IMPACT OF DIFFERENT MEDIA ON PHYSIOLOGICAL AND MORPHOLOGICAL GROWTH OF ORCHID (*Dendrobium* L.)

M. Sc. (Ag.) Thesis

by

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IMPACT OF DIFFERENT MEDIA ON PHYSIOLOGICAL AND MORPHOLOGICAL GROWTH OF ORCHID (*Dendrobium* L.)

Thesis
Submitted to the
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BY

Bhumika Banjare

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CERTIFICATE – I

This is to certify that the thesis entitled **"Impact of Different media on Physiological and Morphological Growth of Orchid (*Dendrobium L.*)."** submitted in partial fulfillment of the requirements for the degree of "**Master of Science in Agriculture**" of the Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) is a record of the bonafide research work carried out by **Bhumika Banjare** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma or has been published/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by her.

Date: 29/7/19

Chairman

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

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Member	:	Dr. Arti Guhey
Member	:	Dr. L.S Verma
Member	:	Dr. Ravi. R. Saxena

CERTIFICATE – II

This is to certify that the thesis entitled **"Impact of Different media on Physiological and Morphological Growth of Orchid (*Dendrobium L.*)."** submitted by **Bhumika Banjare** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur, in partial fulfillment of the requirements for the degree of **Master of Science in Agriculture** in the Department of Plant Physiology, Agricultural Biochemistry and Medicinal and Aromatic Plants has been approved by the external examiner and Student's Advisory Committee after oral examination.

Signature External Examiner

(Name: Dr. R. Diwan)

Date: 23/8/19

Major Advisor

Head of the Department

Dean/ Dean Faculty

Approved/Not approved

Director of Instructions

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Research is creating new knowledge. Research needs the close co-operation of the friends and colleagues and the guidance of experts in the field to achieve something worthwhile with light patience, vigor and dedication of the person."Education plays vital role in personal and social development and teacher plays a fundamental role in imparting education.

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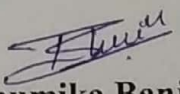

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Date:

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%	**Per cent**
ANOVA	**Analysis of Variance**
CD	**Critical Difference**
SE(m)	**Standard of mean**
Etc	**Etcetra**
G	**Gram**
Mg	**Milligram**
PPM	**Parts per million**
@	**At the rate**
i.e	**That is**

LIST OF ABBREVIATIONS

GA_3	**Gibberellic acid**
$AgNO_3$	**Silver Nitrate**
CRD	**Completely randomized design**
FW	**Fresh weight**
SPAD	**Soil plant analytical development**

THESIS ABSTRACT

a) Title of the Thesis	:	**Impact of different media on physiological and morphological growth of orchid (*Dendrobium* L.)**
b) Full Name of the Student	:	Bhumika Banjare
c) Major Subject	:	Plant Physiology
d) Name and Address of the Major Advisor	:	Dr. S.P. Tiwari, Assistant Professor Department of Plant Physiology, College of Agriculture IGKV, Raipur (C.G.)
e) Degree to the awarded	:	Master of Science in Agriculture (Plant Physiology)

Signature of Student

Signature of Major Advisor

Date : 29/7/19

Signature of Head of Department

ABSTRACT

The present experiment was conducted in Department of Plant Physiology, Agricultural Biochemistry and Medicinal and Aromatic Plant in 2018-19. Experiment entitled "Impact of different growing media on physiological and morphological growth of orchid (*Dendrobium* L.)" in four different media Cocopit, Sawdust, Vermicompost and Charcoal and growth regulator. Four treatment of plant growth substances viz, GA_3 @150 ppm, Kinetin @ 100 ppm and $AgNO_3$ @30 ppm were applied along with control (Water spray) to elucidate the effect of plant growth substances on flower quality and vase life of flower, post harvest studies with holding

solution of GA_3 + 5% Sucrose, Kinetin + 5% Sucrose, $AgNO_3$+5% Sucrose along with control were tried to increase the vase life of cut flower.

Among the growth media tested Charcoal media was found to be the best for plant height (45 cm) at flowering stage, Number of leaves (6.33), Number of shoot (4.33), Shoot girth (4.1 cm), Root length (32.46 cm), Leaf area (21.68 cm^2), SPAD Value (53.54), Spike length (54.23 cm), Spike girth (2.3 cm), Number of floret per spike (6.0). The treatment T_3 (Vermicompost) recorded best for Number of new shoot (2.33), Internode length (7.7 cm), Number of internode per shoot (6.33). The treatment T_2 (Sawdust) registered the lowest values for Plant height (40.66 cm) at flowering stage, Number of leaves (4.00), Shoot girth (3.03 cm), Number of internode per shoot (4.66), Root length (23.23 cm).

Among different growth substances, the minimum day for flower bud initiation was recorded in P_3, Kinetin@100 ppm (23.25 days), P_3, Kinetin@100 ppm was found to be best for spike girth (1.90 cm), Floret size (41.6 cm^2), Longevity of flower (75.08 days). Treatment T_3, was found to be effective for number of spike (2.1), number of floret (5.41), dry matter production (9.35 g). The interaction between Charcoal media and Kinetin@100ppm was found best for Flower bud inititiation (19.66 days), Number of spike (2.6), size of flower (42.26 cm) This second experiment was laid out in Factorial Completely Randomized Design.

In the post harvest study, among the holding solution tried, $AgNO_3$ was found to be best for increase the vase life of cut flower (27 days) also reduced the physiological loss of weight (91 per cent). Control (Pure water) was recorded minimum days for increase the vase life (19.33 days).

शोध सारांश

अ.	शोध शीर्षक	"विभिन्न माध्यम (मीडिया) का आर्किड के कार्यिकी, आकारिकी एवं वृद्धि पर प्रभाव"
ब.	विद्यार्थी का पूरा नाम	भूमिका बंजारे
स.	मुख्य विषय	पादप कार्यिकी
द.	मुख्य सलाहकार नाम एवं पता	डॉ. शशि प्रकाश तिवारी, सहायक प्राध्यापक पादप कार्यिकी, कृषि जैव रसायन, औषधी एवं सुगंधित पौध विभाग कृषि महाविद्यालय, रायपुर, इं.गा.कृ.वि. रायपुर (छ.ग.)
इ.	प्रदान की जाने वाली उपाधि	एम.एस.सी. (कृषि) पादपकार्यिकी

मुख्य सलाहकार के हस्ताक्षर

विद्यार्थी का हस्ताक्षर

दिनांक 29/7/19

विभाग प्रमुख के हस्ताक्षर

शोध सारांश

पादप कार्यिकी विभाग में वर्ष 2018–19 के अंतर्गत शोध किया गया, जिसका शीर्षक **"आर्किड (डेन्ड्रोबियम) के कार्यिकी, आकारिकी तथा वृद्धि पर विभिन्न माध्यम (मीडिया) का प्रभाव"** वर्तमान में आर्किड के सफल वृद्धि विकास तथा फूलों की गुणवत्ता हेतु चार प्रकार के माध्यम का उपयोग किया गया जो क्रमशः कोकोपिट, लकड़ी का बुरादा, वर्मीकम्पोस्ट एवं चारकोल है। पादप वृद्धि नियामकों के चार स्तरों क्रमशः जी.ए.3 @150 पीपएम, काइनेटिन @100 पीपीएम, सिल्वर नाइट्रेट 30 पीपीएम तथा कन्ट्रोल (वाटर स्प्रे) का उपयोग फूल की गुण्वत्ता तथा फूलदान के जीवन को बढ़ाने के लिए किया गया।कट फ्लावर के गुण्वत्ता तथा उनके जीवन को बढ़ाने के लिए चार उपचार कन्ट्रोल (डिस्टिल्ड जल), जी.ए. 3 (25 पीपीएम) +5% सुक्रोज, काइनेटिन (25पीपीएम)+5% सुक्रोज, सिल्वर नाइट्रेट+5% सुक्रोज का उपयोग किया गया था।

वृद्धि मीडिया में चारकोल मीडिया का परीक्षण फूलों की अवस्था में पौधों की ऊँचाई (45 से.मी), पत्तियों की संख्या (6.33), शूट की संख्या (4.33), शूट गर्थ (4.1 से.मी.), जड़ की लम्बाई (32.6 से.मी.), पत्ती की क्षेत्रफल (21.68 से.मी.) SPAD मूल्य (53.54), स्पाईक की लंबाई (54.25 से.मी.), स्पाईक गर्थ (2.3 से.मी.), प्रति स्पाईक फ्लोरेट की संख्या (6.0) में पाया गया। उपचार T_3 (वर्मीकम्पोस्ट) में शूट की संख्या (2.33), इंटरनोड की लंबाई (7.7 से.मी.), इंटरनोड प्रति शूट की संख्या (6.33) के लिये सबसे अच्छा दर्ज किया गया। उपचार T_2 (लकड़ी की बुरादा) में सबसे कम प्रभाव का अध्ययन किया गया। जिसमें पौधे की ऊँचाई (30.66 से.मी.), पत्तियों की संख्या (4.00), शूट गर्थ (3.03 से.मी.), प्रति शूट इंटरनोड की संख्या (4.66) एवं जड़ की लंबाई (23.23 से.मी.) दर्ज किया गया।

विभिन्न वृद्धि नियामकों में पुष्पकली खिलने का न्यूनतम दिन P_3 काइनेटिन 100 पीपीएम (232.25 दिन) में दर्ज किया गया। स्पाईक गर्थ (1.50 से.मी.) व पुष्प आकार (41.6 वर्ग से.मी.), P_3 काइनेटिन 100 पीपीएम में सबसे अच्छा पाया गया। उपचार T_3 (वर्मीकम्पोस्ट) स्पाईक संख्या (2.1), पुष्पक की संख्या (5.41) तथा शुष्क पदार्थ के उत्पादन (9.35 ग्राम) के लिए प्रभावी पाया गया। चारकोल मीडिया+काइनेटिन @100 पीपीएम को पुष्प कली खिलने का न्यूनतम दिन (19.66 दिन), स्पाईक की संख्या (2.6), फूलों का आकार (42.26 से.मी.), के लिए अच्छा पाया गया। इस प्रयोग के अध्ययन के लिए फेक्टोरियल सी.आर.डी. विश्लेषण तीन बार पुनरावृत्ति में किया गया।

फूलों के कटाई के बाद के अध्ययन में सिल्वर नाइट्रेट +5% सुक्रोज को फूलों के फूलदान जीवन को बढ़ाने के लिए अच्छा पाया गयां इसमें फूल 27 दिन तक अधिकतम रहा तथा इसके 91% वजन में कमी आई जबकि फूलदान जीवन को बढ़ाने के लिए कन्ट्रोल (पानी) को सबसे न्यूनतम दिन (19.33 दिन) दर्ज किया गया।

CHAPTER-I
INTRODUCTION

Orchids, one of the most fascinating creations of the nature are one of the most widely distributed groups of flowering plant on the earth. They are cosmopolitan in distribution and known to occur in a wide range of climatic condition from the alpine regions to humid climate. Orchid belongs to family Orchidaceae which is the largest family of plant kingdom and it contains 750 genera and 25,000 species. According to the reports (Misra, 2007) the family has about 186 genera, 1298 species, 5 subspecies and 28 varieties in India. They produce flowers, which are most exotic, amazingly attractive, different colour and shape, it have longer shelf life (2-3 months) made them one of the top ten 'cut flowers' in international flower market.

Orchids have bilateral symmetry flower, many rasupinate flowers, highly modified petals labellum, fused stamen and carpel and extremely small seeds which distinguished easily from the other plants. All orchids are perennial herbs and grow according to two patterns, Monopodial and Sympodial. In their natural habitat, epiphytic orchids absorb nutrients from rain water as it passes over their roots. Their modified aerial roots have a layer outside of exodermis, which is called velamen. Velamen layer are thicker and more lignified that can grow in dry habitat. (Pridgeon, 1987). Some epiphytic orchids have pseudobulb enlarged stem which have storage organs. (Hew and Yong, 2004).

The first scientific account of Indian orchids was provided by the then Dutch Governor of Malabar, Von Rheede (1678- 1703) in his monumental work '*Hortus Malabaricus*'. The 'Father of Indian Botany' (William Roxburgh, 1832) provided a treatment of 57 species in his 'Flora India', vol III.

Dendrobium is a widely distributed genus that can be found in Austalia, East Indies, Far East, India, The Phillipines and South Pacific Island (Fennel, Jr, 1965). *Dendrobium nobile* is relative to Burma, India, Indochina and Thailand

(Yamamoto Dendrobiums, 2006). *Dendrobium nobile* is the most cultivated because its potential to grown in optimal condition (Baker and Baker, 1996). *Dendrobium nobile* are epiphytic in nature which grows in tree. Their growth habitat is Sympodial (Hew and Yong, 2004). Vegetative growth begins at time of December and January of each year. Vegetative bud produces from the base of the pseudobulb. Leaves are alternative and flower buds are formed in the leaf axis. Pseudobulb matures by November and December of the next year. Flowers begin to produce February and March of the following year, following adequate cooling. From each node up to three flowers can be formed (Rotor, jr. 1952).

Denbrobium nobile may be deciduous in nature and lose leaves from the previous years. It is believed that Dendrobium need to go through resting period to produce flower bud. During the resting period, only sufficient amount of water to prevent loss of turgidity are given to plants. But there is no scientific evidence about the resting period. Once flower buds have formed, irrigation and temperature are aid in flower development. (Pring, 1967).

Environment condition for *Dendrobium* requires bright sunlight, warm temperature, good air movement and clean water. Plants and flower grow faster when night temperature does not drop below 18^{o}C and day temperature is between 24^{o}C and 30^{o}C. In Hawaii Dendrobium are grown mostly in shade cloth covered structure. (Leonhardt, 2000)

Wang 1996 determined that fertilization with complete fertilizer in not always as important for growth as the potting mixture and its ability to retain water and nutrients. Orchid has been grown commercially in bark chips (Freed, 1976). Bark does not hold much water that good for root growth of orchids. Orchids can be grown in gardens, pots, basket and indoor gardening.

Cut flowers are very perishable product have gained importance in floriculture industry. Orchids are commercially grown for cut flower demanded in domestic and worldwide. Cut flowers are highly metabolizing heterogeneous organ which are loss due to fault post harvest techniques. The main cause of premature wilt in plant is

disruption of water absorption due to microbial contamination of cut stem. Microbial plugging in vascular stem leads to petal drop, wilted flower and weak stem. (Leonhardt and Sewake, 1999). Sucrose and certain chemicals used as holding solution to prevent microbial activity and increased vase life. Maintaining the quality of flowers and extending post harvest life is most important as quality improvement of orchids.

Potting media play an important role in quality and production of flowering plants. Most used growth media for container production of ornamental plant is peat and soil. (U. Tariq, 2012). Potting soil mixture is most important factor for the quality production of ornamental plants, and media has positive effect against diseases. Organic material from agriculture, forestry, livestock farming and industrial waste are rich source of different nutrient. Various growth media like coco pit, sawdust, rice husk, sewage slurry and compost are used as potting media. Potting media with rich nutrients promotes vegetative growth and delayed senescence, and also minimize the time taken by plants to give flower bud formation.

Flowering relies on a developmentally competent plant to favourably perceive environmental signals to initiate the transition from vegetative to reproductive growth. (Bernier et al.,1993, Goh et al.,1982). Photoperiod, light intensity, temperature, water relations and plant hormone are the reason for natural flowering season for orchids. For many orchids, flowering period modified through plant growth regulators successfully. Auxin application to some orchids like *Phalaenopsis* and exogenous auxin gave to decapitated *Aranda* plants reduced flowering while application of anti-auxin and growth retardants stimulate flowering. (Goh, 1985). The cytokinin N6-benzyladenine (BA) induced flowering of some orchids like (*Aranthera, Aranda, Holttimara, Mokara, Dendrobium Lousiae 'Dark'*, however this response is highly depend on orchid variety (Goh, 1985; Hew and Clifford, 1993). Addition of GA3 with cytokinin enhanced the flowering effect and reduced flower deformity of *Phalaenopsis* and *Dendrobium* (Chen et al., 1997; Sakai et al., 2000).

This experiment was conducted to investigate the comparative study of four different growth media and different plant growth substance on growth and flowering of *Dendrobium* L. The study entitled "**Impact of Different media on Physiological and**

Morphological Growth of Orchid (*Dendrobium L.*)" with the following major objectives:

1. To study of different media on morpho-physiological parameters of orchid under shade net house.
2. To assess the impact of different media on physiological and biochemical parameters of orchid under shade net house.
3. Effect of foliar spray of different Plant growth regulator on shelf life and flowers behavior of orchids under shade net house.

CHAPTER-II

REVIEW OF LITRETURE

The brief review of experimental findings pertaining to studies on impact of different media on physiological and morphological growth of orchid (*Dendrobium* Sp.) has been reviewed under following heads:

1. Effect of growing media on plant growth and flower quality
2. Effect of different growing media for orchids.
3. Effect of nutrients on improving flower yield and quality.
4. Effect of foliar spray of different plant growth regulator on vase life and flower behaviour.
5. Effect of holding solution to increase vase life of cut flower.

2.1 Effect of growing media on plant growth and flower quality

Bose and Bhattacharjee (1980) suggested that in epiphytic orchids and their growing media are different from other plants. It should preferably be inert, porous and resistant to organic decomposition and it should be cheap and easily available.

Bhattacharajee (1985) suggested that for ensuring maximum growth rate and favourable nutrient supply their root system should be vigorous and healthy. Hence, for their healthy root growth selection of ideal growth medium is must. Because of orchids peculiar habitat their growing medium should be different from those used for other plants.

White (1986) reported that potting media used by orchid growers were charcoal, fir bark, tree fern, osmunda fiber, coconut fiber, perlite and commercial orchid mixture containing sugarcane waste, charcoal, and perlite.

S.B Wilson et al., (2002) reported that use of nutrient rich organic media can potentially results in reduction of fertilization and irrigation rates as well as also decrease nursery costs than those peat containing potting media those are commercially an expensive and non reusable.

Ichihashi (2002) reported that Doritaenopsis potted with New Zealand sphagnum moss grew better than when potted with coconut husk or rock wool. These results were due to the holding ability of moisture and mineral elements in media and minerals release from the media.

Verdonck and Demeyer (2004) showed that the growing media physical properties could improve the growing condition of root zone this resulted increasing water and nutrient uptake of plants.

Tahir mehmood et al., (2013) was conducted the experiment to investigate different potting media with different composition and their comparative effect on growth and flowering of *Antirrhinum majus* L. 'Floral Shower'. It was concluded that leaf mould were effective and showed significant result regarding to growth and flowering parameter but showed least result when farm yard containing media alone and in combination with higher silt and with its higher pH used. When farm yard manure and leaf mould were used alone and in combination with silt and topsoil maximum phosphorus contain was found. It concluded that Leaf mould would be best for a standard potting media for *Antirrhinum majus* L. growth.

2.1.1 Coconut husk and fiber

Bose and Bhattacharjee (1980) reported that for commercial propogation of *Denrobium* Pompadour by cutting dry coconut husks are used because of their good moisture holding capacity and capabilities for good supply. And it found suitable for *Phalaenopsis* and *Vanda* also.

Abraham at al., (1981) reported that coconut by product like their fiber and husk are used as growing media for epiphytic orchids. Their husks were pressed, sun dried and cut into pieces and stored for preparing compost as used as growing media.

Dematte and Dematte (1996) observed that pure coconut fiber and coconut fiber mixed with charcoal and eucalyptus bark used instead of xaxim for the cultivation of some orchids.

G. Schmilewski at al., (2007) observed that coconut fiber was very good media because they have very good rewetability, low water capacity and extremely high air capacity. Their fiber and products were originated from the fruit of coconut palm only the part of mesocarp is used as coir fiber. They can be used extensively for the production because of better balance between water and air capacity.

2.1.2 Wood fiber and sawdust

Sheehan at al., (1961) observed that more flower with larger stem was obtained when different kinds of tree barks are used in different proportion. They used cedar tan bark and white fir bark. For growing seedlings fine bark and for majority of orchids medium grade were used and for large fleshy roots such as coarse grades were used.

Bazzochi at al., (1985) reported that bark and their fiber has very good physio-chemical properties that has a neutral pH, lower cation exchange capacity but little higher salt content and they also content slight fungicidal action.

G. Schmilewski (2008) observed that wood fibres are fibrous in structure, porous, loose and elastic. They have low bulk density, very high air capacity, very low water holding capacity and pH 4.0-6.0. Furthermore they have good rewetability, free from weeds and pathogens.

2.1.3 Vermicompost

Edward et al., (1988) reported that vermicompost finely divided peat like materials with high porosity, aeration, drainage and water holding capacity.

Shi.wei et al., (1991) observed that vermicompost has greatly increased; provide more micro site for microbial decomposing organism and strong absorption retention of the nutrients.

Orozco et al., (1996) suggested that vermicompost contain most nutrients in plants availability forms such as nitrate, phosphate and exchangeable calcium & soluble potassium.

Atiyeh et al., (2000) recommended vermicompost which are produced by organic waste breakdown by earthworms. Earthworms fragment the organic matter, alter the physical and chemical properties of matter and accelerate the rate of decomposition. After the transformation obtained result was called vermicompost it has less soluble salt, increased total humic acid and great exchange capacity compared to their parent material.

Normon Q. Arancon et al., (2006) observed that interaction between microorganism and earthworm produces a plant growth hormone and humic acid which act as plant growth regulator for plant. Metro mix 360 (MM60), at the rate of 0, 250, 500mg humates/kg dry wt. of MM360 applied to pepper, marigold and strawberry plant. Increased growth of marigold and pepper roots and increased number of fruits was recorded when humates substitute from 250- 1000mg kg^{-1} of MM360.

A. Hatamzadeh et al., (2011) reported that *Cymbidium* was grown in media container to evaluate the effect of vermicompost on the growth and productivity of flower plant. Cymbidium were grown under shade net house with media 50% pumice, 10% vermiculite, 30% charcoal and 10% peat moss, which was basic growth media and it was substituted with 10%, 20%, 30% & 40% (by volume) vermicompost. Control consist the growth media without vermicompost. Proper mineral nutrition and irrigation was provided regularly. Medium with 30% and 40% vermicompost result the greatest vegetative growth and the lowest growth was recorded in 0% vermicompost. More inflorescence and flower growth and more number were observed in 30% and 40%. Inflorescence length was higher in 30% media.

Vo. H. Manh et al., (2014) conducted the experiment to determine the effect of vermicompost on productivity of muskmelon seedling. Vermicompost produced from rice waste, mixed with rice hull ash and coconut husk in different concentration. Result showed that using substrate with mixture of vermicompost with rice hull and coconut

husk at ratio of 1:1:1 respectively gave the highest value of germination rate, plant biomass, and plant height and leaf area.

2.1.4 Charcoal

Bhattacharjee et al. (1972) suggested *Cattelya, Epidendrum, Phalaenopsis, Dendrobium* and *Vanda* and different epiphytic orchids give better flower production when large pieces of charcoal was used as growing media.

Bhattacharjee (1981) observed hardwood charcoal used as growth media gave better production in *Dendrobium moschatum* and it also supplied with different concentration of water soluble NPK.

Grove (1988) observed chunks of hardwood charcoal in plastic pots with lots of drainage hole could be best growing media for *Vanda* and *Ascocenda.*

Dematte et al., (1998) suggested tree fern fiber, coconut fiber, bark of *Eucalyptus grandis* and mixture of charcoal and latter material growth media used for *Dendrobium nobile*. Different concentration of micronutrients was also sprayed to increase plant growth. S (up to 1.6 g/kg), Zn (up to 147mg/kg) and Cu (up to 46 mg/kg) increase growth and decrease with higher concentration of Ca (up to 13.2 g/kg), Mg (up to 6.6g/ kg) and B (up to 19mg/kg). High loss of leaves recorded when high Mo (up to 5.3 mg/kg) was sprayed.

2.2 Effect of growing media on plant growth and flower quality

Bateman et al., (1957) suggested gravel as the best media for producing quality flower, which compared it with osmunda bark and recorded more flowers in plants grown plants in gravel culture.

Cibes et al., (1957) observed gravel culture as growing media which increase in plant height, length of flower spike and number of floret per spike.

Davidson et al., (1961) observed that mixture of white and red fir bark in standard clay plots give 27% more growth than plastic pots tested in *Cattelya* which is sympodial epiphytic orchid.

Bomba et al., (1975) recommended new orchid chips that made from Styrofoam material used as growth media for epiphytic orchids. It has closed pores which takes up water only on the surface.

Mukherjee et al., (1981) reported that tree fern fiber growth media was suitable for growth and flowering quality of *Dendrobium moschatum,* whereas *Aerides multiflorum* give best result in substrate of hardwood charcoal.

Bhattacharjee (1982), reported that growth media mixture containing charcoal and tree fern fiber give best result in *Rhynchostylis.* Similarly when charcoal was used as media for *Cattelya* maximum stimulation of spike, maximum no. of flower per spike and longevity of flower was recorded.

Paul et al. (1992) studied that combination of charcoal, gravel brick and coconut husk gave the maximum results of plant survival, vegetative growth parameters plant height, no. of leaves and leaf area in *Dendrobium.*

Kumar (1992) stated that *Dendrobium* hybrids potted in charcoal medium followed by fern root and rubber seed husk give the best result in vegetative growth and flowering quality.

Wang et al., (1994) reported mixture of equal parts of perlite, meteromix and charcoal increase in vegetative growth like plant height and twice no. of leaves was recorded in *Phalaenopsis*.

Dematte (1996) observed the pressed coconut bark alone or mix with charcoal growing media was best for cultivation of epiphytic orchids

2.3 Effect of nutrient on flower quality of *Dendrobium L.*

Sandford (1974) reported that cultivated orchids needed supplementary nutrients in low concentration other than that provided by their growing medium.

Boodley (1975) observed the important and role of balanced nutrition in deciding the flower crop.

2.3.1 Nitrogen

Wand (1996) observed that hybrid *Phalaenopsis* with a medium of 70% dougles fir bark and 30% peat moss was grown in container. It determines high fertility required therefore 6 complete fertilizers were applied to provide either 100-200 mg/l nitrogen. Plants that were supplied with 200mg/l N had greater shoot fresh weight and larger leaves than those supplied with 100mg/l. Nitrogen supplied with 200mg/l can benefit young plants by allowing them to grow more rapidly.

Marschner et al., (2003) studied that nitrogen and phosphorus deficiency can affect photosynthesis, because nitrogen is essential for chloroplast formation. It was found that 75% of total organic nitrogen can be found in the chloroplast of green leaf cells.

Hew & Yong (2004) reported that orchids require similar and minimum quantity to that of other plants, but symptoms are slow to appear due to their ability of translocation certain nutrients from older leaves and pseudo bulbs to growing tissue. Nitrogen deficiencies took three weeks to become noticeable, while phosphorus and potassium took more than three months for symptoms of deficiency to be appeared.

2.3.2 Phosphorus

Wang (2000), found that when *Phalenopsis* were grown in a mixture of 80% dougles fir bark and 20% sphagnum peat decreased flower number was obtained and switched to low nitrogen (30mg/l) and high potassium (390 mg/l) and potassium (560mg/l) levels at the beginning of being induced to spike and concluded that adequate nitrogen level were more essential to flowering than high phosphorus level.

Marschner et al. (2003) reported that most healthy plant vegetative tissue contain 0.3-0.5% of phosphorus in dry weight however phosphorus toxicity in more sensitive plants may occur at this level. Phosphorus concentration above 1% concentration in dry matter may create toxicity. Phosphorus deficiency can cause a decrease in leaf number, leaf size and leaf surface area and root shoot growth may decrease and cause reduction in shoot root dry weight ratio.

Whitcher et al. (2005) observed that (*Impatiens hawker* Bull.) and Vince (*Catharanthus roseus* (L.) G. Don) when grown in a soilless media in a greenhouse and phosphorus rate were applied to 0, 0.1, 0.25, 0.5, 1, 2, 4, 16, 32 or 64mM rate between 0.1 & 0.96mM was recorded best for dry shoot weight and increase flower no. and reported that lower level of phosphorus needed for vegetative growth and flower number.

2.3.3 Potassium

Pooley and Seeley (1978) observed that *Phalaenopsis*, when supplied with 100, 200 & 300 mg/l K and *Cattelya & Cymbidium* with 50, 100 or 200mg/l K in a nutrient culture setting in ceramic pots in a greenhouse. They found that for all three orchid genera, 50mg/l K was sufficient for orchid growth and higher level had no further effect except in *Cattelya* at 200mg/l K, which results in fewer leaves.

Woodson and Boodley (1982) conducted the experiment in which potassium was supplied at 0.25, 2.5, 5.0 or 10.0 mg per liter in 'Forever Rose' hybrid of rosa hybrid tea. Flower number and stem length increased when 0.25 to 10.0 meq/liter potassium treated. It suggests that high level of potassium is required for this plant when grown in nutrient solution. Concentration of 0.25 to 10meq/liter did not decrease the level of calcium and magnesium.

Marschner, (2003) reported that 2-5% potassium should be found in plant dry weight of vegetative tissue, fleshy fruits, tubers for optimal plant growth. But it hind the uptake and physiological accessibility of Ca and Mg when potassium is excess on the other hand potassium deficiency can stop the growth in mature leaves and stem. In

severe deficiency condition chlorotic and necrosis condition was found in leaves and stem.

2.3.4 Water soluble fertilizer

Pooley and Seeley (1978) observed that best plant growth and flowering of hybrid *Phalaenopsis and Cymbidium* when applied with 100 ppm of N, 50-100 ppm of K and 25 ppm from water soluble fertilizer, while 50ppm each of Nitrogen and Potassium was found to be optimum for *Cattelya*.

Sheehan (1980) suggested that mixture of osmunda fiber, tree fern, and terrestrial mixture should be fertilized with 10:10:10 water soluble fertilizer at the rate of 453g/393 liter of water applied to 43.2m^2 of growing area.

Abraham and Vatsala (1981) they suggested ration of NPK 20:20:20 used every week for three successive weeks followed by 10:30:20 mixture were successfully used for different orchids grown under South Indian condition.

Khaw (1982) observed that increasing the fertilizer from 0.5 t0 1.5g/l enhanced the leaf production by increasing number of leaves per shoot and floret count per spike in Phalaenopsis.

Griesbach (1985) suggested that 20:20:20 water soluble fertilizer was sprayed at 100mg/l at every watering improved the growth of *Phalaenopsis* orchid.

Baker and baker (1987) observed that in *Dendrobium Higihum* increase of plant height and number of leaves per shoot by application of NPK @1g

Amberger (1997) reported that in *Phalaenopsis* orchids increasing fertilizer dose from 275 to 4000 mg/l from 16:4:18 of water soluble fertilizer resulted in larger plants with significantly more number of floret per spike than those given at lower rates of fertilizer.

Swapna (2000) reported that the nutrient concentration of NPK 20:10:10 @ 0.2% was adjusted as the best ratio for plant growth. Increased Plant height (20.15cm) in *Dendrobium* hybrid Sonia-17 was observed.

2.4 Effect of foliar spray of growth hormone on vase life and flower behaviour

Sakai. S. William et al. (1998) conducted the experiment on *Dendrobium* Jaq-Hawaii 'Uniwai Pearl' and the effect of spray and injection application of Benzyladenine (BA) to leave and leafless stem (Pseudobulb). Spray of BA appeared to have no effect on the induction of inflorescences. However the indication of an increase in number of inflorescence produced by stem injected with 0.1ml of 10mM BA. A Significant increase in the no. of spray inflorescences per stem, 1.33, over non treated control, 0.08 and 95% ethanol, 0.25, was produced by injection of 0.1ml of 10mM BA in 95% ethanol solution below each at the 5 topmost viable lateral buds.

Matthew G Blanchard et al. (2008) conducted two experiments in *Doritaenopsis* and *Phalaenopsis* orchid clone to determine how Cytokinine Benzyladenine (BA) induced flowering. In first experiment, two vegetative orchid clones growing in 15 cm pots were transferred from a 28^{o}C greenhouse. A foliar spray (0.2 L/m^{2}) containing BA at 100,200, or 400 mg/l or 25, 50 or 100mg/l each of BA and gibberellins A4+ A7 (BA+GA) was applied on days 0, 7, and 14. Plants which treated with BA alone at 200 or 400mg/l had a visible infloresecence in 3-9 days earlier and had a mean of 0.7-3.5 more inflorescences and 3-8 more flower/ plant than non treated plants and the combination of BA+GA had no effect on inflorescence number and total flower number at the rates tested. In the second experiment, three orchid clones received a single foliar spray of BA at 200 mg/l at six points relative to time (-1, 0, +1, +2, +4 or +6 weeks).

Latimer & Scoggins (2012) observed that effectiveness of absorbing plant growth regulator in plants depends upon the application method, time of application and amount of active ingredient. The amount of active ingredient applied to a plant depends on the concentration of the solution and volume applied and the correct application method will ensure proper coverage of all tissue or target the responsible tissue. Widely using method of application in commercial orchid cultivation are media drenches and foliar spray.

P.B Sable et al., (2015) reported that maximum height of the plant (59.43cm), no. of leaves (13.9), leaf area (64.8 cm^2) were recorded by treatment GA_3 200ppm foliar spray in Gladiolus CV. 'H.B Pitt'. Minimum number of leaves/plants (10.8) & leaf area (64.8cm^2) were recorded in CCC 250 ppm / plant as foliar spray. In flower quality parameter, maximum no of floret/ spike (13.4), floret length (8.4cm), length of spike (80.28cm) & length of rachis (41.50cm) were recorded with foliar spray of GA3 200ppm.

Ketsa et al., (1994) conducted the experiment on the effect of AgNO3 on the vase life and bud opening of cut flower of Dendrobium 'Pompodour'. AgNO3 must be continuously together with 8-Hydroxyquinoline sulphate and glucose in order to minimize water uptake & vase life. It was observed that foliar application of AgNO3 to the whole inflorescence did not increase vase life. Rates of ethylene production of the halved inflorescence bearing only flower buds or only open floret had no apparent relationship with vase life.

V.E Emongor et al., (2000) conducted experiment was to investigate the effect of plant growth regulator on post harvest quality and vase life of *Alstereomeria* cut flowers. Accel (BA+GAMsub>4+7), gibberellins and Florissant was used. 25 or 50 mg/litre BA increased the number of days to fill opening of Alstereomeria primary floret but it delayed the onset of flower senescence. Increased of leaf chlorophyll, water and nitrogen content of cut flower was recorded when Accel at 25 mg/litre was given. Lower effect of gibberellins had no effect on the number of days to full opening of floret. 2.5, 5.0, 7.5, 10.0, 12.5 or 15.0 mg/litre delayed onset of flower senescence in *Alstroemeria* and Florissant 200, increased the number of days to full opening of primary floret, days to 50% petal fall and delayed the onset of 50% leaf senescence.

2.5 Effect of holding solution to increase vase life of cut flower

K. Ajitkumar et al., (2013) observed that effect of different pulsing treatments and holding solutions on the vase life of cut spikes of the orchid. *Dendrobium* cv.

Sonia-17 was studied. In the trial using different holding solutions, $AgNO_3$ (25 ppm) + sucrose (5%) gave maximum vase life of 35 days, maximum number of days for wilting of first flower (17.3 days) and maximum number of days for wilting of all flowers (53.7 days). Pre-cooling treatment done at 150C for 12 h and holding solutions containing $AgNO_3$ (25 ppm) + sucrose (5%) was found to be the best treatments to enhance the vase life of cut spikes of the orchid, *Dendrobium* cv. SONIA-17.

T. Usha Bharathi et al,. (2015) conducted the experiment to study the role of sucrose, antimicrobial and anti ethylene agents on *Cymbidium* orchid 'Pine Clash Moon Venus'. The cut spikes were subjected to two hours of pulsing with 5% sucrose, 8% sucrose, 10% sucrose, 8-HQS 200 ppm, 10% sucrose + 8-HQS 200 ppm, 10% sucrose + 8-HQS 200 ppm + BA 50 ppm, 0.5mM STS and distilled water as control. It was found that 2 hour pulsing of 5% of sucrose recorded highest increase in fresh weight on 3^{rd} day (2.33gm) as compared to control (0.61g).Total water uptake was maximum in 8% sucrose (38.95g) followed by 5% sucrose (31.99g) and total water loss was maximum in 8% sucrose (40.00g). Vase life of flower was highest in 5 % sucrose (56 days) followed by 8% sucrose (54.78 days).

Tanveer Fatima Miano et al,. (2015) conducted the experiment on *Dendrobium* Sonia to find out the performance of cut flower under various holding solutions and packing materials. Result showed that various holding solutions showed highly significant difference among treatments. However, the maximum opened flower buds (100.00 % at 10 days), minimum flower drop % age (0.00%), maximum days to flower colour retention (23.15 days), flower diameter (30.32 cm), vase life (23.15 days) and water uptake (13.80 ml) were recorded in holding solution containing 30 mM AgNO3 + 225 mM HQC + 400 mM glucose. Similarly results pertaining to packing materials had also significant effect on various parameters of *Dendrobium* Sonia.

CHAPTER III

MATERIAL AND METHODS

The present chapter deals with information regarding the material used and methodology adopted for the investigation.

3.1 Experimental Site

The present experiment was conducted during the Rabi season year 2018-19 at the Department of Plant Physiology, Agricultural Biochemistry, Medicinal and Aromatic Plant under shade net house, College of Agriculture, Indira Gandhi Krishi Vishwavidyalya, Raipur, Chhattisgarh.

3.1.1 Climate

Raipur is located at an altitude of 298.15 meter above sea level. Raipur experiences a tropical climate. The climate will remain moderate throughout the year in Raipur except summer. The average maximum temperature 33.1^{o}C, while the minimum temperature 20^{o}C. Mean annual rainfall of about 1236.1 mm, During Rabi (December to February) only 8 mm of rainfall is being received.

3.2 Materials

3.2.1 Planting material

Dendrobium L. cultivar of orchid was used for the experiment. This is the commercial important genus for cultivation.

3.2.2 Container and benches

Plastic pots with drainage holes at the bottom and sides are used for experiment. 30 pots are allotted to each 4 treatment each replicated 3 times. Total 120 pots are used for experiment and each 30 pots are placed in benches.

3.2.3 Growing media

The following growing media are used under experiment:

S.NO	Growth Media	Media Code	Description
1	Coconut husk	T_1	Coconut husk retain larger amount of moisture and contain large amount of nutrients.
2	Sawdust	T_2	Sawdust are readily available organic matter and moderately in expensive. It become tightly packed which restrict aeration.
3	Vermicompost	T_3	Vermicompost is the product of composting process which fragmented by worms. It contain minerals such as nitrates, phosphorus, magnesium, potassium and calcium which essential for plant growth.
4	Charcoal	T_4	Charcoal is a light weight black carbon residue and it has been accepted as a great potting media. It helps to grow plant root proper and healthy, retain moisture and allow free air movement.

3.2.4 Fertilizers

Water soluble fertilizers have been observed as best nutrient media for epiphytic orchids. It helps fertigation by releasing essential plant nutrients at the root zone from where they are readily absorbed and used elsewhere in the plant system. NPK 19:19:19,

12:46:0 was tried at 0.1 % concentration and fertigated weekly thrice. It improves vegetative and reproductive activity of plant.

1. 19:19:19
2. 12:46:0

Figure no 1.1 Coconut husk

Figure no 1.2 Sawdust media

Figure no 1.3. Vermicompost media

Figure no 1.4. Charcoal media

3.2.5 Plant Growth Regulator

3.2.6 Kinetin

It is a specific cytokinin which induces the cell division in plant roots and shoots. It helps in preventing the senescence of fruit flower and leaves also affect the auxiliary bud growth and apical dominance. When applied to specific plant parts, kinetin can activate or deactivate specific genes and/or enzymes. Kinetin improves nutrient transport also.

3.2.7 Gibberellic acid (GA_3)

Gibberellic acid is a hormone found in plants and fungi and it is weakly acidic. These are synthesized in young leaves. It moves readily in all direction and in all tissues including phloem and xylem. They can stimulate rapid stem and root growth, induce mitotic division in the leaves. It only can be used in small quantity.

Combination of treatment

P_1	WATER SPRAY (CONTROL)
P_2	GA_3 @150PPM
P_3	KINETIN @100PPM
P_4	$AgNO_3$ @30PPM

Kinetin, Gibberellic acid and $AgNO_3$ were applied once in a month each hormone was imposed in six pots.

3.2.8 Silver Nitrate ($AgNO_3$)

Silver Nitrate was used to investigate the vase life and bud opening of flowers of *Dendrobium* L. It acts as antimicrobial agent in holding solution.

3.2.9 Potting of plants

The uniform size of *Dendrobium* plant with one or two pseudobulb were planted in the perforated plastic pots in different growing media.

3.2.10 Irrigation

Irrigation was done by overhead misting system under shade net house. In summer harvesting was done daily and in winter 2-3 days of interval. Fertigation was also done weekly twice or thrice as per plant requirement.

3.2.11 Weeding

Weeding was done by manually to avoid weed competition and proper aeration.

3.2.12 Harvesting

Dendrobium orchid spike were harvested early in the morning and the cut flower was plugged with moist cotton to prevent microbial contamination.

3.3 Observation recorded

Following observation was made from 10 plants in each treatment and average observation was recorded for further analysis.

3.3.1 Morphological Parameter

3.3.1.1 Plant height (cm)

The height of plant was measured from the soil surface base to growing tip of the longest leaves. It was recorded by meter scale at vegetative stage and flowering stage under different growing media, and nutrient were followed.

3.3.1.2 Number of leaves per plant

The total number of leaves was recorded from 5 plants in each treatment at vegetative and flowering stage.

3.3.1.3 Number of shoot per plant

The total number of shoot was counted and recorded at vegetative and flowering stage.

3.3.1.4 Number of new shoot per plant

Number of new shoot per plant was counted and recorded at vegetative and flowering stage in nutrient and growth hormone application.

3.3.1.5 Shoot Girth (cm)

Shoot girth was recorded at vegetative and flowering stage in growth hormone and nutrient.

3.3.1.6 Internodes length per shoot (cm)

Internodes length was measured at vegetative and flowering stage for each growth media.

3.3.1.7 Number of internodes per shoot

The number of internodes was measured at vegetative and flowering stage and mean was measured as number.

3.3.1.8 Root length (cm)

The root length was recorded from each treatment.

3.3.2 Physiological Parameter

3.3.2.1 Leaf area (cm^2)

The leaf area was recorded by measuring leaf length and leaf width in cm.

3.3.2.2 Dry matter production (g)

The dry weight was taken after the fresh sample was sun dried and kept in hot air oven at 70oC for 2-3 days until constant weight was obtained it was expressed as gram/plant.

3.3.2.3 Physiological loss of weight (%)

The loss in weight was derived by subtracting the weight of inflorescence on the date from the original fresh weight. The percentage loss in weight was calculated by the formula.

Physiological loss in weight (PLW) = loss of weight/ Original fresh weight X100

3.3.2.4 Light Intensity (lux)

Light intensity approximation of light was measured in day time by luxmeter and it expressed as Lux or kilolux.

3.3.3 Biochemical parameters

3.3.3.1 SPAD Value (Chlorophyll content)

The SPAD (Soil Plant Analytical Development) value was estimated by SPAD meter. It gets reading in terms of SPAD values that indicate relative chlorophyll content. It was recorded in 5 plants in each treatment.

3.3.3.2 Wax content (mg/cm^2)

Epicuticular wax content was estimated by colorimeter method (Ebercon et al. 1977). This method is based on the colour change produced by the wax reaction with $K_2Cr_2O_7$. Firstly leaf area meter was measured and each sample was cut into pieces, immersed in 20-30ml redistilled chloroform for 15 second. This extract were filtered and evaporated to dryness in a digester at 70^{o}C. Then acidic reagent $K_2Cr_2O_7$ reagent was added to each sample and sample was heated for 30 minutes at 100^{o}C. After cooling 10-12ml of deionised water was added to each sample and several minutes was allowed for colour development. The optical density of sample was measured at 590 nm; it was expressed as mg/dm^2.

3.3.4 Phenological Parameter

3.3.4.1 Flower bud initiation (days)

The number of days required for opening of first flower bud is observed and expressed in days.

3.3.4.2 Number of spike

Total number of spike in each plant was observed and recorded.

3.3.4.3 Spike length (cm)

Spike length was measured from base of the spike to top most of flower stalk of fully open flower and expressed in cm.

3.3.4.4 Spike girth (cm)

Girth of spike was measured and expressed as cm.

3.3.4.5 No. of floret/ spike

The number of five flowers was counted and averaged.

3.3.4.6 Size of flower (length×width)

Size of individual flower was measured as length (vertically) and width (across) was recorded in cm^2.

3.3.4.7 Longevity of spike to the plant (days)

It was measured as first day of opening flower and last withering of spike to the plant. Longevity was recorded in days.

3.3.4.8 Vase life of spike in pure water (days)

One spike from each treatment was kept in distilled in room temperature. First day of keeping in water and till last day of withering of flower was recorded. It expressed in days.

3.3.4.9 Vase life of spike in holding solution (days)

One spike from each treatment was kept in holding solution (Sucrose, GA3, AgNO3 and kinetin and its combination), first day of keeping spike in solution till the last day of withering was recorded. There were three holding solution with three replication viz.

H_1- CONTROL (PURE WATER)

H_2- GA_3 (25PPM) + SUCROSE (5%)

H_3- KINETIN (25PPM) + SUCROSE (5%)

H_4- $AGNO_3$ (20PPM) + SUCROSE (5%)

3.4 Statistical Analysis

The data collected from various observations from each treatment recorded and statistically analysed by using CRD factorial. The critical difference at 5% level of significance for each parameter was worked out for comparing the significance among the treatment means. Data were arranged in tabular form and was given at appropriate places for result interpretation. The data collected for the experiment was recorded in field as well as laboratory and it was subjected to statistical analysis to know the degree of variation among all the treatments. The table for the analysis of variance (ANOVA) was suggested by Gomez and Gomez (1983) which is given below:

Source of variation	**Degree of Freedom**	**Sum of square**	**Mean sum of square**	**F calculated**	**F tabulated**
Replication	(r-1)	RSS	RMSS	RMSS/ ErSS	
Treatment	(ab-1)	TrSS	TrMSS	TrMSS/ErSS	
Factor A	(a-1)	-			
Factor B	(b-1)	-			
Error	(r-1) (ab-1)	ErSS	ErMSS		
Total	rab-1	TSS			

Where, RSS= Replication sum of square RMSS= Replication mean sum of square

TrSS= Treatment sum of square TrMSS= Treatment mean sum of square

ErSS= Error sum of square ErMSS= Mean sum of square of error

The calculated F value is compared with tabulated F value, If F test was recorded significant, then critical difference and standard error was calculated to find out which one treatment is superior over the other. The standard error of mean, standard difference and critical difference were calculated as follow:

a. Standard error of mean

$$SEm\pm=\sqrt{EMS}/r$$

EMS = Error mean of square

r = No. of replication

b. Critical difference

CD (5%) = SEd × t value at 5% degree of freedom

c. Coefficient of variation

$$CV\% = \sqrt{EMS}/grandmean \times 10$$

CHAPTER-IV

RESULT AND DISCUSSION

The present chapter deals with result and discussion obtained for "Impact of Different media on Physiological and Morphological Growth of Orchid (*Dendrobium L.*)". The data has been presented in tabular form as well as supported by graphical representation. Data recorded on various aspects during the course of investigation are briefly described under the following heads:

4.1 Morphological parameters

4.2 Physiological Parameters

4.3 Biochemical Parameters

4.4 Flowering Parameters

4.1 Morphological Parameters

4.1.1 Plant Height

The plant height has been presented in table 4.1 and figure 4.1. The growth media used for *Dendrobium* were significantly different in relation to plant height at vegetative stage. The maximum plant height was recorded in T_4 charcoal media in stage, vegetative stage (41.36 cm) and flowering stage (45 cm). Followed by, T_1 cocopit media at flowering stage (42.13 cm) and T_3, sawdust media at vegetative stage (38.33 cm). Minimum plant height was recorded in T_3, vermicompost at vegetative stage (30.66 cm) and T_2, sawdust at flowering stage (40.66 cm). Similar result was also supported by Bhattacharjee, (1984). Charcoal media has proven its superiority over other media in both vegetative and flowering character of orchids. Vigorous and healthy root system in epiphytic orchids was the first step towards ensuring maximum growth and favourable nutrient supply.

Table 4.1 Impact of different growth media on the plant height (cm) of *Dendrobium* L.

Treatments	Plant height(cm)	
	Vegetative Stage	Flowering Stage
Cocopit (T1)	34.66	42.13
Sawdust (T2)	38.33	40.66
Vermicompost (T3)	30.66	42.00
Charcoal (T4)	41.36	45.00
SE(m)	2.69	2.51
CD (0.05)	10.36	NS
CV (%)	12.87	10.27

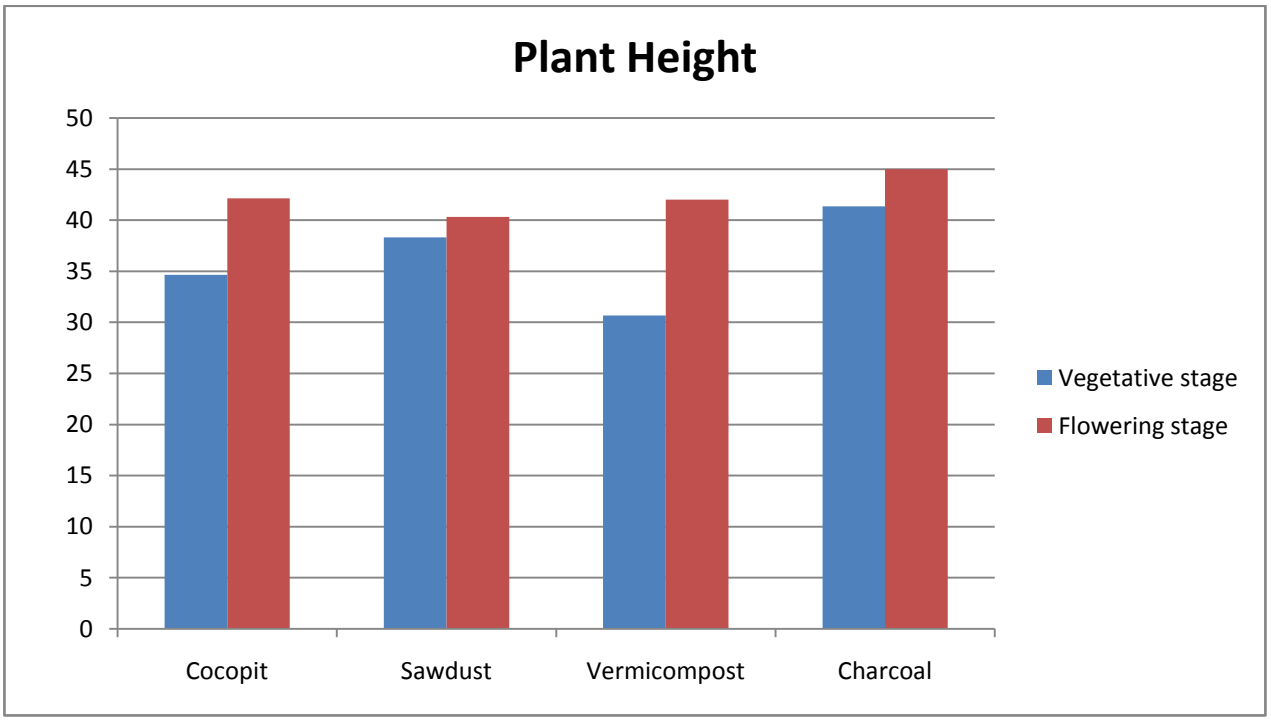

Fig 4.1. Impact of different growth media on the plant height (cm) of *Dendrobium* L.

4.1.2 Number of Leaves

The result on the number of leaves per plant at both stage has been presented in Table 4.2 and figure 4.2. There was significant difference in growth media in relation to number of leaves on both stages. Maximum number of leaves was obtained in T_4, charcoal media at flowering stage (6.33) and T_3, vermicompost at vegetative stage (5.33), followed by T_4, charcoal at vegetative stage (5.00). Minimum number of leaves observed in T_1, cocopit media (2.66) and Sawdust at flowering stage (3.00). Similar result was also obtained by (S. Saravanan, 2001). Lower number of leaves per plant with sawdust and coconut husk medium, respectively, because they had high water retention and poor aeration which leads to oxygen unavailability around the roots.

Table 4.2 Impact of different growth media on the number of leaves of Dendrobium L.

Treatments	Number of leaves	
	Vegetative Stage	Flowering stage
Cocopit (T1)	2.66	4.33
Sawdust (T2)	3.00	4.00
Vermicompost (T3)	5.33	6.00
Charcoal (T4)	5.00	6.33
SE(m)	0.47	0.23
CD (5%)	1.81	0.90
CV (%)	20.41	7.90

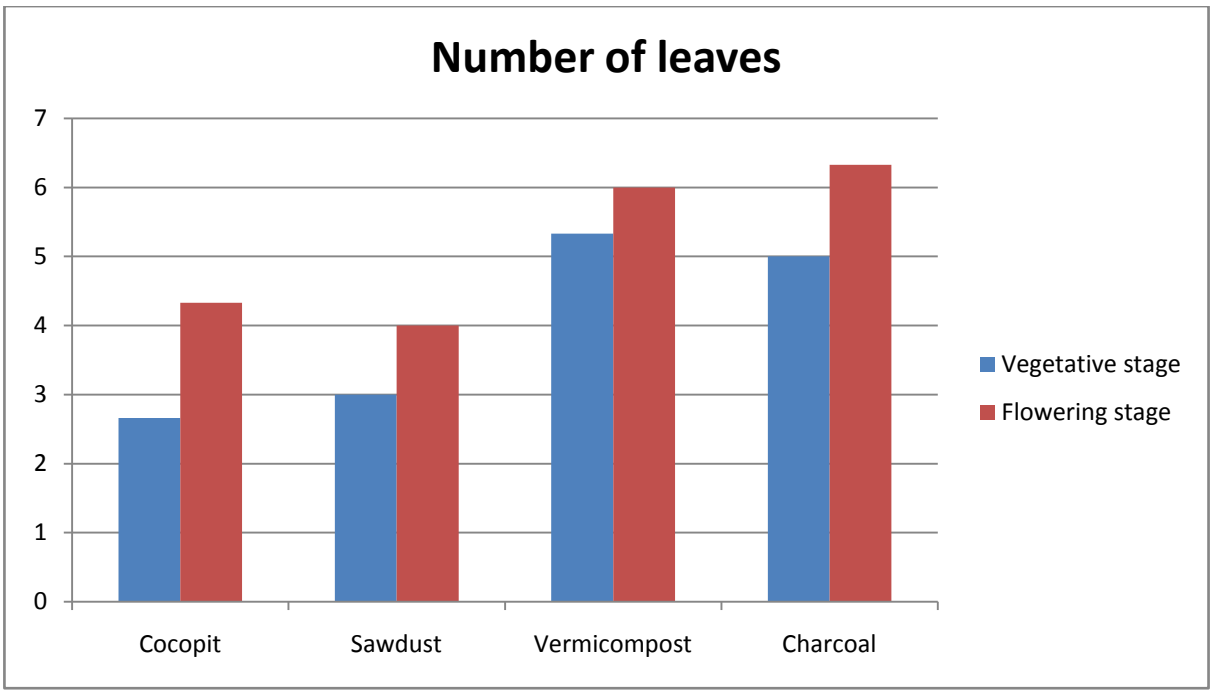

Fig 4.2. Impact of different growth media on the number of leaves of Dendrobium L.

4.1.3 Number of Shoots/ plant

The result on the number of shoot per plant at both stages has been presented in Table 4.3 and figure 4.3. There was significant difference in different growth media in relation to number of shoot at flowering stage. Highest number of shoot recorded in Charcoal media at flowering stage (4.33). Followed by vermicompost and sawdust at flowering stages (3.33) Minimum number of shoot per plant was recorded in Sawdust media at vegetative stage (1.33) and in Cocopit at vegetative stage (2.00). The experiment finding was also supported by (Bhattacharjee, 1980) and (S. Saravanan, 2001). Charcoal media found superior because of better, root aeration, resistance to high heat and supply of nutrients. The reason for reduction in number of shoot in sawdust and coconut husk due to poor root aeration and depletion of nutrient.

Table 4.3 Impact of different growth media on the number of shoots of *Dendrobium* L.

Treatments	No. of shoot/ Plant	
	Vegetative Stage	Flowering stage
Cocopit (T1)	2.00	2.33
Sawdust (T2)	1.33	3.33
Vermicompost (T3)	1.66	3.33
Charcoal (T4)	2.66	4.33
SE(m)	0.40	0.33
CD (5%)	NS	1.28
CV (%)	36.89	17.32

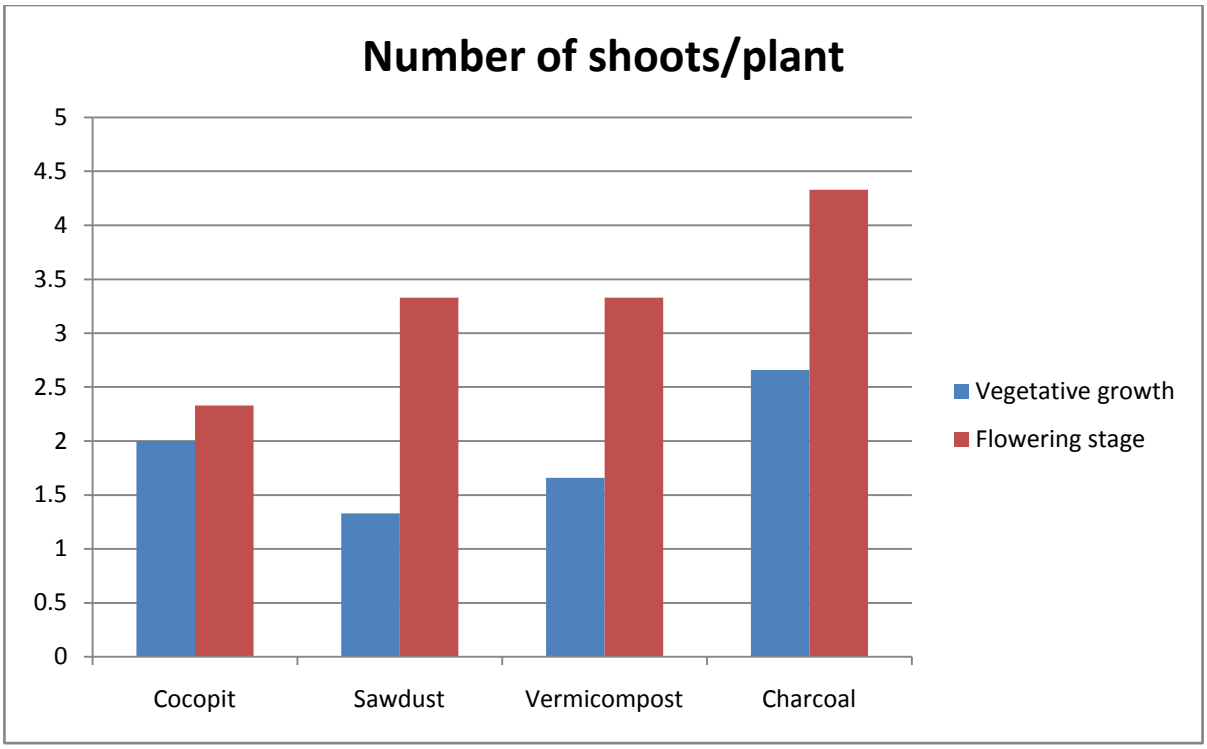

Fig.4.4 Impact of different growth media on the number of shoot of *Dendrobium* L.

4.1.4 Number of New Shoots/ Plant

The result on the number of new shoot per plant at both stage are presented in Table 4.4 figure 4.4. There was significant difference in different growth media in relation to number of new shoot at only flowering stage. The maximum number of new shoot per plant was recorded in T_3, Vermicompost media at flowering stage (2.33) and T_4, charcoal media at flowering stage (2.00). Minimum number of new shoot was observed inT_1, cocopit media at both stage (1.00) and T_2, Sawdust at vegetative stage (1.00). This result was also partially supported by (Arancon et al., 2008 and Joshi and Vig, 2010) they had studied the effect of vermicompost on growth, yield and quality of tomato (*Lycopersicum esculentum* L). Vermicompost have high porosity, aeration, drainage and water holding capacity, therefore it can be used as growth media to maximize number of shoot in orchid.

Table 4.4 Impact of different growth media on the number of new shoots /plant of *Dendrobium* L.

Treatments	No. of new shoot/Plant	
	Vegetative Stage	Flowering stage
Cocopit (T1)	1.00	1.00
Sawdust (T2)	1.00	1.33
Vermicompost (T3)	1.33	2.33
Charcoal (T4)	1.00	2.00
SE(m)	0.16	0.23
CD (5%)	NS	0.90
CV (%)	26.64	24.49

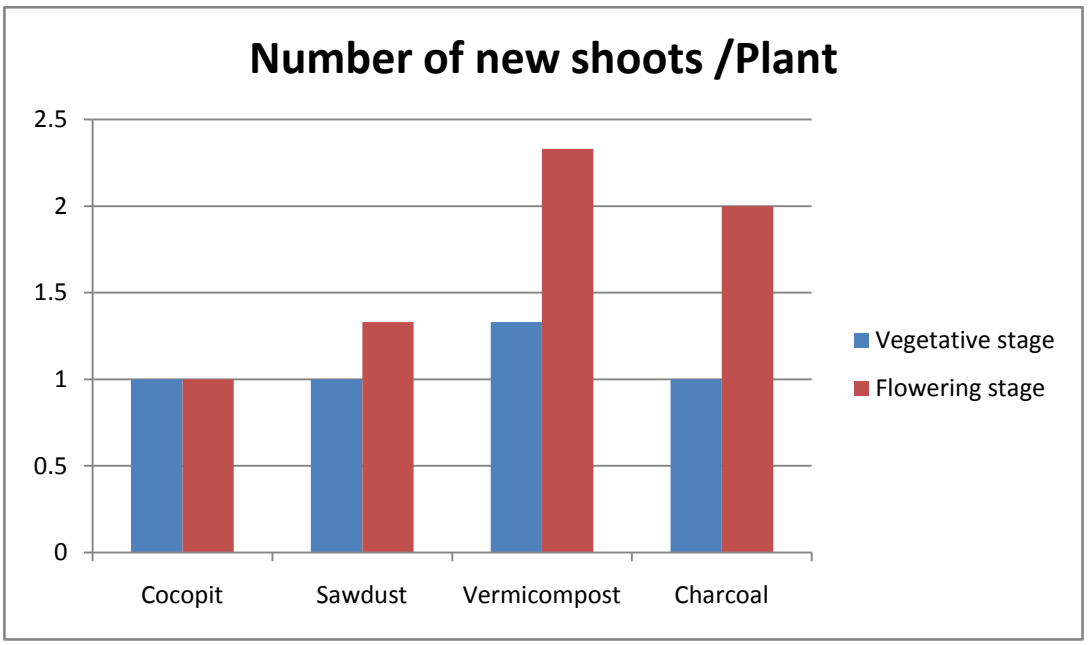

Fig 4.4.Impact of different growth media on the number of new shoots/plant of *Dendrobium* L.

4.1.5 Shoot Girth

Shoot girth result has been showed in Table 4.5 and figure 4.5. Shoot girth was found to be markedly influenced by growth media at both stages. Different growth media found significant effect on shoot girth. The maximum shoot girth was observed in treatment T4, Charcoal at flowering stage (4.1cm) and vegetative stage (3.83 cm). Minimum shoot girth recorded in T2, Sawdust media at vegetative stage (2.56 cm) and at flowering stage (3.03 cm). This experiment was also supported by (Paul and Rajeevan, 1992) and (Kumar, 1992). Charcoal media gave slow nutrient to enhanced shoot girth and good support for shoot growth. Sawdust showed lowest shoot girth because of high compactness of pores after irrigation.

Table 4.5 Impact of different growth media on the shoot girth (cm) of *Dendrobium* L.

Treatments	Shoot Girth (cm)	
	Vegetative Stage	Flowering stage
Cocopit (T1)	3.03	3.33
Sawdust (T2)	2.56	3.03
Vermicompost (T3)	3.33	3.5
Charcoal (T4)	3.83	4.1
SE(m)	0.19	0.23
CD (5%)	0.76	0.91
CV(%)	10.76	11.86

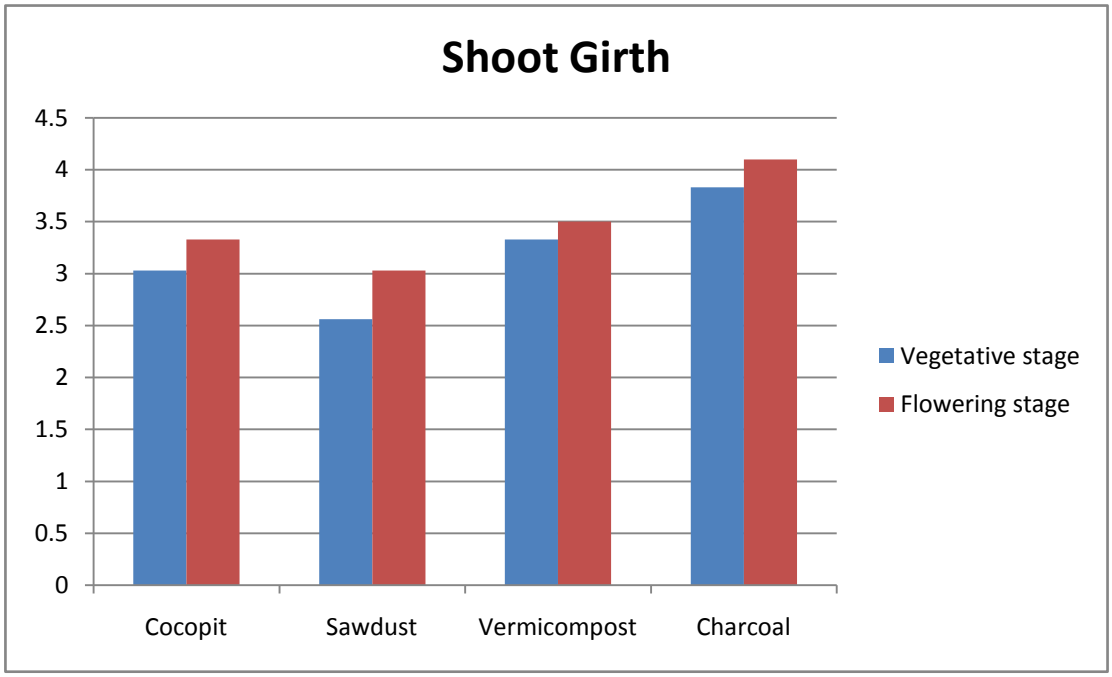

Fig 4.5 Impact of different growth media on the shoot girth (cm) of *Dendrobium* L

4.1.6 Internode length/shoot

The result on the Internode length per shoot at both stage are presented in Table 4.6 and figure 4.6. There was significant difference in different growth media in relation to Internode length per shoot at vegetative stage. The highest Internode length was recorded in treatment T_3, Vermicompost media at flowering stage (7.7cm) and T_4, Charcoal stage at flowering stage (7.46 cm) followed by T_2 Sawdust at flowering stage (7.00 cm). Lowest Internode length was observed in T_4, Charcoal at vegetative stage (4.76 cm). However, the impact of growth media on Internode length was not significant at flowering stage. This finding is similarly supported by S.Saravanan 2001.

Table 4.6 Impact of different growth media on the Internode length/shoot (cm) of *Dendrobium* L.

Treatments	Internode length/shoot (cm)	
	Vegetative Stage	Flowering stage
Cocopit (T1)	5.86	6.83
Sawdust (T2)	4.83	7.00
Vermicompost (T3)	4.80	7.7
Charcoal (T4)	4.76	7.46
SE(m)	0.29	0.39
CD (5%)	1.12	NS
CV (%)	9.96	9.42

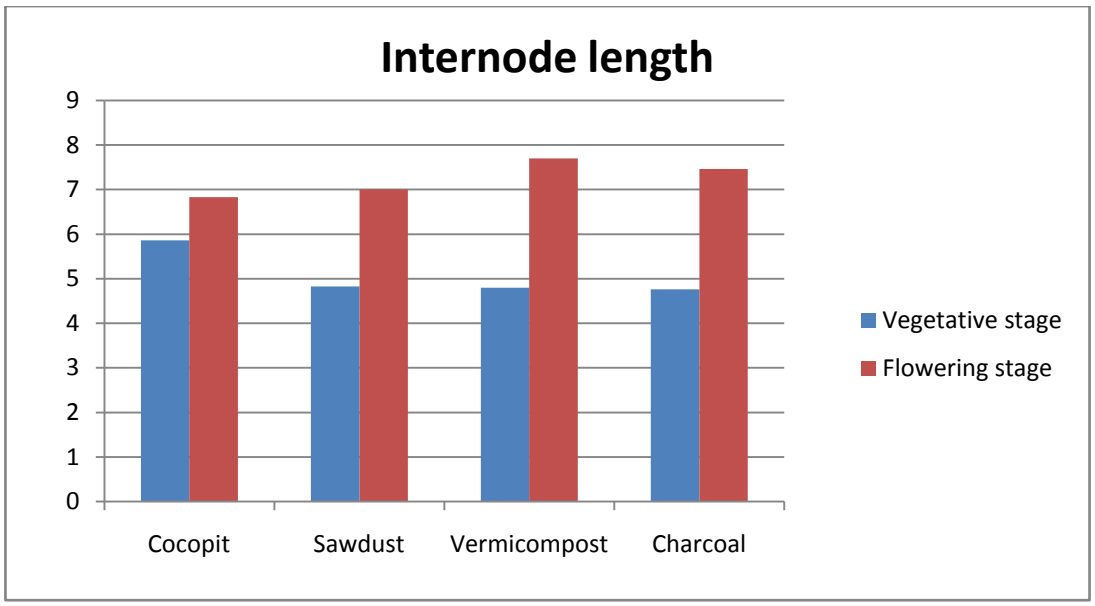

Fig. 4.6 Impact of different growth media on the Internode length/shoot (cm) of *Dendrobium* L.

4.1.7 Number of Internode/shoot

The result on the number of internode per shoot at both stage are presented in Table 4.7 and fig 4.7. Significant influence on number of internodes per shoot at different growth stages of plant growth was noticed among the growth media. Highest number of internodes observed in treatment T_3, Vermicompost at flowering stage (6.33) and T_4, Charcoal at flowering stage (6.00), followed by Vermicompost at vegetative stage (5.66). Lowest number of internode per shoot was observed in T_2, Sawdust at vegetative stage (4.0). Vermicompost contains plant growth regulating substances and other substances which are produced by microorganism and affect plant growth. (Tomati U, 1988).

Table 4.7 Impact of different growth media on number of Internode/Shoot of *Dendrobium* L.

Treatments	No. of Internode/Shoot	
	Vegetative Stage	Flowering stage
Cocopit (T1)	4.33	5.33
Sawdust (T2)	4.0	4.66
Vermicompost (T3)	5.66	6.33
Charcoal (T4)	5.66	6.00
SE(m)	0.40	0.40
CD (5%)	1.56	1.56
CV (%)	14.38	12.66

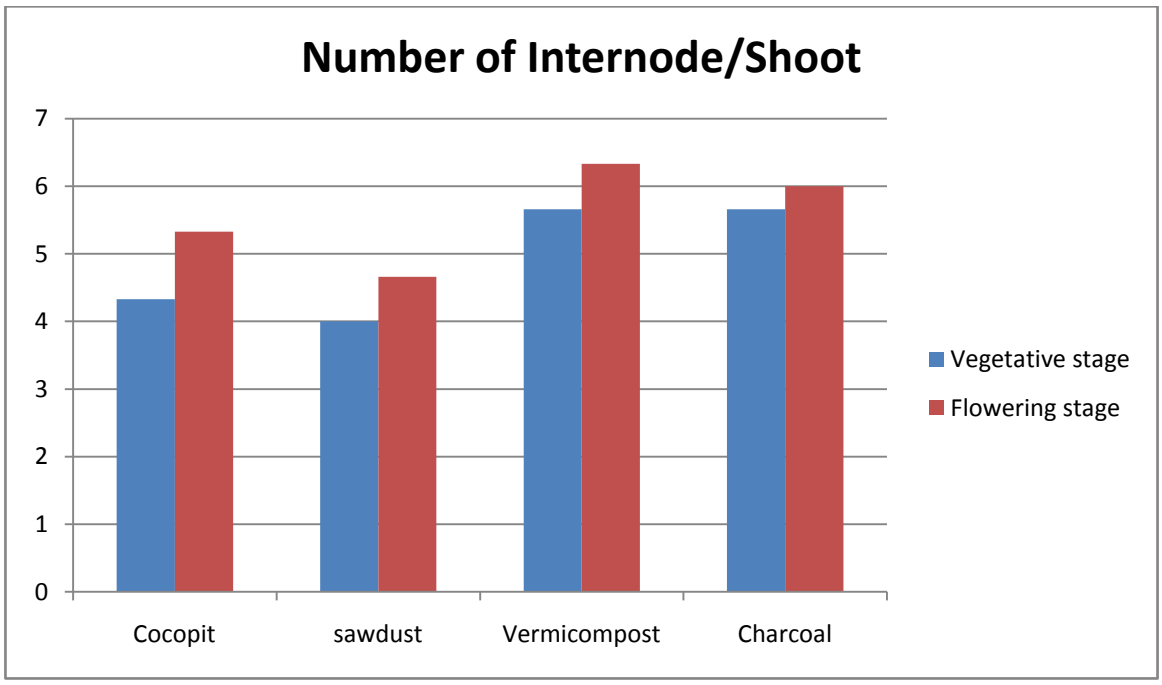

Fig. 4.7 Impact of different growth media on number of Internode/Shoot of *Dendrobium* L.

4.1.8 Root length

The data relevant to root length from each treatment are presented in table 4.8 and fig.4.8. There was significant difference in growth media in relation to root length. The highest root length was recorded in T_4, Charcoal (32.46 cm) followed by T_1, Cocopit media and T_3, Vermicompost and lowest root length observed in T_2, Sawdust media 23.23 cm. Similar results were found by (Paul and Rajeevan, 1982), (Kumar 1992), (S. Saravanan, 2001). Charcoal media was found better for root and shoot growth they provide proper water, supply nutrients, permit gas exchange to roots.

Table 4.8 Impact of different growth media on root length (cm) of *Dendrobium* L.

Treatments	Root Length (cm)
Cocopit (T1)	29.53
Sawdust (T2)	23.23
Vermicompost (T3)	27.36
Charcoal (T4)	32.46
SE(m)	0.98
CD (5%)	3.78
CV (%)	6.05

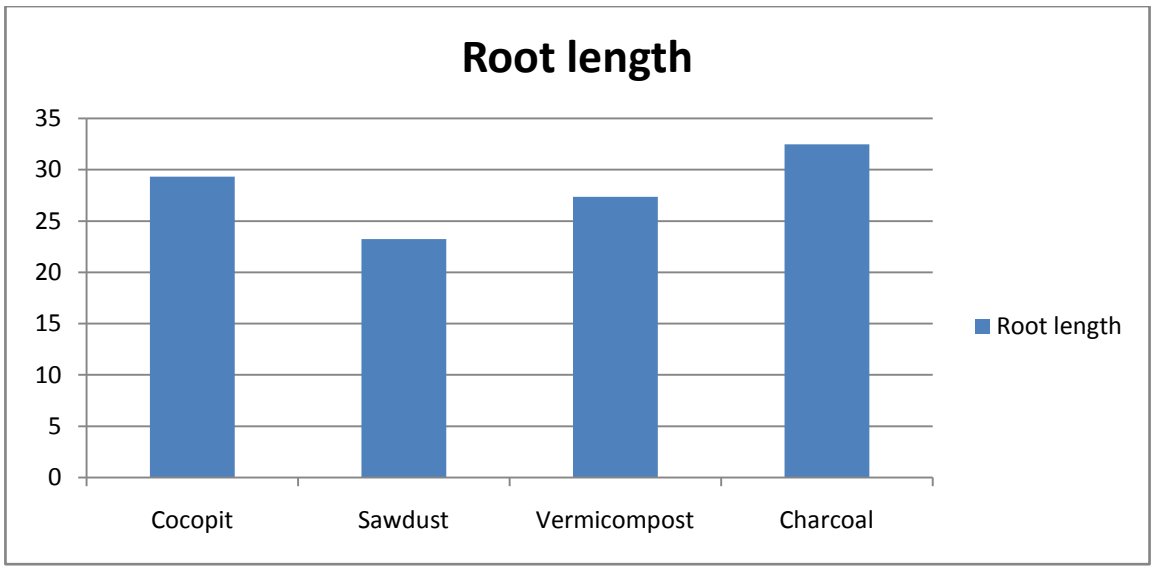

Fig.4.8 Impact of different growth media on root length (cm) of *Dendrobium* L.

4.2 Physiological Parameter

4.2.1 Leaf Area (cm^2)

The data relevant to leaf area (cm^2) from each treatment are presented in Table 4.9 and figure 4.9. Growth media found significantly different in relation to leaf area at both stages. Highest leaf area was observed in T_1, Cocopit media at flowering stage (24.30 cm^2), followed by T_4, Charcoal at flowering stage (21.68 cm^2). Minimum leaf area was recorded in T_2, sawdust at vegetative stages (13.03 cm^2) and T_3, vermicompost. Similar result was also found by (Sessler, 1978) and (S. Saravanan, 2001). The coconut husk media produced the high leaf area because of slow absorbing nutrient and moisture retaining capacity.

Table 4.9 Impact of different growth media on leaf area (cm^2) in *Dendrobium* L.

Treatments	Leaf Area(cm^2)	
	Vegetative Stage	Flowering stage
Cocopit (T1)	19.16	24.30
Sawdust (T2)	13.03	16.74
Vermicompost (T3)	15.90	16.40
Charcoal (T4)	16.03	21.68
SE(m)	0.52	0.44
CD (5%)	2.01	1.71
CV (%)	5.55	3.92

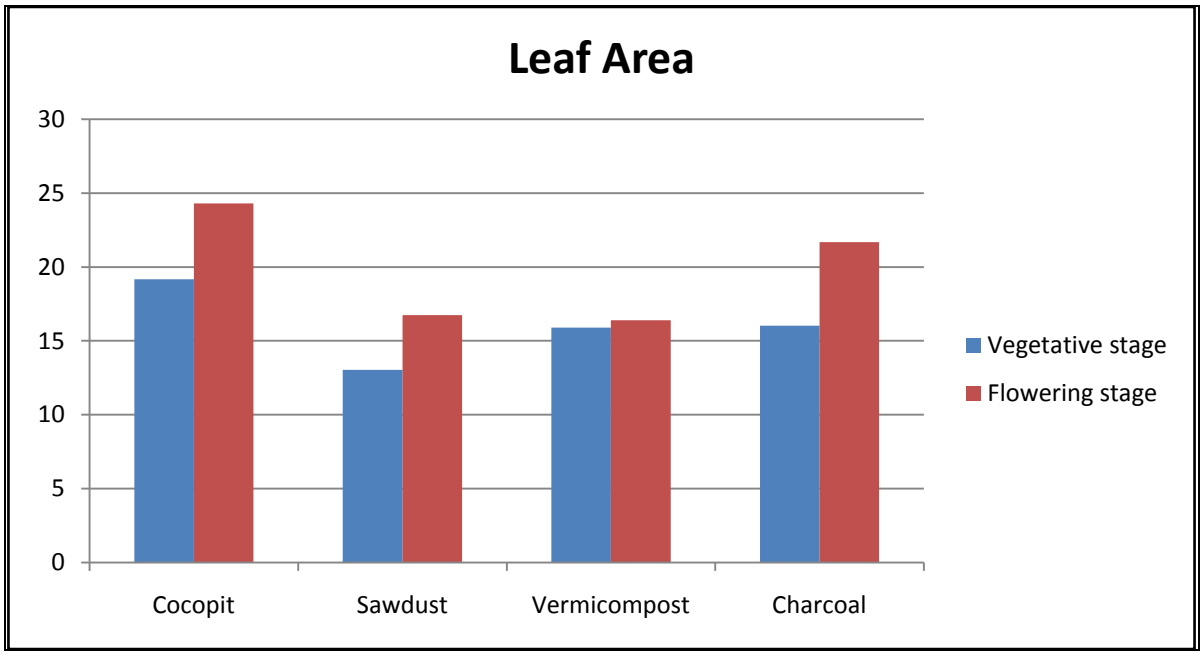

Fig 4.9 Impact of different growth media on leaf area (cm^2) in *Dendrobium* L.

4.2.2 Light Intensity

The data relevant to light intensity from different treatment has been presented in Table 4.10 and figure 4.10. There was no significant difference in growth media in relation to light intensity. Maximum light intensity was observed in T_3, Vermicompost (17.56 kilolux) and T_2, (17.51 kilolux) and minimum was recorded in T_1, Cocopit media (17.01 kilolux). Similar results were supported by Rotor, 1959.

Table 4.10 Impact of different growth media on light intensity (kilo lux) in *Dendrobium* L.

Treatments	Light Intensity (kilo lux)
Cocopit (T1)	17.01
Sawdust (T2)	17.51
Vermicompost (T3)	17.56
Charcoal (T4)	17.36
SE(m)	0.24
CD (5%)	0.92
CV (%)	2.40

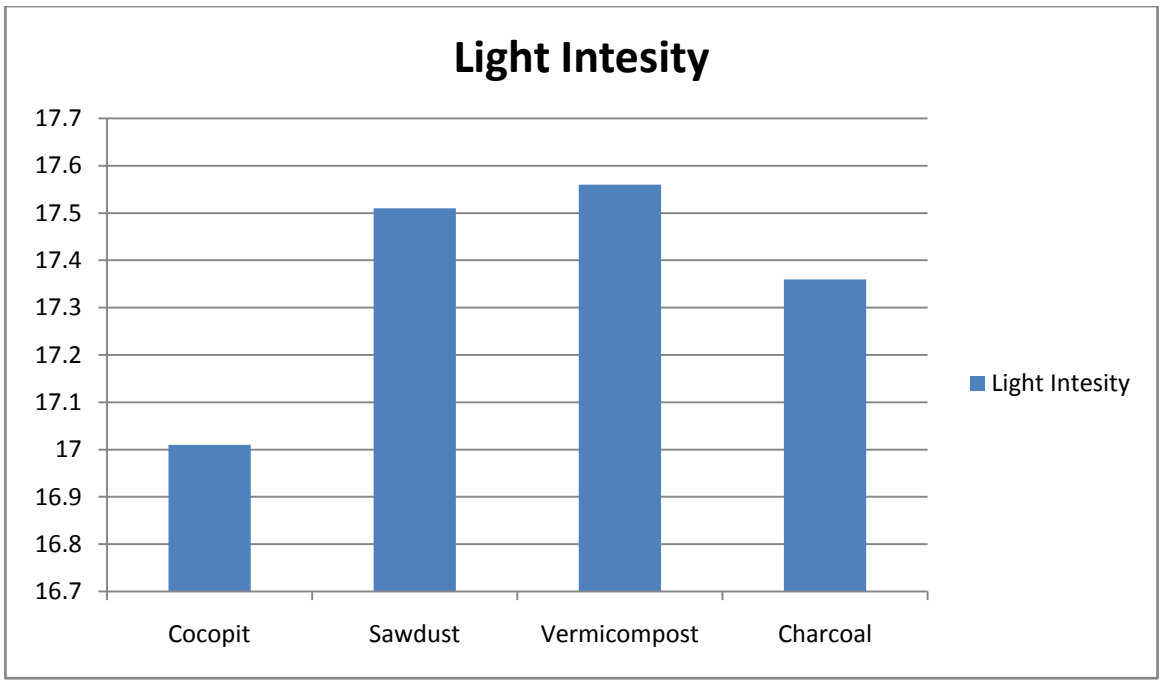

Fig. 4.10 Impact of different growth media on light intensity (kilo lux) in *Dendrobium* L.

4.3 Biochemical Parameter

4.3.1 SPAD Value

The data relevant to SPAD value from different growth media are presented in Table 4.11 and figure 4.11. The SPAD value was found highest in the plant grown in T_4; Charcoal media (53.54) followed by T_3, Vermicompost (47.13) and T_1, (39.26). Lowest was recorded in T_2, sawdust media. The impact of growth media in SPAD value was significantly different. Similar result was found (S. Saravanan 2001) and (M. Sanghamitra, 2019).and Ali Salehi (2014).

Table 4.11 Effect of different growth media on SPAD Value in *Dendrobium* L.

Treatments	SPAD value
Cocopit (T1)	39.26
Sawdust (T2)	37.36
Vermicompost (T3)	47.13
Charcoal (T4)	53.54
SE(m)	2.40
CD (5%)	9.25
CV (%)	9.41

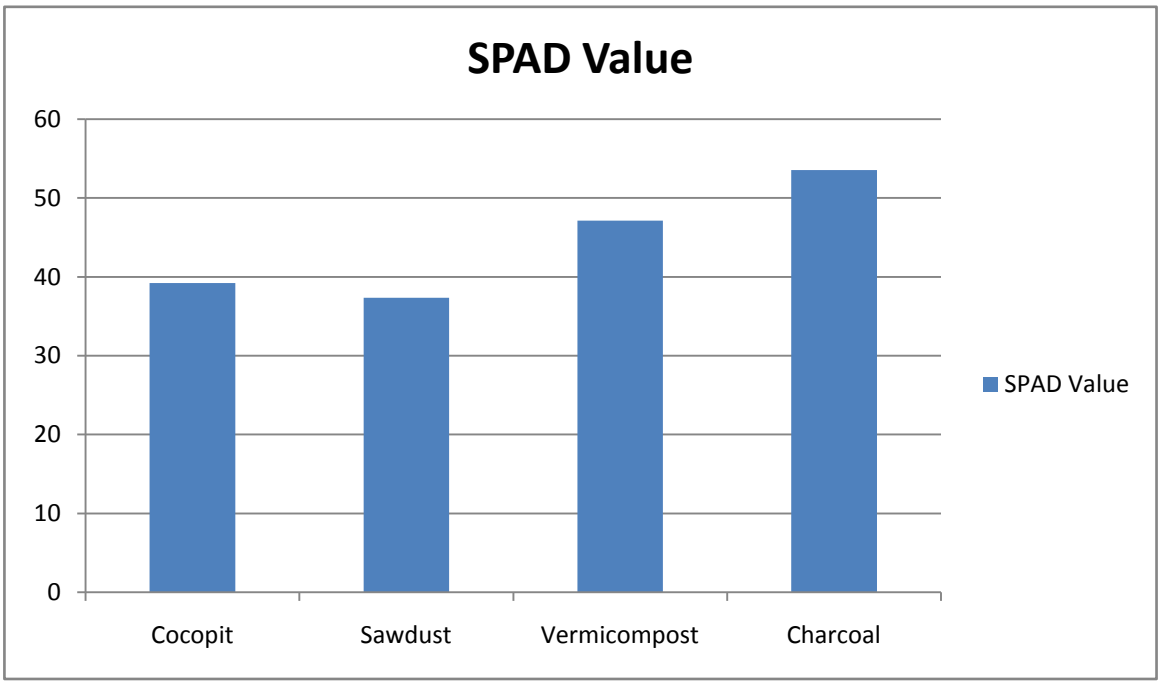

Fig 4.11 Effect of different growth media on SPAD Value (Chlorophyll Content) in *Dendrobium* L.

4.3.2 Wax Content

The data relevant to wax content has been showen in Table 4.12 and figure 4.12. There was non significant difference between growth media and all treatment regarding wax content (mg/cm^2). However, all the growth media T_4, Charcoal media has maximum (2.802 mg/cm^2) wax content followed by T_1, Cocopit (2.384 mg/cm^2) and T_3, Vermicompost (2.131 mg/cm^2) and minimum was recorded in T_2, Sawdust (2.108 mg/cm^2). Amongst all the plant growth regulator treatment P_1, Control (2.488 mg/cm^2) and P_4, (2.473 mg/cm^2) have positive impact over other treatment regarding wax content. Similar result was found by Prathibha, M.D (2012) in Genetic variability and relevance of Epicuticular waxes in rice.

Table 4.12 Effect of plant growth substances and growth media on wax content (mg/cm^2) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	2.69	1.967	1.967	2.913	2.384
Sawdust (T2)	2.377	1.967	2.243	1.847	2.108
Vermicompost (T3)	1.967	1.82	2.443	2.293	2.131
Charcoal (T4)	2.917	2.573	2.88	2.837	2.802
Mean	2.488	2.082	2.383	2.473	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.254	NS
Treatments	0.254	NS
Interaction (T×P)	0.254	NS

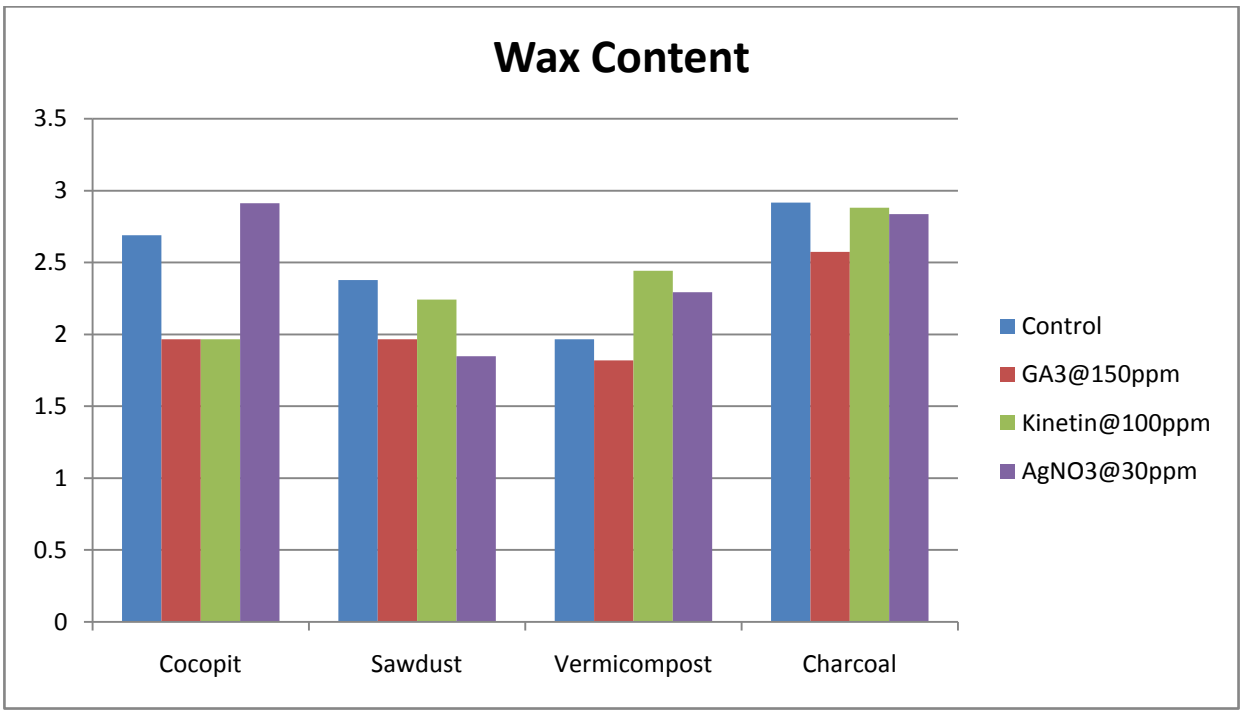

Fig 4.12 Effect of plant growth substances and growth media on wax content (mg/cm^2) in *Dendrobium* L.

4.4 Flowering Parameter

4.4.1 Flower Bud Initiation (days)

The data relevant to flower bud initiation has been presented in table 4.13 and figure 4.13. There was a significant difference between the different growth media regarding flower bud initiation of the *Dendrobium*. Amongst all the growth media T_4, Charcoal media (23 days) was found relatively best. Maximum days for bud initiation were required for T_2, sawdust (26.75 days). Sawdust media delayed the flower bud initiation, it might be due to its tightly packed pore space and it restricts the aeration. The application of treatments were having significant impact on days to flower bud initiation P_3, Kinetin @100ppm was found to be most significant in reducing the days to flower bud initiation (23.25 days) over P_4, $AgNO_3$ @30ppm (24 days) followed by P_2, GA_3@150ppm (24.16 days). Maximum days were required for flower bud initiation in P_1, Control (28.33 days). Similar result was also found by (Boyd, 1983) and (Laishram et al. 1999). Minimum days were required for P_3,Kinetin@100ppm treatment because kinetin trigger the plant growth and flower yield.

Table 4.13 Effect of plant growth substances and growth media on flower bud initiation (days) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	29	26.66	22.66	26.33	26.16
Sawdust (T2)	33.33	26.66	23.66	23.33	26.75
Vermicompost (T3)	24.66	23.66	23.66	23.33	23.83
Charcoal (T4)	26.33	19.66	23	23	23
Mean	28.33	24.16	23.25	24	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	1.024	2.963
Treatments	1.024	2.963
Interaction (T×P)	2.048	NS

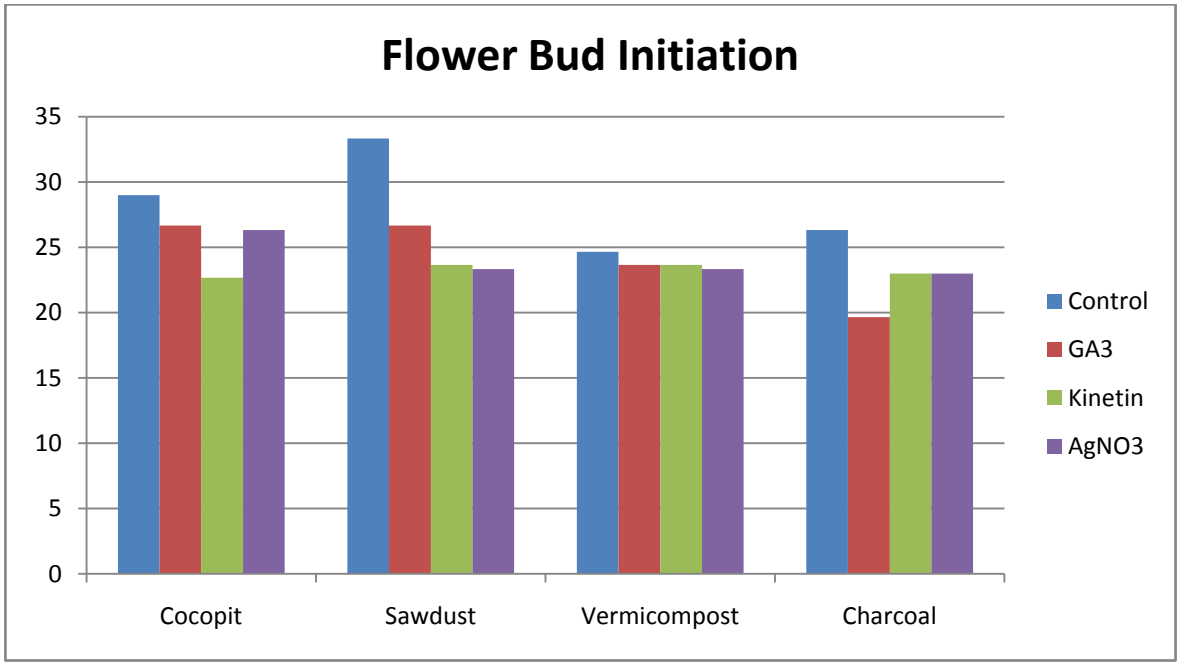

Fig 4.13 Effect of plant growth substance and growth media on Flower bud initiation (days)

4.4.2 Number of spike

The data relevant to number of spike has been presented in Table 4.14 and figure 4.14. There was not significant difference between different growth media but

the maximum number of spikes was recorded in T_4, Charcoal media (2.5) over other growth media T_2, Sawdust (1.8) and T_1, Cocopit (1.7) was found inferior. However, the impact of treatments was significantly different on number of spike. Maximum number of spike was recorded in P_2, GA_3 @150ppm, P_3, Kinetin @100ppm and P_4, $AgNO_3$ @30ppm (2.1) and minimum number of spike observed in P_1, Control (1.4). Kinetin with high concentration along with GA_3 concentration was found to be triggering the flower production effectively. Swapna (2000), reported the same effect of BA in improving the flower production.

Table 4.14 Effect of plant growth substances and growth media on number of spike in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100 ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	1.0	2.3	1.6	2.0	1.7
Sawdust (T2)	1.3	2.0	2.0	2.0	1.8
Vermicompost (T3)	1.0	1.6	2.3	2.3	1.8
Charcoal (T4)	2.3	2.6	2.6	2.3	2.5
Mean	1.4	2.1	2.1	2.1	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.208	NS
Treatments	0.208	0.603
Interaction (T×P)	0.417	NS

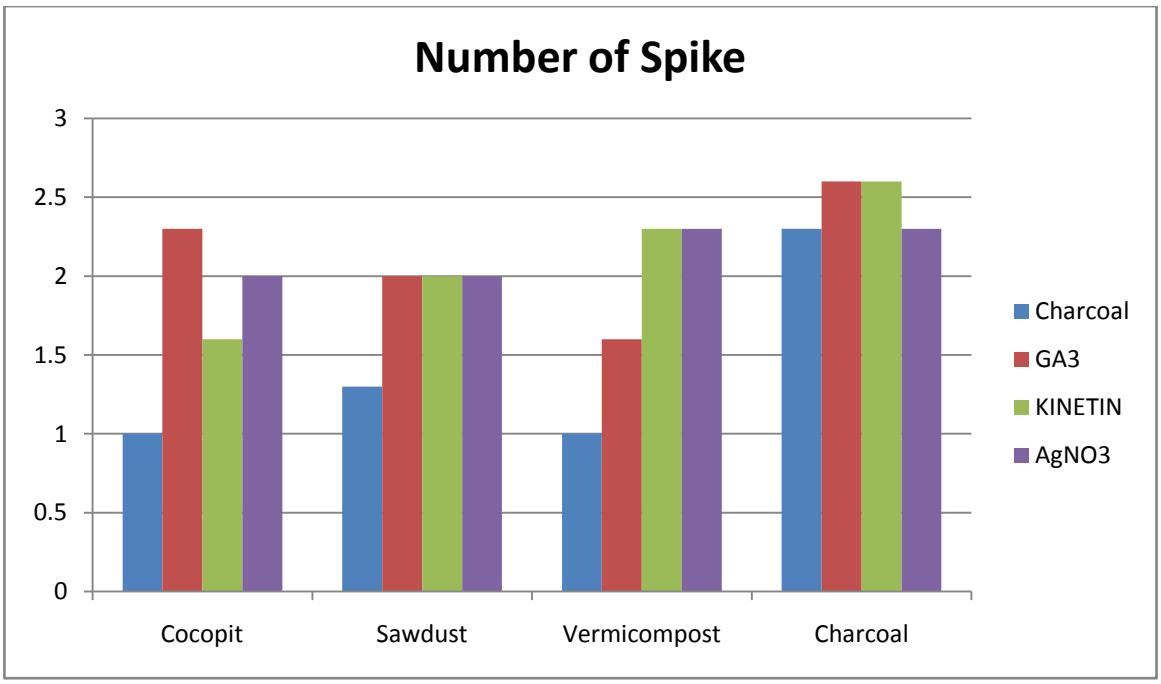

Fig 4.14. Effect of plant growth regulator and growth media on number of spike per plant

4.4.3 Spike length

The data has been presented in Table 4.15 and figure 4.15. The growth media having significant difference in spike length (cm). Amongst the growth media, T_4, charcoal media exhibit maximum spike length (45.16 cm) followed by T_3, vermicompost media (37.72 cm) and minimum spike length was recorded in T_1, cocopit (35.68 cm). However, the impact of plant growth substance found significantly different regarding to spike length. Amongst the treatment P_1, control found significantly highest impact and length was (41.04 cm) followed by P_2, GA_3 @150ppm (40.03 cm) and minimum spike length was observed in P_4, $AgNO_3$@30ppm (36.31 cm). Interaction of Growth media and growth regulator was found significantly different in relation to spike girth. GA_3 had a minor effect on spike production compared to Benzyl adenine, as per the view of James Brasch (2000) and Chong Jin Goh and Joseph Arditti (1981).

Table 4.15 Effect of plant growth substances and growth media on spike length (cm) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100 ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	32.13	42.0	33.36	35.23	35.68
Sawdust (T2)	38.26	33.56	33.56	36.56	35.49
Vermicompost (T3)	39.53	39.53	35.26	36.56	37.72
Charcoal (T4)	54.23	45.03	44.5	36.9	45.16
Mean	41.04	40.03	36.67	36.31	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.758	2.192
Treatments	0.758	2.192
Interaction (T×P)	1.515	4.385

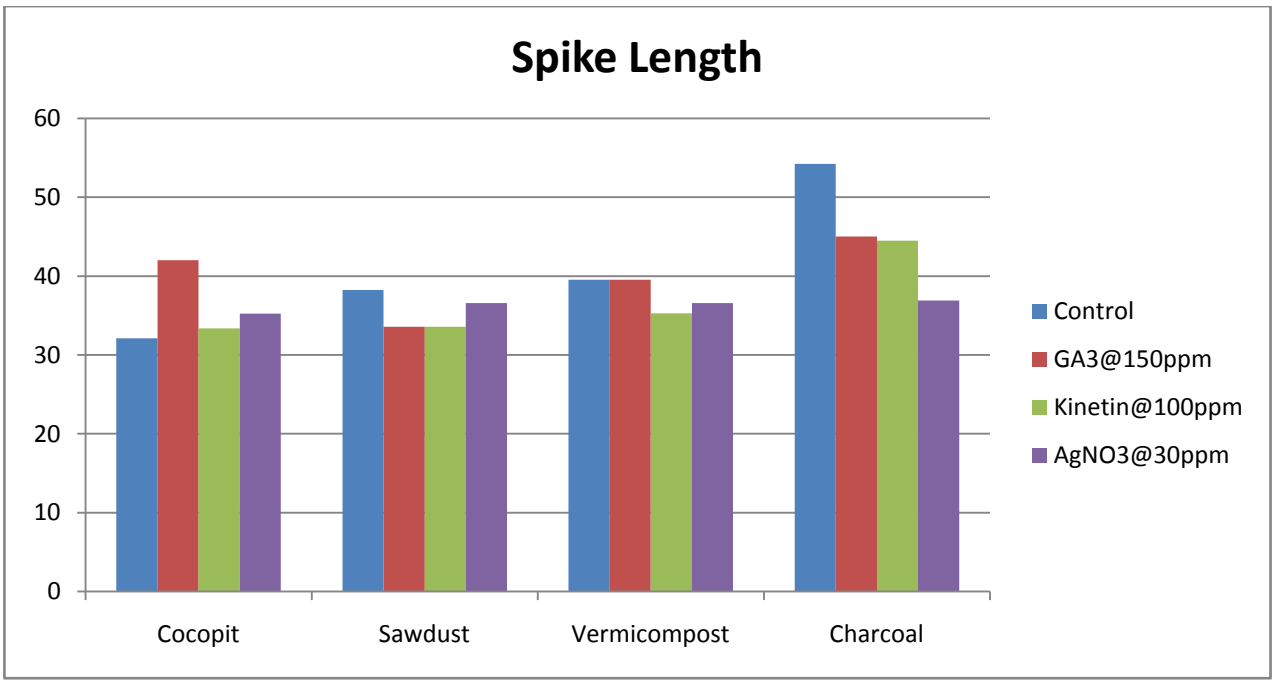

Fig 4.15 Effect of plant growth substances and growth media on spike length (cm) in *Dendrobium* L.

4.4.4 Spike girth

The growth media found significant difference relevant to spike girth (cm). Spike girth was significantly increased by T_4, charcoal media (2.0 cm) then T_3, vermicompost media (1.98 cm) and minimum girth was recorded in T_1, cocopit (1.47 cm) and T_2, sawdust (1.47 cm). The application of plant growth substances also exhibit significant impact on improving spike girth. Amongst the treatment, P_3, kinetin@100ppm found significantly higher impact and average spike girth was (1.90 cm) followed by P_2, GA_3@150ppm (1.77cm) and P_4, $AgNO_3$ @30ppm (1.65 cm). The minimum spike girth was observed in P_1, contol (1.62). Similar results were also reported by several workers (Farnham et al., 1979; Kofranick 1992; Anju bhat and Tripathi, 1999). Spike girth was considered as an important factor for determining post harvest life of flower, because higher spike girth would gave better storage reserve of carbohydrates for utilization of the flower for longer period of time. The nutrients along with Kinetin would have been translocated in the pseudobulb and spike girth was triggered by the action of cytokinin. Similar result was supported by Chong Jin Goh

and Joseph Arditti (1981). Improvement of translocation efficiency due to treatment effect might be the reason for increased spike girth of the *Dendrobium*. (Table 4.16 and figure 4.16)

Table 4.16 Effect of plant growth substances and growth media on spike girth (cm) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	1.367	1.433	1.567	1.533	1.475
Sawdust (T2)	1.267	1.533	1.567	1.533	1.475
Vermicompost (T3)	1.567	2.3	2.333	1.733	1.983
Charcoal (T4)	2.3	1.833	2.133	1.833	2.025
Mean	1.625	1.775	1.90	1.658	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.064	0.186
Treatments	0.064	0.186
Interaction (T×P)	0.129	0.373

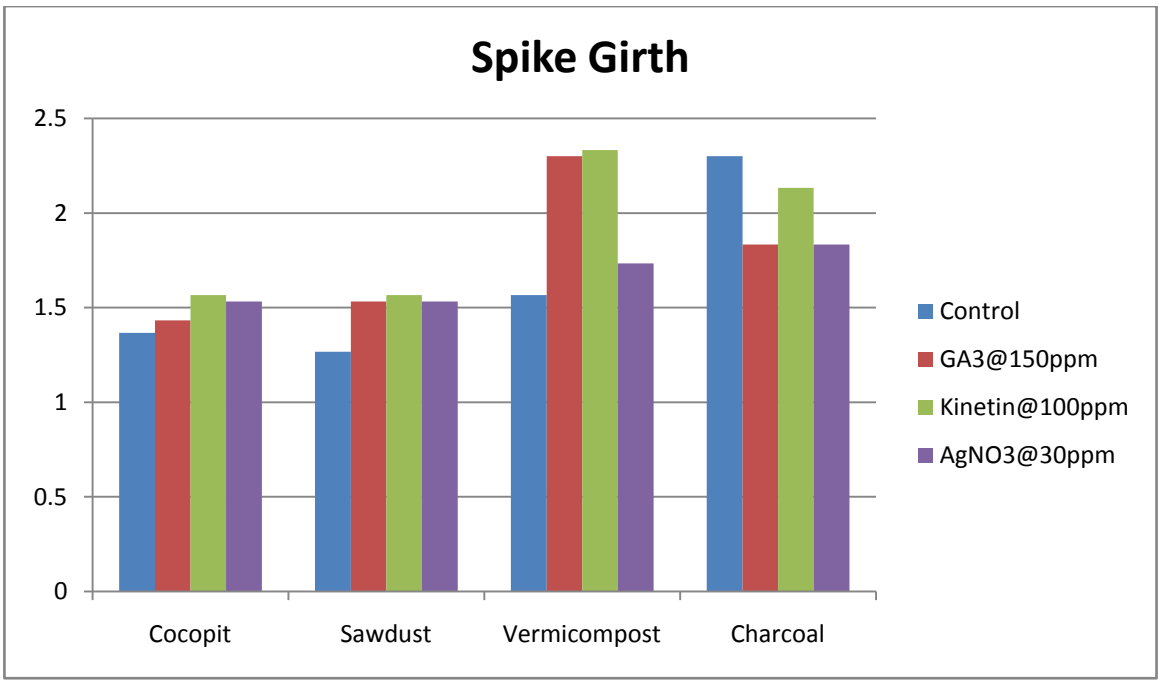

Fig 4.16 Effect of plant growth substances and growth media on spike girth (cm) in *Dendrobium* L.

4.4.5 Number of floret per spike

The data relevant to number of floret per spike has been presented in Table 4.17 and figure 4.17. There is significant difference between different growth media regarding number of floret per spike. T_4, charcoal media (6.0) exhibit higher impact over the other growth media followed by T_1, Cocopit (5.33) then T_2, sawdust (5.25) and T_3, vermicompost (4.33) found inferior effect relevant to number of flower. Amongst all the plant growth substance, P_2, GA_3 @150 ppm and P_4, $AgNO_3$ @30 ppm have the same effect on the flower number (5.41) followed by P_3, Kinetin @100ppm (5.25) and least effect is shown in P_1, control (4.83). However, the impact of growth regulators has not significant. Growth media and growth regulator interaction also had non significant result. Number of flowers produced per spike was important for cut flower trade of *Dendrobium.* Charcoal media performed great response because of their high translocation efficiency. They absorb nutrients, water, air in proper amount due to this might be the reason for more number of flowers in *Dendrobium*. The growth regulators influenced the flower number and quality. Gibberellic acid increase inflorescence

length and higher flower count. Runke (2010), reported that exogenous application of Gibberellic acid (GA_3) can be used to increase inflorescence character in *Phalaenopsis*.

Table 4.17 Effect of plant growth substances and growth media on number of floret/spike in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100 ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	4.33	5.33	6.0	5.66	5.33
Sawdust (T2)	4.66	6.0	4.66	5.66	5.25
Vermicompost (T3)	4.33	4.33	4.33	4.33	4.33
Charcoal (T4)	6.0	6.0	6.0	6.0	6.0
Mean	4.83	5.41	5.25	5.41	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.253	0.733
Treatments	0.253	NS
Interaction (T×P)	0.507	NS

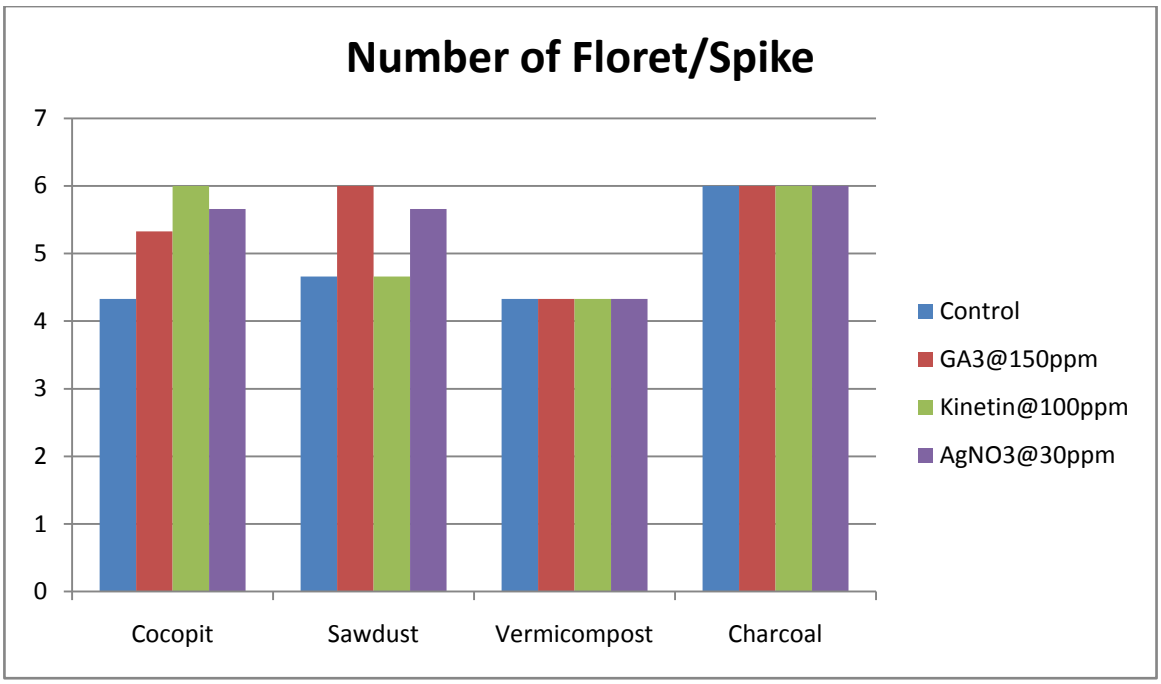

Fig 4.17 Effect of plant growth substances and growth media on number of floret/spike in *Dendrobium* L.

4.4.6 Size of flower

Tha data has been presented on Table 4.18 and figure 4.18. There was a significant difference in size of flower (cm^2) between the different growth media. The overall maximum size was found in media Charcoal (41.26cm^2) followed by, Cocopit (39.21cm^2), Vermicompost (39cm^2) and minimum size of flower observed in Sawdust (34.52 cm^2). The application of plant growth substances also has significant impact on improving flower size. Amongst the treatments P_3, Kinetin@ 100ppm found significant higher impact and average seize was (41.6 cm^2) followed by P_4, $AgNO_3$ @30ppm (38.1 cm^2) and P_1, Control (37.36 cm^2) and minimum size was found in P_2, GA_3 @150ppm (36.95 cm^2). The interaction of growth media and growth substances has significant effect on size of flower. The combination of charcoal and kinetin@100ppm gave the best performance regarding flower size. Kinetin treatment showed a profound effect on flower size. (S. Saravanan, 2001) 6-benzyl amino purine (BAP) played a significant role in improvement of flower size as reported by (James Brasch, 2000)

Table 4.18 Effect of plant growth substances and growth media on size of flower (cm^2) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	38.33	36.66	42.0	39.86	39.21
Sawdust (T2)	29.93	29.93	42.23	36	34.52
Vermicompost (T3)	39.56	39.56	39.9	37	39.00
Charcoal (T4)	41.63	41.63	42.26	39.53	41.26
Mean	37.36	36.95	41.6	38.1	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.632	1.83
Treatments	0.632	1.83
Interaction (T×P)	1.265	3.659

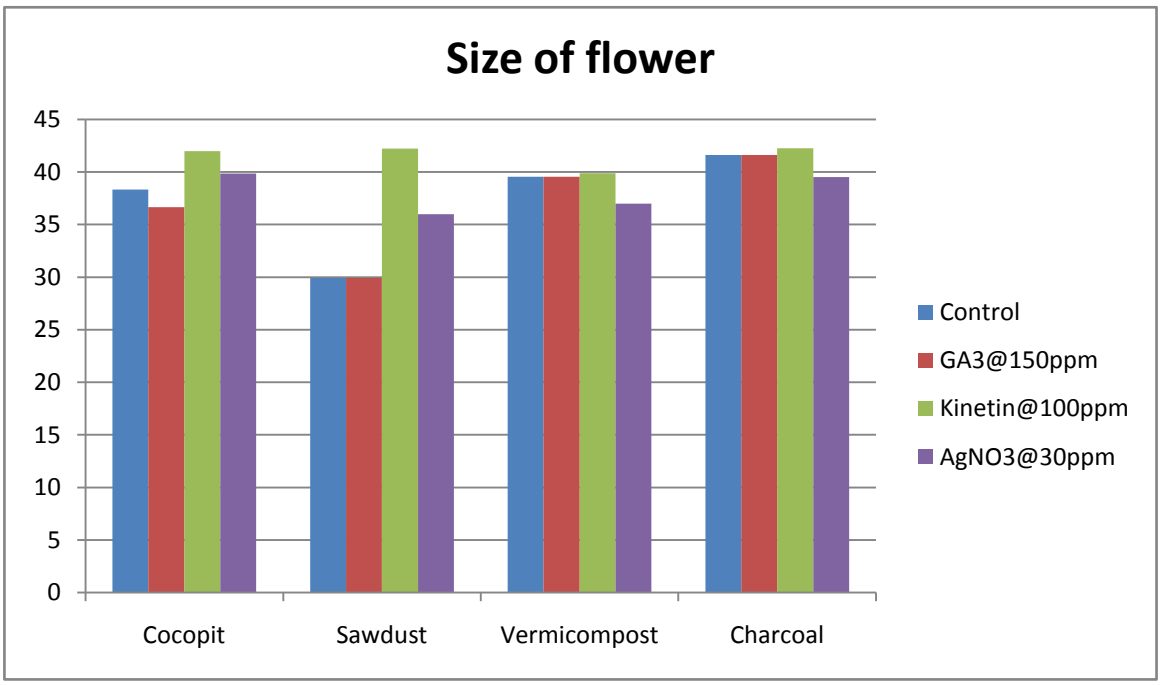

Fig 4.18 Effect of plant growth substances and growth media on size of flower (cm^2) in *Dendrobium* L.

4.4.7 Dry matter production

The data relevant to dry matter production has been presented in the Table 4.19 and figure 4.19. There was significance different in dry matter production between the growth media. The highest dry matter production was recorded in Cocopit T_1, (9.08 g) followed by Charcoal T_4, (8.84 g) and Vermicompost T_3, (8.52 g) and least recorded in Sawdust media T_2, (8.37 g). Amongst all the plant growth substances also have significant difference P_2, (GA3@150 ppm) have the higher impact on dry matter production (9.35 g) followed by P_4, (8.92 g) and P_3, (8.64 g) and least dry matter production observed in Control (7.9 g). Dry matter production of the plant influence the spike production, spike length and flower size. Goh et al. (1982) supported the experiment that dry matter production has positive correlation with floral characters of *Dendrobium*. Dry weight is directly correlated with spike yield of orchids.

Table 4.19 Effect of plant growth substances and growth media on dry matter production (g) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	9.23	9.3	8.76	9.03	9.08
Sawdust (T2)	6.73	9.5	8.20	9.06	8.37
Vermicompost (T3)	7.70	9.5	8.26	8.63	8.52
Charcoal (T4)	7.93	9.13	9.33	8.96	8.42
Mean	7.9	9.35	8.64	8.92	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.126	0.366
Treatments	0.126	0.366
Interaction (T×P)	0.253	0.731

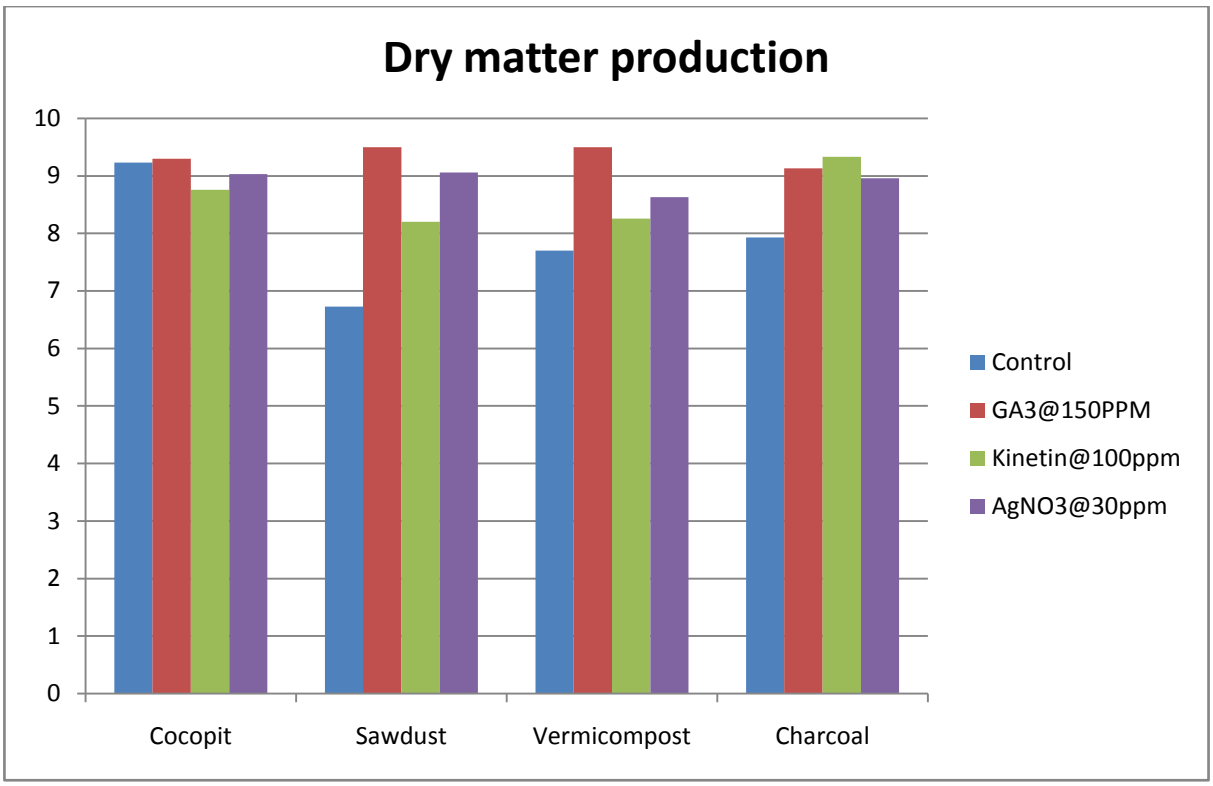

Fig 4.19 Effect of plant growth regulator and growth media on dry matter production

4.4.8 Longevity of flower

The data relevant to longevity of flower has been presented in the Table 4.20 and figure 4.20. Spike in the plant is considered as an important pre harvest parameter. In the present study, the flower longevity of *Dendrobium* orchids was influenced by different growth media and growth regulators. There was significant difference between growth media and highest days was recorded in Cocopit media (74.83 days) followed by Charcoal media (74.75 days) and Vermicompost (73.75 days). Minimum longevity of flower was observed in Sawdust media (71.41 days). The application of plant growth substances also has significant difference. Maximum days was recorded in P_3 Kinetin @100 ppm average days was 75.08 days, followed by P_4, $AgNO_3$@30ppm (74.75 days) minimum days was recorded in P_2, (72.33 days). These results indicate that Cocopit+ kinetin@100ppm and Charcoal+ kinetin@100ppm combination

performed best relevant to longevity of flower. These findings are in consonance with the report of Wen Shaw chen and Hsueh- Wen Chong (1997). Sacher, (1973) reported that Cytokinins delayed the leaf senescence by arresting the degradation of chlorophyll and protein.

Table 4.20 Effect of plant growth substances and growth media on longevity of flower (days) in *Dendrobium* L.

Growth media	Control (P1)	GA_3@150ppm (P2)	Kinetin@100ppm (P3)	$AgNO_3$@30ppm (P4)	Mean
Cocopit (T1)	75.33	76.0	74.33	73.66	74.83
Sawdust (T2)	64.33	72.0	75.33	74.0	71.41
Vermicompost (T3)	75.33	68.0	75.33	76.33	73.75
Charcoal (T4)	75.33	73.33	75.33	75.0	74.75
Mean	72.58	72.33	75.08	74.75	

ANOVA TABLE

Factors	SE(m)	C.D (0.05)
Growth media	0.644	1.864
Treatments	0.644	1.864
Interaction (T×P)	1.288	3.728

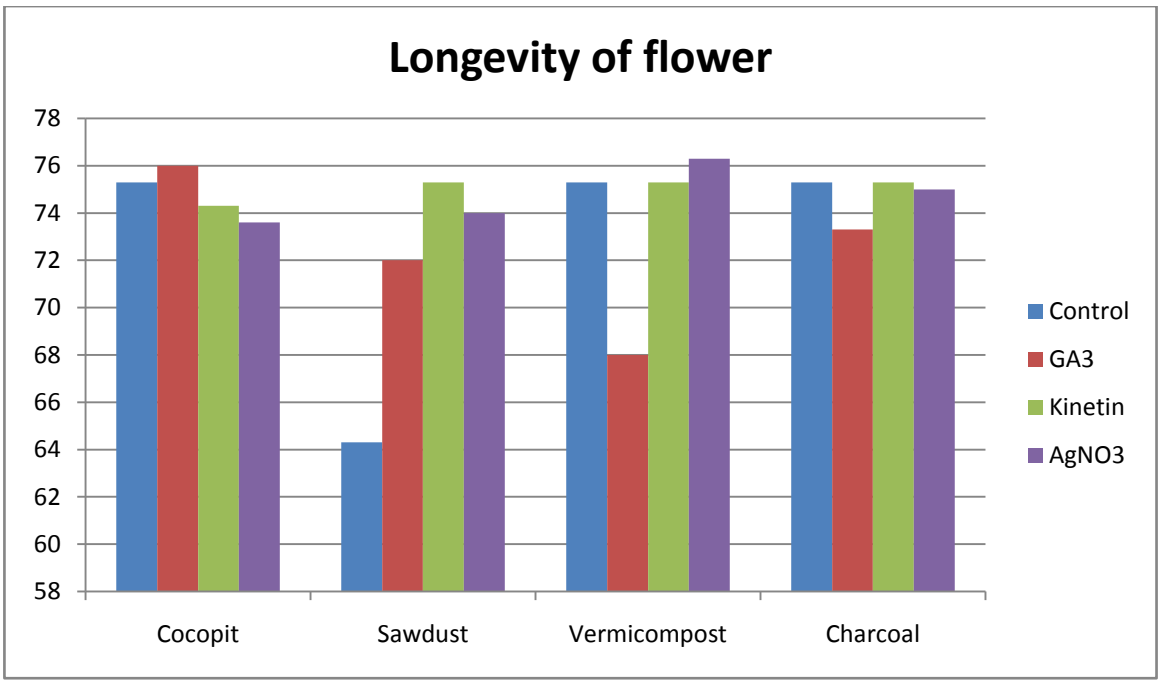

Fig 4.20 Effect of plant growth regulator and growth media on longevity of flower

4.4.8 Vase life of cut flower

Amongst all the holding solution $AgNO_3$ with 5% sucrose gave the best result for enhancing the vase life of cut spike average days was 27 days followed by Kinetin with 5% sucrose (25.33 days) and GA_3 with 5% sucrose gave the 22.66 days of vase life. Minimum days were observed in pure water (19.33 days). Longevity of flowers and vegetative tissue was related to their effect on increased tolerance to the environmental stress which influences the metabolic process and native phytohormones. (Halevy,1967). $AgNO_3$ with sucrose enhance the vase life of *Dendrobium*. $AgNO_3$ inhibited ethylene production by acting as a competitive inhibitor with glucose for *Dendrobium*. (Table 4.20 & figure 4.20). Similar result was also found by (Tanveer Fatima, 2015).and (T. Usha Bharathi, 2015).

The most common and active mineral ion is Silver (Ag+). It also acts like a germicide. Silver nitrate is a very effective bactericide and generally used in preservative formulations. Silver nitrate enhances vase life because it acts as anti-bacterial agent.

(Hunter, D.A, 2004) reported the silver inhibits the 1-Amino cyclo propane-1 carboxylic acid (ACC) content. It raises the respiration in carnation flower

4.4.9 Physiological loss of weight

Physiological loss of weight was found lowest in $AgNO_3$ with 5% sucrose (91%), followed by Kinetin with 5% sucrose (93.5%) and GA_3 with 5% sucrose (94.6%) the maximum loss of weight was recorded in control (95.5%). There was a significant difference between different holding solutions to increase vase life. (Table 4.20) Similar result was found by (Anju Bhat and Tripathi, 1999). Main reason for reduction of physiological loss of weight under the treatment with $AgNO_3$ might be due to the maintenance of water relation by plugging the vascular vessels.

Table 4.21 Effect of holding solution on vase life (days) of *Dendrobium* L.

Holding Solution	Vase Life (days)	Physiological loss of weight (%)
Pure water (H1)	19.33	95.5
GA_3+ 5% Sucrose (H2)	22.66	94.6
Kinetin+5% Sucrose (H3)	25.33	93.5
$AgNO_3$+5% Sucrose (H4)	27.0	91
SE(m)	0.408	0.259
CD (0.05)	1.352	0.857

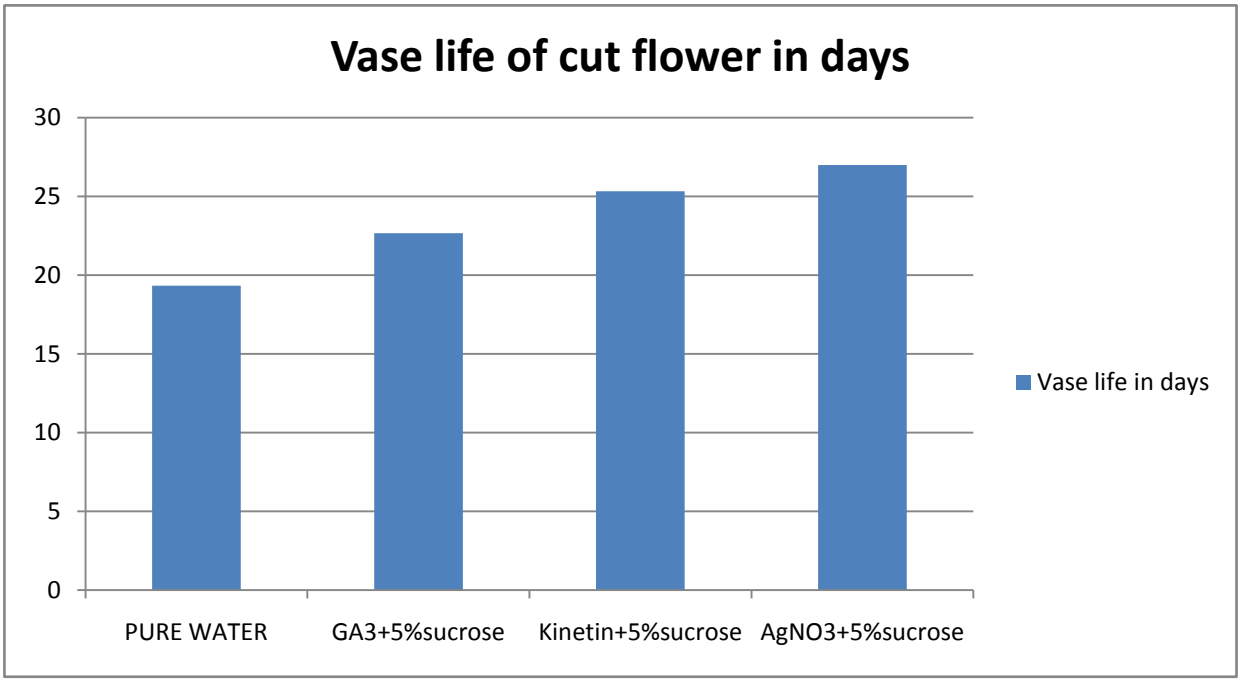

Fig 4.21 Effect of different holding solutions in vase life of cut spike (days)

CHAPTER-V
SUMMARY AND CONCLUSION

5.1 Summary

An experiment on "Impact of Different media on Physiological and Morphological Growth of Orchid (*Dendrobium* L.)" in Rabi season 2018-19 at the Department of Plant Physiology under shade net house, College of Agriculture, Indira Gandhi Krishi Vishwavidyalya, Raipur, Chhattisgarh.

The present research was carried out with the following objectives.

1. To study of different media on morpho-physiological parameters of orchid under shade net house.
2. To assess the impact of different media on physiological and biochemical parameters of orchid under shade net house.
3. Effect of foliar spray of different Plant growth regulator on shelf life and flowers behavior of orchids under shade net house.

There were four treatments used as planting material, viz., T_1, Cocopit, T_2, Sawdust, T_3 Vermicompost, T_4, and Charcoal it replicated thrice. This experiment was laid out in Completely Randomized Design. For another experiment, Four treatments Control, (P_1), P_2, GA_3 @150ppm, P_3, Kinetin@100ppm, P_4, $AgNO_3$ @30ppm were applied by foliar spray. And above four media was also used as potting media. This experiment was laid out in Factorial Complete Randomized Design (Factorial CRD). The results of the experiments are summarized below:

- The plant height was highest at flowering stage in Charcoal media T_4, (45 cm) and least in Sawdust media T_2, (40.66 cm). Number of leaves per plants was highest in Charcoal T_4, (6.3) and minimum in Sawdust T_2, (4.33).
- The overall maximum number of shoot per plant observed in Charcoal media (4.33) followed by Vermicompost and Sawdust (3.33) and recorded lowest in Cocopit media (2.33). The number of new shoot per plant. The

maximum number of new shoot per plant was noticed in T_3, Vermicompost media (2.33) followed by T_4, Charcoal (2.00) and the minimum number of new shoot was recorded in Cocopit media (1.00).

- Highest shoot girth was exhibited in Charcoal media T_4, (4.1 cm) and lowest in Sawdust media T_2 (3.03 cm).
- Root length was observed highest in Charcoal T_4, (32.46 cm) and lowest in Sawdust, T_2 (23.23 cm).
- Maximum leaf area was recorded in T_1, Cocopit (24.3 cm^2) then T_4, charcoal media (21.68 cm^2) and minimum leaf area was found in T_2, Sawdust media (16.40 cm^2).
- The Chlorophyll content was highest in the plant grown in T_4; Charcoal media (53.54) followed by T_3, Vermicompost (47.13) and T_1, (39.26). The impact of growth media in chlorophyll content was significantly different.
- Minimum days was required for flower bud appearance in combination of Charcoal+ Kinetin@100ppm (23 days) and maximum days in Sawdust media. (33.33 days)
- Number of spike per plant was found higher in combination of Charcoal media+ GA3@ 150ppm and Charcoal+ kinetin @100ppm. The average number was 2.6 in both combinations. Spike length of flower was highest in Charcoal media (45.16 cm).
- Spike girth significantly increased by Charcoal media (2.0 cm) and Kinetin@100ppm (1.90 cm). The minimum girth was observed in Sawdust and Cocopit media (1.47 cm).
- Number of floret per spike was higher in Charcoal media (6.0) and GA_3@150ppm (5.41) lower effect was found in Vermicompost (4.33) and Control (4.83). Flower size was influenced by combination of Charcoal+kinetin@100ppm (41.26 cm^2) and least effect was found in GA_3 @150ppm (36.95 cm^2).
- Dry matter production was highest in Cocopit media (9.08 g) and GA_3 @ 150ppm (9.35 g) and least recorded in Sawdust media and Control (7.9 g).

- Longevity of flower in the plant was recorded highest in Cocopit media (74.83 days) and Kinetin@100ppm (75.08 days) and minimum days was recorded in treatment Vermicompost and GA3@100ppm (68.0 days).
- Vase life of flower in the holding solution was highest in treatment H_4, AgNO3+5% sucrose (27 days) while it was found lowest in Pure water (19.33 days).

5.2 Conclusion

On the basis of results obtained from the present investigation, the conclusion is following:

1. Charcoal media have been identified for better performance for plant height, number of leaves per plant, maximum number of shoots per plant, shoot girth, SPAD value, flower bud initiation, number of spike, spike length, spike girth, number of floret/spike, size of flower.
2. Application of plant growth substances found to be effective to achieve better performance of flowering parameters namely flower bud initiation, spike length, number of floret/spike, spike girth and longevity of flower.
3. For root and shoot development charcoal media was found effective because they provide adequate amount of nutrient and water supply for plant growth and sawdust media found ineffective for potting media because they restrict drainage and aeration after irrigation. There pores are tightly packed which restricts the aeration for aerial roots.
4. Application of GA_3 @150ppm was found to effective for number of spike and spike length and number of floret per spike and application of Kinetin@100ppm was found effective for better performance of flower bud initiation, spike girth, size of flower and longevity of flower.
5. $AgNO_3$ inhibited ethylene production by acting as a competitive inhibitor with glucose for *Dendrobium* Orchid. Sugar status of the spikes had an economic role on the postharvest decay of orchids. Sugars used as holding solution

extends the vase life of cut flower because they contribute to the osmotic pressure of plant cell maintain the respiration rate and cell membrane integrity.

Suggestion for future work

Some suggestions for future work may be following:

1. The experiment should be replicate at least three years using more levels and combinations of plant growth regulator for more precise information.
2. Different growth media should be used for plant growth and development.
3. Experiment should be diverted to different varieties of orchid for getting better performance.
4. New group of plant growth substance (Putrescine, Spermidine, Spermine) can be used for quality improvement of flower orchids.

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PLATES

Plate 1. View of experiment- Effect of growth media and plant growth regulator on growth and flower quality in *Dendrobium* L.

Plate 1.1 View of the shade net house at Department of Plant Physiology, IGKV, Raipur

Plate 1.2 Cocopit Media (T_1)

Plate 1.3 Sawdust media (T_2)

Plate 1.4 Vermicompost (T_3)

Plate 1.5 Charcoal (T_4)

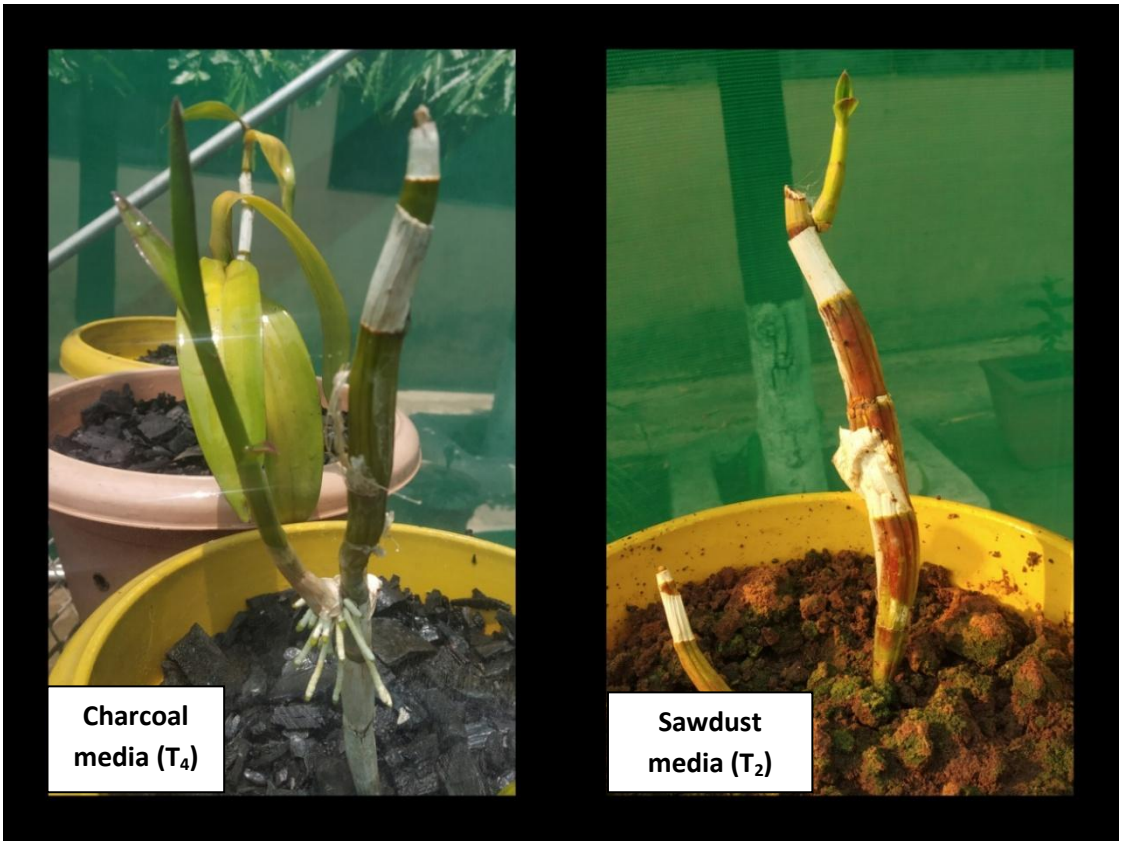

Plate 1.6 Comparison of new shoot formation (Charcoal media,T_4 with Sawdust,

Plate 1.7 Comparison of flower quality in best treatment: Kinetin@100ppm with Control

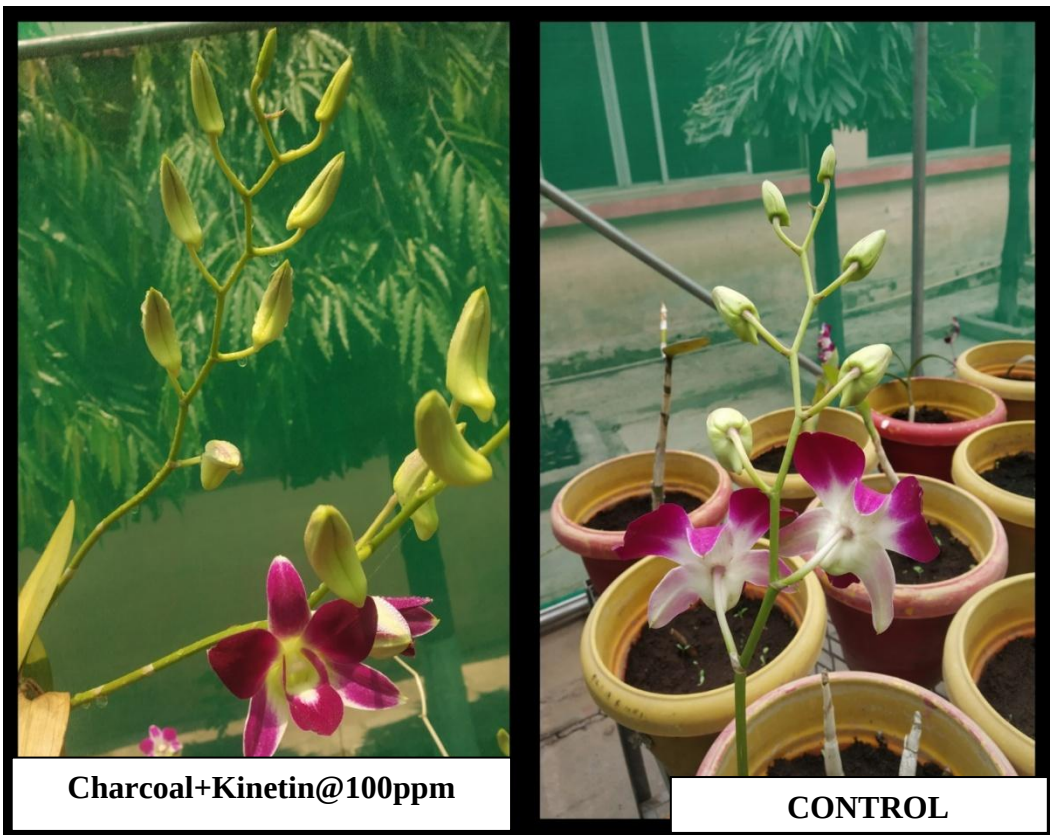

Plate 1.8 Comparison of number of spike in best treatment: Charcoal+Kinetin@100ppm with Control

Palte 1.9 Comparison of number of floret in best treatment: Charcoal+GA_3@150ppm with Control

APPENDIX- A

Appendix A: Table: Agro-meterological data of Raipur during the period of experimentation from August 2018 to April, 2019.

Month	Max. Temp. (^{o}C)	Min. Temp. (^{o}C)	Rainfall (mm)	RH I%	RH II%	WS (kmph)	SS (hr)
August	29.8	24.8	560.2	93	81	5.6	1.5
September	31.3	24.5	84.8	92	65	3.7	4.9
October	32.9	21.4	0.0	88	45	1.5	8.1
November	31.3	16.0	0.0	87	34	1.3	8.5
December	25.9	12.4	47.2	88	42	1.5	4.7
January	26.8	10.3	23.6	86	33	1.2	6.0
February	30.7	14.3	12.4	82	32	1.6	8.4
March	34.5	19.5	9.4	71	30	3.8	8.2
April	40.3	24.6	22.0	51	20	3.8	8.9

RESUME

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