N K and their split applications on number of leaves produced at monthly intervals

Nitrogen at various levels could not effectively influence the number of leaves produced at monthly intervals However rapid emergence of leaves was noticed during the fifth and sixth months after planting An average of 7 40 and 7 31 leaves were the highest values recorded for the first and second crop During sixth month N300 recorded the highest leaf production for both the crops (6 42 and 5 30)

Table 35a Effect of N K and their split application(s) on number of leaves produced at monthly intervals

Number of leaves produced at monthly intervals

Effect	Month after planting 1	2	3	4	5	6	7	8
n_1	3 38	3 63	4 10	4 25	7 16	6 05	4 89	4 60
n_2	3 16	3 55	4 05	4 07	7 14	6 42	4 88	4 24
n_3	3 15	3 61	4 31	4 17	7 40	6 20	4 35	4 16
$F_{2\ 22}$	1 79	<1	1 43	<1	<1	1 11	2 69	1 12
k_1	3 20	3 66	4 15	3 86	7 24	6 29	4 87	4 45
k_2	3 22	3 59	4 11	4 43	7 18	6 29	4 66	4 30
k_3	3 28	3 54	4 22	4 20	7 29	6 09	4 58	4 26
$F_{2\ 22}$	<1	<1	<1	1 29	<1	<1	<1	<1
s_1	3 24	3 70	4 13	3 97	7 27	6 24	4 78	4 34
s_2	3 31	3 53	4 07	4 07	7 25	6 20	4 72	4 26
s_3	3 15	3 55	4 28	4 42	7 18	6 24	4 63	4 41
$F_{2\ 22}$	<1	<1	<1	<1	<1	1 52	<1	<1

Table 35b Effect of N K and their split application(s) on number of leaves produced at monthly intervals

Number of leaves produced at monthly intervals

Effect	Month after planting							
	1	2	3	4	5	6	7	8
n_1	3 24	3 59	3 68	3 81	7 31	5 40	4 37	3 96
n_2	3 22	3 57	3 51	3 70	7 12	5 90	4 65	4 38
n_3	3 12	3 47	3 81	3 77	6 88	5 10	4 07	3 77
$F_{2,22}$	<1	<1	<1	<1	<1	2 16	1 71	2 50
k_1	3 25	3 57	3 75	3 77	7 12	5 42	4 34	4 03
k_2	3 05	3 55	3 75	3 88	7 33	5 92	4 53	4 27
k_3	3 20	3 51	3 49	3 62	6 86	5 14	4 21	3 81
$F_{2\ 22}$	<1	<1	<1	<1	<1	1 70	<1	1 37
s_1	3 12	3 58	3 81	3 68	7 16	5 33	4 46	4 01
s_2	3 35	3 57	3 51	3 81	7 09	5 72	4 29	4 07
s_3	3 11	3 47	3 68	3 71	7 07	5 44	4 34	4 03
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1

The levels of potassium did not influence the number of leaves produced at monthly intervals The production of leaves at monthly intervals was not influenced by level of split application (Table 35a and b)

4 2 2 3 2 Interaction effects of N K and their split applications on number of leaves produced at monthly intervals

In the first crop three months after planting there was significant difference in the number of leaves produced at monthly intervals due to N K interaction The highest value was recorded in N400 K600 (4 78) but it was statistically on par with N200 K450 N300 K600 (4 28 each) and N400 K450 and N200 K300 (4 17 and 4 44 respectively) NK interaction did not record any significant effect in monthly leaf production at any other stage in both the seasons

The number of leaves produced at monthly interval was not influenced by the interaction between levels of nitrogen and split application of fertilizer in both the crops (Table 36a and b)

Table 36a Interaction effect of N K and their split application(s) on number of leaves produced at monthly intervals

Number of leaves produced at monthly intervals

Interaction Effect	Month after planting 1	2	3	4	5	6	7	8
n_1k_1	3 44	3 89	4 44	4 13	7 39	6 048	4 91	4 63
n_1k_2	3 33	3 66	4 28	4 33	6 94	6 44	4 72	4 44
n_1k_3	3 38	3 33	3 61	4 28	7 16	5 67	5 04	4 72
n_2k_1	3 11	3 61	3 99	3 72	6 99	6 67	5 00	4 33
n_2k_2	3 17	3 49	3 88	4 55	7 44	6 22	4 94	4 28
n_2k_3	3 22	3 55	4 28	3 94	6 99	6 39	4 72	4 11
n_3k_1	3 05	3 49	3 99	3 72	7 33	6 17	4 72	4 39
n_3k_2	3 17	3 61	4 17	4 39	7 16	6 22	4 33	4 17
n_3k_3	3 22	3 72	4 78	4 39	7 72	6 22	4 00	3 94
$F_{4\ 22}$	<1	<1	5 00	<1	1 00	<1	<1	<1
n_1s_1	3 38	3 83	4 17	3 97	7 16	5 94	4 86	4 31
n_1s_2	3 50	3 55	3 94	4 16	7 28	6 05	4 98	5 05
n_1s_3	3 276	3 49	4 22	4 61	7 05	6 16	4 83	4 44
n_2s_1	3 11	3 55	3 99	3 72	7 05	6 61	5 17	4 72
n_2s_2	3 22	3 61	3 94	3 99	7 22	6 11	4 67	3 67
n_2s_3	3 16	3 50	4 22	4 49	7 17	6 55	4 83	4 33
n_3s_1	3 22	3 72	4 22	4 22	7 61	6 17	4 33	4 00
n_3s_2	3 22	3 44	4 33	4 05	7 27	6 44	4 50	4 055
n_3s_3	3 00	3 67	4 38	4 22	7 33	5 99	4 22	4 44
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	1 68
k_1s_1	3 11	3 72	4 10	3 80	7 27	6 11	5 19	4 75
k_1s_2	3 38	3 50	3 94	3 78	6 94	6 11	4 88	4 27
k_1s_3	3 11	3 78	4 39	3 99	7 49	6 66	4 55	4 33
k_2s_1	3 33	3 67	4 11	4 05	7 44	6 33	4 61	4 33
k_2s_2	3 17	3 55	4 06	4 60	7 33	6 11	4 67	4 00
k_2s_3	3 17	3 55	4 17	4 61	6 78	6 44	4 72	4 55
k_3s_1	3 28	3 72	4 16	4 05	7 11	6 28	4 55	3 94
k_3s_2	3 38	3 55	4 22	3 83	7 49	6 39	4 60	4 50
k_3s_3	3 17	3 33	4 28	4 72	7 28	5 61	4 61	4 33
$F_{4\ 22}$	<1	<1	<1	<1	1 26	1 62	<1	0 73

Table 36b Interaction effect of N K and their split application(s) on number of leaves produced at monthly interns

Number of leaves produced at monthly intervals

Interaction Effect	Month after planting 1	2	3	4	5	6	7	8
n_1k_1	3 38	3 77	3 66	3 99	7 44	4 94	4 32	3 61
n_1k_2	3 05	3 38	3 83	3 77	7 63	5 88	4 50	4 11
n_1k_3	3 27	3 60	3 55	3 66	7 16	5 38	4 28	4 16
n_2k_1	3 22	3 55	3 49	3 49	7 05	5 83	4 44	4 60
n_2k_2	3 11	3 60	3 60	3 88	7 50	6 60	5 11	4 61
n_2k_3	3 33	3 55	3 44	3 71	6 83	5 49	4 41	3 94
n_3k_1	3 16	3 38	4 10	3 83	6 88	5 49	4 27	3 88
n_3k_2	3 00	3 66	3 82	3 99	7 16	5 27	3 99	4 10
n_3k_3	3 22	3 38	3 49	3 49	6 60	4 55	3 95	3 33
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	1 02
n_1s_1	3 11	3 60	3 66	3 71	7 16	4 88	4 55	3 94
n_1s_2	3 55	3 66	3 55	3 88	7 44	5 83	4 27	3 94
n_1s_3	3 05	3 49	3 83	3 83	7 33	5 49	4 28	4 00
n_2s_1	3 00	3 55	3 63	3 55	7 27	6 05	4 72	4 44
n_2s_2	3 44	3 60	3 38	3 68	7 05	6 22	4 44	4 33
n_2s_3	3 22	3 55	3 49	3 88	7 05	5 66	4 80	4 38
n_3s_1	3 27	3 60	3 10	3 77	7 05	5 05	4 11	3 66
n_3s_2	3 05	3 44	3 60	3 88	6 77	5 10	4 16	3 94
n_3s_3	3 05	3 38	3 71	3 66	6 83	5 16	3 95	3 72
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	3 16	3 60	3 83	3 83	6 99	5 38	4 38	3 88
k_1s_2	3 50	3 38	3 60	3 77	7 22	5 55	4 44	4 05
k_1s_3	3 11	3 72	3 83	3 71	7 16	5 33	4 22	4 16
k_2s_1	3 00	3 55	3 99	3 66	7 44	5 77	4 67	4 16
k_2s_2	3 16	3 72	3 55	4 05	7 33	6 10	4 44	4 38
k_2s_3	3 00	3 38	3 71	3 44	7 22	5 88	4 55	4 27
k_3s_1	3 22	3 60	3 60	3 55	7 05	4 83	4 39	3 99
k_3s_2	3 38	3 60	3 38	3 60	6 72	5 49	3 98	3 77
k_3s_3	3 22	3 33	3 49	3 72	6 68	5 11	4 26	3 66
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1

No significant difference was observed in the number of leaves produced at monthly intervals due to the interaction between levels of potassium and split application of fertilizers

4 2 2 4 Number of leaves retained at monthly intervals

4 2 2 4 1 Effect of N K and their split applications on number of leaves retained at monthly intervals

The number of leaves retained at monthly intervals was not significantly influenced by the level of nitrogen applied in either crop At all the three levels tried the number of leaves retained per plant progressively increased as the plants grew and the plants retained the highest number of leaves towards shooting N300 retained the maximum number of leaves (14 91 & 15 06) in both seasons at shooting

The number of leaves retained at monthly intervals was not influenced by the levels of potassium applied (Table 37a and b)

Table 37a Effect of N K and their split application(s) on number of leaves retained at monthly intervals

Number of leaves retained

Effect	Month after planting 1	2	3	4	5	6	7	8	Harvest
n_1	6 49	8 66	9 07	8 39	11 67	12 81	13 39	14 16	4 38
n_2	6 53	8 63	8 55	7 78	12 29	13 21	13 56	14 93	4 90
n_3	6 40	8 25	8 96	8 77	11 83	13 32	13 94	14 91	4 20
$F_{2\ 22}$	0 15	1 22	2 32	2 81	<1	<1	<1	2 54	3 14
k_1	6 46	8 74	8 6b	8 10	11 5	12 86	13 38	14 28	4 60
k_2	6 31	8 25	8 94	8 22	12 13	13 24	13 72	14 83	4 27
k_3	6 66	8 55	8 97	8 57	12 13	13 24	13 77	14 88	4 84
$F_{2\ 22}$	1 10	1 40	<1	<1	<1	<1	<1	1 48	4 36
s_1	6 33	8 62	8 83	8 13	12 24	13 26	13 77	14 74	4 47
s_2	6 33	8 31	8 77	8 38	11 72	13 15	13 38	14 31	4 48
s_3	6 78	8 61	8 97	8 38	11 83	12 93	13 72	14 95	4 53
$F_{2\ 22}$	2 32	<1	<1	<1	<1	<1	<1	1 41	<1

Table 37b Effect of N K and their split application(s) on number of leaves retained at monthly intervals

Number of leaves retained

Effect	1	2	3	4	5	6	7	8	Harvest
					Month after planting				
n_1	6 49	9 01	8 40	8 97	11 38	12 18	11 94	14 37	5 18
n_2	6 55	8 81	9 60	8 25	11 84	13 14	13 67	15 16	5 42
n_3	6 71	7 88	8 64	8 20	11 10	11 27	11 92	14 56	4 74
$F_{2\ 22}$	<1	2 12	2 19	1 59	<1	2 55	3 16	2 18	2 35*
CD	-	-			-		-	-	0 642
k_1	6 44	8 59	8 88	8 49	11 27	11 92	12 20	14 42	4 96
k_2	6 60	8 68	8 84	9 20	11 68	12 97	13 40	15 23	5 42
k_3	6 71	8 44	8 92	8 73	11 38	11 70	12 23	14 35	4 96
$F_{2\ 22}$	0 23	<1	<1	<1	<1	1 36	1 05	2 17	1 39
t_1	6 51	8 68	8 90	8 75	11 31	12 20	12 57	14 53	5 09
t_2	6 57	8 59	8 79	8 81	11 44	12 21	12 68	14 93	5 20
t_3	6 68	8 44	8 96	8 86	11 58	12 18	12 59	14 85	5 05
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	2 24	<1

The split application of fertilizers did not influence the number of leaves retained at monthly intervals

4.2.2.4.2 Interaction effect of the N K and their split application on the number of leaves retained at monthly intervals

There was no significant difference in the number of leaves retained at monthly intervals due to the interaction between nitrogen and potassium At shooting the number of functional leaves per plant ranged from 15 16 in N300 K450 to 13 23 in N200 K300 in first season and in the second season 15 22 in N300 K450 to 13 88 in N200 K300

The interaction between nitrogen and split application of fertilizers did not make any significant effect on the number of leaves retained (Table 38a and b)

The number of functional leaves retained was not influenced by the interaction between potassium and split application of fertilizers (Table 38 a and b)

Table 38a Interaction effect of N K and their split application(s) on number of leaves retained at monthly intervals

Interaction Effect	Number of leaves retained — Month after planting 1	2	3	4	5	6	7	8	Harvest
n_1k_2	6 44	9 05	9 16	8 78	11 665	12 61	12 83	13 88	6 16
n_1k_2	6 38	8 33	9 39	8 44	11 72	12 94	13 5	14 27	4 55
n_1k_3	6 66	8 61	8 66	7 94	11 61	12 88	13 83	14 33	4 44
n_2k_1	6 50	8 78	8 28	7 83	11 88	13 08	13 67	14 42	4 49
n_2k_2	6 44	8 50	8 55	6 88	12 67	13 28	13 67	15 22	5 77
n_2k_3	6 67	8 61	8 83	8 61	12 33	13 28	13 33	15 17	4 44
n_3k_1	6 44	8 39	8 55	7 72	11 05	12 89	13 67	14 55	4 16
n_3k_2	6 11	7 93	8 88	9 33	11 99	13 05	14 00	15 00	4 22
n_3k_3	6 66	8 44	9 44	9 17	12 44	13 58	14 17	15 17	4 22
$F_{4,22}$	<1	<1	1 70	3 03	<1	<1	<1	<1	1 28
n_1s_1	6 55	8 72	8 829	8 39	11 72	13 00	13 50	14 05	4 33
n_1s_2	6 39	8 67	9 051	8 66	11 28	12 55	13 17	14 17	4 38
n_1s_3	6 55	8 61	9 33	8 11	12 00	12 88	15 05	14 27	4 44
n_2s_1	6 22	8 61	8 67	7 16	12 94	13 28	13 05	15 00	4 88
n_2s_2	6 55	8 50	8 44	8 17	12 33	13 33	13 17	14 38	4 88
n_2s_3	6 83	8 78	8 55	8 00	11 61	13 02	14 00	15 40	4 94
n_3s_1	6 22	8 55	8 99	8 83	12 05	13 49	14 33	15 16	4 22
n_3s_2	6 05	7 77	8 83	8 33	11 55	13 58	13 83	14 30	4 16
n_3s_3	6 94	8 44	9 05	9 05	11 88	12 88	13 67	15 17	4 22
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	6 39	8 66	8 61	8 44	12 22	12 88	13 50	15 05	4 33
k_1s_2	6 28	8 55	8 61	7 89	11 78	12 94	13 17	13 38	4 16
k_1s_3	6 72	9 00	8 77	7 99	10 61	12 75	13 50	14 42	4 33
k_2s_1	6 05	8 58	8 88	7 44	12 44	13 11	14 17	14 67	4 71
k_2s_2	6 28	8 21	8 83	8 72	11 39	13 39	13 67	14 55	4 88
k_2s_3	6 61	8 28	9 10	8 49	12 55	13 22	13 33	15 27	4 94
k_3s_1	6 55	8 94	8 99	8 49	12 05	13 78	13 67	14 50	4 38
k_3s_2	6 44	8 17	8 89	8 55	11 99	13 14	13 33	15 00	4 38
k_3s_3	6 99	8 55	9 05	8 67	12 33	12 83	14 33	15 17	4 33
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	1 47	<1

Table 38b Interaction effect of N K and their split application(s) on number of leaves retained at monthly intervels

Number of leaves retained

Interaction effect	Month after planting 1	2	3	4	5	6	7	8	Harvest
n_1k_1	6 16	8 82	8 44	8 82	11 27	11 60	11 27	14 15	4 94
n_1k_2	6 55	9 27	8 11	8 77	11 10	13 27	12 71	14 86	5 16
n_1k_3	6 77	8 94	8 66	9 33	11 77	11 66	11 83	14 50	5 44
n_2k_1	6 66	8 83	9 44	8 66	11 44	12 99	13 66	14 12	5 22
n_2k_2	6 38	8 99	9 77	10 33	12 49	14 27	14 94	15 23	5 89
n_2k_3	6 60	8 60	9 60	8 83	11 60	12 16	13 33	14 87	5 16
n_3k_1	6 49	8 11	8 70	8 05	11 11	11 16	11 66	14 83	4 72
n_3k_2	6 88	7 77	8 66	8 49	11 44	11 38	12 55	14 15	5 22
n_3k_3	6 77	7 77	8 49	8 05	10 77	11 27	11 55	14 08	4 27
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	1 85	<1
n_1s_1	6 33	9 16	8 33	8 94	11 27	12 16	11 88	14 65	5 16
n_1s_2	6 55	9 21	8 33	8 83	11 38	12 33	11 88	14 82	5 22
n_1s_3	6 60	8 66	8 55	9 16	11 49	12 05	12 05	14 63	5 16
n_2s_1	6 49	8 77	9 66	9 21	11 72	13 27	13 88	14 85	5 33
n_2s_2	6 49	8 77	9 54	9 33	11 71	13 16	14 16	15 18	5 55
n_2s_3	6 66	8 88	9 61	9 21	12 10	12 99	13 88	14 67	5 38
n_3s_1	6 27	8 10	8 71	8 11	10 94	11 16	11 94	14 82	4 77
n_3s_2	6 66	7 77	8 49	8 27	11 22	11 16	11 99	14 51	4 83
n_3s_3	6 77	7 77	8 71	8 22	11 16	11 49	11 83	14 63	4 61
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	6 49	8 67	8 88	8 49	10 99	11 49	12 10	14 35	5 00
k_1s_2	6 33	8 55	8 58	8 49	11 22	11 49	12 27	14 38	5 00
k_1s_3	6 49	8 60	8 88	8 49	11 60	11 88	12 22	14 67	4 88
k_2s_1	6 55	8 83	8 82	9 05	11 55	12 49	13 60	14 92	5 08
k_2s_2	6 60	8 83	8 72	9 27	11 71	12 50	13 27	15 32	5 61
k_2s_3	6 66	8 38	8 99	9 27	11 77	13 10	13 33	14 71	5 27
k_3s_1	6 49	8 60	8 99	8 72	11 38	11 72	11 99	14 63	4 89
k_3s_2	6 77	8 38	8 77	8 66	11 38	11 83	12 49	14 52	4 99
k_3s_3	6 88	8 33	8 99	8 82	11 38	11 55	12 22	14 61	4 99
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1

4 2 2 5 Total number of leaves produced

4 2 2 5 1 Effect of N K and their split application on total number of leaves produced

The total number of leaves produced per plant was not significantly influenced by the quantity of nitrogen applied The total leaf production upto shooting was highest in N300 (41 42 & 39 78 respectively) in both the seasons

The level of potassium applied did not make any significant difference in the total number of leaves produced During the first crop K600 recorded the highest total number of leaves (41 40) and in second crop K450 recorded the highest total leaf production (39 76)

The total leaf production per plant was not significantly influenced by the split application of fertilizers at different levels (Table 39 a and b)

4 2 2 5 2 Interaction effect of N K and their split application on total number of leaves produced

The total number of leaves produced was not significantly influenced by interaction between nitrogen and potassium in both the seasons In the first crop the total

Table 39a Effect of N K and their split application(s) on total number of of leaves produced

Total number of leaves produced

Effect	Month after planting 1	2	3	4	5	6	7	8
n_1	6 81	10 30	14 27	18 46	25 34	31 37	36 54	41 10
n_2	6 78	10 48	14 47	18 75	25 61	32 09	36 99	41 42
n_3	7 21	10 72	14 99	19 31	26 44	32 57	37 01	41 22
$F_{2,22}$	1 41	<1	2 97	1 20	1 29	1 55	<1	<1
k_1	6 82	10 36	14 29	18 27	25 37	31 63	36 57	40 99
k_2	7 06	10 82	14 97	18 99	26 19	32 22	36 83	41 34
k_3	6 92	10 33	14 48	19 26	25 84	32 19	37 16	41 40
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1
s_1	6 943	10 68	14 72	18 86	26 16	32 24	37 08	41 42
s_2	6 813	10 22	14 29	18 62	25 23	31 79	36 75	41 14
s_3	7 052	10 61	14 73	19 05	26 008	32 02	36 72	41 18
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1

Table 39b Effect of N K and their split application(s) on total number of leaves produced

Total number of leaves produced

Effect	Month after planting							
	1	2	3	4	5	6	7	8
n_1	6 72	10 29	14 03	17 79	25 08	30 14	34 44	38 33
n_2	6 89	10 40	13 97	17 66	24 71	30 75	35 40	39 74
n_3	6 87	10 34	14 60	18 21	25 10	30 14	34 19	37 42
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1
k_1	6 75	10 25	14 12	17 90	25 01	30 43	34 73	38 62
k_2	6 83	10 40	14 18	18 01	25 34	31 06	35 49	39 78
k_3	6 90	10 38	14 31	17 75	24 55	29 53	33 81	37 42
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1
s_1	6 85	10 36	14 21	17 88	24 97	30 27	34 73	38 66
s_2	6 84	10 40	14 27	18 03	25 10	30 60	34 90	38 76
s_3	6 79	10 27	14 12	17 75	24 82	30 15	34 40	38 41
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1

Table 40a Interaction effect of N K and their split application(s) on total number of leaves produced

Total number of leaves produced

Interaction Effect	Month after planting 1	2	3	4	5	6	7	8
n_1k_2	6 5	10 11	14 22	18 44	25 33	31 61	36 82	41 26
n_1k_2	6 91	10 64	14 78	18 78	26 08	31 78	36 78	41 17
n_1k_3	6 99	10 17	13 83	18 18	24 64	30 75	36 04	40 88
n_2k_1	6 92	10 58	14 33	17 94	25 00	31 71	36 55	40 88
n_2k_2	6 72	10 61	14 77	18 94	26 05	32 33	37 32	42 27
n_2k_3	6 72	10 28	14 33	19 39	25 77	32 33	37 11	41 11
n_3k_1	7 05	10 38	14 33	18 44	25 77	31 67	36 33	40 83
n_3k_2	7 55	11 22	15 38	19 28	26 65	32 54	36 37	40 60
n_3k_3	7 05	10 55	15 28	20 23	27 11	33 49	38 33	42 22
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	1 32	<1
n_1s_1	6 97	10 58	14 44	18 54	25 33	31 55	36 72	40 94
n_1s_2	6 55	10 11	14 22	18 36	25 58	31 75	37 14	42 08
n_1s_3	6 88	10 22	14 17	18 50	25 14	30 83	35 78	40 28
n_2s_1	6 58	10 64	14 66	18 44	25 83	32 28	37 20	41 99
n_2s_2	6 61	10 22	14 05	18 72	24 83	31 28	36 11	40 17
n_2s_3	7 17	10 61	14 72	19 10	26 17	32 72	37 67	42 11
n_3s_1	7 28	10 83	15 05	19 61	27 33	32 88	37 32	41 33
n_3s_2	7 28	10 33	14 61	18 77	25 28	32 33	37 00	41 17
n_3s_3	7 10	11 00	15 32	19 55	26 72	32 49	36 72	41 17
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	1 05	1 04
k_1s_1	6 47	9 86	13 67	18 00	25 05	30 83	36 33	41 00
k_1s_2	6 83	10 33	14 16	17 89	24 88	31 28	35 98	40 32
k_1s_3	7 16	10 89	15 05	18 94	26 17	32 78	37 38	41 67
k_2s_1	7 08	11 19	15 28	19 05	26 50	32 77	37 42	41 98
k_2s_2	6 88	10 44	14 61	18 99	26 22	32 67	37 50	41 77
k_2s_3	7 22	10 83	15 04	18 94	25 86	31 22	35 55	40 27
k_3s_1	7 28	10 99	15 22	19 54	26 94	33 11	37 50	41 28
k_3s_2	6 72	9 88	14 11	18 97	24 58	31 42	36 77	41 32
k_3s_3	6 78	10 11	14 11	19 28	25 99	32 05	37 22	41 61
$F_{2\ 22}$	<1	1 18	<1	<1	<1	1 70	1 68	<1

Table 40b Interaction effect of N K and their split application(s) on total number of leaves produced

Interaction Effect	Total number of leaves produced — Month after planting 1	2	3	4	5	6	7	8
n_1k_1	6 44	10 16	13 99	17 99	25 38	30 34	34 66	38 22
n_1k_2	6 72	10 16	13 99	17 60	24 94	30 05	34 33	38 28
n_1k_3	7 02	10 55	14 10	17 77	24 93	30 05	34 33	38 50
n_2k_1	7 05	10 44	13 94	17 43	24 49	30 31	34 60	39 05
n_2k_2	6 83	10 44	14 10	17 99	25 49	32 27	37 27	42 39
n_2k_3	6 78	10 33	13 88	17 55	24 16	29 66	34 33	37 77
n_3k_1	6 77	10 16	14 44	18 27	25 16	30 66	34 94	38 61
n_3k_2	6 94	10 60	14 44	18 44	25 60	30 88	34 88	38 67
n_3k_3	6 89	10 20	14 94	17 94	24 55	28 88	32 77	36 00
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1
n_1s_1	6 72	10 33	14 16	17 88	24 99	29 60	33 94	38 00
n_1s_2	6 80	10 38	13 94	17 66	25 10	30 49	34 77	38 72
n_1s_3	6 66	10 16	13 99	17 83	25 60	30 33	34 60	38 27
n_2s_1	6 95	10 27	13 88	17 38	24 49	30 71	35 66	39 78
n_2s_2	6 83	10 49	14 10	17 77	24 77	30 99	35 44	39 78
n_2s_3	6 88	10 44	13 94	17 82	24 88	30 54	35 10	39 78
n_3s_1	6 88	10 49	14 60	18 38	25 43	30 49	34 60	39 67
n_3s_2	6 89	10 33	14 17	18 66	25 44	30 32	34 49	38 22
n_3s_3	6 83	10 21	14 44	17 60	24 44	29 60	33 49	37 78
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	3 23
k_1s_1	6 88	10 33	14 32	18 16	25 11	30 49	34 88	38 72
k_1s_2	6 77	10 10	13 88	17 66	24 88	30 43	34 88	38 72
k_1s_3	6 60	10 33	14 16	17 88	25 05	30 37	34 44	38 44
k_2s_1	6 83	10 38	14 32	17 99	25 43	31 38	35 66	40 16
k_2s_2	6 77	10 55	14 22	18 10	25 44	31 10	35 55	39 61
k_2s_3	6 88	10 27	12 99	17 94	25 16	30 72	35 27	39 56
k_3s_1	6 84	10 38	13 99	17 49	24 38	28 93	33 66	37 11
k_3s_2	6 97	10 55	14 71	18 33	24 99	30 27	34 27	37 94
k_3s_3	6 88	10 21	14 21	17 44	24 27	29 38	33 49	<1
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1

leaf production upto shooting ranged from 40 6 (in N400 K450) to 42 27 (in N300 K450) and in second crop from 36 10 (N400 K600) to 41 88 (N300 K450)

The interaction between nitrogen and split application of fertilizers did not significantly influence the total number of leaves produced at any stage of growth in either crop The total leaf production at shooting ranged from 42 11 (N300 s_3) to 40 17 (N300 S_2) and from 40 10 (N300 S_1) to 37 21 (N400 S_3) in the first and second crop respectively

The total leaf production was not influenced by the interaction between potassium and split application of fertilizers The total leaf production at shooting ranged from 41 98 (K450 S_1) to 40 32 (K300 S_2) in first season and 39 82 (K450 S_1) to 37 06 (K600 S_3) (Table 40 a and b) in the second season

4 2 2 6 Leaf area

4 2 2 6 1 Effect of N K and their split application on leaf area

The highest total leaf area was recorded at N300 at all stages of growth It was significantly higher than other treatments at one stage (six months after planting in both

Table 41a Effect of N K and their split application(s) on leaf area

Leaf area m^2

Effect	Month after planting 1	2	3	4	5	6	7	8	Harvest
n_1	0 12	0 27	0 78	1 76	3 57	6 43	8 78	12 39	4 69
n_2	0 41	0 30	0 85	1 80	3 91	7 73	9 07	12 79	5 16
n_3	0 13	0 28	0 86	1 80	3 77	6 61	8 39	12 49	4 55
$F_{2,22}$	1 57	1 00	1 23	<1	1 06	4 88	<1	<1	2 07
k_1	0 13	0 28	0 82	1 78	3 74	6 95	8 77	2 66	4 59
k_2	0 13	0 28	0 83	1 85	3 79	6 94	8 86	12 68	2 16
k_3	0 13	0 29	0 84	1 74	3 73	6 88	8 62	12 33	4 65
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1	1 98
s_1	0 13	0 28	0 83	1 74	3 75	6 94	8 77	12 54	4 80
s_2	0 13	0 29	0 84	1 81	3 75	6 87	8 72	12 54	4 76
s_3	0 13	0 29	0 83	1 81	3 75	6 96	8 73	12 61	4 84
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 41b Effect of N K and their split application(s) on leaf area

Leaf area m^2

Effect	Month after planting 1	2	3	4	5	6	7	Shoot- ing	Harv- est
n_1	0 12	0 28	0 81	1 78	3 59	6 50	8 94	12 89	5 53
n_2	0 14	0 30	0 86	1 88	3 94	7 86	9 6b	13 46	5 70
n_3	0 13	0 29	0 85	1 81	3 71	6 63	8 73	12 40	5 03
$F_{2\ 22}$	1 50	<1	<1	<1	1 18	5 30*	1 25	<1	1 96
k_1	0 13	0 29	0 85	1 83	3 75	6 93	9 16	12 69	5 28
k_2	0 13	0 30	0 84	1 82	3 78	7 10	9 17	13 14	5 75
k_3	0 13	0 29	0 85	1 82	3 71	6 95	8 99	12 82	5 24
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1	1 32
s_1	0 13	0 29	0 83	1 82	3 74	6 97	9 10	12 87	5 40
s_2	0 13	0 30	0 84	1 83	3 76	6 99	9 13	12 90	5 49
s_3	0 13	0 29	0 84	1 83	3 75	7 02	9 09	12 87	5 37
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1

crops) The leaf area at N300 at this stage was 7 862 m^2 in the first season 7 737 m^2 in the second season N200 and N400 recorded leaf area values statistically on par with each other

The total leaf area was not influenced by level of potassium applied at any stage in either season

The split application of fertilizers did not significantly influence the total leaf area (Table 41a and b)

4 2 2 6 2 Interaction effect of N K and their split application on total leaf area

Leaf area was not influenced by the interaction between NK NS or KS in either crop (Table 42 a and b)

4 2 2 7 Duration of the crop Days taken from planting to shooting and from planting to harvest

4 2 2 7 1 Effect of N K and their split application on duration of the crop

Nitrogen at higher levels tended to increase the number of days taken from planting to shooting and from

Table 42a Interaction effect of N K and their split application(s) on leaf area

Interaction Effect	Leaf area m^2 Month after planting 1	2	3	4	5	6	7	8	Harvest
n_1k_1	0 12	0 27	0 76	1 73	3 49	6 40	8 64	12 24	4 45
n_1k_2	0 12	0 28	0 79	1 78	3 60	6 40	8 82	12 45	4 94
n_1k_3	0 12	0 27	0 80	1 78	3 62	6 49	8 87	12 50	4 69
n_2k_1	0 14	0 30	0 85	1 79	3 88	7 60	9 05	12 76	4 81
n_2k_2	0 14	0 30	0 86	1 92	4 01	7 90	9 32	13 30	5 95
n_2k_3	0 14	0 30	0 86	1 70	3 86	7 69	8 84	12 31	4 70
n_3k_1	0 13	0 28	0 86	1 81	3 83	6 86	8 59	12 99	4 50
n_3k_2	0 13	0 27	0 86	1 84	3 78	6 51	8 43	12 30	4 58
n_3k_3	0 12	0 28	0 85	1 74	3 70	6 45	8 16	12 19	4 56
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
n_1s_1	0 12	0 27	0 78	1 77	3 56	6 40	8 78	12 36	4 62
n_1s_2	0 12	0 28	0 79	1 75	3 58	6 44	8 75	12 39	6 70
n_1s_3	0 12	0 28	0 78	1 77	3 58	6 45	8 80	12 43	4 75
n_2s_1	0 14	0 29	0 85	1 69	3 91	4 76	9 06	12 75	5 17
n_2s_2	0 14	0 30	0 87	1 86	3 91	7 60	9 12	12 19	5 09
n_2s_3	0 14	0 30	0 85	1 86	3 92	7 84	9 03	12 83	5 22
n_3s_1	0 13	0 27	0 85	1 77	3 77	6 66	8 47	12 51	4 61
n_3s_2	0 13	0 28	0 85	1 82	3 76	6 56	8 36	12 43	4 48
n_3s_3	0 13	0 28	0 86	1 80	3 76	6 60	8 35	12 54	4 55
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	0 13	0 28	0 82	1 78	3 74	6 97	8 78	12 59	4 66
k_1s_2	0 13	0 28	0 83	1 77	3 73	6 82	8 78	12 66	4 46
k_1s_3	0 13	0 29	0 82	1 78	3 74	7 06	8 72	72 76	4 66
k_2s_1	0 13	0 28	0 83	1 83	3 77	7 02	8 89	12 71	5 03
k_2s_2	0 13	0 28	0 84	1 86	3 80	6 87	8 81	12 65	5 19
k_2s_3	0 13	0 29	0 83	1 85	3 80	6 92	8 87	12 68	5 24
k_3s_1	0 13	0 28	0 83	1 62	3 73	6 82	8 64	12 34	4 71
k_3s_2	0 13	0 29	0 84	1 80	3 73	6 90	8 64	12 30	4 62
k_3s_3	0 13	0 29	0 84	1 80	3 73	6 91	8 59	12 36	4 62
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 42b Interaction effect of N K and their split application(s) on leaf area

Interaction Effect	Leaf area m^2								
	Month after planting							Shoot-ing	Harv-est
	1	2	3	4	5	6	7		
n_1k_1	0 12	0 27	0 79	1 78	3 49	6 30	8 89	12 48	5 30
n_1k_2	0 12	0 29	0 81	1 78	3 59	6 63	9 00	12 98	5 56
n_1k_3	0 12	0 29	0 82	1 79	3 86	6 57	8 93	12 93	5 72
n_2k_1	0 14	0 30	0 84	1 84	3 90	7 65	9 57	13 24	5 47
n_2k_2	0 13	0 30	0 87	1 92	4 03	8 18	9 90	14 02	6 20
n_2k_3	0 14	0 30	0 87	1 89	3 90	7 74	9 51	13 12	5 42
n_3k_1	0 14	0 30	0 85	1 88	3 86	6 85	9 01	12 37	5 05
n_3k_2	0 13	0 30	0 85	1 77	3 72	6 49	8 63	12 41	5 48
n_3k_3	0 12	0 29	0 85	1 78	3 54	6 54	8 54	12 41	4 57
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
n_1s_1	0 12	0 28	0 80	1 79	3 85	6 43	8 89	12 83	5 53
n_1s_2	0 12	0 29	0 81	1 73	3 59	6 48	8 98	12 76	5 52
n_1s_3	0 12	0 29	0 81	1 79	3 60	6 58	8 95	12 80	5 53
n_2s_1	0 14	0 30	0 86	1 87	3 96	7 88	8 67	13 44	5 58
n_2s_2	0 14	0 30	0 87	1 88	3 95	7 86	9 67	13 45	5 87
n_2s_3	0 14	0 30	0 86	1 88	3 92	7 84	9 64	13 49	5 65
n_3s_1	0 13	0 29	0 85	1 80	3 67	6 61	8 74	12 34	5 08
n_3s_2	0 13	0 30	0 85	1 82	3 73	6 63	8 76	12 48	5 09
n_3s_3	0 13	0 29	0 85	1 81	3 72	6 65	8 69	12 38	4 94
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1
k_1s_1	0 13	0 28	0 82	1 83	3 72	6 89	9 15	12 64	5 29
k_1s_2	0 13	0 29	0 83	1 84	3 76	6 91	9 13	12 73	5 32
k_1s_3	0 13	0 29	0 83	1 83	3 76	7 01	9 19	12 72	5 22
k_2s_1	0 13	0 29	0 84	1 82	3 80	7 07	9 17	13 12	5 70
k_2s_2	0 13	0 30	0 85	1 82	3 79	7 13	9 22	13 12	5 93
k_2s_3	0 13	0 30	0 84	1 82	3 76	7 09	9 13	13 18	5 60
k_3s_1	0 13	0 29	0 84	1 81	3 70	6 95	8 98	12 84	5 19
k_3s_2	0 13	0 29	0 86	1 82	3 73	6 93	9 04	12 85	5 23
k_3s_3	0 13	0 29	0 84	1 82	3 71	6 96	8 96	12 77	5 29
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1	<1	<1

Table 43a Effect of N K and their split application(s) on duration of the crop

Effect	Duration: No of days taken for shooting	Duration: No of days taken for harvesting
n_1	229 50	324 50
n_2	239 66	332 72
n_3	252 38	347 33
$F_{2,22}$	1 01	<1
k_1	241 72	339 22
k_2	237 88	330 72
k_3	241 94	334 61
$F_{2,22}$	<1	<1
s_1	240 94	335 44
s_2	240 05	334 66
s_3	240 55	334 44
$F_{2\ 22}$	<1	<1

Table 43b Average effect of N K and their split application(s) on duration of the crop

Effect	Duration: No of days taken for shooting	Duration: No of days taken for harvesting
n_1	229 83	323 27
n_2	239 00	331 38
n_3	252 27	344 66
$F_{2\ 22}$	<1	<1
k_1	244 16	336 77
k_2	237 77	330 72
k_3	239 16	331 83
$F_{2,22}$	<1	<1
s_1	240 38	332 88
s_2	240 66	333 05
s_3	240 05	333 38
$F_{2,22}$	<1	<1

planting to harvest But the difference was not statistically significant in either season / crop

Number of days taken from planting to shooting and planting to harvest was lowest at K450 in both seasons The difference in the number of days taken for shooting and harvest was however not statistically significant (Table 43 a and b)

The different levels of split application of fertilizers did not significantly influence the number of days taken for shooting and harvest (Table 43 a and b)

4 2 2 7 2 Interaction effect of N K and their split application on duration of the crop

No significant difference was observed in the number of days taken for shooting and harvest in either season due to the interaction between N and K N and S or K and S (Table 44 a and b)

4 2 3 Yield

Yield data for the two seasons as well as the pooled data of the two crops were pooled and subjected to

Table 44a Interaction efect of N K and their split application(s) on duration of the crop

Treatment	Duration: No of days taken for shooting	Duration: No of days taken for harvesting
n_1k_1	236 16	333 50
n_1k_2	226 00	319 66
n_1k_3	226 33	320 33
n_2k_1	236 50	328 33
n_2k_2	234 33	333 16
n_2k_3	248 18	336 66
n_3k_1	252 50	355 83
n_3k_2	253 33	339 33
n_3k_3	251 33	346 83
$F_{4\ 22}$	<1	<1
n_1s_1	230 33	325 50
n_1s_2	229 33	324 33
n_1s_3	228 50	323 66
n_2s_1	240 00	333 16
n_2s_2	238 66	332 16
n_2s_3	240 33	332 00
n_3s_1	252 16	347 83
n_3s_2	252 16	340 50
n_3s_3	252 83	347 66
$F_{4,22}$	<1	<1
k_1s_1	240 10	341 83
k_1s_2	242 16	338 50
k_1s_3	242 83	337 33
k_2s_1	239 33	330 66
k_2s_2	236 66	331 16
k_2s_3	237 66	330 33
k_3s_1	243 33	333 83
k_3s_2	241 33	334 33
k_3s_3	241 16	335 66
$F_{4\ 22}$	<1	<1

Table 44b Interaction effect of N K and their split application(s) on duration of the crop

Treatment	Duration: No of days taken for shooting	Duration: No of days taken for harvesting
n_1k_1	237 33	331 00
n_1k_2	228 00	321 50
n_1k_3	224 16	317 33
n_2k_1	235 83	328 33
n_2k_2	235 16	327 66
n_2k_3	246 00	338 16
n_3k_1	259 33	351 00
n_3k_2	250 16	343 00
n_3k_3	247 33	340 00
$F_{4\ 22}$	<1	<1
n_1s_1	230 33	323 50
n_1s_2	230 33	323 66
n_1s_3	228 83	322 66
n_2s_1	238 00	330 50
n_2s_2	239 66	331 83
n_2s_3	239 33	331 83
n_3s_1	252 83	344 66
n_3s_2	252 00	343 66
n_3s_3	252 00	345 66
$F_{4,22}$	<1	<1
k_1s_1	245 83	338 66
k_1s_2	244 16	336 50
k_1s_3	242 50	335 16
k_2s_1	236 50	328 66
k_2s_2	239 00	331 66
k_2s_3	237 83	331 83
k_3s_1	238 83	331 33
k_3s_2	238 33	331 00
k_3s_3	239 83	333 16
$F_{4\ 22}$	<1	<1

statistical analysis Significant effect for the two nutrients N and K could observed in both the seasons The NK interaction was also significant in the first season and as per the pooled analysis The yield of the second crop was significantly more than that of the first crop / season indicating seasonal effect

4 2 3 1 Effect of N K and their split applications on yield

There was significant difference in the weight of bunch due to different levels of nitrogen applied In both the seasons N 300 recorded the highest yield (11 75 kg and 1331 kg respectively and 12 54 kg as per the pooled analysis) which was higher than the yield/bunch weight at N 200 (11 20 kg 12 13 kg and 11 67 kg respectively) The bunch weight at N 400 was lower than the other two levels tried (10 44 kg 10 65 kg and 10 53 kg respectively) Different levels of N resulted in significant difference in bunch weight between the two crops (Table 45 a)

The total yield/plant was significantly influenced by the level of potassium Potash (K_2O) at 450 g per plant gave significantly higher yield than the other two levels in

Table 45a Effect of N K and their split application(s) on the weight of bunch

Effect	Weight of bunch (kg)		
	Ist year	IInd year	Pooled Data
n_1	11 20	12 13	11 67
n_2	11 75	13 31	12 54
n_3	10 44	10 61	10 53
$F_{2\ 22}$	11 69**	6 69**	179 82**
CD	0 55	1 53	0 424
k_1	10 12	11 15	10 64
k_2	12 18	13 46	12 82
k_3	11 08	11 45	11 27
$F_{2\ 22}$	28 50**	5 74**	223 59**
CD	0 55	1 53	0 42
s_1	11 05	11 83	11 45
s_2	11 14	12 30	11 72
s_3	11 20	11 92	11 56
$F_{2, 22}$	0 149	<1	3 46

both seasons and in the pooled data (12 18 kg 13 46 kg and 12 82 kg) There was significant difference between the yield obtained for the various treatments between the seasons

The weight of bunch was not influenced by the level of split application in either season or by pooled analysis

4 2 3 2 Interaction effect of N K and their split applications on yield

There was significant difference in bunch weight due to NK interaction in the first crop and as per the pooled analysis Treatment N_2K_2 recorded the highest yield in both seasons and as per the pooled analysis (13 84 kg 15 86 kg and 13 13 kg respectively)

The yield was not influenced by NS interaction in either season or as per the pooled analysis

The interaction between potassium and level of split application significantly influenced yield in the first season but did not make any effect on the yield in the second season and in the pooled analysis (Table 45b)

Table 45b Interaction effect of N K and their split application(s) on the weight of bunch

Effect	Weight of bunch (kg) Ist year	IInd year	Pooled Data
n_1k_1	9 76	11 56	10 65
n_1k_2	12 17	12 21	12 19
n_1k_3	11 66	12 64	12 15
n_2k_1	10 94	12 15	11 55
n_2k_2	13 84	15 86	14 85
n_2k_3	10 47	11 94	11 21
n_3k_1	9 67	9 75	9 71
n_3k_2	10 52	12 31	11 42
n_3k_3	11 13	9 77	10 45
$F_{4\ 22}$	10 63**	1 57	52 16**
CD	0 983		0 245
n_1s_1	10 91	12 12	11 52
n_1s_2	11 39	12 32	11 85
n_1s_3	11 29	11 96	11 63
n_2s_1	11 82	12 96	12 39
n_2s_2	11 64	13 57	12 61
n_2s_3	11 81	13 41	12 81
n_3s_1	10 43	10 42	10 42
n_3s_2	10 39	11 02	10 71
n_3s_3	10 50	10 39	10 45
$F_{4\ 22}$	<1	<1	<1
k_1s_1	10 03	11 26	10 65
k_1s_2	9 63	11 47	10 55
k_1s_3	10 72	10 73	10 72
k_2s_1	11 73	13 15	12 44
k_2s_2	12 52	13 73	13 13
k_2s_3	12 30	13 49	12 90
k_3s_1	11 40	11 09	11 25
k_3s_2	11 28	11 71	11 50
k_3s_3	10 58	11 55	11 07
$F_{4,22}$	2 94	<1	<1
CD	<1	--	

4 2 3 3 Corelation of yield with various characters

Corelation values were worked out for various characters morphological character such as height and girth of pseudostem total leaf production number of leaves at shooting and leaf area at shooting and harvest N P_2O_5 and K_2O content of the leaf at shooting and yield attributes such as length of bunch number of hands and fingers length girth and weight of fingers All the factors were significantly correlated with yield (Table 46)

4 2 3 4 Physical and Economic optimum of N and K

The physical and economic optimum for nitrogen and potassium were worked out separately for the two experimental crops fitting quadratic response surface for nitrogen and potassium using the formula

$$Y - b_0 + b_1N + b_2K + b_{11}N^2 + b_{22}k_2^2 + b_{12}NK$$

The estimated equations are presented below

First crop Y 8 652708 + 0 048702 N + 0 067034 K - 0 000093 N^2 - 0 000070 K^2 0 000007 NK

Table 46 Corelation values of various characters with yield

Sl No	Characters	Ist Year	IInd Year
1	Girth of pseudostem at shooting	0 6568	0 7775
2	Height of pseudostem at shooting	0 6111	0 7836
3	Total leaf production	0 6353	0 6192
4	Leaf area at shooting	0 7988	0 8479
5	Leaf area at harvest	0 7182	0 7886
6	No of leaves at shooting	0 6353	0 6394
7	Content of N in index leaf at shooting	0 7658	--
8	Content of P in index leaf at shooting	0 5602	--
9	Content of K in index leaf at shooting	0 5608	--
10	Length of bunch	0 7595	0 7389
11	Number of hands	0 6572	0 6927
12	Number of fingers	0 7715	0 9099
13	Length of finger	0 7595	0 7636
14	Girth of finger	0 6884	0 7657
15	Weight of finger	0 7805	0 8411

(F for regression - 9 20** R^2 - 0 49 or 49 per cent The fitted regression explains 49 per cent of the variation in yield kg $bunch^{-1}$ of banana due to the influence of applied N and K fertilization)

Second crop Y = 22 68674 + 0 11684 N + 0 09259 K - 0 00019 N^2 - 0 00010k^2 0 00001 NK

(F for regression - 28 91** R^2 - 0 75 or 75 per cent The fitted regression explains 75 per cent of the variation in yield (kg $bunch^{-1}$) of banana due to the influence of applied N and K fertilization)

The physical optimum for first crop was 279 g of nitrogen and 474 g of potassium per plant and for the second crop this was 320 g and 457 g of nitrogen and potassium respectively

The economic optimum of nitrogen and potassium for the first and second crop were 322 g $plant^{-1}$ and 504 g $plant^{-1}$ and 297 g and 468 g respectively

4 2 3 5 Bunch characters

4 2 3 5 1 Effect N K and their split application on bunch characters

There was significant difference in the number of fingers/bunch between the different levels of nitrogen in the first crop but this effect was not observed in the second crop The level of nitrogen did not influence the length of bunch and number of hands per bunch in either crop In both crops difference in weight of finger was observed between different levels of N N_{200} and N_{300} were on par (283 27 g and 298 38 g and 286 77 g and 305 g respectively in the two crops) The length of finger was highest at N 300 in both seasons (29 80 cm and 30 56 cm respectively) The girth of finger was also highest at N 300 (16 68 cm and 16 91 cm respectively) in both the crops However in the first crop the girth of finger was influenced by the level of nitrogen though not in the second (Table 47 a and b)

Levels of potassium influenced the length of bunch in the first crop but not in the second crop The greatest length of bunch (41 40 cm) was obtained at K_{450} in the first season In both the crops application of potassium at

Table 47a Effect of N K and their split application(s) on bunch characters

Effect	Weight of bunch kg	Length of bunch cm	No of hands	No of fingers	Weight of finger g	Length of finger cm	Girth of finger cm
n_1	11 20	39 65	4 88	49 13	283 27	29 75	16 00
n_2	11 75	40 19	4 98	50 02	286 77	29 80	16 68
n_3	10 44	40 02	5 02	49 45	264 05	29 56	16 12
$F_{2,22}$	11 69**	1 89	1 07	6 73**	19 13**	<1	4 88*
CD	0 572	—	—	0 965	10 29	—	0 484
k_1	10 12	38 85	4 88	46 67	270 05	28 97	16 05
k_2	12 18	41 40	4 98	52 25	297 05	30 72	16 67
k_3	11 08	39 62	4 99	51 70	277 00	29 44	16 08
$F_{2,22}$	25 49**	42 73**	2 43	87 63**	5 98*	16 56*	4 49*
CD	0 572	0 585	4 001	0 965	10 29	1 263	0 484
s_1	11 05	39 80	4 95	49 22	289 77	29 74	16 20
s_2	11 14	41 40	4 96	51 09	279 39	29 63	16 28
s_3	11 20	39 62	4 95	50 30	274 94	29 76	16 32
$F_{2,22}$	0 14	2 65	< 1	8 11**	4 710*	<1	0 13
CD	—			0 965	10 29		

Table 47b Effect of N K and their split application(s) on bunch characters

Effect	Weight of bunch kg	Length of bunch cm	No of hands	No of finger	Weight of finger g	Length of finger cm	Girth of finger cm
n_1	12 13	39 87	4 51	52 59	298 38	30 15	16 69
n_2	13 31	42 00	4 88	54 64	305 00	30 56	16 97
n_3	10 61	39 86	4 25	50 66	267 66	27 13	15 96
F_2 22	6 69**	<1	2 02	<1	2 29	2 15	<1
CD	1 534	—	—	-	—		
k_1	11 15	39 15	4 44	51 35	277 72	28 27	16 03
k_2	13 46	42 28	4 75	55 14	301 66	30 21	17 07
k_3	11 45	40 30	4 46	51 40	291 66	29 36	16 53
F_2 22	5 74**	<1	<1	<1	<1	<1	<1
CD	1 534	-	—	-	—	-	—
s_1	11 83	40 11	4 49	52 26	290 72	29 31	16 46
s_2	12 30	41 17	4 60	52 93	288 72	29 06	16 55
s_3	11 92	40 46	4 55	52 70	291 61	29 47	16 61
F_2 22	<1	<1	<1	<1	<1	<1	<1

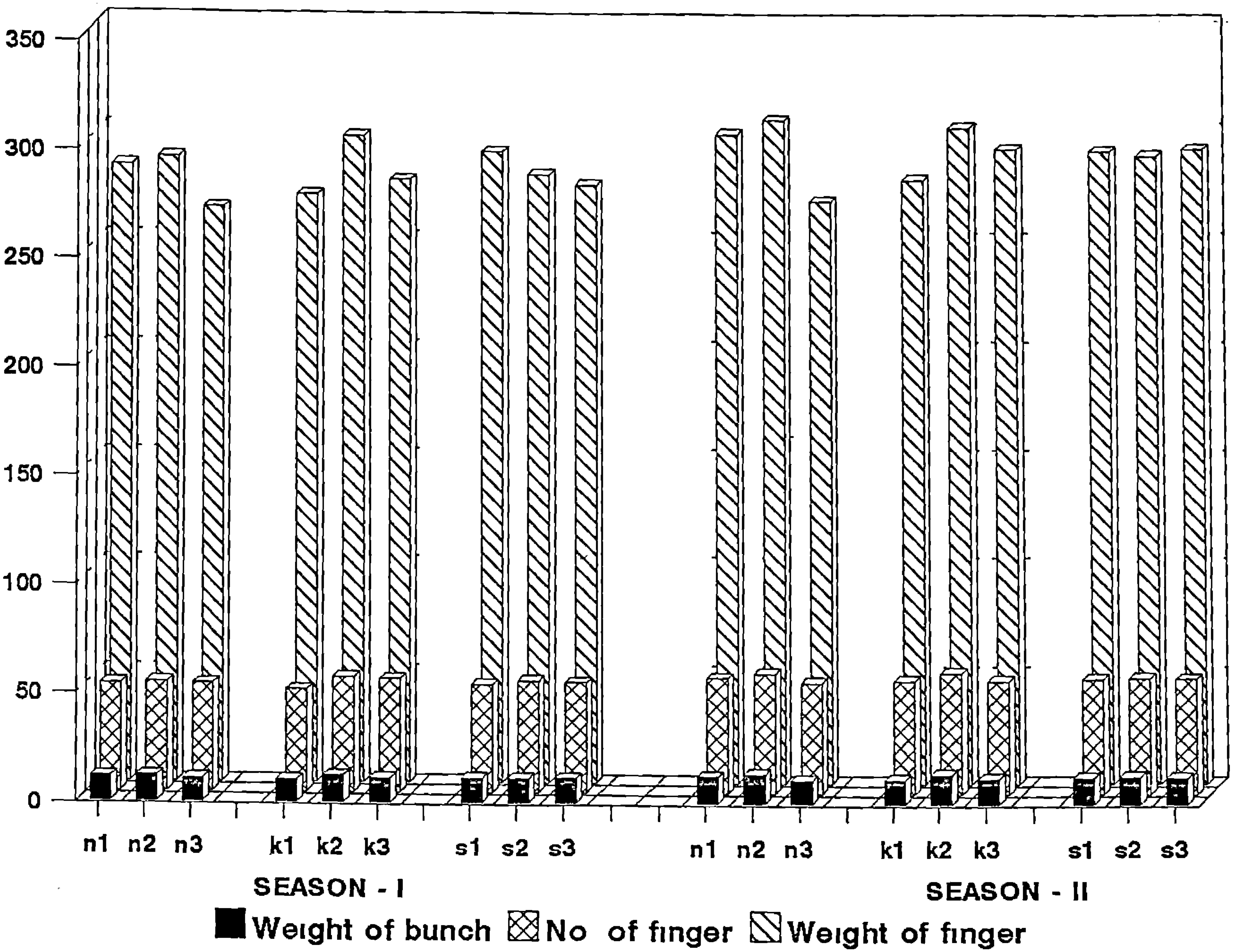


Fig. 7. Effect of N, K and their split applications on bunch characters

Plate 9 A field view Absolute control (left) and treatment plots (right)

Plate 10 Bunches from tissue cultured banana under different fertilizer levels

Plate 11 Individual fingers of tissue cultured banana

(1) Package of practices recommendations vs treatments

(2) Absolute control vs treatments

different levels resulted in differences in the number of fingers per hand the highest values being obtained at K_{450} (52 25 and 55 11 respectively) The length and girth of finger was also influenced by levels of potassium K_{450} recorded the highest values for length and girth of finger in both seasons (Table 47 a and b)

Level of split application did not influence the length of bunch and number of hands per bunch In the first crop the number of fingers per bunch varied between different levels of split application S_2 (Eight split applications) recorded 51 09 fingers per bunch In the second crop no difference was noticed between different levels of split application with regard to number of fingers per bunch Finger weight was influenced by split application in the first crop (highest at S_1) but not in the second crop The length and girth was not influenced by the number of split application in either crop (Table 47 a and b)

4 2 3 5 2 Interaction effect of N K and their split application on bunch characters

Various bunch characters were influenced by NK interaction in the first crop Greater length of bunch was

Table 48a Interaction effect of N K and their split application(s) on bunch characters

Interaction effect	Weight of bunch kg	Length of bunch cm	No of hands	No of finger	Weight of finger g	Length of finger cm	Girth of finger cm
n_1k_1	9 76	37 52	4 67	47 02	257 83	28 75	15 80
n_1k_2	12 17	41 65	5 00	54 63	318 33	30 43	16 21
n_1k_3	11 66	39 79	4 97	51 75	303 67	30 09	15 98
n_2k_1	10 94	39 82	5 00	46 23	291 50	28 77	16 06
n_2k_2	13 84	41 79	4 94	52 91	307 50	32 18	17 78
n_2k_3	10 47	38 98	5 00	50 93	261 33	28 47	16 20
n_3k_1	9 67	39 22	5 00	46 73	260 83	29 42	16 28
n_3k_2	10 52	40 75	5 02	49 21	265 33	29 54	16 02
n_3k_3	11 13	40 11	5 00	52 42	266 00	29 75	16 05
F_4 22	10 36**	7 705**	2 96**	9 56**	13 05**	9 00**	3 68**
CD	0 979	1 014	0 193	1 673	17 824	29 815	0 839
n_1s_1	10 91	39 62	4 88	50 92	296 00	29 96	16 05
n_1s_2	11 39	39 82	4 88	51 55	301 33	29 51	16 06
n_1s_3	11 29	39 54	4 86	50 93	282 50	29 92	15 87
n_2s_1	11 82	40 25	5 00	49 23	293 83	29 79	16 65
n_2s_2	11 64	39 20	5 00	51 82	285 83	29 72	16 67
n_2s_3	11 81	41 10	4 95	49 03	280 67	29 52	16 76
n_3s_1	10 43	39 52	4 97	47 53	279 50	29 14	15 94
n_3s_2	10 39	40 19	5 00	49 90	251 00	30 05	16 09
n_3s_3	10 50	40 36	5 04	50 93	261 67	—	16 31
F_4 22	<1	3 37*	<1	**4 58	2 32	<1	<1
CD	—	1 014	-	1 672		—	
k_1s_1	10 03	37 51	4 94	46 13	273 17	28 87	15 97
k_1s_2	9 63	38 72	4 88	47 33	271 00	29 45	16 02
k_1s_3	10 72	40 35	4 83	46 52	266 00	28 61	16 16
k_2s_1	11 73	41 33	4 92	49 97	307 83	30 73	16 51
k_2s_2	12 52	41 17	5 00	54 33	294 67	31 18	16 73
k_2s_3	12 30	41 71	5 04	52 45	288 67	31 23	16 78
k_3s_1	11 40	40 58	5 00	51 57	288 33	29 64	16 13
k_3s_2	11 28	39 34	5 00	51 61	272 50	29 24	16 09
k_3s_3	10 58	38 95	4 98	51 92	270 17	29 43	16 02
F_4 22	2 93*	10 49**	<1	3 95*	0 45	1 65	0 14
CD	0 979	1 014	—	1 672	-		

Table 48b Interaction effect of N K and their split application(s) on bunch characters

Inter action effect	Weight of bunch kg	Length of bunch cm	No of hands	No of fingers	Weight of finger g	Length of finger cm	Girth of finger cm
n_1k_1	11 56	38 07	4 22	51 11	279 33	28 81	16 18
n_1k_2	12 21	39 78	4 22	52 78	309 66	30 92	17 18
n_1k_3	12 64	41 70	5 11	53 88	306 16	30 71	16 72
n_2k_1	12 15	40 93	5 11	53 09	280 83	27 99	15 73
n_2k_2	15 86	45 23	5 20	59 48	325 83	32 63	18 23
n_2k_3	11 94	39 82	4 20	51 35	308 33	31 06	16 96
n_3k_1	9 75	38 46	4 00	49 85	273 00	28 01	16 20
n_3k_2	12 31	41 83	4 70	53 16	269 50	27 09	15 80
n_3k_3	9 77	39 28	4 00	48 98	260 50	26 30	15 90
$F_{4\ 22}$	1 57	<1	<1	<1	<1	<1	0 33
n_1s_1	12 12	39 76	4 40	52 40	299 85	30 27	16 68
n_1s_2	12 32	40 28	4 60	52 85	297 16	30 06	16 72
n_1s_3	11 96	39 59	4 49	52 52	298 16	30 09	16 68
n_2s_1	12 96	41 48	4 88	53 77	304 66	30 56	16 91
n_2s_2	13 57	42 47	4 83	54 85	302 86	30 16	16 87
n_2s_3	13 41	42 07	4 94	55 30	307 50	30 96	17 14
n_3s_1	10 42	39 10	4 16	50 62	267 80	27 10	15 79
n_3s_2	11 02	40 76	4 38	51 09	266 16	26 94	16 08
n_3s_3	10 39	39 72	4 22	50 28	269 16	27 35	16 03
$F_{4\ 22}$	<1	<1	0 04	<1	<1	<1	<1
k_1s_1	11 26	39 34	4 44	51 38	275 66	28 21	15 79
k_1s_2	11 47	39 66	4 49	51 68	276 50	28 04	15 92
k_1s_3	10 73	38 46	4 38	50 98	281 56	28 56	16 40
k_2s_1	13 5	41 22	4 60	54 60	306 00	30 27	16 92
k_2s_2	13 73	43 09	4 88	55 69	329 50	30 05	17 24
k_2s_3	13 49	42 53	4 77	55 43	302 50	30 32	17 05
k_3s_1	11 09	39 78	4 44	51 1	293 50	29 45	16 68
k_3s_2	11 71	40 75	4 44	51 42	290 16	29 09	16 51
k_3s_3	11 55	40 38	4 49	51 69	291 33	29 53	16 40
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1

recorded in the combinations $N_{200}K_{450}$ $N_{300}K_{450}$ $N_{400}K_{450}$ and $N_{400}K_{600}$ The number of hands was lowest at $N_{200}K_{300}$ The highest number of fingers was recorded in $N_{200}K_{450}$ Higher finger weights were observed in $N_{200}K_{450}$ $N_{200}K_{600}$ and $N_{300}K_{450}$ The length and girth of fingers were highest at $N_{300}K_{450}$ In the second crop NK interaction didnot influence the bunch chara ters (Table 48 a and b)

Interaction between nitrogen and split application of fertilizers influenced the length of the bunch in the first crop Greater length was observed in the combinations $N_{300}S_1$ $N_{200}S_3$ $N_{300}S_2$ and $N_{400}S_2$ In the second crop NS interaction did not affect the length of the bunch NS interaction had no effect on the number of hands per bunch in either season In the first crop NS interaction influenced the number of fingers per bunch $N_{300}S_2$ recorded the highest number There was no difference between the various combinations in the second crop The length, girth and weight of finger was not affected by NS interaction in either crop (Table 48 a and b)

In the first crop length of bunch was influenced by KS interaction The combinations $K_{300}S_3$ $K_{450}S_2$ $K_{450}S_3$ and

$K_{600}S_1$ recorded greater length of bunches In the second crop there was no significant difference between the different combinations of KS as far as the length of bunch was concerned The number of hands was not influenced by this interaction The number of fingers per bunch differed depending on the combination of KS in the first crop K_{450} in combination with S_2 and S_3 and K_{600} in combination with S_1 S_2 and S_3 recorded higher values The weight of finger and length and girth of finger were not influenced by KS interaction

4 2 4 Quality of fruits

The quality of fruits were assessed in terms of TSS (^{o}brix) total sugars reducing sugars non-reducing sugars acidity sugar/acid ratio and pulp/peel ratio (Table 49 a and b)

4 2 4 1 Effect of N K and their split application on quality of fruits

The TSS of fruits was influenced by the level of nitrogen in both crops N_{200} recorded the highest TSS in both the crops (21 31°brix & 23 93°brix) In the first crop N_{200} and N_{300} were on par N_{300} was on par with N_{400} in both crops

Nitrogen influenced the total sugar content (per cent) in both crops The highest total sugars was observed at N_{200} in both crops (22 08 and 22 10 per cent) In the first crop N_{300} and N_{400} were on par with respect to total sugar content (19 52 and 17 53 per cent) and in the second crop N_{300} recorded a total sugar content of 19 78 per cent which was on par with N_{400} (18 62 per cent) In the first crop nitrogen influenced the reducing sugar content of fruits Higher levels of nitrogen decreased the reducing sugar content of fruits N_{200} recorded the highest content of reducing sugars in both crops This was higher than the values observed at N_{300} and N_{400} In the second crop the difference in the content of reducing sugars between different levels of nitrogen was not significant (Table 49a and b)

The non reducing sugar content of fruits showed difference in their values depending on the level of nitrogen applied to both crops The non reducing sugar content

Table 49a Effect of N K and their split application(s) on quality of fruits

Effect	TSS °brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acid ratio	Pulp/ peel ratio
n_1	23 93	22 80	8 04	15 04	0 394	58 39	3 88
n_2	19 86	19 52	7 17	12 27	0 405	48 54	3 63
n_3	18 39	17 48	6 27	11 99	0 535	34 10	3 43
$F_{2\ 22}$	31 64**	40 60**	38 74**	10 42*	94 01**	93 61**	<1
CD	1 496	1 237	0 417	1 531	0 023	3 825	
k_1	21 09	20 73	7 41	13 92	0 434	48 03	3 56
k_2	20 31	19 27	7 12	12 18	0 428	48 92	3 88
k_3	20 77	19 79	6 94	13 21	0 471	43 40	3 92
$F_{2\ 22}$	<1	3 04	2 64	2 77	8 07	5 18*	2 30
CD	—	-	—	-	—	3 825	
s_1	21 15	20 65	7 09	13 65	0 44	49 18	3 76
s_2	20 17	19 38	7 16	13 00	0 43	45 86	3 80
s_3	20 86	19 77	7 22	12 65	0 45	45 32	3 75
$F_{2\ 22}$	0 98	2 37	<1	<1	1 22	2 58	<1
CD	-		—	—	—	—	—

Table 49b Effect of N K and their split application(s) on quality of fruits

Treatment	°TSS brix	Total sugars%	Reducing sugars%	Non reducing sugars%	Acidity %	Sugar/ acid ratio	Pulp/ peel ratio
n_1	22 04	22 10	7 98	4 11	0 36	60 50	3 95
n_2	21 31	14 78	7 60	12 20	0 48	41 09	3 81
n_3	18 39	18 62	7 00	11 61	0 54	34 05	3 61
$F_{2\ 22}$	3 61*	2 74	<1	3 49*	24 46**	21 49**	0 91
CD	2 974	3 165	1 162	2 052	5 374	8 665	—
k_1	19 98	20 36	7 45	12 91	0 47	44 22	3 63
k_2	21 04	20 16	8 06	12 11	0 44	46 63	3 81
k_3	20 71	19 98	7 07	12 91	0 46	44 79	3 93
$F_{2\ 22}$	<1	<1	1 59	<1	<1	<1	<1
CD	—				—	—	—
s_1	20 59	20 33	7 55	12 77	0 46	45 36	3 78
s_2	20 58	20 30	7 60	12 69	0 46	45 70	3 79
s_3	20 57	19 87	7 42	12 46	0 46	44 58	3 81
$F_{2\ 22}$	<1	<1	<1	<1	<1	<1	<1
CD	—	—	—				

decreased with increase in nitrogen level In both crops N_{200} recorded the highest values (15 04 per cent and 14 11 per cent) In the first crop the non reducing sugar content observed at N_{300} and N_{400} was low (12 27 and 11 99 per cent) But in second crop the non reducing sugar content at N_{300} (12 20 per cent) did not differ significantly from that at N_{200} The treatment N_{400} recorded a low value (11 61 per cent)

Acidity of fruits increased with increase in level of nitrogen The lowest acidity was observed at N_{200} (0 39 and 0 36 per cent) N_{300} and N_{400} recorded higher acidity of fruits Increase in the level of nitrogen resulted in decrease in sugar/acid ratio of fruits in both crops N_{200} had the highest sugar/acid ratio N_{300} and N_{400} recorded lower values for sugar/acid ratio

Nitrogen did not influence the pulp/peel ratio of fruits in either crops

The level of potassium in general did not influence the quality of fruits in either season The sugar/acid ratio was however different at different levels of potassium in the first crop K_{300} and K_{450} recorded significantly higher values of sugar/acid ratio compared to K_{600}

The quality of fruits were not altered by the level of split application

4 2 4 2 Interaction effect of N K and their split application on quality of fruits

The TSS of fruits was influenced by NK interaction in the first season $N_{200}K_{300}$ $N_{200}K_{450}$ $N_{200}K_{600}$ and $N_{300}K_{300}$ recorded significantly higher TSS than rest of the combinations and were on par with each other In the second season no difference in TSS was observed due to NK interaction Total sugars reducing sugars and non reducing sugars were not significantly influenced by NK interaction in either season The acidity and sugar acid ratio recorded difference in their values due to NK interaction in the first season but not the second K_{450} in combination with N_{200} and N_{300} recorded lower acidity than the rest of the treatments $N_{200}K_{450}$ recorded the highest values for sugar / acid ratio

Table 50a Interaction effect of N K and their split appication(s) on quality of fruits

Interaction effect	TSS °brix	Total sugar %	Reducing sugar %	Non reducing sugar (%)	Acidity	Sugar/ Acid ratio	Pulp/ peel ratio
n_1k_1	26 02	23 68	8 17	16 01	0 40	58 64	3 69
n_1k_2	25 71	22 71	8 17	16 01	0 40	65 13	3 85
n_1k_3	26 07	22 03	7 78	14 68	0 43	51 42	3 88
n_2k_1	23 89	20 29	7 69	12 21	0 42	47 87	3 58
n_2k_2	18 54	18 21	6 98	11 22	0 36	50 38	3 76
n_2k_3	20 82	20 06	6 84	13 38	0 42	47 87	3 40
n_3k_1	20 51	18 21	6 35	13 52	0 48	37 57	3 55
n_3k_2	17 12	16 92	6 23	10 89	0 57	31 25	3 59
n_3k_3	17 80	17 30	6 22	11 52	0 55	31 42	3 63
$F_{4\ 22}$	5 58*	<1	<1	<1	8 65**	3 57	<1
n_1s_1	26 48	23 61	8 07	15 47	0 38	62 45	3 91
n_1s_2	26 06	22 06	7 92	14 38	0 40	55 87	3 87
n_1s_3	25 24	2 75	8 13	15 27	0 40	56 87	3 85
n_2s_1	21 72	20 47	7 06	13 58	0 41	50 47	3 86
n_2s_2	21 14	19 14	7 31	11 79	0 39	49 92	3 82
n_2s_3	20 39	18 95	7 15	11 44	0 42	45 24	3 76
n_3s_1	18 19	17 87	6 16	11 89	0 54	34 61	3 79
n_3s_2	19 43	16 93	6 26	12 83	0 53	31 79	3 58
n_3s_3	17 79	17 63	6 38	11 25	0 54	33 84	3 55
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1
k_1s_1	23 38	21 84	7 50	14 50	0 43	51 56	3 68
k_1s_2	24 27	19 61	7 55	13 69	0 42	46 45	3 78
k_1s_3	22 76	20 75	7 17	13 56	0 45	46 08	3 74
k_2s_1	21 34	19 98	7 05	13 03	0 46	47 73	3 75
k_2s_2	19 97	18 63	6 94	11 69	0 40	49 86	3 70
k_2s_3	20 06	19 22	7 38	11 83	0 43	49 20	3 73
k_3s_1	21 67	20 13	6 74	13 42	0 43	48 26	3 88
k_3s_2	22 40	19 90	7 00	13 64	0 50	41 28	3 85
k_3s_3	20 61	19 35	7 10	12 58	0 49	40 68	3 92
$F_{4\ 22}$	1 46	<1	<1	<1	5 85*	1 49	1 51

Table 50b Interaction effect of N K and their split application(s) on quality of fruits

Treatment	TSS °brix	Total sugars %	Reducing sugars %	Non reducing sugars %	Acidity %	Sugar/acid ratio	Pulp/peel ratio
n_1k_1	22 47	20 51	8 21	14 25	0 38	58 72	3 75
n_1k_2	22 37	23 10	8 38	13 98	0 34	63 38	3 98
n_1k_3	21 47	22 51	7 35	14 11	0 36	59 41	4 12
n_2k_1	19 78	21 06	7 81	11 96	0 50	39 55	3 69
n_2k_2	18 71	20 01	7 81	10 95	0 47	39 86	3 80
n_2k_3	20 86	22 85	7 17	13 69	0 47	43 86	3 95
n_3k_1	18 84	18 38	6 31	12 52	0 54	34 38	3 40
n_3k_2	19 39	20 01	8 00	11 39	0 50	36 65	3 64
n_3k_3	17 62	16 76	6 69	10 92	0 58	31 11	3 73
$F_{4,22}$	<1	<1	<1	<1	<1	<1	<1
CD		—	—		—	—	—
n_1s_1	22 50	22 31	7 97	14 51	0 36	61 98	3 89
n_1s_2	22 08	21 83	7 98	14 10	0 36	60 10	3 97
n_1s_3	21 74	21 98	8 00	13 73	0 36	59 43	3 99
n_2s_1	19 97	21 11	7 62	12 36	0 48	41 04	3 82
n_2s_2	19 87	21 24	7 82	12 04	0 47	41 89	3 79
n_2s_3	19 52	21 57	7 35	12 22	0 48	43 50	3 82
n_3s_1	18 54	18 35	7 06	11 47	0 53	33 06	3 61
n_3s_2	18 96	18 66	7 02	11 94	0 54	35 11	3 61
n_3s_3	18 35	18 17	6 92	11 42	0 54	33 99	3 62
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1
k_1s_1	20 24	19 68	7 61	12 62	0 46	44 76	3 65
k_1s_2	20 76	20 21	9 49	13 26	0 47	44 93	3 60
k_1s_3	20 09	20 06	7 23	12 85	0 48	42 97	3 65
k_2s_1	20 39	21 38	8 01	12 37	0 44	46 30	3 80
k_2s_2	20 20	20 63	8 11	12 09	0 44	47 47	3 81
k_2s_3	19 89	21 11	8 07	11 86	0 44	46 12	3 82
k_3s_1	20 38	20 71	7 03	13 34	0 47	45 02	3 88
k_3s_2	19 94	20 89	7 21	12 72	0 46	44 69	3 95
k_3s_3	19 63	20 55	6 97	12 65	0 46	44 66	3 96
$F_{4\ 22}$	<1	<1	<1	<1	<1	<1	<1

which was significantly higher than the rest of the combinations Pulp / peel ratio was not influenced by NK interaction

None of the quality attributes were significantly altered by NS interaction The interaction between potassium and its split application at different levels did not significantly influence the quality of the fruits (Table 50 a and b)

4 2 5 Content of nutrients in index leaf

4 2 5 1 Effect of N K and their split doses on N and K content

The third leaf was analysed for estimating the N and K content of leaves at monthly invervals during the first four months after planting and again at shooting and harvest The different levels of nitrogen influenced the N content of leaves at all the stages sampled One month after planting N_1 and N_2 had 1 03 per cent nitrogen which was significantly higher than the other two levels Two months after planting the content of N at N_{400} (1 16 per cent) was higher than the

Table 51 Effect of N K and their split application on N and K content of index leaf

	N content N %						K content K %					
	MAP						MAP					
Effect	1	2	3	4	Shooting	Harvest	1	2	3	4	Shooting	Harvest
n_1	0 99	1 10	1 21	2 58	2 79	2 29	1 29	1 27	0 54	0 72	2 57	2 22
n_2	0 99	1 11	1 26	2 71	2 97	2 49	1 31	1 29	0 54	0 71	2 55	2 20
n_3	1 03	1 16	1 26	2 70	2 98	2 51	1 31	1 28	0 53	0 72	2 55	2 23
F	20 45**	31 27**	13 37**	4 34**	7 89**	10 61**	<1	<1	<1	<1	<1	<1
CD	0 015	0 015	0 021	0 102	0 108	0 109						
k_1	1 01	1 12	1 245	2 68	2 87	2 37	1 26	1 24	0 44	0 66	2 48	2 17
k_2	1 00	1 13	1 24	2 66	2 94	2 46	1 32	1 29	0 55	0 72	2 58	2 23
k_3	1 01	1 12	1 24	2 66	2 94	2 47	1 32	1 29	0 61	0 77	2 61	2 25
F	1 20	1 40	0 22	0 06	1 15	2 86	4 28*	3 81*	23 01*	5 15*	1 73	<1
CD												
s_1	1 04	1 09	1 24	2 66	2 89	2 41	1 29	1 27	0 61	0 73	2 59	2 23
s_2	1 03	1 09	1 25	2 67	2 922	2 43	1 36	1 33	0 40	0 71	2 53	2 21
s_3	0 96	1 18	1 24	2 66	2 93	2 46	1 27	1 24	0 51	0 71	2 50	2 21
F	70 20**	93 88**	<1	<1	<1	<1	10 38**	9 57**	11 37**	<1	<1	1
CD									0 053			

other two levels tried Three and four months after planting and again at shooting and harvest N_{300} and N_{400} recorded N content on par and superior to N_{200}

The level of potassium significantly influenced the K content of leaves one two three and four months after planting One and two months of planting K_{450} and K_{600} were on par and significantly superior to K_{300} Three months after planting there was difference between all the three levels of K higher levels of potassium resulting in higher contents of K in the leaves Four months after planting K_{450} and K_{600} were on par and significantly higher than K_{300} During shooting and harvest higher levels of potassium resulted in higher content of K but the differences were not statistically significant

The different levels of split application resulted in significant difference in K content of leaves one two and three months after planting The highest number of split applications resulted in highest content of K in the first two months and in the third month there was no difference between seven and eight split applications but K content in the first level of split application was significantly lower

During the late stages there was no difference in K content due to different levels of split application

The different levels of potassium did not influence the content of N in index leaf The different levels of split application also did not influence the content of N in the index leaf (Table 51)

4 2 5 2 **Interaction effect of N K and their split application on N and K content**

NK interaction resulted in significant difference in N content two months after planting $N_{400}K_{450}$ and $N_{400}K_{600}$ resulted in highest content which was significantly higher than the other combinations tried At all the other stages studied there was no difference between the various combinations of nitrogen and potassium The K content of leaves were not influenced by NK interaction at any stage (Table 52)

The interaction between levels of nitrogen and split application of fertilizers resulted in significant difference in the N content in the first and second month

Table 52 Interaction effect of N K and their split application on N and K content of index leaf

Intraction effect	N content N % MAP 1	2	3	4	Shooting	Harvest	K content K % MAP 1	2	3	4	Shooting	Harvest
n_1k_1	0 99	1 11	1 21	2 59	2 79	2 29	1 23	1 23	0 45	0 65	2 46	2 16
n_1k_2	0 98	1 10	1 21	2 59	2 80	2 28	1 33	1 30	0 57	0 74	2 67	2 25
n_1k_3	0 99	1 09	1 22	2 57	2 79	2 30	1 32	1 29	0 59	0 77	2 62	2 26
n_2k_1	0 99	1 09	1 26	2 73	2 89	2 33	1 28	1 25	0 43	0 65	2 52	2 19
n_2k_2	0 99	1 10	1 26	2 69	3 01	2 57	1 33	1 31	0 55	0 72	2 54	2 18
n_2k_3	1 00	1 12	1 26	2 72	3 03	2 56	1 33	1 32	0 61	0 76	2 60	2 23
n_3k_1	1 04	1 16	1 26	2 72	2 93	2 46	1 28	1 27	0 44	0 67	2 46	2 16
n_3k_2	1 03	1 17	1 25	2 69	2 99	2 53	1 32	1 29	0 52	0 71	2 59	2 26
n_3k_3	1 04	1 14	1 26	2 70	3 01	2 54	1 33	1 28	0 62	0 77	2 59	2 25
$F_{2\ 22}$	0 931	2 89**	<1	<1	<1	1 29	<1	<1	<1	<1	<1	<1
CD		0 027										
n_1s_1	1 03	1 07	1 22	2 59	2 79	2 29	1 26	1 24	0 63	0 73	259	2 21
n_1s_2	1 01	1 07	1 21	2 59	2 79	2 28	1 38	1 35	0 48	0 72	2 55	2 25
n_1s_3	0 92	1 18	1 21	2 58	2 80	2 32	1 23	1 23	0 51	0 70	2 56	2 21
n_2s_1	1 04	1 07	1 26	2 70	2 91	2 41	1 31	1 29	0 62	0 72	2 61	2 22
n_2s_2	1 03	1 07	1 27	2 73	3 03	2 54	1 36	1 32	0 51	0 71	2 52	2 18
n_2s_3	0 93	1 18	1 25	2 71	2 99	2 52	1 28	1 26	0 51	0 71	2 53	2 21
n_3s_1	1 04	1 15	1 25	2 70	2 98	2 52	1 29	1 27	0 58	0 75	2 58	2 25
n_3s_2	1 04	1 13	1 27	2 72	2 94	2 47	1 35	1 32	0 49	0 68	2 52	2 21
n_3s_3	1 03	1 18	1 25	2 69	3 00	2 55	1 28	1 25	0 53	0 72	2 55	2 22
$F_{2\ 22}$	15 62**	5 73**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
CD	0 026	0 027										
k_1s_1	1 04	1 09	1 24	2 65	2 81	2 22	1 27	1 25	0 44	0 66	2 53	2 18
k_1s_2	1 04	1 08	1 26	2 71	2 89	2 39	1 29	1 27	0 44	0 66	2 45	2 18
k_1s_3	0 96	1 19	1 24	2 68	2 91	2 49	1 23	1 22	0 45	0 65	2 45	2 16
k_2s_1	1 04	1 08	1 24	2 67	2 93	2 47	1 30	1 28	0 68	0 72	2 62	2 24
k_2s_2	1 01	1 10	1 24	2 68	2 95	2 46	1 39	1 36	0 48	0 73	2 62	2 22
k_2s_3	0 96	1 19	1 23	2 64	2 93	2 46	1 27	1 25	0 45	0 72	2 58	2 24
k_3s_1	1 04	1 11	1 25	2 66	2 95	2 53	1 28	1 27	0 70	0 81	2 63	2 26
k_3s_2	1 04	1 08	1 25	2 65	2 93	2 44	1 40	1 36	0 55	0 73	2 58	2 24
k_3s_3	0 96	1 17	1 24	2 67	2 95	2 44	1 90	1 26	0 59	0 76	2 60	2 25
$F_{2\ 22}$	<1	2 29	<1	<1	<1	2 17	<1	<1	3 29*	<1	1	1
CD									0 092			

after planting The N content was lower at $N_{200}S_2$ and $N_{300}S_3$ one month after planting $N_{300}S_1$ $N_{300}S_2$ and $N_{300}S_3$ had lower content of N two month after planting The K content of leaves was not influenced by NS interaction (Table 52)

N content of leaves was not influenced by KS interaction Significant difference in K content was observed only three months after planting $K_{600}S_1$ $K_{450}S_1$ and $K_{450}S_2$ had significantly higher content of K than others

4 2 5 3 Effect of N K and their split applications on P_2O_5 content

The P_2O_5 content of leaves were not influenced by level of nitrogen

The level of potassium influenced the P_2O_5 content of leaves two and four months after planting and at shooting P_2O_5 content of leaves were significantly higher at K_{450} and K_{600} (Table 53)

The content of P_2O_5 in leaves was not significantly influenced by the level of split application

4 2 5 4 Interaction effect of N K and their split doses on P_2O_5 content

The data are presented in Table 24a No difference was observed in the P_2O_5 content of leaves due to the interaction between nitrogen and potassium

The interaction between nitrogen and split application of fertilizers as well as the interaction between potassium and split application of fertilizers did not result in any difference in P_2O_5 content of leaves (Table 54)

4 2 5 5 Effect of N K and their split application on the calcium magnesium iron and zinc content

The content of calcium magnesium iron and zinc in leaves was estimated at the time of shooting and the data are presented in Table 55

The calcium content of leaves was significantly influenced by the level of nitrogen N_{200} and N_{300} had significantly higher content of calcium than N_{400} Th

Table 53 Effect of N K and their split application(s) on P Ca Mg Fe and Zn content of index leaf

Effect	P content (%)				Ca %	Mg %	Fe ppm	Zn %
	2MAP	4 MAP	Shooting	Harvest	Shooting			
					Ca%	Mg%	Feppm	Zn%
n_1	0 124	0 138	0 510	0 461	0 318	0 046	185 66	0 415
n_2	0 124	0 137	0 523	0 469	0 301	0 042	190 11	0 437
n_3	0 126	0 135	0 520	0 472	0 288	0 045	184 61	0 398
$F_{2,22}$	<1	1 50	<1	0 38	3 51*	1 36	5 15*	3 52*
CD	—	—	—	—	0 023	-	3 771	0 0304
k_1	0 116	0 129	0 497	0 454	0 352	0 053	186 39	0 411
k_2	0 125	0 136	0 521	0 468	0 281	0 039	189 39	0 441
k_3	0 132	0 144	0 534	0 480	0 273	0 041	184 62	0 396
$F_{2,22}$	30 73**	32 20**	4 10*	1 89*	30 10**	27 38**	3 52*	5 00*
CD	0 0043	0 0037	0 0027	0 003	0 023	0 0044	3 771	0 0304
s_1	0 124	0 138	0 511	0 461	0 300	0 044	186 50	0 425
s_2	0 124	0 136	0 521	0 474	0 302	0 045	186 60	0 423
s_3	0 125	0 137	0 521	0 467	0 304	0 044	187 20	0 403
$F_{2,22}$	<1	<1	<1	<1	<1	<1	<1	1 42

Table 54 Interaction effect of N K and their split application(s) on P [illegible] Mg Fe and Zn content of index leaf

Interaction effect	P content P% 2MAP	4 MAP	Shooting	Harvest	Shooting Ca %	Mg %	Fe ppm	Zn %
n_1k_1	0 117	0 129	0 498	0 459	0 348	0 054	183 17	0 416
n_1k_2	0 123	0 141	0 497	0 444	0 300	0 041	190 00	0 410
n_1k_3	0 132	0 145	0 533	0 478	0 305	0 043	183 83	0 420
n_2k_1	0 115	0 131	0 495	0 450	0 360	0 054	186 50	0 408
n_2k_2	0 121	0 136	0 530	0 476	0 281	0 036	193 50	0 488
n_2k_3	0 136	0 145	0 543	0 483	0 261	0 039	190 33	0 415
n_3k_1	0 117	0 129	0 498	0 453	0 350	0 053	189 50	0 417
n_3k_2	0 131	0 134	0 537	0 484	0 261	0 042	184 67	0 427
n_3k_3	0 129	0 143	0 526	0 478	0 251	0 041	179 67	0 352
$F_{4, 22}$	2 44	<1	<1	<1	1 383	<1	3 34*	3 15*
CD	—			—	—	—	6 536	0 0527
n_1s_1	0 123	0 137	0 491	0 447	0 320	0 045	185 17	0 430
n_1s_2	0 123	0 138	0 510	0 462	0 311	0 047	185 67	0 415
n_1s_3	0 127	0 140	0 529	0 473	0 322	0 046	186 17	0 402
n_2s_1	0 124	0 141	0 520	0 471	0 293	0 043	190 67	0 442
n_2s_2	0 124	0 136	0 523	0 471	0 310	0 042	189 17	0 445
n_2s_3	0 125	0 135	0 525	0 467	0 300	0 043	190 50	0 425
n_3s_1	0 127	0 137	0 521	0 466	0 288	0 045	183 67	0 403
n_3s_2	0 126	0 135	0 531	0 489	0 285	0 048	185 00	0 410
n_3s_3	0 124	0 135	0 509	0 460	0 290	0 044	185 17	0 382
$F_{4, 22}$	<1	1 17	<1	<1	<1	<1	<1	<1
CD	—	—	—	—	—	—	—	
k_1s_1	0 117	0 131	0 491	0 447	0 355	0 055	187 33	0 415
k_1s_2	0 117	0 129	0 499	0 460	0 357	0 054	187 66	0 410
k_1s_3	0 115	0 130	0 501	0 456	0 347	0 053	184 17	0 416
k_2s_1	0 124	0 138	0 502	0 451	0 286	0 046	188 83	0 445
k_2s_2	0 124	0 134	0 538	0 482	0 273	0 038	187 33	0 445
k_2s_3	0 126	0 139	0 526	0 469	0 283	0 039	192 00	0 435
k_3s_1	0 132	0 146	0 538	0 485	0 260	0 038	183 33	0 415
k_3s_2	0 132	0 146	0 528	0 479	0 277	0 044	184 83	0 415
k_3s_3	0 134	0 140	0 536	0 476	0 282	0 044	185 67	0 357
$F_{4, 22}$	<1	1 23	<1	<1	<1	<1	1 04	1 11
CD	—	—	—	—	—			—

magnesium content of leaves was not significantly influenc l by level of nitrogen The iron content of l aves was significantly higher at N_{300} N_{200} and N_{400} were on par with respect to iron content The zinc content of leav s was highest at N_{300} which was on par with zinc content at N_{200} but significantly different from Zn content at N_{400}

The calcium and magnesium content of leaves were highest at K_{300} which was significantly higher than the Ca content at K_{450} and K_{600} The iron and zinc content was highest at K_{450} ich es significantly higher than iro content at K_{300} and K_{600}

The content of Ca Mg Fe and Zn at shooting was not influenced by level of split application

4 2 5 6 Interaction effect of N K and their split application on calcium magnesium iron and zinc content in leaves

The content of calc um and magnesium in leaves was not influenced by interaction between nitrogen and potassium The iron content of leaves was significantly influenced by interaction of N and K_2O $N_{200}K_{450}$ $N_{300}K_{450}$ $N_{300}K_{600}$ and $N_{400}K_{300}$ had significantly higher content of iron compared to other combinations The zinc content of leaves was influenced by NK interaction The highest content of zinc was noticed at $N_{300}K_{450}$ (0 488%) and the lowest at $N_{400}K_{600}$ (0 352%) The rest of the combinations differed significantly from these two and were on par with each other

No difference was observed in the content of Ca Mg Fe and Zn due to the interaction between potassium and split application of fertilizers (Table 54)

4 2 6 OTHER OBSERVATIONS

4 2 6 1 Effect of treatments on pests and disease incidence in banana

The data on the incidence of sigatoka leaf spot disease and banana rhizome weevil are presented in Table 55 and b The data revealed that the attack of rhizome weevil was greater with higher doses of fertilizers whereas at lower levels the attack was less severe The highest attack was recorded in treatments T24 (9 51) T23 (9 45) & T25 (9 40) in

Table 55a Effect of treatments on incidence of pests and diseases in banana

Treatment	No of rhizome Weevils/plant	Sigatoka leaf Disease index	Spot disease incidence leaf area infected (percentage)
T_1	3 40	2	18 60
T_2	3 55	2	17 52
T_3	3 30	2	16 53
T_4	3 25	2	15 16
T_5	3 15	2	16 79
T_6	3 50	2	16 82
T_7	3 36	2	14 38
T_8	3 08	2	14 25
T_9	3 15	2	14 38
T_{10}	5 65	3	27 83
T_{11}	5 80	3	25 58
T_{12}	5 50	3	25 81
T_{13}	4 95	2	23 85
T_{14}	4 85	2	23 93
T_{15}	4 65	2	20 56
T_{16}	4 75	2	19 30
T_{17}	4 80	2	21 50
T_{18}	4 65	2	22 05
T_{19}	8 55	3	27 13
T_{20}	8 95	3	29 25
T_{21}	9 45	2	24 26
T_{22}	9 58	3	27 25
T_{23}	9 60	3	28 23
T_{24}	9 50	2	24 25
T_{25}	9 25	2	21 26
T_{26}	9 00	2	22 50
T_{27}	9 15	2	23 25
Ac	5 65	2	18 18
PP	3 85	2	19 30

Note

Disease index	Leaf area infected
1	0-5
2	11-25
3	26-30
4	31-40
5	41-50
6	51-75
7	76 & above

Table 55b Effect of treatments on incidence of pests and diseases in banana

Treatment	No of rhizome Weevils/plant	Sigatoka leaf Disease index	Spot disease incidence leaf area infected (percentage)
T_1	3 35	2	14 43
T_2	3 25	2	15 12
T_3	3 30	2	14 48
T_4	3 68	2	13 58
T_5	3 50	2	13 43
T_6	3 25	2	14 40
T_7	3 13	2	12 58
T_8	3 05	2	12 60
T_9	3 35	2	12 81
T_{10}	5 65	2	20 35
T_{11}	5 42	2	22 85
T_{12}	5 56	2	22 52
T_{13}	5 13	2	17 75
T_{14}	5 28	2	17 85
T_{15}	5 08	2	17 95
T_{16}	4 95	2	16 23
T_{17}	4 63	2	17 58
T_{18}	4 85	2	17 11
T_{19}	8 48	2	24 56
T_{20}	9 06	2	23 23
T_{21}	8 85	2	24 77
T_{22}	9 38	2	24 58
T_{23}	9 45	2	24 00
T_{24}	9 51	2	24 15
T_{25}	9 40	2	20 26
T_{26}	9 20	2	20 23
T_{27}	9 18	2	22 58
Ac	5 23	2	18 51
PP	3 35	2	16 55

Disease index	Leaf area infected
1	0 5
2	11-25
3	26-30
4	31 40
5	41-50
6	51 75
7	76 & above

4 2 6 2 Effect of treatments on soil nutrient status after harvest of tissue cultured banana

The data presented in Table 56 a and b show the status of major nutrients (N P and K) from different treatments before and after harvest of the crop The initial nutrient content of the experimental plot after analysis of composite sample was found to be N 76 kg ha^{-1} P_2O_5 35 kg ha^{-1} and K_2O 108 kg ha^{-1} for the first season trial and for the second season trial N 72 kg ha^{-1} P_2O_5 36 kg ha^{-1} and K_2O 113 kg ha^{-1}

After harvest of the first crop the available nitrogen content in plots receiving 200g N/plant ranged from 64 to 72 which accounted for a decrease of 9 21 to 15 71 per cent from the original nitrogen content In the second season the percentage of decrease ranged from 6 29 to 11 32 and the content of nitrogen after harvest ranged from 63 85 to 67 52 It is thus clear that the amount of nitrogen applied was inadequate In the treatments involving 300g nitrogen there was slight increase and in certain treatments negligible decrease in the content of nitrogen in soil after harvest (73 5 kg ha^{-1} to 79 6 kg ha^{-1} in first season 73 5 kg ha^{-1} to 79 5 kg ha^{-1} in second season) indicating that application of N at this level was more or less sufficient for the crop In the treatments involving N400 the content

Table 56a Effect of treatments on soil nutrient status after harvest of banana

Treatments	Soil nutrient status after harvest kg/ha			Increase/decrease of nutrients		
	N	P	K	N	P	K
T_1	68	43 51	104 53	-10 53	14 50	3 47
T_2	69	45 26	105 46	-9 21	19 11	2 54
T_3	65	46 33	106 27	14 47	21 92	1 73
T_4	70	44 71	113 52	-7 89	17 66	5 52
T_5	72	43 25	112 71	5 26	13 82	4 71
T_6	67	45 52	111 15	-11 84	19 79	3 15
T_7	65	47 24	124 24	14 47	24 31	16 24
T_8	68	47 83	123 52	-14 47	25 86	15 52
T_9	64	46 61	128 33	15 79	22 66	20 33
T_{10}	78	44 72	106 58	2 63	17 68	1 42
T_{11}	73 5	42 63	103 25	-3 29	12 18	4 75
T_{12}	76 5	43 52	104 16	0 66	14 53	-3 84
T_{13}	78 3	44 25	111 17	3 03	16 45	3 17
T_{14}	79 6	42 55	109 05	4 74	11 97	1 05
T_{15}	77 9	43 33	113 26	2 5	14 03	5 26
T_{16}	75 6	41 87	123 26	-0 53	10 18	15 26
T_{17}	74 8	42 53	122 34	-1 58	11 92	14 34
T_{18}	77 5	43 77	127 61	1 97	15 18	19 61
T_{19}	82 6	44 88	106 26	8 68	18 10	-1 74
T_{20}	84 5	43 63	108 52	11 18	14 82	0 52
T_{21}	87 3	44 52	103 46	14 87	17 16	4 54
T_{22}	83 8	47 26	110 18	10 26	24 37	2 18
T_{23}	85 6	43 52	113 26	12 63	14 52	5 26
T_{24}	84 8	46 53	114 15	11 58	22 45	6 15
T_{25}	86 2	42 66	125 56	13 42	12 26	17 56
T_{26}	84 3	45 55	124 61	10 96	26 53	16 61
T_{27}	83 8	43 33	128 25	10 26	14 03	20 25
Ac	45	33	96 26	-40 70	-13 16	11 74
PP	65	42 80	103 15	-14 47	12 63	-4 85

Table 56b Effect of treatments on soil nutrient status after harvest of banana

Treatments	Soil nutrient status after harvest kg/ha			Increase/decrease of nutrients		
	N	P	K	N	P	K
T_1	64 73	42 28	104 65	-10 09	17 44	8 35
T_2	66 52	41 87	108 51	9 00	16 31	-4 49
T_3	65 94	43 52	107 25	-8 42	20 89	-5 75
T_4	66 58	44 71	116 26	-7 53	24 19	3 26
T_5	67 47	43 75	117 25	-6 29	21 53	4 25
T_6	63 85	42 52	112 21	-11 32	18 11	-0 79
T_7	64 74	43 23	128 53	-10 08	20 08	15 53
T_8	65 51	42 28	130 21	9 01	17 44	17 21
T_9	65 73	43 56	129 61	-8 70	21	16 61
T_{10}	73 50	44 83	110 26	-2 08	24 53	2 74
T_{11}	72 85	41 38	108 51	1 18	14 94	4 39
T_{12}	71 70	44 55	110 07	0 42	23 64	-2 93
T_{13}	74 55	43 53	114 75	3 54	20 92	1 75
T_{14}	72 48	42 75	113 21	0 67	18 75	0 21
T_{15}	73 86	41 88	110 65	2 58	16 33	2 35
T_{16}	71 65	42 70	130 23	-0 49	18 61	17 23
T_{17}	72 30	43 50	128 55	0 42	20 83	15 55
T_{18}	73 77	44 51	126 64	2 46	23 64	13 64
T_{19}	78 58	42 20	104 25	9 14	17 22	-8 75
T_{20}	80 65	43 30	106 55	12 01	20 28	6 45
T_{21}	77 35	44 51	105 22	7 43	23 64	-7 78
T_{22}	76 51	43 61	116 21	6 26	21 14	3 21
T_{23}	78 54	44 51	111 77	9 08	23 64	-1 23
T_{24}	79 32	42 23	119 53	10 17	17 31	6 53
T_{25}	77 84	43 88	124 25	8 11	21 89	11 25
T_{26}	80 82	44 52	127 63	12 25	23 67	14 63
T_{27}	79 30	42 23	123 51	10 14	17 31	10 51
Ac	42 50	32 33	103 45	-29 50	-10 19	-9 55
PP	60 25	43 28	110 23	-16 32	20 22	-2 77

of N in soil in these treatments ranged from 82 6 kg ha ^{1} to 87 3 kg ha ^{1} in the first season and in second season 78 58 kg ha^{-1} to 80 82 kg ha ^{1} The percentage increase ranged from 8 68 per cent to 14 87 per cent and 9 14 per cent to 12 25 per cent respectively (Table 56a and b)

The soil of experimental plot was rated to be high in available P content in both seasons After harvest the P content of soil increased in all the treatments except absolute control The percentage increase ranged from 10 18 to 26 53 in first season and in the second season from 14 04 to 24 19 per cent

The available K_2O content of soil ranged from 103 25 kg ha^{-1} to 128 33 kg ha ^{1} in the different treatments after the harvest of first crop and 104 25 kg ha ^{1} to 130 21 kg ha ^{1} after the second crop In the treatments involving 300g K_2O plant ^{1} the available K_2O content ranged from 103 25 kg ha ^{1} to 108 52 kg ha ^{1} (a decrease of 7 74 to 2 5 per cent) The data thus indicate that the higher levels of K_2O are required for satisfactory crop production With regard to the treatments which include 450 g K_2O/plant slight increases in available K_2O content of soil was observed (1 05 kg ha ^{1} to 5 52 kg ha ^{1} after the first crop and 1 23 to 6 53 kg ha ^{1} after the second crop) Application of K_2O at this level does not result in a depletion of potassium in soil At the highest level of K_2O the content of available K_2O in the soil registered an increase after both crops (15 25 to 20 33 kg ha^{-1} and 10 51 to 17 23 kg ha^{-1} respectively)

4 2 6 3 Effect of treatments on cost of cultivation net profit and cost benefit ratio of tissue cultured banana

The cost of cultivation excluding the cost of fertilizers and expenditure on fertilizer application is given in Appendix 38 The cost of fertilizers for different treatments and the total cost of cultivation for different treatments are given in Appendix 39a and 39b 40a and 40b The abstract of cost of cultivation net profit and benefit cost ratio are given in Table 57 A and B

The cultivation cost ranged from Rs 94232 in T_1 to 97399 in T_{26} in the different treatments and for the package of practices recommendations the total cost of cultivation was Rs 94057 and for the absolute control it was Rs 72199 in the first crop in the second crop the total

Table 57a Effect of treatments on cost of cultivation net profit and benefit cost ratio of tissue cultured nendran banana

Treatment	Yield/ha	Income (bunches) Rs 8/kg	Income suckers	Total income Rs	Total expenditure	Net profit	Benefit cost ratio
T_1	19845	158760	9600	168360	94232	74128	1 79
T_2	19600	156800	9600	166400	95376	71024	1 75
T_3	21340	170720	9600	180320	94805	85515	1 90
T_4	24721	197768	9600	207368	96467	110901	2 14
T_5	26558	212464	9600	222064	97611	124453	2 27
T_6	24745	197960	9600	207560	97039	110521	2 14
T_7	24672	197376	9600	206976	98701	108275	2 10
T_8	25333	202664	9600	212264	99845	112199	2 13
T_9	24721	197768	9600	207368	99273	108095	2 08
T_{10}	23275	186200	9600	195800	95962	99838	2 04
T_{11}	21340	170720	9600	180320	97106	83214	1 86
T_{12}	24190	193520	9600	203120	96534	106586	2 10
T_{13}	28420	227360	9600	236960	98196	138764	2 41
T_{14}	29302	234416	9600	244016	99340	144676	2 46
T_{15}	29351	234808	9600	244408	98768	145640	2 47
T_{16}	22908	183260	9600	192860	100430	92430	1 92
T_{17}	22663	181304	9600	190904	101574	89330	1 88
T_{18}	20360	162880	9600	172480	101002	71478	1 71
T_{19}	19600	156800	9600	166400	97701	68699	1 70
T_{20}	18792	150336	9600	159936	98845	61091	1 62
T_{21}	21658	173264	9600	182864	98273	84591	1 86
T_{22}	20825	166600	9600	176200	99935	76265	1 76
T_{23}	22663	181304	9600	190904	101079	89825	1 89
T_{24}	21658	173264	9600	182864	100507	82357	1 82
T_{25}	25235	201880	9600	211480	98737	112743	2 14
T_{26}	23889	191112	9600	200712	103313	973[illegible]	1 94
T_{27}	20440	163513	9600	173113	102741	70372	1 69
Ac	13034	104272	9600	113872	94057	19365	1 21
PP	19061	152488	9600	162088	72199	89889	2 24

Table 57b Effect of treatments on cost of cultivation net profit and benefit cost ratio of tissue cultured nendran banana

Treatment	Yield/ha	Income (bunches) Rs 8/kg	Income suckers	Total income Rs	Total expenditure	Net profit	Benefit cost ratio
T_1	24917	224253	9600	233853	94633	139220	2 47
T_2	25137	226233	9660	235833	95812	140021	2 46
T_3	23863	214767	9600	224347	95223	129144	2 36
T_4	26191	235719	9600	245319	95953	149366	2 56
T_5	25431	228879	9600	238479	97132	141347	2 46
T_6	24647	221823	9660	231423	96543	134880	2 40
T_7	25750	231750	9600	241350	97273	144077	2 48
T_8	26509	238581	9600	248181	98452	149729	2 52
T_9	25921	233289	9600	242889	97863	145026	2 48
T_{10}	24647	221823	9660	231423	96279	135144	2 10
T_{11}	25725	231525	9600	241125	97458	143667	2 47
T_{12}	25456	229104	9600	238704	96868	111836	2 46
T_{13}	32267	290403	9600	300003	97599	202404	3 07
T_{14}	34594	311346	9660	320946	98778	222168	3 25
T_{15}	35011	315095	9600	324695	98188	226507	3 31
T_{16}	24892	224028	9600	233628	98919	134709	2 39
T_{17}	24770	222926	9600	232526	100898	131628	2 30
T_{18}	24647	221823	9660	231423	99508	131915	2 33
T_{19}	20948	188532	9600	198132	97993	100139	2 02
T_{20}	21217	190953	9600	200553	99046	101507	2 02
T_{21}	18473	166257	9600	175857	98523	77334	1 78
T_{22}	24770	222930	9660	235530	99253	133277	2 37
T_{23}	26240	236160	9600	245760	100366	115394	2 15
T_{24}	24794	223146	9600	232746	99843	132903	2 33
T_{25}	18645	167805	9600	177405	100573	76832	1 76
T_{26}	21315	191835	9600	201435	101752	99683	1 98
T_{27}	20850	187650	9600	197250	101163	96087	1 95
Ac	13058	117527	9600	127127	73700	53427	1 72
PP	22148	199332	9600	208932	94466	114466	2 21

first crop and in second crop also the high fertilizer treatments resulted in higher incidence of weevil attack T23 (9 60) T22 (9 58) & T21 (9 50) The control plots following package of practices recommendations and treatments with lower levels of nitrogen (N 200) resulted in less severe incidence of weevil attack as also the absolute control with no fertilizers

Incidence of sigatoka leaf spot disease was more in first crop The disease was most severe in T20 (29 2? per cent) T23 (28 23 per cent) in first crop and in the second crop T21 T22 and T19 (24 77 per cent 24 77 per cent and 24 58 per cent respectively)

The disease was less severe and almost to the same extent in T7 T8 & T9 (12 58 12 60 & 12 81 per cent respectively) in the first crop as also in the second crop (14 38 14 25 & 14 35 per cent respectively) The control following the package of practices recommendations for fertilizers and the absolute control with no fertilizer application suffered comparatively less severe incidence of pests and disease (16 55 and 19 30 per cent and 18 51 and 18 18 per cent respectively) cost of cultivation increased to Rs 94633 in T_1 & Rs 101752 in T_{26} For the package of practices recommendations the total cost of cultivation was Rs 94466 and for the absolute control Rs 73700

The income per hectare ranged from Rs 159936 in T_{20} to Rs 244408 in T_{15} for the different treatments in the first crop For the package of practices recommendations the total income is Rs 162088 and for the absolute control it was Rs 113872 In the second crop the total income ranged from Rs 175857 T_{21} to Rs 324695 in T_{15} In this crop the package of practices recommendations had a total income of Rs 208932 and the absolute control Rs 127127

The benefit cost ratio ranged from 1 62 in T_{20} to 2 47 in T_{15} and the control recorded ratios 2 24 and 1 21 for the package of practices and absolute control respectively in the first crop In the second crop benefit cost ratio was lowest in T_{25} & T_{21} (1 76) and highest in T_{15} (3 31) and for the controls the ratio was 2 21 and 1 72 respectively

DISCUSSION

DISCUSSION

Banana is the most important of all the tropical fruits Nendran is the leading commercial variety of Kerala It fetches premium price in the market both as green and ripe fruits Banana is conventionally propagated by sword suckers Initial reports on the in vitro propagation of banana was made by Ma and Shii (1972) Subsequently the technique was refined for various cultivars by many workers (Steward and Krikorian 1979 Krikorian 1982 Withers 1980) Commercial in vitro propagation of banana was taken up by many private firms all over the world Tissue cultured banana plants have been widely accepted by farmers However preliminary reports indicated difference in growth and physiology of tissue cultured plants compared to conventional suckers (Israeli et al, 1986 Daniells 1988 Robinson 1989) especially at different developmental stages This necessitated a detailed study of tissue cultured plants and conventional suckers and to evolve a suitable fertiliser schedule for the tissue cultured plants

The present study was undertaken with two main objectives

To compare the growth flowering and yield potential of tissue cultured banana plants with that of those produced from conventional suckers and to standardise a suitable fertilizer schedule for tissue cultured banana

The study was conducted in two separate experiments from March 1991 to February 1993 for two seasons in the rice fallows attached of the Instructional Farm College of Agriculture Vellayani The results obtained are discussed in the following pages

Experiment - 1 Growth pattern, flowering and yield potential of tissue cultured plants vis-a-vis suckers

The study revealed that tissue cultured plants were superior in performance over the conventional suckers The tissue cultured plants exhibited vigorous vegetative growth and recorded increased yields No difference in duration was observed

The initial establishment and early growth of tissue cultured plants were comparable with that of conventional suckers Hwang (1984) reported 91 per cent survival of tissue cultured plants and Robinsons and Anderson (1990) obtained 100 per cent survival of tissue cultured plants on transfer to soil

The tissue cultured plants had vigorous vegetative growth and produced full grown plants which were taller and thicker than those from conventional suckers Physiological invigoration due to tissue culture has been reported earlier (Rajmohan 1985) Upto three months after planting average increase in height per week was 11 26 cm for suckers and 11 15 cm for tissue cultured plants and for girth this was 2 29 cm for suckers and 2 51 cm for tissue cultured plants Thereafter the tissue cultured plants exhibited a rapid rate of growth (Table 1 and 3) The maximum increase in pseudostem height was observed during fifth and sixth months after planting and just before shooting (51 72 cm and 44 84 cm for suckers and 52 65 cm and 51 50 cm for tissue cultured plants) The tissue cultured plants exhibited a rapid increase in pseudostem girth (11 48 cm) between third and fourth months after planting The suckers recorded the greatest difference in girth (10 53 cm) between the fourth and fifth months after planting The average monthly increment in girth from three months after planting to shooting was 6 22 cm for suckers and 7 44 cm for tissue cultured plants The tissue cultured plants ultimately recorded an increase of 6 7 per cent in height and 11 92 per cent in girth over the suckers

The tissue cultured plants had a vigorous growth phase throughout its life cycle But this was evident only after three months The suckers might have had the advantage of stored food in their corms and were able to perform as good as the tissue cultured plants in the initial growth phase

Increase in height and girth of tissue cultured banana over the plants produced from conventional suckers was reported previously by Robinson (1989) Israeli et al (1986) Daniells (1988) Drew and Smith (1990) Arias and Valverde, (1987) and Robinson et al (1993) These studies conducted in geographically distant places such a Israel Taiwan Africa and Australia agree that tissue cultured bananas have vigorous vegetative growth and produce taller and thicker plants The age and size of planting material used and the variety under study are critical Kwa and Ganry (1990) observed differences in performance between different varieties of banana Cavendish plantlets were taller than suckers but Grandnain plantlets were shorter In Kannara Nendran plantlets were found smaller in size at planting but progressively attained the height of plants from sword suckers while reaching the flowering stage (Pradeep et al 1992)

The number of leaves produced by a plant and its functional leaf area are critical factors in determining photosynthetic efficiency The role of parameters such as number of leaves produced at monthly intervals progressive leaf production & number of leaves retained are crucial in determining the yield potential Leaf production in banana is related to increased rate of plant growth (Barker and Steward 1962 Sathyanarayana 1985) In the present study also the vigor with which the tissue cultured plants grew was reflected in the number of leaves produced A lower rate of leaf senescence combined with greater leaf production resulted in the higher retention of leaves in tissue cultured plants (13 31 leaves for tissue cultured plants 10 69 leaves for suckers at shooting) The greater heights attained by the tissue cultured plants enabled them to bear greater number of leaves compared to the plants form suckers The average monthly leaf production of tissue cultured plants was 4 57 and that of suckers 3 72 (Table 7) The maximum difference was observed just before shooting (5 53 and 3 85 leaves/month) The maximum increase in pseudostem height was also recorded at this stage This shows that in banana pseudostem growth and production of leaves are related The tissue cultured plants produced 3 35 leaves more than the plants from suckers during their growth in the field Results of various trials in different parts of the world show that the tissue cultured plants produced more number of leaves compared to plants from suckers and retained more number of leaves at shooting (Robinson 1989 Pradeep et al 1992 Robinson et al 1993 Daniells 1988)

There was no difference in duration of the crop (either in the number of days taken from planting to shooting or number of days taken from planting to harvest) between tissue cultured plants and plants form suckers The tissue cultured plants exhibited an enhanced rate of vegetative growth But this obviously did not delay flowering period Similar observations were made by Reuveni et al (1985) using cv William However in banana the time taken for flowering varies according to the variety and age of planting material This may be the reason for the contradictory reports regarding time taken for shooting of tissue cultured bananas Early flowering was reported by Novak et al (1990) Robinson (1989) and Drew and Smith (1990) Late flowering was reported by Daniells (1988) and Pradeep et al (1992) The cultivation of tissue cultured plants is adopted to obtain uniformity in performance with regard to growth flowering, yield and quality A careful study of the flowering behaviour of all the individual plants in the field showed that the average number of days taken to complete flowering in tissue cultured plants under same treatment ranged from 7 to 12 67 days The plants from suckers took 15 67 to 20 days to complete flowering The average number of days taken to complete flowering was thus 8 67 and 17 75 for the tissue cultured plants and plants propagated from suckers respectively (Appendix 15b) The slight variation in number of days taken for flowering observed among tissue cultured plants may be due to difference in age of lateral meristems that develop to plants and mixing up of somaclones from callus with the plants from lateral buds The observation that tissue cultured plants were able to complete flowering in 9 08 days earlier is itself an advantage that could be utilized by farmers

The tissue cultured plants had significantly higher yields than suckers An increase in yield of 25 63 per cent was obtained in tissue cultured plants over the plants from suckers Tissue cultured plants recorded higher values compared to plants from suckers for all the yield attributes namely length of bunch number of hands and fingers and weight length and girth of finger The yield increase may be due to the genetic uniformity of the plants as well as due to the selecton of superior types for micro propagation Yield increase in tissue cultured plants upto 7 0 per cent (Daniells 1988) 24 6 per cent (Robinson and Anderson 1992) and 39 0 per cent (Pradeep et al 1992) has been reported The increase in yield varied according to the cultivar location and management practices Cavendish bananas in Australia recorded 24 6 per cent increase (Robinson and Anderson 1992) Nendran in Kannara recorded 39 0 per cent increase (Pradeep et al 1992) and Williams in Australia seven per cent increase (Daniells 1988) The uniformly superior performance of plants vigorous growth leading to production of more hands and fingers and less variability in fruit size have been proposed as the reason for higher yield of tissue cultured bananas

High corelation values with yield were obtained for height and girth of plants (at shooting) total leaf production leaf area and number of functional leaves (at shooting) and content of N P and K in leaves (at shooting) Higher values were recorded for all the above characters in tissue cultured plants The lack of food reserves in tissue cultured plants due to absence of well developed corms is adequately compensated by the presence of functional leaves at the time of planting The increased photosynthetic efficiency greater height and circumference of pseudostem and production of more leaves increases the potential for producing heavier bunches Heavier bunches have thicker and longer peduncles Peduncle thickness and diameter is decided by length and girth of pseudostem Among the yield attributes the number of fingers and length of bunch had the greatest corelation with yield (corelation coefficient of 0 93 each) Similar results were reported by Vijaya Raghavakumar (1981) and Rosamma and Nambuthiri (1990) The tissue cultured plants had longer bunches (increase of 14 0 cm) and more number of fingers (increase of 10 42) Nitrogen was found to be less responsible for increased yields compared to P and K This is in agreement with the results obtained in the second experiment

There are no reports on the quality of fruits nutrient content of leaves and nutrient removal from soil by tissue cultured bananas In the present study fruit quality of tissue cultured plants was better having a higher TSS (23 58) total sugars (23 74) sugar/acid ratio (66 79) and pulp/peel ratio (3 88) Mineral nutrition of a plant is important in determining its quality The tissue cultured plants had a better nutritional status and might have contributed to the development of quality attributes The increased photosynthetic efficiency due to higher leaf area might have led to the production of more carbohydrates and in turn more sugars The uniformity in fruit quality among the tissue cultured plants due to genetic uniformity was reflected in the high values recorded

The tissue cultured plants responded well to fertilizer application and had a higher content of N P K Mg Fe and Zn in the leaves The nutrient removal from soil was also higher in tissue cultured plants which might have led to the higher vegetative growth of the plant and nutrient content of leaves There was a drop in the content of N and K in soil after harvest in the case of tissue cultured plants which showed that higher yields could be obtained from such plants only with increased application of these two nutrients

The highest benefit cost ratio (2 26) was obtained when 2 5 months old tissue cultured plants were used for planting by applying fertilizers in seven splits and retaining two suckers per plant

Age of plants split application of fertilizers and retention of suckers after flowering were other factors in the study Age of planting material influenced the total leaf production and leaf area in the initial stages The 3 5 month old plants were found to be superior in this respect The age of planting material was also critical in determining the duration of the crop The 2 5 month old plants took 15 6 days more to flower and 13 21 days more for harvest compared to the 3 5 month old plants Patel and Chuntawat (1988) and Prasanna and Aravindakshan (1985) also reported early harvest when older and longer suckers were used for planting

Split application of fertilizers at higher levels enabled the retention of more leaves (Table 10) during the first four months after planting Retention of two suckers per plant after shooting did not affect bunch weight or other bunch characters (Table 22) Martinez and Garnica (1984) reported that upto three suckers per plant could be retained without affecting bunch weight There is enough of food reserves in banana for translocation to two developing suckers without limiting bunch development Observations made by Daniells (1988) in this regard is noteworthy According to him increase in length of finger is critical It serves as a sink with increased capacity for drawing photosynthates from the source This has been significantly observed in the present study also In banana as the capacity of the sink for drawing photosynthates increases there is a consequent increase in yield and there is enough of nutrient reserves in the plant for translocation to the bunch as well as upto the developing suckers as has been observed by various workers Under this condition it is the capacity of the bunch governed by characters like number of fingers and characters of fingers like length and girth that act as a limiting factor for yield rather than the retention of suckers Two or even three suckers can thus be retained without affecting bunch weight This has been very much observed in the present investigation

Experiment No II Standardisation of fertilizer schedule for tissue cultured plants of banana

The fertilizer schedule for Nendran banana recommended by the Kerala Agricultural University is 190 N 115 g P_2O_5 and 300 g K_2O to be applied in six split doses This recommendation is based on studies under upland conditions with conventional suckers The commercial cultivation of Nendran is now mainly undertaken in rice fallows in Southern Kerala the culture conditions of which are unique Three levels of N and K were tried along with the present recommendation as per package of practices recommendations (190 115 300) and absolute control In Nendran banana it has already been established (Geetha V Nair 1988) that fertilizers are best applied in six split doses starting from the time of planting at monthly intervals upto four months and again a top dressing of N alone just after complete emergence of inflorescence The tissue cultured plants possess an active root system and functional leaves at the time of planting It was necessary to find the optimum time for first application of fertilizers for the tissue cultured plants The application of fertilizers was avoided at planting to prevent scorching the very young roots and the tender tissue cultured plant The first application of fertilizer was made after one month except in the treatments consisting of seven and eight splits In such case the first application of fertilizer was made 20 and 15 days after planting respectively

Nitrogen and potassium significantly influenced the yield of plants The highest yields were obtained with the application of 300 g N and 450 g K_2O per plant in both seasons Both N and K at higher levels beyond the optimum did not favourably influence bunch weight Significantly higher yields were recorded for all the treatments of NPK in the second season This indicates an influence of the growing season on crop yield High and continuous rains in the active growing period in the first crop led to a stagnation of growth and consequent reduction in yield compared to second crop (related weather data given in Appendix 1) The moderate and better distributed rainfall received by the crop in the second season favoured an uninterrupted growth and led to higher yields in all the treatments compared to the first crop As mentioned earlier 300 g N and 450g K_2O per plant gave the best yields The average of the physical optimum worked out for the two seasons comes to 299 5 g of N and 465 5 g of K_2O per plant Besides the individual effect of N and K the interaction between the two nutrients also influenced bunch weight N_2 K_2 (N 300 + K 450) combination recorded the highest yield in both the seasons (13 84 kg 15 86 kg per plant respectively) The results thus confirm the reports that increased yield is possible in banana when N and K is applied together than when supplied separately The finding that banana requires much higher quantities of potassium compared to nitrogen for increased yield is supported in the previous reports by Pillai and Khader (1980) Chattopadhyaya and Bose (1986) and Obeifuna and Onyele (1987)

In the present experiment also it can be seen that excess N and K is not effective in increasing the yield Potassium is probably the only nutrient subjected to luxury consumption Application of this nutrient in quantities above the optimum level also leads to greater uptake but with no proportionate effect on yield

Split application in excess of the present recommended six splits of fertilizers did not make significant difference in yield The application of 10 kg farmyard manure per plant at the time of planting might have supplied enough nutrients for the initial establishment and growth of plants Geetha V Nair (1988) also reported the usefulness of upto six splits for fertilizer application

Fertilizer application in six splits starting from one month after planting can be considered as optimum since supply of fertilizers in seven and eight splits starting from 20 and 15 days after planting did not result in increased yield

The attributes responsible for the increase in yield are length of bunch number of fingers and individual finger characteristics such as length girth and weight of finger The effect of potash on increasing yield attributes was more pronounced than that of nitrogen confirming the earlier reports (Geetha V Nair 1988 Valsamma Mathew 1980 Sheela V L 1982 Langenggar and Smith 1986) Potassium exerted influence on every aspect of bunch development while nitrogen did not have influence on attributes like length of bunch and length of finger Even in those features where the influence of nitrogen was observed it was at a much lower level compared to the effect of potassium In this experiment the number of fingers was the single attribute having maximum direct influence on yield (r - 0 8407) This is thus an experimental proof for statistical study by Vijaya Raghava Kumar (1981) The number of fingers per bunch was influenced by level of nitrogen level of potash and also by the interaction between the two nutrients and between the nutrients and their split application

The second most important factor influencing yield is weight of individual finger (r - 0 8108) Both nitrogen and potassium influenced the weight of finger But there was no difference in weight of finger between 200 and 300 g N per plant whereas in case of potassium there was significant difference between each level of the nutrient 450 g potassium recorded an increase of 9 04 per cent over 300 g K_2O per plant and 5 33 per cent increase over 600 g K_2O per plant This shows the more pronounced effect of potash over nitrogen in increasing weight of finger The length of finger was significantly influenced by level of potash alone Potash at 450 g per plant recorded the highest length of finger The interaction between nitrogen and potash also influenced finger length The length of bunch also influenced the yield and this attribute was altered with different levels of potassium and also due to NK interaction It is obvious that a longer bunch is capable of carrying more number of hands and more number of fingers compared to a shorter bunch The dominating role of potash in various yield attributes is in confirmity with the results obtained previously (Leigh 1969 Yang and Pao 1962 Sheela 1982)

Nitrogen and Potash could make a significant increase in height of pseudostem only from the fifth month after planting at all the levels tried A considerable increase in height of pseudostem noticed at this stage might be due to the increased hormonal activity at the flower initiation stage which occured at this time Potash alone was able to maintain it upto sixth and seventh month The height of plant increased with increasing nitrogen and potash though not significantly But yield did not follow this trend Beyond the optimum level further vegetative growth did not contribute to increase in yield The height of plants was not influenced by split application of nutrients or by the interaction between nutrients

Both nitrogen and potassium were able to influence significantly the girth of the pseudostem but at different stages of growth The effect of nitrogen was evident two months after planting in the first crop and three months after planting in the second crop (Table 3a and b) At this stage N 200 and N 300 recorded higher girth of pseudostem and were on par with each other N 400 recorded significantly lower girth But potash was able to influence the pseudostem circumference only in sixth and fifth months after planting in the first and second crop respectively Split application of both nutrients did not influence the girth of pseudostem NK interaction influenced the girth of plants in the seventh month after planting This is probably due to the direct effect of potassium and indirect effect of nitrogen on pseudostem girth at this stage The girth of the pseudostem and yield of plants in banana is positively correlated (Valsamma Mathew 1980) This is further confirmed in the present study also Nitrogen 300 g/plant recorded the highest bunch weight in both seasons The combination of N 300 and K 450 also gave the highest yield Height and girth of plants increases with increasing levels of nitrogen according to Ashok Kumar (1977) and Valsamma Mathew (1980) But according Anjorin and Obigesan (1992) N at higher levels retarded plant height and girth Increase in potash increase the height and pseudostem circumference

(Oubahou & Dafiri 1987) But Yang and Pao (1962) did not observe any difference in height and girth with varied levels of potash

A high rate of leaf production was observed in all the treatments (Table 5a and b) The rate of leaf production was highest during the late vegetative phase between five and six months after planting (7 40 and 7 31 in the first and second crop respectively) N 300 resulted in the highest leaf production at monthly intervals (6 42 and 5 90 in the first and second crop) During the fifth and sixth month after planting new leaves were seen to emerge even before the previous leaf had fully opened During the stage of flower initiation there is a temporary suppression in the emergence of leaves due to the development of floral parts Soon after this there is a rapid emergence of the leaves which actually might have initiated previously The development of flower bud is completed by the fifth month and it moves to the apex at a very fast speed Production of hormones is enhanced at this time for elongation In the course of movement the subsequent leaves are also carried above the base of the plant towards the apex So the time taken for a leaf to emerge out will be short which result in fast development of leaves during late vegetative phase The opening of leaves could not keep pace with this increased rate of leaf production Delay in unfurling of leaves naturally leads to a reduction in their photosynthetic efficiency In this context it is pertinent to consider whether any other nutrient would have played a limiting role Thus the role of phosphorus or that of a trace element like boron with the ability to assist unfurling of leaves needs to be further studied Further work in this direction would help in increasing productivity

The number of leaves retained per plant was higher at N 300 in both the seasons (Table 7 a and b) N 300 K 450 retained the highest number of leaves at shooting (Table 8a and b) This combination also gave the highest yield and shows clearly the importance of combined effect of nitrogen and potassium on the growth and yield of banana In the second crop it was seen that at harvest the number of leaves retained was influenced by nitrogen Highest number of leaves were retained at N 300 This probably improved the size of fingers leading to the production of fingers with greater girth and weight It can also be seen that the number of leaves retained at harvest is higher in the second crop compared to the first which accounts for the increased yield observed in the same

Among the nutrients only nitrogen influenced the leaf area The effect of nitrogen was significant at the period of maximum vegetative growth (six months after planting, Table 11 a and b) Split application of fertilizers did not influence leaf area

The total number of leaves produced per plant was not altered either by N or K or by different levels of split application as in the early report (Geetha V Nair 1988)

Nitrogen and interaction of nitrogen with potash were found to exert greater influence on production and retention of leaves and leaf area compared to the effect of potash alone Role of nitrogen in production and retention of leaves and increasing leaf area in banana has been reported by many scientists (Baruah and Mohan 1985 Oubahou and Dafiri 1987 Khoreby and Salem 1991) The results are also in conformity with the observations of Yang and Pao 1962) and Sheela (1982) According to them the role of K_2O is not significant in influencing leaf production and leaf area But potassium starvation would significantly affect leaf area (Lahav 1972) as evident in this study too This is further substantiated by the observation that plants under absolute control recorded very low values both for rate of leaf production as well as leaf area (Appendix 5a and b 6a and b)

The effect of split application in increasing leaf production reported by Geetha V Nair (1988) Battikah and Khalidy (1962) and Rajeevan (1985) was not evident in this experiment probably because application of fertilizer in six split doses was sufficient to create this favourable response in banana

The influence of nitrogen and potash and their split application as well as their interactions did not significantly influence the duration of the crop in either seasons

The index leaf was analysed for the content of N P K Ca Mg Fe and Zn Application of nitrogen in higher quantities resulted in an increased concentration of the same whereas increased application of potash led to an increase in its own the content at all stages of growth This is in agreement with a similar report by Ray _et al_ (1988) No antagonistic effect between N and K as observed by Osborne and Hewitt (1963) was evident in the present experiment Increased number of split applications increased the content of nitrogen in the first two months and of potash in the initial three months

The content of nitrogen in the index leaf in the initial two months was influenced by the interaction between split applications of fertilizers and levels of nitrogen During the third month the potassium content of index leaf was influenced by the interaction between levels of potassium and split application of fertilizers A synergestic relation ship was observed between phosphorous and potassium Higher levels of potassium resulted in increased level of P_2O_5 in index leaf at all stages of growth

A similar trend was reported earlier by Lahav (1973) Level of N did not influence the P content of leaves Antagonism between K on one hand Ca and Mg on the other has been reported to be evident in many early studies in banana (Childers 1966 Garcia and Gujjaro 1981 Turner and Barkus 1984) A similar trend was observed in the present study also especially in the case of calcium and to a lesser extent in magnesium Increased levels of nitrogen led to lower levels of calcium but magnesium content was not altered The iron and zinc content of index leaves exhibited similar trends in the case of two elements followed by a decrease with increasing applications of nitrogen and potassium

The application of nitrogen and potash at varying levels influenced the quality of fruits The quality of fruits was best expressed in terms of high TSS total sugar reducing and non-reducing sugar low acidity and high sugar/acid ratio when supplied with 200 g nitrogen A decrease in quality was noticed when nitrogen levels higher than 200 g per plant were tried Potassium influenced sugar/acid ratio of fruits K 450 g gave the highest ratio in both seasons The interaction between nitrogen and potash influenced the TSS acidity and sugar/acid ratio The lowest level of nitrogen (N 200) in combination with the moderate level of potash (N 450) resulted in highest sugar/ acid ratio and lowest acidity Geetha V Nair (1988) obtained an increase in TSS upto 300 g/plant and a decrease there after A decrease in quality noticed in the present study at higher levels of nitrogen is in conformity with a similar report by Mustaffa (1983)

An increase in sugar/acid ratio, TSS reducing and non-reducing sugars and total sugars and reduction in acidity was obtained by various scientists by increasing levels of potassium (Venkatarayappa et al 1978 Vadivel and Shanmughavelu 1988 Singh et al 1974 Tandon and Sekhon 1988) In the present investigation increasing the number of split applications especially that of potassium had a favourable effect on quality by significantly reducing the acidity

The pest and disease incidence in the crop was comparatively less in the treatments which recorded the highest yields Some of the other combinations with lower doses of fertilizers like T_2 T_3 also recorded a lower incidence of pests and disease However the results are in agreement with the best NK values obtained

The soil nutrient status before and after harvest of the crop gave a good indication of its nutrient requirements Application of 300g N and 450g K_2O/plant more or less maintained soil fertility besides giving a good yield

SUMMARY

SUMMARY

Tissue cultured plants of banana "Musa (AAB group) Nendran" are now being produced in Kerala in large numbers by private entrepreneurs However for its large scale adoption especially in the rice fallows of southern Kerala their growth pattern flowering and yield potential compared to plants propagated from suckers have to be fully understood Further it is essential to formulate a suitable fertilizer schedule especially the nutrients N and K and their split-application for the tissue cultured plants

Two separate experiments were laid out with the above objectives in view between March 1991 and February 1993 in the rice fallows of the Instructional Farm College of Agriculture Vellayani Thiruvananthapuram The first a critical comparison between tissue cultured plants and plants propagated from suckers by traditional techniques was laid out in the split split plot design Besides the type of planting material the other factors included in the study were age of planting material split application of fertilizers and mode of retention of suckers The second experiment in the confounded factorial design with two controls was conducted for two seasons in 1991 and 1992 and was mainly intended to arrive at a suitable fertilizer schedule for tissue cultured plants The salient results based on the two experiments are briefly summarised below

The initial establishment and the early growth stages of tissue cultured plants were comparable with those of the plants propagated from conventional suckers The tissue cultured plants had a more vigorous growth throughout their life However their growth became faster during the later stages

The maximum increase in the pseudostem height was observed during the fifth and sixth months after planting and just before shooting in both tissue cultured plants and the plants propagated from suckers Tissue cultured plants ultimately recorded an increase of 6 7 per cent in height over the plants produced from suckers

Both nitrogen and potash were able to make a significant increase in height from the fifth month after planting Potash was able to maintain this effect upto the seventh month However the total height of the pseudostem at shooting was not influenced either by the level of nitrogen or potash or their split application The interaction effect between split application and level of potash was evident during the fourth and fifth months after planting

A rapid increase in the girth of the pseudostem was recorded between the third and fourth month after planting in tissue cultured plants while such an increase happened only in the fourth and fifth months in plants propagated from suckers Tissue cultured plants recorded an increase of 11 92 per cent in girth over the plants from suckers

The girth of the pseudostem was influenced by nitrogen and potash at different stages of growth Nitrogen influenced the girth of the pseudostem in the early stages (two and three months after planting) and potash at the later stages (six and seven months after planting) Interaction effect of nitrogen and potash was observed seven months after planting However the final girth of the pseudostem at shooting was not influenced by levels of nitrogen potash or split application of these nutrients

The average monthly leaf production of tissue cultured plants was 4 57 and that of the plants from suckers 3 72 The rate of leaf production was the highest in the late vegetative phase between five and six months after planting N300 resulted in the highest leaf production at monthly intervals NK interaction influenced the rate of leaf production in the early stages (three months after planting)

The tissue cultured plants retained more number of leaves compared to the plants from suckers throughout their growth period The number of leaves retained per plant was not altered by fertilizer treatments The number of leaves retained progressively increased the highest being at shooting stage Increased splits (seven and eight numbers) of fertilizer applications resulted in the retention of more leaves during the initial stages up to four months The tissue cultured plants produced 6 35 leaves more than in plants propagated from suckers during their growth in the field They also had significantly higher leaf area at all stages However the total number of leaves produced was not altered by either nitrogen or potash or by different levels of split application

The influence of the level of nitrogen on leaf area became evident at six months after planting Age of planting material also influenced the total leaf production and leaf area in the initial stages The 3 5 month old plants had larger leaf area in the initial stages

No difference in duration of the crop between tissue cultured plants and plants from suckers could be noticed The 3 5 month old plants flowered 15 61 days earlier and could be be harvested 13 19 days earlier than the 2 5 month old plants The different levels of nitrogen and potash and their split application did not significantly influence the duration of the crop

Tissue cultured plants recorded an increase in yield of 25 63 per cent compared to plants from suckers Nitrogen and potash significantly influenced the yield of plants

The highest yields were obtained with the application of 300g nitrogen and 450g potash per plant in both 1991 and 1992 Yield was also influenced by interaction between N and K Nitrogen and potash beyond the optimum level did not increase yield The yield of the crop was significantly higher in the second season compared to the first indicating a seasonal effect Treatments including the application of the nutrients exceeding six splits did not significantly enhance the yield

The optimum of nitrogen and potash for the two seasons was 299 5g and 465 5g per plant respectively

The highest benefit-cost ratio (2 47 and 3 01) was obtained with tissue cultured plants supplied with 300g nitrogen 450g potash and in six split doses

The attributes responsible for increase in yield were length of bunch number of fingers and length, girth and weight of finger Highest values for all these characters were recorded by the tissue cultured plants The role of potash was found to be more pronounced in increasing the yield attributes compared to that of nitrogen

Tissue cultured plants produced superior quality fruits with a higher TSS total sugars reducing and non reducing sugars high sugar/acid ratio and low acidity Application of 200g nitrogen per plant resulted in the highest TSS total sugars reducing and non reducing sugars, sugar/acid ratio and acidity Potassium at 450g/plant resulted in the highest sugar/acid ratio The interaction between nitrogen and potash also influenced TSS sugar/acid ratio and acidity

Nutrient content in index leaf with respect to N P K Ca Mg Fe and Zn was higher in tissue cultured plants which also recorded a higher yield

The content of nitrogen and potash in index leaf increased with increasing levels of the two nutrients Split application of fertilizers led to an increase in the concentration of N and K in the index leaf in the early stages Interaction between split application of fertilizers and level of nitrogen and potash influenced the nutrient content of leaf during the second and third month

Higher levels of potassium resulted in increased concentration of phosphorus in index leaf at all stages of growth indicating a synergestic relationship between the two elements in banana

Level of nitrogen did not influence the phosphorus content of leaves The well known antagonistic relationship between potassium and calcium and potassium and magnesium was also observed in their content in the index leaf of banana

The incidence of pest and disease was lower in the treatments which ultimately recorded the highest yields Treatments T_1 T_2 T_3 with low fertilizer levels also recorded lower incidence of pest and disease

A slight decline in available nitrogen and potash in soil after harvest of tissue cultured plants could be observed Application of 300g nitrogen and 450g potash per plant was able to maintain soil fertility besides giving the best yields

The three field experiments conclusively proved that tissue cultured plants of Nendran banana gave invariably 25 per cent higher yields than the traditional plants from suckers The N and K trials showed that highest yield could be obtained by application 300 g of N and 450 g of potash in six splits in both seasons The study indicates the highest benefit cost ratio for tissue cultured plants (2 47 in 1991 and 3 31 in 1992) The results can be given as an adhoc recommendation to Nendran cultivation in rice fallow

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APPENDICES

Appendix 1 Weather data that prevailed during the growth and development period of the crop in the field

Meteorological data during March 1991 to Aug 1993

Month	Temp-r (°C) Max-m	Min-m	Rainfall (mm)	Mean RH (%)
March 1991	32 10	23 00	0 00	76 00
April	34 10	24 70	0 00	78 90
May	32 00	24 80	101 00	80 20
June	29 50	24 00	669 30	86 70
July	29 40	23 50	272 00	82 80
Aug	29 40	23 40	154 50	80 90
Sep	30 70	24 10	22 40	77 00
Oct	30 80	23 70	205 80	80 10
Nov	30 20	23 20	247 10	82 60
Dec	30 40	21 90	20 20	75 70
Jan 1992	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
April	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
Jan 1993	30 30	20 56	nil	77 15
Feb	31 20	21 30	2 80	76 46
Mar	32 39	23 10	36 30	75 55
April	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 1993	29 80	23 30	33 20	84 62

Appendix 2 Details of split application of fertilizers

Experiment I

Quantity of fertilizers applied

N - 190 g/plant P - 115 g/plant K - 300 g/plant

I 6 split doses II 7 split doses III 8 split doses

I				II				III			
Time of application	Quantity applied g/plant			Time of application	Quantity applied g/plant			Time of application	Quantity applied g/plant		
	N	P	K		N	P	K		N	P	K
30 DAP	40	65	60	20 DAP	20	65	40	15 DAP	10	25	30
60 DAP	30	50	60	40 DAP	20	50	40	30 DAP	20	30	30
90 DAP	30		60	60 DAP	30		40	45 DAP	20	30	30
120 DAP	30		60	90 DAP	30		60	60 DAP	20	30	30
150 DAP	30		60	120 DAP	30		60	90 DAP	30		60
Just after complete emergence of bunch	30			150 DAP	30		60	120 DAP	30		60
				Just after complete bunch emergence	30			150 DAP	30		60
								Just after complete bunch emergence	30		

Contd

Appendix 2 (Contd)

Experiment II

Levels of N-3 Levels of K-3 split applications-3

A Application of N

I 6 splits				II 8 splits				III 7 splits			
Time of appli-cation	Quantity applied g/plant			Time of appli-cation	Quantity applied g/plant			Time of appli-cation	Quantity applied g/plant		
	200	300	400		200	300	400		200	300	400
30 DAP	40	40	50	15 DAP	15	20	25	20 DAP	20	20	30
60 DAP	40	40	50	30 DAP	20	20	25	40 DAP	30	30	35
90 DAP	30	55	75	45 DAP	20	20	25	60 DAP	30	30	35
120 DAP	30	55	75	60 DAP	25	20	25	90 DAP	30	55	75
150 DAP	30	55	75	90 DAP	30	55	75	120 DAP	30	55	75
Just after complete bunch emergence	30	55	75	120 DAP	30	55	75	150 DAP	30	55	75
				150 DAP	30	55	75	Just after complete bunch emergence	30	55	75
				Just after complete bunch emergence	30	55	75				

Contd

Appendix 2 (Contd)

B Application of P 115 g/plant

I 6 splits		II 8 splits		III 7 splits	
Time of appli-cation	Quantity applied g/plant	Time of appli-cation	Quantity applied g/plant	Time of appli-cation	Quantity applied g/plant
30 DAP	65	15 DAP	25	20	40
60 DAP	50	30 DAP	30	40	35
90 DAP	—	45 DAP	30	60	40
120 DAP	—	60 DAP	30	90	—
150 DAP	—	90 DAP	--	120	—
Just after complete bunch emergence	—	120 DAP	--	150	—
		150 Dap		Just after complete bunch emergence	
		Just after complete bunch emergence			

Contd

Appendix 2 (Contd)

Application of K

Time of application	Quantity applied g/plant			Time of application	Quantity applied g/plant			Time of application	Quantity applied g/plant		
	300	450	600		300	450	600		300	450	600
30 DAP	60	60	60	15 DAP	30	50	60	20 DAP	40	60	60
60 DAP	60	90	120	30 DAP	30	50	80	40 DAP	40	60	80
90 DAP	60	120	140	45 DAP	30	70	100	60 DAP	40	80	120
120 DAP	60	90	140	60 DAP	30	70	90	90 DAP	60	80	120
150 DAP	60	90	140	90 DAP	60	70	90	120 DAP	60	80	110
Just after complete bunch emergence	—	—	—	120 DAP	60	70	90	150 DAP	60	90	110
				150 DAP	60	70	90	Just after complete bunch emergence	—	-	—
				Just after complete bunch emergence							

Contd

Appendix 2 (Contd)

D Fertilizer application according to package of practices recommendation

Time of application	Quantity g/plant		
	N 190	P 115	K 300
30 DAP	40	65	60
60 DAP	30	50	60
90 DAP	30	--	60
120 DAp	30	--	60
150 DAP	30	--	60
Just after complete bunch emergence	30	--	--

Appendix 3 Interaction effect of the factors (3 factors interaction) on height of pseudostem

Treatment	Height of pseudostem cm														
	Weeks after planting										Month after planting				
	3	4	5	6	7	8	9	10	11	12	4	5	6	7	Shooting
a1c1d1	20 76	27 63	33 83	41 08	49 11	64 08	86 63	101 88	108 62	119 58	138 38	187 82	208 63	239 83	285 83
a1c1d2	22 08	27 95	32 45	37 23	65 31	57 73	81 67	96 38	104 03	114 45	134 77	182 67	206 52	228 83	272 34
a1c2d1	21 16	27 26	32 65	43 70	51 95	66 45	86 76	102 72	109 80	123 06	142 15	192 37	213 41	250 33	297 67
a1c2d2	19 76	27 03	34 80	41 41	49 30	60 40	82 38	101 12	104 88	113 13	136 53	187 12	208 61	238 17	278 83
a1c3d1	21 60	29 98	40 03	49 68	56 92	67 40	88 20	102 80	110 02	120 27	143 57	194 19	215 60	250 67	300 17
a1c3d2	21 13	28 98	38 50	46 66	54 86	63 88	86 78	101 58	105 82	115 18	135 87	186 93	209 63	235 83	281 50
a1c1d1	22 90	32 15	36 53	43 26	51 70	65 63	87 88	102 95	109 77	119 10	138 82	192 13	214 46	241 83	293 33
a1c1d2	23 28	32 36	35 80	41 06	49 88	60 85	83 12	98 90	104 38	116 65	135 48	186 63	208 56	233 50	275 00
a1c2d1	24 20	32 86	40 28	47 45	52 85	68 55	88 17	106 17	110 67	132 55	140 18	196 06	216 23	242 00	291 33
a1c2d2	23 28	32 10	36 86	42 60	51 03	62 12	84 45	99 18	104 92	114 85	134 80	190 68	212 41	232 33	284 33
a1c3d1	23 76	32 80	41 30	49 35	56 66	68 98	86 48	103 52	110 18	121 77	140 98	196 87	217 83	241 50	305 00
a1c3d2	23 23	32 60	39 35	46 26	54 33	65 32	87 03	101 48	104 47	114 18	136 42	190 18	212 51	232 83	278 50
f2 16	1 43	0 15	2 90	2 88	0 93	4 12	0 20	2 27	< 1	0 39	3 21	3 21	0 51	0 21	0 65
se	0 67	0 871	0 481	0 625	0 583	0 68	1 16	1 15	0 58	4 15	0 46	0 78	0 61	2 24	6 53
cd															

Appendix 4 Treatment means Height of pseudostem cm

Height of pseudostem cm

Treatment	3	4	5	6	7	8	9	10	11	12	4	5	6	Shooting
	Week after planting										Month after planting			
a1b1c1d1	20 66	27 36	33 43	40 67	47 60	64 90	86 97	101 17	107 93	118 67	138 50	187 37	239 33	280 67
a1b1c1d2	22 10	27 86	32 06	36 80	44 70	57 06	83 43	97 90	103 20	113 77	135 10	181 67	226 67	268 67
a1b1c2d1	20 83	27 33	35 76	43 83	51 36	66 66	85 53	103 97	109 60	122 60	141 87	192 43	248 00	294 67
a1b1c2d2	19 66	27 70	36 06	40 30	50 06	60 17	81 60	103 57	104 93	113 17	136 27	187 27	233 33	276 00
a1b1c3d1	22 33	30 46	40 60	50 50	56 70	68 03	87 90	103 03	111 03	120 93	143 27	194 47	249 33	298 33
a1b1c3d2	20 86	26 36	37 83	46 00	54 03	63 43	86 90	101 17	106 83	115 70	135 83	187 6	233 67	281 00
a1b2c1d1	20 86	27 90	34 33	41 50	50 63	63 27	86 29	102 60	109 30	120 50	138 27	188 27	240 33	291 00
a1b2c1d2	22 06	28 03	32 83	37 67	45 93	58 40	79 90	94 877	104 87	155 13	134 43	183 67	231 00	276 00
b1b2c2d1	21 50	27 20	35 33	43 56	52 53	66 23	88 00	101 47	110 00	123 53	142 43	192 30	252 67	300 67
a1b2c2d2	19 86	26 36	33 53	42 53	48 53	60 63	83 17	98 677	104 83	113 10	136 80	186 97	243 00	281 67
a1b2c3d1	20 86	29 50	39 46	48 86	57 15	66 77	88 50	102 57	109 80	119 60	143 87	195 33	252 00	302 00
a1b2c3d2	21 40	31 60	39 16	47 33	55 63	64 33	86 67	100 00	104 80	114 67	135 90	186 23	238 00	282 00
a2b1c1d1	22 50	32 36	35 90	42 46	51 20	66 17	88 17	103 13	109 83	119 67	138 43	191 83	240 00	283 00
a2b1c1d2	22 86	32 03	35 86	40 76	49 50	60 43	83 03	98 67	104 87	117 43	135 37	186 30	231 33	279 33
a2b1c2d1	24 82	32 83	40 30	47 53	54 00	68 37	90 47	106 53	110 67	120 93	139 93	195 53	242 67	305 67
a1b1c2d2	23 36	31 76	36 30	42 10	50 66	62 13	85 30	98 80	104 83	114 60	134 77	190 37	233 67	280 33
a2b1c3d1	23 16	33 00	41 60	49 83	56 70	69 17	86 20	103 43	109 93	121 70	140 87	197 03	242 67	303 00
a2b1c3d2	22 80	32 63	39 43	46 20	54 23	64 90	87 10	101 33	104 37	114 37	136 27	189 33	233 33	283 67
a2b2c1d1	23 23	32 00	37 16	44 06	52 20	65 10	87 60	102 71	109 70	118 53	139 20	192 43	243 67	303 67
a2b2c1d2	24 50	32 70	35 73	41 36	52 26	61 27	83 20	99 137	103 90	115 87	135 60	186 97	235 67	274 67
a2b2c2d1	23 56	32 90	40 26	47 36	51 70	68 73	86 93	103 80	110 86	144 17	141 43	196 00	241 33	277 00
a2b2c2d2	23 20	32 43	37 43	43 10	51 40	62 10	83 60	99 57	105 00	115 10	134 83	191 00	231 00	288 33
a2b2c3d1	24 36	32 60	41 00	48 86	56 63	68 80	86 77	103 60	110 43	121 83	140 10	196 70	240 33	207 00
a2b2c3d2	23 66	32 56	39 26	46 33	54 43	65 73	86 97	101 63	104 57	114 00	136 57	191 03	232 33	270 33
f2 16	0 645	1 53	2 44	3 33	2 04	< 1	0 162	0 062	0 198	0 549	> 1	0 773	0 111	1 334
se	0 948	1 231	0 680	0 884	0 824	0 958					0 663	1 113	3 160	9 245
cd														

Appendix 5 Interaction effect of he factors on girth of pseudostem

Girth of pseudostem (cm)

Interaction effect	3	4	5	6	7	8	9	10	11	12	4	5	6	7	8
	Weeks after planting										Months after planting				
1c1d1	6 02	8 85	10 65	12 37	14 70	17 78	20 33	23 85	26 41	29 52	40 18	50 98	56 23	60 42	63 42
a1c1d2	7 93	9 13	10 98	12 26	13 38	15 12	18 01	21 27	24 10	28 10	37 70	47 28	50 15	55 53	59 87
a1c2d1	5 85	8 96	11 05	12 83	14 88	18 17	20 40	24 12	27 17	29 83	41 45	52 10	56 86	62 03	66 18
a1c2d2	8 06	9 51	11 02	12 23	13 66	15 50	18 13	21 35	24 16	28 10	36 17	47 18	50 03	55 28	60 25
a1c3d1	6 43	8 92	10 96	12 93	14 96	17 97	20 22	24 60	26 56	29 06	42 52	53 05	58 61	61 68	66 12
a1c3d2	8 25	9 70	11 20	12 20	13 75	15 53	18 11	21 23	24 20	30 56	35 85	46 36	50 55	53 60	59 48
a2c1d1	6 37	8 67	10 83	12 86	15 08	18 00	20 11	24 20	26 50	29 80	41 12	51 35	56 83	62 75	68 18
a2c1d2	7 27	9 40	10 96	12 18	13 60	15 40	18 00	21 13	23 60	28 11	34 88	45 33	50 33	53 01	58 35
a2c2d1	6 45	9 22	11 25	13 18	15 22	18 62	20 62	24 26	27 30	29 42	40 20	52 60	55 33	63 97	68 85
a2c2d2	7 63	9 57	11 28	12 35	14 52	15 72	18 67	20 96	24 28	28 43	36 52	46 70	50 16	55 61	60 20
a2c3d1	7 52	9 16	11 25	13 02	15 22	18 52	20 73	24 43	27 43	29 63	40 65	51 78	54 32	62 85	67 97
a2c3d2	8 40	9 75	11 38	12 27	14 25	16 26	18 43	22 06	24 86	28 07	35 40	46 85	49 86	53 83	59 92
f	0 031	3 639	0 509	1 770	1 582	0 626	0 509	2 978	0 353	1 862	5 814	2 526	2 261	2 252	2 221
cd		0 295									0 831				

Appendix 6 Treatment means Girth of pseudostem (cm)

Girth of pseudostem (cm)

Treatment	3	4	5	6	7	8	9	10	11	12	4	5	6	7	Shooting
	Weeks after planting										Months after planting				
a1b1c1d1	6 00	8 90	10 47	12 33	14 50	17 67	20 03	23 77	27 03	30 63	40 42	52 10	56 21	59 83	64 53
a1b1c1d2	7 93	8 97	10 73	12 50	13 27	15 23	18 03	21 70	24 43	29 57	39 10	48 17	52 23	56 60	60 03
a1b1c2d1	5 87	9 17	11 1	12 46	14 76	18 10	20 600	24 03	27 56	30 13	41 36	52 50	55 81	61 67	65 70
a1b1c2d2	8 03	9 50	11 03	12 33	13 67	15 56	18 23	21 70	24 76	28 73	37 50	47 27	52 13	56 33	60 80
a1b1c3d1	6 03	8 97	11 10	12 86	14 90	18 00	20 33	24 27	27 03	29 60	40 37	53 57	56 95	60 93	65 00
a1b1c3d2	8 40	9 67	11 10	12 86	13 83	15 43	18 30	21 53	24 47	32 37	36 00	46 13	50 25	54 43	59 30
a1b2c1d1	6 03	8 80	10 83	12 40	14 90	17 90	20 63	23 93	25 80	28 40	39 43	49 87	54 25	61 00	62 30
a1b2c1d2	8 40	9 30	11 23	12 03	13 50	15 00	18 00	20 83	23 77	26 63	36 30	46 40	50 18	54 47	59 70
a1b2c2d1	6 03	8 77	11 00	13 20	15 00	18 23	20 20	24 20	26 77	29 53	41 53	51 70	56 55	62 40	66 66
a1b2c2d2	7 93	9 53	11 00	12 23	13 67	15 43	18 03	21 00	23 56	27 47	34 83	47 10	51 23	54 23	59 70
a1b2c3d1	5 83	8 87	10 83	13 00	15 03	17 93	20 10	24 90	26 10	28 53	44 67	52 53	58 26	62 43	67 23
a1b2c3d2	8 10	9 73	10 90	12 16	13 67	15 63	17 93	20 93	23 93	28 77	35 70	46 60	48 26	52 77	59 17
a2b1c1d1	6 83	8 57	10 67	12 90	15 23	17 96	20 03	24 96	26 00	30 93	40 73	50 10	54 32	62 53	67 20
a2b1c1d2	8 10	9 60	11 06	12 13	13 60	15 40	18 00	21 16	23 73	29 55	33 50	46 17	48 23	52 60	58 36
a2b1c2d1	5 83	9 13	11 23	13 13	15 10	18 40	20 40	24 16	27 10	28 10	40 63	52 50	56 15	63 27	68 30
a2b1c2d2	7 00	9 56	11 20	12 33	13 90	15 80	18 10	21 60	24 30	27 80	37 63	46 93	50 26	54 17	59 46
a2b1c3d1	6 56	9 16	11 16	13 10	15 23	18 63	20 63	24 23	27 23	28 10	41 73	51 80	57 26	62 50	68 00
a2b1c3d2	7 23	9 80	11 43	12 50	14 23	16 27	18 43	22 10	25 26	27 93	36 53	46 84	50 08	54 00	59 67
a2b2c1d1	7 46	8 70	11 00	12 83	14 93	18 03	20 20	23 43	27 00	28 66	41 50	52 60	56 35	62 97	69 16
a2b2c1d2	8 23	9 20	10 87	12 23	13 60	15 40	18 00	21 10	23 46	26 66	36 26	44 50	50 06	53 42	58 33
a2b2c2d1	6 90	9 30	11 27	13 16	15 33	18 83	20 83	24 37	27 50	30 73	39 77	52 70	56 63	64 68	69 40
a2b2c2d2	7 50	9 60	11 37	12 46	15 13	15 63	18 03	20 33	24 26	29 06	35 67	46 47	50 13	57 07	60 93
a2b2c3d1	6 30	9 20	11 33	13 03	15 20	18 40	20 83	24 63	27 63	31 17	39 57	51 77	56 27	63 20	67 93
a2b2c3d2	8 00	9 70	11 33	12 37	14 27	16 27	18 43	22 03	24 47	28 20	34 27	46 87	48 15	53 67	60 17
se	0 191	0 139	0 182	0 164	0 194	0 189	0 258	0 356	0 333	1 023	0 891	0 925	1 160	0 990	1 193

Appendix 7 Interaction effect of the factors on number of leaves producted at monthly intrevels

Interaction effect	No of leaves produced / Month after planting							
	1	2	3	4	5	6	7	8
a1c1d1	3 055	3 28	3 89	5 22	5 11	5 33	5 05	3 50
a1c1d2	3 000	3 06	3 06	3 33	4 11	3 77	3 54	3 05
a1c2d1	3 490	3 44	4 33	5 33	5 39	5 55	5 22	3 72
a1c2d2	3 000	3 00	3 17	4 33	4 39	4 11	3 66	3 89
a1c3d1	3 490	3 28	4 28	5 28	5 28	5 78	5 66	4 05
a2c3d2	3 055	3 06	3 22	4 28	4 50	4 27	3 99	3 50
a2c1d1	3 165	3 11	3 94	5 22	5 43	5 50	5 33	3 33
a2c1d2	3 000	3 06	3 06	3 72	4 50	4 06	3 55	3 11
a2c2d2	3 550	3 55	4 39	5 33	5 72	5 72	6 10	3 78
a2c2d2	3 000	3 06	3 17	4 27	4 67	4 17	4 16	3 39
a2c3d1	3 550	3 06	4 28	5 44	5 72	5 89	5 83	4 00
a2c3d2	3 000	3 11	3 11	4 66	4 94	4 11	4 21	3 39
f 2 6	0 017	0 503	0 303	0 779	0 086	0 942	0 925	3 230
cd	-	-	-		-		-	-

Appendix 8 Treatment means - Number of leaves produced at monthly intervals

Treat- ments	No of leaves produced Month after planting							
	1	2	3	4	5	6	7	8
a1b1c1d1	3 00	3 33	5 11	3 99	5 11	5 11	4 88	3 33
a1b1c1d2	3 00	3 00	3 33	3 11	4 11	3 77	3 43	3 00
a1b1c2d1	3 66	3 35	5 33	4 33	5 33	5 22	5 22	3 55
a1b1c2d2	3 00	3 00	4 33	3 00	4 44	4 11	3 44	3 99
a1b1c3d1	3 33	3 33	5 44	4 22	5 22	5 55	5 55	4 00
a1b1c3d2	3 11	3 00	4 22	3 11	4 55	4 33	4 22	3 33
a1b2c1d1	3 11	3 22	5 33	3 77	5 11	5 55	5 22	3 66
a1b2c1d2	3 00	3 11	3 33	3 00	4 11	3 77	3 66	3 11
a1b2c2d1	3 33	3 33	5 33	4 33	5 44	5 870	5 22	3 89
a1b2c2d2	3 00	3 00	4 33	3 33	4 33	4 11	3 88	3 77
a1b2c3d1	3 66	3 22	5 33	4 22	5 33	5 99	5 77	4 11
a1b2c3d2	3 00	3 11	4 33	3 11	4 44	4 22	3 77	3 66
a2b1c1d1	3 33	3 22	5 33	4 11	5 44	5 440	4 99	3 22
a2b1c1d2	3 00	3 11	3 66	3 11	4 11	4 00	3 44	3 00
a2b1c2d1	3 55	3 55	5 33	4 44	5 66	5 66	5 99	3 67
a2b1c2d2	3 00	3 00	4 33	3 33	4 78	4 22	3 99	3 11
a2b1c3d1	3 55	3 78	5 55	4 33	5 55	5 77	5 77	3 89
a2b1c3d2	3 00	3 11	4 33	3 33	5 10	4 11	4 21	3 11
a2b2c1d1	3 00	3 00	5 11	4 11	5 42	5 55	5 66	3 44
a2b2c1d2	3 00	3 00	3 77	3 11	4 89	4 11	3 66	3 22
a2b2c2d1	3 55	3 55	5 33	4 44	5 77	5 77	6 22	3 89
a2b2c2d2	3 00	3 11	4 22	3 00	4 55	4 11	4 33	3 67
a2b2c3d1	3 55	3 44	5 33	4 33	5 61	5 99	5 88	4 11
a2b2c3d2	3 00	3 10	4 99	3 11	4 61	4 11	4 22	3 67
f2 22	0 769	0 037	0 578	0 856	2 278	0 027	1 232	0 924
se	0 179	0 225	0 194	0 110	0 150	0 144	0 167	0 155

Appendix 9 Interaction effect of the factors on number of leaves retained at monthly intervals

Interaction effect	No of leaves produced Month after planting 1	2	3	4	5	6	7	8
a1c1d1	5 55	7 39	7 88	7 67	9 61	11 38	12 50	12 78
a1c1d2	5 11	5 39	5 88	5 95	8 22	9 33	9 72	9 00
a1c2d1	6 78	8 28	8 95	9 00	10 72	12 11	12 88	13 33
a1c2d2	5 22	5 67	6 33	6 17	8 39	10 00	10 83	10 28
a1c3d1	7 05	8 61	9 11	9 11	11 00	12 11	15 99	13 61
a1c3d2	5 52	5 78	6 89	6 94	8 00	9 66	11 89	10 72
a2c1d1	5 89	7 56	7 89	8 17	10 00	12 05	12 38	12 78
a2c1d2	5 16	5 61	6 00	6 56	8 22	9 11	11 17	10 67
a2c2d1	6 83	8 61	9 05	9 00	11 22	12 22	12 55	13 67
a2c2d2	5 61	5 55	6 05	6 85	8 39	9 49	12 117	11 67
a2c3d1	7 05	8 72	8 95	9 00	11 06	12 33	12 73	13 72
a2c3d2	5 72	8 78	6 28	6 67	8 23	9 22	12 39	11 83
f	1 646	99 572	2 955	2 722	2 722	0 166	0 162	1 510
cd	—	0 270	—	—	—	—	—	—

Appendix 10 Treatment means - Number of leaves retained at monthly intervals

Treat-ments	1	2	3	4	5	6	7	8
	No of leaves produced							
	Month after planting							
a1b1c1d1	5 55	7 33	7 67	7 67	9 44	11 33	12 78	12 78
a1b1c1d2	5 11	5 33	6 11	5 89	8 11	9 22	9 33	9 00
a1b1c2d1	6 78	8 33	8 89	9 11	10 67	12 00	13 67	13 00
a1b1c2d2	5 22	5 66	6 33	6 11	8 33	9 89	10 89	10 89
a1b1c3d1	6 99	8 55	9 11	9 11	11 11	11 89	12 00	13 56
a1b1c3d2	5 50	5 78	6 89	6 98	8 00	9 33	11 89	10 33
a1b2c1d1	5 55	7 45	8 11	7 67	9 78	11 44	12 22	12 78
a1b2c1d2	5 11	5 44	5 66	6 00	8 33	9 44	10 11	9 00
a1b2c2d1	6 78	8 22	9 00	8 89	10 78	12 22	12 11	13 33
a1b2c2d2	5 22	5 66	6 33	6 22	8 45	10 11	10 78	9 67
a1b2c3d1	7 11	8 66	9 11	9 11	10 89	12 33	11 98	13 67
a1b2c3d2	5 55	5 77	6 89	6 89	8 00	10 00	11 89	11 11
a2b1c1d1	5 89	7 67	7 89	8 11	10 00	11 77	12 11	12 56
a2b1c1d2	5 11	5 78	6 11	6 78	8 11	9 00	11 22	10 44
a2b1c2d1	6 77	8 66	9 11	9 00	11 11	12 11	12 44	13 33
a2b1c2d2	5 67	5 66	6 11	6 80	8 44	9 55	12 22	11 56
a2b1c3d1	7 00	8 67	9 00	9 00	11 00	12 33	13 00	13 67
a2b1c3d2	5 67	8 78	6 33	6 67	8 34	9 22	12 22	11 67
a2b2c1d1	5 89	7 44	7 89	8 22	10 00	12 33	12 67	13 00
a2b2c1d2	5 21	5 44	5 89	6 33	8 33	9 22	11 11	10 89
a2b2c2d1	6 89	8 55	9 00	9 00	11 33	12 33	12 67	14 00
a2b2c2d2	5 55	5 44	6 00	6 90	8 33	9 44	12 11	11 78
a2b2c3d1	7 11	8 78	8 89	9 00	11 11	12 33	12 46	13 78
a2b2c3d2	5 78	8 78	6 22	6 67	8 11	9 22	12 55	12 00
f 2 16	0 121	0 116	1 00	0 559	0 957	0 031	0 241	1 067

Appendix 11 Interaction effect of factors on total no leaves produced

Interaction effect	No of leaves producted Month after planting 1	2	3	4	5	6	7	8
a1c1d1	6 83	10 10	14 10	19 32	24 44	29 67	34 77	38 27
a1c1d2	3 00	6 11	9 05	10 38	16 49	20 49	24 04	27 10
a1c2d1	7 49	10 77	15 10	20 44	25 82	31 33	36 49	40 60
a1c2d2	3 00	6 00	9 16	13 49	17 88	21 99	25 74	29 88
a1c3d1	7 33	10 55	14 77	20 21	25 49	31 16	36 93	40 99
a2c3d2	3 05	6 05	9 17	13 33	17 83	22 10	26 10	29 94
a2c1d1	7 33	10 44	14 55	19 17	25 49	31 05	36 16	39 44
a2c1d2	3 00	6 05	9 16	12 88	17 38	21 44	24 99	28 39
a2c2d2	7 71	11 27	15 71	21 21	26 94	32 66	38 21	31 77
a2c2d2	3 00	6 05	9 22	13 49	18 16	22 33	26 38	30 16
a2c3d1	7 71	11 16	15 21	20 66	26 38	32 27	38 11	40 88
a2c3d2	3 00	6 11	9 72	14 16	19 17	23 21	27 21	29 93
f 2 6	0 50	0 05	0 65	1 48	1 13	0 63	0 52	0 10
se	0 09	0 18	0 22	0 24	0 28	0 31	0 34	0 87
cd	-	-		-	-	-	-	-

Appendix 12 Treatment means - total number of leaves produced

Treat- ments	Total no of leaves produced Month after planting 1	2	3	4	5	6	7	8
a1b1c1d1	6 55	9 88	13 88	18 99	24 17	29 21	34 10	37 44
a1b1c1d2	3 00	6 00	9 10	12 44	16 55	20 77	24 21	27 21
a1b1c2d1	7 44	10 99	15 33	20 66	25 99	31 21	36 32	39 88
a1b1c2d2	3 00	6 00	9 00	13 33	17 77	21 88	25 32	29 55
a1b1c3d1	7 33	10 66	14 88	20 43	25 66	31 00	36 77	40 77
a1b1c3d2	3 11	6 00	9 10	13 33	17 85	22 22	26 44	30 43
a1b2c1d1	7 11	10 33	14 32	19 66	24 77	30 13	35 44	39 10
a1b2c1d2	3 00	6 22	9 00	12 33	16 44	20 22	23 88	26 99
a1b2c2d1	7 55	10 55	14 88	20 22	25 66	31 44	36 66	41 33
a1b2c2d2	3 00	6 00	9 33	13 66	18 00	22 11	26 10	30 21
a1b2c3d1	7 33	10 44	14 66	19 99	25 33	31 33	37 10	41 21
a1b2c3d2	3 00	6 11	9 10	13 33	17 77	21 99	25 77	29 44
a2b1c1d1	7 55	10 77	14 88	20 21	26 22	31 77	36 55	39 77
a2b1c1d2	3 00	6 11	9 22	12 88	16 99	20 99	24 44	28 00
a2b1c2d1	7 66	11 21	15 66	20 99	26 66	32 33	38 22	41 44
a2b1c2d2	3 00	6 00	9 33	13 66	18 44	22 66	26 66	30 55
a2b1c3d1	7 77	11 55	15 32	20 88	26 44	32 22	38 00	41 11
a2b1c3d2	3 00	6 11	10 22	14 33	19 44	23 55	27 33	24 44
a2b2c1d1	7 11	10 11	14 22	19 33	24 77	30 32	25 77	39 22
a2b2c1d2	3 00	6 00	9 10	12 88	17 77	21 88	25 55	28 77
a2b2c2d1	7 77	11 32	15 77	21 44	27 21	32 99	38 10	42 10
a2b2c2d2	3 00	6 11	9 10	13 33	17 88	21 99	26 11	29 77
a2b2c3d1	7 66	10 77	15 10	20 43	26 32	32 33	38 22	40 66
a2b2c3d2	3 00	6 11	9 22	13 99	18 77	22 88	27 10	32 43
f2 16	1 85	0 75	1 86	2 72	4 64	4 66	2 66	1 14
cd	-	-	-		1 21	1 32	-	

Appendix 13 Interaction effect of the factors on leaf area

Inter-action effect	Leaf area m²								
	1	2	3	4	5	6	7	Shooting	Harvest
	Month after planting								
a1c1d1	0 118	0 268	0 762	1 748	3 466	6 226	8 549	13 231	5 197
a1c1d2	0 815	0 214	0 675	1 409	2 909	5 161	7 805	8 961	3 139
a1c1d1	0 0997	0 281	0 806	1 796	3 713	6 703	9 570	13 332	5 194
a1c1d2	0 0832	0 216	0 693	1 439	3 356	5 349	7 938	9 448	3 152
a1c2d1	0 119	0 285	0 814	1 790	3 720	6 759	9 513	13 585	5 333
a1c2d2	0 0841	0 223	0 698	1 422	3 288	5 284	7 688	10 048	3 115
a1c3d1	0 124	0 285	0 815	1 857	3 765	6 235	9 240	13 380	5 359
a1c3d2	0 0904	0 225	0 725	1 582	3 104	5 225	7 240	9 926	3 358
a2c1d1	0 126	0 295	0 902	1 881	3 866	6 689	9 503	13 703	5 294
a2c1d2	0 0913	0 223	0 732	1 603	3 157	5 265	7 378	10 015	3 388
a2c2d1	0 124	0 300	0 906	1 887	3 839	6 728	9 556	13 722	5 022
a2c2d2	0 0906	0 223	0753	1 604	3 217	5 257	7 327	10 369	3 365
a2c3d1	0 697	0 429	2 195	0 072	0 526	0 224	3 019	1 367	1 214
a2c3d2	0 006	0 404	0 009	0 019	0 086	0 065	0 135	0 513	0 124
f 2 6	<1	1 33	1 26	1 03	<1	<1	1 15	1 18	1 11

Appendix 14 Treatment means - Leaf area

Inter-action effect	Leaf area m² 1	2	3	4	5	6	7	Shooting	Harvest
	Month after planting								
a1b1c1d1	0 115	0 269	0 756	1 740	3 466	6 225	8 746	13 281	5 111
a1b1c1d2	0 0809	0 213	0 671	1 404	2 930	5 148	7 707	8 962	3 013
a1b1c2d1	0 0818	0 279	0 806	1 792	3 708	6 713	9 592	13 388	5 086
a1b1c2d2	0 0834	0 218	0 690	1 440	3 378	5 263	7 942	9 4461	3 015
a1b1c3d1	0 120	0 286	0 813	1 790	3 711	6 769	9 499	13 429	5 195
a1b1c3d2	0 0838	0 222	0 702	1 425	2 948	5 200	7 557	9 6251	3 030
a1b2c1d1	0 109	0 268	0 767	1 757	3 465	6 227	8 351	13 179	5 282
a1b2c1d2	0 802	0 215	0 679	1 414	2 889	5 175	7 903	8 959	3 266
a1b2c2d1	0 118	0 283	0 806	1 800	3 719	6 692	9 549	13 25	5 302
a1b2c2d2	0 0827	0 215	0 696	1 439	3 335	5 436	7 933	9 448	3 289
a1b2c3d1	0 117	0 284	0 815	1 790	3 729	6 742	9 528	13 774	5 473
a1b2c3d2	0 0845	0 223	0 693	1 419	3 629	5 369	7 820	10 471	3 200
a2b1c1d1	0 125	0 284	0 815	1 857	3 734	6 245	9 172	13 235	5 200
a2b1c1d2	0 0891	0 225	0 724	1 579	3 097	5 241	7 243	9 671	3 225
a2b1c2d1	0 125	0 296	0 902	1 883	3 830	6 683	9 481	13 378	5 147
a2b1c2d2	0 0919	0 225	0 730	1 601	3 152	5 269	7 518	9 408	3 295
a2b1c3d1	0 124	0 304	0 911	1 888	3 843	6 760	9 439	13 703	4 809
a2b1c3d2	0 089	0 225	0 746	1 603	3 239	5 270	7 284	10 176	3 345
a2b2c1d1	0 122	0 287	0 815	1 857	3 796	6 225	9 307	13 436	5 518
a2b2c1d2	0 0916	0 224	0 725	1 585	3 111	5 210	7 236	10 179	3 491
a2b2c2d1	0 128	0 293	0 901	1 878	3 902	6 696	9 522	13 027	5 400
a2b2c2d2	0 0907	0 223	0 736	1 604	3 163	5 262	7 239	10 622	3 480
a2b2c3d1	0 125	0 296	0 902	1 887	3 836	6 696	9 673	13 741	5 234
a2b2c3d2	0 921	0 222	0 759	1 605	3 196	5 244	7 371	10 562	0 027
f 2 16	0 164	0 368	0 228	< 1	1 333	0 136	0 147	0 298	0 154

Appendix 15a Treatment means - Duration of the crop

Treatment	Days taken for the shooting	Days taken for harvest
a1b1c1d1	246 39	339 00
a1b1c1d2	251 00	344 33
a1b1c2d1	244 00	344 33
a1b1c2d2	250 33	340 33
a1b1c3d1	252 33	345 33
a1b1c3d2	250 33	343 33
a1b2c1d1	234 00	329 66
a1b2c1d2	233 00	330 00
a1b2c2d1	233 00	328 00
a1b2c2d2	233 33	329 33
a1b2c3d1	233 00	330 00
a1b2c3d2	236 00	333 33
a2b1c1d1	227 00	324 66
a2b1c1d2	234 61	331 66
a2b1c2d1	228 33	323 66
a1b1c2d2	233 33	329 00
a2b1c3d1	238 33	331 66
a2b1c3d2	231 33	326 00
a2b2c1d1	216 33	313 00
a2b2c1d2	218 00	311 66
a2b2c2d1	222 33	316 33
a2b2c2d2	217 00	311 33
a2b2c3d1	220 67	315 66
a2b2c3d2	221 67	316 66
f2 16	0 083	0 656

Appendix 15 b Days taken to complete flowering

Mean number of days taken to complete flowering under different treatments (Ex I)		Effect of age split application of fertilisers and type of planting material on mean number of days taken to complete flowering (Ex I)	
T1	8	a1	12 97
T2	18	a2	13 44
T3	9	f1 2	0 39
T4	17 6	CD	-
T5	8 33	C1	12 67
T6	16	C2	12 79
T7	18	C3	14 16
T8	19 33	F2 4	0 68
T9	7 67	CD	-
T10	16 33	d1	8 67
T11	8 67	d2	17 75
T12	18 67	F1 16	135 78
T13	7	CD	1 653
T14	18 67		
T15	10		
T16	15 67		
T17	10 33		
T18	18 67		
T19	6 33		
T20	16		
T21	8		
T22	18		
T23	12 67		
T24	20		

Appendix 16 Interaction effect of the factors on bunch characters

Inter-action effect	Weight of bunch kg	Weight of bunch cm	No of hands	No of fingers	Length of fingure cm	Girth of fingure cm	Weight of finger cm
a1b1c1	10 29	33 83	4 88	42 00	27 17	15 14	241 83
a1b1c2	10 38	34 33	4 78	41 67	27 55	15 58	249 33
a1b1c3	10 25	33 66	4 89	40 50	28 17	15 97	249 33
a1b2c1	10 38	35 16	4 61	41 67	27 83	15 72	248 50
a1b2c2	10 83	35 33	4 78	42 33	29 76	16 97	256 67
a1b2c3	11 00	34 67	4 56	42 33	29 17	16 77	254 83
a2b1c1	10 33	34 83	4 56	42 83	28 38	15 89	244 00
a2b1c2	10 54	34 50	5 00	43 00	28 67	15 88	242 17
a2b1c3	11 21	34 83	4 78	43 50	27 43	16 22	235 33
a2b2c1	11 21	34 50	5 06	43 50	28 50	15 88	248 50
a2b2c2	11 58	37 00	4 83	44 67	28 33	15 55	252 67
a2b2c3	11 42	36 17	4 78	43 33	27 67	15 47	245 50
f 2 4	1 150	1 372	1 412	1 434	1 417	0 458	0 098
a1b1d1	11 61	36 67	5 04	45 44	29 70	16 78	269 88
a1b1d2	9 00	31 88	4 66	37 33	25 55	14 35	223 77
a1b2d1	12 00	37 00	4 97	44 44	30 65	17 22	273 22
a1b2d2	9 47	33 11	4 33	39 44	27 19	15 76	233 45
a2b1d1	11 88	36 77	4 96	46 11	29 55	16 77	259 11
a2b1d2	9 50	32 66	4 59	40 11	26 78	15 22	221 88
a2b2d1	12 55	38 66	5 11	47 11	30 33	16 87	270 56
a2b2d2	10 55	33 11	4 67	40 55	26 00	14 41	227 22
f 1 16	< 1	8 413	0 321	5 626	4 606	8 541	2 197

Contd

Appendix 16 (contd) Interaction effects of the factors on bunch characters

Interaction effect	Weight of bunch kg	Weight of bunch cm	No of hands	No of fingers	Length of fingure cm	Girth of fingure cm	Weight of finger cm
a1c1d1	11 58	36 33	5 00	44 67	29 33	16 72	267 67
a1c1d2	9 08	32 66	4 50	38 50	25 67	14 14	222 67
a1c2d1	12 00	37 33	4 95	45 50	30 53	17 17	274 17
a1c2d2	9 20	32 33	4 61	38 50	26 78	15 39	231 83
a1c3d1	11 83	36 83	5 06	44 67	30 67	17 11	272 83
a1c3d2	9 42	32 50	4 39	38 17	26 67	15 64	231 33
a2c1d1	12 00	37 00	5 00	46 50	29 88	17 11	267 17
a2c1d2	9 54	32 33	4 61	39 83	27 00	14 67	225 33
a2c2d1	12 33	38 50	5 06	47 00	30 50	16 78	266 33
a2c2d2	9 79	33 00	4 78	40 67	26 50	14 67	228 50
a2c3d1	12 33	37 67	5 06	46 33	29 43	16 58	261 00
a2c3d2	10 29	33 33	4 50	40 50	25 67	15 11	219 83
f 2 4	0 158	0 514	0 012	0 256	0 324	0 192	0 091
b1c1d1	11 45	36 33	4 95	46 00	29 38	16 62	263 17
b1c1d2	9 17	32 33	4 50	38 83	26 17	14 42	222 67
b1c2d1	11 88	36 67	5 00	46 17	30 06	17 00	266 00
b1c2d2	9 04	32 17	4 78	38 50	26 17	14 47	225 50
b2[illegible]	11 92	37 47	5 06	45 17	29 43	16 72	264 33
b2[illegible]	9 54	32 33	4 60	38 83	28 17	15 47	220 33
b2c1d1	12 13	37 00	5 06	45 17	29 83	17 22	271 67
b2c1d2	9 46	32 67	4 61	39 50	26 50	14 38	225 33
b1c2d1	12 46	39 17	5 00	46 33	30 97	16 95	274 50
b1c2d2	9 96	33 17	4 61	40 67	27 12	15 59	234 83
b2c3d1	12 25	37 33	5 00	45 83	30 67	16 97	269 50
b2c3d2	10 16	33 50	4 28	39 83	26 17	15 28	230 83
f 1 16	0 883	3 220	0 336	0 409	0 584	3 194	0 599

Appendix 17 Treatment means - Bunch characters

Treat- ments	Weight of bunch kg	Length of bunch cm	No of hands	No of fingers	Length of finger cm	Girth of finger cm	Weight of finger g
a1b1c1d1	11 42	35 67	5 00	46 00	29 00	16 44	266 00
a1b1c1d2	9 17	32 00	4 78	38 00	25 33	13 83	217 66
a1b1c2d1	11 83	37 00	5 00	46 33	30 11	17 11	271 00
a1b1c2d2	8 92	31 67	4 55	37 00	25 00	14 05	227 67
a1b1c3d1	11 58	37 33	5 11	44 00	30 00	16 78	272 67
a1b1c3d2	8 92	32 00	4 66	37 00	26 33	15 17	226 00
a1b2c1d1	11 75	37 00	5 00	43 33	29 67	17 00	269 33
a1b2c1d2	9 00	33 33	4 22	39 00	26 00	14 44	227 67
a1b2c2d1	12 16	37 67	4 90	44 67	30 94	17 22	277 33
a1b2c2d2	9 50	33 00	4 67	40 00	28 57	16 73	236 00
a1b2c3d1	12 08	36 00	5 00	45 33	31 33	17 43	273 00
a1b2c3d2	9 92	33 00	4 11	39 33	27 00	16 11	236 67
a2b1c1d1	11 50	37 00	4 89	46 00	29 78	16 78	260 33
a2b1c1d2	9 17	32 67	4 22	39 67	27 00	15 00	227 67
a2b1c2d1	11 92	36 33	5 00	46 00	30 00	16 89	261 00
a2b1c2d2	9 17	32 67	5 00	40 00	27 33	14 88	223 33
a2b1c3d1	12 25	37 00	5 00	46 33	28 87	16 67	256 00
a2b1c3d2	10 17	32 67	4 55	40 67	26 00	15 78	214 67
a2b2c1d1	12 50	37 00	5 11	47 00	30 0	17 44	274 00
a2b2c1d2	9 92	32 00	5 00	40 00	27 00	14 33	223 00
a2b2c2d1	12 75	40 67	5 11	48 00	31 00	16 67	271 67
a2b2c2d2	10 42	33 33	4 55	41 33	25 67	14 44	233 67
a2b2c3d1	12 42	38 33	5 11	46 33	30 00	16 50	266 00
a2b2c3d2	10 42	34 00	4 44	40 33	25 33	14 44	225 00
f 2 16	0 181	1 768	2 656	0 606	2 305	0 506	0 625

Appendix 18 (Contd)

Interaction effect of the factors on quality of fruits

Main effect	TSS brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acids ratio	Pulp/ peel ratio
a1c1d1	23 75	23 41	7 92	15 47	0 353	66 67	3 86
a1c1d2	20 38	18 33	5 57	12 77	0 438	41 30	3 31
a1c2d1	23 87	24 34	7 64	16 69	0 353	70 82	3 89
a1c2d2	20 80	18 63	5 67	12 91	0 455	41 38	3 36
a1c3d1	23 63	23 45	7 95	15 50	0 362	65 11	3 95
a1c3d2	20 67	18 17	5 85	12 32	0 460	41 53	3 46
a2c1d1	23 07	24 09	7 70	16 40	0 370	65 57	3 91
a2c1d2	20 68	18 65	5 72	13 10	0 473	39 94	3 30
a2c2d1	23 22	23 42	7 52	15 78	0 368	66 06	3 79
a2c2d2	20 42	18 37	5 78	12 92	0 467	39 25	3 28
a2c3d1	23 97	23 72	7 40	16 32	0 343	69 12	3 89
a2c3d2	20 40	18 93	5 98	13 43	0 468	37 32	3 34
f2 16	0 946	0 256	0 275	0 352	0 280	0 647	0 112
b1c1d1	23 83	24 06	7 90	16 16	0 365	66 28	3 83
b1c1d2	20 42	18 57	5 66	12 91	0 455	40 83	3 26
b1c2d1	23 26	23 93	7 77	16 04	0 361	68 46	3 82
b1c2d2	20 30	19 03	5 83	13 53	0 452	41 56	3 25
b1c3d1	23 92	23 29	7 80	15 49	0 358	65 28	3 84
b1c3d2	20 70	18 58	5 82	12 68	0 447	41 53	3 33
b2c1d1	22 98	23 44	7 72	15 72	0 358	65 57	3 93
b2c1d2	20 65	18 42	5 63	12 96	0 457	39 94	3 36
b2c2d1	23 82	23 82	7 39	16 43	0 362	66 06	3 87
b2c2d2	20 92	17 97	5 62	12 29	0 470	39 25	3 40
b2c3d1	23 68	23 87	7 55	16 32	0 347	69 12	3 99
b2c3d2	20 37	18 52	6 02	13 07	0 482	37 32	3 46
f2 16	0 617	0 209	0 157	0 676	0 473	0 910	0 228

Appendix 19 Treatment means - Quality of fruits

Treatments	TSS brix	Acidity %	Sugar acid ratio	Total sugar %	Reducing sugar %	Non reducing sugar %	Pulp/ peel ratio
a1b1c1d1	24 07	0 350	67 89	23 58	8 13	15 41	3 86
a1b1c1d2	20 50	0 437	42 47	18 53	5 58	12 95	3 27
a1b1c2d1	23 53	0 350	73 57	24 40	7 90	16 49	3 82
a1b1c2d2	20 27	0 433	42 96	19 33	5 77	13 57	3 28
a1b1c3d1	23 43	0 357	64 67	22 89	8 00	14 88	3 88
a1b1c3d2	20 77	0 437	42 63	18 56	5 80	12 77	3 32
a1b2c1d1	23 43	0 357	65 44	23 24	7 70	15 54	3 86
a1b2c1d2	20 27	0 440	40 12	18 13	5 55	12 58	3 35
a1b2c2d1	24 20	0 357	68 08	24 28	7 39	16 89	3 96
a1b2c2d2	21 33	0 477	39 80	17 93	5 56	12 25	3 45
a1b2c3d1	23 83	0 367	65 55	24 01	7 90	16 11	4 012
a1b2c3d2	20 57	0 483	34 42	17 77	5 90	11 87	3 58
a2b1c1d1	23 60	0 380	64 67	24 55	7 67	16 90	3 82
a2b1c1d2	20 33	0 473	39 20	18 60	5 73	12 87	3 24
a2b1c2d1	23 00	0 370	63 37	23 46	7 63	15 59	3 82
a2b1c2d2	20 33	0 470	40 16	18 73	5 90	13 50	3 22
a2b1c3d1	24 40	0 360	65 90	23 70	7 60	16 10	3 80
a2b1c3d2	20 63	0 457	40 44	18 60	5 83	12 60	3 34
a2b2c1d1	22 53	0 360	65 70	23 63	7 73	15 90	4 01
a2b2c1d2	21 03	0 473	39 76	18 70	5 70	13 33	3 36
a2b2c2d1	23 43	0 367	64 04	23 37	7 40	15 97	3 78
a2b2c2d2	20 50	0 463	38 69	18 00	5 67	12 33	3 34
a2b2c3d1	23 53	0 327	72 69	23 73	7 20	16 53	3 98
a2b2c3d2	20 17	0 480	40 22	19 27	6 13	14 27	3 33
f2 16	0 450	0 366	0 115	0 209	0 383	0 385	0 755

Appendix 20 Treatment means - Content of N in index leaf

Treatment	P content	%	Shooting	Harvest
	2 MAP	4 MAP		
a1b1c1d1	0 97	1 176	3 543	2 050
a1b1c1d2	0 823	1 050	3 203	1 680
a1b1c2d1	1 117	1 203	3 670	2 043
a1b1c2d2	0 879	1 107	3 327	1 706
a1b1c3d1	1 096	1 203	3 670	2 046
a1b1c3d2	0 903	1 126	3 303	1 726
a1b2c1d1	0 967	1 167	3 527	2 073
a1b2c1d2	0 820	1 057	3 143	1 773
a1b2c2d1	1 113	1 203	3 670	2 073
a1b2c2d2	0 879	1 107	3 293	1 853
a1b2c3d1	1 113	1 213	3 683	2 070
a1b2c3d2	0 910	1 133	3 290	1 907
a2b1c1d1	1 030	1 223	3 567	1 956
a2b1c1d2	0 906	1 117	3 223	1 700
a2b1c2d1	1 203	1 260	3 660	2 013
a2b1c2d2	0 913	1 140	3 310	1 893
a2b1c3d1	1 203	1 240	3 676	1 983
a2b1c3d2	0 923	1 163	3 343	1 856
a2b2c1d1	1 037	1 223	3 533	2 003
a2b2c1d2	0 893	1 120	3 210	1 693
a2b2c2d1	1 200	1 276	3 680	2 103
a2b2c2d2	0 923	1 140	3 323	1 946
a2b2c3d1	1 213	1 240	3 660	2 083
a2b2c3d2	0 907	1 173	3 330	1 860
f 2 16	0 026	0 097	0 031	0 067
se	0 037	0 19	0 051	0 080
cd	-	-	-	-

Appendix 21 Treatment means - Content of P in index leaf

	P content %			
	2 MAP*	4 MAP	Shooting	Harvest
a1b1c1d1	0 109	0 106	0 525	0 492
a1b1c1d2	0 0916	0 080	0 372	0 363
a1b1c2d1	0 114	0 106	0 532	0 520
a1b1c2d2	0 0926	0 0903	0 386	0 361
a1b1c3d1	0 120	0 106	0 573	0 544
a1b1c3d2	0 0946	0 0916	0 380	0 367
a1b2c1d1	0 1093	0 101	0 529	0 507
a1b2c1d2	0 093	0 081	0 372	0 353
a1b2c2d1	0 112	0 107	0 525	0 498
a1b2c2d2	0 0926	0 903	0 401	0 379
a1b2c3d1	0 121	0 109	0 563	0 533
a1b2c3d2	0 0956	0 889	0 402	0 363
a2b1c1d1	0 116	0 108	0 532	0 511
a2b1c1d2	0 0926	08830	0 369	0 344
a2b1c2d1	0 122	0 118	0 539	0 514
a2b1c2d2	0 102	0 105	0 425	0 406
a2b1c3d1	0 123	0 118	0 540	0 512
a2b1c3d2	0 107	0 102	0 421	0 381
a2b2c1d1	0 117	0 104	0 538	0 504
a2b2c1d2	0 0943	0 0873	0 377	0 371
a2b2c2d1	0 121	0 119	0 531	0 489
a2b2c2d2	0 102	0 103	0 420	0 395
a2b2c3d1	0 123	0 118	0 543	0 509
a2b2c3d2	0 101	0 103	0 423	0 375
f 2 16	0 005	0 303	0 367	1 387
se	-	0 003	0 011	0 014
cd	-	-	-	-

* MAP - Months after planting

Appendix 22 Treatment means Content of K in index leaf

Treatment	2 MAP	4 MAP	Shooting	Harvest
a1b1c1d1	1 203	0 526	2 300	2 220
a1b1c1d2	0 92	0 300	1 643	1 453
a1b1c2d1	1 353	0 637	2 553	2 407
a1b1c2d2	1 15	0 343	1 953	1 830
a1b1c3d1	1 323	0 613	2 520	2 313
a1b1c3d2	1 1376	0 3476	1 893	1 717
a1b2c1d1	1 22	0 543	2 273	2 233
a1b2c1d2	0 967	0 307	1 643	1 550
a1b2c2d1	1 323	0 627	2 566	2 513
a1b2c2d2	1 153	0 353	1 913	1 870
a1b2c3d1	1 333	0 553	2 487	2 390
a1b2c3d2	1 16 6	0 33	1 880	1 797
a2b1c1d1	1 237	0 59	2 340	2 227
a2b1c1d2	0 997	0 343	1 660	1 493
a2b1c2d1	1 363	0 613	2 607	2 440
a2b1c2d2	1 17	0 41	1 937	1 727
a2b1c3d1	1 363	0 587	2 580	2 463
a2b1c3d2	1 173	0 387	1 840	1 720
a2b2c1d1	1 363	0 593	2 367	2 267
a2b2c1d2	1 020	0 343	1 667	1 587
a2b2c2d1	1 347	0 63	2 653	2 510
a2b2c2d2	1 120	0 387	1 963	1 817
a2b2c3d1	1 363	0 617	2 667	2 513
a2b2c3d2	1 123	0 577	1 837	1 737
f 2 16	0 064	0 777	0 245	0 126

Appendix 23 Treatment means - Content of Ca Mg Fe and Zn in index leaf

Treatment	Ca	Mg	Fe	Zn
a1b1c1d1	0 353	0 055	173 33	0 400
a1b1c1d2	0 310	0 042	156 33	0 223
a1b1c2d1	0 360	0 055	171 33	0 430
a1b1c2d2	0 333	0 0456	155 00	0 237
a1b1c3d1	0 360	0 0553	172 33	0 477
a1b1c3d2	0 330	0 026	154 00	0 243
a1b2c1d1	0 337	0 0543	174 67	0 333
a1b2c1d2	0 290	0 0416	158 33	0 230
a1b2c2d1	0 370	0 0557	170 67	0 330
a1b2c2d2	0 337	0 044	159 33	0 323
a1b2c3d1	0 367	0 563	163 67	0 363
a1b2c3d2	0 326	0 0423	152 00	0 273
a2b1c1d1	0 350	0 0543	173 67	0 453
a2b1c1d2	0 297	0 0413	156 33	0 317
a2b1c2d1	0 363	0 553	164 00	0 353
a2b1c2d2	0 317	0 0447	155 33	0 216
a2b1c3d1	0 353	0 0553	167 33	0 293
a2b1c3d2	0 310	0 041	154 00	0 287
a2b2c1d1	0 313	0 053	173 33	0 340
a2b2c1d2	0 287	0 0456	157 67	0 203
a2b2c2d1	0 370	0 0563	162 00	0 350
a2b2c2d2	0 327	0 0423	155 67	0 290
a2b2c3d1	0 673	0 056	165 67	0 320
a2b2c3d2	0 317	0 0393	152 00	0 283
f 2 16	0 337	0 088	0 230	0 950
se	0 008	0 001	2 86	0 032
cd	-	-	-	-

Appendix 24 a Cost of cultivation for nendran banana excluding charges for fertilizer application and cost of planting material

Sl No	Details	Number of labourers	Quantity	Amount Rs 65/Lbr
1	Cleaning of land	22	-	1430
2	Earthing up	25		1625
3	Making irrigation and drainage channels	5	-	325
4	Taking pits	25	-	1625
5	Planting material	-	-	-
6	Planting	12		780
7	Shading	8		520
8	Cowdung 10 kg/plant	-	25 T	7500
9	Gap filling	1	-	-
10	Cowdung application	8	-	-
11	Irrigation after planting	50		
12	Cost of fertilizers	-	-	16752
13	Fertilizer application	-		-
14	Irrigation after fertilizer application	25	-	1625
15	Irrigationduring summer months	75		4875
16	Clearing channels	5	-	325
17	Weeding and earthing up	50	-	3250
18	Desuckering	4		260
19	Phorate	-	197 kg	10835
20	Application of phorate	10	-	650
21	Propping and bunch covering	25		1625
22	Cost of propping material	-	Rs 3/plant	7500
23	Harvesting and transporting	20		1300
24	Total amount	-		66637

Appendix 24 b Cost of cultivation for banana under different treatments

Treatment	Cultivation expenditure Rs	Cost of fertilizer application	Cost of plantlets Rs	% interest on working capital 10% / annum	Total Rs
T_1	66637	3120	15750	8550	94057
T_2	66637	3120	5270	7503	82530
T_3	66637	3640	15750	8603	94630
T_4	66637	3640	5270	7555	83102
T_5	66637	4160	15750	8655	95202
T_6	66637	4160	5270	7607	83674
T_7	66637	3120	15750	8550	94057
T_8	66637	3120	5270	7503	82530
T_9	66637	3640	15750	8603	94630
T_{10}	66637	3640	5270	7555	83102
T_{11}	66637	4160	15750	8655	95202
T_{12}	66637	4160	5270	7607	83674
T_{13}	66637	3120	15750	8550	94057
T_{14}	66637	3120	5270	7503	82530
T_{15}	66637	3640	15750	8603	94630
T_{16}	66637	3640	5250	7555	83102
T_{17}	66637	4160	15750	8655	95202
T_{18}	66637	4160	5270	7607	83674
T_{19}	66637	3120	15750	8550	94057
T_{20}	66637	3120	5270	7503	82530
T_{21}	66637	3640	15750	8603	94630
T_{22}	66637	3640	5270	7555	83102
T_{23}	66637	4160	15750	8655	95202
T_{24}	66637	4160	5270	7607	83674

Cost of tissue cultured plantlets Rs 6/plant
Cost of tissue cultured suckers Rs 2/plant
(for 2625 plants considering 5% mortality)

Appendix 25 a   Treatment means Height of pseudostem (Experiment - II)

Treat-ment	Height of pseudostem (cm)							
	Months after planting							
	1	2	3	4	5	6	7	8
t_1	28 25	41 00	60 00	80 00	118 00	205 50	262 33	295 00
t_2	27 50	41 50	57 50	82 50	125 00	176 00	270 30	290 00
t_3	27 17	36 67	44 67	57 17	121 00	171 50	266 30	296 00
t_4	22 00	32 00	47 00	67 50	127 50	177 50	260 50	307 50
t_5	28 00	36 50	54 00	68 66	147 50	206 00	270 50	296 00
t_6	28 15	41 17	55 00	71 00	120 50	176 25	262 00	291 50
t_7	28 17	38 00	45 15	68 83	111 50	170 00	260 50	295 50
t_8	30 25	41 00	50 84	62 33	123 00	203 50	276 00	313 00
t_9	31 50	46 50	64 00	82 17	152 50	212 50	270 50	306 50
t_{10}	25 00	34 50	40 50	63 00	95 50	165 50	260 50	281 00
t_{11}	25 33	33 08	40 50	65 61	139 00	201 50	265 50	292 00
t_{12}	26 70	38 50	47 50	64 67	123 00	188 50	287 00	306 50
t_{13}	29 50	37 92	50 00	65 50	112 30	174 80	244 50	297 00
t_{14}	25 67	35 17	48 50	63 00	132 80	204 30	248 00	303 50
t_{15}	27 00	33 50	52 67	60 00	115 50	182 00	252 50	291 00
t_{16}	26 25	38 42	52 00	73 00	153 42	211 00	261 00	318 50
t_{17}	25 50	33 00	42 33	57 67	136 33	194 50	259 50	289 00
t_{18}	28 00	37 50	66 00	68 00	132 00	210 00	269 50	318 50
t_{19}	26 00	34 75	49 00	62 25	138 75	155 65	257 50	286 00
t_{20}	24 00	28 00	42 00	69 50	145 50	202 25	269 56	304 50
t_{21}	29 00	37 50	44 50	59 50	111 50	180 00	260 50	306 50
t_{22}	23 00	29 00	47 50	58 33	166 00	208 50	241 50	300 50
t_{23}	28 25	37 00	48 50	61 75	147 25	203 34	260 50	311 50
t_{24}	27 50	36 50	48 75	65 25	137 00	190 50	251 00	301 00
t_{25}	28 50	36 75	50 75	77 25	161 50	217 50	257 00	312 00
t_{26}	26 50	36 67	55 50	69 50	131 50	205 00	269 50	306 00
t_{27}	724 00	35 00	47 00	76 00	166 25	227 50	266 00	303 00
AC	29 43	38 66	52 11	64 16	101 22	143 76	173 00	2 00
PP	27 44	36 55	56 10	70 92	113 93	201 83	247 00	281 00

Appendix 25 b Treatment means Height of pseudostem (Experiment II)

Treatment	Height of pseudostem							
	Month after planting							
	1	2	3	4	5	6	7	8
t_1	27 90	35 35	46 90	63 78	115 44	206 5	247 5	284 0
t_2	29 25	36 90	46 93	64 39	114 9	211 5	252 0	284 5
t_3	27 40	35 50	50 15	65 64	116 58	213 0	248 0	276 0
t_4	29 15	37 25	47 45	66 54	115 34	212 0	260 50	282 5
t_5	27 90	36 70	47 59	66 48	119 43	213 0	250 50	283 0
t_6	29 50	36 85	47 02	65 94	117 87	209 35	248 50	280 5
t_7	28 08	35 75	47 75	66 14	114 54	208 50	250 00	274 0
t_8	29 50	35 15	49 71	68 99	113 64	213 45	252 00	277 5
t_9	30 00	36 50	50 65	65 85	119 67	212 00	248 00	274 5
t_{10}	27 02	38 45	55 94	79 67	129 52	218 78	250 00	280 0
t_{11}	31 50	36 00	56 73	78 28	124 64	220 98	253 50	280 0
t_{12}	30 60	36 50	56 05	74 71	124 24	222 00	249 50	277 0
t_{13}	32 05	40 90	56 90	81 62	132 76	228 78	266 50	309 0
t_{14}	32 05	41 15	58 20	81 08	128 67	228 75	265 00	305 0
t_{15}	30 38	37 95	54 93	78 76	132 09	229 29	262 00	302 5
t_{16}	31 30	40 15	54 64	74 70	126 25	235 79	251 50	290 5
t_{17}	29 95	41 30	55 75	72 43	134 10	227 28	252 00	287 5
t_{18}	29 95	36 00	51 45	78 36	29 64	221 91	252 00	300 0
t_{19}	30 00	37 30	51 99	71 76	127 07	221 76	258 50	302 5
t_{20}	30 35	38 65	53 74	75 91	126 56	227 63	255 00	312 0
t_{21}	29 60	39 80	54 32	76 73	127 85	230 78	252 50	297 0
t_{22}	29 35	37 00	50 72	79 00	118 54	226 26	240 50	292 5
t_{23}	29 20	36 35	49 46	74 94	121 33	227 00	250 50	300 5
t_{24}	27 15	36 85	56 33	75 85	113 54	227 50	263 00	294 5
t_{25}	27 55	34 62	44 53	65 71	117 18	220 00	262 00	289 5
t_{26}	27 55	35 30	45 03	63 95	117 14	216 20	257 50	290 0
t_{27}	29 15	34 75	44 20	65 14	112 57	212 85	254 00	287 5
AC	24 67	28 42	35 48	43 26	67 17	122 38	160 92	190 0
PP	28 02	35 15	47 27	65 55	110 68	209 00	254 33	276 33

Appendix 26 a   Treatment means Girth of pseudostem (Experiment II)

Treatment	Girth of pseudostem (cm)							
	Months after planting							
	1	2	3	4	5	6	7	8
t_1	11 17	15 33	25 67	33 39	61 24	66 50	72 83	79 00
t_2	10 50	13 50	19 00	31 42	30 67	49 67	60 00	67 50
t_3	9 83	13 83	19 00	23 83	40 50	53 67	65 5	70 5
t_4	7 75	11 5	19 17	29 50	42 07	47 50	57 00	69 80
t_5	8 00	12 00	19 67	28 00	47 33	55 67	64 00	70 50
t_6	11 50	17 00	22 83	33 25	39 67	52 83	57 42	69 00
t_7	11 67	16 00	20 67	25 17	37 83	55 00	59 50	71 50
t_8	9 50	16 67	23 17	28 00	46 00	57 50	62 50	70 00
t_9	11 50	15 50	21 00	28 67	46 33	58 50	64 00	73 50
t_{10}	11 33	15 17	20 83	26 17	34 00	53 67	64 00	72 50
t_{11}	9 00	12 50	18 17	25 11	40 82	57 56	64 00	67 50
t_{12}	10 83	14 83	21 50	28 08	41 33	55 00	61 30	67 00
t_{13}	9 17	13 33	18 67	22 67	38 83	54 50	66 34	74 00
t_{14}	8 83	12 67	20 17	28 00	40 49	59 00	65 75	70 60
t_{15}	11 25	14 75	17 00	30 00	43 75	61 17	66 00	72 00
t_{16}	10 83	14 33	21 33	29 00	44 84	61 25	66 50	69 50
t_{17}	10 25	14 25	20 00	26 75	38 75	55 75	64 50	70 00
t_{18}	9 00	12 33	20 67	25 33	45 65	59 33	63 50	69 50
t_{19}	8 83	12 00	17 67	23 17	34 17	45 00	55 50	65 00
t_{20}	8 50	12 00	19 50	28 50	42 75	57 34	59 50	64 56
t_{21}	10 17	14 17	21 33	25 33	37 67	54 50	61 00	70 10
t_{22}	8 50	11 75	20 67	26 67	40 00	56 33	63 17	68 10
t_{23}	8 59	11 33	18 50	24 33	40 83	62 34	62 50	75 10
t_{24}	9 33	13 00	19 33	25 33	40 00	53 08	50 50	67 00
t_{25}	8 83	12 17	20 42	25 90	46 34	65 00	70 50	73 50
t_{26}	8 67	12 17	21 67	35 17	45 00	56 50	67 50	71 70
t_{27}	9 00	11 23	20 67	31 33	4 33	63 33	69 67	71 00
AC	10 33	14 22	19 83	25 22	32 26	37 55	44 83	49 16
PP	10 46	13 22	20 49	27 29	40 44	53 05	60 66	68 33

Appendix 26 b Treatment means - Girth of pseudostem (Experiment II)

Treatment	Girth of pseudostem (cm)							
	Month after planting							
	1	2	3	4	5	6	7	8
t_1	9 83	15 92	21 25	30 84	39 55	52 41	59 03	68 10
t_2	10 66	14 90	21 92	30 69	39 15	52 02	60 01	67 61
t_3	9 08	14 70	22 26	28 28	39 53	54 71	60 52	68 38
t_4	10 75	13 56	21 98	31 37	38 60	52 74	60 32	70 23
t_5	10 76	11 93	21 54	28 87	40 04	55 69	61 97	68 35
t_6	9 95	11 99	22 04	31 81	39 40	53 35	60 09	70 86
t_7	9 33	15 75	21 05	28 91	40 44	55 50	62 04	70 15
t_8	10 92	16 90	22 61	30 43	40 95	53 55	61 37	70 18
t_9	10 50	16 09	21 65	31 97	39 79	52 77	60 64	69 94
t_{10}	10 00	15 84	24 04	32 07	42 15	55 93	63 39	69 43
t_{11}	8 75	13 31	23 38	31 40	45 15	56 83	63 62	70 83
t_{12}	9 45	15 28	27 55	35 18	43 94	56 19	64 23	70 22
t_{13}	8 79	14 04	24 44	32 47	46 70	59 57	65 73	74 04
t_{14}	9 95	13 74	28 70	36 59	46 68	57 51	66 20	75 38
t_{15}	10 80	14 96	25 74	32 87	43 40	57 02	65 68	73 01
t_{16}	11 42	14 54	25 09	43 83	44 74	55 68	64 55	71 33
t_{17}	8 94	14 70	22 99	32 10	41 96	55 87	64 63	69 39
t_{18}	11 30	12 70	24 42	31 57	43 11	56 82	64 69	71 89
t_{19}	11 01	12 69	21 26	30 28	39 45	56 61	63 38	68 88
t_{20}	9 60	12 72	21 25	28 06	41 10	53 75	60 82	68 04
t_{21}	8 83	14 56	19 04	28 62	40 69	50 41	61 05	68 38
t_{22}	9 52	12 63	19 67	27 19	41 29	53 33	62 04	69 19
t_{23}	10 12	11 61	19 52	26 88	36 41	56 10	61 38	71 01
t_{24}	10 70	12 87	21 12	28 74	39 39	51 87	58 87	66 92
t_{25}	11 30	12 37	19 36	26 60	35 08	46 69	56 84	66 75
t_{26}	9 93	12 61	20 76	27 41	37 56	49 91	55 40	64 07
t_{27}	9 12	11 37	19 63	27 16	37 42	48 68	54 71	63 89
AC	10 07	12 22	19 03	23 39	26 95	32 72	38 25	43 43
PP	9 30	12 58	20 98	28 81	37 51	53 06	59 78	67 91

Appendix 27 a Treatment means, Number of leaves produced at monthly invervals (Experiment II)

	Month after planting 1	2	3	4	5	6	7	8
t_1	3 00	4 17	4 33	4 58	8 00	6 00	5 08	5 15
t_2	4 00	3 67	4 33	4 00	6 33	5 65	5 15	5 15
t_3	3 30	3 83	4 67	3 83	7 83	6 50	4 50	4 00
t_4	3 50	3 67	4 83	4 00	7 33	6 17	4 50	4 17
t_5	3 50	4 00	4 00	4 83	7 33	6 00	4 50	43 00
t_6	3 00	3 33	4 00	4 17	6 17	7 16	5 15	5 17
t_7	3 66	3 67	3 33	3 33	6 16	5 67	5 00	4 00
t_8	3 00	3 00	3 50	3 67	8 17	6 50	5 30	6 00
t_9	3 50	3 33	4 00	5 83	7 16	4 83	4 83	4 17
t_{10}	3 33	3 33	3 83	3 50	6 50	6 00	5 50	4 50
t_{11}	3 00	3 83	3 83	3 33	7 66	7 00	4 50	3 50
t_{12}	3 00	3 67	4 33	4 33	6 83	7 00	5 00	5 00
t_{13}	3 00	3 83	8 83	3 66	8 00	7 16	4 83	4 83
t_{14}	3 00	3 50	3 67	3 83	7 17	5 67	5 00	4 00
t_{15}	3 50	3 17	4 17	5 17	7 17	5 83	5 00	4 00
t_{16}	3 00	3 50	4 33	4 00	6 67	6 67	5 16	4 83
t_{17}	3 66	3 50	4 33	3 83	6 83	5 67	4 50	3 50
t_{18}	3 00	3 67	4 17	4 00	7 50	6 83	4 50	4 00
t_{19}	3 00	3 67	4 17	3 34	7 33	6 33	5 00	5 00
t_{20}	3 17	3 00	3 67	4 00	6 83	5 67	5 00	4 17
t_{21}	3 00	3 83	4 17	3 83	7 83	6 50	4 17	4 00
t_{22}	3 50	3 50	3 67	4 50	7 00	5 67	4 50	4 00
t_{23}	3 00	3 17	4 50	4 17	7 49	6 66	4 50	4 00
t_{24}	3 00	4 17	4 33	4 50	7 00	6 33	4 00	4 50
t_{25}	3 17	4 00	4 83	4 83	8 50	6 50	3 50	3 00
t_{26}	3 50	6 17	4 83	4 00	7 50	7 00	4 00	4 00
t_{27}	3 00	3 00	4 67	4 33	7 17	5 17	4 50	4 80
AC	3 33	4 22	4 11	3 44	5 72	4 50	4 06	3 00
PP	3 33	3 72	4 11	3 94	7 28	6 11	4 39	3 78

Appendix 27 b   Treatment mean Number of leaves produced at monthly intervals

Treatment	Number of leaves produced Month after planting 1	2	3	4	5	6	7	8
t_1	3 00	3 83	3 66	3 83	7 49	4 66	4 33	3 49
t_2	4 00	3 49	3 49	4 16	7 66	5 16	4 49	3 83
t_3	3 17	4 00	3 83	3 66	7 16	5 00	4 16	3 50
t_4	3 00	3 33	3 66	4 00	6 99	5 16	4 66	3 83
t_5	3 16	3 66	3 66	3 66	7 66	6 16	4 33	4 00
t_6	3 00	3 16	4 16	3 49	7 33	6 33	4 51	4 50
t_7	3 33	3 66	3 66	3 83	6 99	4 83	4 68	4 49
t_8	3 50	3 83	3 49	3 66	7 00	6 16	4 00	4 00
t_9	3 00	3 33	3 49	3 49	7 49	5 16	4 16	4 00
t_{10}	3 00	3 49	3 49	3 49	6 49	6 00	4 49	4 49
t_{11}	3 50	3 49	3 49	3 49	7 16	6 00	4 33	4 16
t_{12}	3 17	3 66	3 49	3 49	7 50	4 49	4 50	5 16
t_{13}	3 00	3 50	3 83	4 00	8 00	6 66	5 16	4 83
t_{14}	3 33	3 83	3 49	4 16	7 33	6 83	5 00	4 83
t_{15}	3 00	3 49	3 49	3 66	7 16	6 33	5 16	4 16
t_{16}	3 00	3 66	3 66	3 49	7 33	5 49	4 50	3 99
t_{17}	3 50	3 49	3 16	3 99	6 66	5 83	4 00	4 00
t_{18}	3 50	3 49	3 49	4 00	6 50	5 16	4 75	3 83
t_{19}	3 50	3 49	4 33	3 99	7 00	5 49	4 33	3 66
t_{20}	3 00	3 16	3 83	3 49	6 83	5 49	4 49	4 10
t_{21}	3 00	3 49	4 16	3 83	6 83	5 49	4 00	3 83
t_{22}	3 00	3 83	4 49	4 16	7 33	5 49	4 00	3 83
t_{23}	3 00	3 66	3 49	4 00	7 00	5 33	4 00	4 32
t_{24}	3 00	3 49	3 49	3 49	7 16	5 00	3 99	4 16
t_{25}	3 33	3 49	3 49	3 50	6 83	4 16	4 00	3 49
t_{26}	3 17	3 49	3 49	3 50	6 90	4 49	3 99	3 33
t_{27}	3 17	3 16	3 49		6 49	5 00	3 86	3 16
AC		3 05	3 38	3 50	4 55	4 49	2 83	2 72
PP		3 22	3 38	3 83	7 34	6 16	4 16	3 49

Appendix 28 a Number of leaves retained at monthly intervals

Treatment	Month after planting 1	2	3	4	5	6	7	8	Harvest
t_1	6 00	8 83	8 16	8 83	11 16	11 50	11 33	12 66	5 00
t_2	6 16	9 16	8 50	8 66	11 33	11 99	11 16	13 33	4 83
t_3	6 33	8 49	8 66	8 99	11 33	11 33	11 33	13 33	5 00
t_4	6 50	9 49	8 16	8 83	10 66	13 16	12 83	13 82	8 16
t_5	6 49	9 49	8 00	8 66	11 33	13 33	12 66	13 83	5 33
t_6	6 66	8 83	8 16	8 83	11 33	13 33	12 66	12 33	5 00
t_7	6 49	9 16	8 66	9 16	12 00	11 83	7 49	12 83	5 33
t_8	7 00	8 99	8 49	9 16	11 49	11 66	11 83	13 00	5 50
t_9	6 83	8 66	8 83	9 66	11 83	11 49	12 16	13 16	5 50
t_{10}	7 00	8 83	9 49	8 49	10 83	13 16	13 83	16 00	5 16
t_{11}	6 33	8 49	9 66	8 83	11 16	12 83	13 83	16 00	5 33
t_{12}	6 66	9 16	9 16	8 49	12 33	13 00	13 33	15 83	5 16
t_{13}	6 16	8 83	9 83	10 16	12 66	14 49	14 83	16 83	5 83
t_{14}	6 49	9 16	9 49	10 49	12 33	14 33	14 83	16 33	6 00
t_{15}	6 49	9 00	10 00	10 33	12 49	13 99	15 16	16 66	5 83
t_{16}	6 33	8 66	9 66	8 99	11 66	12 16	12 99	14 99	5 00
t_{17}	6 66	8 66	9 49	8 66	11 66	12 33	13 83	15 83	5 33
t_{18}	6 83	8 49	9 66	8 83	11 49	11 99	13 16	15 16	5 16
t_{19}	6 49	8 16	9 00	8 16	11 00	11 16	11 16	14 33	4 83
t_{20}	6 49	8 00	8 49	7 99	11 16	11 00	11 83	14 66	4 83
t_{21}	6 49	8 16	8 83	8 00	11 16	11 33	12 00	14 66	4 50
t_{22}	7 00	8 16	8 49	8 16	11 33	11 16	13 16	15 66	5 16
t_{23}	6 83	7 83	8 66	8 66	11 49	11 00	12 33	15 16	5 50
t_{24}	6 83	7 33	8 83	8 66	11 49	11 99	12 16	15 33	5 00
t_{25}	6 66	7 99	8 66	8 00	10 49	11 16	11 49	14 66	4 33
t_{26}	6 66	7 49	8 33	8 16	11 00	11 49	11 83	14 50	4 16
t_{27}	7 00	7 83	8 49	7 99	10 83	11 16	11 33	14 66	4 33
AC	6 05	8 05	7 72	6 94	9 38	8 38	7 11	8 44	3 00
PP	6 16	8 83	9 22	8 94	11 68	11 94	12 44	12 94	4 70

Appendix 28 b Number of leaves retained at monthly intervals (Experiment II)

Treat-ment	Month after planting 1	2	3	4	5	6	7	8	Harvest
t_1	5 83	9 50	9 33	9 17	12 33	13 00	12 50	14 67	4 16
t_2	6 83	9 00	9 00	8 67	10 67	11 83	12 50	12 50	4 16
t_3	6 67	8 66	9 16	8 50	12 00	13 00	13 50	14 50	4 16
t_4	6 66	8 00	9 67	8 50	11 67	13 00	14 00	13 50	4 33
t_5	6 33	8 50	9 16	9 16	12 00	13 17	13 50	14 50	4 67
t_6	6 16	8 50	9 33	7 67	11 50	12 66	13 00	14 83	4 66
t_7	7 17	8 66	7 50	7 50	11 17	13 00	14 00	14 00	4 50
t_8	6 00	8 50	8 87	8 17	11 17	12 67	13 50	15 50	4 33
t_9	6 83	8 67	8 85	8 17	12 50	13 00	14 00	13 50	4 50
t_{10}	6 50	8 00	8 00	8 33	13 00	13 00	13 50	15 00	4 49
t_{11}	6 00	8 67	8 50	8 83	13 17	13 50	13 50	14 00	4 33
t_{12}	7 00	9 66	8 33	8 50	9 50	12 74	14 00	14 25	4 67
t_{13}	5 67	8 50	8 33	10 15	14 00	12 83	14 00	15 50	5 66
t_{14}	6 67	8 83	8 50	10 50	11 50	13 50	13 50	14 67	5 83
t_{15}	7 00	8 17	8 83	10 33	12 50	13 50	13 50	15 50	5 83
t_{16}	6 50	9 33	9 67	9 00	11 83	14 00	13 00	14 50	4 49
t_{17}	7 00	8 00	8 33	8 67	12 33	13 0	12 50	14 50	4 49
t_{18}	6 50	8 50	8 50	8 83	12 83	12 83	14 50	16 50	4 33
t_{19}	6 83	8 50	8 50	8 17	11 53	12 67	14 50	15 50	4 33
t_{20}	6 00	8 00	8 33	8 00	11 50	13 50	13 50	13 67	4 00
t_{21}	6 50	8 67	8 83	8 17	10 33	12 50	13 00	14 50	4 16
t_{22}	5 83	8 34	8 67	8 66	11 65	13 50	14 50	15 00	4 16
t_{23}	5 83	7 33	8 83	8 67	10 67	13 50	14 00	14 50	4 16
t_{24}	6 70	8 17	9 16	8 00	13 67	13 50	13 50	15 50	4 33
t_{25}	6 00	8 83	9 83	8 17	13 17	14 33	14 00	15 00	4 16
t_{26}	6 33	8 00	9 33	8 66	12 50	13 75	14 00	15 00	4 33
t_{27}	7 67	8 50	9 16	8 66	11 67	12 67	14 50	15 50	4 16
AC	6 66	8 61	8 39	7 44	10 23	9 22	7 50	6 72	3 13
PP	6 50	8 61	8 72	7 87	10 62	11 94	11 88	13 28	3 66

Appendix 29 a Treatment means - Total number of leaves produced (Experiment II)

Treatment	Month after Planning 1	2	3	4	5	6	7	8
t_1	06 00	09 50	13 50	18 33	25 17	31 50	37 50	42 00
t_2	06 50	10 17	14 50	18 50	25 17	31 17	36 30	41 30
t_3	07 00	10 67	14 67	18 50	25 67	32 17	36 67	40 50
t_4	07 25	10 92	15 17	19 33	26 66	33 33	37 83	42 00
t_5	06 50	10 50	14 83	19 33	26 33	32 33	37 83	41 67
t_6	07 00	10 50	14 33	17 67	25 25	29 67	34 67	39 83
t_7	07 67	11 33	14 67	18 00	24 17	29 83	34 83	38 83
t_8	06 67	09 67	13 33	17 25	25 25	31 75	37 30	43 30
t_9	06 67	09 50	13 50	19 33	24 50	30 67	36 00	40 50
t_{10}	06 75	10 25	13 50	17 17	24 00	30 00	35 50	40 00
t_{11}	06 50	10 33	14 00	17 00	24 67	31 67	36 17	39 67
t_{12}	07 50	11 17	15 49	19 67	26 34	33 17	38 00	43 00
t_{13}	06 33	11 50	15 83	18 66	26 17	33 17	38 13	43 67
t_{14}	06 17	10 17	13 83	18 67	25 83	31 67	36 67	41 67
t_{15}	07 16	10 17	14 66	19 50	26 17	32 17	37 17	41 50
t_{16}	06 67	10 17	14 66	19 50	27 33	33 66	38 00	42 33
t_{17}	06 67	10 17	14 33	20 50	24 00	30 50	35 50	39 17
t_{18}	06 83	10 50	14 00	18 17	26 00	32 83	37 83	41 83
t_{19}	06 67	09 83	14 00	18 50	26 00	31 00	36 00	41 00
t_{20}	07 50	10 50	14 00	18 17	24 83	31 00	35 50	40 00
t_{21}	06 98	10 83	15 00	18 67	26 50	33 00	37 50	41 50
t_{22}	07 67	11 17	14 83	19 17	26 68	31 80	36 30	40 30
t_{23}	07 50	10 67	15 17	19 00	26 50	34 00	38 00	42 00
t_{24}	07 50	11 83	16 13	19 66	26 17	31 83	34 83	39 50
t_{25}	07 50	11 50	16 33	21 17	29 33	35 83	39 67	42 67
t_{26}	06 83	09 83	14 67	19 16	24 50	32 00	37 50	41 50
t_{27}	06 83	10 33	14 83	20 35	27 50	32 67	37 83	42 50
AC	07 31	11 27	15 22	18 24	25 11	28 72	32 55	36 44
PP	07 16	10 78	14 94	18 33	24 99	31 78	36 72	39 16

Appendix 29 b Treatment means Total number of leaves produced (Experiment II)

Treatment	Month after Planning 1	2	3	4	5	6	7	8
t_1	6 49	10 33	14 49	18 49	25 84	30 49	34 33	38 16
t_2	6 49	9 83	13 33	17 16	24 82	29 99	34 50	38 33
t_3	6 33	10 33	14 16	18 33	25 50	30 50	34 66	38 16
t_4	6 66	10 00	13 66	17 33	24 33	29 49	33 49	37 83
t_5	6 49	10 33	13 99	17 49	25 16	29 99	34 33	38 33
t_6	7 00	10 16	14 33	18 00	25 33	30 66	35 16	38 66
t_7	7 00	10 66	14 33	17 83	24 82	28 82	33 50	37 99
t_8	7 41	11 00	14 49	18 33	25 33	31 50	33 50	39 50
t_9	6 66	9 99	13 49	17 16	24 66	29 83	33 99	37 99
t_{10}	7 33	10 33	13 83	17 33	28 83	29 83	34 33	38 83
t_{11}	7 00	10 49	14 00	17 49	24 66	30 66	35 00	39 16
t_{12}	6 83	10 50	13 99	17 49	24 99	30 46	34 49	39 16
t_{13}	6 83	10 33	13 99	17 49	25 49	32 66	37 49	42 83
t_{14}	6 83	10 66	14 50	18 50	25 83	32 66	37 66	42 50
t_{15}	6 83	10 33	13 82	17 99	25 16	31 55	36 66	41 85
t_{16}	6 70	10 16	13 83	17 33	24 16	29 66	35 16	37 66
t_{17}	6 66	10 33	13 82	17 33	23 83	29 66	33 66	37 66
t_{18}	7 00	10 49	14 00	17 99	24 49	29 66	34 16	38 00
t_{19}	6 83	10 33	14 66	18 66	25 66	31 16	35 49	39 16
t_{20}	6 83	9 99	14 33	18 33	25 16	30 66	35 16	38 66
t_{21}	6 66	10 16	15 33	17 83	24 66	30 16	34 16	37 99
t_{22}	7 00	10 83	15 32	19 16	26 49	31 99	35 99	39 83
t_{23}	7 00	10 66	14 16	18 33	25 33	30 66	34 66	38 00
t_{24}	6 83	10 33	13 83	17 83	25 00	30 00	33 99	38 16
t_{25}	6 83	10 33	13 83	17 33	24 16	28 33	32 33	35 66
t_{26}	6 85	10 33	15 62	19 33	25 83	29 66	33 66	36 66
t_{27}	7 00	10 16	15 16	17 16	23 66	28 66	32 33	31 33
AC	6 44	9 77	13 27	16 77	21 32	25 83	28 66	33 88
PP	6 77	10 27	13 93	17 77	25 10	31 21	35 88	39 49

Appendix 30 a   Treatment means - Leaf area (Experiment II)

Treat-ment	Leaf area m^2								
	Month after planting								
	1	2	3	4	5	6	7	8	Harvest
t_1	0 126	0 268	0 768	1 757	3 480	6 338	8 682	12 195	4 437
t_2	0 129	0 278	0 771	1 686	3 509	6 397	8 568	12 269	4 514
t_3	0 130	0 279	0 767	1 768	3 509	6 465	8 681	12 266	4 399
t_4	0 121	0 278	0 787	1 780	3 570	6 405	8 807	12 469	4 705
t_5	0 131	0 283	0 798	1 787	3 620	6 414	8 814	12 444	2 125
t_6	0 133	0 289	0 788	1 782	3 615	6 403	8 864	12 451	4 993
t_7	0 132	0 270	0 804	1 774	3 629	6 460	8 874	12 428	4 718
t_8	0 123	0 280	0 815	1 788	3 624	6 519	8 878	12 482	4 481
t_9	0 120	0 284	0 809	1 787	3 633	6 503	8 878	12 591	4 887
t_{10}	0 139	0 300	0 840	1 804	3 908	7 719	8 989	12 568	4 804
t_{11}	0 145	0 301	0 871	1 806	3 859	7 270	9 198	12 871	4 570
t_{12}	0 140	0 303	0 845	1 787	3 880	7 831	8 976	12 865	5 079
t_{13}	0 141	0 293	0 857	1 929	3 990	7 902	9 300	13 369	5 909
t_{14}	0 145	0 302	0 879	1 920	4 021	7 825	9 334	13 216	5 980
t_{15}	0 144	0 307	0 844	1 927	4 025	7 984	9 347	13 325	5 985
t_{16}	0 141	0 300	0 860	1 360	3 847	7 671	8 896	12 329	4 797
t_{17}	0 142	0 310	0 862	1 879	3 870	7 714	8 854	12 303	4 720
t_{18}	0 144	0 310	0 866	1 869	3 867	7 714	8 788	12 305	4 607
t_{19}	0 139	0 274	0 862	1 801	3 849	6 879	8 693	12 957	4 706
t_{20}	0 139	0 281	0 868	1 823	3 834	6 821	8 579	12 862	4 296
t_{21}	0 138	0 288	0 867	1 812	3 830	6 879	8 526	12 162	4 520
t_{22}	0 139	0 275	0 873	1 790	3 770	6 769	8 566	12 319	4 494
t_{23}	0 135	0 282	0 845	1 890	3 771	6 398	8 311	12 309	4 489
t_{24}	0 137	0 277	0 866	1 845	3 764	6 386	8 420	12 288	4 770
t_{25}	0 127	0 282	0 844	1 743	3 717	6 342	8 161	12 279	4 634
t_{26}	0 127	0 292	0 855	1 755	3 697	6 482	8 210	12 119	4 681
t_{27}	0 132	0 290	0 863	1 746	3 713	6 535	8 117	12 189	4 372
AC	0 0863	0 2153	0 5379	1 190	2 490	3 814	5 936	7 790	3 746
PP	0 1245	0 2778	0 7608	1 707	3 475	6 265	8 853	1 324	4 651

Appendix 30 b Treatment means Leaf area (Experiment II)

Treat-ment	Leaf area m^2								
	Month after planting								
	1	2	3	4	5	6	7	Shooting	Harvest
t_1	0 125	0 270	0 789	1 805	3 470	6 176	8 884	12 05	5 309
t_2	0 127	0 284	0 779	1 768	3 495	6 261	8 904	12 523	5 129
t_3	0 127	0 284	0 805	1 792	3 510	6 485	8 896	12 524	5 419
t_4	0 121	0 287	0 808	1 789	3 594	6 600	8 897	13 093	5 572
t_5	0 130	0 298	0 811	1 777	3 594	6 634	9 044	12 973	5 702
t_6	0 123	0 300	0 814	1 788	3 601	6 659	8 991	12 890	5 407
t_7	0 130	0 290	0 819	1 787	3 699	6 538	8 835	12 999	5 664
t_8	0 129	0 299	0 839	1 798	3 704	6 562	8 990	12 811	5 752
t_9	0 123	0 299	0 825	1 801	3 695	6 611	8 976	12 989	5 769
t_{10}	0 143	0 303	0 838	1 827	3 894	7 689	9 569	13 180	5 38
t_{11}	0 140	0 311	0 850	1 854	3 919	7 603	9 568	13 283	5 625
t_{12}	0 139	0 303	0 840	1 850	3 896	7 669	9 574	13 257	5 434
t_{13}	0 136	0 307	0 870	1 924	4 095	8 147	9 894	13 894	6 101
t_{14}	0 138	0 310	0 888	1 919	4 044	8 299	9 938	13 968	6 388
t_{15}	0 143	0 308	0 876	1 918	3 966	8 111	9 879	14 215	6 114
t_{16}	0 146	0 309	0 877	1 881	3 908	7 808	9 554	13 254	5 272
t_{17}	0 141	0 304	0 880	1 896	3 910	7 693	9 504	13 125	5 600
t_{18}	0 145	0 300	0 868	1 896	3 901	7 639	9 489	13 009	5 411
t_{19}	0 141	0 301	0 857	1 881	3 807	6 825	8 997	12 338	5 145
t_{20}	0 148	0 303	0 854	1 901	3 874	6 872	8 947	12 394	5 220
t_{21}	0 148	0 299	0 855	1 875	3 901	6 880	9 103	12 388	4 881
t_{22}	0 135	0 300	0 849	1 759	3 714	6 474	8 656	12 387	5 445
t_{23}	0 139	0 308	0 858	1 788	3 735	6 469	8 697	12 419	5 706
t_{24}	0 136	0 296	0 858	1 779	3 739	6 526	8 565	12 446	5 306
t_{25}	0 125	0 294	0 848	1 786	3 504	6 523	8 569	12 295	4 650
t_{26}	0 130	0 295	0 866	1 787	3 599	6 554	8 640	12 637	4 350
t_{27}	0 124	0 293	0 847	1 788	3 539	6 555	8 422	12 326	4 710
AC	0 0878	0 226	0 528	1 427	2 542	3 869	6 010	12 373	4 390
PP	0 127	0 282	0 794	1 781	3 505	6 487	8 100	12 961	5 170

Appendix 31 a   Treatment means - Duration of the crop (Experiment II)

Treatment	No of days taken for shooting	No of days taken for harvesting
t_1	238 0	336 0
t_2	235 5	331 5
t_3	235 0	332 5
t_4	227 0	320 5
t_5	226 5	320 0
t_6	224 5	318 5
t_7	227 0	319 5
t_8	226 0	321 5
t_9	226 0	321 0
t_{10}	237 0	328 5
t_{11}	235 5	329 5
t_{12}	237 0	327 0
t_{13}	233 0	331 5
t_{14}	233 0	335 5
t_{15}	237 0	332 5
t_{16}	250 0	339 0
t_{17}	247 5	334 5
t_{18}	247 0	336 5
t_{19}	245 5	360 5
t_{20}	255 5	354 5
t_{21}	256 5	352 5
t_{22}	258 0	340 0
t_{23}	250 5	338 0
t_{24}	251 5	340 0
t_{25}	253 0	340 0
t_{26}	250 5	347 0
t_{27}	250 5	350 5
AC	257 66	353 33
PP	231 16	328 50

Appendix 31 b Treatment means - Duration of the crop (Experiment II)

Treatment	No of days taken for shooting	No of days taken for harvesting
t_1	240 5	334 5
t_2	238 0	331 5
t_3	233 5	327 0
t_4	227 5	320 5
t_5	229 0	322 0
t	227 5	322 0
9	225 5	319 0
t_{10}	235 5	328 5
t_{11}	236 5	328 5
t_{12}	235 5	328 0
t_{13}	232 0	324 0
t_{14}	237 0	330 0
t_{15}	236 5	329 0
t_{16}	246 5	339 0
t_{17}	245 5	337 0
t_{18}	246 0	338 5
t_{19}	261 5	353 0
t_{20}	258 0	349 5
t_{21}	258 5	350 5
t_{22}	250 0	341 5
t_{23}	251 0	343 0
t_{24}	249 5	344 5
t_{25}	247 0	339 5
t_{26}	247 0	338 5
t_{27}	248 0	342 0
AC	253 5	346 83
PP	231 5	324 16

Appendix 32 Abstract of pooled ANOVA (yield)

Source	df	Mss	F
Year (y)	1	21 520	106 01**
N	2	36 503	179 82**
K	2	45 388	223 59**
S	2	0 703	3 46
NK	4	10 589	52 16**
NS	4	0 067	< 1
KS	4	0 702	3 46
NKS	8	0 111	< 1
NY	2	4 361	21 48**
KY	2	2 007	9 89**
SY	2	0 521	2 57
NRY	4	4 118	20 29
NSY	4	0 335	1 63
RSY	4	1 705	8 40
NRSY	8	0 203	

Appendix 33a Treatment means - Bunch Characters (Experiment II)

Treatments	Bunch wt kg	Length cm	No of hands	No of fingers	Weight of finger	Girth of finger	Length of finger
t_1	09 59	36 75	04 83	45 50	260 50	15 75	28 75
t_2	09 50	37 85	04 67	47 00	260 50	16 00	29 75
t_3	10 21	37 99	04 50	48 55	252 50	15 65	27 75
t_4	11 59	41 21	04 84	54 00	327 50	16 25	30 50
t_5	12 84	42 50	05 00	56 00	325 00	16 08	29 75
t_6	12 10	41 25	05 17	53 92	302 50	16 30	31 03
t_7	11 57	40 90	05 00	53 25	300 00	16 15	30 17
t_8	11 84	39 10	05 00	51 67	318 50	16 11	30 38
t_9	11 59	39 38	04 93	50 33	292 50	15 68	29 75
t_{10}	11 00	38 78	05 00	46 63	301 50	16 14	28 68
t_{11}	10 21	38 03	05 00	47 56	295 00	16 01	29 43
t_{12}	11 63	42 65	05 00	44 50	278 00	16 05	28 20
t_{13}	13 60	42 50	05 00	49 09	320 00	17 50	32 50
t_{14}	13 96	40 92	05 00	55 00	312 50	17 90	31 65
t_{15}	13 98	41 98	04 84	54 65	290 00	17 94	32 40
t_{16}	10 85	39 58	05 00	51 97	260 00	16 18	28 58
t_{17}	10 75	38 68	05 00	52 90	250 00	18 11	28 28
t_{18}	09 81	38 68	05 00	47 93	274 00	16 31	28 55
t_{19}	09 50	37 00	05 00	46 25	257 50	16 02	29 19
t_{20}	09 17	40 26	05 00	47 45	257 50	16 05	29 19
t_{21}	10 34	40 40	05 00	46 50	267 50	16 78	29 87
t_{22}	10 00	40 28	04 94	46 83	276 00	15 76	29 20
t_{23}	10 75	40 08	05 00	52 00	246 50	16 19	29 15
t_{24}	10 84	41 90	05 13	48 80	273 50	16 10	30 27
t_{25}	11 80	41 28	05 00	49 50	305 00	16 05	30 17
t_{26}	11 25	40 25	05 00	50 25	249 00	16 04	29 06
t_{27}	10 34	38 80	05 00	57 50	244 00	16 07	30 12
AC	06 78	32 18	04 00	35 31	204 00	14 58	26 12
PP	09 28	37 90	04 83	45 25	266 17	15 79	29 03

Appendix 33 b Treatments means Bunch Characters (Experiment II)

Treatments	Bunch wt kg	Length cm	No of hands	No of fingers	Weight of finger	Girth of finger	Length of finger
t_1	11 67	38 71	04 16	51 00	278 00	28 65	15 95
t_2	11 73	38 60	04 33	51 30	278 50	26 85	15 97
t_3	11 24	36 90	04 16	51 03	281 50	28 94	16 61
t_4	12 19	39 14	04 00	52 50	312 00	31 06	17 07
t_5	12 38	40 13	04 33	53 10	309 00	30 90	17 49
t_6	12 06	40 09	04 33	52 75	308 00	30 81	16 98
t_7	12 51	41 44	05 16	53 70	309 50	31 12	17 02
t_8	12 82	42 10	05 16	54 16	304 00	30 49	16 70
t_9	12 58	41 77	05 00	53 79	305 00	30 54	16 45
t_{10}	12 06	40 73	05 16	52 61	279 00	28 04	15 47
t_{11}	12 50	41 49	05 16	53 25	280 50	27 49	15 78
t_{12}	11 89	40 57	05 00	53 42	283 00	28 46	15 94
t_{13}	15 17	44 19	05 33	57 75	328 00	32 94	18 24
t_{14}	16 12	45 78	05 16	60 15	321 00	32 24	18 09
t_{15}	16 29	45 71	05 33	60 55	328 50	32 72	18 37
t_{16}	11 66	39 53	04 16	50 95	307 00	30 70	17 03
t_{17}	12 11	40 13	04 16	51 15	307 00	30 77	16 75
t_{18}	12 06	39 92	04 49	51 95	311 00	31 71	17 10
t_{19}	10 05	38 58	04 00	50 55	270 00	27 95	15 95
t_{20}	10 16	38 91	04 00	50 50	270 50	27 79	16 00
t_{21}	09 04	37 90	04 00	48 50	278 50	28 30	16 65
t_{22}	12 11	40 33	04 49	52 67	269 00	26 82	15 45
t_{23}	12 71	43 36	05 16	53 83	268 50	27 02	16 15
t_{24}	12 12	41 80	04 66	52 99	271 00	27 44	15 79
t_{25}	09 11	36 39	04 00	48 65	264 00	26 54	15 98
t_{26}	10 20	40 01	04 00	48 95	259 50	26 03	16 08
t_{27}	10 01	39 46	04 00	49 35	258 00	26 33	15 66
AC	07 29	31 32	04 16	34 50	192 56	25 66	13 92
PP	10 54	37 48	04 60	48 21	273 41	27 78	15 85

Appendix 34 a Treatment means Quality of fruits (Experiment II)

Treatments	TSS °Brix	Total sugar %	Reducing sugar %	Acidity %	Sugar/ Acid ratio	Non reducing sugar %	Pulp/ Peel ratio	
t_1	24 88	23 99	8 44	0 40	60 02	16 05	3 73	
t_2	24 75	23 06	7 98	0 40	56 72	15 08	3 68	
t_3	25 00	24 00	8 09	0 41	59 18	16 91	3 80	
t_4	24 50	23 86	8 08	0 35	69 17	15 50	3 94	
t_5	22 50	21 23	8 05	0 34	63 64	13 19	4 10	
t_6	24 75	23 05	8 39	0 37	62 58	14 63	3 85	
t_7	24 00	22 98	7 70	0 40	58 16	14 87	3 87	
t_8	23 00	21 91	7 75	0 47	47 27	14 88	4 06	
t_9	22 00	21 19	7 90	0 44	48 55	14 30	4 12	
t_{10}	21 50	22 06	7 93	0 41	54 10	14 13	3 68	
t_{11}	18 75	18 92	7 81	0 40	47 91	11 01	3 62	
t_{12}	19 50	19 92	7 36	0 46	41 60	11 50	3 65	
t_{13}	17 00	19 17	6 91	0 44	43 53	12 26	3 74	
t_{14}	21 00	18 17	7 07	0 33	55 93	11 09	3 72	
t_{15}	19 50	17 28	6 96	0 34	51 71	10 32	3 80	
t_{16}	20 50	20 18	6 33	0 38	53 78	14 36	3 93	
t_{17}	20 50	20 34	7 05	0 45	45 93	13 29	3 92	
t_{18}	20 50	19 66	7 15	0 47	42 43	12 51	3 90	
t_{19}	19 75	19 47	6 14	0 48	40 56	13 33	3 45	
t_{20}	17 50	16 83	6 86	0 48	34 71	14 97	3 49	
t_{21}	18 25	18 33	6 06	0 50	37 45	12 27	3 46	
t_{22}	18 00	16 92	6 16	0 60	30 48	11 34	3 58	
t_{23}	17 00	16 50	5 72	0 53	29 99	10 79	3 59	
t_{24}	18 50	17 35	6 80	0 58	33 29	10 55	3 63	
t_{25}	20 25	17 23	6 19	0 53	32 82	11 03	3 70	
t_{26}	16 50	17 46	6 21	0 57	30 67	12 75	3 72	
t_{27}	19 75	17 20	6 27	0 56	30 77	10 80	3 71	
AC	22 33	21 41	7 38	0 39	55 57	14 10	3 87	2
PP	23 16	23 75	8 56	0 38	62 58	15 16	3 91	2

Appendix 34 b Treatment mean - Quality of fruits (Experiment II)

Effect	°TSS brix	Total sugar %	Reducing sugar %	Non reducing sugar %	Acidity %	Sugar/ Acid ratio	Pulp/ peel ratio
t_1	20 10	22 25	8 21	14 04	0 37	59 31	3 75
t_2	21 00	22 9	8 27	14 66	0 37	59 59	3 69
t_3	20 45	22 24	8 17	14 07	0 39	57 25	3 82
t_4	23 80	23 21	8 39	14 77	0 35	65 35	3 96
t_5	22 15	22 09	8 27	13 81	0 33	63 28	4 40
t_6	23 35	21 84	8 47	13 36	0 35	61 52	3 95
t_7	23 05	22 05	7 30	14 74	0 36	61 20	3 97
t_8	22 35	21 22	7 39	13 82	0 37	57 43	4 18
t_9	22 50	21 14	7 37	13 77	0 35	59 53	4 20
t_{10}	20 70	19 92	8 03	11 88	0 49	40 25	3 73
t_{11}	20 85	19 64	8 10	11 54	0 49	39 69	3 65
t_{12}	21 65	19 77	7 31	12 46	0 51	38 72	3 68
t_{13}	20 50	18 89	7 75	11 14	0 46	40 62	3 79
t_{14}	19 60	19 00	7 95	11 05	0 46	40 88	3 77
t_{15}	19 95	18 25	7 73	10 67	0 48	38 09	3 85
t_{16}	22 15	21 10	7 09	14 01	0 50	42 24	3 95
t_{17}	23 27	20 96	7 40	13 55	0 46	45 10	3 95
t_{18}	23 12	20 53	7 01	13 52	0 46	44 24	3 94
t_{19}	18 25	18 55	6 60	11 95	0 53	4 69	3 46
t_{20}	18 80	19 72	6 12	13 60	0 55	35 57	3 48
t_{21}	18 10	18 27	6 23	12 03	0 55	32 94	3 45
t_{22}	19 85	19 08	7 88	11 20	0 50	32 94	3 63
t_{23}	20 15	19 52	8 11	11 41	0 52	38 27	3 61
t_{24}	20 05	19 57	8 01	11 56	0 50	36 74	3 66
t_{25}	16 95	17 98	6 71	11 27	0 59	31 55	3 73
t_{26}	17 05	17 65	6 84	10 80	0 56	31 56	3 74
t_{27}	16 37	17 22	6 54	10 68	0 57	30 23	3 73
AC	22 16	22 36	8 11	14 23	0 40	56 06	3 84
PP	20 15	23 09	8 59	14 49	0 36	62 94	3 84

Appendix 35 Treatments means - Content of N in index leaf (Experiment II)

Treatments	N content %					
	1MAP	2MAP	3MAP	4MAP	Shooting	Harvest
t_1	1 04	1 06	1 18	2 52	2 82	2 31
t_2	1 04	1 08	1 23	2 72	2 82	2 29
t_3	0 93	1 20	1 23	2 52	2 74	2 29
t_4	1 04	1 07	1 24	2 72	2 84	2 31
t_5	0 98	1 06	1 22	2 54	2 75	2 18
t_6	0 90	1 18	1 18	2 52	2 84	2 34
t_7	1 03	1 06	1 23	2 51	2 72	2 25
t_8	1 04	1 06	1 19	2 50	2 83	2 35
t_9	0 93	1 16	1 22	2 70	2 83	2 31
t_{10}	1 03	1 04	1 25	2 62	2 56	1 92
t_{11}	1 04	1 08	1 29	2 75	3 04	2 50
t_{12}	0 91	1 17	1 25	2 81	3 05	2 50
t_{13}	1 05	1 08	1 28	2 70	3 00	2 58
t_{14}	1 03	1 09	1 25	2 79	3 14	2 72
t_{15}	0 93	1 14	1 24	2 60	2 89	2 43
t_{16}	1 04	1 09	1 26	2 77	3 15	2 75
t_{17}	1 03	1 05	1 25	2 66	2 89	2 40
t_{18}	0 95	1 25	1 28	2 73	3 05	2 55
t_{19}	1 04	1 18	1 29	2 80	3 03	2 45
t_{20}	1 04	1 09	1 26	2 66	2 81	2 38
t_{21}	1 03	1 19	1 24	2 69	2 95	2 57
t_{22}	1 03	1 10	1 21	2 60	2 95	2 57
t_{23}	1 03	1 17	1 26	2 70	2 95	2 47
t_{24}	1 04	1 25	1 29	2 80	3 08	2 61
t_{25}	1 04	1 17	1 25	2 71	2 97	2 59
t_{26}	1 04	1 13	1 29	2 80	3 07	2 57
t_{27}	11 03	1 112	1 23	2 60	2 99	2 46

* MAP - Month After Planting

Appendix 36 Treatment means - Content of K in index leaf (Experiment II)

	K content %					
Treatments	1MAP	2MAP	3MAP	4MAP	Shooting	Harvest
t_1	1 23	1 23	0 48	0 68	2 57	2 18
t_2	1 34	1 33	0 43	0 65	2 42	2 19
t_3	1 13	1 14	0 46	0 62	2 41	2 11
t_4	1 33	1 30	0 74	0 70	2 58	2 20
t_5	1 39	1 36	0 47	0 76	2 61	2 28
t_6	1 25	1 24	0 52	0 75	2 68	2 28
t_7	1 22	1 19	0 68	0 82	2 62	2 26
t_8	1 40	1 37	0 56	0 76	2 64	2 28
t_9	1 33	1 31	0 56	0 74	2 61	2 25
t_{10}	1 28	1 25	0 36	0 53	2 41	2 06
t_{11}	1 30	1 25	0 48	0 72	2 60	2 29
t_{12}	1 28	1 25	0 47	0 70	2 56	2 23
t_{13}	1 34	1 30	0 73	0 79	2 69	2 27
t_{14}	1 39	1 35	0 52	0 76	2 60	2 19
t_{15}	1 28	1 28	0 41	0 62	2 34	2 08
t_{16}	1 31	1 36	0 76	0 85	2 75	2 34
t_{17}	1 40	1 37	0 51	0 64	2 36	2 05
t_{18}	1 28	1 25	0 64	0 79	2 71	2 32
t_{19}	1 29	1 30	0 49	0 79	2 63	2 31
t_{20}	1 26	1 24	0 42	0 60	2 35	2 06
t_{21}	1 30	1 27	0 43	0 63	2 40	2 14
t_{22}	1 25	1 24	0 56	0 68	2 60	2 25
t_{23}	1 40	1 38	0 45	0 67	2 48	2 19
t_{24}	1 30	1 26	0 58	0 79	2 73	2 35
t_{25}	1 33	1 27	0 68	0 77	2 53	2 18
t_{26}	1 40	1 36	0 60	0 80	2 75	2 39
t_{27}	1 26	1 22	0 60	0 75	2 51	2 18

* MAP - Month After Planting

Appendix 37 Treatment means Content of P Ca Mg Fe and Zn in index leaf (Experiment II)

Treatments	P content %				Ca %	Mg %	Fe ppm	Zn %
	2MAP	4MAP	Shooting	Harvest	Ca%	Mg%	Fe(ppm)	Zn%
t_1	0 11	0 12	0 46	0 42	0 37	0 055	183 5	0 42
t_2	0 11	0 12	0 48	0 45	0 32	0 052	186 5	0 42
t_3	0 12	0 14	0 56	0 51	0 36	0 057	179 5	0 42
t_4	0 12	0 14	0 45	0 41	0 28	0 041	189 5	0 41
t_5	0 13	0 14	0 57	0 50	0 30	0 042	189 0	0 41
t_6	0 13	0 14	0 48	0 42	0 32	0 041	191 5	0 42
t_7	0 14	0 15	0 57	0 51	0 31	0 041	182 5	0 46
t_8	0 13	0 15	0 48	0 44	0 32	0 046	181 5	0 43
t_9	0 13	0 14	0 45	0 49	0 29	0 042	187 5	0 37
t_{10}	0 11	0 14	0 49	0 45	0 34	0 059	188 0	0 42
t_{11}	0 12	0 13	0 49	0 45	0 39	0 049	185 0	0 37
t_{12}	0 11	0 13	0 49	0 44	0 36	0 055	186 5	0 44
t_{13}	0 12	0 14	0 52	0 46	0 30	0 034	195 5	0 49
t_{14}	0 12	0 13	0 53	0 48	0 30	0 035	191 0	0 50
t_{15}	0 12	0 13	0 54	0 48	0 26	0 039	194 0	0 47
t_{16}	0 14	0 15	0 55	0 49	0 25	0 037	188 5	0 41
t_{17}	0 13	0 15	0 54	0 48	0 25	0 043	191 5	0 47
t_{18}	0 14	0 14	0 54	0 48	0 29	0 036	191 0	0 37
t_{19}	0 12	0 13	0 52	0 46	0 36	0 050	190 5	0 41
t_{20}	0 12	0 13	0 52	0 48	0 37	0 062	191 5	0 45
t_{21}	0 12	0 12	0 46	0 42	0 33	0 048	186 5	0 40
t_{22}	0 14	0 14	0 56	0 48	0 29	0 047	181 5	0 44
t_{23}	0 13	0 13	0 51	0 46	0 23	0 039	182 5	0 43
t_{24}	0 14	0 14	0 57	0 51	0 27	0 039	190 5	0 42
t_{25}	0 12	0 14	0 50	0 46	0 23	0 038	179 0	0 37
t_{26}	0 13	0 15	0 56	0 52	0 26	0 042	181 5	0 36
t_{27}	0 13	0 14	0 52	0 46	0 28	0 044	178 5	0 33

* MAP - Month After Planting

Appendix 38 Cost of cultivation for tissue cultured banana (excluding cost of fertilizers and charges for fertilizer application

Sl No	Details	Number of labourers	Quantity	Amount First crop Rs 65/Lbr	Amount First crop Rs 67/Lbr
1	Cleaning of land	22	-	1430	1474
2	Earthing up	25	-	1625	1675
3	Making irrigation and drainage channels	5		325	335
4	Taking pits	25	-	1625	1675
5	Planting material	-	-	15750	15750
6	Plouting	12	-	780	804
7	Shading	8	-	520	536
8	Cowdung 10 kg/plant		25 T	7500	8125
9	Gap filling	1		65	67
10	Cowdung application	8	-	520	536
11	Irrigation after planting	50	-	3250	3350
12	Cost of fertilizers	-	-	-	-
13	Fertilizer application	-	-		-
14	Irrigation after fertilizer application	25	-	1625	1675
15	Irrigationduring summer months	75	-	4875	5025
16	Clearing channels	5	-	325	335
17	Weeding and earthing up	50	-	3250	3350
18	Desuckering	4	-	260	268
19	Phorate		197kg	10835	10835
20	Application of phorate	10	-	650	670
21	Propping and bunch covering	25	-	1625	1675
22	Cost of propping material	-	Rs 3/plant	7500	7500
23	Harvesting and transporting	20	-	1300	1340
24	Total amount	-		65635	67000

Appendix 39 a Cost of fertilizers used for different treatments

Sl No	Treat-ments	N	P	K	Urea	SSP	MOP	Urea	SSP	MOP	Amount Urea	SSP	MOP	Total amount
		per plant			per plant			per ha kg						
1	T_1	200	115	300	435	718	500	1088	1795	1250	3155	9693	4063	16911
2	T_2	200	115	300	435	718	500	1088	1795	1250	3155	9693	4063	16911
3	T_3	200	115	300	435	718	500	1088	1795	1250	3155	9693	4063	16911
4	T_4	200	115	450	435	718	750	1088	1795	1875	3155	9693	6094	18942
5	T_5	200	115	450	435	718	750	1088	1795	1875	3155	9693	6094	18942
6	T_6	200	115	450	435	718	750	1088	1795	1875	3155	9693	6094	18942
7	T_7	200	115	600	435	718	1000	1088	1795	2500	3155	9693	8125	20973
8	T_8	200	115	600	435	718	1000	1088	1795	2500	3155	9693	8125	20973
9	T_9	200	115	600	435	718	1000	1088	1795	2500	3155	9693	8125	20973
10	T_{10}	300	115	300	652	718	500	1630	1795	1250	4727	9693	4063	18483
11	T_{11}	300	115	300	652	718	500	1630	1795	1250	4727	9693	4063	18483
12	T_{12}	300	115	300	652	718	500	1630	1795	1250	4727	9693	4063	18483
13	T_{13}	300	115	450	652	718	750	1630	1795	1875	4727	9693	6094	20514
14	T_{14}	300	115	450	652	718	750	1630	1795	1875	4727	9693	6094	20514
15	T_{15}	300	115	450	652	718	750	1630	1795	1875	4727	9693	6094	20514
16	T_{16}	300	115	600	652	718	1000	1630	1795	2500	4727	9693	8125	22545
17	T_{17}	300	115	600	652	718	1000	1630	1795	2500	4727	9693	8125	22545
18	T_{18}	300	115	600	652	718	1000	1630	1795	2500	4727	9693	8125	22545
19	T_{19}	400	115	300	870	718	500	2175	1795	1250	6308	9693	4063	20064
20	T_{20}	400	115	300	870	718	500	2175	1795	1250	6308	9693	4063	20064
21	T_{21}	400	115	300	870	718	500	2175	1795	1250	6308	9693	4063	20064
22	T_{22}	400	115	450	870	718	750	2175	1795	1875	6308	9693	6094	22095
23	T_{23}	400	115	450	870	718	750	2175	1795	1875	6308	9693	6094	22095
24	T_{24}	400	115	450	870	718	750	2175	1795	1875	6308	9693	6094	22095
25	T_{25}	400	115	600	870	718	1000	2175	1795	2500	6308	9693	8125	24126
26	T_{26}	400	115	600	870	718	1000	2175	1795	2500	6308	9693	8125	24126
27	T_{27}	400	115	600	870	718	1000	2175	1795	2500	6308	9693	8125	24126
28	PP	190	115	300	413	718	500	1033	1795	1250	2996	9693	4063	16752

SSP- Single Super Phosphate MOP-
Single Sper Phosphate Rs 5 40/kg

Appendix 39 b Cost of fertilizers for different catments

Sl No	Treatment	N K per plant		Urea Mop g plant^{-1}		Urea Mop kg ha^{-1}		Amount Rs urea	Rs Mop	* SSP Rs	Total Rs
1	T_1	200	300	435	500	1088	1250	3003	2400	10411	15814
2	T_2	200	300	435	500	1088	1250	3003	2400	10411	15814
3	T_3	200	300	435	500	1088	1250	3003	2400	10411	15814
4	T_4	200	450	435	750	1088	1875	3003	3600	10411	17014
5	T_5	200	450	435	750	1088	1875	3003	3600	10411	17014
6	T_6	200	450	435	750	1088	1875	3003	3600	10411	17014
7	T_7	200	600	435	1000	1088	2500	3003	4800	10411	18214
8	T_8	200	600	435	1000	1088	2500	3003	4800	10411	18214
9	T_9	200	600	435	1000	1088	2500	3003	4800	10411	18214
10	T_{10}	300	300	652	500	1630	1250	4499	2400	10411	17310
11	T_{11}	300	300	652	500	1630	1250	4499	2400	10411	17310
12	T_{12}	300	300	652	500	1630	1250	4499	2400	10411	17310
13	T_{13}	300	450	652	750	1630	1875	4499	3600	10411	18510
14	T_{14}	300	450	652	750	1630	1875	4499	3600	10411	18510
15	T_{15}	300	450	652	750	1630	1875	4499	3600	10111	18510
16	T_{16}	300	600	652	1000	1630	2500	4499	4800	10411	19710
17	T_{17}	300	600	652	1000	1630	2500	4499	4800	10411	19710
18	T_{18}	300	600	652	1000	1630	2500	4499	4800	10411	19710
19	T_{19}	400	300	870	500	2175	1250	6003	2400	10411	18814
20	T_{20}	400	300	870	500	2175	1250	6003	2400	10411	18814
21	T_{21}	400	300	870	500	2175	1250	6003	2400	10411	18814
22	T_{22}	400	450	870	750	2175	1875	6003	3600	10411	20014
23	T_{23}	400	450	870	750	2175	1875	6003	3600	10411	20014
24	T_{24}	400	450	870	750	2175	1875	6003	3600	10411	20014
25	T_{25}	400	600	870	1000	2175	2500	6003	4800	10411	21214
26	T_{26}	400	600	870	1000	2175	2500	6003	4800	10411	21214
27	T_{27}	400	600	870	1000	2175	2500	6003	4800	10411	21214
28	PP	190	300	413	500	1033	1250	2851	2400	10411	15662

* P 115 g plant^{-1} SSP 718 g plant^{-1} 1795 kg ha^{-1}
Urea Rs 3 20/kg SSP 5 80/kg Mop Rs 1 92/kg
SSP - Single super phosphate Mop Muriate of potash

Appendix 40 a Total cost of cultivation for tissue culture banana (Experiment II)

Treatment	Expenditure except for fertilizers	Cost of fertilizer Rs	Expenditure of fertilizer application	Interest on working capital Rs 10%/annum	Total
T_1	65635	16911	3120	8566	94232
T_2	65635	16911	4160	8670	95376
T_3	65635	16911	3640	8619	94805
T_4	65635	18942	3120	8770	96467
T_5	65635	18942	4160	8874	97611
T_6	65635	18942	3640	8822	97039
T_7	65635	20973	3120	8973	98701
T_8	65635	20973	4160	9077	99845
T_9	65635	20973	3640	9025	99273
T_{10}	65635	18483	3120	8724	95962
T_{11}	65635	18483	4160	8828	97106
T_{12}	65635	18483	3640	8776	96534
T_{13}	65635	20514	3120	8927	98196
T_{14}	65635	20514	4160	9031	99340
T_{15}	65635	20514	3640	8979	98768
T_{16}	65635	22545	3120	9130	100430
T_{17}	65635	22545	4160	9234	101574
T_{18}	65635	22545	3640	9182	101002
T_{19}	65635	20064	3120	8882	97701
T_{20}	65635	20064	4160	8986	98845
T_{21}	65635	20064	3640	8934	98273
T_{22}	65635	22095	3120	9085	99935
T_{23}	65635	22095	4160	9189	101079
T_{24}	65635	22095	3640	9137	100507
T_{25}	65635	24126	3120	8976	98737
T_{26}	65635	24126	4160	9392	103313
T_{27}	65635	24126	3640	9340	102741
PP	65635	16752	3120	8550	94057
Ac	65635	—		6564	72199

Appendix 40 b Total cost of cultivation for tissue culture banana (Experiment II)

Treatment	Expenditure except for fertilizers	Cost of fertilizer Rs	Expenditure for fertilizer application	Interest on working capital Rs 10%/annum	Total
T_1	67000	15814	3216	8603	94633
T_2	67000	15814	4288	8710	95812
T_3	67000	15814	3752	8657	95223
T_4	67000	17014	3216	8723	95953
T_5	67000	17014	4288	8830	97132
T_6	67000	17014	3752	8777	96543
T_7	67000	18214	3216	8843	97273
T_8	67000	18214	4288	8950	98452
T_9	67000	18214	3752	8897	97863
T_{10}	67000	17310	3216	8753	96279
T_{11}	67000	17310	4288	8860	97458
T_{12}	67000	17310	3752	8806	96868
T_{13}	67000	18510	3216	8873	97599
T_{14}	67000	18510	4288	8980	98778
T_{15}	67000	18510	3752	8926	98188
T_{16}	67000	19710	3216	8993	98919
T_{17}	67000	19710	4288	9100	100098
T_{18}	67000	19710	3752	9046	99508
T_{19}	67000	18814	3216	8903	97933
T_{20}	67000	18814	4288	9004	99046
T_{21}	67000	18814	3752	8957	98523
T_{22}	67000	20014	3216	9023	99253
T_{23}	67000	20014	4288	9124	100366
T_{24}	67000	20014	3752	9077	99843
T_{25}	67000	21214	3216	9143	100573
T_{26}	67000	21214	4288	9250	101752
T_{27}	67000	21214	3752	9197	101163
PP	67000	15662	3216	8588	94466
AC	–	–	–	6700	73700

ABSTRACT

The present study was under taken with the objective of comparing the growth pattern, flowering and yield potential of tissue cultured plants of Nendran banana with that of plants produced from suckers and to formulate a suitable fertilizer schedule for the tissue cultured plants Two separate experiments were conducted for this purpose in the Department of Horticulture College of Agriculture Vellayani for two seasons from March 1991 to February 1993 The first experiment was laidout in split split plot technique and the second in confounded factorial design in RBD

Tissue cultured plants recorded an increase in yield of 25 63 per cent compared to plants from suckers The highest yield were obtained in both seasons with the application of 300g nitrogen and 450g potash per plant NK interaction on yield was also significant Treatments with fertiliser application exceeding six splits did not enhance yield The optimum nitrogen and potash for the two seasons was 299 5g and 465 5g per plant respectively

The attributes responsible for increase in yield were length of bunch number of fingers and length and girth of finger

The tissue cultured plants produced superior quality fruits Application of 200g N per plant resulted in highest TSS (23 9^{o} bri) 22 80 per cent) sugars sugar/acid ratio (58 39) and lowest acidity (0 39 per cent) Potassium at 450g/plant resulted in highest sugar/acid ratio (48 92)

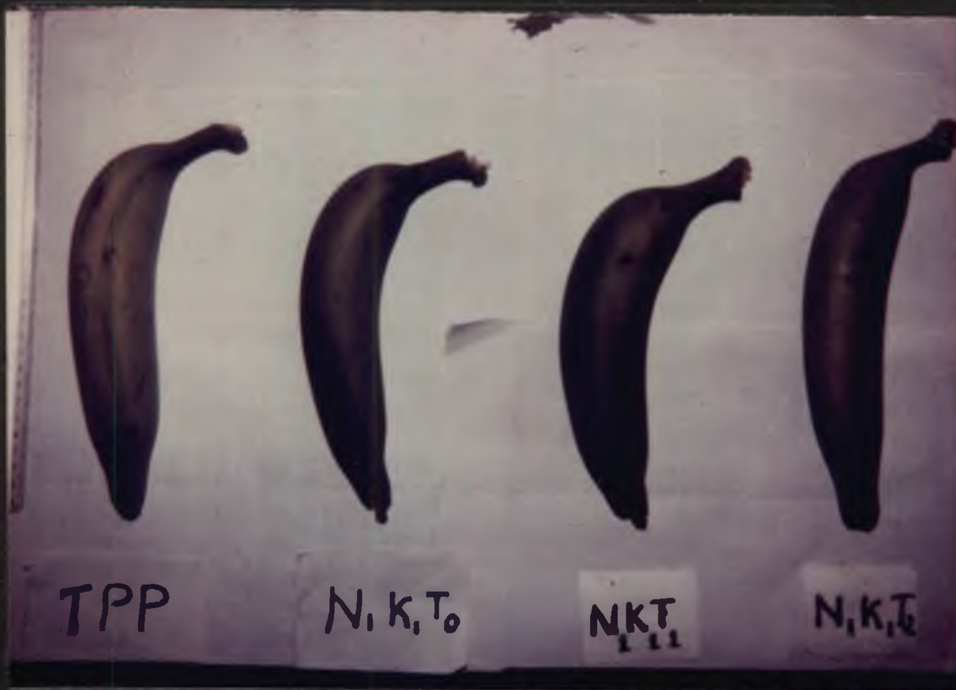
The tissue cultured plants had a slow growth rate at the early stages and a much higher growth rate during the later stages and ultimately recorded an increase of 6 7 per cent in height and 11 92 per cent in girth over the plants propagated from suckers The slow growth of the early stages of tissue cultured cultured plants enables to take up short duration intercrop such as vegetables

The tissue cultured plants had a higher leaf area compared to plants from suckers throughout their growth period and they produced 6 35 leaves more during their growth in the field

The 3 5 months old plants flowered 15 61 days earlier and could be harvested 13 19 days earlier than 2 5 months old plants

Nutrient content in index leaf (N P K Ca Mg Fe & Zn) was more in tissue cultured plants Increased application of N and K resulted in increased content of these two nutrients in index leaf The elements K and P exhibited synergism and K and Ca and K and Mg exhibited antagonism Application of 300 g N and 450 g potash per plant was able to maintain soil fertility besides giving the best yields

The study conclusively proved that tissue cultured plants of Nendran banana gave 25 per cent higher yields than the plants from suckers Highest yields were obtained by application of 300g N and 450 g potash in six splits


TPP
N1K1T0
N1K1T2


TO
N2K1T0
N2K1T1
N2K1T2


Ta2N7
Ta2R7
Sa2N7
Sa2R7