Standardization of Growing Media for Pot Culture of Crown Lily (*Fritillaria imperialis* L.)

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(2016-H-121-M)

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Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir

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in partial fulfillment of requirements for the award of the degree of

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(Floriculture and Landscape Architecture)

2018


DEDICATED
TO MY
PARENTS

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Certificate-I

This is to certify that the thesis entitled, **"Standardization of Growing Media for Pot Culture of Crown Lily (*Fritillaria imperialis* L.)"** submitted in partial fulfilment of the requirements for the award of the degree of **Master of Science in Horticulture (Floriculture and Landscape Architecture)**, to the **Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir** is a record of bonafide research work carried out by **Mr. Reyaz Ahmad Bhat (Regd. No. 2016-H-121-M)** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma. It is further certified that any help or information received during the course of investigation has duly been acknowledged.

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We, the members of the Advisory Committee of **Mr. Reyaz Ahmad Bhat (Regd. No. 2016-H-121-M)** a candidate for the degree of **Master of Science in Horticulture (Floriculture and Landscape Architecture)** have gone through the manuscript of the thesis entitled, **"Standardization of Growing Media for Pot Culture of Crown Lily (*Fritillaria imperialis* L.)"** and recommend that it may be submitted by the student in partial fulfillment of the requirements for the award of the degree.

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This is to certify that the thesis entitled, **"Standardization of Growing Media for Pot Culture of Crown Lily (*Fritillaria imperialis* L.)"** submitted by **Mr. Reyaz Ahmad Bhat (Regd. No. 2016-H-121-M)** to the **Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir** in partial fulfilment of the requirements for the award of the degree of **Master of Science in Horticulture (Floriculture and Landscape Architecture)** was examined and approved by the Advisory Committee and External Examiner on ……..

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ABSTRACT

An experiment entitled **"Standardization of Growing Media for Pot Culture of Crown Lily (*Fritillaria imperialis* L.)**'' was carried out at the Floricultural experimental field SKUAST-K during the year 2017-18. The investigation involved 11 treatment combinations (T_1= Soil/control, T_2= Soil + Sand 1:1, T_3 = Soil + Sand 2:1, T_4 = Soil +Sand +FYM 1:1:1, T_5 = Soil + Sand + FYM 1:1:2, T_6 = Soil +Sand + Vermicompost 1:1:1, T_7 = Soil + Sand + Vermicompost 1:1:2, T_8 = Soil +Sand + Sheep manure 1:1:1, T_9 = Soil + Sand + Sheep manure 1:1:2, T_{10} = Soil + Sand + Forest litter 1:1:1 and T_{11} = Soil +Sand + Forest litter 1:1:2) laid out in triplicate complete randomized design (CRD). The results of the study revealed that the treatment T_{11} (Soil +Sand + Forest litter 1:1:2) significantly improved vegetative, floral and yield attributes of crown lily. Maximum plant height (73.47 cm), number of leaves plant^{-1} (63.33), floret length (5.87 cm), weight of main bulb (149.25 g), number of bulblets per bulb (2.00) was recorded in treatment T_{11} (Soil +Sand + Forest litter 1:1:2) while as the minimum plant height (61.00 cm), number of leaves plant^{-1} (50), floret length (4.33 cm), weight of main bulb (141. g), number of bulblets bulb^{-1} (1.00) was recorded in treatment T_1 (control/Soil).

Key Words: crown lily, bulb, media, growth, yield.

Signature of Student
Dated_____

Signature of Major Advisor
Dated _____

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Chapter - 1

INTRODUCTION

Crown lily (*Fritillaria imperialis* L.) commonly known as crown lily or tears of Marry or Kaiser's crown is a species of flowering perennial plant in lily family with high medicinal and ornamental importance (Wang *et al.,* 2005). It's native to Kurdistan all across the plateau of Turkey, Iraq, and Iran to Afghanistan, Pakistan and Himalayan foot hills including our Kashmir valley. It is also widely cultivated as an ornamental and reportedly naturalized in Austria, Sicily, and Was hington State. The common names and also the epithet *"Imperialis,"* literally "of the emperor," refers to the large circle of golden flowers, reminiscent of an emperor's crown.

This aristocrat reaches almost 4ft. tall. The lance-shaped, glossy leaves appear at intervals along the stem with a prominent whorl of downward facing orange flowers at the top of the stem, topped by a pineapple style crown of small leaves hence the common name of crown imperial. The other common name, tears of Mary, refers to the great drops of nectar at the base of each petal, Christian tradition tells that of all the flowers, only the proud crown imperial refused to bow its head at the crucifixion it has bowed and wept ever since. The flowers emit a distinctly foxy smell that's reputed to repel mice and moles.

The genus *Fritillaria* belongs to the subclass Monocotyledonae and family *Liliaceae*. The genus includes about 100 species native to temperate climatic zones of the Northern Hemisphere (Ekim *et al.,* 1992).

Crown lily has big and attractive bell-shaped florets, so it is being used as a cut flower, pot plant and in landscape design and has revealed a great commercial potential (Hertogh *et al.,* 1993). Growing media is another important factor in propagation studies because rooting performance depends on the type of medium used (Mehmood *et al*., 2013). It has showy flowers it is cultivated and its bulbs are exported, especially to Holland and many other Europe countries.

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Crown lily grows about one meter in height and bears lance-shaped, glossy leaves at intervals along the stem. Its bulb is ovoid, tunica thin and papery. The stem is erect and smooth. Leaves are sessile, shiny and green. Flowers are orange to red, inner yellowish-orange, tepals brownish-black at the base. Seeds flat, elliptic, oblong, oblanceolate, testa is brown and reticulate (Linnaeus 1753). It bears a prominent whorl of downward facing flowers at the top of the stem. Various colors are found in cultivation, ranging from nearly a true scarlet through oranges to yellow. In the northern hemisphere, flowering takes place in the late spring, accompanied by a distinctly foxy odor that repels mice, moles, and other small animals.

Crown lily is also having high medicinal properties. The bulbs are diuretic and emollient. Bulbs are regarded as a natural resource in the medical sector because they contain steroids, which are effective substances (Bingol *et al.,* 1996). Its bulb is an important source of anti-tussive, expectorant and anti-hypertensive drugs and has high starch content so can be considered as new starch source for the food and medicine industry (Wang *et al.,* 2005) and is an important source of steroidal alkaloids which have cholinesterase inhibiting role (Atta-ur-rahman *et al.,* 2002).

Media is the base of the material needed for plant growth, providing moisture and nutrients for crop root, affecting plant physiology and yield (Sonneled, 1991). Use of suitable growing media or substrates is essential for the production of quality horticultural crops. It directly affects the development and later maintenance of the extensive functional rooting system.

Growth medium is known to have effect on value of potted ornamental plants (Vendrame *et al*., 2005) and plays an important role in germination rate, and many other physiological parameters including plant height, number of leaves, spike length, number of florets per spike, spike diameter and yield etc., (Vendrame *et al*., 2005). A best-growing media should have proper aeration, water holding capacity and adequate nutrition supply; different manures provide

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good nutrition to plants when applied in combination with Soilless substrates (Khobragade *et al*., 1997). Different vegetative and reproductive growth parameters produced best results favored by different Soilless media are observed in rose (Ahmad, 1989), *Lagerstroemia speciosa* (Tahir *et al*.,1997), Dieffenbachia plant (Aquila and Pasini, 1989) and tuberose (Mahrose, 1999).

A good growing medium would provide sufficient anchorage or support to the plant, serves as a reservoir for nutrients and water, allow oxygen diffusion to the roots and permit gaseous exchange between the roots and atmosphere outside the root substrate (Abad *et al.,* 2002). Top Soil is used as a part of the growing medium by many nurserymen. It is a non-renewable resource. Increasing utilization of available land for physical and infrastructural development rapidly declines the supply of quality top Soil and thus promoting the utilization of Soilless materials in the production of horticultural crops (Abad *et al.,* 2002).

There is absolutely no data available with regard to suitable growing media that could augment better productivity of the crop in pot culture. The growing media which is an important determinant of productivity in pot culture still remains to be standardized. Keeping in view the above facts, the present investigation entitled "Standardization of growing media for pot culture of Crown lily (*Fritillaria imperialis* L.)" was proposed to carry out with the following objective:

- To find out suitable growing media for growth and flowering on pot culture of Crown lily (*Fritillaria imperialis* L.).

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Chapter-2

REVIEW OF LITERATURE

The literature available related to *Fritillaria* and other related crops are highlighted below. However, very little work has been done on the effect of potting media on growth, flowering and bulb production of *Fritillaria*. The literature available on this aspect in relation to *Fritillaria* and other ornamental crops are presented in this section:

The cattle extract based FYM in India can potentially supply approximately 33 million tonnes of N, P and K per year (Gaur *et al*., 1984). The FYM seems to act directly by increasing crop yield either by the acceleration of the respiratory process by cell permeability or by hormone growth action. It supplies N, P and K in available forms to the plants through biological decomposition.

Dinova *et al*. (1988) conducted *Alstroemeria hybrida* (I) studies on N accumulation in the vegetative mass of cv. Regina with 4 substrates of local origin viz. peat + conifer needles, peat, conifer needles and Soil + straw compared with Soil containing no amendments. Out of 5 substrates tested, the flower yield was highest in plants grown on the conifer needle substrate.

Farmyard manure (FYM) is the most commonly used organic manure in the Indian subcontinent. It is a composed mixture of cattle dung, bedding material in the stable, remnants of straw and plant stalks fed to the cattle. The application of organic manure (FYM) increases the Soil microbial biomass. (Goyal *et al.,*1993).

The effect of different substrates for cut flowers production in Lilium cv. 'Connecticut King' was studied by Lopez *et al*. (1994). The substrates comprised of Soil, Sand and peat in different proportions. The positive effect was induced in total scape length, scape length up to the flower, a number of inflorescences and bulb size in Lilium with an increase in the proportion of Cocopeat in the medium.

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The best results of growth and flowering were obtained in a medium consisting of Soil (60-70%) + peat (30-40%).

Dilta *et al*. (2000) carried out studies on Asiatic and Oriental lily cvs. 'Pollyanna' and 'Star Gazer'. The growing media comprised of Sand + FYM + Soilrite (1:1:1;v/v) or FYM + Soilrite (1:1;v/v) and growth regulator NAA 50ppm or IBA 100 ppm were used. Best results were found in 'Pollyanna', the greatest bulblet formation was produced with 100 ppm NAA or IBA in FYM + Soilrite.

Vermicomposts are products derived from the accelerated biological degradation of organic wastes by earthworms and microorganisms. Earthworms consume and fragment the organic wastes into finer particles by passing them through a grinding gizzard resulting in organic matter rich in nutrients. Vermicompost incorporation at 20%, with or without chemical fertilizers, reduced the incidence of diseased plants, and the disease growth rate. The macro and micronutrient content (except K and Mn) were at an optimum level in plants treated with 20% Vermicompost with or without chemical fertilizer (Rodriguez Navarro *et al.,* 2000)**.** The significant increase in plant height, leaf number, spike length and the number of florets per spike in gladiolus in the plots treated with a combination of Vermicompost @10 tonnes per hectare + 80 percent recommended NPK (100:60:60 kg NPK/ha) was reported by Gangadharan and Gopinath (2000).

In Marigold, the plants applied with Vermicompost (15 tonnes per hectare) + 100 percent recommended NPK produced the maximum number of flowers per plant with greater flower diameter and flower yield than plants without Vermicompost and fertilizer application (Mashaldi, 2000).

The goldenrod plants supplied with Vermicompost (10 tonnes per hectare) and 100 percent recommended NPK (100:50:50 kg/ha) produced greater plant height, the maximum number of leaves and highest flower yield (Kusuma, 2001).

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Sekar and Sujata (2001) tested the efficacy of five growing substrates viz., coir pith medium (Coir pith + Garden Soil + FYM), Sawdust medium (Sawdust + Garden Soil + FYM), commercial mixture (Sand + Red Soil + FYM), Sand medium (Sand + FYM) and red Soil medium (Red Soil + FYM) in equal ratios on volume basis on growth and flowering of (*Gerbera jamesonii* Bolus.) cv. 'Mammut' grown in pots. They reported best results in the coir pith medium comprising coir pith, garden Soil and FYM (1:1:1,v/v).

Barreto and Jagtap (2002) tested different substrate media viz. Cocopeat, Peat, Soilrite, Perlite, Vermicompost, compost and garden Soil in various proportions for pot culture of Gerbera. They found that vegetative growth was best in Cocopeat alone. The flower quality was found to be superior in pots having the combination of peat and Vermicompost (1:1). The highest flower yield with better vase life was obtained in Cocopeat combined with either compost or Vermicompost (1:1).

In China aster, Haripriya and Sriramachandrasekharan (2002) reported that application of FYM + Mine Soil at 1:2 ratio resulted in the better growth and yield of marigold as compared to leaf mold and press mud.

Hidalgo and Harkess (2002) noticed that plants grown in 50% Vermicompost had a greater growth index at height, foliar area, number of flowers per pot, dry weight and early flower development in chrysanthemum cv. 'Miramar'

An experiment was carried out to study the effect of three different substrates for cut flower and bulb production in Asiatic hybrid cv. 'Novecento' and 'America'. The substrates were comprised of Soil, Soil + Sand (1:1;v/v) and Soil + Rice hulls + River Sand + Perlite (1:2:2:3; v/v). The best bulb multiplication was obtained in a medium consisting of Soil + Rice hulls + River Sand+ Perlite (1:2:2:3; v/v) (Klasman *et al.*, 2002).

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Another study on the use of substrates for root development in *Lilium speciosum* cv. 'Elite' was carried by Vetal *et al*. (2002). The substrates comprised of Agropeat, Soilrite, Agropeat + Soilrite (1:1;v/v), Agropeat + Vermicompost (1:1;v/v), Soilrite + Vermicompost (1:1;v/v), brick power + Vermicompost (1:1;v/v) and Soil + Vermicompost (1:1;v/v). The best results of the longest bulb roots were obtained in the substrate containing Agropeat + Vermicompost. Longest stem roots and highest fresh and dry weights were obtained in Soilrite + Vermicompost.

Prakash *et al.* (2002) stated that phosphorous and potassium content in the leaves increased with the addition of 5 and 10 percent FYM whereas, N content was increased in the leaves only with the addition of 5 percent FYM, the addition of FYM to the Soil also increased the yield parameters in their study.

From the various media tested by Tiwari and Saxena (2003) in *Dalbergia sissoo* Roxb. Seedlings, substrates Soil + Sand + FYM (1: 2: 2) and Soil + Sand + FYM (1: 2: 1) showed higher growth, dry weight, and a quality index of seedlings.

Anuje *et al.* (2004) found that Gerbera cultivation under polyhouse conditions using the medium consisting of Red Soil + FYM in a 1:1 ratio recorded the maximum plant height and flower stalk length, while that consisting of Cocopeat (coir) and FYM in a 1:1 ratio recorded the maximum number of leaves, flowers/plant, flower diameter, and vase-life and the earliest flowering. The thickest flower stalk was observed in the medium containing Cocopeat and Garden Soil + FYM in 1:1:1 ratio.

Effect of growing media containing Cocopeat and normal media (Sand + Soil + FYM, 2:1:1) in different ratios on Gerbera were studied by Aswath and Pillai (2004), reported that medium containing 100 percent Cocopeat (v/v) results in high stalk length, stalk thickness, flower diameter, and low dry matter production.

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Jhon *et al.* (2004) studied the effect of growing media as Soil, Sand, Sheep or Poultry manure (2:1:1, v/v) in tulip cultivar 'Apeldoorn' and found maximum growth and bulb production when bulbs are grown in medium Soil + Poultry manure + Sand (2:1:1) as compared with other media tested.

Chauhan *et al.* (2005) in marigold cv. Pusa Narangi Gainda reported that the application of Vermicompost @ 1000 g/m^2 recorded higher yield of flowers (1757.76 g/m^2) compared to the application of Vermicompost @ 500 gm/m^2 (1429.00 g/m^2).

Jhon *et al.* (2005) reported that when tulip bulbs were grown in medium comprising Soil + Poultry manure + Sand (2:1:1) under polyhouse conditions produced longest flower scapes, whereas, those grown in Soil + Sheep manure + Sand (2:1:1) resulted in flowers with significantly larger tepal diameter.

Gupta *et al.* (2006) suggested that in Alstroemeria, the growing media of Sand + Soil + FYM (1:1:1) exhibited a maximum number of rhizomes whereas Cocopeat + Peat (1:1) produced the maximum number of storage roots, fibrous roots, and heaviest rhizome clusters.

Khayyat *et al.* (2007) reported that in *Epipremnum aureum* Lindl. and Andre 'Golden Pothos' the parameters such as freshness, shoot length, shoot fresh and dry weights, root fresh and dry weights and root number were higher in medium containing only Cocopeat.

Kiran *et al.* (2007) conducted an experiment to study the effect of different growing media on the growth and development of Dahlia. The results revealed that plant height, number of branches per plant, stem thickness, number of flowers per plant, number of petals per flower, the diameter of flower and vase life were recorded maximum in the media containing Sand + Silt + Leaf mold. Whereas minimum growth parameters were recorded with Sand alone.

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Rajesh Bhalla *et al*. (2007) revealed maximum plant height (73.20 cm) in carnation cultivar Raggio - de- Sole when grown in media containing Sand + Soil + Vermicompost at ratio 1:1:1 + Inorganic fertilizers + Bio-fertilizers.

Standardization of potting media for production of quality seedlings of *Cedrus deodara* was carried by Sofi and Bhardwaj (2007). They reported that medium containing Soil + Sand + FYM (1:1:3) gave maximum plant percent, plant height, collar diameter, root-shoot ratio, and total fresh biomass.

Turhan *et al*. (2007) while studying 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 applied with a double layer of corm was found to be the best for production

Asil (2008) studied the effect of different growing medium on six lily cultivars viz 'Amarone', 'Orlando', 'Pink Superior', 'Pollyanna', 'Salsa' and 'Vignola. Bulbs were planted in Soilless substrate containing Peat, Perlite, Garden Soil, and Humus Soil. The results showed that shoot length, number of flower buds, flowering time and chlorophyll content of leaves were better when bulbs were grown in the Soilless substrate; Peat + Perlite + Garden Soil

Gupta *et al*. (2008) conducted an experiment to assess the performance of gladiolus to varying treatments of vermicompost, FYM, and NPK. Results revealed that among the three treatments i.e. (F_1) Vermicompost (125 gm /sqm), (F_2) NPK (75gm\sqm), (F_3) FYM (2.5 kg/sqm), F_3 treatment was recorded with best results for plant growth, flowering and corm yield parameters

Bashir *et al*. (2009) tested four growing media in *Pinus wallichiana* and reported that media containing Soil + Sand + Forest litter (1:1:2) showed best results in collar diameter, fresh root weight, dry root weight, and plant height.

Use of Sand and FYM (1:1) produced maximum plant height, number of sprouts per plant, number of leaves per plant, the diameter of shoot and number of flowers plant in wax Begonia (Anil *et al.,* 2009).

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Sindhu *et al*. (2009) reported highest bulk density (0.58 g/cm3) and electric conductivity (0.85 dS/m) in media amended with Soil + Farmyard manure + Vermicompost + Samridhi + Sawdust. Leaf magnesium content was maximum (0.55%) recorded in media amended with Vermicompost.

Jackson and Wright (2009) tested pine tree substrate for nursery and greenhouse crop production. They reported that pine tree substrate is a reliable, consistent, renewable and economical alternative to traditional substrates for both nursery and greenhouse crop production.

Rawat *et al.* (2009) recorded that mean survival was highest in Soil but mean plant height was maximum in media Soil + Sand + FYM (1:1:1) in case of *Valeriana wallichii* under different media.

Wazir *et al.* (2009) tested the efficacy of five growing media viz., Soil + Cocopeat + Vermicompost + FYM + Sand (1:1:1:1:1,v/v), Soil + MSW + Leaf mould + FYM + Sand (1:1:1:1:1,v/v), Mashobra peat + Vermicompost + FYM + Sand (1:1:1:1,v/v) and Soil + Sand + FYM (1:1:1,v/v) as control for pot plant production of three Alstroemeria cultivars namely, 'Selection no. 14', 'Pluto' and 'Riana'. They reported the best results for various vegetative, flowering and pot presentability attributes of all Alstroemeria cultivars in the growing medium comprising Soil + Cocopeat + Vermicompost + Sand + FYM (1:1:1:1, v/v).

Jing *et al*. (2010) reported the effect of four growing media on Oriental lily cv. 'Sorbonne' grown in perlite, Vermicompost, Peat, Sand and their mixture. It has been found that media containing a combination of Perlite + Vermiculite + Peat + Sand (1:1:1:1;v/v) showed high survival rate after transplanting.

Singh (2010) investigated the effect of seven growing media viz M_1 (Rhododendron Forest Soil : FYM : Vermicompost ,1:1:1, v/v), M_2 (Rhododendron Forest Soil : FYM : Vermicompost, 2:1:1,v/v), M_3 (Rai Forest Soil : FYM : Vermicompost (1:1:1,v/v), M_4 (Rai Forest Soil : FYM : Vermicompost, 2:1:1,v/v), M_5 (Mohru oak Forest Soil : FYM : Vermicompost,

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1:1:1, v/v), M_6 (Mohru oak Forest Soil : FYM : Vermicompost, 2:1:1, v/v) and M_7 (Soil + FYM + Sand,1:1:1, v/v) on growth, flowering and pot presentability of florist's geranium. He reported the best growth, flowering and pot presentability of geranium in a growing substrate consisting of Rai Forest Soil: FYM: Vermicompost (2:1:1, v/v).

Sangwan *et al.* (2010) in pot culture experiments on marigold reported that addition of Vermicompost, in appropriate quantities, to potting media has synergistic effects on a number of buds, number of flowers, plant shoot biomass, root biomass, plant height and diameter of flowers.

An investigation to evaluate the response of growth and flowering of hyacinths towards 15 different growing media was undertaken by (Nazari *et al*., 2011). The results indicated that growing media significantly influences visual quality, leaf number, leaf fresh and dry weights, flowering stem height, bulblet number, and root fresh and dry weights, were higher in the mixture containing an equal amount of Sand: coco peat compared to other media. The highest photosynthesis rate, mesophyll efficiency, flowering stem fresh weight, and floret length were observed in the media containing only coco peat and the highest transpiration rate and stomatal conductance resulted from the medium consisted of only Sand. The highest water use efficiency was obtained in Soil/coco peat/Sand (2:1:1) medium.

An experiment entitled effect of Various Substrates on Growth, Flowering and Tuber Production of Dahlia (*Dahlia variabilis* Desf.) cv. 'Pink Attraction' was carried out by Nissa, 2011. The study revealed that medium Cocopeat + FYM (1:1) recorded maximum plant height (54.72 cm), number of leaves (102.93), primary branches (8.30), stem diameter (10.68 mm) and plant spread (3364.45 cm^2). Cocopeat + FYM (1:1) also recorded earliness in flowering (82.0 day) and maximum flower diameter (12.6 cm), length of flower stalk (9.5 cm), number of flowers/plant (18.5), fresh weight of flowers (20.8 g), duration of flowering (13.5) and flower yield (253.8 g/plant). Moreover, the various

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physiological parameters in Dahlia were also influenced markedly by the growing substrates Cocopeat peat + FYM (1:1). However, the maximum number of tubers/plant (14.8) and fresh weight of tubers (213.1 g) were recorded under substrate vermiculite + FYM (1:1). The maximum net return was obtained with Cocopeat + FYM medium. The study concluded that substrates Cocopeat + FYM (1:1) can be taken for better plant growth and flower production whereas vermiculite + FYM (1:1) can be effectively used for tuber production in Dahlia cv. Pink Attraction under Kashmir valley conditions.

In another study, 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, stem, leaf area, height, stem diameter, number of leaves, and bulb parameters in both cultivars were recorded in media containing Cocopeat.

Abdulrahman and Kako (2012) conducted a pot experiment to study the effect of four different growth media clay, loam, clay plus Sheep manure (1:1) and loam plus Sheep manure (1:1) as volumetric rates on vegetative and flowering growth characters of five different cultivars of Hyacinths ('Blue Giant', 'City of Haarlem', 'Jon Bos', 'Delf Blue' and 'Fondant'). The best results for early emergence (22.53 days) and flowering (73.13 days) were recorded in a medium consisting of loam and Sheep manure, while maximum plant height (19.75 cm), leaf number (6.13), leaf area (31.47 cm2) were recorded in clay medium. A maximum number of florets/ plant (31.93) and spike length (7.95 cm) were recorded in medium containing clay and Sheep manure. On the other hand, the maximum length of spike stem (9.61 cm) and total chlorophyll (53.45%) were recorded in medium containing loam.

Kukal *et al.* (2012) studied the effect of natural bio-amendments in improving physical condition and water retention in ten growing media containing

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Soil, sewage sludge, coir, Vermicompost, and FYM. They have concluded that a media containing Soil, Vermicompost, and coir are best for all parameters.

The response of Lilium Asiatic hybrid variety 'Navona' to the application of different Vermicompost levels 0, 10%, 20%, and 30% was studied by Moghadam *et al.* (2012). They concluded that application of Vermicompost at 20% and 30% had a stimulating effect on the number of flowers and their diameter and inducing early flowering in Lilium.

Seyedi *et al.* (2012) studied the effect of five different growing media on growth and flowering of Asiatic Lilium hybrids. The media comprised of 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.

Ikram *et al.* (2012) carried out a study using different potting media in different combinations to check their effect on the morphological parameters as well as on the vase life of the tuberose. Maximum plant spread, a number of leaves and vase life was recorded in Sand + FYM. Coconut coir + FYM contributed to the maximum values of plant height, leaf area, and spike length. Maximum plantlets were counted for Sand + Poultry manure. The highest values of floral diameter, number of flowers per spike and shelf life were observed in Sand + leaf compost. Moghadam *et al.* (2012) reported a maximum number of bulbs per plant in medium amended with different doses of Vermicompost in Asiatic hybrid lily "Navona".

An experiment aimed to select the optimum medium of productive seeding and to study on the effects of different media on the growth of *F. cirrhosa* seeding was carried out by (Hu *et al*., 2013). The results suggested that (1) Sowing with seeds and one-year-old bulbs of *F. cirrhosa*, S_1 (100% humus Soils with the dung of Hepialidae larvae) was the best nursery media for sprouting. (2) The integrated performance was considered, including transverse diameter, longitudinal

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diameter, the ratio of longitudinal diameter to transverse diameter, 30-grain fresh weight and 30-grain dry weight. Sowing with *F. cirrhosa* seeds, S_1 (100% humus Soils with the dung of Hepialidae Larvae) was the best medium for promoting the seedlings and getting a larger size of bulbs. Sowing with one-year-old *F. cirrhosa* bulbs, S_1 (100% humus Soils with the dung of Hepialidae Larvae) and S_2 (100% humus Soils) were advantageous for the growth of plantlet bulbing and getting a larger size of bulbs. Adding Sandy Soil to substrates or 100% Sandy Soil as nursery media could inhibit the growth of *F. cirrhosa* bulbs, getting a better shape of *F. cirrhosa* bulbs.

An experiment was conducted by Mayuri *et al*. (2013) to investigate the effect of integrated nutrient management on growth, yield, and quality of ratoon tuberose. Result showed the significant result and application of FYM @ 30 t/ha + PSB @ 2 g/m^2 + *Azotobacter* @ 2 g/m^2 (T_{13}) took minimum days to sprouting (18.47 days), maximum plant height (61.67 cm) and plant spread at E-W and N-S (37.93 cm and 37.07 cm, respectively). With respect to flowering, significantly maximum length of spike (78.00 cm), number of florets per spike (44.07), number of spikes per plant (4.26), number of spikes per net plot (127.67), number of spikes per hectare (4.73 lacks), longest vase life (12.33 days) and *in situ* longevity of spike (20.80 days) were recorded in treatment ½ RDF + NC @ 1 t/ha + PSB @ 1 g/m² + *Azotobacter* @ 1 g/m² (T_4). Similarly, the application of ¼ RDF+ PSB @ 1.5 g/m2+ @ *Azotobacter* 1.5 g/m_2 (T_6) gave poor performance.

Mehmood *et al.* (2013) conducted an experiment to investigate the comparative effect of different potting media with different compositions on the growth and flowering of *Antirrhinum majus* cv. 'Floral Shower'. The results regarding growth and flowering parameters showed a significant increase in Leaf Mould potting media. However, Farm Yard Manure was seen to prove less effective for better plant growth due to its less contribution to the availability of nutrients.

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Mirkalaei *et al.* (2013) reported the effect of different organic fertilizers on the growth and development of lilies. Two levels of Vermicompost, sugarcane bagasse, sewage sludge (0 and 10% v/v) based compost were applied, It was found that application of Vermicompost had promotional effects on the root length, root fresh weight, plant height, stem fresh and dry mass and total chlorophyll content in Lilium.

Bostan *et al.* (2014) studied the effect of different growing media on growth and flower production of Amaryllis. Growing medium composed of Garden Soil, canal silt, and mushroom compost resulted in a maximum number of flowers (5.42) per plant, length of flower stalk (44.00 cm) and flower diameter (11.58 cm). While the medium composed of garden Soil, canal silt, and leaf mold resulted in maximum flower persistency (7.58 days) whereas earlier flowering (43.50 days) was observed in amaryllis plants grown in the medium composed of garden Soil, canal silt, and farmyard manure. Singh *et al.* (2014) studied the effect of propagation media on shoot and rhizome development in Alstroemeria cv. SERENA. Among the different growing media used, Soil + Sand + Cocopeat (1:1:2) performed superior recording maximum sprouting (63.42%), established plants (61.76%), number of vegetative shoots at 30, 60, 90, 120 DAP (1.42, 2.67, 3.94, 5.92), weight of the rhizome cluster per plant (14.53 g), number of rhizomes developed (2.96), length of the longest rhizome (6.20 cm), number of new storage roots (6.12), number of new fibrous roots (7.28) and propagation coefficient (42.07).

A field experiment was carried out by Singh *et al.* (2014) to investigate the effect of propagation media on clonal propagation through rhizome sections in Alstroemeria cv. SERENA. Experimental treatments comprised of nine growing media viz., Soil + Sand (1 : 1), Soil + Sand + farmyard manure (FYM) (1 : 1 : 1), Soil + Sand + FYM (1 : 2 : 1), Soil + Sand + FYM (1: 1: 2), Soil + Cocopeat + Sand (1 : 1 : 1), Soil + Sand + Cocopeat (1 : 2: 1), Soil + Sand + Cocopeat (1:1: 2), Sand + FYM (1 : 1) and Sand + Cocopeat (1: 1) were tested for their influence

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on shoot and rhizome development. Among the different growing media used, Soil + Sand + Cocopeat (1 : 1: 2) performed superior recording maximum per cent sprouting (63.42%), per cent established plants (61.76%), number of vegetative shoots at 30, 60, 90, 120 DAP (1.42, 2.67, 3.94, 5.92), weight of the rhizome cluster per plant (14.53 g), number of rhizomes developed (2.96), length of the longest rhizome (6.20 cm), number of new storage roots (6.12), number of new fibrous roots (7.28) and propagation coefficient (42.07) whereas, media containing Sand + Cocopeat (1:1) performed poorly.

Dilta *et al*. (2015) studied the effect of growing medium and Daminozide dose for producing the best quality and most presentable potted hydrangeas. Seven growing media comprising of Soil, Sand, Vermicompost, Rhododendron Forest Soil, pine Forest Soil etc., were used in different proportions along with Daminozide doses. The growing medium containing Forest Soil (Rhododendron) + FYM + Vermicompost (2:1:1, v/v) was found to be the best for promoting all growth and flowering parameters

Lyngdoh *et al.* (2015) studied the effect of growing medium on the propagation of three hybrid lily cultivars viz. 'Brindisi' 'Menorca' and 'Serrada' with fifteen substrates Cocopeat, Sawdust, Sand, Forest Soil, compost, and their mixture. Maximum numbers of bulblets were obtained in 'Serrada' when grown in Forest Soil.

Nair and Bharathi (2015) conducted a study on pot mums and chrysanthemum cv. Sadhbhavana was grown in pots on seven different potting media combinations, the constituents being Soil, Sand, FYM, Cocopeat, and vermicompost. Cocopeat + Sand + FYM +Vermicompost (2:1:0.5:0.5 v/v) was found to be one of the best potting media combinations resulting in the production of highest number of flowers per plant (192.02) with prolonged flowering duration (101.83 days) as compared to other Cocopeat based and conventional media. Sisodia and Singh (2015) conducted an experiment to study the effect of farmyard manure (FYM), Vermicompost and Trichoderma alone and in

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combination on flowering and corm yield in gladiolus. Application of Vermicompost + Trichoderma resulted in early spike emergence, floret color show, the opening of the first floret and increased diameter of first, third and fifth floret. The maximum length of the spike, no. of florets/spike and duration of flowering was registered with the application of farmyard manure. Treatment FYM + Vermicompost significantly enhanced the shelf life of first and third floret. However, the maximum weight of corms/plant and diameter of corm recorded with FYM + Vermicompost + Trichoderma and FYM + Vermicompost treatments, respectively.

A pot experiment was conducted to study the effect of growing media on growth, physiology and flowering of Dahlia by Nissa *et al.* (2015). Twelve growing media Soil, farm yard manure (FYM) + Sand (1:1), Sheep manure + Sand (1:1), Poultry manure + Sand (1:1), Cocopeat + FYM (1:1), Perlite + FYM (1:1), vermiculite + FYM (1:1), Soil + FYM + Sand (1:1:1), Soil + Sheep manure + Sand (1:1:1), Soil + Cocopeat + FYM (1:1:1), Soil + Perlite + FYM (1:1:1), Soil + vermiculite + FYM (1:1:1) were used. All parameters were best recorded in Cocopeat + FYM (1:1).

To see the effect of farmyard manure (FYM), Vermicompost and Trichoderma alone and in combination on flowering and corm yield in gladiolus, a field experiment was conducted by Sisodia and Singh, 2015. The results revealed that the application of Vermicompost + Trichoderma resulted in early spike emergence, floret color show, the opening of the first floret and increased diameter of first, third and fifth floret. The maximum length of the spike, no. of florets/spike and duration of flowering was registered with the application of farmyard manure. Treatment FYM + Vermicompost significantly enhanced the shelf life of first and third floret. However, the maximum weight of corms/plant and diameter of corm recorded with FYM + Vermicompost + Trichoderma and FYM + Vermicompost treatments, respectively.

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Jehoshaphat *et al*. (2017) investigated the effect of Different Growing Media on Growth, Flowering and Corm Yield of Gladiolus Cultivars (*Gladiolus grandiflorus* L.).The treatments consisted of different growing media (Farm Yard Manure @ 2kg/m^2, Vermicompost @ 1kg/m^2 and Sawdust @ 1kg/m^2) and 4 varieties (Deepest Red, Jessica, Amsterdam, and Esta Bonita). Early spike emergence (55.27) was found in Jessica Variety with the application of FYM @ 2kg whereas spike length was maximum (94.00 cm) in variety Esta Bonita. Regarding a number of florets per spike (14.83), a number of daughter corms (65.16) per plant was found to be best in variety Amsterdam when FYM @ 2kg was applied whereas the number of cormels (59.57) was found to be maximum in variety Deepest Red.

An experiment was conducted by Masoodi *et al*. (2017) with an aim to know the effect of different organic manures and bio-fertilizers on morphological, floral and bulb traits on Narcissus (Daffodil) cv. "Salome". Seven different nutrient combinations were tested with a distinct range of organic manures *viz.* Vermicompost (1.5 t/h,2.5t/h, 5 tonnes /ha,), Sheep manure (1.5t/ha, 2.5t/h, 5 t/h) and recommended a dose of NPK without organic manures as a control treatment. In addition to these manures**,** all bulbs were treated with Azotobacter and Phosphorus Solubilising Bacteria (PSB) before planting. It was observed that treatment T_3 (Vermicompost 5t/ha + Azotobacter + PSB) resulted with earliness in bulb sprouting, bud initiation and to reach gooseneck stage. However, the treatment T_5 (1.25 t/ha Vermicompost +1.5t/ha Sheep manure+ Azotobacter + PSB) resulted in a delay of bulb sprouting, bud initiation and duration to reach gooseneck stage. From qualitative parameters point of view maximum tepal length (34.61mm), spathe length (40.97cm), flower diameter (79.47mm**)** and duration of flowering (26.86 days) resulted with the treatment T_3 and minimum values for all these traits were observed with treatment T_5. Bulb weight was recorded maximum (24.48g) with treatment T_3 (Vermicompost 5t/h+ Azotobacter + PSB) and minimum (16.12g) with treatment T_5 (1.5 t/h Sheep manure +

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Azotobacter + PSB) while as bulb diameter followed the same trend with maximum (33.21mm) with T_3 and minimum (20.10mm) with T_5.

Rajera and Sharma (2017) investigated the effect of different growing media on bulb production of LA hybrid lilies. The results revealed that among different growing media maximum number of bulbs, the diameter of the bulb, the weight of bulb, number of bulblets, the diameter of bulblet and weight of bulblet were recorded maximum in Sand +Soil + FYM (1:1:1 v/v).

An investigation was carried out by Singh *et al*. (2017) to assess the impact of Growing media and NPK on growth and flowering of Alstroemeria. The results revealed that growing substrate comprising of rhododendron Forest Soil and application of NPK dose at 150:100:150 ppm twice a week through fertigation is best for commercial cultivation of Alstroemeria.

Masoodi and Nayeem 2018 carried out an investigation to study the effects of growth regulators which includes NAA (500 ppm), IBA (500ppm) and NAA (500ppm) + IBA (500ppm) and propagation media which includes Cocopeat, Perlite +vermiculite (1:1) and Sand + Soil + FYM 91:1:1) on propagation of three cultivars of Lilium namely; Navona , *Parrano* and yellow diamond . The results pertaining to different parameters are as Days taken to bublet formation, Number of bulblets formed, the average weight of bulblet, the circumference of bulblet and propagation index. The data reveals that the earliest scale bulblet formation (29.1 days) was recorded in cv. Navona. Similarly, earliest bulblet formation (35.6 days) noticed when scales were planted in Perlite and vermiculite (v/v; 1:1) propagation media. In case of growth regulators, minimum days taken to bulblet formation (31.2 days) were recorded with IBA 500 ppm. The maximum number of bulblet formation (2.0) was recorded in 'Navona' which was statistically at par with cultivar '*Parrano*' (1.8). In the case of propagation media, maximum bulblet formation (2.0) was recorded with Perlite and vermiculite. Among cultivars, maximum weight of bulblets formed (3.32 g) was recorded in *cv*. 'yellow diamond' which was statistically at par with cv. '*Parrano*" (3.09 g)'.

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Chapter-3

MATERIAL AND METHODS

The present investigation 'Standardization of growing media for pot culture of Crown lily (*Fritillaria imperialis* L.)' was carried out during the year 2017-18. The details of the materials used and techniques employed during the course of studies are being described in this chapter.

3.1 Experimental site

3.1.1 Location

The Floriculture Experimental Field, Shalimar is situated at $34^{o}.9'$ N latitude and $74^{0}.50'$ E longitude at an elevation of 1606 meters above sea level.

3.1.2 Climate

The climate, in general, is temperate-cum-Mediterranean of continental type with June and July being hottest months and December, January and February the coldest months.

3.2 Growing media

In the present investigation, different growing media were prepared using Sand, Soil, Farm Yard Manure, Forest litter, Sheep manure and Vermicompost in different proportions. The constituents of growing media were the first solar sterilized for a week before planting of the bulbs. Thorough cleaning of the media constituents was done by removing the stones, pebbles and unwanted materials present in it. Different growing media as per technical programme were prepared by mixing Sand, Soil, FYM, Forest litter, Sheep manure and Vermicompost in required ratios. The respective media were then filled into plastic pots with drainage holes for aeration and drainage of excess water.

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3.3 Planting

Uniform sized *Fritillaria* bulbs were selected for the experimentation. Before planting, bulbs were treated in a solution comprising of Bavistin (0.1%) and Dithane M-45 (0.2 %) for 30 minutes. The excess water is drained out and bulbs were planted at a depth of 10-12cm with 1 bulb per pot. The optimum moisture level was maintained in the medium by spraying water depending on the requirement.

3.4 Cultural operations

The crop was grown following standard cultural practices. Immediately after planting, light watering was applied to maintain a uniform level of moisture**.** Irrigation was applied at weekly intervals after sprouting during the entire growing period. The frequency of irrigation was, however, scheduled depending upon the prevailing weather conditions. Manual weeding helped in control of weeds. Hoeing, being performed with a garden hoe from time to time helped in loosening of the Soil and control of weeds.

3.5 Experimental Details

The details of the treatment combination and their respective notation are given below:

Treatment codes	Treatment Combination Details
T_1	Soil (control)
T_2	Soil+ Sand (1:1)
T_3	Soil +Sand (2:1)
T_4	Soil + Sand + FYM (1:1:1)
T_5	Soil + Sand + FYM (1:1:2)
T_6	Soil + Sand + Vermicompost (1:1:1)
T_7	Soil + Sand + Vermicompost (1:1:2)

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T_8	Soil + Sand + Sheep manure (1:1:1)
T_9	Soil + Sand + Sheep manure (1:1:2)
T_{10}	Soil + Sand + Forest litter (1:1:1)
T_{11}	Soil + Sand + Forest litter (1:1:2)

Number of treatment combinations : 11

Number of replications : 03

Experimental design : CRD (Complete Randomized Design)

3.6 Observations recorded

3.6.1 Days taken for sprouting

Days taken for sprouting were recorded from the date of planting of the bulb to the appearance of sprouts above growing medium.

3.6.2 Plant height at flowering (cm)

Plant height was measured from the surface of Soil to the top of inflorescence with the help of meter rod in centimeters at peak flowering stage

3.6.3 Number of leaves per plant

Total number of leaves on a plant was4 counted at the peak flowering stage

3.6.4 Leaf area (cm^2)

Leaf area per plant was calculated with the help of digital leaf area meter (Systronics-211).

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3.6.5 Stalk thickness (cm^2)

The thickness of stalk was recorded with the help of digital Vernier caliper in centimeters.

3.6.6 Days to floral bud emergence

The Number of days taken to floral bud emergence was counted from the sowing to the visible floral bud appearance.

3.6.7 Number of days taken to flower opening

It was recorded by counting the number of days taken from sprouting to the full opening of flowers.

3.6.8 Number of florets per plant

The total number of florets was counted at the time of plant maturity.

3.6.9 Inflorescence diameter (cm)

Size of inflorescence was recorded as an average of distance between margins of inflorescence in the East to West direction and North to South direction.

3.6.10 Floret diameter (cm)

Floret diameter was measured at the time of fully opened flower with the help of digital Vernier caliper in centimeters.

3.6.11 Floret length (cm)

Floret length was measured with the help of measuring tape in centimeters.

3.6.12 Pot presentability

The quality of the plants was evaluated on the basis of the Point System modified after Conover (1986). The points allotted to various growth and flowering parameters studied have been earmarked out of 100 as per the details are given below:

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	Parameters	Description	Maximum points
1)	**Appearance as the whole plant**	1) Fresh appearance, no indication of senescence, mechanical and insect damage in flowers/stems/shoots/foliage	20 (20)
		2) Fresh appearance but very less indication of senescence	15 (20)
		3) Fresh appearance but a considerable indication of senescence	10 (20)
2)	**Flowering (1)**	Scoring of the pots during flowering (total number of flowers per plant). i. >10 ii. >8 to 10 iii. >7 to 9 iv. >5 to 7 v. >3 to 5 vi. >1 to 5	 20 (20) 18 (20) 15 (20) 12 (20) 10 (20) 08 (20)
	(2)	Scoring of the pots at the time of peak flowering (number of flowers per plant open at a time) i. >10 ii. >8 to 10 iii. >7 to 9 iv. >5 to 7 v. >3 to 5 vi. ≥ 3	 20 (20) 18 (20) 14 (20) 10 (20) 07 (20) 05 (20)
3)	**Form**	1) Plant in balance with pot, neither too large nor too small (generally 1.5-2.0 times the height of the container) and optimum plant spread.	20 (20)
		2) Plants too large or too small and less plant spread	12 (20)
4)	**Stem and foliage**	1) Plant self-supportive with very strong stems having foliage healthy and free of any infestation of insect pests diseases and bruises etc.	20 (20)
		2) Plants less self-supportive with relatively less strong stems, foliage somewhat healthy and having a little infestation of insect-pests, diseases and bruises etc.	15 (20)
		3) Plants not self supportive, having less strong stems with unhealthy foliage and considerable infestation of insect- pests, diseases, and bruises etc.	10 (20)

3.6.13 Days to senescence

A number of days were counted from an opening of the first flower till the last flower on the plant faded.

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3.6.14 Seed set

Seed set was calculated by counting the average number of seeds set per treatment.

3.6.15 Bulb weight (g)

It was recorded by weighing each bulb per plant using an electronic weighing balance and then taking the mean weight of all the bulbs.

3.6.16 Bulb size (cm)

This observation was recorded by measuring the bulb diameter with the help of a digital Vernier caliper.

3.6.17 Number of bulbs per plant

It was recorded by counting the number of daughter bulbs obtained from a plant.

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Plate-1: General view of trial

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Chapter - 4

EXPERIMENTAL FINDINGS

The present chapter deals with the observations concerning various aspects of growth, flowering and bulb production of *Fritillaria imperialis* L. as influenced by various substrates. The study was carried out in plastic pots during autumn of 2017 up to July of 2018 at the Experimental Farm of Division of Floriculture and Landscape Architecture, SKUAST-K, Shalimar. The data has been presented in tabular form.

4.1 Effect of growing substrates on growth characters of *Fritillaria imperialis* L

4.1.1 Days to Bulb Sprouting

In general, media amendments seems to have a positive effect on bulb sprouting with earlier sprouting observed in all the amended media over control (T_1 Soil; v/v). Earliest sprouting (146 days) was, however, observed when bulbs of *Fritillaria imperialis* were planted in growing medium containing Soil +Sand + Forest litter ; 1:1:2;v/v (T_{11}), which was found to be at par with the treatment (T_7) containing Soil +Sand + Vermicompost; 1:1:2;v/v. On the other hand, the maximum delay in sprouting (156.33 days) was observed in T_1 (Soil v/v).

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Table-1: Effect of growing media on days taken for bulb sprouting of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Days to Bulb Sprouting (mean)
T_1	Soil (control)	156.33
T_2	Soil+ Sand (1:1)	152.50
T_3	Soil +Sand (2:1)	151.00
T_4	Soil +Sand + FYM (1:1:1)	148.33
T_5	Soil +Sand + FYM (1:1:2)	147.00
T_6	Soil +Sand + Vermicompost (1:1:1)	149.00
T_7	Soil +Sand + Vermicompost (1:1:2)	146.50
T_8	Soil +Sand + Sheep manure (1:1:1)	148.00
T_9	Soil +Sand + Sheep manure (1:1:2)	147.00
T_{10}	Soil +Sand + Forest litter (1:1:1)	150.67
T_{11}	Soil +Sand + Forest litter (1:1:2)	146.00
C.D ($p \leq 0.05$)		**3.96**

4.1.2 Plant height (cm)

Among different growing media, maximum plant height (73.47 cm) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v). On the other hand, minimum plant height (61.00 cm) was recorded when bulbs were grown in T_1 Soil (control); v/v).

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Table -2: Effect of growing media on plant height of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Plant Height at Flowering (cm)
T_1	Soil (control)	61.00
T_2	Soil+ Sand (1:1)	61.67
T_3	Soil +Sand (2:1)	62.67
T_4	Soil +Sand + FYM (1:1:1)	64.88
T_5	Soil +Sand + FYM (1:1:2)	66.45
T_6	Soil+ Sand + Vermicompost (1:1:1)	68.60
T_7	Soil+ Sand + Vermicompost (1:1:2)	69.18
T_8	Soil +Sand + Sheep manure (1:1:1)	67.90
T_9	Soil +Sand + Sheep manure (1:1:2)	68.50
T_{10}	Soil +Sand + Forest litter (1:1:1)	68.78
T_{11}	Soil +Sand + Forest litter (1:1:2)	73.47
C.D ($p \leq 0.05$)		**3.148**

4.1.3 Number of leaves per plant

The data recorded on number of leaves has been presented in Table-3 and From perusal of the data it is quite evident that the number of leaves was significantly affected by various substrates and the highest number of leaves (63.33) was found in treatment T_{11} (Soil + Sand + Forest litter, 1:1:2; v/v.) followed by treatment T_7 comprised of Soil + Sand + Vermicompost, 1:1:2 registering (60.00) leaves per plant. The lowest plant height (50.00) was observed in the treatment T_1 (Soil). In the present study, media amended with Forest litter proved most superior for enhancing a number of leaves per plant.

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Table -3 **Effect of growing media on the number of leaves on *Fritillaria imperialis* L.**

Treatment codes	Treatment Combination Details	No. of leaves plant^{-1}
T_1	Soil (control)	50.00
T_2	Soil+ Sand (1:1)	52.00
T_3	Soil +Sand (2:1)	53.00
T_4	Soil +Sand + FYM (1:1:1)	53.33
T_5	Soil +Sand + FYM (1:1:2)	54.00
T_6	Soil+ Sand + Vermicompost (1:1:1)	60.00
T_7	Soil+ Sand + Vermicompost (1:1:2)	63.00
T_8	Soil +Sand + Sheep manure (1:1:1)	60.33
T_9	Soil +Sand + Sheep manure (1:1:2)	62.00
T_{10}	Soil +Sand + Forest litter (1:1:1)	61.33
T_{11}	Soil +Sand + Forest litter (1:1:2)	63.33
C. D ($p \leq 0.05$)		**2.30**

4.1.4 Leaf area (cm^2)

The perusal of data revealed that the leaf area was significantly influenced by growing media. Significantly highest leaf area (3070.00 cm^2) was recorded in (T_{11}) Soil +Sand + Forest litter (1:1:2) whereas the lowest (2995.00 cm^2) was recorded in (T_1) Soil (control).

Table- 4: Effect of growing media on leaf area of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Leaf area (cm^2)
T_1	Soil (control)	2995.00
T_2	Soil+ Sand (1:1)	3004.33
T_3	Soil +Sand (2:1)	3006.20
T_4	Soil +Sand + FYM (1:1:1)	3009.43
T_5	Soil +Sand + FYM (1:1:2)	3027.33
T_6	Soil+ Sand + Vermicompost (1:1:1)	3052.67
T_7	Soil+ Sand + Vermicompost (1:1:2)	3068.33
T_8	Soil +Sand + Sheep manure (1:1:1)	3051.00
T_9	Soil +Sand + Sheep manure (1:1:2)	3053.33
T_{10}	Soil +Sand + Forest litter (1:1:1)	3052.60
T_{11}	Soil +Sand + Forest litter (1:1:2)	**3070.00**
C.D ($p \leq 0.05$)		**4.26**

4.1.5 Stalk thickness (cm)

Maximum stalk thickness (1.92 cm) was recorded when *Fritillaria imperialis* were grown in T_{11} (Soil +Sand + Forest litter; 1:1:2; v/v). The results were found to be at par when the bulbs were grown in T_7 containing Soil + Sand + Forest litter 1:1:2; v/v (1.88 cm). In contrast, stalk thickness was found the minimum (1.34 cm) in T_1 Soil (Control).

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Table -5: Effect of growing media on stalk thickness of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Stalk thickness (cm)
T_1	Soil (control)	1.34
T_2	Soil+ Sand (1:1)	1.53
T_3	Soil +Sand (2:1)	1.61
T_4	Soil +Sand + FYM (1:1:1)	1.67
T_5	Soil +Sand + FYM (1:1:2)	1.74
T_6	Soil+ Sand + Vermicompost (1:1:1)	1.74
T_7	Soil+ Sand + Vermicompost (1:1:2)	1.88
T_8	Soil +Sand + Sheep manure (1:1:1)	1.51
T_9	Soil +Sand + Sheep manure (1:1:2)	1.42
T_{10}	Soil +Sand + Forest litter (1:1:1)	1.55
T_{11}	Soil +Sand + Forest litter (1:1:2)	1.92
C.D ($p \leq 0.05$)		**0.249**

4.2 Effect of growing substrates on floral characters of *Fritillaria imperialis* L

4.2.1 Days to floral bud emergence

Data revealed that days taken to the appearance of 1st floral bud were significantly affected by different substrates. A perusal of data clearly shows that substrate (T_{11}) consisting of Soil + Sand + Forest litter (1:1:2), was significantly superior over other substrates and took lesser days (162.00) for bud appearance. This treatment was statistically at par with substrate Soil + Sand + Vermicompost (1:1:2), wherein 1st floral bud was evidenced after (162.33) days. However, Soil alone (T_1) showed the most delayed floral bud appearance and took (169.00) days.

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Table-6: Effect of growing media on number days taken to floral bud appearance of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Days took to floral bud appearance
T_1	Soil (control)	172.00
T_2	Soil+ Sand (1:1)	171.33
T_3	Soil +Sand (2:1)	170.33
T_4	Soil +Sand + FYM (1:1:1)	166.67
T_5	Soil +Sand + FYM (1:1:2)	166.67
T_6	Soil+ Sand + Vermicompost (1:1:1)	167.00
T_7	Soil+ Sand + Vermicompost (1:1:2)	165.33
T_8	Soil +Sand + Sheep manure (1:1:1)	167.00
T_9	Soil +Sand + Sheep manure (1:1:2)	165.67
T_{10}	Soil +Sand + Forest litter (1:1:1)	166.33
T_{11}	Soil +Sand + Forest litter (1:1:2)	164.00
C.D ($p \leq 0.05$)		**0.07**

4.2.2 Days to flower opening

An overview of the data (Table-7) clearly showed significant effects of various substrates on days taken to flower opening. Data revealed that the plants are grown in treatment T_{11} i.e.; Soil +Sand + Forest litter (1:1:2); v/v took a minimum number of days for flower opening (169.00 days) whereas; a maximum number of days (178.00) were recorded in treatment T_1. Further, treatment T_7 was at par taking 169.33 days, respectively**.**

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Table -7: Effect of growing media on a number of days taken to the flowering of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Days to flower opening
T_1	Soil (control)	186.02
T_2	Soil+ Sand (1:1)	184.17
T_3	Soil +Sand (2:1)	183.71
T_4	Soil +Sand + FYM (1:1:1)	181.23
T_5	Soil +Sand + FYM (1:1:2)	179.78
T_6	Soil+ Sand + Vermicompost (1:1:1)	178.51
T_7	Soil+ Sand + Vermicompost (1:1:2)	174.44
T_8	Soil +Sand + Sheep manure (1:1:1)	180.02
T_9	Soil +Sand + Sheep manure (1:1:2)	177.00
T_{10}	Soil +Sand + Forest litter (1:1:1)	178.67
T_{11}	Soil +Sand + Forest litter (1:1:2)	174.16
C.D ($p \leq 0.05$)		**0.34**

4.2.3 Number of florets per plant

An appraisal of data in Table 8 elucidates that a number of florets per plant were significantly affected by different growing media. *Fritillaria* bulbs grown in T_{11} (Soil +Sand + Forest litter 1:1:2; v/v) gave maximum number of florets per plant (6.67), it was found to be at par with the treatment T_7 containing (Soil +Sand + Vermicompost 1:1:2 v/v ;) On the other hand, minimum number of flowers per spike (3.33) was recorded in T_1 (Soil).

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Table -8: Effect of growing media on the number of florets per plant of *Fritillaria imperialis* L

Treatment codes	Treatment Combination	No. of florets
T_1	Soil (control)	3.33
T_2	Soil+ Sand (1:1)	4.00
T_3	Soil +Sand (2:1)	4.66
T_4	Soil +Sand + FYM (1:1:1)	5.00
T_5	Soil +Sand + FYM (1:1:2)	5.33
T_6	Soil+ Sand + Vermicompost (1:1:1)	5.33
T_7	Soil+ Sand + Vermicompost (1:1:2)	6.00
T_8	Soil +Sand + Sheep manure (1:1:1)	5.67
T_9	Soil +Sand + Sheep manure (1:1:2)	6.00
T_{10}	Soil +Sand + Forest litter (1:1:1)	5.33
T_{11}	Soil +Sand + Forest litter (1:1:2)	6.67
C.D ($p \leq 0.05$)		**0.785**

4.2.4 Inflorescence diameter (cm)

A perusal of data in Table 9 reveals that growing media had a significant effect on inflorescence size (cm) in *Fritillaria imperialis*. Among different growing media, larger sized inflorescence (10.57 cm) was observed in T_{11} (Soil +Sand + Forest litter 1:1:2; v/v) which was found to be at par with the treatment T_7 containing (Soil +Sand + Vermicompost 1:1:2; v/v) medium. In contrast, the size of inflorescence (7.30 cm) was recorded minimum in *Fritillaria* grown in T_1 (Soil).

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Table-9: Effect of growing media on the diameter of the inflorescence *Fritillaria imperialis* L

Treatment codes	Treatment Combination Details	Inflorescence diameter (cm)
T_1	Soil (control)	7.30
T_2	Soil+ Sand (1:1)	7.84
T_3	Soil +Sand (2:1)	8.57
T_4	Soil +Sand + FYM (1:1:1)	9.13
T_5	Soil +Sand + FYM (1:1:2)	9.30
T_6	Soil+ Sand + Vermicompost (1:1:1)	9.21
T_7	Soil+ Sand + Vermicompost (1:1:2)	10.33
T_8	Soil +Sand + Sheep manure (1:1:1)	9.80
T_9	Soil +Sand + Sheep manure (1:1:2)	10.13
T_{10}	Soil +Sand + Forest litter (1:1:1)	9.33
T_{11}	Soil +Sand + Forest litter (1:1:2)	10.57
C.D ($p \leq 0.05$)		**0.153**

4.2.5 Floret diameter (cm)

A perusal of data in Table 9 reveals that growing media had a significant effect on floret diameter (cm) in *Fritillaria imperialis*. Among different growing media, larger floret diameter (4.98 cm) was observed in T_1 Soil (control) medium. In contrast, diameter of floret (3.33 cm) was recorded minimum in *Fritillaria* grown in T_{11} (Soil +Sand +Forest litter 1:1:2; v/v).

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Table-10: Effect of growing media on floret diameter per plant of *Fritillaria imperialis* L

Treatment codes	Treatment Combination Details	Floret diameter (cm)
T_1	Soil (control)	4.98
T_2	Soil+ Sand (1:1)	4.57
T_3	Soil +Sand (2:1)	4.38
T_4	Soil +Sand + FYM (1:1:1)	4.35
T_5	Soil +Sand + FYM (1:1:2)	4.06
T_6	Soil+ Sand + Vermicompost (1:1:1)	4.11
T_7	Soil+ Sand + Vermicompost (1:1:2)	3.86
T_8	Soil +Sand + Sheep manure (1:1:1)	4.17
T_9	Soil +Sand + Sheep manure (1:1:2)	3.87
T_{10}	Soil +Sand + Forest litter (1:1:1)	4.07
T_{11}	Soil +Sand + Forest litter (1:1:2)	3.33
C.D ($p \leq 0.05$)		**0.70**

4.2.6 Floret length (cm)

The observations recorded on floret length are presented in Table-11. Significant effects of growing media were observed on floret length. Largest floret length (5.87 cm) was recorded under growing media T_{11} comprising of (Soil +Sand + Forest litter 1:1:2; v/v) whereas smallest flower diameter (4.33cm) was noticed with medium Soil alone (T1). Further, treatments T_7 and T_5 were at par with each other, registering value of 5.79 and 5.76 cm, respectively.

Table-11: Effect of growing media on floret length per plant of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Floret length (cm) mean
T_1	Soil (control)	4.33
T_2	Soil+ Sand (1:1)	5.13
T_3	Soil +Sand (2:1)	5.16
T_4	Soil +Sand + FYM (1:1:1)	5.17
T_5	Soil +Sand + FYM (1:1:2)	5.76
T_6	Soil+ Sand + Vermicompost (1:1:1)	5.59
T_7	Soil+ Sand + Vermicompost (1:1:2)	5.79
T_8	Soil +Sand + Sheep manure (1:1:1)	5.64
T_9	Soil +Sand + Sheep manure (1:1:2)	5.74
T_{10}	Soil +Sand + Forest litter (1:1:1)	5.36
T_{11}	Soil +Sand + Forest litter (1:1:2)	5.87
C.D ($p \leq 0.05$)		**0.716**

4.2.7 Presentability (score out of 100)

The data generated on pot presentability score exhibited significant variations due to the effect of different growing media (Table-12). Maximum pot presentability score (84.20) was attained by the treatment T_{11} containing (Soil +Sand + Forest litter 1:1:2; v/v), which was found to be significantly higher over all other cultivars. Whereas, the minimum pot presentability score (73.56) was recorded in treatment T_1 containing Soil alone

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Table -12: Effect of growing media on presentability of *Fritillaria imperialis* L

Treatment codes	Treatment Combination Details	Presentability score (out of 100)
T_1	Soil (control)	73.20
T_2	Soil+ Sand (1:1)	73.60
T_3	Soil +Sand (2:1)	74.00
T_4	Soil +Sand + FYM (1:1:1)	76.43
T_5	Soil +Sand + FYM (1:1:2)	78.43
T_6	Soil+ Sand + Vermicompost (1:1:1)	77.50
T_7	Soil+ Sand + Vermicompost (1:1:2)	83.37
T_8	Soil +Sand + Sheep manure (1:1:1)	77.77
T_9	Soil +Sand + Sheep manure (1:1:2)	79.40
T_{10}	Soil +Sand + Forest litter (1:1:1)	78.43
T_{11}	Soil +Sand + Forest litter (1:1:2)	84.20
C.D ($p \leq 0.05$)		**0.47**

4.2.8 Days to senescence of Flower

Duration of flowering (days) Data depicted in (Table-13). Reflected significant effect of growing media on the duration of flowering. The analysis of data indicated that treatment T_{11} comprising of (Soil + Sand + Forest litter 1:1:2; v/v) recorded maximum duration of flowering (22.33 days) followed by treatment T_7 i.e. (Soil+ Sand + Vermicompost 1:1:2;v/v) (21.83 days) while minimum flowering duration was observed in treatment T_1 i.e. Soil alone (16.67) whereas T_2, T_3 & T_4, T_8 & T_6 and T_5, T_9 & T_{10} were at par with each other registering values of 17.33, 18.50, 18.33, 18.50, 18.83, 19.1, 19.50 and 19.33 days, respectively.

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Table-13: Effect of growing media on days to senescence of flower

Treatment codes	Treatment Combination Details	Days to senescence (flower)
T_1	Soil (control)	16.67
T_2	Soil+ Sand (1:1)	17.33
T_3	Soil +Sand (2:1)	18.50
T_4	Soil +Sand + FYM (1:1:1)	18.33
T_5	Soil +Sand + FYM (1:1:2)	19.17
T_6	Soil+ Sand + Vermicompost (1:1:1)	18.83
T_7	Soil+ Sand + Vermicompost (1:1:2)	21.83
T_8	Soil +Sand + Sheep manure (1:1:1)	18.50
T_9	Soil +Sand + Sheep manure (1:1:2)	19.50
T_{10}	Soil +Sand + Forest litter (1:1:1)	19.33
T_{11}	Soil +Sand + Forest litter (1:1:2)	22.33
C.D ($p \leq 0.05$)		**0.756**

4.2.9 Number of Seeds set per plant

The analysis of data registered on number of seeds set per plant is affected by different growing media in *Fritillaria imperialis* L. has been depicted in (Table-14). The data reveals that seed yield was significantly affected by different substrates and growing medium Soil + Sand + Forest litter 1:1:2; v/v gave maximum seed yield (701.65 numbers/plant), it was found to be at par with the treatment T_7 containing (Soil +Sand + Vermicompost 1:1:2 v/v;) (701.33 numbers/plant). The minimum seed yield was recorded under growing medium Soil alone (626.33 numbers/plant).

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Table-14: Effect of growing media on Number of seeds set per plant

Treatment codes	Treatment Combination Details	Number of seeds set per plant (Mean)
T_1	Soil (control)	626.33
T_2	Soil+ Sand (1:1)	634.67
T_3	Soil +Sand (2:1)	639.67
T_4	Soil +Sand + FYM (1:1:1)	641.03
T_5	Soil +Sand + FYM (1:1:2)	651.67
T_6	Soil+ Sand + Vermicompost (1:1:1)	659.33
T_7	Soil+ Sand + Vermicompost (1:1:2)	701.33
T_8	Soil +Sand + Sheep manure (1:1:1)	691.00
T_9	Soil +Sand + Sheep manure (1:1:2)	685.19
T_{10}	Soil +Sand + Forest litter (1:1:1)	687.48
T_{11}	Soil +Sand + Forest litter (1:1:2)	701.65
C.D ($p \leq 0.05$)		**7.97**

4.3 Effect of growing substrates on Bulb characters of *Fritillaria imperialis* L.

4.3.1 Bulb Weight (g)

A perusal of data in (Table-15). Reveals that variation among different growing media, maximum weight of bulb (149.25 g) was observed in T_{11} (Soil +Sand + Forest litter 1:1:2; v/v;) On the other hand, the minimum weight of bulb (141.00g) was obtained when grown in T_{11} Soil (Control).

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Table-15: Effect of growing media on the weight of bulb per plant of *Fritillaria imperialis* L

Treatment codes	Treatment Combination Details	Bulb weight (g)
T_1	Soil (control)	141.00
T_2	Soil+ Sand (1:1)	140.33
T_3	Soil +Sand (2:1)	143.13
T_4	Soil +Sand + FYM (1:1:1)	145.03
T_5	Soil +Sand + FYM (1:1:2)	146.67
T_6	Soil+ Sand + Vermicompost (1:1:1)	145.07
T_7	Soil+ Sand + Vermicompost (1:1:2)	148.63
T_8	Soil +Sand + Sheep manure (1:1:1)	144.24
T_9	Soil +Sand + Sheep manure (1:1:2)	147.29
T_{10}	Soil +Sand + Forest litter (1:1:1)	146.79
T_{11}	Soil +Sand + Forest litter (1:1:2)	149.25
C.D ($p \leq 0.05$)		**3.87**

4.3.2 Bulb diameter (cm)

A perusal of data in (Table- 16). Reveals that variation due to growing media had a significant effect on bulb diameter (cm) in *Fritillaria*. Among different growing media, the largest bulb size (7.22 cm) was observed in T_{11} (Soil +Sand + Forest litter; 1:1:2; v/v). It was, however, found to be at par with bulb size obtained in T_7 (6.97 cm) (Sand + Soil + Vermicompost; 1:1:2; v/v), T_9 (6.80 cm) (Soil +Sand + Sheep manure 1:1:2;v/v). On the other hand, the minimum bulb diameter (6.37 cm) was recorded in T_1 (Soil).

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Table-16: Effect of growing media on bulb diameter (cm) of *Fritillaria imperialis* L.

Treatment codes	Treatment Combination Details	Bulb size (cm)
T_1	Soil (control)	6.37
T_2	Soil+ Sand (1:1)	6.66
T_3	Soil +Sand (2:1)	6.68
T_4	Soil +Sand + FYM (1:1:1)	6.53
T_5	Soil +Sand + FYM (1:1:2)	6.59
T_6	Soil+ Sand + Vermicompost (1:1:1)	6.70
T_7	Soil+ Sand + Vermicompost (1:1:2)	6.97
T_8	Soil +Sand + Sheep manure (1:1:1)	6.43
T_9	Soil +Sand + Sheep manure (1:1:2)	6.80
T_{10}	Soil +Sand + Forest litter (1:1:1)	6.79
T_{11}	Soil +Sand + Forest litter (1:1:2)	7.22
C.D ($p \leq 0.05$)		**0.401**

4.3.3 Number of bulbs per plant

A perusal of data in (Table-17). Reveals that a number of bulbs were significantly affected by different growing media. The maximum number of bulbs per plant (2.00) was observed in T_{11} (Soil +Sand + Forest litter; 1:1:2; v/v. On the other hand, almost similar results were obtained from the rest of the treatment combinations. On the other hand, minimum bulb diameter (6.37 cm) was recorded in T_{11} (Soil +Sand + Forest litter 1:1:2; v/v).

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Table-17: Effect of growing media on the number of bulbs per plant of *Fritillaria imperialis* L

Treatment codes	Treatment Combination Details	Number of bulbs
T_1	Soil (control)	1.00
T_2	Soil+ Sand (1:1)	1.00
T_3	Soil +Sand (2:1)	1.33
T_4	Soil +Sand + FYM (1:1:1)	1.00
T_5	Soil +Sand + FYM (1:1:2)	1.33
T_6	Soil+ Sand + Vermicompost (1:1:1)	1.33
T_7	Soil+ Sand + Vermicompost (1:1:2)	1.67
T_8	Soil +Sand + Sheep manure (1:1:1)	1.33
T_9	Soil +Sand + Sheep manure (1:1:2)	1.33
T_{10}	Soil +Sand + Forest litter (1:1:1)	1.00
T_{11}	Soil +Sand + Forest litter (1:1:2)	2.00
C.D ($p \leq 0.05$)		**0.55**

Plate-2: Flower bud emergence

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Plate 3(a): Flowering stage of crop

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Plate 3(b): Flowering stage of crop

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Plate 3(c): Flowering stage of crop

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Plate 4: Seed formation

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Plate 5: Seed of *Fritillaria Imperialis*

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Plate 6: Bulb of *Fritillaria Imperialis*

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Chapter-5

DISCUSSION

5.1 Vegetative parameters

Fritillaria imperialis is one of the unknown and underutilized geophyte, with multiple origins and is been observed growing excellently in wild area of its respective geological center of origins including Kashmir valley. The geophyte has been observed to grow vigorously around the lawns of oldest Sufi shrines, graveyards etc. The plant is having a unique shape of flowers, and is known to dazzle the brides during the ceremonial departure, hence the name ‘‘weeping bride’’. The crop is having the potential to overtake the conventional flowers supplied in the market. Keeping in view the scenario and the potentiality of the crop in mind the foregoing investigation entitled “Standardization of growing media for pot culture of crown lily (*Fritillaria imperialis* L.)’’ was undertaken to find out the suitable growing media.

In the foregoing investigation different growing media were evaluated for their respective influence on overall growth and bulb production of *Fritillaria imperialis* L. It was recorded that almost all the treatments were having the significant impact on vegetative growth like plant height, number of leaves /plant, leaf area, stalk thickness and bulb sprouting of the crop. The appraisal of data recorded revealed that among all the treatments, treatment T_{11} (1 Soil +1 Sand + 2 Forest litter) significantly influenced the vegetative parameters as depicted by their highest numerical values. The results of influences the growth of fritillary with the Forest litter might be due to the fact that the crop is phylogenetically adapted to the wild climate of coniferous Forests. Forest litter acts as an excellent growing media in terms of holding moisture, improving the porosity of Soil and harboring the symbiotic microorganisms and Soil arthropods. The complexity of the bulb and Forest Soil/litter relationship is yet to be unraveled. The probable reasons of hassle-free growing of *Fritillaria imperialis* L. in Forest litter might be

also due to the symbiotic relationship of crop bulb with the surrounding media, as its well-known that the bulbs of *Fritillaria imperialis* L. are exuding some chemicals those might be beneficial in improving the Soil microbe/arthropod quantum hence the results. Furthermore, Forest ecosystem arthropod communities play a vital role in decomposition and production of humus (Bird *et al.* 2000: Ponge et al. 1986). Humus is considered an important media for bulbous growth this might have influenced the sturdy vegetative growth of *Fritillaria imperialis* L. furthermore.

5.2 Floral and Seed parameters

While comparing the results of different growing media on floral and seed characteristics of *Fritillaria imperialis* L., astonishingly to our results the impact of treatment T_{11} (1 Soil +1 Sand + 2 Forest litter) was significant in influencing the floral and seed attributes of *Fritillaria imperialis* L. viz., days to floral bud emergence, days to flower opening, number of florets/plant, inflorescence diameter, floret diameter/length, days to senescence, presentability and seed set. The sturdy growth and vigour of the crop were recorded among the treatment having more Forest litter (T_{11}). The tendency of more vigorous increases with increased partiality of shade. The results reflect the fact that the crop *Fritillaria imperialis* L. is more adapted to grow freely under its corresponding natural habitat and climate conditions. The results indicated the crop specificity towards the edaphic conditions. The improved results of floral and seed parameters are reflected to the fact that the organisms (especially geophytes) are more responsive when subjected to the natural culturing media (Forest Soil), this perhaps might be due to the complex physiological and chemical interaction between the underground growth and the composition of the active ingredients present within the potting/culturing media. The complexity of bulb physiology and mechanism of its corresponding interaction with the growing media need to be discussed and elaborated further.

5.3 Bulb parameters

Taking into consideration the economic importance of *Fritillaria imperialis* L. bulbs as indicated by the fact that a single bulb price ranges from 50-80 INR in Indian and as well as in Kashmir markets. The investigation was further extended to evaluate the response of *Fritillaria imperialis* L. bulbs towards different proportions and the type of growing/potting media. The investigation is first of its kind to be evaluated under Kashmir conditions. To our observation, the rate of multiplication, size and weight of bulbs were significantly impacted when the crop was subject to growing media containing 1 Soil +1 Sand + 2 Forest litter (T_{11}). It's noteworthy that the results may seem statistically significant but while comparing to the same treatment the improvement in the aforementioned observations was seen beyond the normal under shade conditions. Thus to our opinion, the growth and bulb production of *Fritillaria imperialis* L. could be further improved if the crop is subjected to an artificial or natural shade. Furthermore, the physical properties of Forest litter (like movement of water in both vertical and horizontal direction, water retention capacity, nutrient status, porosity and the presence of some beneficial microorganisms and arthropods) and the intrinsic relationship between the bulb and media are having a tremendous influence on any geophytes especially the *Fritillaria imperialis* L. crop. Soil microbial activity and biomass varies with crop species and is dependent on various factors like Soil moisture, temperature, Soil texture, organic matter content etc., (Kramer and Green 2000). Furthermore, the presence of dissolved organic matter (DOM) Forest Soils plays an important role in cycling and availability of nutrients to plants (Hebert and Bertsch 1995), consequently all these factors might have contributed to improved yield attributes. Furthermore, *Fritillaria* growing in media containing Forest litter showed the increased leaf area as well as leaf thickness, therefore, producing more photo-assimilates and thus total photosynthetic capacity might have also provided greater photosynthates to the bulb and helpful in increasing the number as well as the fresh weight of the bulbs.

Chapter-6

SUMMARY AND CONCLUSION

The present investigation entitled "Standardization of growing media for pot culture of Crown lily (*Fritillaria imperialis* L.)" was carried out at the experimental farm of Department of Floriculture and Landscape Architecture, Sher-e-Kashmir University of Agricultural Sciences and Technology Kashmir) during 2017-2018. In this experiment, the effect of different growing media on *Fritillaria imperialis* L was studied. The results obtained are summarized observation-wise below:

- The bulbs of *Fritillaria imperialis* L. sprouted earlier (146.00 days) when planted in growing medium containing (Soil+ Sand + Forest litter; 1:1:2; v/v). (T_{11}) and maximum delay in sprouting (156.33 days) was observed in T_1 i.e. when bulbs were grown in Soil (control).
- Among different growing media, maximum plant height (73.47 cm) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and minimum plant height (61.00 cm)was recorded when bulbs were grown in T_1 Soil (control)
- Bulbs grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), resulted in a maximum number of leaves per plant (63.33) and it was recorded minimum (50.00) when bulbs were grown in T_1 Soil (control).
- Among different growing media, earliest flowering (174.16days) was observed when bulbs of *Fritillaria* were planted in medium containing T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and maximum delay in flowering (186.02 days) was noted when bulbs were grown in T_1 Soil (control).
- In case of growing media, maximum stalk thickness (1.92 cm) was recorded when *Fritillaria* was grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and it was found the minimum (1.34 cm) in T_1 Soil (control)

- *Fritillaria imperialis* L bulbs grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), gave a maximum number of florets/spike (6.67) and minimum number of flowers per spike (3.33) were recorded in T_1 Soil (control).
- Among different growing media, larger sized inflorescence (10.57cm) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and size of inflorescence (7.30 cm) was recorded minimum in *Fritillaria* bulbs grown in T_1 Soil (control).
- The longest duration of flowering (22.33 days) was obtained when bulbs were grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and bulbs grown in T_1 Soil (control) recorded minimum flowering duration (16.67 days).
- Among different growing media, highest preventability score (84.20) was achieved when the bulbs were grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and minimum score (73.20) was recorded when the bulbs were grown in T_1 Soil (Control)
- No disease symptoms were observed during the study period.
- Among different growing media, a maximum number of bulbs per plant (1.14) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and a minimum number of bulbs (1.00) was recorded in T_1 Soil (control).
- Among different growing media, largest bulb size (7.22cm) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and minimum bulb diameter (6.37cm) was recorded in T_1 Soil (Control)
- Maximum weight of bulb (149.25 g) was observed in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and a minimum weight of bulb (141.00 g) was obtained when bulbs were grown in T_1 Soil (Control).
- Among different growing media, the maximum number of bulblets (2.00) was observed when bulbs were grown in T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v), and minimum (1.00) in T1 Soil (Control)

CONCLUSION

Based upon the study i.e., "To find out suitable growing media for growth and flowering on pot culture of Crown lily (*Fritillaria imperialis* L.)" it is concluded that the treatment T_{11} (Soil+ Sand + Forest litter; 1:1:2; v/v) resulted in sturdy vegetative growth, quality floral attributes and higher bulb yield in *Fritillaria imperialis* L.

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➢ APPENDIX:

Physico-chemical properties of different growing substrates used

Treatments	pH	EC	Bulk density (g/cm^3)	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1	6.93	0.17	1.32	0.91	393.56	9.94	184.17
T_2	6.97	0.16	1.24	0.62	329.21	8.73	163.87
T_3	6.93	0.16	1.30	0.85	374.92	9.10	177.91
T_4	6.87	0.17	1.19	3.73	516.46	14.71	229.53
T_5	6.90	0.16	1.17	5.38	537.36	15.68	238.52
T_6	6.90	0.15	1.05	15.62	594.86	16.28	291.26
T_7	6.70	0.16	0.92	14.60	607.39	20.56	300.11
T_8	6.73	0.17	1.10	8.71	464.13	12.08	255.71
T_9	6.67	0.16	1.06	11.15	482.89	13.56	264.24
T_{10}	6.77	0.17	1.08	11.74	506.72	9.76	253.94
T_{11}	6.80	0.16	0.92	18.71	525.03	21.18	261.28
C.D ($p \leq 0.05$)	**NS**	**NS**	**0.05**	**1.11**	**19.94**	**1.68**	**10.03**