# Integrated nutrient management in dendrobiums

**By**

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**THESIS**

**Submitted in partial fulfillment of the**

**requirement for the degree of**

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# DECLARATION

I hereby declare that this thesis entitled **"Integrated nutrient management in dendrobiums "** is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship or other similar title of any other University or Society.

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# CERTIFICATE

Certified that this thesis, entitled “Integrated nutrient management in dendrobiums” is a record of research work done independently by Ms. Meghana Davis 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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*Dedicated to*
*My Beloved*
*Parents,*
*Sister*
*&*
*Husband*

# *Introduction*

# 1. INTRODUCTION

Orchids, the most spectacular among the flowers, are unique with their versatility in colour, form, size, shape and longer life span of the plant and flower. The biological adaptability of orchids to difficult habitats, their amenability to an aerial mode of life, wide range of variation in floral architecture and the specialized mechanism that they have developed for cross pollination, enable a highly successful rate of evolution.

Taxonomically orchids belong to the family Orchidaceae and they represent the most highly evolved family among monocotyledons with 600-800 genera and 25,000-35,000 species. They bear bewitchingly beautiful, intricately fabricated and long lasting flowers of myriad shapes, sizes and colours and have contributed immensely to the international trade in cut flower and potted plants.

Orchids are represented in all the continents, except in Antarctica and majority of the cultivated orchids are native to tropical countries, occurring in their greatest diversity in humid tropical forests of South and Central America, Mexico, India, Ceylon, Burma, South China, Thailand, Malaysia, Philippines, New Guinea and Australia.

India is an orchid rich country with orchids contributing to nine per cent of its flora represented by nearly 1300 species in 140 genera with the Himalayan and Western Ghats as their natural homes. The diverse climatic belts in India are highly suitable for growing orchids of various types.

The climatic condition of Kerala is highly congenial for growing orchids and is one of the leading states in India in the commercial cultivation of orchids. Commercial cultivation of orchids has started in the late 90's (Chadha, 1992). Kerala can rightly be called an open green house for orchid cultivation where orchids are found from sea level up to higher altitudes (2400metre). Tropical

orchids like *Arachnis*, *Dendrobium*, *Cattleya*, *Phalaenopsis* and *Vanda* thrive well under Kerala conditions. Among the cultivated epiphytics, dendrobiums and vandas are the most popular.

In Kerala, dendrobiums occupy more than 90 per cent of cultivated orchids. *Dendrobium* hybrids are highly floriferous and occur in all possible shape, size and colour. Being sympodial in growth, they are easy to house and maintain. But the various species and hybrids do not have synchronous flowering habit. Many of them do not have year round flowering.

The major constraints encountered in orchid cultivation are long preblooming period, susceptibility to pest and diseases, poor health, short vase life, etc. Most of these problems are because of improper nutrition and hormonal imbalance.

Application of nutrients in adequate proportion, quantities and frequencies is the key factor in regulating growth and flowering in cut flowers. Proper relationship between nutrients and hormones, major and minor nutrients, inorganic and organic forms play a significant role.

In this context, a study was undertaken in two varieties of *Dendrobium* namely Earsakul and Shavin White with the main objective of studying the effect of inorganic nutrients and organic manures on growth and flowering of orchids.

# *Review of Literature*

# 2. REVIEW OF LITERATURE

Floriculture in Kerala assumed a commercial status only in the early nineties with the introduction of orchids and anthuriums as potential crops. Orchids, aptly called as "Angel of flowers", are one among the most beautiful flowers on earth. The elegance and excellent keeping quality add immense value to use them as an ornamental plant and as a cut flower worldwide.

Orchids are perennial, herbaceous plants distributed throughout the world. *Dendrobium*, the second largest genus in the family of orchids with respect to number of species, is the most popular sympodial orchid under commercial cultivation.

As orchids are introduced recently, research work on the aspect of nutrition in *Dendrobium* is meagre in our country. In this chapter, efforts have been made to review available information on the effect of organic manures in addition with inorganic one on vegetative and floral growth in orchids.

## 2.1 EFFECT OF INORGANIC FERTILIZERS

Like any other crops, for orchids also, the macronutrients nitrogen, phosphorus and potassium are required in considerably large quantities.

In comparison study of different levels of N in growing medium of *Phalaenopsis* and *Cattleya* seedlings, Sheehan (1960) reported increase in leaf growth with increase in nitrogen application. Penningsfield and Fast (1962) reported the effect of deficient and excess uses of nitrogen in Cattleya. Increased use led to rotting of roots and leaves and deficiency resulted in yellowing and wilting of leaves.

An increase in N was found to have a favourable effect on plant height as reported by Sagarik and Siripong (1963) in young dendrobium hybrids. Northen (1970) observed that excess nitrogen to increased vegetative growth and delayed flowering in orchids. Bhattacharjee (1977) observed that spraying N, $P_2O_5$ and $K_2O$ 100 ppm each at fortnightly intervals was beneficial in *Bulbophyllum.*

The plants require macronutrients, nitrogen, phosphorus and potassium in varied amounts. It is noticed that cultivated orchids needed a little supplementary nutrition other than provided by their growing medium (Sanford, 1974).

Increased nitrogen supply in *Phalaenopsis* upto 1000 ppm produced longer flower spike and spike with increased girth. With an increase in the NPK dose of 3:2:2 to 5:5:2 improvement in flowering of *Dendrobium* Madame Pompadour was observed (Vachorotayan and Keethapirom, 1975).

Bhattacharjee (1977) reported that spraying N, $P_2O_5$ and $K_2O$ 100 ppm each at fortnightly intervals was beneficial in *Bulbophyllum*. In *Cymbidium* and *Phalaenopsis* seedlings, 100 ppm N together with 50 ppm P and 25 ppm K was found to be optimal (Poole and Seeley, 1978). Based on their studies on nutrient culture of *Cattleya, Cymbidium* and *Phalaenopsis,* they concluded that 'N' concentration was the most important factor determining growth of all the three orchid genera.

Bose (1978) suggested that growth and flowering in orchids are improved by a regular schedule of fertilizers in liquid form. Khaw and Chew (1980) reported that frequency of application of nutrient mixture has favourable effect on plant height.

According to Arditti and Ernst (1981), ammonium nitrate is the best source of N during the early ex-vitro stage of orchids. Bhattacharjee (1981) reported that effect of nitrogen, phosphorus and potassium (0,500,1000 ppm) had marked improvement on vegetative growth of *Dendrobium moschatum* grown in chunks of hardwood charcoal.

The application of liquid fertilizers, containing 500 ppm potassium nitrate, 500ppm ammonium nitrate and 100ppm ammonium sulphate on seedlings of *Cymbidium* 'Pharoah Pathfinder' resulted in overall increase in vegetative growth when applied as spray at weekly intervals for a period of 6 months (Bik and Berg, 1983). A spray of nutrient solution of N, P and K 100: 20: 75 ppm, respectively, showed improvement in growth characters in *Cymbidium* and *Cattleya* (Johnson, 1984).

Higher dose of nitrogen was found to be beneficial under outdoor cultivation of orchids and longer pseudobulbs were produced when nitrogen was applied at 48 $mgl^{-1}$ (Sakai *et al*, 1985). Schum and Fisher (1985) obtained higher number of leaves and fresh weight with N and K applied in the ratio 1:1. According to Higaki and Imamura (1987) and Schum and Fisher (1985) N and K have a beneficial effect on number of leaves and girth of stem.

Yadav and Bose (1986) reported that spraying of N, P and K at 1000 ppm each, enhanced length and number of leaves in *Aerides multiflorum*, but plants deficient in nitrogen showed stunted growth and early maturity. In study conducted by Uesato *et al* (1987) in *Dendrobium* 'Lim Hepa' reported that by increasing N dose from 50 to 300 ppm and K dose from 25 to 150 ppm gave positive results with respect to vegetative growth. Nitrogen at 300 ppm delayed flowering and enhanced stem length.

In *Cattleya* and *Phalaenopsis*, with an increase of NPK dose from 77:15.5:39.1ppm to 308:62:156.40 ppm resulted in early flowering, increased

fresh weight and increased N and K content in leaves (Tanaka *et al*.1981, 1988a, 1988b and 1989).

Based on a nutrition trial conducted by Longman (1989) recommended foliar feeding of mature flowering plants of orchids using NPK at 18:18:18 was recommended, however NPK at 10: 30: 30 produced more number of spikes per year.

A fertilizer mixture of NPK (30:10:10) rich in nitrogen was found to be good for vegetative growth of orchids as reported by Boodley (1981); Linda (1987); Stewart (1988); Marguerite (1989) and Peter (1990). Abraham and Vatsala (1981) and Singh (1992) reported that N has significant influence on the vegetative growth of orchids. Stewart (1988) recommended a combination of 3:1:1 NPK for better vegetative growth and 1:1:1 for sustained growth respectively.

Seeni and Latha (1990) suggested that combination of diammonium phosphate and potassium nitrate (20:10:10 NPK) was by far the most effective in terms of rapid leaf and root growth in *phalaenopsis*. A trial conducted to study the uptake of nitrate and ammonium by *Cymbidium sp*., *Bombidia sp* and *Dendrobium* cv. White Fairy resulted in higher uptake rate for ammonium (Hew C.S, 1993).

Wang and Gregg (1994) reported that increasing the nitrogen application from 0.25 to 1.00$gl^{-1}$ increased the flower number, stalk diameter and stalk length. NPK 17:17:17 complex sprayed at weekly intervals at 10$gl^{-1}$ could increase the number of clumps and leaves in *Cymbidium traceanum* (Sobhana and Rajeevan, 1995).

Effect of nitrate nitrogen and ammoniacal nitrogen on growth and development in *Cymbidium sinensis* was studied by Ruichi *et al* (1994).Wang

(1996) reported that fertilizer application using 20.0, 8.6 and 16.6 NPK @1 $gl^{-1}$ in *Dendrobium* Renappa resulted in more number of inflorescence and flowers

Application of 100 ppm BA along with 30:10:10 (0.1%) NPK at 123 days after planting (DAP) resulted in early flowering in *Dendrobium* Sonia-17 (Devi and Chezhiyan, 2002). Nitrogen has a positive response on vegetative growth. Phosphorus is related with growth and early maturity, potassium is involved in enzyme activation, translocation of assimilates, protein synthesis and nitrogen uptake (Tisdale *et al*., 1995).

Wang (1996) observed that higher N rate produced wider leaf spread, more and larger leaves and greater total leaf area, regardless of the type of fertilizer used in young seedlings of *Phalaenopsis* cv. Tam Butterfly. In *Phalaenopsis* Pink Chiffon, an increment of nitrogen from 50 to 1000 ppm, showed positive results on vegetative aspects, especially on the number of leaves and leaf area (Sheehan, 1996).

Thekkayam (1996) reported that application of 300 ppm N, 400 ppm P and 300 ppm K from the time of planting to nine months after planting and thereafter a dosage of 400 to 500 ppm N, 400 ppm P and 500 ppm K showed positive results in *Arachnis* 'Maggie Oei Red Ribbon' grown in trenches .

Taejung *et al* (1998) reported that healthy compact plants were produced in *Cymbidium* with NPK combination having high content of K. Leaf analysis showed high N content when 30:10:10 NPK was applied and least, when 6:40:6 NPK was given.

Yoneda *et al* (1999) studied the effect of macro element concentration on growth, flowering and nutrient absorption in *Odontoglossum* hybrid. They observed that low N rates resulted in shorter and thinner stalks, fewer flowers and advanced flowering date. Studies conducted by Umamaheswari

(1999) indicated that nutrient recommendation of 2.0 mg NPK each from three to six months, 6:2:2 NPK from six to nine months and 6:2:6 NPK from nine to twelve months were noticed good for growing orchids.

Swapna (2000) noticed that application of NPK as ammonium nitrate, orthophosphoric acid and potassium nitrate 10:20:20 at 0.2 percent was significantly superior to all other nutrient treatments for highest spike production in *Dendrobium* var. Sonia 17. Nandini (2000) reported that *ex vitro* established six months old tissue cultured plants of *Dendrobium* cv. Sonia 17 when treated with NPK 30:10:10 at 0.2 percent concentration along with BA 200 ppm proved very effective in improving the leaf parameters such as length of leaf (12.85 cm), width of leaf (6.04 cm) and perimeter of the leaf (32.15 cm)

Nair (2001) reported that the concentration of nitrogen significantly influenced the shoot emergence in Sonia 17. Fertilizer mixture of N: $P_2O_5$: $K_2O$ 3:6:1 applied during vegetative period and 1:2:2 applied during flowering period is very effective in orchids (KAU, 2002).

In Zinnia, different treatment combinations of NPK fertilizers, 10:30:30, 20:30:30, and 30:20:20 and 30:20:30 were practiced. Out of which, the treatment combination 30:20:20 NPK showed maximum plant height, number of lateral shoots, number of leaves, leaf area, number of flowers/plant and flower size (Javid *et al*, 2005).

## 2. 2. EFFECT OF ORGANIC MANURES

Chinnaswamy (1967) reported that the mixture of organic and inorganic fertilizers gave better results than organic manures given alone on tomatoes. According to Wue *et al* (1994), application of organic manures @10-40 percent promoted growth significantly in *Phalaenopsis*. A study in spinach showed that growth was increased by the application of organic manure (Sorin

and Tanaka, 1991). The application of organic supplements had a positive effect on the growth parameters, especially in brinjal (Prasanna, 1998).

Kumaraswami (2002) reported that complete substitution of inorganic fertilizers by organic manures like vermicompost is not suitable. This is because the nutrient concentration of organic manure is generally low compared to inorganic fertilizers, signifying the need to apply very large quantities to meet the crop nutrient requirement.

### 2.2.1 Farmyard manure

Farmyard manure applied will supply available nutrients directly to the plant and also had solubilizing effect on fixed form of nutrients in the soil (Sinha *et al.*, 1981). Chellamuthu (1978) reported that application of nitrogen as FYM registered the highest available nitrogen content as against inorganic source of nitrogen and control.

The increase in available nitrogen status by continuous addition of FYM was reported by Singh *et al* (1980) and Gupta *et al* (1983). Subbiah *et al* (1983) reported that the yield of brinjal fruit was significantly influenced by the level of farmyard manure, but not by the levels of fertilizers or by the interaction between FYM and inorganic fertilizers

Nair and Peter (1990) reported highest yield in chilli grown with FYM and NPK in three seasons when compared to FYM alone or inorganic fertilizers alone. Dhanorkar *et al* (1994) reported that continuous use of FYM raised the available K by 1.3 to 5.4 fold over control on tomato fruits.

Minhas and Sood (1994) opined that FYM application was beneficial in enhancing the uptake of all three major nutrients by potato and

maize. The available nitrogen was higher in treatments receiving entire dose of nitrogen as organic manure in *Phyllanthus amarus* (Prameela, 1996).

Khandkar and Nigam (1996) found that rhizome yield increased with increase in levels of FYM and application of FYM found superior for number of leaves and number of tillers per plant than that of an amended control in ginger.

In turmeric, Gill *et al* (1999) concluded that application of FYM produced higher rhizome yield. They also reported that nitrogen content was increased in plants, applied with FYM. Application of FYM in the soil improved the physical and biological properties of soil and also enhanced plant growth and N, P and K content of leaf (Reddy and Swamy, 2000).

The application of FYM produced significantly higher number of shoots on scented geranium *(Pelargonium graveolens*), while no significant difference was observed in this parameter due to N fertilizer application. The total number of shoots per plant was also highest for 30 t FYM/ha as compared to inorganic fertilizer application (Bhaskar *et al*., 2001).

Singh (2004) reported significant increase in N, P and K, leaf area index, plant height, weight of the flowers during first flush and yield of flowers in rose plant with application of FYM (5 kg $m^{-2}$). It was observed that application of FYM delayed flowering in rose plant, where as diameter of flowers, number of petals/flower were significantly higher with application of FYM as compared to control.

### 2.2.2 Panchagavya

Vrikshayrveda defined certain plant growth stimulants. Among them panchagavya is an important one that helps to enhance the biological efficiency of crop plants and enhance the quality of fruits and vegetables (Anon., 2001). Panchagavya is prepared from five components got from cow, namely urine, dung, milk, curd and ghee.

According to Varahamihira (Brahat samhita, 505-587 AD), the general practice of sowing seeds involve soaking them in milk for 10 days, taking out daily with hand, smearing with ghee, rolling many times in cow dung before seeds are sown in soil. They grew and bloomed when sprinkled with milk and water. (Deshpande and Menon, 1995).

Panchagavya contains a lot of macro, micro nutrients and growth regulators like auxins, GA, which helps to increase the growth parameters and flowering characters (Kanimozhi, 2004).cytokinin have a property of induction of more number of shoots and leaves. Production of multiple inflorescence by cytokinin (BA) and regulation of flowering by gibberellins were reported in orchids by Yadav and Bose (1989).

#### 2.2.2.1 Constituents of panchagavya

##### 2.2.2.1.1 Cow's milk

Cow's milk is reported to be an excellent sticker and spreader (casein), and a good medium for saprophytic bacteria and virus inhibitors (Nene, 1999). Milk contains proteins, fat, carbohydrates, amino acid, Ca, lactic acid and lactobacillus bacterium. Vrikshayurveda of Chavundaraya, which dealt with agriculture and botany, described the use of milk that changed the flower colour and enhanced the fruit taste (Shenoy *et al.,* 2000).

#### 2.2.2.1.2 Cow's ghee

Ghee not only contains Vitamin A and B, Ca, fat etc.and but also contain glycosides, which protected cut wounds from infection.

#### 2.2.2.1.3 Cow curd

Cow's curd is rich in microbes (*Lactobacillus* sp) that are responsible for fermentation (Chadha, 1996).

#### 2.2.2.1.4 Cow dung

Singh (1996) recorded that cowdung contain 82 % water and 18 % solid matter (minerals 0.1 %, ash 2.4 %, organic matter 14.6 %, Ca and Mg 0.4 %, $SO_3$ 0.05 %, silica 1.5 %, N 0.5 %, P 0.2 % and K 0.5 %).

Nene (1999) reported that cowdung had been used by Kautilya (32-296 BC); Varahamihira (505-587 AD) in ancient history. It contained undigested fibre, epithelial cells, pigments and salts, rich in N, P, K, S, micronutrients and intestinal bacteria and mucous. Cow dung is rich in bacteria, fungi and other microbial organisms

#### 2.2.2.1.5 Cow's urine

Singh (1996) reported that cow's urine contains uric acid and hippuric acid in large quantities along with other mineral matters like NaCl, sulphates of Ca and Mg, P and hippurate etc. It contains 1.4 % minerals, 2 % ash, 1 % N and traces of P, K. Cow's urine which is rich in urea acted both as a nutrient as well as hormone (Reddy, 1998).

#### 2.2.2.1.6. Coconut water

Foliar spray of coconut water as a growth hormone increased the chlorophyll content. The application of coconut water increased cytokinin content which in turn increased the chlorophyll content and photosynthetic activity for longer period (Kalarani, 1991), increased the biomass and yield up to 200 % over control (Mamaril and Lopez, 1997).

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### 2.2.2.2 Influence of panchagavya on growth, yield and quality of crops

In annual moringa, panchagavya spraying doubled the fruit yield besides giving resistance against pests and diseases (Vivekanadan, 1999a). In rose cultivars, *Rosa bourbiana* and *Rosa centifolia*, a treatment combination of calcium acetate 0.5 % with panchagavya 5 % proved to be effective in improving height of bush in both cultivars on $30^{th}$ and $60^{th}$ day respectively after planting. (Thamaraiselvi, 2001).

Singh (1996) reported significantly higher diameter, maximum length of setting and retaining percent with foliar spray of cytosine in peach trees. Panchagavya spray @ 1.0 % reduced flower drop, increased fruit size, retained freshness and enhanced taste in rice (Vivekanandan, 1999b).

Panchagavya on chilli produced dark green leaves and new growth within 10 days (Subhashini *et al*, 2001). The key feature of panchagavya was its efficacy to restore the yield level of all crops during the transitory period from very first year (Natarajan, 2002).

Panchagavya and vermicompost combination had given the highest pod yield of French bean, which was 30 % higher than conventional methods (Selvraj, 2003). Kanimozhi (2003) reported that, organic growth promoters were found to be more superior to synthetic bio promoters in *Coleus forskohli*

### 2.2.3 Vermiwash

Ismail (1995) reported that vermiwash application in foliar form could be very effective for lawns and orchards. Growth hormones and other growth promoting substances are present in vermiwash (Grappelli *et al*., 1987, Tomati *et al*., 1983 and Neilson, 1965). Vermiwash contains N 0.02 %, P 0.007 %, K 0.100 %, and Zn 170 ppm and some nitrogen fixing bacteria, nitrosomonas and nitrobacter.

Nitrogen present in vermiwash helps to promote vegetative growth (Ramachandran and Thimmaraju., 1983). Ushakumari *et al* (1996) have made similar observations when vermicompost was used as an organic source along with inorganic fertilizers for chilli. Higher uptake of P in rice treated with vermiwash was observed by Kale *et al* (1992).

Phebe (1998) studied that the addition of vermicompost showed increased ascorbic acid content in snake gourd. Vermiwash reduced the requirement for chemical fertilizer in cowpea and bitter gourd (Jiji *et al*., 1996). Jasmin (1999) reported that vermiwash application in conjunction with organic manures could increase the yield and quality parameters of fruits of tomato.

Application of vermiwash increased the growth parameters in chilli (Zacharia, 1995 and Rajalekshmi, 1996). In tomato plants, fruit size and number of fruits produced was higher, when vermiwash application was done (Pushpa, 1996). Sagaya and Gunathilaguraj (1996) Arun Kumar (1997) reported that the numbers of leaves in chilli plants were increased by the application of vermiwash. Arunkumar (2000) reported that amaranthus plants gave better yield when vermiwash was applied as fertilizer.

In studies conducted by Saha *et al* (2005), a positive result was marked with organic manures like, vermicompost and vermiwash on aloevera (*Aloe barbadensis*), where plant height, number of leaves per plant and

chlorophyll content were increased when it was treated with organic manures, than inorganic one.

Haripriya and Poonkodi (2005) reported that vermiwash application resulted in better yield parameters, like increased number of flowers and more petals in flower in tuberose plants. According to them, vermiwash contain 1.16 ppm dissolved oxygen, 50 micro gram inorganic phosphate $l^{-1}$, 68 ppm potassium and 121 ppm sodium.

Vermiwash is a transparent, pale yellow, liquid biofertilizer. It is a mixture of excretory products and mucous secretion of earthworms (*Lampito mauritii* and *Eisenia fetida*) and organic micronutrients of soil, which may be promoted as a potent fertilizer for better growth and yield of plants (Shweta *et al*., 2005).

Significant increase in biological and gel yield, plant height, number of leaves per plant and chlorophyll content were observed in aloevera (*A. barbadensis)* due to fertilizer treatments. Organic manure in the form of vermicompost and vermiwash were effective and comparable to the inorganic fertilizers in increasing gel moisture, gel ash and aloin content. The organic aloevera thus produced was expected to be a better marketable product. (Saha *et al*., 2005).

# *Materials and Methods*

# 3. MATERIALS AND METHODS

The present study entitled "Integrated nutrient management in dendrobiums" was conducted to determine the effect of organic manures on growth and flowering of *Dendrobium* in combination with inorganic fertilizers. It was carried out in the orchidarium of All India Co-ordinated Floriculture Improvement Project in the Department of Pomology and Floriculture, College of Horticulture, Vellanikkara from March 2005 to June 2007.

## 3.1 MATERIALS UTILIZED

### 3.1.1 Variety

Two well known hybrid varieties of *Dendrobium* namely Earsakul and Shavin White were used for the experiment.

### 3.1.2 Planting material

Three months old *ex vitro* tissue cultured plants of the varieties Ersakul and Shavin White were used.

### 3.1.3 Potting media

A media containing tile pieces, charcoal and coconut fibre were used.

### 3.1.4 Shading

The plants were grown under 50 per cent shade provided by green coloured shade nets.

### 3.1.5 Inorganic fertilizers

The inorganic fertilizers NPK 30:10:10 and 13:27:27 @ 0.2 % were applied as foliar sprays during vegetative and flowering stages respectively.

**Plate. 1. Variety used for the study – *Dendrobium* Earsakul**

**Plate. 2 . Variety used for the study – *Dendrobium* Shavin White**

### 3.1.6 Organic manures

Organic manures such as modified form of panchagavya, Manchurian tea, vermiwash and fermented farmyard manure were used and they were applied at fortnightly intervals.

## 3.2 METHOD

### 3.2.1 Design of the experiment

The experiment was laid out in CRD with 9 treatments, 3 replications and 4 plants per replication. .

### 3.2.2 Nutrient treatments

Treatments comprised of a combination of organic manures along with inorganic one.

$T_1$ – Control (Recommended dose:-Vegetative stage- Foliar spray of 30:10:10 (0.2%) NPK –twice weekly and fermented FYM (4-5 days) - 1:10 fortnightly, Flowering stage- foliar spray of 13:27:27 (0.2%), NPK twice weekly and fermented FYM (4-5 days) –1:10 fortnightly).

$T_2$ - 50% recommended dose

$T_3$ - 50% recommended dose + 3% Manchurian tea

$T_4$ - 50% recommended dose + 3% modified form of panchagavya

$T_5$ - 50% recommended dose + 3% Manchurian tea + 3% modified form of panchagavya

$T_6$ - 50% recommended dose + 3% vermiwash

$T_7$ - 50% recommended dose + 3% vermiwash + 3% Manchurian tea

$T_8$ -50% recommended dose + 3% vermiwash + 3% modified form of panchagavya

$T_9$ - 50% recommended dose + 3% vermiwash + 3% Manchurian tea + 3% modified form of panchagavya

### 3.2.3 Plant protection

For fungal rot Akomin (3ml $l^{-1}$) and Indofil M-45 (3g $l^{-1}$) was sprayed. Snails were controlled by snail killers and poison baits.

## 3.3 OBSERVATIONS

Observations were recorded at monthly intervals from March 2005 to June 2007 for all the vegetative characters and flowering characters.

### 3.3.1 Growth characters

#### *3.3.1.1 Plant height*

The height of the plant was measured from the base of the plant upto the new emerging leaf and expressed in cm.

#### *3.3.1.2 Stem girth*

Girth of the stem was measured and recorded in cm.

#### *3.3.1.3 Number of leaves*

Number of leaves on each shoot were counted and recorded.

#### *3.3.1.4 Leaf length*

Length of the leaf was measured and expressed in cm.

#### *3.3.1.5 Leaf width*

Width of one leaf was measured and recorded in cm.

#### *3.3.1.6 Internodal length*

The distance between two adjacent nodes on each plant was measured and recorded in cm.

#### *3.3.1.7 Number of shoots*

Number of leafy shoots and leafless shoots were counted separately and recorded.

### 3.3.2 Floral characters

#### *3.3.2.1 Days to first flowering*

Total number of days taken for the first flower to open was recorded.

#### *3.3.2.2 Number of spikes per plant*

Number of spikes initiated in each plant, during the period of observation was counted and recorded.

#### *3.3.2.3 Size of flower (cm)*

Size of individual flowers was recorded by noting down the length and breadth of the flowers, expressed in cm.

#### *3.3.2.4 Spike length (cm)*

Length of spike was measured from the point of emergence to the tip of flower pedicel emergence and expressed in cm.

#### *3.3.2.5 Number of flowers per spike*

Number of flowers per spike was counted and recorded.

#### *3.3.2.6 Internodal length (cm)*

Internodal length was measured and expressed in cm.

#### *3.3.2.7 Flower pedicel length (cm)*

The length of the pedicel of individual flowers in each spike was measured and recorded.

#### *3.3.2.8 Longevity of spike on the plant (days)*

The time period between emergences of inflorescence to the wilting of first flower was recorded in days.

#### *3.3.2.9 Vase life (days)*

The number of days that the flowers can be kept fresh, after removing from the plant was observed and recorded.

#### *3.2.2.10 Colour variation*

Variation in colour of flowers was observed and recorded

### 3.3.3 Incidence of pest and diseases

Incidence of pest and diseases was also observed during the study period and prophylactic measures were taken.

### 3.3.4 Nutrient analysis

Plant parts like shoot, leaf and root were taken separately at the flowering time, washed and dried in shade for one week and then dried in oven at 65-70$^{o}$C for 6 hours. The dried samples were ground, mixed and then chemically analysed for nitrogen, phosphorus and potassium.

#### *3.3.4.1 Nitrogen*

One gram dried leaf sample was digested using concentrated sulphuric acid, oxidized using 30 % $H_2O_2$ and the N content was estimated by Microkjeldahl method (Jackson, 1958).

#### *3.3.4.2 Phosphorus*

The leaf sample (0.5 g) was digested using diacid mixture of nitric acid and perchloric acid taken in the ratio of 9:4 (Johnson and Ulrich, 1959). Finally phosphorus was estimated using vanadomolybdophosphoric yellow colour

method (Jackson, 1958). The intensity of yellow colour was read in Spectronic-20 at 470 nm.

#### *3.3.4.3 Potassium*

From the digested sample as mentioned in section 3.3.4.2, K content was estimated using a flame photometer.

## 3.4 STATISTICAL ANALYSIS

The experimental data were analysed using Duncan's Multiple Range Test (DMRT) technique. MSTATC and MS-Excel software were used for computation of data.

# *Results*

# 4. RESULTS

The results of the experiment entitled “Integrated nutrient management in dendrobiums” carried out in two hybrids, namely Earsakul and Shavin White are presented in this chapter.

## 4.1 VEGETATIVE CHARACTERS

### *4.1.1 Dendrobium* Earsakul

Trimonthly observations on growth parameters of variety Earsakul upto 27th month of planting are presented in Tables 1 to 8.

#### 4.1.1.1 Plant height

The effect of organic manures on plant height at trimonthly intervals are presented in Table 1.

When plant height was considered there was not much influence of organic manures during third month after planting. During that period the treatment $T_6$ (50 % recommended dose + 3 % vermiwash) expressed maximum value (8.78 cm) for plant height followed by $T_8$ (8.7 6cm). Almost all the treatments were found to be on par with $T_6$ except $T_5$ and $T_3$ in which $T_3$ reported minimum plant height (7.45 cm).

From sixth month onwards there was significant difference among the treatments in data pertaining to plant height. The treatment $T_6$ recorded maximum value (11.39 cm). Majority of the treatments were on par with $T_6$. The least value (8.56 cm) was recorded by $T_3$ (50 % recommended dose + 3 % Manchurian tea).

**At planting**

**Six months after planting**

**Plate. 3. View of experimental plot at different stages of growth**

Height of the plants made a progressive increase during ninth month after planting and the treatment $T_6$ reported highest value (15.85 cm). The treatment $T_8$ (50 % recommended dose + 3 % vermiwash + 3 % modified form of panchagavya) (15.16 cm) and $T_1$ (14.81 cm) were statistically on par with $T_6$.The least value was recorded by $T_3$ (10.25 cm).

Twelfth month after planting again the treatment $T_6$ showed maximum value for plant height (17.38 cm), followed by $T_8$ (17.03 cm), $T_1$ (Vegetative stage – spraying with 30:10:10 NPK (0.2 %) –twice weekly and fermented FYM (4-5 days) - 1:10 fortnightly, Flowering stage 13:27:27(0.2 %) twice/weekly and fermented FYM (4-5 days) –1:10 fortnightly). (16.56 cm) and $T_4$ (50 % recommended dose + 3 % modified form of panchagavya) and these treatments were found to be statistically on par with $T_6$. Treatment $T_3$ had the least value for plant height (13.22 cm) and the treatments were on par with $T_3$.

At the end of fifteenth month of planting the maximum value was shown by $T_6$ (18.75 cm) and the treatment $T_8$ (18.23 cm) and $T_1$ (17.76 cm) were statistically on par with $T_6$.The treatment $T_3$ recorded lowest plant height (14.78 cm) and majority of the treatments were found to be on par with $T_3$.

Eighteenth month after planting the treatments showed significant differences due to the effect of different organic manures. During that period the treatment $T_6$ had the maximum plant height value (21.01 cm) followed by $T_8$ (20.76 cm). The treatments $T_3$, $T_5$ and $T_9$ had minimum values for plant height in which $T_3$ recorded the least value (16.09 cm).

After twenty-first month of planting again the treatment $T_6$ recorded maximum value for plant height (22.18 cm) and the majority of the treatments were found to be on par with $T_6$.The least value was recorded by $T_3$ (18.92 cm).

Table 1. Plant height (cm) in *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.20$^{a}$ | 8.52$^{a}$ | 10.85$^{ab}$ | 14.81$^{abc}$ | 16.56$^{abc}$ | 17.76$^{abc}$ | 19.23$^{b}$ | 21.30$^{abcd}$ | 22.56$^{ab}$ | 22.51$^{ab}$ |
| 2 | 4.13$^{a}$ | 8.10$^{ab}$ | 9.87$^{bcd}$ | 12.95$^{cde}$ | 15.84$^{bc}$ | 16.85$^{bcd}$ | 18.75$^{bcd}$ | 20.62$^{bc}$ | 20.55$^{bcd}$ | 21.10$^{bcd}$ |
| 3 | 3.93$^{abc}$ | 7.45$^{bc}$ | 8.56$^{de}$ | 10.25$^{efg}$ | 13.22$^{def}$ | 14.78$^{cd}$ | 16.09$^{efg}$ | 18.92$^{de}$ | 18.75$^{ef}$ | 19.11$^{f}$ |
| 4 | 4.17$^{a}$ | 8.13$^{ab}$ | 10.12$^{bc}$ | 13.25$^{cd}$ | 16.32$^{abc}$ | 17.32$^{bc}$ | 19.02$^{b}$ | 20.55$^{bc}$ | 22.11$^{b}$ | 21.81$^{b}$ |
| 5 | 3.96$^{ab}$ | 7.85$^{bc}$ | 8.94$^{cd}$ | 10.33$^{efg}$ | 13.86$^{de}$ | 15.00$^{cde}$ | 17.21$^{ef}$ | 19.52$^{cde}$ | 19.41$^{def}$ | 19.80$^{de}$ |
| 6 | 4.28$^{a}$ | 8.78$^{a}$ | 11.39$^{a}$ | 15.85$^{a}$ | 17.38$^{a}$ | 18.75$^{a}$ | 21.01$^{a}$ | 22.18$^{a}$ | 22.82$^{a}$ | 23.18$^{a}$ |
| 7 | 4.01$^{ab}$ | 7.99$^{abc}$ | 9.28$^{cd}$ | 10.84$^{ef}$ | 14.56$^{bcd}$ | 15.15$^{cd}$ | 18.18$^{cd}$ | 19.63$^{cd}$ | 19.81$^{cd}$ | 20.01$^{cde}$ |
| 8 | 4.22$^{a}$ | 8.76$^{a}$ | 11.00$^{ab}$ | 15.16$^{ab}$ | 17.03$^{ab}$ | 18.23$^{a}$ | 20.76$^{ab}$ | 21.75$^{ab}$ | 22.61$^{ab}$ | 22.81$^{a}$ |
| 9 | 4.07$^{ab}$ | 7.90$^{abc}$ | 9.56$^{bcd}$ | 12.21$^{de}$ | 14.83$^{cd}$ | 15.32$^{cd}$ | 18.23$^{c}$ | 20.21$^{c}$ | 20.13$^{c}$ | 20.55$^{cd}$ |

Table 2. Number of leaves per plant in *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.32$^{ab}$ | 5.13$^{ab}$ | 6.32$^{ab}$ | 7.02$^{ab}$ | 7.57$^{bc}$ | 6.48$^{bc}$ | 6.66$^{ab}$ | 6.02$^{ab}$ | 5.55$^{abc}$ | 6.03$^{abc}$ |
| 2 | 4.01$^{b}$ | 4.18$^{b}$ | 5.31$^{c}$ | 6.13$^{bc}$ | 6.55$^{de}$ | 5.55$^{de}$ | 5.85$^{bcd}$ | 5.18$^{c}$ | 4.92$^{bcd}$ | 5.18$^{cd}$ |
| 3 | 3.78$^{b}$ | 3.23$^{cd}$ | 4.56$^{cde}$ | 4.98$^{de}$ | 5.77$^{ef}$ | 4.56$^{efgh}$ | 5.21$^{cde}$ | 4.76$^{cde}$ | 4.51$^{de}$ | 4.15$^{efgh}$ |
| 4 | 4.65$^{ab}$ | 4.51$^{abc}$ | 5.65$^{bc}$ | 6.41$^{bc}$ | 6.98$^{cd}$ | 6.03$^{c}$ | 6.00$^{bc}$ | 5.26$^{bcd}$ | 5.11$^{bc}$ | 5.56$^{bc}$ |
| 5 | 5.01$^{a}$ | 3.55$^{bcd}$ | 4.21$^{de}$ | 5.43$^{cde}$ | 5.58$^{efg}$ | 4.93$^{efg}$ | 5.19$^{cde}$ | 4.29$^{e}$ | 4.22$^{def}$ | 4.75$^{e}$ |
| 6 | 3.81$^{bc}$ | 5.56$^{a}$ | 6.71$^{a}$ | 7.48$^{a}$ | 8.33$^{a}$ | 7.53$^{a}$ | 7.03$^{a}$ | 6.22$^{a}$ | 6.08$^{a}$ | 6.38$^{a}$ |
| 7 | 4.85$^{a}$ | 3.76$^{bc}$ | 4.98$^{cd}$ | 5.78$^{bcde}$ | 6.05$^{e}$ | 5.01$^{e}$ | 5.62$^{c}$ | 5.00$^{cd}$ | 4.87$^{cd}$ | 4.50$^{ef}$ |
| 8 | 3.72$^{bc}$ | 4.85$^{ab}$ | 5.92$^{abc}$ | 6.75$^{abc}$ | 7.23$^{bcde}$ | 6.75$^{abc}$ | 6.21$^{b}$ | 5.72$^{b}$ | 5.32$^{b}$ | 5.75$^{b}$ |
| 9 | 4.99$^{a}$ | 5.81$^{a}$ | 6.65$^{a}$ | 7.13$^{ab}$ | 8.02$^{abc}$ | 7.10$^{ab}$ | 6.85$^{ab}$ | 6.18$^{a}$ | 5.92$^{ab}$ | 6.15$^{ab}$ |

Twenty fourth month after planting again the treatment $T_6$ expressed maximum value for plant height (22.82 cm) and the treatments $T_8$, $T_1$, $T_4$ and $T_9$ were found to be on par with $T_6$. During that period $T_3$ recorded lowest plant height. plant and the least value (19.11 cm) was recorded by plants receiving 50 % recommended dose of fertilizers and 3 % Manchurian tea.

Data recorded after twenty-seventh month of planting (23.18 cm) showed that treatment receiving 50 % recommended dose of fertilizers and 3 % vermiwash as organic manure showed maximum value for plant height during the entire growth of plant and the least value (19.11 cm) recorded by plants receiving 50% recommended dose of fretilizers and 3 % Manchurian tea

#### 4.1.1.2 Number of leaves per plant

Data regarding leaf production are presented in Table 2.

During third month of planting the treatment did not show any significant difference on leaf production. The maximum value was recorded by $T_9$ (5.81) and least value was noticed for $T_3$ (3.23).

Sixth month after planting treatments showed progressive increase in leaf production and significant difference was noticed. The treatment $T_6$ recorded maximum leaf production (6.71) followed by $T_1$ (6.32) and $T_8$ (5.92) and these were found to be statistically superior and on par with $T_6$.The treatment $T_5$ (4.21) showed minimum leaf production.

After ninth month of planting the treatment $T_6$ recorded more leaf production. The treatments $T_9$ (7.13) and $T_1$ (7.02) showed superior values and found to be on par with $T_9$.The treatment $T_3$ recorded minimum leaf production (4.98).

Twelfth month after planting the treatment $T_6$ recorded highest leaf production (8.33). The treatments $T_9$ (8.02), $T_1$ (7.57) and $T_8$ (7.23) were found to be on par with $T_6$.The treatment $T_5$ recorded minimum leaf production (5.58) and majority of the treatments were on par with $T_5$.

Data recorded after fifteenth month revealed that leaf production showed a decreasing trend with significant variation among the treatments. The maximum value was recorded for $T_6$ (7.53) followed by $T_9$ (7.10) and $T_8$ (6.78). The least value was recorded by $T_3$ (4.56).

After eighteenth month of planting treatment $T_6$ again showed maximum leaf production (7.03). The treatments $T_9$ (6.85) and $T_1$ (6.66) were statistically on par with $T_6$.The treatment $T_5$ recorded minimum value for leaf production (5.19).

Twenty first month after planting the treatment $T_6$ showed maximum leaf production (6.22) followed by $T_9$ (6.18). Least value was recorded for $T_5$ (4.29). Majority of the treatments were found to be on par with $T_5$ i.e. $T_3$ (4.76), $T_7$ (5.00), $T_2$ (5.18) and $T_4$ (5.26).

Twenty fourth month after planting treatment $T_6$ (6.08) showed highest leaf production followed by $T_9$ (5.92) and $T_1$ (5.55). Least leaf production was recorded for $T_5$ (4.22).

Data recorded after twenty seventh month of planting recorded maximum leaf production for $T_6$ (6.38) i.e. treatment receiving 50% inorganic fertilizers and 3% vermiwash. The treatments $T_9$ (6.15), $T_1$ (6.03) and $T_8$ (5.75) were found to be on par with $T_6$.The least leaf production value was recorded for $T_3$ (4.15).

#### 4.1.1.3 Leaf length

Data pertaining to leaf length is presented in Table 3.

During the third month of planting treatments did not show much difference. During this period $T_1$ recorded the maximum value (5.02 cm). Majority of the treatments were found to be on par with $T_1$.ie $T_6$ (4.82 cm), $T_2$ (4.75 cm), $T_3$ (4.22 cm) and $T_7$ (4.01 cm). Least value for leaf length was recorded by $T_8$ (3.23 cm).

From sixth month onwards-significant differences among treatments were reported i.e. the organic manures started to show their influence on leaf length. During this period the treatment $T_6$ (7.21 cm) recorded maximum leaf length. The treatments $T_1$ (7.03 cm) and $T_8$ (6.75 cm) were found to be statistically on par with $T_6$.The least value for leaf length was recorded by $T_5$ (4.82 cm).

Nine months after planting again the treatment $T_6$ recorded maximum value (9.13 cm) followed by $T_1$ (9.02 cm), $T_8$ (8.75 cm) and $T_2$ (8.32 cm). The least value for leaf length was recorded by $T_3$ (6.93 cm).

At twelfth month of planting the treatment $T_6$ again reported maximum leaf length (11.98 cm). The treatments $T_1$ (11.65 cm) and $T_8$ (11.22 cm) were statistically on par with $T_6$.The treatment $T_3$ again showed least value (9.89 cm).

Fifteen months after planting the maximum value for leaf length was observed for $T_6$ (12.98 cm). Treatments $T_1$ (12.75 cm) and $T_8$ (12.32 cm) were found to be on par with $T_6$. The least value was recorded by $T_3$ (10.01 cm).

Table 3. Leaf length (cm) in *Dendrobium var.Earsakul* as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the time of planting | 3MAP | 6MAP | 9MAP | 12MAP | 15MAP | 18MAP | 21MAP | 24MAP | 27MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $2.98^{abc}$ | $5.02^{a}$ | $7.03^{ab}$ | $9.02^{a}$ | $11.65^{ab}$ | $12.75^{ab}$ | $14.03^{ab}$ | $15.33^{ab}$ | $15.98^{ab}$ | $15.98^{ab}$ |
| 2 | $3.13^{ab}$ | $4.75^{a}$ | $6.11^{bc}$ | $8.32^{abcd}$ | $10.76^{bcd}$ | $11.55^{bc}$ | $13.02^{bc}$ | $14.86^{bc}$ | $14.93^{bcde}$ | $14.88^{bc}$ |
| 3 | $3.62^{a}$ | $4.22^{ab}$ | $5.05^{de}$ | $6.93^{e}$ | $9.86^{de}$ | $10.01^{ef}$ | $11.62^{def}$ | $13.35^{cde}$ | $13.18^{efg}$ | $13.27^{def}$ |
| 4 | $2.51^{b}$ | $4.13^{abc}$ | $6.38^{b}$ | $8.21^{bc}$ | $11.08^{b}$ | $11.78^{c}$ | $13.77^{abc}$ | $14.67^{bcd}$ | $15.13^{bc}$ | $14.75^{bc}$ |
| 5 | $3.92^{ab}$ | $3.95^{b}$ | $4.82^{ef}$ | $7.28^{cde}$ | $10.21^{cd}$ | $10.62^{de}$ | $12.01^{d}$ | $13.21^{def}$ | $13.78^{e}$ | $13.89^{d}$ |
| 6 | $3.55^{a}$ | $4.82^{a}$ | $7.21^{a}$ | $9.13^{a}$ | $11.98^{a}$ | $12.98^{a}$ | $14.22^{a}$ | $15.53^{a}$ | $16.11^{a}$ | $16.18^{a}$ |
| 7 | $3.78^{ab}$ | $4.01^{abc}$ | $5.56^{cde}$ | $7.68^{c}$ | $10.08^{def}$ | $10.55^{def}$ | $12.32^{cd}$ | $13.58^{cd}$ | $14.22^{cde}$ | $14.18^{cd}$ |
| 8 | $3.21^{abc}$ | $3.23^{bcd}$ | $6.75^{ab}$ | $8.75^{ab}$ | $11.22^{abc}$ | $12.32^{ab}$ | $13.92^{ab}$ | $15.01^{abcd}$ | $15.54^{abc}$ | $15.65^{abc}$ |
| 9 | $2.85^{abcd}$ | $3.78^{bc}$ | $5.99^{cd}$ | $7.92^{bcde}$ | $10.41^{bcde}$ | $10.98^{bc}$ | $12.68^{cde}$ | $13.92^{e}$ | $14.61^{cd}$ | $14.51^{bcd}$ |

Table 4. Leaf width (cm) in *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the time of planting | 3MAP | 6MAP | 9MAP | 12MAP | 15MAP | 18MAP | 21MAP | 24MAP | 27MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $1.53^{abc}$ | $1.99^{b}$ | $2.66^{abc}$ | $3.48^{ab}$ | $3.18^{abc}$ | $3.55^{ab}$ | $3.72^{ab}$ | $3.62^{ab}$ | $3.73^{ab}$ | $3.94^{abc}$ |
| 2 | $1.81^{ab}$ | $2.31^{a}$ | $2.11^{bc}$ | $2.85^{b}$ | $2.53^{bc}$ | $2.75^{bc}$ | $2.95^{bc}$ | $3.08^{bcd}$ | $3.08^{bc}$ | $3.08^{cd}$ |
| 3 | $2.03^{ab}$ | $1.85^{b}$ | $1.08^{cde}$ | $2.20^{c}$ | $1.60^{cdef}$ | $1.87^{de}$ | $1.98^{e}$ | $2.01^{de}$ | $2.09^{d}$ | $2.11^{de}$ |
| 4 | $1.55^{abc}$ | $2.12^{ab}$ | $2.03^{bc}$ | $3.02^{abcde}$ | $2.83^{bc}$ | $3.03^{b}$ | $3.11^{b}$ | $3.03^{b}$ | $3.22^{b}$ | $3.26^{c}$ |
| 5 | $2.32^{a}$ | $1.76^{bc}$ | $1.20^{cd}$ | $2.02^{cde}$ | $1.63^{cdef}$ | $2.00^{d}$ | $2.10^{cd}$ | $2.51^{cd}$ | $2.22^{cde}$ | $2.40^{cdef}$ |
| 6 | $2.71^{a}$ | $2.23^{a}$ | $2.93^{a}$ | $3.61^{a}$ | $3.40^{a}$ | $3.71^{a}$ | $3.92^{a}$ | $3.81^{a}$ | $3.88^{a}$ | $4.13^{a}$ |
| 7 | $1.78^{ab}$ | $2.05^{ab}$ | $1.48^{c}$ | $2.50^{bcde}$ | $1.89^{cd}$ | $2.16^{cde}$ | $2.51^{bcde}$ | $2.42^{cd}$ | $2.61^{cd}$ | $2.28^{d}$ |
| 8 | $1.68^{ab}$ | $1.88^{b}$ | $2.41^{abcd}$ | $3.26^{abc}$ | $3.20^{abc}$ | $3.23^{abc}$ | $3.49^{abc}$ | $3.50^{abc}$ | $3.48^{abcd}$ | $3.73^{abcd}$ |
| 9 | $1.61^{a}$ | $2.32^{a}$ | $1.89^{bcd}$ | $2.73^{bc}$ | $2.05^{c}$ | $2.48^{bcd}$ | $2.32^{c}$ | $2.80^{c}$ | $2.85^{c}$ | $2.75^{cde}$ |

During eighteenth month after planting a progressive increase in leaf length was noticed. The treatments $T_6$ recorded the highest leaf length value of 14.22 cm. Majority of the treatments were found to be on par with $T_6$ i.e. $T_1$ (14.03 cm), $T_8$ (13.92 cm) and $T_4$ (13.77 cm) and the minimum value was recorded by $T_3$ (11.62 cm).

Twenty first month after planting the treatment $T_6$ (15.5 3cm) again recorded maximum leaf length value. The treatments $T_1$ (15.33 cm), $T_8$ (15.01 cm) and $T_2$ (14.86 cm) were significant and statistically on par. The treatment $T_5$ (13.21 cm), $T_3$ (13.35 cm), $T_7$ (13.58 cm) and $T_9$ (13.92 cm) showed minimum leaf length value of which $T_5$ recorded the least value.

After twenty fourth month after planting again $T_6$ recorded maximum leaf length (16.11cm) followed by $T_1$ (15.98 cm) and $T_8$ (15.54 cm). Least value was recorded by $T_3$ (13.18 cm).

The data recorded twenty-seventh month after planting revealed that the treatment $T_6$ showed maximum value for leaf length during the entire growth stage of plants (16.18 cm). Majority of the treatments i.e. $T_1$ (15.98 cm), $T_8$ (15.65 cm), $T_2$ (14.88 cm) and $T_4$ (14.75 cm) were found to be on par with $T_6$.The least value was noticed for the treatment $T_3$ (13.27 cm).

#### 4.1.1.4 Leaf width

Data pertaining to leaf width is presented in Table 4.

Three months after planting no significant difference was noticed among the treatments, even though the treatment $T_9$ recorded maximum value for leaf width (2.32 cm) followed by $T_2$ (2.31 cm), $T_6$ (2.23 cm), $T_4$ (2.12 cm) and $T_7$ (2.05 cm) and the least value was recorded by $T_5$ (1.76 cm).

Sixth month onwards treatments showed significant difference due to the influence of different organic manures. The treatment $T_6$ (2.93 cm) recorded maximum leaf width value. The treatments $T_1$ (2.66 cm) and $T_8$ (2.41 cm) were found to be on par with $T_6$.

After ninth month of planting the treatment $T_6$ recorded maximum leaf width value (3.61 cm). The treatments $T_1$ (3.48 cm), $T_8$ (3.26 cm) and $T_4$ (3.02 cm) were statistically superior and on par with $T_6$.The treatment $T_5$ (2.02 cm) recorded the least value of leaf width.

Twelfth month after planting again the treatment $T_6$ (3.40 cm) recorded maximum value for leaf width. The treatments $T_1$ (3.18 cm) and $T_8$ (3.20 cm) were found to be statistically on par with $T_6$.The treatments $T_3$ (1.60 cm), $T_5$ (1.63 cm) and $T_7$ (1.89 cm) recorded lowest leaf width.

Data recorded after fifteenth month of planting revealed substantial increase in width of leaf. The treatment $T_6$ (3.71 cm) recorded maximum leaf width value. The treatment $T_1$ (3.55 cm) and $T_8$ (3.23 cm) were found to be statistically on par with $T_1$. The lowest leaf width value of 1.87 cm was noticed in $T_3$.

Eighteenth month after planting the treatment again showed an increasing trend in width of leaves and the treatment $T_6$ recorded maximum value of 3.92 cm.The treatments $T_1$ (3.72 cm) and $T_8$ (3.49 cm) recorded superior values than other treatments and found to be on par with $T_6$. The treatment $T_3$ recorded minimum value for leaf width (1.98 cm).

After twenty first month of planting the treatment $T_6$ (3.81 cm), $T_1$ (3.62 cm) and $T_8$ (3.50 cm) recorded superior values for leaf width of which $T_6$ recorded maximum value. The treatment $T_3$ (2.01 cm) had the least value for leaf width. Twenty fourth month after planting the treatment $T_6$ recorded maximum

leaf width value (3.88 cm) followed by $T_1$ (3.73 cm) and $T_8$ (3.48 cm). The least value was recorded by $T_3$ (2.09 cm).

Data recorded twenty seventh month after planting revealed that the treatment receiving inorganic fertilizers along with vermiwash showed maximum value for leaf width during the entire growth period of plants (4.13 cm). The treatments $T_1$ (3.94 cm) and $T_8$ (3.73 cm) were found to be on par with $T_6$. The treatment $T_3$ recorded minimum leaf width value of 2.11cm.

#### 4.1.1.5 Number of leafy shoots per plant

The effect of organic manures on leafy shoot production at trimonthly intervals are presented in Table 5.

When leafy shoot production was considered there was not much influence of organic manures during third month after planting. The maximum leafy shoot production was recorded by $T_6$ (2.75) and it was found to be on par with majority of the treatments. The least value was recorded for $T_9$ (1.75).

From sixth month of planting onwards significant difference among the treatments were recorded due to the influence of organic manures. The maximum value was recorded by the treatment $T_6$ (3.02). The treatments $T_8$ (2.91), $T_1$ (2.76) and $T_4$ (2.70) were found to be statistically on par with $T_6$. Maximum leafy shoot production was recorded by $T_3$ (1.78).

Ninth month after planting leafy shoot production made a progressive increase and significant results were obtained for the treatment $T_6$ (3.68) followed by $T_1$ (3.58) and $T_8$ (3.13) and these treatments were found to be on par with $T_6$. The treatment $T_3$ recorded minimum value for leafy shoot production (1.89).

During twelfth month after planting treatments showed a decreasing trend in leafy shoot production and the maximum value was recorded by $T_6$

Table.5. Number of leafy shoots in *Dendrobium* var. Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.02$^{abc}$ | 2.13$^{abc}$ | 2.76$^{abc}$ | 3.58$^{ab}$ | 3.10$^{ab}$ | 3.53$^{abc}$ | 3.65$^{ab}$ | 3.51$^{ab}$ | 3.45$^{ab}$ | 3.68$^{ab}$ |
| 2 | 2.25$^{ab}$ | 1.98$^{b}$ | 2.38$^{b}$ | 2.65$^{c}$ | 2.53$^{bc}$ | 3.03$^{bcd}$ | 3.03$^{bcd}$ | 3.05$^{abcde}$ | 2.85$^{bcd}$ | 2.98$^{c}$ |
| 3 | 1.65$^{bc}$ | 1.90$^{b}$ | 1.78$^{cde}$ | 1.89$^{def}$ | 2.11$^{d}$ | 2.10$^{d}$ | 2.11$^{def}$ | 2.21$^{e}$ | 2.18$^{de}$ | 2.03$^{e}$ |
| 4 | 2.72$^{a}$ | 2.08$^{abcd}$ | 2.70$^{abc}$ | 3.01$^{bc}$ | 2.95$^{abcd}$ | 3.28$^{bc}$ | 3.21$^{abcd}$ | 3.10$^{abcd}$ | 3.03$^{bc}$ | 3.20$^{bc}$ |
| 5 | 2.85$^{a}$ | 2.22$^{ab}$ | 1.85$^{bcd}$ | 2.12$^{cde}$ | 2.35$^{bcd}$ | 2.31$^{cde}$ | 2.38$^{de}$ | 2.73$^{cd}$ | 2.35$^{cde}$ | 2.21$^{de}$ |
| 6 | 2.32$^{ab}$ | 2.75$^{a}$ | 3.02$^{a}$ | 3.68$^{a}$ | 3.27$^{a}$ | 4.09$^{a}$ | 3.98$^{a}$ | 3.72$^{a}$ | 3.61$^{a}$ | 3.98$^{a}$ |
| 7 | 1.85$^{bc}$ | 2.19$^{abc}$ | 2.06$^{bcd}$ | 2.44$^{cd}$ | 2.08$^{cd}$ | 2.68$^{cd}$ | 2.75$^{c}$ | 2.65$^{cde}$ | 2.52$^{bcde}$ | 2.53$^{cd}$ |
| 8 | 2.84$^{a}$ | 2.52$^{a}$ | 2.91$^{ab}$ | 3.13$^{abcd}$ | 3.05$^{ab}$ | 3.75$^{ab}$ | 3.48$^{abc}$ | 3.23$^{abc}$ | 3.11$^{b}$ | 3.51$^{abc}$ |
| 9 | 2.35$^{ab}$ | 1.75$^{bc}$ | 2.22$^{bc}$ | 2.51$^{cd}$ | 2.26$^{bcd}$ | 2.89$^{c}$ | 2.95$^{bcde}$ | 2.96$^{c}$ | 2.67$^{bcde}$ | 2.75$^{cd}$ |

Table .6. Number of pseudobulbs in *Dendrobium* var.Earsakul as influenced by different levels
of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2.08$^{ab}$ | 2.42$^{a}$ | 2.72$^{ab}$ | 3.08$^{a}$ | 3.55$^{ab}$ | 3.65$^{ab}$ | 4.01$^{a}$ | 3.75$^{ab}$ | 3.88$^{a}$ | 3.92$^{ab}$ |
| 2 | 2.33$^{ab}$ | 2.02$^{ab}$ | 2.01$^{abcd}$ | 2.69$^{abc}$ | 3.21$^{abc}$ | 2.85$^{bcd}$ | 3.16$^{bc}$ | 3.10$^{b}$ | 3.23$^{b}$ | 2.84$^{bcd}$ |
| 3 | 1.83$^{abc}$ | 1.32$^{bc}$ | 1.87$^{bc}$ | 2.65$^{abc}$ | 2.23$^{c}$ | 3.10$^{bc}$ | 2.68$^{cd}$ | 2.51$^{c}$ | 2.45$^{cd}$ | 2.18$^{cd}$ |
| 4 | 2.10$^{ab}$ | 2.21$^{ab}$ | 2.21$^{abc}$ | 2.75$^{abc}$ | 3.18$^{abc}$ | 3.23$^{b}$ | 3.75$^{abc}$ | 3.33$^{abc}$ | 3.55$^{abc}$ | 3.21$^{bc}$ |
| 5 | 1.75$^{b}$ | 1.15$^{bcd}$ | 1.46$^{cd}$ | 1.89$^{cd}$ | 1.93$^{cde}$ | 2.03$^{de}$ | 2.55$^{cd}$ | 2.73$^{bcd}$ | 2.56$^{c}$ | 2.23$^{cd}$ |
| 6 | 2.73$^{a}$ | 2.75$^{a}$ | 2.98$^{a}$ | 3.13$^{a}$ | 3.76$^{a}$ | 3.98$^{a}$ | 4.08$^{a}$ | 3.98$^{a}$ | 3.93$^{a}$ | 4.08$^{a}$ |
| 7 | 2.96$^{a}$ | 1.61$^{bc}$ | 2.23$^{abc}$ | 2.31$^{b}$ | 2.98$^{b}$ | 2.23$^{d}$ | 2.32$^{cde}$ | 2.85$^{bcd}$ | 2.98$^{bcd}$ | 2.55$^{c}$ |
| 8 | 2.11$^{ab}$ | 2.53$^{a}$ | 2.51$^{ab}$ | 2.91$^{ab}$ | 3.21$^{abc}$ | 3.58$^{ab}$ | 3.86$^{abc}$ | 3.52$^{ab}$ | 3.63$^{ab}$ | 3.57$^{b}$ |
| 9 | 1.53$^{b}$ | 1.89$^{b}$ | 1.85$^{bc}$ | 2.23$^{bc}$ | 3.01$^{b}$ | 2.62$^{bcde}$ | 2.98$^{bcd}$ | 3.15$^{b}$ | 3.10$^{bc}$ | 2.99$^{cd}$ |

(3.27). The treatments $T_1$ (3.10), $T_8$ (3.05) and $T_4$ (2.95) were statistically superior and on par. The least value was recorded by $T_3$ (2.11).

Fifteenth month onwards treatments showed increasing trend in leafy shoot production. The treatment $T_6$ again recorded maximum value (4.09). The treatments

(3.27). The treatments $T_1$ (3.10), $T_8$ (3.05) and $T_4$ (2.95) were statistically superior and on par. The least value was recorded by $T_3$ (2.11).

Fifteenth month onwards treatments showed increasing trend in leafy shoot production. The treatment $T_6$ again recorded maximum value (4.09). The treatments $T_8$ (3.75) and $T_4$ (3.28) were found to be on par with $T_6$. The treatment $T_3$ (2.10) again showed least value for leafy shoot production.

During eighteenth month after planting again the treatment $T_6$ recorded more value (3.98). The treatments $T_1$ (3.65), $T_8$ (3.48) and $T_4$ (3.21) were statistically significant and on par. The minimum leafy shoot production was recorded by $T_3$ (2.11), followed by $T_5$ (2.38).

Twenty first month after planting the treatment $T_6$ again showed highest leafy shoot production (3.72). Majority of the treatments were found to be statistically superior and on par with $T_6$. ie $T_1$ (3.51), $T_8$ (3.23), $T_4$ (3.10) and $T_2$ (3.05). The least value was recorded by $T_3$ (2.21).

Twenty fourth month after planting treatment $T_6$ recorded maximum leafy shoot produced (3.61). The treatments $T_1$ (3.45), $T_4$ (3.03) and $T_2$ (2.85) were found to be on par with $T_6$.Treatment $T_3$ showed minimum leafy shoot production (2.18).

The data recorded twenty seventh month after planting revealed that the treatment $T_6$ (3.98) i.e. the treatment receiving vermiwash as organic manure produced more leafy shoots during the entire plant growth stages and $T_3$ recorded minimum value (2.03).

#### 4.1.1.6 Number of pseudobulbs per plant

Data corresponding to number of pseudobulbs per plant as influenced by different treatments are presented in Table 6.

No appreciable difference in pseudo bulbs produced was observed three months after planting and the treatments were found to be statistically insignificant. The treatment $T_6$ recorded maximum pseudobulb production (2.75).

Sixth month after planting treatment $T_6$ recorded maximum pseudo bulb production (2.98). The least value was recorded for the treatment $T_5$ (1.46). Ninth month after planting, the treatment $T_6$ (3.13) again recorded maximum pseudobulb production. The treatments $T_1$ (3.08), $T_8$ (2.91), $T_4$ (2.75), $T_2$ (2.69) and $T_3$ (2.65) were found to be statistically on par with $T_6$.The least value was recorded by the treatment $T_5$ (1.89).

Data recorded after twelfth month of planting revealed substantial increase in pseudo bulb production. The treatment $T_6$ (3.76) recorded the highest number of pseudo bulb produced followed by $T_1$ (3.55), $T_2$ (3.21), $T_8$ (3.21) and $T_4$ (3.18). Least number of pseudobulbs produced was recorded for the treatment $T_5$ (1.93).

Fifteenth month after planting again the treatment $T_6$ recorded maximum pseudobulb production (3.98). The treatments $T_1$ (3.65) and $T_8$ (3.58) were found to be statistically on par with $T_6$.The treatment $T_5$ (2.03) had minimum pseudobulb production.

Eighteenth month after planting again the treatment $T_6$ recorded maximum pseudobulb production (4.08). The treatments $T_1$ (4.01), $T_8$ (3.86) and $T_4$ (3.75) were statistically significant and on par. Least production of pseudobulb was recorded for $T_7$ (2.32).

Twenty first month of planting onwards the treatments showed a decreasing trend in pseudo bulb production. During that period the treatment $T_6$ (3.98) showed highest value for pseudo bulb production. Majority of the

treatments i.e. $T_1$ (3.75), and $T_8$ (3.52) were found to be on par with $T_6$.The least value was recorded for $T_3$ (2.51).

After twenty fourth month of planting again the treatment $T_6$ (3.93) recorded maximum number of pseudo bulb produced and the minimum number was recorded for $T_3$ (2.45).

Data recorded after twenty seventh month of planting revealed that the treatment $T_6$ receiving vermiwash showed maximum pseudo bulb production (4.08) followed by $T_1$ (3.92). The least value was noted for the treatment $T_3$ (2.18).

4.1.1.7 **Girth of shoot**

Data related to shoot girth are presented in Table 7.

Treatments did not show any significant difference after three months of planting. During this period the treatments $T_6$ (2.88) showed highest shoot girth value followed by $T_8$ (2.63), $T_1$ (2.51), $T_4$ (2.49) and $T_2$ (2.13).

Sixth month after planting the treatment $T_6$ recorded maximum value for girth of shoot (3.25cm). The treatments $T_8$ (3 .11), $T_1$ (3.02) and $T_4$ (2.81cm) were found to be on par with $T_6$.The least value was recorded by $T_9$ (2.13cm).

Ninth month after planting again the treatment $T_6$ recorded maximum shoot girth (3.68 cm) followed by $T_1$ (3.61 cm), $T_8$ (3.42 cm), $T_4$ (3.21 cm) and $T_9$ (3.03 cm). The treatment $T_3$ (2.45 cm) showed minimum value for shoot girth.

Twelfth month after planting a similar trend in shoot girth was noticed. The treatment $T_6$ recorded the highest value (4.02 cm) and the lowest value was observed for the treatment $T_5$ (2.55 cm).

Shoot girth at fifteenth month after planting showed significant variation due to the influence of different treatments. The treatment $T_6$ again recorded maximum value for shoot girth of 4.18 cm followed by $T_8$ (4.00 cm) and $T_8$ found to be on par with $T_6$.The treatment $T_5$ (2.62 cm) again recorded the least shoot girth.

Even after eighteenth month of planting the treatment $T_6$ (4.23 cm) showed highest value for shoot girth. The treatments $T_8$ (4.01 cm) and $T_1$ (3.76 cm) were found to be significant and on par with $T_6$.The least value of shoot girth was recorded by $T_5$ (2.11 cm).

Shoot girth at twenty first month of planting showed a similar trend. The treatment $T_6$ recorded the highest shoot girth value (4.18 cm). The treatments $T_8$ (4.03 cm), $T_1$ (3.89 cm) and $T_4$ (3.55 cm) were found to be statistically on par with $T_6$. The treatment $T_5$ (2.76 cm) showed the minimum value for shoot girth.

Again after twenty fourth month of planting the treatment $T_6$ (4.25 cm) recorded highest shoot girth value. Treatments $T_8$ (4.18 cm), $T_1$ (4.09 cm) and $T_4$ (4.00 cm) showed superior values and found to be statistically significant and on par with $T_6$. The least value was recorded by $T_5$ (3.18 cm) followed by $T_3$ (3.21cm) and $T_7$ (3.35 cm).

Data for twenty seventh month after planting revealed that there was a progressive increase in shoot girth for treatments $T_6$ (4.32 cm), $T_1$ (4.29 cm) and $T_8$ (4.01 cm). Best result was obtained for the treatment $T_6$ and others found to be on par with $T_6$. The least value was recorded for $T_3$ (2.95 cm).

Table 7. Girth of shoot (cm) in *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the time of planting | 3MAP | 6MAP | 9MAP | 12MAP | 15MAP | 18MAP | 21MAP | 24MAP | 27MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $2.00^{a}$ | $2.51^{ab}$ | $3.02^{ab}$ | $3.61^{a}$ | $3.72^{ab}$ | $3.56^{b}$ | $3.76^{abc}$ | $3.89^{ab}$ | $4.09^{ab}$ | $4.29^{a}$ |
| 2 | $1.87^{ab}$ | $2.13^{abc}$ | $2.55^{bc}$ | $2.89^{b}$ | $3.03^{bcd}$ | $3.21^{bc}$ | $3.20^{bc}$ | $3.12^{bc}$ | $3.75^{abc}$ | $3.62^{b}$ |
| 3 | $2.18^{a}$ | $1.33^{bc}$ | $2.22^{bcd}$ | $2.45^{bcd}$ | $2.65^{c}$ | $2.43^{cd}$ | $2.35^{d}$ | $2.81^{c}$ | $3.21^{bc}$ | $2.95^{c}$ |
| 4 | $1.93^{ab}$ | $2.49^{ab}$ | $2.81^{abc}$ | $3.21^{abc}$ | $2.99^{bcd}$ | $3.42^{b}$ | $3.41^{b}$ | $3.55^{abcd}$ | $4.00^{ab}$ | $3.87^{abc}$ |
| 5 | $1.86^{abc}$ | $1.54^{b}$ | $2.15^{bcd}$ | $2.71^{bc}$ | $2.55^{cd}$ | $2.62^{c}$ | $2.11^{de}$ | $2.76^{cd}$ | $3.18^{bc}$ | $3.08^{bcd}$ |
| 6 | $1.33^{b}$ | $2.88^{a}$ | $3.25^{a}$ | $3.68^{a}$ | $4.02^{a}$ | $4.18^{a}$ | $4.23^{a}$ | $4.18^{a}$ | $4.25^{a}$ | $4.32^{a}$ |
| 7 | $1.24^{b}$ | $1.92^{abc}$ | $2.09^{bcd}$ | $2.56^{bc}$ | $3.22^{bc}$ | $2.87^{bcde}$ | $2.85^{bcd}$ | $2.89^{c}$ | $3.35^{b}$ | $3.55^{bc}$ |
| 8 | $2.22^{a}$ | $2.63^{ab}$ | $3.11^{a}$ | $3.42^{ab}$ | $3.95^{a}$ | $4.00^{a}$ | $4.01^{ab}$ | $4.03^{a}$ | $4.18^{a}$ | $4.01^{ab}$ |
| 9 | $1.75^{ab}$ | $1.89^{abcd}$ | $2.13^{bcd}$ | $3.03^{abc}$ | $2.92^{bcd}$ | $3.03^{bcd}$ | $3.11^{bc}$ | $3.01^{bcd}$ | $3.42^{b}$ | $3.13^{bcd}$ |

Table 8. Internodal length (cm) in *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the time of planting | 3MAP | 6MAP | 9MAP | 12MAP | 15MAP | 18MAP | 21MAP | 24MAP | 27MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $1.88^{ab}$ | $2.32^{ab}$ | $3.45^{ab}$ | $4.28^{a}$ | $4.12^{abc}$ | $4.11^{abcd}$ | $4.60^{ab}$ | $4.76^{ab}$ | $4.35^{ab}$ | $4.38^{abcd}$ |
| 2 | $2.31^{a}$ | $2.11^{abc}$ | $3.08^{b}$ | $3.85^{abc}$ | $3.85^{b}$ | $3.92^{bc}$ | $4.12^{b}$ | $4.02^{b}$ | $4.21^{abc}$ | $3.89^{bcd}$ |
| 3 | $2.50^{a}$ | $1.32^{bcd}$ | $2.31^{bcde}$ | $3.11^{bcd}$ | $2.61^{cd}$ | $2.97^{cde}$ | $2.75^{de}$ | $2.60^{cde}$ | $3.08^{bcde}$ | $2.89^{d}$ |
| 4 | $1.75^{ab}$ | $2.03^{abc}$ | $3.01^{b}$ | $4.01^{ab}$ | $4.00^{abcd}$ | $4.03^{b}$ | $4.25^{abcd}$ | $4.49^{abcd}$ | $4.18^{abc}$ | $4.02^{bc}$ |
| 5 | $2.00^{a}$ | $1.51^{bc}$ | $2.28^{c}$ | $3.28^{bc}$ | $2.89^{c}$ | $3.13^{cd}$ | $2.89^{de}$ | $2.95^{cd}$ | $3.11^{bcde}$ | $3.03^{cde}$ |
| 6 | $1.54^{abc}$ | $2.50^{ab}$ | $3.98^{a}$ | $4.31^{a}$ | $4.63^{a}$ | $4.78^{a}$ | $4.89^{a}$ | $5.01^{a}$ | $4.68^{a}$ | $4.81^{a}$ |
| 7 | $1.21^{b}$ | $1.72^{b}$ | $2.53^{bcd}$ | $3.52^{b}$ | $3.52^{bc}$ | $3.52^{c}$ | $3.41^{c}$ | $3.23^{bcde}$ | $3.52^{bc}$ | $3.21^{cd}$ |
| 8 | $1.42^{abcd}$ | $2.83^{a}$ | $3.53^{ab}$ | $4.08^{ab}$ | $4.35^{ab}$ | $4.32^{abc}$ | $4.68^{ab}$ | $4.58^{abcd}$ | $4.50^{a}$ | $4.65^{ab}$ |
| 9 | $1.35^{abc}$ | $1.89^{b}$ | $2.79^{bc}$ | $3.61^{b}$ | $3.75^{b}$ | $3.75^{bcd}$ | $3.87^{bcd}$ | $3.89^{bc}$ | $3.81^{b}$ | $3.55^{c}$ |

### 4.1.1.8. Internodal length

Data related to internodal length as influenced by different treatments are presented in Table 8.

After third month of planting internodal length did not show any significant difference as influenced by the various treatment combinations. During this time the treatment $T_8$ (2.83 cm) showed highest value for internodal length. Majority of the treatments were found to be on par with $T_8$.

From sixth month of planting onwards significant difference among the treatments were recorded and the treatments $T_6$ (3.98 cm), $T_8$ (3.53 cm) and $T_1$ (3.45 cm) showed superior values for internodal length of which $T_6$ recorded maximum value. The least value was recorded by $T_5$ (2.28 cm).

Ninth month of planting onwards significant difference among the treatments were noticed. The treatment $T_6$ (4.31 cm) recorded maximum internodal length followed by $T_1$ (4.28 cm), $T_8$ (4.08 cm) and $T_4$ (4.01 cm). The least value for internodal length was noticed for the treatment $T_3$ (3.11cm).

After twelfth month of planting some treatments showed decreasing trend in internodal length even though the treatment $T_6$ (4.63 cm) showed highest value for internodal length. The treatment $T_8$ (4.35 cm), $T_1$ (4.12 cm) and $T_4$ (4.00 cm) were statistically on par with $T_6$. The treatment $T_3$ (2.61cm) again showed minimum value for internodal length.

Fifteenth month after planting the internodal length showed marked variation among different treatments and the treatment $T_6$ (4.78 cm) recorded the longest internodal length. The least value was recorded for $T_3$ (2.97cm).

After eighteenth month of planting the treatments showed an increasing trend in the length of internode. The treatment $T_6$ again showed maximum value for internodal length (4.89cm). The treatments $T_8$ (4.68 cm), $T_1$ (4.60 cm) and $T_4$ (4.25 cm) were found to be statistically significant and on par with $T_6$. The treatment $T_3$ (2.75 cm) recorded minimum value for internodal length, followed by $T_5$ (2.89 cm).

During the subsequent months the treatments showed decreasing trend in the value of internodal length in many of the treatments. Twenty first month after planting again $T_6$ (5.01 cm) recorded maximum value followed by $T_1$ (4.76 cm), $T_8$ (4.58 cm) and $T_4$ (4.49 cm). The treatment $T_3$ and $T_5$ recorded minimum values of which $T_3$ (2.60 cm) recorded the least value.

Twenty fourth month after planting the treatment $T_6$ (4.68 cm) recorded maximum internodal length. Majority of the treatments i.e. $T_8$ (4.50 cm), $T_1$ (4.35 cm), $T_2$ (4.21cm) and $T_4$ (4.18 cm) were found to be on par with $T_6$. Least value was recorded by $T_3$ (3.08 cm).

After twenty seventh month of planting the treatments did not show much difference due to the influence of organic manures, even though $T_6$ again marked maximum value for internodal length (4.81 cm) followed by $T_8$ (4.65 cm), $T_1$ (4.38 cm) and $T_4$ (4.02 cm). Minimum value was recoded for $T_5$ (3.03 cm).

### *4.1.2.* *Dendrobium* Shavin White

Trimonthly observation on growth parameters of the variety Shavin White is presented in Tables 9 to 18.

#### 4.1.2.1 Plant height

The effect of organic manures on plant height at trimonthly intervals is presented in Table 9.

When plant height was considered there was not much influence of organic manures ever after third month of planting. During this period the treatment $T_5$ recorded the maximum value of about 7.30 cm, followed by $T_4$ (7.13 cm), $T_2$ (7.03 cm) and $T_6$ (7.00 cm) were found to be statistically on par with majority of the treatments.

From sixth month onwards there was significant difference among the treatments in data pertaining to plant height. The treatment $T_6$ recorded highest plant height value of 10.31cm followed by $T_8$ (10.25 cm) and $T_1$ (10.01cm) and all these treatments were found to be statistically superior and on par. The minimum value for plant height was recorded by the treatment $T_3$ (7.52 cm).

Ninth month after planting the treatment $T_6$ recorded maximum value (13.02 cm) followed by $T_8$ (12.75 cm) and these were found to be superior to other treatments. Majority of the treatments were found to be on par with $T_6$ except $T_5$ (10.73 cm), $T_7$ (10.21 cm) and $T_3$ (10.03 cm).

Height of the plant made a progressive increase after twelfth month of planting. The treatment $T_6$ (15.72 cm) showed maximum value for plant height. The treatments $T_1$ (15.32 cm) and $T_8$ (15.03 cm) were found to be statistically on par with $T_6$ .The least value was recorded by $T_3$ (11.51 cm).

After fifteenth month of planting the treatment $T_6$ showed the maximum value (17.61 cm) for plant height followed by $T_1$ (17.32 cm). These treatments were found to be statistically superior to others. The treatments $T_8$ (17.00 cm) and $T_4$ (16.78 cm) were found to be on par with $T_6$. The treatment $T_3$ (13.12 cm) recorded minimum value for plant height. The treatments $T_5$ (13.81 cm), $T_7$ (14.03 cm) and $T_9$ (14.75 cm) were found to be on par with $T_3$.

Eighteenth month after planting plants showed a progressive increase in plant height. The treatment $T_6$ again recorded the maximum plant height value

Table 9. Plant height (cm) in *Dendrobium* var. Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.38$^{a}$ | 6.75$^{ab}$ | 10.01$^{ab}$ | 12.02$^{abc}$ | 15.32$^{ab}$ | 17.32$^{ab}$ | 18.93$^{abc}$ | 21.03$^{a}$ | 20.56$^{abc}$ | 21.03$^{ab}$ |
| 2 | 4.21$^{a}$ | 7.03$^{a}$ | 9.32$^{abc}$ | 11.03$^{bcd}$ | 14.75$^{bcd}$ | 15.42$^{de}$ | 17.95$^{cd}$ | 18.21$^{bcd}$ | 19.03$^{bc}$ | 19.00$^{bc}$ |
| 3 | 4.56$^{a}$ | 6.55$^{ab}$ | 7.52$^{cde}$ | 10.03$^{cdef}$ | 11.51$^{efg}$ | 13.12$^{fgh}$ | 16.56$^{de}$ | 16.56$^{de}$ | 16.78$^{efg}$ | 17.03$^{cdef}$ |
| 4 | 4.35$^{a}$ | 7.13$^{a}$ | 9.75$^{ab}$ | 11.65$^{bc}$ | 14.68$^{bcd}$ | 16.78$^{bcd}$ | 18.75$^{bc}$ | 18.75$^{bc}$ | 19.21$^{bc}$ | 19.89$^{abc}$ |
| 5 | 4.71$^{a}$ | 7.30$^{a}$ | 8.05$^{cd}$ | 10.73$^{cde}$ | 12.78$^{def}$ | 13.81$^{fg}$ | 16.28$^{de}$ | 16.28$^{de}$ | 17.00$^{de}$ | 17.32$^{cdef}$ |
| 6 | 3.81$^{ab}$ | 7.00$^{a}$ | 10.31$^{a}$ | 13.02$^{a}$ | 15.72$^{a}$ | 17.61$^{a}$ | 21.61$^{a}$ | 21.71$^{a}$ | 22.03$^{a}$ | 22.78$^{a}$ |
| 7 | 4.20$^{a}$ | 6.05$^{abc}$ | 8.75b$^{c}$ | 10.21$^{bcd}$ | 13.00$^{de}$ | 14.03$^{fg}$ | 17.03$^{cde}$ | 17.03$^{cde}$ | 17.23$^{de}$ | 18.21$^{cd}$ |
| 8 | 3.75$^{a}$ | 6.72$^{ab}$ | 10.25$^{a}$ | 12.75$^{a}$ | 15.03$^{abc}$ | 17.00$^{bc}$ | 19.00$^{ab}$ | 19.00$^{ab}$ | 20.78$^{abc}$ | 21.56$^{a}$ |
| 9 | 4.02$^{ab}$ | 6.51$^{ab}$ | 8.92$^{bc}$ | 11.58$^{bc}$ | 13.32$^{de}$ | 14.75$^{efg}$ | 17.75$^{cd}$ | 17.75$^{cd}$ | 17.69$^{de}$ | 18.65$^{bcd}$ |

Table .10. Number of leaves per plant in *Dendrobium* var. Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 4.92$^{a}$ | 5.00$^{a}$ | 5.75$^{b}$ | 6.53$^{ab}$ | 6.28$^{abc}$ | 5.92$^{ab}$ | 6.45$^{ab}$ | 5.35$^{ab}$ | 5.00$^{abcd}$ | 5.75$^{abc}$ |
| 2 | 3.90$^{ab}$ | 4.31$^{abc}$ | 4.42$^{cd}$ | 5.55$^{cd}$ | 5.42$^{bcd}$ | 4.15$^{bcd}$ | 4.81$^{bcd}$ | 4.72$^{bc}$ | 4.23$^{bcd}$ | 5.01$^{bcd}$ |
| 3 | 5.02$^{a}$ | 3.81$^{bc}$ | 3.00$^{ef}$ | 4.52$^{de}$ | 4.22$^{de}$ | 3.28$^{de}$ | 3.75$^{cdef}$ | 3.52$^{cde}$ | 4.01$^{de}$ | 3.75$^{def}$ |
| 4 | 4.73$^{a}$ | 4.52$^{ab}$ | 4.32$^{cd}$ | 5.78$^{bcd}$ | 5.92$^{bc}$ | 5.00$^{bc}$ | 5.00$^{bc}$ | 5.00$^{abc}$ | 4.82$^{bc}$ | 5.50$^{bc}$ |
| 5 | 3.97$^{ab}$ | 3.75$^{bc}$ | 3.95$^{de}$ | 4.75$^{de}$ | 4.95$^{cde}$ | 3.75$^{cde}$ | 4.01$^{cd}$ | 3.93$^{cd}$ | 3.92$^{cde}$ | 3.92$^{def}$ |
| 6 | 4.73$^{a}$ | 5.65$^{a}$ | 6.73$^{a}$ | 7.13$^{a}$ | 7.78$^{a}$ | 6.75$^{a}$ | 6.00$^{a}$ | 6.15$^{a}$ | 5.80$^{a}$ | 6.22$^{a}$ |
| 7 | 5.00$^{a}$ | 3.90$^{bc}$ | 4.15$^{cde}$ | 5.00$^{cde}$ | 5.13$^{cd}$ | 4.00$^{cd}$ | 4.52$^{cd}$ | 4.18$^{bcde}$ | 3.89$^{cde}$ | 4.22$^{cde}$ |
| 8 | 3.75$^{ab}$ | 4.81$^{a}$ | 5.00$^{bcd}$ | 6.03$^{bc}$ | 6.00$^{bc}$ | 5.35$^{abc}$ | 5.35$^{abc}$ | 4.28$^{bcd}$ | 4.00$^{cd}$ | 4.56$^{cd}$ |
| 9 | 4.62$^{a}$ | 5.72$^{a}$ | 6.00$^{ab}$ | 7.00$^{a}$ | 7.18$^{ab}$ | 6.45$^{a}$ | 5.68$^{ab}$ | 6.00$^{a}$ | 5.25$^{abc}$ | 6.01$^{ab}$ |

Of (21.60 cm). The treatment $T_3$ (16.56 cm) recorded minimum plant height. The treatments $T_5$ (16.28 cm) and $T_7$ (17.03 cm) were on par with $T_3$.

The plant height after twenty first month of planting showed maximum value for the treatment $T_6$ (21.17 cm), followed by $T_1$ (21.03 cm) and $T_8$ (19.00 cm) and they were found to be statistically on par with $T_1$. The minimum value for plant height was recorded for the treatment $T_5$ (16.28cm). The treatment $T_3$ (16.56 cm) was on par with $T_5$.

Twenty fourth month after planting again the treatment $T_6$ showed maximum value for plant height (22.03 cm). The treatment $T_8$ (20.78 cm) and $T_1$ (20.56 cm) were found to be statistically on par with $T_6$. The treatment $T_3$ (16.78 cm) showed minimum value for plant height. The treatments $T_5$ (17.00 cm), $T_7$ (17.23 cm) and $T_9$ (17.69 cm) were found to be on par with $T_3$.

The data recorded after twenty seventh month of planting revealed that the treatment $T_6$ gave the better result for plant height (22.78 cm). The treatments $T_8$ (21.56 cm), $T_1$ (21.03 cm) and $T_4$ (19.89 cm) were found to be superior and on par with $T_6$.The treatments $T_5$ (17.32 cm) and $T_3$ (17.03 cm) were found to be minimum in plant height and the treatment $T_3$ recorded the least value for plant height.

#### 4.1.2.2 Number of leaves per plant

The effect of organic manures on number of leaves at trimonthly intervals is presented in Tables 10.

Treatments did not record significant difference with regard to leaf number produced after three month of planting. After third month of planting treatments $T_9$ (5.72), $T_6$ (5.65) and $T_1$ (5.00) showed maximum number of leaves

and found to be statistically on par. The least values for number of leaves were recorded by $T_5$ (3.75)

Even after sixth month of planting the variation were not significant, but there was a progressive increase in leaf number and the treatment $T_6$ recorded the maximum value (6.73) and the treatment $T_3$ (3.00) recorded minimum value.

Ninth month after planting the treatment $T_6$ recorded maximum number of leaves per plant (7.13), followed by $T_9$ (7.00) and $T_1$ (6.53) and these treatments were superior and on par with $T_6$.The least value for leaf production was recorded by $T_3$ (4.52).

Twelfth month after planting the treatment $T_6$ showed maximum leaf production (7.78). The treatments $T_9$ (7.18) and $T_1$ (6.28) were found to be superior and on par with $T_6$.

Fifteen months after planting there was a sudden decrease in leaf production and the treatment $T_6$ showed maximum number of leaves (6.75) followed by $T_9$ (7.18). Lowest leaf production was shown by the treatment $T_3$ (3.28)

After eighteenth month of planting the treatment $T_1$ showed maximum leaf production (6.45). The treatments $T_6$ (6.00), $T_9$ (5.68) and $T_8$ (5.35) were found to be statistically on par with $T_1$.The treatment $T_3$ showed minimum value for leaf production (3.75).

Even after twenty first month of planting the treatment $T_6$ showed maximum leaf production of 6.15.The treatments $T_9$ (6.00), $T_1$ (5.35) and $T_4$ (5.00) were superior and on par with $T_6$.The treatments $T_3$ (3.52) and $T_5$ (3.93) showed lowest values foe leaf production of which $T_3$ produced lowest number of leaves.

The leaf production showed a decreasing trend after twenty-fourth month of planting, where the treatment $T_6$ showed highest number of leaves followed by $T_9$ (5.25) and $T_1$ (5.00). The treatment $T_7$ produced lowest number of leaves (3.89). The treatments $T_5$ (3.92), $T_8$ (4.00) and $T_3$ (4.01) were found to be inferior and on par with $T_7$.

Twenty seventh month after planting the treatment $T_6$ again showed highest leaf production (6.22) followed by $T_1$ (5.75). The lowest number of leaf production was shown by the treatment $T_3$ (3.75). The treatment $T_5$ (3.92) and $T_7$ (4.22) were on par with $T_3$.

#### 4.1.2.3 Leaf length

Data pertaining to leaf length is presented in Table 11.

Treatments did not record much significant difference with regard to leaf length upto third month of planting. However the treatment $T_6$ recorded maximum value for leaf length (5.87 cm) followed by $T_5$ (5.55 cm) and $T_2$ (5.25 cm).

Even after sixth month of planting the variation was not significant but there was a progressive increase in leaf length and the treatment $T_6$ recorded maximum value for leaf length (7.85 cm) followed by $T_1$ (7.60 cm), $T_8$ (7.58 cm) and $T_4$ (7.26 cm). The least value was recorded by the treatment $T_7$ (6.30 cm).

Significant variation was noticed in case of leaf length due to the effect of different treatments after ninth month of planting. The data revealed that the treatment $T_6$ recorded the highest leaf length (9.92 cm). The treatment $T_1$ (9.65 cm) and $T_8$ (9.41 cm) were on par with $T_6$. The lowest value of leaf length was

noticed by $T_3$ (8.20 cm). The treatments $T_5$ (8.26 cm), $T_9$ (8.45 cm), $T_7$ (8.58 cm) and $T_2$ (8.73 cm) were found to be inferior and on par with$T_3$.

Twelfth month after planting again the treatment $T_6$ showed maximum leaf length (12.85 cm). The treatments $T_1$ (12.62 cm), $T_8$ (12.25 cm), $T_4$ (12.13 cm) and $T_2$ (11.98 cm) were on par with $T_6$. The treatment $T_3$ (10.85 cm) recorded minimum value for leaf length.

After fifteenth month of planting the treatments $T_6$ (13.38 cm), $T_1$ (13.05 cm), $T_7$ (12.78 cm), $T_4$ (12.54 cm) and $T_2$ (12.03 cm) showed superior values for leaf length of which the treatment $T_6$ showed maximum value for leaf length. The minimum value was recorded by the treatment $T_5$ (11.15 cm).The treatments $T_3$ (11.22 cm), $T_7$ (11.62 cm) and $T_9$ (11.85 cm) were on par with $T_5$.

Even after eighteenth month of planting the treatment $T_6$ recorded highest leaf length value of 14.56 cm.The treatments $T_1$ (14.32 cm) and $T_8$ (14.11 cm) were statistically superior and on par with $T_6$ and the minimum value was showed by $T_3$ (13.01 cm).

Twenty first month after planting the treatments $T_6$ (15.83 cm), $T_1$ (15.55 cm) and $T_8$ (15.32 cm) recorded highest values of which the treatment $T_6$ recorded maximum length and $T_1$ and $T_8$ were found to be significant and on par with $T_6$. The treatment $T_3$ (13.18 cm) had minimum leaf length. The treatment $T_5$ (13.22 cm) was on par with $T_3$.

The treatments did not show much difference in leaf length after twenty fourth month of planting even though there was a progressive increase. During this period the treatment $T_6$ recorded maximum leaf length of 16.23 cm followed by $T_1$ (16.03 cm) and $T_4$ (15.83 cm).

Table11. Leaf length (cm) in *Dendrobium* var. Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.01$^{abc}$ | 5.08$^{b}$ | 7.60$^{ab}$ | 9.65$^{ab}$ | 12.62$^{a}$ | 13.05$^{ab}$ | 14.32$^{a}$ | 15.55$^{ab}$ | 16.03$^{ab}$ | 15.45$^{ab}$ |
| 2 | 3.10$^{ab}$ | 5.25$^{abc}$ | 6.83$^{bc}$ | 8.73$^{cde}$ | 11.98$^{abc}$ | 12.03$^{cd}$ | 13.88$^{bcd}$ | 14.76$^{cde}$ | 15.51$^{bc}$ | 15.21$^{abc}$ |
| 3 | 3.28$^{ab}$ | 4.32$^{bcd}$ | 6.70$^{bc}$ | 8.20$^{de}$ | 10.85$^{de}$ | 11.22$^{de}$ | 13.01$^{e}$ | 13.18$^{e}$ | 14.02$^{ef}$ | 13.75$^{e}$ |
| 4 | 2.81$^{b}$ | 5.16$^{abc}$ | 7.26$^{abcd}$ | 9.00$^{bcd}$ | 12.13$^{ab}$ | 12.54$^{bcd}$ | 14.08$^{abc}$ | 15.08$^{bc}$ | 15.83$^{abc}$ | 15.00$^{bc}$ |
| 5 | 3.55$^{a}$ | 5.55$^{ab}$ | 6.59$^{bcd}$ | 8.26$^{de}$ | 10.92$^{de}$ | 11.15$^{de}$ | 13.26$^{cdef}$ | 13.22$^{e}$ | 14.23$^{def}$ | 13.88$^{e}$ |
| 6 | 2.95$^{abc}$ | 5.87$^{a}$ | 7.85$^{a}$ | 9.92$^{a}$ | 12.85$^{a}$ | 13.38$^{a}$ | 14.56$^{a}$ | 15.83$^{a}$ | 16.23$^{a}$ | 15.99$^{a}$ |
| 7 | 3.12$^{ab}$ | 4.65$^{bc}$ | 6.34$^{cde}$ | 8.58$^{cde}$ | 11.42$^{bcd}$ | 11.62$^{cde}$ | 13.23$^{cdef}$ | 14.21$^{def}$ | 14.56$^{de}$ | 14.01$^{de}$ |
| 8 | 3.08$^{ab}$ | 5.03$^{b}$ | 7.58$^{ab}$ | 9.41$^{abc}$ | 12.25$^{ab}$ | 12.78$^{bc}$ | 14.11$^{ab}$ | 15.32$^{abc}$ | 15.02$^{cd}$ | 14.87$^{bcd}$ |
| 9 | 2.93$^{abc}$ | 5.28$^{abc}$ | 6.67$^{bcd}$ | 8.45$^{cde}$ | 11.56$^{bcd}$ | 11.85$^{bcd}$ | 13.55$^{cd}$ | 14.56$^{de}$ | 14.83$^{d}$ | 14.26$^{d}$ |

Table 12. Leaf width (cm) in *Dendrobium* var.Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.98$^{ab}$ | 1.92$^{abc}$ | 2.61$^{ab}$ | 3.18$^{ab}$ | 3.09$^{ab}$ | 3.56$^{ab}$ | 3.60$^{abc}$ | 3.35$^{abc}$ | 3.42$^{bc}$ | 3.82$^{abc}$ |
| 2 | 1.89$^{ab}$ | 2.31$^{a}$ | 2.24$^{abc}$ | 2.31$^{c}$ | 2.84$^{bc}$ | 2.54$^{c}$ | 2.85$^{cd}$ | 2.91$^{cd}$ | 2.92$^{cd}$ | 3.01$^{cd}$ |
| 3 | 2.01$^{a}$ | 1.99$^{abc}$ | 1.95$^{bc}$ | 1.56$^{de}$ | 1.82$^{d}$ | 1.55$^{def}$ | 1.99$^{e}$ | 2.03$^{f}$ | 1.75$^{efg}$ | 2.63$^{def}$ |
| 4 | 1.92$^{ab}$ | 1.85$^{b}$ | 1.56$^{de}$ | 2.82$^{abc}$ | 3.01$^{ab}$ | 2.99$^{bcd}$ | 3.01$^{bcd}$ | 3.18$^{bc}$ | 3.00$^{cd}$ | 3.23$^{c}$ |
| 5 | 1.56$^{abc}$ | 1.92$^{abc}$ | 1.88$^{c}$ | 2.29$^{c}$ | 2.00$^{cd}$ | 1.78$^{de}$ | 2.18$^{def}$ | 2.01$^{f}$ | 2.01$^{ef}$ | 2.63$^{def}$ |
| 6 | 2.23$^{a}$ | 2.35$^{a}$ | 2.89$^{a}$ | 3.42$^{a}$ | 3.32$^{a}$ | 3.76$^{a}$ | 3.98$^{a}$ | 3.79$^{a}$ | 3.99$^{a}$ | 4.06$^{a}$ |
| 7 | 1.92$^{ab}$ | 2.19$^{ab}$ | 1.75$^{cd}$ | 1.89$^{d}$ | 2.33$^{c}$ | 2.00$^{d}$ | 2.55$^{de}$ | 2.18$^{def}$ | 2.17$^{ef}$ | 2.65$^{def}$ |
| 8 | 1.75$^{ab}$ | 2.00$^{abc}$ | 2.56$^{abc}$ | 3.00$^{abc}$ | 2.72$^{bc}$ | 3.12$^{bc}$ | 3.21$^{bc}$ | 3.08$^{bcd}$ | 3.12$^{e}$ | 3.50$^{bc}$ |
| 9 | 2.11$^{a}$ | 2.01$^{abc}$ | 2.00$^{bc}$ | 2.18$^{c}$ | 2.55$^{bcd}$ | 2.28$^{cd}$ | 2.71$^{d}$ | 2.55$^{def}$ | 2.55$^{de}$ | 2.86$^{de}$ |

Even after twenty seventh month of planting the treatment $T_6$ showed highest value for leaf length (15.99 cm) and was found to be statistically on par with treatments $T_1$ (15.45 cm), $T_2$ (15.21 cm) and $T_4$ (15.00 cm). The lowest value was obtained for the treatment $T_3$ (13.75 cm).

#### 4.1.2.4 Leaf width

Data pertaing to leaf width are presented in Table 12.

Treatments did not record significant difference with regard to leaf width upto third month of plant growth. However the treatment $T_6$ (2.35 cm) showed maximum value for leaf width and was found to be statistically on par with majority of the treatments. The lowest value was recorded by $T_4$ (1.85 cm).

Even after sixth month of planting the variation was not significant but there was a progressive increase in leaf width and the treatment $T_6$ recorded the maximum value for leaf width (2.89 cm) and the treatment $T_4$ recorded the minimum value (1.56 cm).

Significant variation was noticed in case of leaf width due to the effect of different treatments after ninth month of planting. The data revealed that the treatment $T_6$ recorded the maximum value of leaf width (3.42 cm). The treatments $T_1$, $T_8$ and $T_4$ were on par with $T_6$. The minimum value was recorded for the treatment $T_3$ (1.56 cm).

Twelfth month after planting, plants showed a decreasing trend in width of leaf in many of the treatments and among them the treatment $T_6$ recorded the maximum value for leaf width (3.32 cm) and the minimum value was recorded by $T_3$ (1.82 cm).

Fifteenth month after planting the treatment $T_6$ (3.76 cm) recorded maximum value for leaf width followed by $T_1$ (3.56 cm) and $T_8$ (3.12 cm). The minimum value was recorded by $T_5$ (1.78 cm). Treatments had significantly influenced leaf width after eighteenth month of planting and again the treatment $T_6$ showed maximum leaf width (3.98 cm). The treatment $T_3$ (1.99 cm) recorded the minimum value for leaf width.

Twenty first month after planting again the treatment $T_6$ recorded maximum value (3.79 cm) followed by $T_1$ (3.53 cm), $T_4$ (3.18 cm) and $T_8$ (3.08 cm). The minimum value was recorded by $T_3$ (2.03 cm).

After twenty-fourth month of planting again the treatment $T_6$ recorded maximum value for leaf width (3.99 cm). Least value was recoded for the treatment $T_3$ (1.75 cm). The treatments $T_5$ (2.01 cm) and $T_7$ (2.17 cm) had showed minimum values and were on par with $T_3$.

The data recorded after twenty-seventh month of planting revealed that the treatment $T_6$ receiving inorganic fertilizers along with vermiwash, showed maximum value for leaf width (4.06 cm). The treatment effect was least pronounced in treatment $T_3$ (2.65 cm).

#### 4.1.2.5 Number of leafy shoots per plant

Data pertaining to the number of leafy shoots per plant are presented in Table 13.

Treatments did not give significant result with regard to leafy shoot upto third month after planting. The maximum number of leafy shoots produced during this period was 2.98 and it was recoded by the treatment $T_6$. Majority of the treatments was on par with $T_6$.

Six months after planting there was significant difference among the treatments and the treatment $T_6$ (3.58) recorded maximum number of leafy shoots. The treatments $T_1$ (3.13) and $T_8$ (3.10) were superior and on par with $T_6$. The least number of leafy shoots production were produced by the treatment $T_3$ (2.00).

After ninth month of planting there was not much difference among the treatment regarding leafy shoots and the treatment $T_6$ (3.33) recorded maximum number of leafy shoots followed by $T_1$ (3.01) and $T_4$ (2.93). The least number of leafy shoot was recorded by $T_3$ (2.22).

Twelfth month after planting again the treatment $T_6$ expressed maximum number of leafy shoots (3.85). The treatments $T_1$ (3.51), $T_8$ (3.03), $T_4$ (2.99) and $T_2$ (2.87) were superior and found to be on par with $T_6$.During this period $T_3$ had showed minimum number of leafy shoots per plant (2.12).

After fifteenth month of planting there was slight increase in leafy shoot production and the treatment $T_6$ recorded maximum number of leafy shoot (3.90) followed by $T_1$ (3.75) and $T_8$ (3.60). Lowest number of leafy shoot production was recorded by treatment $T_3$ (2.25).

Eighteen months after planting the treatments showed a decreasing trend with regard to leafy shoot production. However the treatment $T_6$ had reported maximum number of leafy shoots (3.65). The treatment $T_1$ (3.58), $T_8$ (3.20) and $T_4$ (3.02) were on par with $T_6$. During this period the treatment $T_7$ (2.55) showed minimum number of leafy shoots.

Even after twenty first month of planting the treatment $T_6$ recorded maximum number of leafy shoots (3.78). The treatment $T_1$ (3.52) was on par with $T_6$.The lowest number of leafy shoots was recorded by $T_7$ (2.65). Majority of the treatments were on par with $T_7$.

Table .13. Number of leafy shoots in *Dendrobium* var.Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $2.12^{abc}$ | $2.22^{bc}$ | $3.13^{abc}$ | $3.01^{ab}$ | $3.51^{a}$ | $3.75^{ab}$ | $3.58^{abc}$ | $3.52^{abc}$ | $3.58^{a}$ | $3.44^{a}$ |
| 2 | $2.20^{ab}$ | $2.35^{abc}$ | $2.65^{bcd}$ | $2.62^{bc}$ | $2.87^{abcd}$ | $3.30^{bc}$ | $2.85^{bcd}$ | $3.08^{bcde}$ | $3.18^{abc}$ | $2.92^{bc}$ |
| 3 | $2.02^{abc}$ | $2.42^{abc}$ | $2.00^{de}$ | $2.22^{c}$ | $2.12^{cde}$ | $2.25^{cde}$ | $2.75^{cd}$ | $2.72^{cde}$ | $2.68^{bc}$ | $2.61^{bc}$ |
| 4 | $2.18^{abc}$ | $2.68^{ab}$ | $2.89^{bc}$ | $2.93^{abc}$ | $2.99^{abc}$ | $3.25^{bc}$ | $3.02^{abcd}$ | $3.02^{bcde}$ | $3.21^{abc}$ | $3.18^{ab}$ |
| 5 | $2.35^{ab}$ | $2.50^{abc}$ | $2.22^{cde}$ | $2.45^{bc}$ | $2.33^{bcd}$ | $2.76^{bcde}$ | $2.82^{bcd}$ | $2.50^{cde}$ | $2.78^{bc}$ | $2.38^{c}$ |
| 6 | $2.24^{ab}$ | $2.98^{a}$ | $3.58^{a}$ | $3.33^{a}$ | $3.85^{a}$ | $3.90^{a}$ | $3.65^{a}$ | $3.78^{a}$ | $3.65^{a}$ | $3.51^{a}$ |

Table .14. Number of pseudobulbs in *Dendrobium* var.Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | $2.35^{b}$ | $2.02^{ab}$ | $2.32^{bc}$ | $2.02^{bcd}$ | $2.92^{bc}$ | $2.98^{bcd}$ | $2.83^{cd}$ | $2.89^{abc}$ | $3.74^{abc}$ | $3.76^{ab}$ |
| 2 | $2.02^{bc}$ | $2.22^{ab}$ | $2.28^{bc}$ | $2.32^{bc}$ | $2.83^{bc}$ | $3.32^{bc}$ | $3.12^{bc}$ | $2.52^{bcd}$ | $3.65^{bc}$ | $3.55^{abc}$ |
| 3 | $1.65^{c}$ | $1.58^{abc}$ | $1.76^{cde}$ | $1.78^{cd}$ | $2.00^{cd}$ | $2.18^{def}$ | $2.18^{de}$ | $2.11^{cde}$ | $2.55^{de}$ | $2.12^{cd}$ |
| 4 | $1.81^{c}$ | $2.16^{ab}$ | $2.85^{ab}$ | $2.65^{b}$ | $3.02^{abc}$ | $3.85^{ab}$ | $3.58^{abc}$ | $3.12^{ab}$ | $3.98^{ab}$ | $3.82^{ab}$ |
| 5 | $2.00^{bc}$ | $2.00^{ab}$ | $2.12^{bcd}$ | $1.53^{cde}$ | $1.85^{d}$ | $1.99^{ef}$ | $2.03^{def}$ | $2.08^{cde}$ | $2.01^{def}$ | $2.65^{bcd}$ |
| 6 | $2.81^{a}$ | $2.93^{a}$ | $3.11^{a}$ | $3.08^{a}$ | $3.95^{a}$ | $4.12^{a}$ | $3.93^{a}$ | $3.58^{a}$ | $4.25^{a}$ | $4.18^{a}$ |
| 7 | $2.15^{bc}$ | $1.63^{abc}$ | $1.89^{cde}$ | $1.75^{cd}$ | $2.18^{bcd}$ | $2.72^{cd}$ | $2.25^{de}$ | $2.32^{cd}$ | $2.89^{cde}$ | $2.79^{bcd}$ |
| 8 | $2.85^{a}$ | $2.50^{a}$ | $3.02^{a}$ | $3.00^{a}$ | $3.26^{abc}$ | $4.00^{a}$ | $3.71^{ab}$ | $3.23^{ab}$ | $4.10^{a}$ | $4.03^{a}$ |
| 9 | $2.18^{bc}$ | $1.89^{ab}$ | $2.18^{bc}$ | $1.89^{bcd}$ | $2.21^{bcd}$ | $2.65^{cd}$ | $2.96^{c}$ | $2.18^{cde}$ | $3.58^{bc}$ | $3.18^{abcd}$ |

In subsequent months i.e., twenty fourth and twenty seventh month after planting the treatments did not show much significant difference. During this period a decreasing trend in leafy shoot production was recorded. Again the treatment $T_6$ recorded the highest number of leafy shoot production (3.65and 3.51) during twenty-fourth and twenty seventh month after planting respectively.

#### 4.1.2.6 Number of pseudo bulbs

Data pertaing to the number of pseudo bulbs are in Table 14.

During third month after planting there was no appreciable difference in pseudo bulb production and the treatments were found to be statistically insignificant. During that period $T_6$ recorded maximum no of pseudo bulbs (2.93). Sixth month after planting the treatments showed significant difference and $T_6$ recorded maximum number of pseudo bulb produced (3.11). The treatment, $T_8$ (3.02) and $T_4$ (2.85) were statistically on par. The least value was recorded for the treatment $T_3$ (1.76).

Ninth month after planting the treatment $T_6$ reported maximum pseudo bulb production (3.08) followed by $T_8$ (3.00) and the treatment $T_5$ (1.53) showed minimum number of pseudo bulb production.

Data recorded after twelfth month of planting revealed substantial increase in pseudo bulb production. Again the treatment $T_6$ recorded the highest number of pseudo bulb production (3.95). The treatments $T_8$ (3.26) and $T_4$ (3.02) were found to be statistically on par with $T_3$.The lowest number of pseudo bulbs were produced by $T_5$ (1.85).

Fifteenth month after planting a similar trend in pseudo bulb production was noticed. The treatment $T_6$ (4.12) recorded the maximum value for pseudo bulb production and the lowest value was recorded by $T_5$ (1.99).

After eighteenth and twenty first month of planting the pseudo bulb production showed a decreasing trend and $T_6$ recorded maximum values for both months i.e. 3.93 and 3.58.The minimum values were recorded by $T_5$ for both months (2.03 and 2.08 respectively).

Twenty fourth month after planting pseudo bulb production increased and $T_6$ (4.25) recorded maximum value. The treatments $T_8$ (4.10), $T_4$ (3.98) and $T_1$ (3.74) were superior and statistically on par with $T_6$.The minimum value for pseudo bulb production was recorded by $T_5$ (2.01).

Data pertaining to twenty seventh month of planting revealed that the treatment $T_6$ which received vermiwash showed highest value (4.18) for pseudo bulb production. Majority of the treatments i.e. $T_8$ (4.03), $T_4$ (3.82), $T_1$ (3.76), $T_2$ (3.55) and $T_9$ (3.18) were found to be statistically on par with $T_6$.The lowest number of pseudo bulb production was noticed for the treatment $T_3$ (2.12).

#### 4.1.2. 7 Girth of shoot

Data pertaing to shoot girth are presented in Table 15.

Three months after planting no significant difference was observed among the treatments regarding the girth of shoot and the treatment $T_6$ showed maximum value (2.93 cm) and $T_2$ (2.21cm) recorded minimum value of shoot girth.

Significant effect of treatments on shoot girth was noticed after sixth month of planting. The treatment $T_6$ (3.37 cm) recorded maximum value followed by $T_8$ (3.03 cm). The treatment $T_8$ was found to be statistically on par with $T_6$. The lowest value was recorded by the treatment $T_3$ (2.31 cm).

Ninth month after planting again the treatment $T_6$ (3.92 cm) recorded maximum value for shoot girth. The treatments $T_8$ (3.53 cm), $T_1$ (3.31 cm), $T_9$ (3.02 cm) and $T_2$ (3.00 cm) were statistically on par with $T_6$.The treatment $T_3$ (2.56 cm) recorded the minimum value for shoot girth.

After twelfth month of planting the treatment $T_6$ again expressed maximum value for shoot girth (4.11cm). The treatments $T_8$ (4.02 cm), and $T_1$ (3.91cm) were significant and on par with $T_6$. The minimum shoot girth values were noticed for $T_5$ (2.85 cm) and $T_3$ (2.56 cm).

Again after fifteenth month of planting the treatment $T_6$ showed maximum shoot girth of 4.07 cm. The treatments $T_8$ (3.91 cm), $T_1$ (3.80 cm), $T_9$ (3.72 cm) and $T_4$ (3.55 cm) were statistically on par with $T_6$. The lowest value for shoot girth was recorded for the treatment $T_3$ (2.26 cm).

Eighteenth month after planting $T_6$ showed maximum shoot girth value of 4.16cm followed by $T_8$ (3.85 cm), $T_9$ (3.81 cm) and $T_1$ (3.72 cm). These treatments were found to be statistically on par with $T_6$. Minimum value for shoot girth was recorded for the treatment $T_3$ (2.55 cm).

Significant difference on shoot girth was not observed among the treatments after twenty first month of planting. During this period again the treatment $T_6$ recorded highest shoot girth value of 4.02 cm and the lowest value was recorded by the treatment $T_3$ (3.01 cm).

Twenty fourth month after planting the treatments showed an increasing trend in shoot girth value due to the influence of various treatments. The treatment $T_6$ showed maximum shoot girth value of 4.22 cm.The treatments $T_1$ (4.11 cm) and $T_8$ (4.02 cm) were statistically on par with $T_6$. The lowest value was recorded by $T_3$ (2.71 cm).

Table.15. Girth of shoot (cm) in *Dendrobium* var.Shavin White as influenced by different levels of inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.85$^{ab}$ | 2.50$^{ab}$ | 3.21$^{a}$ | 3.31$^{ab}$ | 3.91$^{ab}$ | 3.80$^{ab}$ | 3.72$^{abc}$ | 3.92$^{ab}$ | 4.11$^{ab}$ | 4.00$^{ab}$ |
| 2 | 2.00$^{ab}$ | 2.21$^{abc}$ | 2.73$^{abc}$ | 3.00$^{abc}$ | 3.20$^{cde}$ | 2.85$^{cdef}$ | 3.00$^{bcd}$ | 3.35$^{cd}$ | 3.51$^{cd}$ | 3.45$^{bcd}$ |
| 3 | 1.65$^{ab}$ | 1.78$^{bcd}$ | 2.31$^{bc}$ | 2.56$^{bcde}$ | 2.86$^{def}$ | 2.26$^{efg}$ | 2.55$^{def}$ | 3.01$^{def}$ | 2.71$^{efg}$ | 2.28$^{efgh}$ |
| 4 | 2.32$^{a}$ | 2.71$^{a}$ | 2.98$^{ab}$ | 2.77$^{bcd}$ | 3.63$^{bc}$ | 3.55$^{abc}$ | 3.81$^{abc}$ | 3.95$^{a}$ | 3.62$^{cd}$ | 2.81$^{abcd}$ |
| 5 | 1.31$^{abc}$ | 1.99$^{bc}$ | 2.17$^{bcd}$ | 2.55$^{bcde}$ | 2.85$^{def}$ | 3.02$^{bcd}$ | 2.85$^{cde}$ | 3.00$^{def}$ | 2.68$^{fg}$ | 2.95$^{de}$ |
| 6 | 2.02$^{a}$ | 2.93$^{a}$ | 3.37$^{a}$ | 3.92$^{a}$ | 4.11$^{a}$ | 4.07$^{a}$ | 4.16$^{a}$ | 4.02$^{a}$ | 4.22$^{a}$ | 4.25$^{a}$ |
| 7 | 1.92$^{ab}$ | 2.05$^{abcd}$ | 2.26$^{bc}$ | 2.75$^{bcd}$ | 2.93$^{def}$ | 3.23$^{bcd}$ | 2.93$^{cd}$ | 3.25$^{cde}$ | 3.41$^{cde}$ | 2.75$^{de}$ |
| 8 | 2.41$^{a}$ | 2.65$^{ab}$ | 3.03$^{ab}$ | 3.53$^{ab}$ | 4.02$^{ab}$ | 3.91$^{ab}$ | 3.85$^{abc}$ | 3.81$^{ab}$ | 4.02$^{abc}$ | 4.13$^{a}$ |
| 9 | 1.73$^{ab}$ | 2.71$^{a}$ | 2.85$^{abc}$ | 3.02$^{abc}$ | 3.50$^{bcd}$ | 3.72$^{abc}$ | 3.81$^{abc}$ | 3.75$^{abc}$ | 3.65$^{cd}$ | 3.00$^{cd}$ |

Table.16. Internodal length (cm) in *Dendrobium* var. Shavin White as influenced by different levels inorganic fertilizers and organic manures

| Treatment | At the planting | 3 MAP | 6 MAP | 9 MAP | 12 MAP | 15 MAP | 18 MAP | 21 MAP | 24 MAP | 27 MAP |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.61$^{a}$ | 2.62$^{ab}$ | 3.69$^{bcd}$ | 3.96$^{ab}$ | 4.06$^{abcd}$ | 4.21$^{abc}$ | 4.33$^{ab}$ | 4.55$^{ab}$ | 4.31$^{abc}$ | 4.38$^{ab}$ |
| 2 | 1.42$^{ab}$ | 1.85$^{bc}$ | 3.08$^{de}$ | 3.12$^{bcd}$ | 2.59$^{de}$ | 2.99$^{de}$ | 3.28$^{cd}$ | 3.29$^{cd}$ | 3.39$^{bcde}$ | 3.65$^{bc}$ |
| 3 | 1.22$^{abc}$ | 2.09$^{b}$ | 1.55$^{def}$ | 2.03$^{cde}$ | 2.16$^{def}$ | 3.48$^{cde}$ | 2.51$^{def}$ | 2.61$^{e}$ | 2.17$^{e}$ | 2.25$^{def}$ |
| 4 | 1.47$^{ab}$ | 2.15$^{b}$ | 3.55$^{bcd}$ | 3.55$^{abcd}$ | 3.88$^{bc}$ | 3.75$^{bcd}$ | 3.59$^{bc}$ | 3.78$^{bc}$ | 4.00$^{bc}$ | 3.89$^{b}$ |
| 5 | 1.29$^{abc}$ | 1.92$^{b}$ | 2.01$^{de}$ | 2.23$^{cd}$ | 2.79$^{de}$ | 2.86$^{def}$ | 2.91$^{de}$ | 2.89$^{de}$ | 2.54$^{def}$ | 2.36$^{de}$ |
| 6 | 1.70$^{a}$ | 3.01$^{a}$ | 3.37$^{abc}$ | 4.25$^{a}$ | 4.59$^{a}$ | 4.73$^{a}$ | 4.81$^{a}$ | 4.92$^{a}$ | 4.72$^{a}$ | 4.75$^{a}$ |
| 7 | 1.35$^{ab}$ | 2.08$^{b}$ | 2.55$^{cdef}$ | 2.45$^{cd}$ | 3.18$^{cd}$ | 3.21$^{cd}$ | 3.39$^{cd}$ | 3.29$^{cd}$ | 2.89$^{de}$ | 2.94$^{cd}$ |
| 8 | 1.79$^{a}$ | 2.90$^{a}$ | 3.8 2$^{a}$ | 4.01$^{ab}$ | 4.21$^{ab}$ | 4.55$^{ab}$ | 4.45$^{ab}$ | 4.67$^{ab}$ | 4.55$^{ab}$ | 4.56$^{a}$ |
| 9 | 1.43$^{ab}$ | 2.32$^{abc}$ | 2.78$^{cde}$ | 2.89$^{bcd}$ | 3.29$^{cd}$ | 3.89$^{abcd}$ | 3.76$^{b}$ | 3.15$^{cde}$ | 3.16$^{cd}$ | 3.22$^{bcd}$ |

At twenty seventh month of planting the treatments showed significant variation identifying T6 as the best treatment (4.25 cm) and the treatment T8 (4.13 cm) was found to be on par with $T_6$. The treatment $T_3$ (2.28 cm) recorded minimum value for shoot girth.

#### 4.1.2.8 Internodal length

Data pertaining to internodal length are presented in Table 16.

During third month after planting internodal length did not show much effect as influenced by the various treatment combinations.

A significant difference was noticed for the length of internode after sixth month of planting. The treatment receiving vermiwash and panchagavya recorded the highest internodal length (3.82 cm). The minimum internodal length was recorded by the treatment $T_3$ (1.55 cm).

Ninth month after planting the treatment $T_6$ recorded maximum internodal length of 4.25 cm.The treatments $T_8$ (4.01 cm), $T_1$ (3.96 cm) and $T_4$ (3.55 cm) were found to be statistically on par with $T_6$. But majority of the treatments were found to be on par with the treatment $T_3$ (2.03 cm) that recorded the shortest internodal length.

After twelfth month of planting the treatments showed significant variation identifying $T_6$ as the best treatment (4.59 cm) and the treatment $T_8$ (4.21 cm) and $T_1$ (4.06 cm) were found to be on par with $T_6$.The lowest internodal length was noticed for $T_3$ (2.16 cm).

Fifteen months after planting again the treatment $T_6$ (4.73 cm) recorded maximum value for internodal length followed by $T_8$ (4.55 cm), $T_1$ (4.21 cm) and $T_9$ (3.89 cm). The lowest value was recorded by $T_5$ (2.86 cm).

After eighteenth month of planting the treatment $T_6$ (4.81cm) recorded maximum value for internodal length. The treatments $T_8$ (4.45 cm) and $T_1$ (4.33 cm) were found to be statistically on par with $T_6$. The treatment $T_3$ (2.51 cm) showed minimum value for internodal length.

Twenty first month after planting the treatments showed appreciable difference in internodal length and the best result was showed by $T_6$ (4.92 cm). The treatments $T_8$ (4.67 cm) and $T_1$ (4.55 cm) were found to be on par with $T_1$. The treatment $T_3$ recorded the lowest value for internodal length (2.61 cm).

Twenty fourth month after planting again the treatment $T_6$ showed maximum value for internodal length (4.72 cm) followed by $T_8$ (4.55 cm) and $T_1$ (4.31 cm). The treatment $T_3$ recorded the minimum value for internodal length (2.17 cm).

The value for internodal length recorded after twenty seventh month of planting revealed that the treatment $T_6$ receiving vermiwash resulted in maximum internodal length (4.75 cm) than the other combinations. The treatments $T_8$ (4.56 cm) and $T_1$ (4.38 cm) were found to be statistically on par with $T_6$. The lowest value was noticed for the treatment $T_3$ (2.25 cm).

## 4.2 FLOWER CHARACTERS

### 4.2.1 *Dendrobium* Earsakul

#### 4.2.1.1 Days to first flowering

Data regarding days to first flowering are presented in Table 17.

With respect to the data recorded, early flowering was obtained for the treatment $T_1$ (608days). The plants grown under controlled condition receiving only inorganic fertilizers produced flowers earlier than other treatments.

**Plate. 4. *Dendrobium* Earsakul at flowering stage**

**Plate. 5. *Dendrobium* Shavin White at flowering stage**

Table: 17.Flower characters in *Dendrobium* var. Earsakul as influenced by different level of inorganic and organic manures.

| Treatment | Days to first flowering | Number of spikes/ plant | Size of the flower | Spike length | Number of flowers/ spike | Internodal length | Flower pedicel length | Longevity of spike per plant |
|---|---|---|---|---|---|---|---|---|
| 1 | 608 | 1 | 6.5 x 5.0 | 18.75 | 4.32 | 3.29 | 3.37 | 31.03 |
| 2 | 635 | 1 | 6.6 x 5.3 | 17.92 | 3.70 | 3.31 | 3.23 | 31.30 |
| 3 | - | - | - | - | - | - | - | - |
| 4 | 620 | 1 | 5.8 x 4.9 | 20.91 | 4.11 | 3.31 | 3.28 | 31.08 |
| 5 | - | - | - | - | - | - | - | - |
| 6 | 652 | 1 | 6.2 x 5.1 | 21.58 | 3.18 | 3.38 | 3.39 | 32.05 |
| 7 | - | - | - | - | - | - | - | - |
| 8 | 642 | 1 | 6.8 x 5.9 | 19.24 | 4.56 | 3.26 | 3.30 | 30.00 |
| 9 | - | - | - | - | - | - | - | - |

#### 4.2.1.2 Number of spikes per plant

Data are presented in Table 17.

The results obtained indicated that the different treatments did not show significant influence on the number of spikes per plant. Result was homogenous and plants produced only one spike during the whole study period

#### 4.2.1.3 Size of the flower

Data regarding the size of the individual flowers are presented in Table 17.

However the treatment $T_8$, receiving vermiwash and modified form of panchagavya along with inorganic fertilizers produced larger flowers than others (6.8 X 5.9 $cm^2$).

Of the various treatments, beneficial effect on size of the flowers was not observed in any of the treatments. Majority of the plants produced almost similar size of flowers indicating that treatments did not have any marked effect on flower size.

#### 4.2.1.4 Spike length

The spike lengths of flowers are presented in Table 17.

Treatments had significant influence on plant and therefore marked difference was observed on spike length. Maximum length of spike (21.58 cm) was observed for $T_6$ (treatment receiving vermiwash).

#### 4.2.1.5 Number of flowers per spike

Data regarding the number of flowers per spike a influenced by various treatments are expressed in Table 17.

Maximum number of flowers per spike (4.56) was observed for $T_{8.}$ In other treatments flowers were produced in a range of 3.18 to 4.32.

#### 4.2.1.6 Internodal length

The internodal length observed is presented in Table 17.

The internodal length produced was highest for the treatment $T_6$ and the value was 3.38 cm. Others recorded values in between 3.26 and 3.31 cm. Majority of the treatments were similar in internodal length.

#### 4.2.1.7 Flower pedicel length

The length of the flower pedicel obtained is presented in Table 17.

Majority of the treatments showed almost similar flower pedicel length and the treatments recorded in a range from 3.23 cm to 3.39 cm.

#### 4.2.1.8 Longevity of spike on plant

Data pertaining to longevity of spike on the plants are presented in Table17.

Majority of the treatments showed a similar trend with values ranging from 30.00 to 32.03 days.

#### 4.2.1.9 Vase life in water

Due to lack of spikes, the study on the vase life in water could not be carried out for all the treatments.

#### 4.2.1.10 Colour variation

In the present study no significant variation for the colour of petals was observed. All the flowers were found to have the same shade of colour.

### 4.2.2 *Dendrobium* Shavin White

#### 4.2.2.1 Days to first flowering

Data regarding days to first flowering are presented in Table 18.

With respect to the data recorded, early flowering was obtained for the treatment $T_1$ (619days). The plants grown under controlled condition (inorganic fertilizers) produced flowers earlier than other treatments. The plants receiving the treatments $T_6$ and $T_8$ had come to flowering within a period ranging from 615 to 638 days.

#### 4.2.2.2 Number of spikes per plant

Data presented in Table 18.

The results obtained indicated that the different treatments did not markedly influence the number of spikes per plants. A homogenous result and plants of one spike per plant was obtained during the whole period of study.

Table: 18. Flower characters in *Dendrobium* var. Shavin White as influenced by different levels of inorganic and organic manures

| Treatment | Days to first flowering | Number of spikes/ plant | Size of the flower ($cm^2$) | Spike length (cm) | Number of flowers/ spike | Internodal length (cm) | Flower pedicel length (cm) | Longevity of spike per plant (days) |
|---|---|---|---|---|---|---|---|---|
| 1 | 619 | 1 | 6.5 x 5.4 | 19.21 | 5.50 | 3.32 | 3.36 | 31.07 |
| 2 | 631 | 1 | 6.5 x 5.1 | 18.73 | 5.31 | 3.29 | 3.41 | 30.53 |
| 3 | - | - | - | - | - | - | - | - |
| 4 | - | - | - | - | - | - | - | - |
| 5 | - | - | - | - | - | - | - | - |
| 6 | 625 | 1 | 6.3 x 5.2 | 20.05 | 4.21 | 3.37 | 3.38 | 32.67 |
| 7 | - | - | - | - | - | - | - | - |
| 8 | 638 | 1 | 6.8 x 5.7 | 17.48 | 6.23 | 3.35 | 3.33 | 32.23 |
| 9 | | | | | | | | |

#### 4.2.2.3 Size of the flower

Data regarding the size of the individual flowers are presented in Table 18.

Beneficial effects of the treatments on size of the flowers were not observed. Most of the plants produced almost similar size of flowers indicating treatments did not show marked influence. However the treatment $T_8$, receiving vermiwash and panchagavya along with inorganic fertilizers produced more large flowers than others (6.8 x 5.7 $cm^2$).

#### 4.2.2.4 Spike length

The spike lengths of individual flowers are presented in Table 18.

Marked difference in spike length was observed due to the effect of various treatments. Highest spike length (20.05 cm) was obtained for the treatment $T_6$ and the remaining observations showed that higher values were obtained for higher values were obtained for higher dose of inorganic spray in combination with organic fertilizers

#### 4.2.2.5 Number of flowers per spike

Data regarding the number of flowers per spike as influenced by various treatments are expressed in Table 18.

Treatment receiving vermiwash and panchagavya along with inorganic fertilizers had influenced the number of flowers per spike. Maximum numbers of flowers per spike was obtained for $T_8$ (6.23).

#### 4.2.2.4 Internodal length

Data regarding the internodal length as influenced by various treatments are expressed in Table 18.

The internodal length was not markedly influenced by the treatments and almost all the treatments showed a similar trend. The length of the internodal recorded for the different treatments ranged from 3.29 cm to 3.37 cm, showing only a slight variation among the treatments.

#### 4.2.2.7 Flower pedicel length

The lengths of the flower pedicel obtained are presented in table 18.

No significant influences of treatments were observed for flower pedicel length. Almost all the treatments showed a similar trend with values ranging from 3.33 cm to 3.41 cm.

#### 4.2.2.8 Longevity of spike on plant

Data pertaing to longevity of spike on the plants are presented in Table 18.

Longevity of spike on plant did not show much difference among the treatments, ranging from 30.53 to 32.67days.

#### 4.2.2.9 Vase life in water

Due to lack of spikes, the study on the vase life in water could not be carried out for all the treatments.

#### 4.2.2.10 Colour variation

In the present study no significant variation for the colour of petals was observed. All the flowers were found to have the same shade of colour.

### 4.2.3 INCIDENCE OF PESTS AND DISEASES

During the entire period of study the commonly noticed pest was snails (*Ariophanta* sp.) and slugs (*Arion* sp.). They fed on tender stem, buds and blossoms. These pests were controlled by metaldehyde 2.5 per cent pellet (Snail kill). No other pest was noticed during the period of study.

Regarding diseases, the most commonly observed disease was fungal leaf blight which mainly affected the leaves. The affected areas first changed into yellow and later purplish brown and black. This disease was mainly observed immediately after rains, in a humid weather condition. It was controlled by applying Indofil $3gl^{-1}$.Moreover Akomin was sprayed $3ml^{-1}$ weekly once as a prophylactic measure against fungal pathogen.

## 4.4 NUTRIENT ANALYSIS

4.4.1 *Dendrobium* Earsakul

#### 4.4.1.1 Total nitrogen

Total nitrogen content present in plant sample expressed in percentage are presented in Table 19.

Analysis of the nitrogen content in plants revealed that the treatment $T_8$ was significantly superior with higher nitrogen content (1.36 %) followed by

$T_7$ (1.33 %).The least value for nitrogen content was noted for the treatment $T_2$ and the value was 1.35 %.

#### 4.4.1.2 Total phosphorus

Data pertaining to total phosphorus present in plant sample are presented in Table 19.

Estimation of phosphorus revealed that the treatment $T_8$ showed highest phosphorus content of 0.32 %. The treatment $T_6$ and $T_9$ were found to be statistically on par with $T_8$. The least value was recorded for $T_3$ (0.26 %).

#### 4.4.1.3 Total potassium

Total potassium content in the plant sample expressed in percentage is presented in Table 19.

The results of potassium analysis revealed that superior results were obtained for the treatment $T_8$ (2.61 %). The least potassium content was recorded by $T_3$ (2.34 %).

### *4.4.2 Dendrobium* Shavinwhite

#### 4.4.2.1 Total nitrogen

Total nitrogen content present in plant sample expressed in percentage are presented in Table 20.

Analysis of the nitrogen content in plants revealed that the treatment $T_8$ was significantly superior with higher nitrogen content (1.34 %). The treatment $T_6$ (1.31 %) and $T_7$ (1.37 %) were found to be statistically on par with the treatment

Table: 19. Nutrient (NPK) content (%) in plants of *Dendrobium* variety Earsakul as influenced by different levels of inorganic and organic manures.

| Treatment | Nitrogen content (%) | Phosphorus content (%) | Potassium content (%) |
|---|---|---|---|
| 1 | $1.271^{c}$ | $0.285^{cde}$ | $2.382^{de}$ |
| 2 | $1.232^{de}$ | $0.281^{cdef}$ | $2.426^{cde}$ |
| 3 | $1.784^{efg}$ | $0.261^{def}$ | $2.343^{defg}$ |
| 4 | $1.257^{cdef}$ | $0.292^{cd}$ | $2.418^{cdefg}$ |
| 5 | $1.263^{cd}$ | $0.263^{de}$ | $2.475^{cd}$ |
| 6 | $1.348^{ab}$ | $0.318^{abc}$ | $2.593^{bc}$ |
| 7 | $1.325^{abcde}$ | $0.305^{bc}$ | $2.481^{c}$ |
| 8 | $1.358^{a}$ | $0.323^{a}$ | $2.612^{a}$ |
| 9 | $1.282^{cde}$ | $0.282^{cde}$ | $2.608^{abc}$ |

Table: 20. Nutrient (NPK) content (%) in plants of *Dendrobium* variety Shavin White as influenced by different levels of inorganic and organic manures.

| Treatment | Nitrogen content (%) | Phosphorus content (%) | Potassium content (%) |
|---|---|---|---|
| 1 | $1.273^{cdef}$ | $0.281^{bc}$ | $2.418^{de}$ |
| 2 | $1.226^{defg}$ | $0.278^{bcd}$ | $2.521^{bcde}$ |
| 3 | $1.180^{efgh}$ | $0.259^{de}$ | $2.338^{def}$ |
| 4 | $1.262^{de}$ | $0.265^{cd}$ | $2.462^{cdef}$ |
| 5 | $1.25^{def}$ | $0.273^{bcd}$ | $2.391^{d}$ |
| 6 | $1.307^{bcd}$ | $0.308^{abc}$ | $2.598^{b}$ |
| 7 | $1.321^{abcd}$ | $0.289^{bc}$ | $2.481^{cd}$ |
| 8 | $1.335^{a}$ | $0.312^{a}$ | $2.612^{a}$ |
| 9 | $1.275^{cde}$ | $0.301^{abcde}$ | $2.573^{bc}$ |

$T_8$. The least value for nitrogen content was noted for the treatment $T_3$ and the value was 1.18 %.

#### 4.4.2.2 Total phosphorus

Data pertaining to total phosphorus present in plant sample are presented in Table 20.

Estimation of phosphorus revealed that the treatment $T_8$ showed highest phosphorus content of 0.31 %. The treatment $T_6$ was found to be statistically on par with $T_8$. The least value was recorded for $T_3$ (0.26 %).

#### 4.4.2.3 Total potassium

Total potassium content in the plant sample expressed in percentage is presented in Table 20.

The results of potassium analysis using flame photometry revealed that the highest value was obtained for the treatment $T_8$ and the value was 2.61 % followed by $T_6$ (2.60 %). The lowest content of potassium was observed for the treatment $T_3$ (2.34 %) that represented treatment receiving inorganic fertilizers along with Manchurian tea.

# *Discussion*

# 5. DISCUSSION

The results obtained from studies regarding the effect of organic manures in *Dendrobium* are briefly presented in this chapter.

Orchids, one of the most beautiful flowers with perplexing range of floral structures, fascinating colours and longer vase life have great economic potential as cut bloom. Improving the yield through plant growth and its various parameters are the main objectives in economic crop production. Nowadays the use of organic manures had produced better yield and quality and also helps in economizing the use of inorganic fertilizers when used in combination.

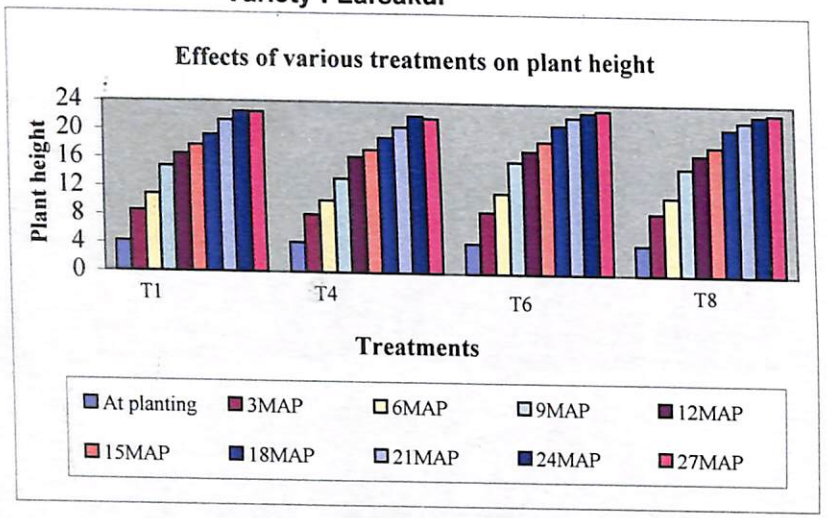
The present trial conducted on *Dendrobium* var.Earsakul and Shavin White clearly revealed the effect of various organic manures used on the growth and development of orchids.

## 5.1 EFFECT OF INORGANIC SPRAY AND ORGANIC MANURES ON GROWTH PARAMETERS

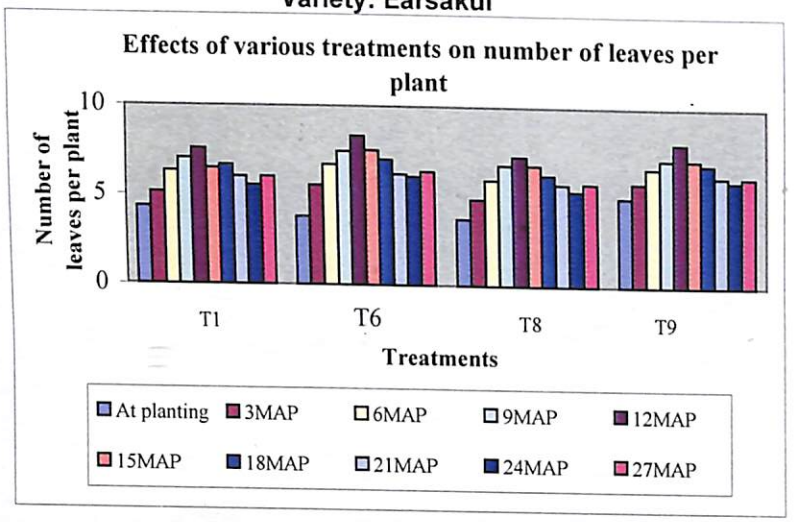
The influence of organic manures on growth was studied by recording data on vegetative characters such as plant height, internodal length, leaf length, leaf width, leafy shoots and number of pseudo bulbs.

When the effect of organic manures on plant characters was considered, better response could be observed wherever organic manures were included in the treatment. The treatment $T_6$ consisted of vermiwash along with inorganic fertilizer NPK 30:10:10 at 0.1 % concentration and fermented FYM recorded superior values for plant height, internodal length, number of leafy shoots, shoot girth and leaf parameters.

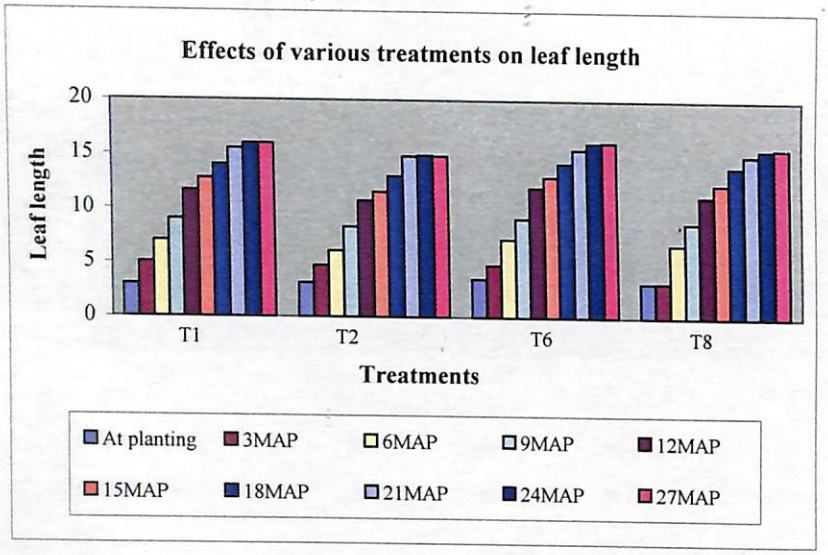
Variety : Earsakul



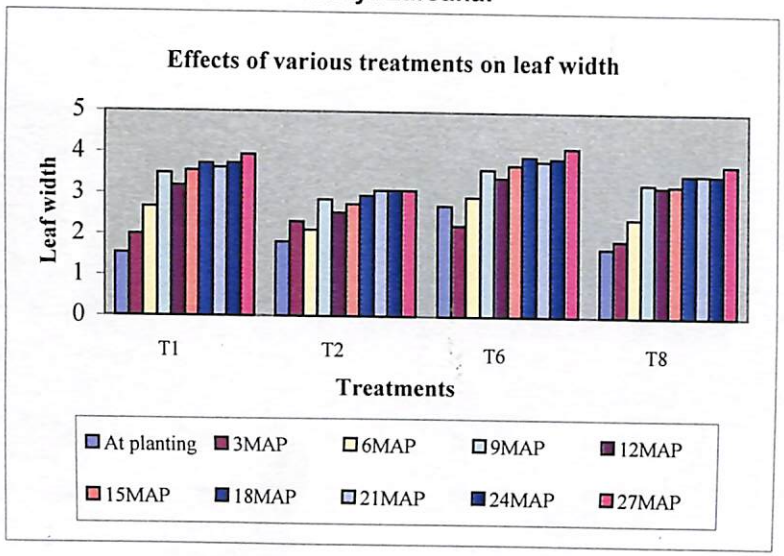

Variety: Earsakul



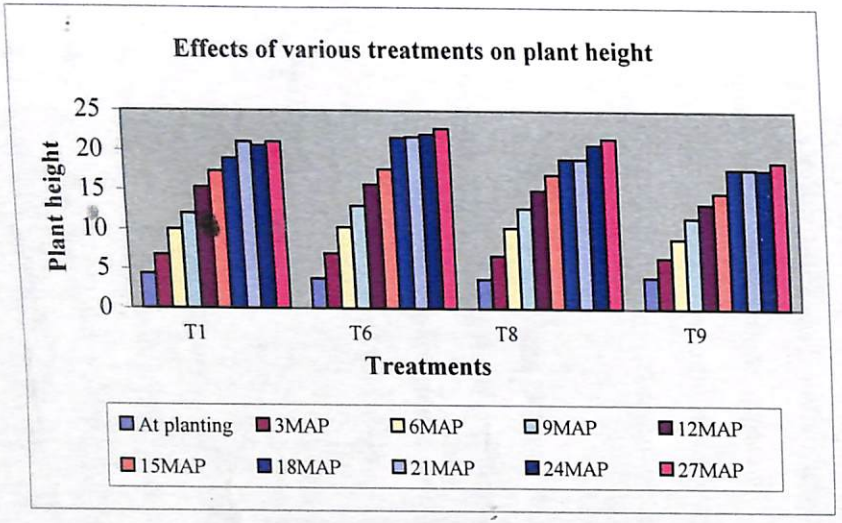

Variety: Earsakul



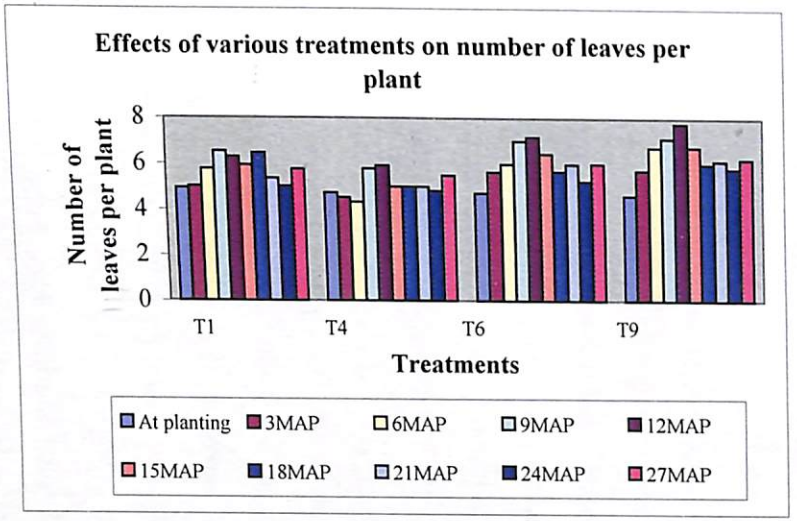

Variety: Earsakul



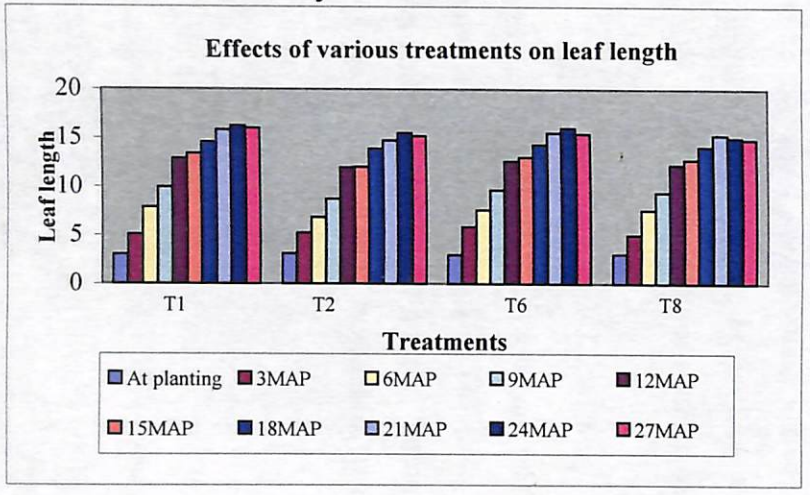
Variety: Shavin White



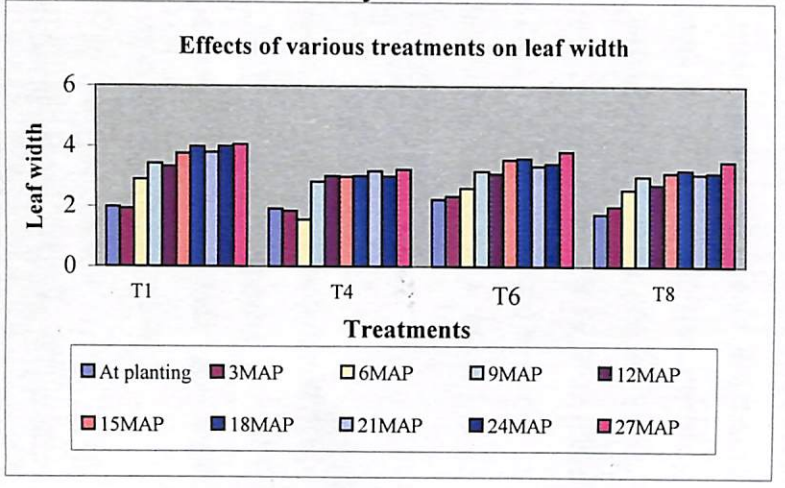

Variety: Shavin White




Variety: Shavin White




Variety: Shavin White



Plant height and internodal length were influenced by organic manures after sixth month of planting. During the initial months significant differences were not observed. But later from sixth month onwards organic manures were found to have significant influence on plant height and internodal length (Fig. 1 and Fig.8).
Hence it is clearly evident that $T_6$ (NPK 30:10:10 + FYM + 3 % vermiwash) was the best treatment among the various treatment combinations. This result is in conformity with the findings of Haripriya and Poonkodi (2005) in tuberose.

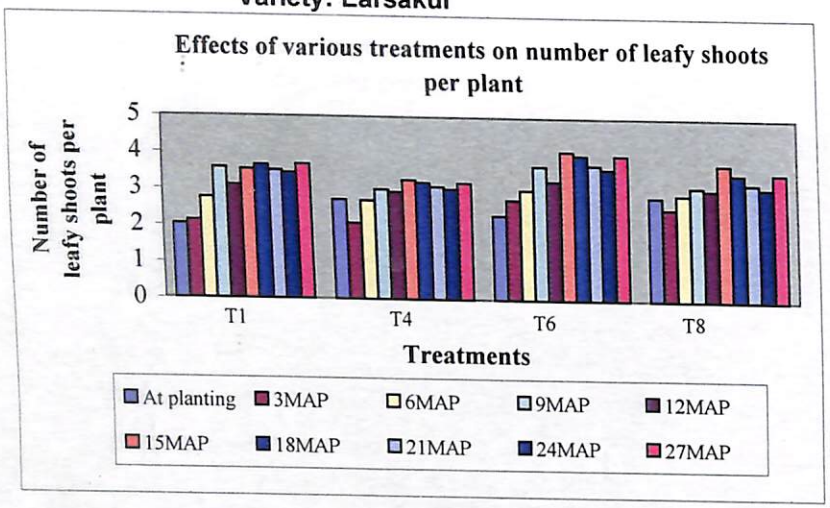
Even though the rate of action of organic manures was slow; it had significant influence in the long run. Nitrogen present in vermiwash helped to promote vegetative growth. Increase in plant height due to increase in nitrogen fertilization have been reported by Ramachandran and Thimmaraju (1983).

Vermiwash contains some growth hormones, like auxins, gibberellins. $GA_3$ induces cell elongation and thus shoot elongation (Jones and Mac Millan, 1984). The rapid meristematic activity triggered by plant nutrients especially nitrogen and the higher rate of metabolic activity coupled with rapid cell division brought about by phosphorus resulted in better vegetative growth (Meera, 1998).

In the present study, the influence of organic manures on leaf production was noticed from sixth months onwards (Fig.2 and Fig.10). Thereafter a profound influence was noticed during the entire period of observation. Higher leaf production was noticed in the treatment $T_6$ (NPK 30:10:10 + FYM + 3 % vermiwash).

Leaf length and leaf width were also found to be better for the treatment receiving vermiwash. This may be due to the foliar uptake of nutrients (Cu,Zn,Ca,Mg) present in the vermiwash. Higher level of N resulting in higher leaf area has been reported by Russell (1973).

Variety: Earsakul

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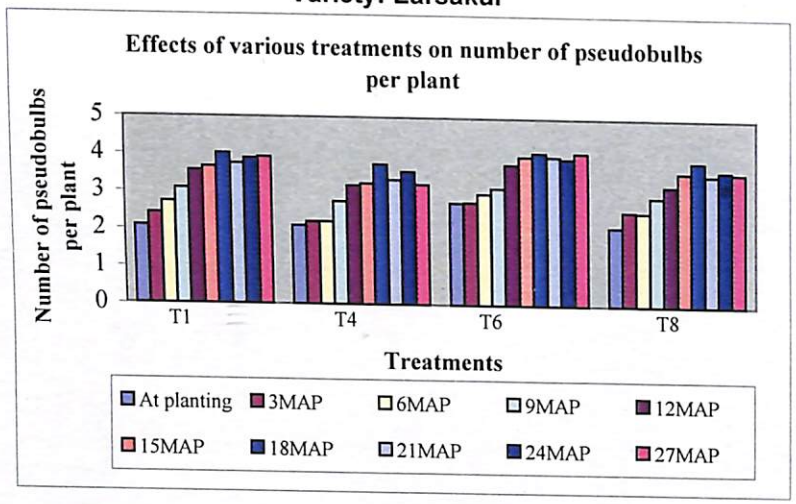
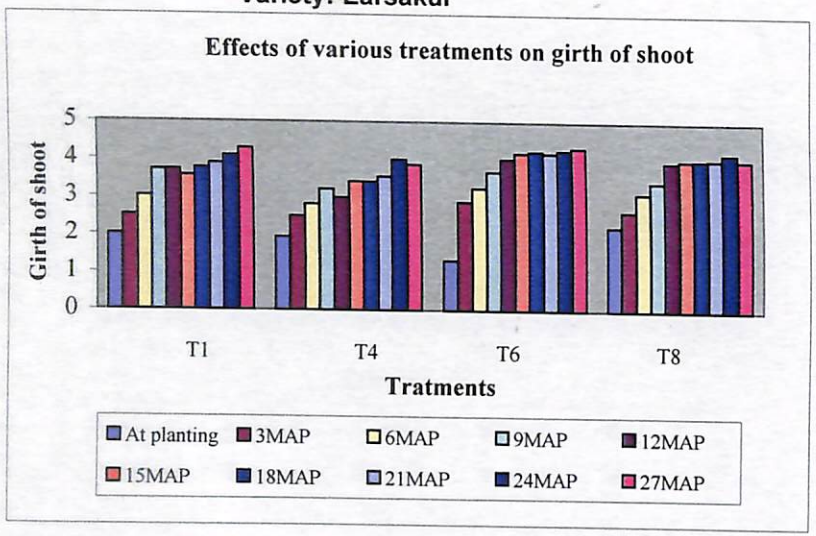
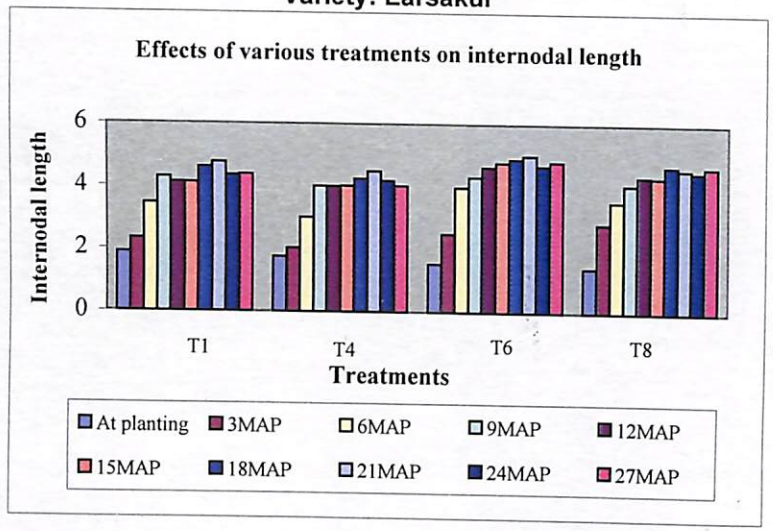


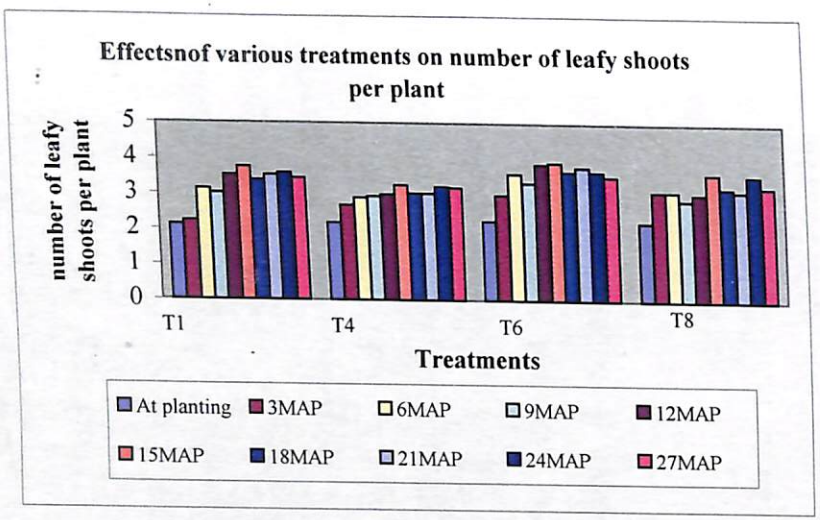

Variety: Earsakul



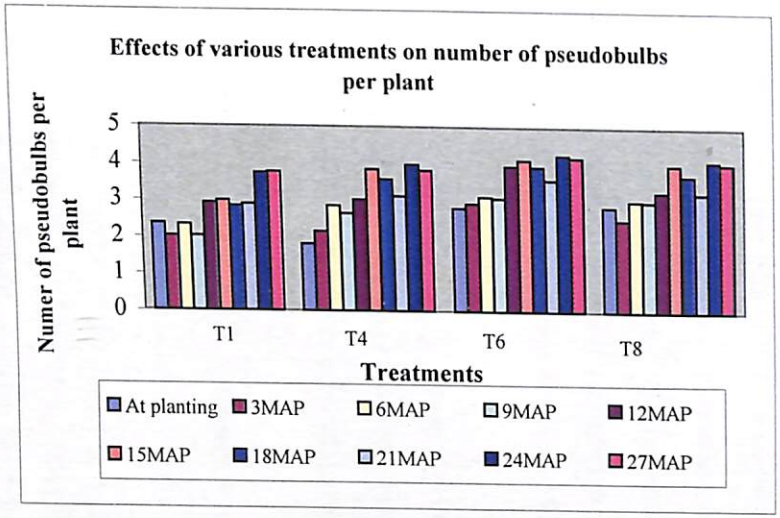

Variety: Earsakul

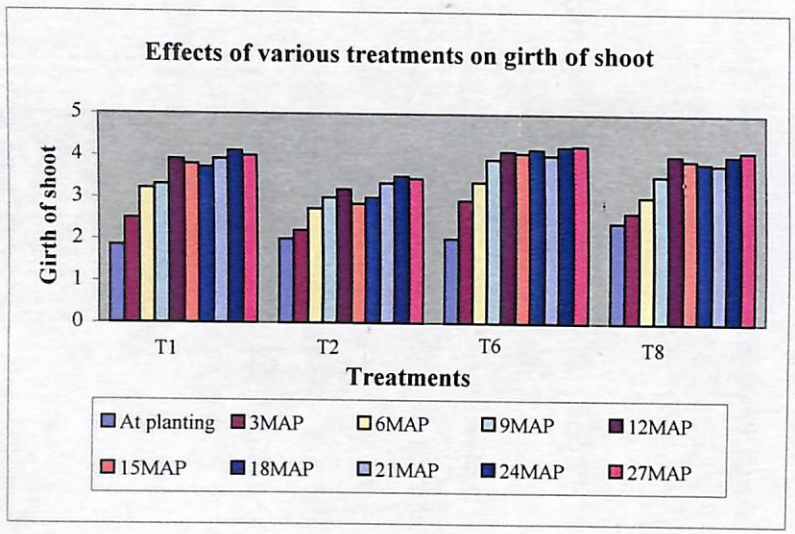


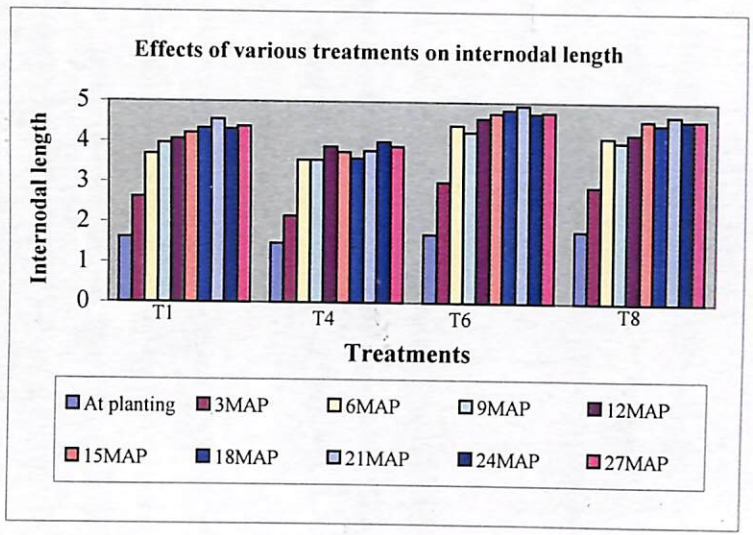
Variety: Shavin White




Variety: Shavin White



Increase in leaf area through N application in solanaceous vegetables has been reported by Ramachandran and Subbiah (1982). Muchow (1990) reported an increased leaf area with increasing dose of nitrogen. Nitrogen being the essential constituent of proteins might have resulted in better growth, leading to increased production of leaves. (Maynard *et al.*, 1962).

When leafy shoots produced per plant was observed, significant influence of organic manures was noticed from sixth month onwards. The treatment $T_6$ gave the best result for leafy shoot production (Fig.3 and Fig.13).

Shoot girth produced during the entire experimental period seemed to be significantly influenced by organic manures. Maximum shoot girth was noticed for the treatment $T_6$ (Fig.5 and Fig.15). This may be due to the influence of nitrogen, chief constituent of proteins essential for the formation of protoplasm which lead to cell division and cell enlargement. Nitrogen is an important component of amino acids and co-enzymes which have considerable biological importance (Bakely, 1974). In marigold Rathore *et al* (1985) expressed similar views.

When internodal length was considered, treatments showed a significant influence after sixth month of planting. Vermiwash is a mixture of excretory products of earth worms and organic nutrients of soil, which may help to increase cell division and cell elongation in the region of axillary buds, which ultimately resulted in internodal length (Torrey, 1950). Similar findings were reported by Preethi (1990) in Edward Rose and Balasubramanian (1989) in French marigold

## 5.2 EFFECT OF ORGANIC MANURES ON FLOWER CHARACTERS

Orchids are known as the wonder flowers of the world. The economic part of the orchid plant is cut bloom. In the present trial, results regarding number of days to first flowering, number of spikes and size of flowers are reported. During the period of study, all the plants did not come to flowering.

The plants which received higher dose of inorganic nutrients (NPK 30:10:10 @ 0.2%) with fermented FYM (1:10) came to flowering earlier (control). This may be due to nitrogen present in inorganic spray and helps to flower earlier.

In case of the number of spikes produced per plant the organic manures application coupled with inorganic spray were found to have no influence on the number of spikes produced by the plants during the period of the present study.

Regarding the spike length and internodal length, the treatment receiving vermiwash along with inorganic fertilizers & FYM had a favourable effect on these characters.

When size of the flowers and number of flowers per spike were considered maximum result was reported for the treatment $T_8$ (NPK 30:10:10 + FYM + 3 % vermiwash + 3 % panchagavya).The favourable effect might be due to the translocation of sugars, production of auxins and gibberellins induced by the organic fertilizers which ultimately leading to increased yields (Nagarajaih and Reddy, 1986). Similar findings were reported by Haripriya and Poonkodi (2005) in tuberose.

Flowers per spike are positively correlated with total number of leaves, mean height of shoots etc. Mean height of shoots was highly correlated with length of inflorescence. Thus selection for taller shoots will help in obtaining longer

inflorescence. The increased number of leaves would have contributed to higher rate of photosynthesis, which in turn would have resulted in longer inflorescence (Sobhana, 2000).

Regarding longevity of spikes on plants, almost all the treatments showed a similar trend without much variation among the treatments.

Regarding the vase life of the flowers, due to the lack of sufficient number of spikes during the period of study the superiority of the treatments could not be assessed.

## 5.3 EFFECT OF INORGANIC AND ORGANIC SPRAY ON INCIDENCE OF DISEASE AND PEST

During the entire period of study, there was not much incidence of pests and diseases. But snails and slugs were common during rainy season which is a common phenomenon in orchids grown in Kerala. Fungal and bacterial diseases were also observed and kept controlled timely using right prophylactic measures.

## 5.4 EFFECT OF ORGANIC SPRAY AND INORGANIC FERTILIZER APPLICATION ON NUTRIENT CONTENT OF THE CROP

Nutrient analysis was carried out to estimate the total nitrogen, phosphorus and potassium content in plants. Results revealed that there is a slight increase in nutrient content in treatments receiving inorganic fertilizers along with organic manures. The increase in nutrient content of the plant might be attributed to the multiplication of micro-organisms and certain growth promoting substances like gibberellins and auxins (Rao and Venkateswaralu, 1985).

**Fig. 17. Nutrient content (%) in plants of *Dendrobium* var.Earsakul as influenced by different levels of inorganic fertilizers and organic manures**

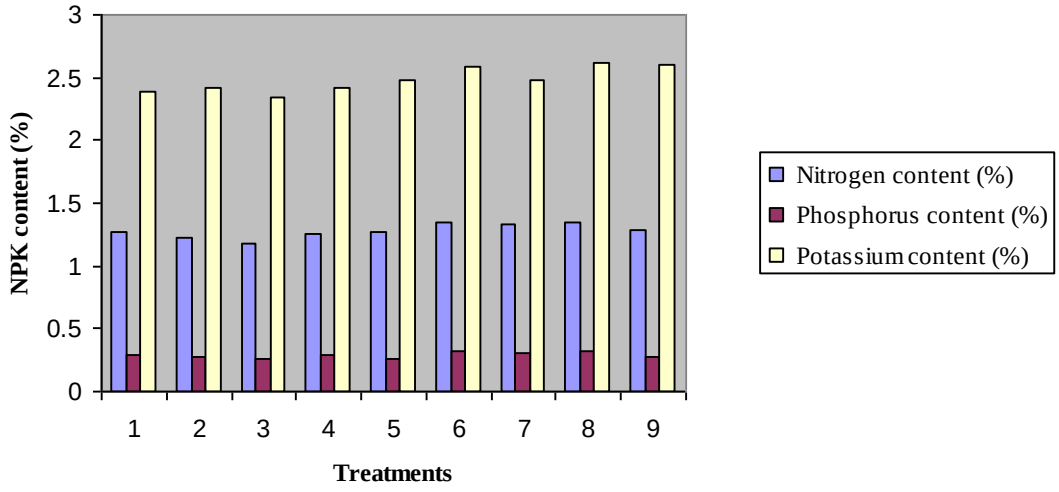
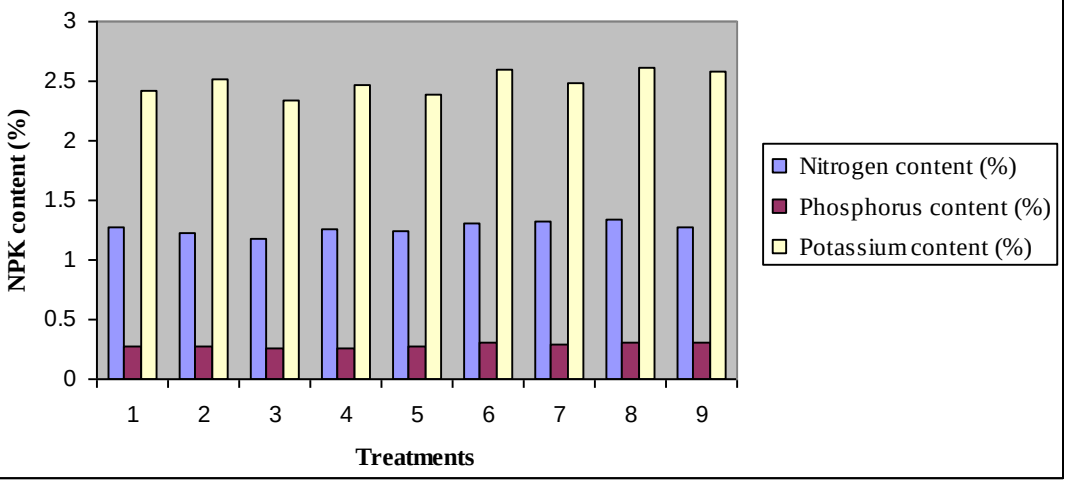



**Fig. 18. Nutrient content (%) in plants of *Dendrobium* var.Shavin White as influenced by different levels of inorganic fertilizers and organic manures**



Nitrogen estimation revealed that the nitrogen content was more in plants receiving 30:10:10 NPK + FYM along with 3 % panchagavya and 3 % vermiwash (Fig.19 and Fig.20).This may be due to the presence of nitrogen fixing bacteria, nitrosomonas and nitrobacter in vermiwash and easy translocation of nutrients by organic manures.

Phosphorus and potassium estimation also revealed that the treatment receiving inorganic fertilizers along with panchagavya and vermiwash recorded maximum values for phosphorus and potassium. Higher potassium content was due to the absorption of nutrient at a faster rate (Preethi, 1990).

# *Summary*

# SUMMARY

An experiment was conducted during March 2005 to June 2007 in the orchidarium of All India Co-ordinated Floriculture Improvement Project in the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University,Vellanikkara, Thrissur to determine the effect of organic manures along with inorganic fertilizers on the growth and flowering in *Dendrobium*. The study was undertaken using the commercial hybrid varieties Earsakul and Shavin White of the genus *Dendrobium*. The organic manures like panchagavya, Manchurian tea, vermiwash and fermented farmyard manure were applied at fortnightly intervals as treatments. The inorganic nutrients NPK were applied twice weekly. The salient findings of the study are summarized below.

When plant height was considered a significant difference was noticed from sixth month onwards in both Earsakul and Shavin White varieties. Maximum plant height of 23.18 cm and 22.78 cm were observed in plants which received NPK spray weekly twice and FYM along with vermiwash at fortnightly interval in Earsakul and Shavin White varieties respectively.

The number of leaves produced per plant showed an increasing trend during the initial months and thereafter a decreasing nature in both varieties. However treatment receiving vermiwash along with NPK 30:10:10 fertilizers and FYM expressed maximum number of leaves in Earsakul (6.38) and Shavin White (6.22) varieties.

The organic spray treatments had a direct influence on number of leafy shoots from third month of planting onwards. The treatment receiving vermiwash along with NPK spray & FYM recorded the highest values of 3.98 and 3.51 in Earsakul and Shavin White varieties respectively after twenty-seventh month of planting.

Pseudobulb production showed an appreciable change from sixth month of planting onwards. The treatment receiving vermiwash along with 0.1 % NPK spray & FYM recorded maximum values of 4.08 and 4.18 in Earsakul and Shavin White varieties respectively, after twenty seventh month of planting.

Significant superiority in girth of shoots was observed for Earsakul (4.32 cm) and Shavinwhite (4.25 cm) varieties for treatments provided with NPK at 0.1 % concentration & FYM along with vermiwash. A significant influence of this treatment was observed on plants over the entire period of study.

Organic manures had a significant role in improving leaf length of plants. The treatments receiving only inorganic fertilizers, NPK 30:10:10 @ 0.1 % concentration and FYM along with vermiwash showed maximum value for leaf length for both Earsakul and Shavinwhite (16.18 cm and 15.99 cm respectively) varieties after twenty seventh month of planting.

Significant influence on leaf width of plants was observed from sixth month of planting onwards in both the varieties. The treatments receiving inorganic fertilizer, 30:10:10 NPK @ 0.1 % concentration & FYM along with vermiwash recorded highest values of 4.13 cm and 4.06 cm in Earsakul and Shavin White varieties respectively.

Earliest flowering (608 DAP and 619 DAP) were recorded in plants receiving only inorganic fertilizers, NPK 30:10:10 at 0.2 % applied weekly twice and FYM (1:10) fortnightly in both Earsakul and Shavin White varieties respectively.

Nutrients, inorganic as well as organic manures in various concentrations did not show any improvement in the production of spikes per plant. Only single spike was observed in all plants.

Floral characters like flower size (6.8 cm x 5.9 $cm^2$ and 6.8cm x 5.7 $cm^2$) and number of flowers per spike (4.56 and 6.23) were the highest for the treatments receiving vermiwash and panchagvya along with inorganic fertilizers and FYM in both Earsakul and Shavin White respectively.

Internodal length and spike length were the highest for the treatments receiving vermiwash at 3 % along with inorganic spray 30:10:10 NPK @ 0.1 % concentration, weekly twice & FYM in both varieties.

Significant influence of treatments was not observed for flower pedicel length and longevity of spike on plants.

Application of NPK 30:10:10 at 0.1 per cent along with FYM and panchagavya 3 % and vermiwash 3 % resulted in maximum N (1.35 % and 1.34 %), phosphorus (0.32 % and 0.31 %) and potassium (2.61 % and 2.60 %) content in plants for Earsakul and Shavin White varieties respectively.

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- Originals not seen

# *Appendices*

# APPENDIX – I

## Preparation of modified form of panchagavya

| | |
|---|---|
| Cow dung | – 5 kg |
| Cow's urine | – 3 litres |
| Cow's milk | – 2 litres |
| Cow's curd | – 1 litre |
| Cow's ghee | – 100gm |
| Sugarcane juice | – 3 litres |
| Tender coconut water | – 3 litres |
| Banana fruits | – 12 nos |

Keep the mixture for 2- 3 months in an earthen pot covered with, muslin cloth, kept in shade and stirred daily. Its 1- 5% at 15 days interval is used after filtering.

# APPENDIX – II

## Preparation of Manchurian tea

12 % sugar solution + ordinary tea @ 4- 5 tsp/ 2.5 litres of sugar solution and then boiling for 5 minutes. It is cooled to lukewarm stage and mixed with starter Manchurian yeast culture 30 -40g /2.5 lit solution and the mouth of the jar is covered with muslin cloth. The jar is kept in a well aerated place. After 15-20 days, this will emit sour smell, then tea is ready to use.

# APPENDIX- III

## Preparation of vermiwash

A trench of convenient size (4 x 2 x 2.5 $m^3$) is made and filled with partially decomposed wastes. Earthworms are laid to that .This is moistened by sprinkling cowdung slurry and water over it. Allow the composting process to continue for one week until brownish black mask of compost is obtained. Soak the entire mask with water. After 24 hours, about vermiwash can be collected.

# Integrated nutrient management in dendrobiums

**By**

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**ABSTRACT OF THE THESIS**

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## ABSTRACT

Studies on “Integrated nutrient management in dendrobiums” were carried out in the orchidarium of All India Co-ordinated Floriculture Improvement Project in the Department of Pomology and Floriculture, College of Horticulture, Kerala Agricultural University, Vellanikkara, Thrissur during the period from March 2005 to June 2007. The study was conducted using two *Dendrobium* varieties, Earsakul and Shavin White, with the main objective of determining the effect of organic manures on growth and flowering in *Dendrobium* in combination with inorganic fertilizers.

The inorganic nutrients NPK were applied twice weekly @ 0.2 % concentration along with fermented farmyard manure (1:10) fortnightly as recommended dose for control. The organic manures like panchagavya, Manchurian tea and vermiwash were applied at fortnightly interval as treatments along with 50% of the recommended dose.

Results revealed that, different treatments involving combinations of organic manures and inorganic fertilizers highly influenced the growth characters of the plant. The plant height obtained was the highest for the treatment which received 50% recommended dose along with 3 % vermiwash. This treatment also improved vegetative characters like number of leaves per plant, number of leafy shoots, girth of shoots and internodal length.

Plants which received only NPK 30:10:10 @ 0.2% along with FYM (1:10) came to flowering early. Number of spikes per plant, colour, and size of the flower and longevity of spike on plant were not found to be influenced by fertilizer application. Significant incidence of pests and diseases were not noticed during the period of study.

From this trial conducted, an indication was obtained that, vermiwash application increased the growth parameters in orchid plants. The treatment $T_8$, receiving 3 % vermiwash and 3 % panchagavya along with inorganic fertilizers (0.1 %) and FYM produced more large flowers than others. Maximum numbers of flowers per spike was also obtained for $T_8$.

Longest spike (21.58 cm & 20.05 cm) were obtained for the treatment receiving 30:10:10 NPK @ 0.1 % along with 3 % vermiwash and FYM in both Earsakul and Shavin White varieties.

Nutrient contents in plants were found to be influenced by organic manure application. The plants treated with 50% recommended dose + 3 % vermiwash + 3 % panchagavya recorded higher values for nutrients analysed