STUDIES ON THE EFFECT OF GROWING MEDIA AND JEEVAMRIT ON POTTED PETUNIA (*Petunia* x *hybrida* Vilm.)

Thesis

by

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CERTIFICATE-I

This is to certify that the thesis titled, **"Effect of growing media and jeevamrit on potted petunia (*Petunia* × *hybrida* Vilm.)"** submitted in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE (HORTICULTURE) FLORICULTURE AND LANDSCAPE ARCHITECTURE** in the discipline of **HORTICULTURAL SCIENCES** to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan (HP) – 173 230 is a bonafide research work carried out by **Mr Rahul Sharma** (H-2018-24-M) son of Shri Chaman Lal under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been fully acknowledged.

Place: Nauni, Solan
Date : , 2020

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CERTIFICATE-II

This is to certify that the thesis titled, **"Effect of growing media and jeevamrit on potted petunia (*Petunia x hybrida* Vilm.)** submitted by **Mr Rahul Sharma** (H-2018-24-M) son of Sh Chaman Lal to the Dr Yashwant Singh Parmar University of Horticulture and Forestry, (Nauni) Solan (HP) – 173 230 India in partial fulfillment of the requirements for the degree of **Master of Science (Horticulture) Floriculture and Landscape Architecture** in the discipline of **Horticulture Sciences** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an Internal Examiner.

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Needless to say, errors and omissions are solely mine.

Place: Nauni, Solan
Date: **(Rahul Sharma)**

CONTENTS

ABBREVIATIONS

%	:	Per cent
@	:	At the rate of
+	:	Plus
<	:	Less than
>	:	Greater than
°C	:	Degree centigrade
ANOVA	:	Analysis of Variance
CD	:	Critical difference
cm	:	Centimetre
cm^2	:	Centimetre square
cv.	:	Cultivar
DAT	:	Days after transplanting
dS/m	:	Deci Siemens per metre
EC	:	Electrical conductivity
et al.	:	*et alli* (and co-workers)
etc.	:	*et cetera*
Fig.	:	Figure
FYM	:	Farm yard manure
g/m^2	:	Gram(s) per metre square
GA_3	:	Gibberellic acid
IAA		Indole acetic acid
ha	:	Hectare
HP	:	Himachal Pradesh
i.e.	:	*id est* (that is)
cfu	:	colony forming unit
N	:	Nitrogen
P	:	Phosphorous
K	:	Potassium
Mg	:	Magnesium
Cu	:	Copper
S/l	:	Sulphur/litre
K_2O	:	Potassium oxide
kg	:	Kilogram
kg/ha	:	Kilogram per hectare
kg/m^2	:	Kilogram per metre square
KVK	:	Krishi Vigyan Kendra
m	:	Metre
m^2	:	Metre square
mm	:	Millimetre
ml	:	Millilitre
N	:	Nitrogen
NPK	:	Nitrogen: Phosphorus: Potassium

OC	:	Organic carbon
P	:	Phosphorus
pH	:	Potential of hydrogen
ppm	:	Parts per million
PSB	:	Phosphate solublizing bacteria
q	:	Quintal
q/ha	:	Quintal per hectare
CRD	:	Completely Randomised Design
RDF	:	Recommended dose of fertilizer
spp/sp.	:	Species
SSP	:	Single super phosphate
t	:	Tonnes
t/acre	:	Tonnes per acre
t/ha	:	Tonnes per hectare
VC	:	Vermicompost
viz.	:	*videlicet* (namely)
w.r.t.	:	with respect to
w.e.f	:	with effect from
vis-à-vis	:	with regard to

LIST OF TABLES

LIST OF PLATES

Chapter-1

INTRODUCTION

Petunia (*Petunia* × *hybrida* Vilm.) is one of the most popular flowering pot and landscape plant. It belongs to the family Solanaceae. Flowers are trumped shaped, borne in leaf axils, which are single, double and semi-double. Many cultivars of petunia are popular in modern landscape due to their availability in wide variety of colours like; white, red, scarlet, blue, violet, light pink, magenta etc. Many cultivars in petunia are bicoloured and tricoloured also. Petunias are used in landscape gardening as bedding plant, for window boxes, hanging baskets and for herbaceous borders. Petunia is also grown for container gardening due to its vivid variety of flower colours and shapes. For pot plant production of petunia, soil alone as a growing medium does not produce quality blooms. An ideal growing medium should be porous, have good water holding capacity, well drained, provide a reservoir for different essential macro and micro-nutrients; and should be free from weeds and diseases. Now a days, soil less media has become very popular among growers of ornamental plants because of its excellent consistency, good water holding capacity, aeration and low bulk density and also reduce transportation and handling charges. Various growing media like; peat, vermicompost, cocopeat, rockwool, woodchips, sawdust perlite etc. have been used singly or in mixture and found suitable for quality pot plant production of different pot plants. Chamani *et al.* (2008) recommended vermicompost augmented medium for quality production of petunia. Further, Popescu and Popescu (2015) used soil, leaf compost, biolan peat, acid peat and perlite in different combinations for petunia production and 60% biolan peat, 30% acid peat and 10% perlite were found suitable for quality production of petunia. Keeping in view the importance of growing media for quality pot production of petunia, the present investigation was carried out to evaluate suitable growing medium for potted petunia which are easily available and cheaper in price like; local soil, sand, FYM, vermicompost and cocopeat.

Due to booming business of floriculture industry, uncontrolled amount of chemical fertilizers, insecticides and fungicides are being used for many years. Uses of chemical fertilizers and pesticides reduce the soil quality and microbial count in soil which decreases the soil productivity. Chemical fertilizers are highly soluble in water; hence they leach out into groundwater easily without fully benefiting the plants. Leaching of chemical fertilizers

pollute the water. When chemical fertilizers and pesticides are used for prolonged duration, the soil get damaged and reduce the mineral content in soil. To maintain the soil health, use of organic formulations is more beneficial as compared to chemical fertilizers. Natural farming is necessary to reduce the harsh effects of chemical fertilizers on human health and natural habitat. Microorganisms present in organic formulation help in increasing soil fertility and play a major role in recycling nutrients into soil (Lazarovits, 1997). Natural farming is focused on cultivating the land and raising crop in such a manner so that the soil remain alive or in good health by using organic wastes (farm waste, crop, animal and aquatic waste etc.) and other biological material along with beneficial microbes which release nutrients to crops for quality production in an eco-friendly approach (George, 2012). Natural farming involves growing crops without the use of fertilizers and pesticides. This farming is mainly depending on local inputs like livestock waste and then used effectively for sustainable crop production. Liquid formulations used in natural farming includes jeevamrit, panchagvya and beejamrit etc. used as plant growth enhancing substances prepared by using locally available material like; cow dung, cow urine, jaggery, grain flour and soil, which are easily available for the farmers and is a rich source of beneficial microflora. It enhances the biological and physio-chemical properties of soil and maintains plant growth. Main purpose is to maintain production and productivity without using chemical fertilizers and pesticides. Jeevamrit is a fermented liquid product made from cow dung, cow urine, jaggery, grain flour and soil. Jeevamrit converts the non-available form of nutrients into available form when applied to soil. It contains large amount of microbial load, which acts as a tonic for improving health of soil and increase activity of microorganism in soil, which ensure the higher availability of nutrients. Jeevamrit is used in the form of spray and drench application in crops. Beneficial microorganisms which are present in jeevamrit formulation are mainly due to their constituents such as cow dung, cow urine, grain flour, jaggery and soil which contain essential and non-essential nutrients like; amino acids, vitamins and other growth promoting compounds including indole acetic acid (IAA) and gibberellic acid (GA). Gore and Sreenivasa (2011) stated that jeevamrit is a low-cost liquid organic manure prepared from indigenous material which is easily available with farmers. Further, Sreenivasa *et al.* (2011) assessed the amount of macro and micro nutrients present in jeevamrit and reported 770-1000 ppm N, 166-175 ppm P, 126-194 ppm K and micro-nutrients i.e. manganese, zinc, copper and iron (1.8-10.7, 1.27-4.29,0.38-1.58 and 29.7-282 ppm, respectively) in jeevamrit. Positive effects of jeevamrit were observed by different research workers in many ornamental crops

with respect to plants growth and development like; in China aster (Pathania, 2019), potted gerbera (Singh, 2018), sunflower (Manjunatha *et al*., 2009), carnation (Harshavardhan *et al*., 2016) etc.

Keeping in view the importance of growing media and jeevamrit in pot plant production, the present investigation was carried out to study the effect of growing media and jeevamrit on potted petunia (*Petunia* × *hybrida* Vilm.) with the following objectives;

i) To standardize growing media for potted petunia.
ii) To standardize application method and frequency of jeevamrit on potted petunia.

Chapter-2

REVIEW OF LITERATURE

Petunia is one of the important flowers of the world used for landscaping and container gardening. The available literature on effect of growing medium and jeevamrit application on petunia and other crops have been reviewed in this chapter under the following headings:

2.1 Effect of growing media

2.2 Effect of organic formulations and jeevamrit application

2.1 Effect of growing media

2.1.1 Petunia

Klock (1997) studied the effect of compost made from biosolid and yard trimmings on growth of petunia. It was found that addition of 60% compost in growing medium gave best results in terms of shoot dry mass, size and plant height of petunia.

In another study, Gun and Ryong (2000) evaluated the growth of plug seedlings of petunia and pansy in various mixtures of recycled horticultural media. Plug seedlings of *Petunia hybrida* were cultured in media containing recycled plug medium, recycled coir, perlite, granular rockwool, and vermiculite. Plant height, root formation, shoot dry weight and leaf count of petunia, were found highest in recycled coir (75%) + perlite (25%) mixture.

Ohlm *et al.* (2000) conducted a study to find out a suitable medium composition on growth of seedlings of petunia. Petunia seedlings were grown in plugs filled with mixtures of steam-sterilized rockwool particles, coir, peat, perlite and chestnut wood chips. Results indicated that leaf length, root development; and shoot fresh and dry weights were found maximum in rockwool particles + peat + coir medium.

Young and Ryong (2000) studied the effect of growing medium composition including chestnut woodchips and granular rockwool on growth of plug seedlings of petunia. Different mixtures of chestnut wood chips and granular rockwool was examined. Chestnut wood chips were soaked in water for 48 h before use. Fresh weight, dry weight and chlorophyll content were found maximum when grown in chestnut wood chips.

Arias *et al.* (2001) used coal – mine spoils as substrate alone (100%) or in combinations with peat (85% coal-mine spoil and 15% peat, 70% coal-mine spoil and 30%

peat; and 50% coal-mine spoil and 50% peat) and used perlite as control to cultivate petunia. Cultivation was done in plastic pots of three litres capacity using slow release fertilization and watering was accomplished by an automatic microsprinkler. The test was monitored measuring suitable plant production parameters (aerial plant parts dry weight, root dry weight and number of flowers). The results revealed that though all the substrates were found suitable for petunia cultivation however, best results were obtained using a mixture of 85% coal-mine spoil and 15% peat as well as with the substrate made of 100% coal-mine spoil.

An experiment was conducted to evaluate the effectiveness of solarization of spent potting media and the addition of organic amendments on bedding plants Zinati *et al.* (2001) reported that solarization of spent media for 2 or 4weeks increased plant height, width, plant dry weight, and flower number per plant in petunia as compared to non-solarized media irrespective of organic amendments and further observed that the addition of humic acid significantly increased petunia plant width, dry weight and number of flowers.

Zubillaga *et al.* (2001) studied the effect of different proportions of compost biosolids in substrate mixtures on the growth and quality of petunia. Different growing media included soil, peat, perlite and compost either singly or in combinations were used. Plant height was found maximum when petunias were grown in substrates with 25-75% compost.

An experiment was conducted to investigate the growth of plug seedlings of *Petunia hybrida* influenced by irrigation frequency in mixtures of CGF (Cellulose glass fibre) and peatmoss by Jeong *et al*. (2003). Seeds were sown in plug trays and filled with mixtures of CGF and peatmoss in the ratio of 33:67 and 25:75. A commercial plug medium was used as the control. Plant height, fresh and dry weights of shoots and roots, number of leaves, leaf area, chlorophyll content of seedlings were found maximum in25% CGF + 75% peat moss mixture.

Jobin *et al*. (2004) evaluated the impact of two hydrophilic acrylic-based polymers (acrylic polymer and acrylic-acrylamide copolymer) on the physical properties of three substrates and the growth of *Petunia x hybrida*. Rooted cuttings of *Petunia hybrida* were transplanted into pots containing different substrates amended with one or 2 types of hydrogels (Commercial acrylic polymer and acrylic-acrylamide copolymer) for 9 weeks. Results indicated that hydrogels increased water retention of media and reduced irrigation frequency.

Dong *et al*. (2005) studied the effect of different substrates on rooting of *Petunia hybrida*. Different growing substrates like; peat, sand, soil, cocopeat, perlite and reed residue were used in various combinations. They found that root length and number of roots were highest in medium containing peat. Average rooting rate was observed 94.4% higher in medium containing peat than other growing substrates.

Benedetto *et al*. (2006) evaluated that argentinean peat as a substitute for canadiansphagnum peat for ornamental bedding plants like; petunia, chrysanthemum and salvia. The canadian peat had organic matter content of >90%, pH of 3.0-4.0, electrical conductivity of <1.50 dS/m and cation exchange capacity of 130-150 me/l. On the other hand, argentinean peat had organic matter content of >85-95%, pH of 3.8-4.0, electrical conductivity of 0.7-0.9 dS/m and cation exchange capacity of 40-50 me/l. It was concluded that argentinean peat did not found an acceptable substitute for canadian peat because of lower dry matter production of plants which could reduce flower productivity.

The influence of vermicompost produced from cattle manure, food waste and paper waste on growth and flowering of petunias in greenhouse was studied by Arancon *et al.* (2008). Results indicated that shoot dry weight, plant height, number of flowers increased when 20-40% cattle manure vermicompost and paper waste vermicompost (40%) was used.

Chamani *et al*. (2008) evaluated the effect of vermicompost on growth and flowering of petunia. Vermicompost treatments included 30%, 40% and 60% added in media. Number of flowers, leaf growth and shoot fresh weight was found to be maximum when growing media was used with 30% vermicompost.

Chavez *et al*. (2008) investigated the use of soil less media like river waste, *Sphagnum* sp. and *Carex* sp. of peat in *Petunia hybrida* and *Impatiens walleriana* with two fertilization levels (200 and 400 mg/l N). The results showed that the river waste promoted growth and flowering and concluded that this medium can be used to grow high quality potted plants. Further, leaching of nitrogen was also less in this medium, which makes river waste medium most suitable for quality pot production of petunia and impatiens.

Studies were carried out to evaluate the different soil based and soilless media compositions on growth and flowering of *Petunia hybrida* (Dubey *et al.*, 2013). Different media compositions comprising of leaf mould, sewage sludge, vermicompost, farm yard manure, cocopeat and soil were used in different ratios. Petunia plants raised in the medium containing Soil + Sewage sludge (K) (2:1) exhibited maximum number of branches, flower

buds, flowering duration and minimum number of days taken to bud emergence. This media composition was observed to be an ideal to raise petunia seedlings to full grown floriferous potted petunia plants with all the desirable characteristics essential for display.

Moghadam and Shoor (2013) conducted a research to study the effect of vermicompost and two bio-fertilizer applications on growth, yield and quality of petunia (*Petunia hybrida*). The experiment consisted of 9 treatment combinations comprising of vermicompost, bio-fertilizers and NPK fertilizers. The treatment receiving *Azospirillum* sp. + phosphate solubilizing bacterium + vermicompost + NPK (25% of recommended dose) recorded the highest plant height, number of branches, plant spread, leaf area index, dry matter accumulation and yield attributes such as number of flowers per plant and flowering duration.

In a study on *Petunia* × *hybrida* 'Bravo', Popescu and Popescu (2015) used four growing media in which soil, leaf compost, biolan peat, acid peat and perlite were mixed in different formulations. Photosynthesis rates and leaf area were found maximum in medium containing 60% biolan peat, 30% acid peat and 10% perlite.

Goldani and Kamali (2016) carried out a study to investigate the effects of organic fertilizers (vermicompost, compost and manure) on physiological characteristics of *Petunia hybrida*. Treatments consisted of three irrigation levels and four fertilizer treatments (control, compost, vermicompost and manure). Different morphophysiological traits like plant height, number of lateral branches, number of leaves, number of flowers, volume of roots, dry weight of leaf, electrolyte leakage, stomatal conductance and photosynthetic pigments. Results showed that flower weight of petunia increased with the application of vermicompost fertilizer, compost and manure (16.26, 65.9 and 40.8% respectively) as compare to control with 100% field capacity.

A comparative greenhouse study was conducted by Alvarez *et al.* (2017) to assess the suitability of biochar and vermicompost as partial substitutes for peat-based growing media for ornamental plant production. Different blends of biochar at a volume fraction of 0, 4, 8, 12 % and vermicompost at 0, 10, 20, 30, 40, 50 % were compared to a baseline peat substrate as control in the cultivation of geranium (*Pelargonium peltatum*) and petunia (*Petunia hybrida*). Mixtures with low–medium vermicompost levels (10 -30%) and high biochar level (8 – 12 %) in petunia and pelargonium induced more growth and flower production than that of the control.

A research was conducted to investigate the amendment of coconut coir dust (0, 25, 50 and 75%, v/v) in potting medium (40% rice husk, 20% rice husk charcoal, 20% sand and 20% fermented leaf compost, v/v) on growth and flowering of *Petunia hybrida*. Negative correlation was observed between coconut coir dust portion and growth of petunia. Result showed that increase in the portion of coconut coir dust in substrates resulted in decreased number of branches, root dry weight, number of flowers, percentage of flowering and flower dry weight when compared with non-coconut coir dust base. Therefore, it is suggested that higher coconut coir dust ratio is not found suitable as renewable potting mixed media for *Petunia hybrida* growth (Hongpakdee and Ruamrungsri, 2017).

Gulser *et al*. (2019) studied the effect of different growing media on plant growth and nutrient content of petunia. The growing substrates include soil, peat, barnyard manure and sugar beet. Flower dimeter, flower stalk length, plant fresh weight was found maximum when petunia were grown in medium containing soil: peat (2:1, v/v).

2.1.2 Other Floricultural Crops

Gartner and Mclntyre (1962) investigated the effects of different growing substrates like; perlite, sand, saw dust and soil on growth and flowering of potted chrysanthemum. Number of flowers, weight of flower, flower diameter was observed highest in the mixture of soil + saw dust + perlite (3:1/2:1/2, v/v).

The effect of compost-based media on growth, flowering and nutrition of geranium (*Pelargonium zonale* cv. 'Lucky Bark') was evaluated by Lopez *et al.* (1998). Positive results regarding various growth and flowering parameters were found in potting medium made from peat which is supplemented with mineral fertilizers.

A study was conducted by Pathak and Sharma (1998) to find out suitable growing substrate for growth and flowering of *Primula obconica*. Results indicated that highest pot presentability was observed in growing substrate comprising of leaf mould + FYM + sand in the ratio of 1:1:1 (v/v)

Eleni *et al*. (2001) evaluated three growing media for commercial cultivation of rose cultivars 'First Red' and 'Bianca', which included perlite: zeolite (3:1, v/v), cocopeat: perlite (3:1, v/v) and perlite: cocopeat (3:1, v/v). They reported that rose cultivar 'Bianca' and 'First Red' gave best performance in perlite: cocopeat (3:1, v/v) in terms of yield and flower quality.

The effect of various combinations of FYM, cocopeat, river sand, loam soil, coconut fibre, leaf mould on growth and flowering of anthurium was evaluated by Jawaharlal *et al.* (2001). Maximum number of suckers per plant were recorded when cocopeat was used with FYM or leaf mould.

In another experiment, rose cvs. 'Bianca' and 'First Red' were cultivated on three substrates like; cocopeat, perlite-cocopeat (3:1, v/v) and perlite: zeolite, (3:1, v/v) in an open soilless culture system to determine the yield and flower quality. Cultivar 'Bianca' demonstrated better yield when grown in the mixtures of perlite: cocopeat (3:1, v/v), whereas 'First Red' showed better flower quality when grown in cocopeat: perlite (3:1, v/v) mixture (Maloupa *et al.*, 2001).

Raviv *et al*. (2001) studied the effect of growing substrates on growth, flowering and yield of rose cv. 'Kardinal' which was grown in containers. The growing substrates used were coconut coir (partially composted husk fibres) and University of California (UC) mix (42% composted fir bark, 33% peat and 25% sand). Results showed that 19% higher yield was observed in rose plants when grown in coconut coir as compared to UC mix.

Five different growing media were evaluated for growth and flowering of *Gerbera jamesonii* Bolus. cv. 'Mammut' by Sekar and Sujata (2001). Potted media used were saw dust, coir pith, commercial mixture, sand mixture and red soil in different combinations. Best results with respect to growth and flowering were found in coir pitch medium comprising of coir pitch + garden soil + FYM (1:1:1, v/v).

Dutt *et al.* (2002) evaluated the effect of different growing substrates on growth and flowering of chrysanthemum under Pune conditions. Two cultivars of chrysanthemum 'Sonali Tara' and 'Spray Purple' were taken for the study and growing media included cocopeat, compost and soil rite in different combinations along with rice husk. Cocopeat and soilrite (1:1, v/v) gave best results in terms of shoot length, shoot girth, number of flowers per plant, flower diameter and number of shoots.

The effect of different growing media on plant growth and flowering of cineraria was studied by Atta-Alla (2003). Maximum plant height, number of leaves, number of flowers per plant and number of shoots were obtained when loam sand, sewage sludge and chicken manure (2:1:1, v/v) was used as substrate.

Gupta *et al*. (2004) studied the effect of growing media on growth and flowering of gerbera under protected conditions in mid-hills of Himachal Pradesh. They used various media like cocopeat, sawdust and sand in different combinations. Best results were found when cocopeat was used with sand and sawdust in the ratio of 1:1:1 (v/v) with increased flower stalk length, flower diameter, flower weight, number of flowers per plant and vase life over control.

Turhan *et al.* (2007) studied the effects of different growing media on growth and corm formation in saffron grown under greenhouse conditions. The results showed that growing medium containing soil, sand and manure (1:1:1, v/v) was found to be the best for corm production.

Al-Menaie *et al*. (2008) tested different growing media for quality pot plant production of *Gardenia jasminoides*. Different combinations of sand, perlite and peat moss were used as growing media. For indoor pot production, soil: perlite (1:1, v/v) and for outdoor soil: peat moss (1:1, v/v) were proved best for canopy development and flower production of gardenia.

The effect of growing media on growth and flowering parameters of *Zinnia elegans* cv. 'Blue Point' was studied by Riaz *et al*. (2008). Different combinations of growing media were used which included coconut compost, leaf manure, silt, soil and leaf manure mix. Various parameters like; plant height, number of side branches, number of leaves per plant and number of flowers were found maximum, when plants were grown in leaf manure mix i.e. silt + leaf manure + coconut compost (1:1:1, v/v).

Kale *et al.* (2009) studied the effect of four growing media on growth and flowering of gerbera under controlled conditions. Two different containers were used in the experiment i.e. plastic and earthen pots. They reported that cocopeat when used in earthen pots gave maximum flower diameter, vase life, number of flowers and stalk length.

Wazir *et al.* (2009) tested the effectiveness of five different growing media for quality pot production of alstroemeria. Best results for various vegetative, flowering and pot presentability parameters were found in growing medium containing soil + cocopeat + vermicompost + sand in the ratio of 1:1:1:1 (v/v).

A study was conducted on *Celosia cristata* to find the effect of cocopeat based media on growth and flowering by Awang *et al*. (2010). Different combinations of growing media

were used with the cocopeat like burnt rice hull, perlite and kenaf core fibre. Results stated that the chemical and physical properties of cocopeat was improved by addition of burnt rice hull and resulted in increased plant height, number of leaves per plant and canopy growth of *Celosia cristata*.

Dhiman *et al*. (2010) evaluated different potting media for growing chrysanthemum as pot mums. Growing media used were soil + sand + vermicompost (2:1:1, v/v), soil + sand + vermicompost + FYM (2:1:1:1, v/v), soil + sand + FYM (2:1:1, v/v), cocopeat + sand + FYM + vermicompost (2:1:0.5:0.5, v/v), cocopeat + sand + FYM (1:1:1, v/v) and cocopeat + sand + vermicompost (2:1:1, v/v). Plant height and number of shoots per plant were found maximum in the plants grown in growing medium having cocopeat + sand + FYM + vermicompost (2:1:0.5:0.5, v/v).

In a study on geranium, Singh *et al*. (2010) evaluated the effect of different growing media on growth and pot presentability. In his studies, various media like; soil, sand, Rhododendron forest soil, FYM, vermicompost, Rai forest soil, Mohru oak forest soil were used in different combinations. Rai Forest soil: vermicompost: FYM in the ratio of 2:1:1 (v/v) resulted in best growth, flowering and pot presentability of geranium.

Younis *et al.* (2010) evaluated the effect of various growing media on *Codiaeum variegatum* cv. 'Gold Sun'. Different substrate combinations were used which consist of normal soil, FYM, sand, leaf compost, perlite, silt and mushroom spent composts (button and oyster). Results indicated that combination of sand + leaf compost + silt + spent compost (button) in the ratio of 1:1:1:1 (v/v) was found best for better growth and development of *Codiaeum variegatum*.

Nikrazm *et al.* (2011) carried out an experiment to study the effect of different growing media including cocopeat, sand, vermiculite, perlite and their mixture on lilium cultivars 'Bernini' and 'Cebdazzle'. The best results in terms of plant chlorophyll content, fresh and dry weight of leaves, leaf area, height, stem diameter and number of leaves in medium containing cocopeat.

The effect of three soilless media on growth and development of Asiatic and Oriental hybrids 'Gironde' and 'Cassandra' was studied by Tehranifar *et al.* (2011). The media consisted of different combinations of cocopeat, sand, gravel and perlite. Growing medium containing 50% gravel and 50% sand resulted in significant improvement in growth and flowering parameters.

The effect of coir based growing substrates on growth, flowering and physiological parameters of hyacinth (*Hyacinthus orientalis* L. cv. 'Sonbol-e-Irani') was studied by Nazari *et al*. (2011). Different growing media were used which include soil + cocopeat + sand (2:1:1, v/v), sand + soil (1:1, v/v), soil + cocopeat (1:1, v/v) and cocopeat + sand (1:1, v/v). Maximum leaf area, fresh and dry leaf weight, flowering stem height, root fresh and dry weights and visual quality were found in substrate containing sand + cocopeat (1:1, v/v).

Khalaj *et al.* (2011) worked on the effect of different growing media on growth and yield of gerbera. They used various substrates like; peat, fine sand, perlite, expanded clay, cocopeat and sand, which were used singly or in combinations. Results indicated that increased flower diameter, vase life and stem neck diameter was observed when peat (70%) + perlite (25%) + expanded clay (5%) was used as potting media.

Meng *et al.* (2012) carried out a study to investigate the composition of four kinds of soilless media using different proportion of fermented rice husk, corn straw and corn cob on the growth of *Gerbera jamesonii*. The results showed that rice husk, corn cob, peat and sand in the ratio of 3:2:1:1 (v/v) was found best in terms of plant growth, cut flower yield and quality of cut flowers.

Seyedi *et al.* (2012) studied the effect of five different growing substrates on growth and flowering of Asiatic lilium hybrids. The media were prepared in combinations of perlite and cocopeat in different ratios. A medium consisting of 70% cocopeat and 30% perlite was found best for plant height, stem diameter, flower diameter, number of buds per spike and early flowering in lilium.

Yasmeen *et al*. (2012) studied the effect of different growing substrates on growth and flowering of potted carnation. Sand, leaf manure, garden soil, silt and FYM were used in different combinations. Highest quality flowers along with maximum flower size were obtained when potted carnations were grown in medium containing leaf compost and sand (1:1, v/v).

Bala and Singh (2013) conducted a study to find out suitable growing medium for the production of pot mum chrysanthemum cv. 'Yellow Charm'. Different growing media were used in combination of soil, sand, cocopeat, vermicompost and FYM. Best results in terms of plant height, number of flowers, number of days taken for flowering were found in soil + sand + FYM + cocopeat (2:1:0.5:0.5, v/v).

Singh *et al*. (2015) evaluated the effect of various growing substrates and organic formulations on growth and flowering of marigold. Results indicated that plant height, plant spread, flower bud diameter, leaf length, number of flowers per plant and flower diameter were found highest in growing substrate containing sand + soil + vermicompost in the ratio of 1:1:2 (v/v) along with jeevamrit application.

In another study, Singh *et al*. (2016) evaluated the effect of organic waste on growth and flowering characters of chrysanthemum. In this experiment burnt rice husk, ash and composted sewage were used in different proportions with soil, sand and cocopeat. Best results were found in combination of cocopeat, sewage sludge, sand and soil for better growth and quality performance of potted chrysanthemum.

An experiment was conducted by Dingrodiya *et al*. (2017) on dutch roses under naturally ventilated polyhouse. The planting was done in three soil-based substrates like soil + FYM + sand, soil + FYM + cocopeat and soil + FYM + sawdust each mixed in (2:1:1, v/v) and three fertilizer treatments *viz*., water soluble fertilizers, commercial straight fertilizers and Biofertilizers + water soluble fertilizers. Results revealed that plants grown in a medium containing soil + FYM + sawdust (2:1:1, v/v) and fertilized with water soluble fertilizers resulted in maximum plant height, leaf area, size of flower, number of flowers per plant and flower yield.

2.2 Effect of organic formulations and jeevamrit application

The effect of fermented liquid organics (beejamrit, panchagavya, jeevamrit and vermiwash etc.) made from cow dung, cow urine, jaggery and leguminous flour was studied by Yadav and Mowade (2004). Results indicated that the application of liquid organic products helped in increasing the soil fertility and increased the activity of microorganisms in soil.

Jeevamrit is a fermented organic formulation obtained from mixing cow dung (10.0 kg), cow urine (10.0 litre), legume flour (1.0 kg), jaggery (2.0 kg) and one handful of soil as prepared by Palekar (2006). Jeevamrit is rich in microbial population which multiplies and act as a tonic for improving soil health. In different studies, the results revealed that application of jeevamrit increased the microbial activities in soil and converted the non-available form of nutrients into available form and increased the uptake of nutrients in the crops.

Vasanthkumar (2006) evaluated the effect of small doses of jeevamrit on soil fertility. It was reported that jeevamrit when applied in very less amount in soil, improved the soil health and acted as a tonic and hence it was concluded that small amount of jeevamrit can also enhance soil bio-mass.

Sreenivasa *et al*. (2009) confirmed the presence of beneficial microorganisms in the organic formulations *viz.*, jeevamrit, beejamrit and panchagavya prepared by using cow products (cow dung and cow urine). It was found that these formulations are rich in beneficial microorganism like; *Phosphobacteria, Pseudomonas, Azotobacter, Azospirillum* and lactic acid bacteria etc. The presence of some beneficial fungi and actinomycetes were also confirmed in his studies.

Gore and Sreenivasa (2011) stated that jeevamrit is a low-cost liquid organic manure prepared from indigenous material which is easily available with farmers. It increases the amount of microbial load in the soil. Jeevamrit is also a rich source of essential amino acids and growth enhancing compounds including indole acetic acid (IAA) and gibberellic acid (GA) and micronutrients.

Sreenivasa *et al*. (2011) conducted a study to assess the amount of macro and micro nutrients present in jeevamrit. Among macronutrients, nitrogen content was 770-1000 ppm, phosphorous 166-175 ppm and potassium content was assessed to be 126-194 ppm. The micro-nutrients i.e. manganese, zinc, copper and iron were assessed to be 1.8-10.7, 1.27-4.29, 0.38-1.58 and 29.7-282 ppm, respectively.

2.2.1 Effect of organic formulations and jeevamrit application on flower crops

Bhalla *et al.* (2006) studied the effect of biofertilizers and biostimulants on growth and flowering of standard carnation (*Dianthus caryophyllus* L.). Maximum plant height was observed when common basal dose of NPK + vermicompost (500 g/m^2) + manchurian mushroom tea (3 %) + panchgavya (3%) was used in carnation.

The effect of FYM and jeevamrit on seed yield and seed weight of sunflower was studied by Manjunatha *et al*. (2009). Positive results were found regarding seed yield, seed weight, stalk yield and head diameter when FYM was used with jeevamrit. Jeevamrit increased the microbial load and helped to increase nutrients uptake capacity of soil.

An experiment was conducted by George (2012) to study the effect of organic and inorganic manures on growth and flowering of *Gerbera jamesonii* Bolus cv. 'Galileo Red'. It was found that the application of 75% recommended dose of nitrogen + 100% (potassium + phosphorus) + *Trichoderma harzianum* + vermicompost + jeevamrit + panchagavya helped to improve the growth, flowering and yield parameters of the crop.

Sushma *et al.* (2012) studied the effect of jeevamrit, amritpani and panchgavya on growth and flowering of Heliconia cv. 'Golden Torch'. They observed that organic formulations significantly reduced number of days for sprouting, flower bud formation, first flowering and increases plant growth.

Harshavardhan *et al.* (2016) studied the effect of different organic and inorganic formulations on growth and flowering of carnation cv. 'Big Mama'. It was noted that application of 75% recommended dose of N, P and 100% K + *Bacillus megaterium* + *Azospirillum brasilense* + vermicompost + *Glomus fasciculatum* (VAM Fungi) + jeevamrit + panchagavya enhanced the growth, flowering and yield attributes of carnation cv. 'Big Mama'.

Koppala (2018) conducted an experiment to evaluate the effect of controlled release fertilizers (CRF) and organic amendments on pot mum production and concluded that the combined application of CRF (11.2 g/plant) and Jeevamrit @ 5 % (250 ml/plant) at monthly interval in two genotypes of chrysanthemum i.e. 'UHFS Chr-56' and 'UHFS Chr-68' enhanced majority of the characters like plant height, spread, number of side shoots, number of flowers, earlier formation of flower buds, peak flowering, days required for marketability stage and pot presentability score as well.

Pamya (2018) assessed the impact of organic fertilizers in conjunction with chemical fertilizers on growth and flowering of gerbera cvs. 'Salvador' and 'Goliath'. Different combinations of NPK, jeevamrit, PSB and *Azotobacter* were used. 10:15:20g NPK/m^2 + PSB + *Azotobacter* + jeevamrit was found best integrated nutrient management schedule for better growth and quality flower production of gerbera.

In another study, Singh (2018) investigated the effect of jeevamrit and different growing media on growth and flowering of gerbera cv. 'Primrose'. Different combinations of jeevamrit and growing media (soil, sand, FYM, cocopeat and vermicompost) were used and reported that the use of cocopeat and vermicompost in the ratio of 1:1 (v/v) along with the

application of jeevamrit at 20 days interval resulted in better growth, flowering and cut flower yield in gerbera.

The effect of jeevamrit on flower and seed yield of China aster was studied by Pathania (2019). In the studies, it was revealed that maximum plant height, spread, number of flowers per plant and seed yield were recorded with drench application of jeevamrit @ 5% along with 10% foliar application of jeevamrit. The parameters like; flower diameter and flower weight were observed maximum with 7.5% drench application combined with 10% foliar application of jeevamrit.

2.2.1 Effect of organic formulations and jeevamrit application on other Horticultural and Agricultural Crops

Chandrakala (2008) conducted a study to find out suitable liquid organic manure for chilli. It was found that combination of beejamrit + jeevamrit + panchagavya resulted in significantly higher plant growth and other yield attributes of chilli.

Baban (2011) while evaluating the effects of some organic inputs on yield and quality in pigeon pea, observed that the application of FYM @ 2.5 t/ha + vermicompost @ 1 t/ha + two applications of jeevamrit @ 500 L/ha (30 and 45 DAS) significantly increased the plant height, number of branches per plant, number of compound leaves, leaf area per plant, seed and stalk yield.

Jaysinghrao (2011) studied the efficacy of FYM, dung slurry and urine of Indian cow on microbiological status of soil and yield component of fenugreek. The results revealed that the application of organic amendments such as cow dung + cow urine, jeevamrit, neem cake, vermicompost and FYM increased the microbial population in the rhizosphere and also enhanced the plant growth, yield and nutrient uptake as well.

A field experiment was conducted by Ramteke (2011) to evaluate the effects of organic amendments on microbial status of soil, plant growth and fruit yield in tomato. Application of biofertilizers with organic manures in the form of jeevamrit, poultry manure, FYM, neem cake, vermicompost and mud cake increased microbial population in soil, improved plant growth as well as fruit yield of tomato besides increasing the fertility status of the soil.

In another study, Boraiah (2013) revealed that fruit yield, total dry matter per plant, number of fruits per plant and fruit weight of chilli was maximum when jeevamrit was used.

Further, Amareswari and Sujathamma (2014) evaluated the impact of jeevamrit on yield and return of two varieties of rice (‘Masura’ and ‘Hamsa’) and concluded higher cost-benefit ratio with the use of jeevamrit.

Similarly, Ashokbhai (2014) conducted an experiment to check the efficacy of some organic growth promoters on yield as well as quality of chickpea. Different combinations of bio-compost, vermicompost, castor cake, banana pseudostem sap, vermiwash, panchagavya, jeevamrit and cow urine. The results revealed that the treatment consisting of biocompost + vermicompost + castor cake + cow urine (2%) recorded significantly higher grain and straw yield of chickpea.

Further, Channagouda *et al.* (2014) evaluated the role of some organic farming practices on yield parameters of cotton. The results indicated that the application of green leaf manure along with jeevamrit significantly increases number of bolls per plant, boll weight, kapas weight and kapas yield over other green manuring treatments.

Kumbar *et al*. (2015) laid out an experiment to know the influence of FYM, jeevamrit and panchagavya applications on yield attributes of organic French bean. Combined application of FYM, jeevamrit and panchagavya resulted in higher pod yield, pod weight and number of pods per plant.

Siddappa (2015) in an experiment, studied the influence of jeevamrit and FYM on growth and yield parameters of field bean. They found that application of jeevamrit 1500 l/ha and FYM increased pod size and pod yield in field bean. Jeevamrit also increases the population of bacteria and actinomycetes after the harvest of crop.

Application of 100% N equivalent compost along with recommended dose of FYM, jeevamrit and beejamrit significantly increased the plant height, number of leaves, number of branches, grain yield and stover yield in cowpea (Yogananda *et al.*, 2015).

Application of jeevamrit at 2000 l/ha resulted in higher green pod yield of French bean followed by the application of jeevamrit at 1500 l/ha as reported by (Kumbar and Devakumar, 2017).

Chapter-3

MATERIALS AND METHODS

The present investigation, **"Studies on the effect of growing media and jeevamrit on potted Petunia (*Petunia* x *hybrida* Vilm.)"** was carried out at the Experimental Farm of Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan during 2019-20. The materials and methodologies followed in the present study have been described in this chapter under the different sub heads as below:

3.1 EXPERIMENT SITE

The Experimental Farm of the Department of Floriculture and Landscape Architecture is situated at Nauni, 13Km away from Solan at an elevation of 1276m above mean sea level. It falls under mid hill zone of H.P.

3.2 CLIMATE

The climate at Nauni is sub-temperate to sub-tropical type. The summers are mild and winters are cool. May and June being the hottest months, while December and January are the coolest ones. Maximum rainfall is received during July to September.

3.3 PLANTING MATERIAL

The study was conducted on F_1 hybrid Petunia, bright red in colour. Healthy, disease free and uniform seedling of petunia of about 6-8 cm in height (with 2-3 leaf stage) were procured from private nursery for carrying out the experiment.

3.4 MEDIA PREPARATION

Different growing media were prepared for the studies as per the technical programme. Ingredient like sand, soil, FYM, vermicompost and cocopeat were collected. FYM, sand, soil and vermicompost were sieved before use, while cocopeat was washed thoroughly so that the phenolic compounds drain out properly and to reduce the EC. Cocopeat was dried under the sun before use. All the ingredients were mixed thoroughly in different proportions as mention in below.

(1) Soil + Sand + FYM (1:1:1, v/v)

(2) Soil + Cocopeat + FYM (1:1:1, v/v)

(3) Soil + Cocopeat + Vermicompost (1:1:1, $_{V/V}$).

These media were filled in plastic pots of size 7 inches in diameter as per the experimental details.

3.5 PREPARATION OF JEEVAMRIT

Under the experiment, jeevamrit was used as drench and spray applications. The various ingredients of jeevamrit preparation is presented in the Table 1.

Table 3.1 Composition of Jeevamrit

Ingredients	**Quantity**
Cow dung	10 kg
Cow urine	10 litres
Jaggery	2 kg
Grain flour (Besan)	1 kg
Soil	A handful of soil
Water	200 litres

Method for preparation of jeevamrit

Freshly collected cow dung and cow urine were mixed in water in above mentioned proportions. Jaggery is crushed in small pieces before use. Legume flour and soil were mixed in water. Now all these ingredients were mixed in a drum. The contents were stirred thoroughly twice a day i.e. morning and evening for 7 days consecutively. After 7 days, the solution is ready for soil drenching/spray applications. For application, dilution of 10 litres of jeevamrit in 100 litres of water is done for preparing 10% concentration of jeevamrit for foliar spray/drench treatment.

3.6 TRANSPLANTING OF SEEDLING IN POTS

Healthy, disease free seedling of uniform size and vigour were planted in 7-inch plastic pots (one seedling/pot) in the evening hours on 27th September 2019. Pots were irrigated immediately after transplanting. All the pots were kept under naturally ventilated polyhouse throughout the studies

Plate 1. Preparation of Jeevamrit

Plate 2. Transplanting of seedlings

Plate 3. Petunia in vegetative stage

Plate 4. Overview of experimental trail at peak flowering

3.7 INTERCULTURAL OPERATIONS

3.7.1 Irrigation

Pots were irrigated manually with the help of watering can from transplanting to termination of the experiment. Plants were irrigated as per requirement which depended upon prevailing climate conditions and growing media also.

3.7.2 Weeding and hoeing

Generally, no serious weed population was noticed during the experimentation. However, manual weeding was done with hands or kurpis as and when required to control the emergence of weeds. Simultaneously hoeing was done regularly when hard crust formed over the surface.

3.7.3 Jeevamrit application

Application of jeevamrit was done in the form of spray and drench. Jeevamrit application was done at an interval of 15 and 30 days starting from 15 days after transplanting. Jeevamrit is diluted to 10% before use by dissolving 10 litres of jeevamrit solution in water making final volume 100 litres.

Drench application of jeevamrit was done manually in pots. (250 ml of jeevamrit was applied to each pot) at an interval of 15 and 30 days as per treatment.

Spray application was done with the help of spray pump. Jeevamrit was filtered before spray application. Spray was applied to the foliage till droplet formation.

3.8 EXPERIMENT DETAILS:

A. Growing media (M): 3

M_1: Soil + Sand + FYM (1:1:1, v/v)

M_2: Soil + Cocopeat + FYM (1:1:1, v/v)

M_3: Soil + Cocopeat + Vermicompost (1:1:1, $_{V/V}$)

B. Jeevamrit application and frequency (T): 5

T_1: Drench application of 10% jeevamrit at fortnightly interval (250 ml/pot)

T_2: Drench application of 10% jeevamrit at monthly interval (250 ml/pot)

T_3: Spray application of 10% jeevamrit at fortnightly interval

T_4: Spray application of 10% jeevamrit at monthly interval

T_5: Control (no application)

- Total treatment combinations :15
- Replications : 3
- Statistical design : Completely Randomised Design (factorial)

3.9 OBSERVATIONS RECORDED

3.9.1 Plant height (cm):

Plant height was recorded at the time of peak flowering from level of the growing medium in the pot to the apex of plant with the help of scale at peak flowering.

3.9.2 Plant spread (cm):

It was measured at the time of flowering as an average of the distance between outer most side shoot in east to west and north to south direction.

3.9.3 Number of days taken to first flower opening:

Days taken for first flower opening was counted from the transplanting date to the stage when first flower became fully open in a pot.

3.9.4 Number of days taken for peak flowering:

Number of days were counted from the date of transplanting to the stage when pots became presentable (5 flowers/pot).

3.9.5 Maximum number of flowers open at a time:

The number of flowers open at a time in a pot were recorded at weekly intervals and maximum reading was selected.

3.9.6 Flower diameter (cm):

It was measured as the average of the flower diameter recorded in east to west direction and north to south direction.

Plate 5. Drenching with jeevamrit

Plate 6. Foliar application of jeevamrit

Plate 7. Recording of different growth parameters

3.9.2 Duration of flowering (days):

Number of days taken from full opening of first flower to the stage till the pots remained presentable.

3.9.3 Pot presentability:

It was calculated on the basis of point system modified after Conover (1986). The parameters studied and points allotted to each parameter out of maximum of 100 points are as follows.

3.9.4 Pot presentability:

Parameters	Description	Maximum points
a) Appearance as whole plant	**i.** Fresh appearance with no indication of senescence	10
	ii. No mechanical, insect, mite or disease damage on flower or stems	10
b) Flowering	**i.** Number of flowers open at a time per pot	10
	ii. Size of flower (cm)	10
	iii. Duration of flowering	10

For number of flowers per pot, flower size (cm) and duration of flowering following scores were given

Number of flowers open at a time per pot	Maximum points
Less than 11	7
11-13	8
13-15	9
15-17	10
Flower size (cm)	
Less than 7	7
7-7.5	8
7.5-8	9
More than 8	10
Duration of flowering (days)	
Less than 30	7
30-40	8
40-50	9
More than 50	10

c) Colour	**i.**	Flower with good clarity and clean colour.	10
	ii.	No fading or residue present.	10
d) Stem and foliage	**i.**	Plant with strong stem.	10
	ii.	Foliage without chlorosis or necrosis.	10
e) Form	**i.**	Pot spread in balance with pots, generally 1.5 to 2.5 times to the diameter of the pot (Pot spread lying between 27-45 cm are given 10 marks)	10

3.10 STATISTICAL ANALYSIS

For working out the analysis of variance, the data was analysed by using the following CRD (factorial) given by Panse and Sukhatme (2000).

Analysis of variance

Source of variation	Degree of Freedom	Sum of Squares	Mean sum of Squares	Variance ratio
Growing media (A)	(a-1)	S_a	$\frac{S_a}{(a-1)} = M_a$	$\frac{M_a}{M_e}$
Jeevamrit Treatment (B)	(b-1)	S_b	$\frac{S_b}{(b-1)} = M_b$	$\frac{M_b}{M_e}$
A × B interaction	(a-1) × (b-1)	S_{ab}	$\frac{S_{ab}}{(a-1)\times(b-1)}$	$\frac{M_{ab}}{M_e}$
Error	e_0 = by subtraction	S_e	$\frac{S_e}{e_0} = M_e$	

Where,

n = r × a × b, total number of observations

a = Level of Growing media

b = Level of jeevamit treatment

A×B = Interaction of A & B

S_a = Sum of squares due to Growing media

S_b = Sum of squares due to jeevamrit treatment

S_{ab} = Sum of squares due to interaction of A & B

S_e = Sum of squares due to error

M_a = Mean sum of squares due to Growing media

M_b = Mean sum of squares due to jeevamrit treatment

M_{ab} = Mean sum of squares due to A & B

M_e = Mean sum of squares due to error

The standard error of mean SE (m) and critical difference (CD) for comparing the means of any two treatments were calculated as below:

$$\text{SE (m)} \pm = \sqrt{\frac{M_e}{b \times r}}$$

SE (d) $\pm = \sqrt{\frac{2 \times M_E}{b \times r}}$

Critical Difference (CD) = SE(d) x t (5%) value at error degrees of freedom.

The standard error of mean SE (m) and critical difference (CD) for comparing the means of any two cultivars were calculated as below:

SE (m) $\pm = \sqrt{\frac{M_E}{a \times r}}$

SE (d) $\pm = \sqrt{\frac{2 \times M_E}{a \times r}}$

Critical Difference (CD) = SE(d) x t (5%) value at error degrees of freedom.

The standard error of mean SE (m) and critical difference (CD) for comparing the means of A × B interaction were calculated as below:

SE (m) $\pm = \sqrt{\frac{M_E}{r}}$

SE (d) $\pm = \sqrt{\frac{2 \times M_E}{r}}$

Critical Difference (CD) = SE(d) x t (5%) value at error degrees of freedom.

Where, SE (m) = standard error of mean & SE (d) = Standard error of difference

Chapter-4

RESULTS AND DISCUSSION

The present investigation was conducted at the Experimental Farm of Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2019-2020 on potted *Petunia* × *hybrida* Vilm. The results obtained during the present investigation have been described as below.

4.1 PLANT HEIGHT (cm)

Data presented in Table 1 shows that maximum plant height (23.32 cm) was found when petunias were grown in medium containing Soil + Cocopeat + FYM (1:1:1, v/v) (M_2). In contrast, lowest plant height (21.89 cm) was recorded in the plants grown in Soil + Sand + FYM (1:1:1, v/v) (M_1).

Table 1: Effect of growing media and jeevamrit applications on plant height (cm) of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	21.65	23.04	21.74	21.55	21.47	**21.89**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	25.06	22.82	23.36	23.37	21.97	**23.32**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	23.60	23.87	22.80	22.89	20.49	**22.73**
Mean	**23.44**	**23.24**	**22.63**	**22.60**	**21.31**	

$CD_{0.05}$
Media : 0.56
Treatments : 0.72
Media x Treatments : 1.25

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)

T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)

T_3= Spray application of 10% jeevamrit at fortnightly interval

T_4= Spray application of 10% jeevamrit at monthly interval

T_5= No application (control)

Among different jeevamrit treatments, plant height (23.44 cm) was recorded maximum in T_1 when the pots were drenched with jeevamrit at fortnightly interval. It was found to be at par (23.24 cm) with drench application of jeevamrit at monthly interval (T_2). On the other hand, plant height was recorded lowest (21.31 cm) in control when no jeevamrit was applied (T_5).

Interaction data indicated that the plants grown in M_2T_1 resulted in maximum height (25.06 cm) i.e. when plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnightly interval. It was found statistically at par (23.87 cm) with Soil + Cocopeat + Vermicompost (1:1:1, v/v) as growing medium along with drench application of jeevamrit at monthly intervals (M_3T_2). On the other hand, plant height was observed lowest (20.49 cm) when petunias were grown in Soil + Cocopeat + Vermicompost (1:1:1, v/v) without application of jeevamrit (M_3T_5). It was found to be at par with M_1T_1 (21.65 cm), M_1T_3 (21.74 cm), M_1T_4 (21.55 cm) and M_1T_5 (21.47 cm).

It has been observed that both media amended with cocopeat have resulted in significantly more plant height in petunias over the general medium i.e. Soil+ Sand + FYM (1:1:1, v/v). Addition of cocopeat in the medium has shown positive effects on plant height. Cocopeat increases the porosity of potting mixture which helps to keep the soil loose and airy and resulted in better root growth. Better root growth leads to better plant growth.
Gupta *et al*. (2004) confirmed the above results when Cocopeat + Sand + Sawdust (1:1:1, v/v) was used as growing medium and reported maximum plant height in gerbera. Further, Singh *et al.* (2016) also confirmed the above results in chrysanthemum. They found that when Cocopeat + Sewage sludge was used as growing medium in the ratio of 2:1 (v/v) gave better growth of chrysanthemum.

Simultaneously, it was noted that all the jeevamrit treatments, irrespective of method of application (drench or spray) significantly increased plant height in all the growing media over control. Jeevamrit contains macro nutrients in the form of N (0.16%), P (0.02%) and K (0.123%) (George., 2012). Nitrogen helped in the production of carbohydrates and amino acids and helped in the synthesis of hormones like; cytokinin, auxin and gibberellin. Jeevamrit is rich source of phosphorus, and it is important component in chlorophyll and also jeevamrit converts the non-available form of nutrients into available form, and hence resulting in increase in plant height (Sreenivasa *et al.,* 2009).

Addition of cocopeat with soil and FYM had improved soil texture, porosity and water holding capacity which helped in increasing plant height. Simultaneously drench application of jeevamrit at 15 days interval further, improved plant height as jeevamrit acted as a tonic for soil health and promoted the growth as it is a rich source of NPK.

4.2 PLANT SPREAD (cm)

It is evident from the data presented in Table 2 that plants grown in Soil + Cocopeat + FYM (1:1:1, v/v) resulted in maximum plant spread (33.49 cm) (M_2) which was found to be at par (32.75 cm) with Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3). In contrast, plant spread was found lowest (32.42 cm) in growing medium containing Soil + Sand + FYM (1:1:1, v/v) (M_1). It was found to be at par (32.75 cm) with (M_3) Soil + Cocopeat + Vermicompost (1:1:1, v/v).

The effects of jeevamrit on plant spread was found significantly higher over control. Maximum plant spread (34.03 cm) was recorded in the plants which were drenched with jeevamrit at fortnightly interval (T_1). It was found to be at par with drench application at monthly interval (33.82 cm) (T_2) and spray application of jeevamrit at fortnight interval (32.99 cm) (T_3). On the other hand, plant spread was recorded lowest (31.08 cm) in control when no jeevamrit was applied (T_5).

Table 2: Effect of growing media and jeevamrit applications on plant spread(cm) of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	33.78	33.06	32.56	32.28	30.41	**32.42**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	36.29	34.42	33.26	32.17	31.30	**33.49**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	32.04	33.97	33.17	33.06	31.53	**32.75**
Mean	**34.03**	**33.82**	**32.99**	**32.50**	**31.08**	

$CD_{0.05}$
Media : 0.83
Treatments : 1.08
Media x Treatments : 1.86

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)

T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)

T_3= Spray application of 10% jeevamrit at fortnightly interval

T_4= Spray application of 10% jeevamrit at monthly interval

T_5= No application (control)

Interaction between growing media and jeevamrit revealed that plants spread was found maximum (36.29 cm) when the plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnightly interval (M_2T_1). In contrast, minimum plant spread (30.41 cm) was found in (M_1T_5) when plants were grown in Soil + Sand + FYM (1:1:1, v/v) with no application of jeevamrit. It was found to be at par with M_2T_4 (32.17 cm), M_2T_5 (31.30 cm), M_3T_5 (31.53 cm) and M_3T_1 (32.04 cm).

In the present studies, it is evident that addition of cocopeat in the media significantly improved plant spread over the general growing medium. Similar reports were given by Wazir *et al.* (2009) while working on alstroemeria and concluded that when Sand + Soil + Cocopeat was used in the ratio of 1:1:1 (v/v) as a growing medium, resulted in maximum plant spread.

The efficacy of jeevamrit for enhancing growth is well known. Jeevamrit act as a tonic for soil health and promoter of growth as it is a rich source of N, P and K. Nitrogen is a major constituent of proteins and also helped in increasing growth parameters. Further phosphorus helps in the translocation and absorption of nutrients into plant and improve nutrient absorption. Similar results of enhancement in plant spread by application of jeevamrit has also been reported by Sushma *et al*. (2012) in heliconia.

Further best results with respect to plant spread was obtained when the plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnight interval which can be directly correlated to better vegetative growth obtained in Soil + Cocopeat + FYM (1:1:1, v/v) and addition of jeevamrit as drench application, further improved the plant spread as it acted as a organic amendment with beneficial microorganism like yeast, lactic acid bacteria, actinomycetes which helped in increasing soil biomass and availability of nutrients (Sreenivasa *et al*., 2009).

4.3 NUMBER OF DAYS TAKEN TO FIRST FLOWER OPENING (days)

Data presented in Table 3 shows that the plants grown in medium containing Sand + Soil + FYM (1:1:1, v/v) (M_1) resulted in earliest flower opening (39.64 days) as compared to other media. In contrast, maximum number of days taken to first flower opening (41.23 days) was recorded in Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3). It was found to be at par (41.02 days) with (M_2) Soil + Cocopeat + FYM (1:1:1, v/v).

Regarding different jeevamrit treatments, all the applications resulted in earlier flowering over control. Minimum number of days taken to first flower open was observed when jeevamrit was applied as drench at fortnight interval (39.45 days) (T_1), which was found to be at par (39.64 days) with drench application of jeevamrit at monthly interval (T_2). On the other hand, maximum number of days taken to first flower open (42.20 days) was recorded in control when no jeevamrit application was given (T_5).

Interaction data indicated that the plants grown in M_1T_1 resulted in earliest flowering (37.48 days) i.e. when plants were grown in Sand + Soil + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnight interval. It was found at par with the treatments M_1T_2 (38.39 days) and M_2T_1 (39.04 days). On the other hand, maximum number of days taken to flowering, (44.58 days) was observed when petunias were grown in Soil + Cocopeat + FYM (1:1:1, v/v) without application of jeevamrit.

Table 3: Effect of growing media and jeevamrit applications on number of days taken to first flower opening of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	37.48	38.39	4106	40.50	40.79	**39.64**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	39.04	39.84	40.70	40.94	44.58	**41.02**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	41.84	40.68	41.15	41.26	41.22	**41.23**
Mean	**39.45**	**39.64**	**40.97**	**40.90**	**42.20**	**-**

$CD_{0.05}$
Media : 0.88
Treatments : 1.13
Media x Treatments : 1.83

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)
T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)

T_3= Spray application of 10% jeevamrit at fortnightly interval

T_4= Spray application of 10% jeevamrit at monthly interval

T_5= No application (control)

Sandy soil is lighter and do not compact easily, which is good for root growth. Better root growth resulted in earliest flower emergence. Singh *et al*. (2015) confirmed the above results in marigold, when sand was used with soil and vermicompost (1:1:2, v/v)

Jeevamrit helped in increasing the nitrogen fixation in the soil and helped in the uptake of nutrients into the crops. Phosphorus helped in absorption of nutrients. All these factors combined together helped in the earliest flowering as suggested by (Harshavardhan *et al.,* 2016).

4.4 NUMBER OF DAYS TAKEN TO PEAK FLOWERING

Data presented in Table 4 shows that the plants grown in Soil + Cocopeat + FYM (1:1:1, v/v) (M_2) took minimum days to come into peak flowering (48.99 days). In contrast, maximum number of days were recorded to attain peak flowering (51.45 days) in Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3).

Table 4: Effect of growing media and jeevamrit applications on number of days taken to peak flowering of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	48.33	47.53	51.89	52.27	54.25	**50.53**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	46.69	49.39	47.33	48.80	52.75	**48.99**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	51.24	50.88	51.83	51.55	51.76	**51.45**
Mean	**48.75**	**49.27**	**50.35**	**50.87**	**52.92**	

$CD_{0.05}$
Media : 0.72
Treatments : 0.93
Media x Treatments : 1.61

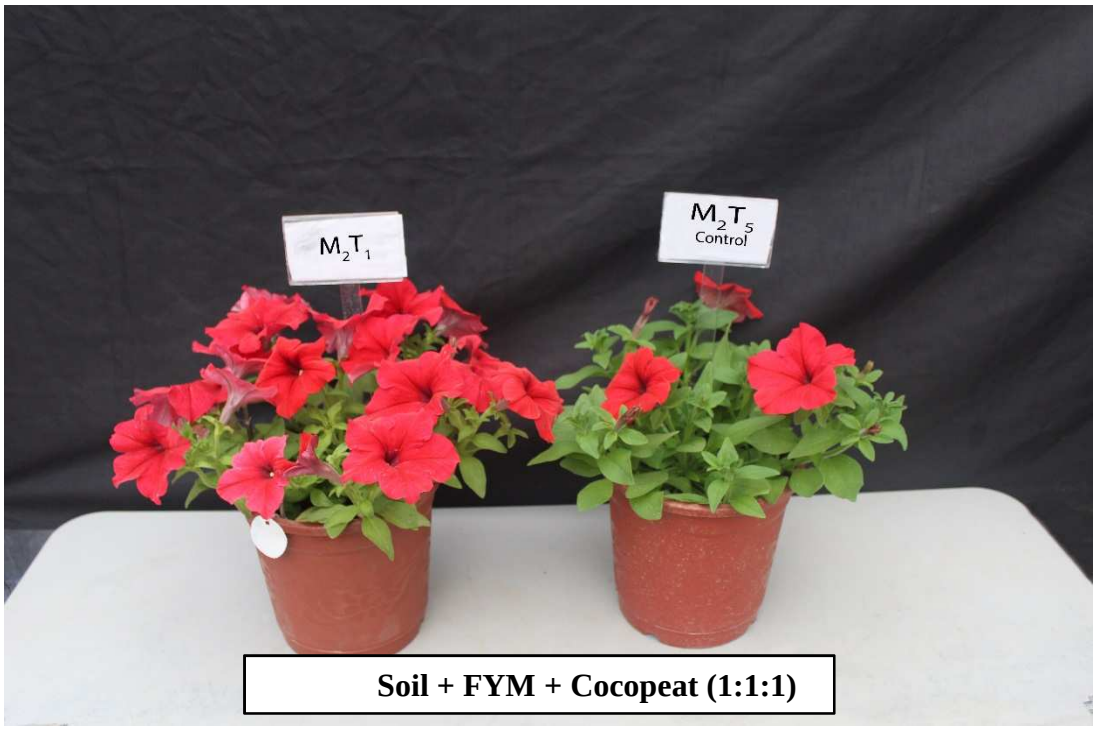

Plate 8. Number of days taken to peak flowering

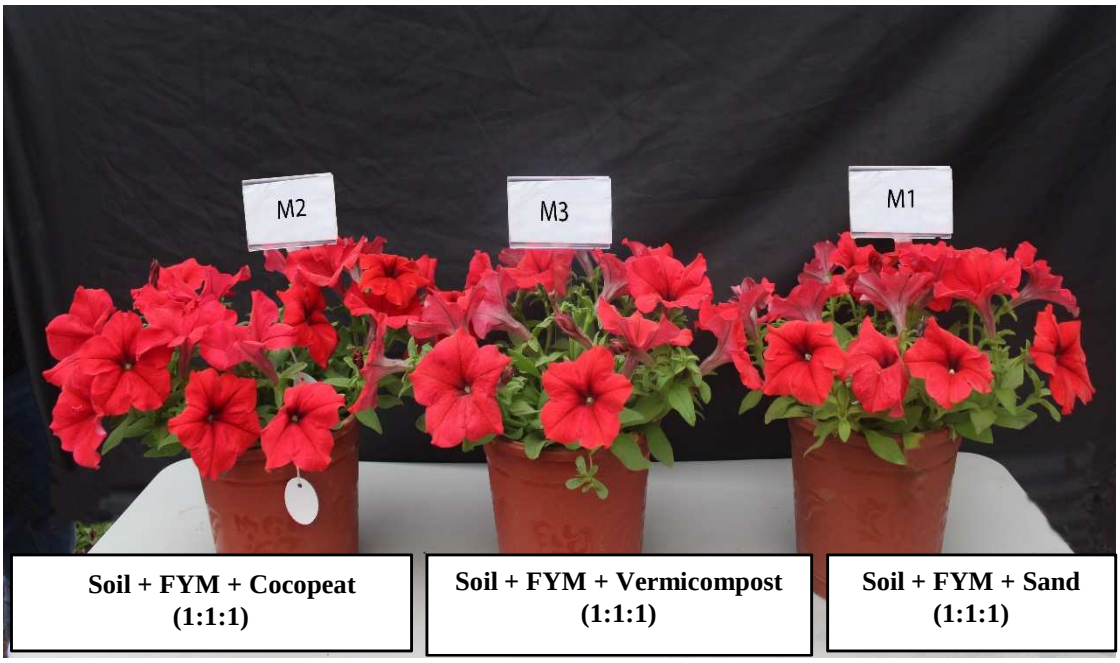

Plate 9. Maximum number of flowers open at a time in M_2

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)

T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)

T_3= Spray application of 10% jeevamrit at fortnightly interval

T_4= Spray application of 10% jeevamrit at monthly interval

T_5= No application (control)

Among different jeevamrit treatments, minimum number of days taken to peak flowering (48.75 days) was observed in drench application of jeevamrit at fortnightly interval (T_1), which was found to be at par (49.27 days) with the treatment where drench application of jeevamrit was applied at monthly interval (T_2). On the other hand, maximum number of days taken to peak flowering (52.92 days) were noted in control, when no jeevamrit was given (T_5).

Interaction data shows that minimum number of days taken to peak flowering was noted in M_2T_1 (46.69 days) when petunias were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and treated with jeevamrit as drench application at fortnight interval. On the other hand, maximum number of days taken for peak flowering (54.25 days) was recorded in Soil + Sand + FYM (1:1:1, v/v) with no application of jeevamrit (M_1T_5). It was found to be at par with M_2T_5 (52.75 days).

It is well known that cocopeat has higher water holding capacity and high cation exchange capacity. Cocopeat increases the soil porosity, and helps to keep the soil loosen and airy which may result in earliest peak flowering. Bala and Singh (2013) confirmed the above results in chrysanthemum, when Soil + Sand + FYM + Cocopeat (2:1:0.5:0.5, v/v) was used as growing medium, it resulted in earliest flowering.

Jeevamrit is rich in beneficial microorganisms, which act as a tonic for improving soil health. Jeevamrit increases the microbial activity in soil and converts the non-available form of nutrients into available form which increases vegetative growth and enhances flower production hence resulting in minimum number of days taken to reach peak flowering. Similar results were reported by Sushma *et al*. (2012) in Heliconia.

Earliest peak flowering was obtained when the plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnight interval which can be directly correlated to better root growth of plants grown in Soil + Cocopeat + FYM(1:1:1, v/v) and further application of jeevamrit at fortnight interval helped in increasing nitrogen fixation in soil and uptake of nutrients which resulted in minimum number of days taken to peak flowering.

4.5 NUMBER OF FLOWERS OPEN AT A TIME

Data presented in Table 5 indicated that maximum number of flowers were open at a time in a pot (16.75) when the plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v) (M_2). It was found to be at par (16.71) with Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3). In contrast, lowest number of flowers were open at a time (15.97) when petunias were grown in Soil + Sand + FYM (1:1:1, v/v) (M_1).

The effect of different jeevamrit treatments shows that maximum number of flowers were found open at a time in a pot (17.49) when the plants were treated with spray application of jeevamrit at fortnight interval (T_3). It was found to be at par with the treatment of drench application of jeevamrit at monthly interval (16.98) (T_2). On the other hand, minimum number of flowers were open at a time (14.88) in control when no jeevamrit was applied (T_5).

Table 5: Effect of growing media and jeevamrit applications on number of flowers open at a time of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	15.53	17.53	17.07	16.07	13.67	**15.97**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	17.37	16.93	17.93	16.73	14.77	**16.75**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	17.13	16.48	17.47	16.26	16.20	**16.71**
Mean	**16.68**	**16.98**	**17.49**	**16.35**	**14.88**	

$CD_{0.05}$
Media : 0.47
Treatments : 0.61
Media x Treatments : 1.05

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)

T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)

T_3= Spray application of 10% jeevamrit at fortnightly interval

T_4= Spray application of 10% jeevamrit at monthly interval

T_5= No application (control)

Interaction data shows that the plants grown in Soil + Cocopeat + FYM in the ratio of 1:1:1(v/v) resulted in maximum number of flowers open at a time (17.93), when jeevamrit was applied as spray at fortnight interval (M_2T_3). It was found to be at par with M_3T_3 (17.47), M_2T_1 (17.37), M_3T_1 (17.13), M_1T_2 (17.53), M_2T_2 (16.93) and M_1T_3 (17.07). On the other hand, minimum number of flowers were open at a time (13.67) in Soil + Sand + FYM (1:1:1, v/v) with no application of jeevamrit (T_5).

Addition of cocopeat had improved soil texture which may positively affected number of flowers. Raviv *et al.* (2001) reported in rose that maximum number of flowers were open in the plants grown coconut coir + peat + sand (2:1:1, v/v). Dutt *et al*. (2002) also confirmed the above results in chrysanthemum, when Cocopeat + Soil rite was used in the ratio of 1:1 (v/v) gave best results in terms of number of flowers open.

In this experiment it was found that all the jeevamrit applications resulted in more number of flowers open at a time over control. Jeevamrit is an organic amendment rich in beneficial microorganism like yeast, lactic acid bacteria, actinomycetes, which helps in increasing soil biomass and microbial count in soil. It helps in increasing availability and uptake of nutrients into soil, and helped in increasing the number of flowers (Sreenivasa *et al*., 2009).

4.6 FLOWER DIAMETER (cm)

Data presented in Table 6 shows that maximum flower diameter (8.59 cm) was recorded in the plants grown in medium consisting of Soil + Cocopeat + FYM (1:1:1, v/v) (M_2). In contrast, flower diameter (8.34 cm) was found minimum in Sand + Soil + FYM (1:1:1, v/v) (M_1), which was found to be at par (8.41cm) with Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3).

Data on the effect of different jeevamrit treatments on flower diameter was found significant. Maximum flower diameter (8.78 cm) was observed when jeevamrit was applied as drench at monthly interval (T_2). It was found to be at par (8.70 cm) with the treatment where drench application of jeevamrit was applied at fortnightly interval (T_1). On the other hand, least flower diameter (7.60 cm) was recorded in control when no jeevamrit was applied (T_5).

Table 6: Effect of growing media and jeevamrit applications on flower diameter (cm) of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	8.64	8.79	8.57	8.38	7.31	**8.34**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	8.85	8.84	8.61	8.76	7.91	**8.59**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	8.60	8.70	8.64	8.51	7.59	**8.41**
Mean	**8.70**	**8.78**	**8.61**	**8.55**	**7.60**	-

$CD_{0.05}$
Media : 0.09
Treatments : 0.11
Media x Treatments : 0.20

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)
T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)
T_3= Spray application of 10% jeevamrit at fortnightly interval
T_4= Spray application of 10% jeevamrit at monthly interval
T_5= No application (control)

Interaction data shows that maximum flower diameter (8.85 cm) was noted when petunias were grown in Soil + Cocopeat + FYM (1:1:1, v/v) and drenched with jeevamrit at fortnight interval (M_2T_1). It was found to be at par with M_1T_2 (8.79 cm), M_2T_2 (8.84 cm), M_3T_2 (8.70 cm) and M_2T_4 (8.76 cm). In contrast, minimum flower diameter (7.31 cm) was observed in the plants grown in medium consisting of Sand + Soil + FYM (1:1:1, v/v) without application of jeevamrit i.e. control (M_1T_5).

Gupta *et al*. (2004) also reported that maximum flower diameter was found in growing medium containing Cocopeat + Sand + Saw dust in the ratio of 1:1:1 (v/v) in gerbera.

Jeevamrit is rich in beneficial microorganism like yeast, lactic acid bacteria, actinomycetes, which helps in increasing soil biomass and microbial count in soil. It helps in increasing availability and uptake of nutrients into soil. In addition to NPK, jeevamrit is rich in growth hormone like GA and IAA, which help in increasing flower diameter. The above results also confirmed by Sreenivasa *et al.* (2009), Aulakh *et al.* (2013) and Devakumar *et al.* (2014).

Soil + Cocopeat + FYM (1:1:1, v/v) as a growing medium combined with application of jeevamrit has resulted in improved flower size in our study which is correlated with the beneficial characteristics of cocopeat like improving soil texture, water holding capacity with beneficial properties of jeevamrit in improving flower diameter.

4.7 DURATION OF FLOWERING

Data presented in Table 7 shows that flowering pots remain presentable for maximum flowering duration (50.20 days) was found in medium containing Soil + Cocopeat + FYM (1:1:1, v/v) (M_2). It was found to be at par (49.14 days) with Soil + Cocopeat + Vermicompost (1:1:1, v/v) (M_3). In contrast, minimum flowering duration (43.53 days) was observed in Soil + Sand + FYM (1:1:1, v/v) (M_1).

Among different jeevamrit treatments, flowering remained for maximum duration (57.60 days) when jeevamrit was applied as drench at fortnightly interval (T_1). On the other hand, least flowering duration (36.41 days) was obtained in control when no jeevamrit was applied (T_5).

Interaction data shows that when petunias were grown in medium containing Soil + Cocopeat + FYM (1:1:1, v/v) and treated with jeevamrit as drench at fortnightly interval resulted in maximum flowering duration (65.28 days) (M_2T_1). On the other hand, minimum flowering duration (32.43 days) was observed in plants grown in Soil + Sand + FYM (1:1:1, v/v) with no application of jeevamrit (M_1T_5).

Table 7: Effect of growing media and jeevamrit applications on duration of flowering of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	53.74	45.07	42.20	44.22	32.43	**43.53**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	65.28	53.26	50.34	47.29	34.85	**50.20**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	53.80	47.14	52.80	49.98	41.95	**49.14**
Mean	**57.60**	**48.49**	**48.45**	**47.16**	**36.41**	

$CD_{0.05}$
Media : 1.45
Treatments : 1.87
Media x Treatments : 3.24

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)
T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)
T_3= Spray application of 10% jeevamrit at fortnightly interval
T_4= Spray application of 10% jeevamrit at monthly interval
T_5= No application (control)

Dutt *et al*. (2002) also confirmed the above results when chrysanthemum was grown in Cocopeat + Soil rite in the ratio of 1:1(v/v) and obtained best results in terms of duration of flowering.

Jeevamrit is a rich source of beneficial microorganism like yeast, lactic acid bacteria, actinomycetes, which helps in increasing soil biomass and microbial count in soil. Further, it helps in increasing availability and uptake of nutrients into soil. Jeevamrit is rich in growth promoting hormones like IAA, GA and Cytokinin, which helped in increasing the flowering duration (Gore and Sreenivasa., 2011) and (Chadha *et al*., 2012).

Growing petunias in Soil + Cocopeat + FYM (1:1:1, v/v) with jeevamrit as drench application resulted in maximum flowering duration, which can be correlated to better vegetative parameters in Soil + Cocopeat + FYM and addition of jeevamrit act as a tonic to improve soil health and vegetative and flowering parameters of petunia which leads to more flowering duration.

4.8 POT PRESENTABILITY

Data presented in Table 8 shows that maximum pot presentability score (94.01) was observed in the plants grown in growing medium consisting of Soil + Cocopeat + FYM (1:1:1, v/v) (M_2). In contrast, pot presentability was found minimum (91.79) in Sand + Soil + FYM (1:1:1, v/v) (M_1), which was found to be at par with Soil + Cocopeat + Vermicompost (1:1:1, v/v) (92.26) (M_3).

Among different jeevamrit treatments, pot presentability score (96.93) was recorded maximum in T_1 when the pots were drenched with jeevamrit at fortnight interval. It was found to be at par with drench application of jeevamrit at monthly interval (95.04) (T_2). On the other hand, pot presentability score was recorded lowest (85.95) in control when no jeevamrit was applied (T_5).

Table 8: Effect of growing media and jeevamrit applications on pot presentability of *Petunia* × *hybrida* Vilm.

Treatments (T)* / Media	T_1	T_2	T_3	T_4	T_5	Mean
M_1: Soil + Sand + FYM (1:1:1, v/v)	95.93	93.80	92.87	92.53	84.33	**91.79**
M_2: Soil + Cocopeat + FYM (1:1:1, v/v)	98.67	96.53	93.00	93.47	88.40	**94.01**
M_3: Soil + Cocopeat + Vermicompost (1:1:1, v/v)	96.20	94.80	92.33	92.93	85.13	**92.26**
Mean	**96.93**	**95.04**	**92.73**	**92.98**	**85.95**	

$CD_{0.05}$
Media : 0.84
Treatments : 1.09
Media x Treatments : NS

***T_1** = Drench application of 10% jeevamrit at fortnightly interval (250ml/pot)
T_2 = Drench application of 10% jeevamrit at monthly interval (250ml/pot)
T_3= Spray application of 10% jeevamrit at fortnightly interval
T_4= Spray application of 10% jeevamrit at monthly interval
T_5= No application (control)

Pot presentability is directly dependent on scores given to various growth and flowering parameters. Maximum presentability score (94.01) obtained in plants grown in growing medium consisting of Soil + Cocopeat + FYM (1:1:1, v/v) (M_2) is directly correlated

to maximum number of parameters scoring highest in this growing medium viz. plant height, plant spread, earliest peak flowering, maximum number of flowers open at a time, flower diameter and duration of flowering. Similarly, among jeevamrit treatments, highest presentability score (96.93) was noted in drench application of jeevamrit at fortnight interval.

Addition of cocopeat in the medium has positive effects on pot presentability. Cocopeat increases the porosity of potting mixture, which helps to keep the soil loose resulted in better root growth. Better root growth leads to better plant development. Wazir *et al*. (2009) reported similar results in alstroemeria when plants were grown in Soil + Cocopeat + Vermicompost + Sand (1:1:1:1, v/v) gave best results in terms of flowering and pot presentability.

Jeevamrit contains macro nutrients in the form of N (0.16%), P (0.02%) and K (0.123%). Nitrogen helped in the production of carbohydrates and amino acids and helped in the synthesis of growth hormones like cytokinin, auxin and gibberellin. Jeevamrit is a rich source of phosphorus, and it is important component in chlorophyll. Jeevamrit converts the non-available form of nutrients into available form and increases the uptake of nutrients. (Sreenivasa *et al*., 2011). Further, it was also observed in this experiment that drench application of jeevamrit was found better as compare to spray application in all vegetative and flowering parameter of petunia, which resulted in good overall presentability.

Soil + FYM + Cocopeat (1:1:1) (Drench with Jeevamrit at 15 days interval)

Plate 10. Soil + FYM + Cocopeat (1:1:1) showing highest pot presentability score

Plate 11. Overview of the pots under M_2 (Soil + FYM + Cocopeat (1:1:1)

Chapter-5

SUMMARY AND CONCLUSION

The present investigation, **"Studies on the effect of growing media and jeevamrit on potted Petunia (*Petunia* x *hybrida* Vilm.)"** was carried out at the Experimental Farm of Department of Floriculture and Landscape Architecture, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan during 2019-20. The experiment was laid out in CRD (Factorial) using three different growing media and two applications of jeevamrit in the form of drench and spray.

Plant growth parameter like plant height, plant spread, number of days taken to first flower opening, days taken for peak flowering, maximum number of flowers open at a time, flower diameter, duration of flowering and pot presentability were studied. The effect of growing media, jeevamrit and their interactions were found to be significant with regards to all vegetative and flowering parameters of petunia.

Result obtained from present study is summarized below:

1. Maximum plant height (23.32 cm) was resulted in the plants which were grown in medium Soil + Cocopeat + FYM (1:1:1, v/v). Among jeevamrit treatments, plant height (23.44 cm) was found maximum when the plants were drenched with jeevamrit at fortnight interval.

2. Maximum plant spread (33.49 cm) was recorded in the plants grown in Soil + Cocopeat + FYM (1:1:1, v/v). Regarding different jeevamrit treatments, maximum plant spread (34.03 cm) was recorded in the plants which were drenched with jeevamrit at fortnightly interval.

3. Flowering was earliest (39.64 days) in the plants grown in Sand + Soil + FYM (1:1:1, v/v). Minimum number of days taken to first flower opening (39.45 days) was observed when jeevamrit was applied as drench at fortnightly interval.

4. Plant grown in Soil + Cocopeat + FYM (1:1:1) took minimum days (48.99 days) to come into peak flowering. Further, minimum number of days taken to peak flowering (48.75 days) was observed in the plants which were drenched with jeevamrit at fortnight interval.

5. Maximum number of flowers were open at a time (16.75) when the plants were grown in Soil + Cocopeat + FYM (1:1:1, v/v). Among jeevamrit treatments, maximum number of flowers were open at a time (17.49) when the plants were treated with spray application of jeevamrit at fortnight interval.

6. Maximum flower diameter (8.59 cm) was recorded in the plants grown in Soil + Cocopeat + FYM (1:1:1, v/v). Flower diameter (8.78 cm) was found maximum in jeevamrit treatment when applied as drench at monthly interval.

7. Duration of flowering (50.20 days) was noted maximum in Soil + Cocopeat + FYM (1:1:1, v/v). Further, flowering remained for longer duration when jeevamrit treatment was given as drench at fortnight interval.

8. Maximum pot presentability score (94.01) was recorded in the plants grown in Soil + Cocopeat + FYM (1:1:1, v/v). Regarding drench application of jeevamrit at fortnight interval resulted in maximum pot presentability score (96.93).

CONCLUSION

- Soil + FYM + Cocopeat (1:1:1, v/v) was found to be the best growing medium for quality pot production of petunia.
- Drench application of jeevamrit (10%) at fortnight interval was proved better as compared to spray application for quality pot plant production of *Petunia* × *hybrida* Vilm.

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APPENDIX – 1

Mean monthly meteorological data of Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (H.P) during the research period (September 2019 to March 2020)

Months	Maximum Mean Monthly Temperature (^{o}C)	Minimum Mean Monthly Temperature (^{o}C)	Relative Humidity (%)	Mean Precipitation (mm)
September, 2019	29.2	20.0	81.8	224.3
October, 2019	28.0	23.0	65.5	2.6
November, 2019	23.5	17.5	70.5	24.8
December, 2019	22.5	12.0	66.1	21.6
January, 2020	15.71	1.98	59	73
February, 2020	16.28	4.4	63	103.1
March, 2020	20.34	6.56	54	54.6

APPENDIX – 2

Sources of variation	Mean sum of squares				
	df	Plant Height	Plant spread	Days to first flower	Days to peak flowering
Growing media	2	7.71	4.49	11.17	17.12
Treatments	4	6.24	12.60	11.28	23.77
Growing media X Treatments	8	2.10	3.21	5.26	10.60
Error	30	0.56	1.81	1.20	0.92
Total	44				

Sources of variation	Mean sum of squares				
	df	No. of flowers open at a time	Flower diameter	Duration of flowering	Pot presentability
Growing media	2	2.85	0.26	192.696	9.327
Treatments	4	8.76	2.07	510.813	79.952
Growing media X Treatments	8	1.68	0.04*	46.274	1.294*
Error	30	0.39	0.02	3.595	0.675
Total	44				

*Non-significant

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Title of the Thesis	**:**	**Effect of growing media and jeevamrit on potted petunia (*Petunia* × *hybrida* Vilm.)**
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Date of Thesis Submission	**:**	2020
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No. of words in Abstract	**:**	240

ABSTRACT

The present investigation entitled, **"Effect of growing media and jeevamrit on potted petunia (*Petunia hybrida* vilm.)"** was carried out at Research Farm of Department of Floriculture and Landscape Architecture, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, (HP) – 173230 during 2019 to 2020 on potted petunia. Field experiment was laid out in Completely Randomized Design (Factorial) using three different growing media ie. Soil+ Sand + FYM (1:1:1, v/v), Soil + Cocopeat + FYM (1:1:1, v/v) and Soil + Cocopeat + Vermicompost (1:1:1, v/v) with the application of jeevamrit in the form of spray and drench at the interval of 15 and 30 days. The observations were recorded on various growth and flowering parameters. Maximum plant height (23.44 cm), plant spread (33.49 cm), minimum days to peak flowering (48.99 days), duration of flowering (50.20 days) and pot presentability score (94.21) was obtained in the plants grown in Soil + Cocopeat + FYM (1:1:1 v/v). Further, drench application of jeevamrit at fortnight interval resulted in maximum plant height (23.44 cm), plant spread (34.03), minimum days taken to peak flowering (48.75), maximum duration of flowering (57.60 days) and highest pot presentability score (96.93), while spray application at fortnight interval of jeevamrit resulted in maximum flower diameter. From the present investigation, it was concluded that Soil + Cocopeat + FYM (1:1:1 v/v) was found best growing medium for quality pot production of petunia when drenched with 10% jeevamrit at fortnight interval.

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