EFFECT OF DIFFERENT GROWING MEDIA AND BIOAGENT APPLICATIONS ON GROWTH AND SURVIVAL OF MANGO GRAFTS (*Mangifera indica* L.) cv. KESAR

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(FRUIT SCIENCE)

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COLLEGE OF AGRICULTURE
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PARBHANI 431 402 (M.S.) INDIA

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BY

AMBRISH S

B.Sc. (Hons.) Horticulture

A thesis submitted to
Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani
in partial fulfilment of the requirement for the degree of

MASTER OF SCIENCE
IN
HORTICULTURE
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DEPARTMENT OF HORTICULTURE

COLLEGE OF AGRICULTURE

VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH

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2022

DECLARATION BY THE CANDIDATE

I hereby declare that the thesis entitled, **"Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar"** submitted by me is based on the actual work carried out by me under the guidance and supervision of **Dr. A. S Lohakare**. The extent of information derived from the existing literature have been duly cited and referenced. The existing research work or its any part is not submitted anywhere else for the award of any degree or diploma.

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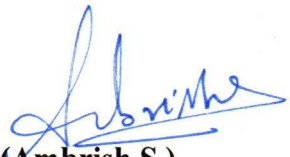

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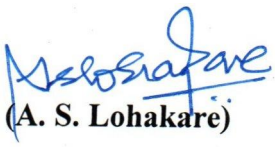

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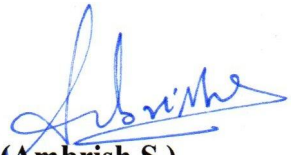

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ABBREVIATIONS

%	-	Per cent
C.D	-	Critical difference
cm	-	Centimetre
C.V	-	Coefficient of variation
cv.	-	Cultivar
RBD	-	Randomized block design
DAG	-	Days after grafting
et al.	-	Et alia (and association)
Fig.	-	Figure
FYM	-	Farm Yard Manure
g	-	Grams
GA_3	-	Gibberellic acid
Anon.	-	Anonymous
ha	-	Hectare
Hrs	-	Hours
Kg	-	Kilogram (s)
m	-	Meter
cm^2	-	Centimetre square
mm	-	Millimetre
mg	-	Milligram
ml	-	Millilitre
mg/l	-	Milligram per liter
MSL	-	Mean Sea Level
No.	-	Number
^0C	-	Degree Celsius
RH	-	Relative Humidity
ppm	-	Parts per million
NAA	-	Naphthalene Acetic Acid
NS	-	Non- significant
SE±	-	Standard error
Viz.	-	Videlicet (namely)
@	-	At the rate of
PDKV	-	Panjabrao Deshmukh Krishi Vidyapeeth
TNAU	-	Tamil Nadu Agricultural University
VNMKV	-	Vasnthrao Naik Marthwada Krishi Vidyapeeth
Co	-	Coimbatore series
PPFM		Pink pigmented facultative methylotropic bacteria

THESIS ABSTRACT

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1. Title of the Thesis :Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar.
2. Full name of the candidate : Ambrish S.
3. Full name of Research Guide :Dr.Anshul SubhashraoLohakare.
4. Department : Horticulture (Fruit Science).
5. College / University : College of Agriculture, VNMKV, Parbhani.
6. Degree to be awarded : M.Sc. (Horticulture).

ABSTRACT

An investigation entitled "Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar"was carried out at College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhaniduring the year 2021-2022. The experiment was laid out in randomized block design with thirteen treatments replicated thrice. The experiment consisted of 13 treatments *viz.* control- Orchard soil (T_1), Orchard soil + FYM (2:1) + Biomix 1% (T_2), Orchard soil + Biomix 1% (T_3), Orchard soil + FYM + Sand (2:1:1) + Biomix 1% (T_4), Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (T_5), Clay soil + FYM (1:1) + Biomix 1% (T_6), Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% (T_7), Orchard soil + Sand (1:1) + Biomix 1% (T_8), Orchard soil + Vermicompost (1:1) + Biomix 1% (T_9), Cocopeat + FYM (1:1) + Biomix (T_{10}), Orchard soil + FYM (2:1) + PSB (0.5%) (T11), Orchard soil + FYM (2:1) + PSB 1% (T_{12}), Cocopeat + FYM (1:1) (T_{13}).

Different growing media significantly influenced on growth and survival of mango grafts. Among different treatment combinations treatment T_7- Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% showed better in terms of minimum number of days required for sprouting (10.52) and highest success percentage (74.31 %)at 120 DAG. Treatment T_7 also showed highest survival percentage (87.06%, 83.17 %, 78.33%, 74.31 %) and minimum mortality percentage (12.94 %, 16.83 %,

21.67 %, 25.69 %) at 30,60,90 &120 DAG respectively. Graft growth attributes *viz*. maximum height of grafts (24.24, 28.25 cm, 31.38 cm and 34.33 cm), girth of scion (6.66 mm, 7.11 mm, 7.91 mm and 9.7 mm), length of scion (16.75, 20.16 cm, 23.39 cm and 24.58 cm), number of leaves (7.33, 10.72, 13.78 and 15.69), leaf area (13.36 cm^2, 19.75 cm^2, 23.56 cm^2 and 28.79 $cm^{2)}$were observed with the treatment T_7 at 30, 60, 90 and 120 days after grafting respectively. The maximum root length (24.60 cm), number of primary and secondary root (2.64 g and 43.38 g), fresh and dry weight of root (14.38 g and 8.78 g), fresh and dry weight of shoot (24.53 g and 17.25 g), dry root to shoot ratio (0.55) were also noted in the treatment T_7at 120 days after grafting.

Hence it can be concluded that the mango graft raised on a media combination of orchard soil, FYM and vermicompost with biomix resulted in better physiological growth and survival of mango grafts.

(**Keywords:** Mango, Kesar, grafts success, growing media, biomix)

CHAPTER-I
INTRODUCTION

CHAPTER-I

INTRODUCTION

Fruits are natures gift to mankind and undoubtedly man's oldest food. It is delicious refreshing and also the chief source of vitamins, minerals and proteins.Mango (*Mangifera indica* L.) is a tropical fruit and also known as "King of fruits" belongs to genus Mangifera, family Anacardiaceae which is grown almost all parts of the world. This genus had its origin in the continental region of Burma, Thailand, Indo-China and Malaysia peninsula as reported by in India, it is cultivated at sub-continent for well over 4000 years.

Mangoes possessing the pride position in tropical and subtropical region, between 23° North and South latitude. The mango tree is naturally resilient, withstanding temperatures as high as 48 °C. However, rain and high humidity during flowering and fruit development limit fruit yield. The cultivation of mango plant grows well on wide variety of soils, such as lateritic, alluvial, sandy loamand sandy. It is widely grown and prefers a mild frost-free region with well-drained soil (pH = 5.5-7.5), a winter dry season, temperatures ranging from 24-27 °Cand annual rainfall of 400-3600mm (16-142 inch). Above a pH of 7.5, it does not perform well (Singh 1960). As a result, there is a lot of room for large-scale mango planting in the country's low-rainfall zones, as long as the temperature and soil conditions are favourable.

It is considered an Indian national fruit due to its exquisite taste, excellent flavour or aroma and appealing colour. It includesprotein, a moderate quantity of carbohydrates and minerals such as calcium, phosphorusand iron. It'salso containing the most vitamin A, B_1, B_2, and C. Mango fruit is utilized at all the stages of its development both in immature and mature form. Raw fruits are used making chutney, pickles and drinks. The ripe fruit besides being used as dessert and also utilize for preparing several products like squash, syrup, nectar, jam and jelly.

In India mango industry flourished during middle age and British era. India is the world's greatest mango producer, with an area of 2.29 million hectares with 20.44 million tonnes of annual production and 9.66 MT ha^{-1} productivity during 2019-20 (Anon, 2020). In Maharashtra mango occupies area of 0.166 million ha with 0.791 million tonnes production and 4.75 MT ha^{-1} productivity (Anon, 2020). It is widely

grown in the Indian states of Punjab, Haryana, Uttar Pradesh, Gujarat, Rajasthan, West Bengal, Maharashtra, Orissa, Andhra Pradesh, Karnatakaand Tamil Nadu (Anon, 2020).

Due to the long history of cultivation in this subcontinent, thousands of mango cultivars are known to exist in India. In terms of Kesarvariety it has attractive colour, size, shape, rich flavour, pleasant aroma, outstanding taste and good keeping quality, maximum total sugar and shelf life, moderate days to ripening, minimum physiological weight lossand acidity (Patel *et al*.2003). This type is becoming increasingly popular. As a result, the area under Kesar cultivation is expanding, which will undoubtedly boost output. However, development is not moving at a breakneck pace. The greatest impediment to the rapid expansion of the mango industry is a scarcity of high-quality mango planting material for new plantations. For the expansion of the mango fruit industry, the availability of true-to-type planting material in sufficient quantities is a must.

Mango grafts are created from seedlings (stones). The root stock must be prepared in advance for the preparation of grafts in mango. For improved grafts, timely germinated seedlings with robust and rapid growth are required. Grafting is a vegetative propagation technique used to multiply plants that are genetically identical to the desired tree. Grafted mango trees blossom and yield fruits in a shorter period of time. Because trees grafted on dwarfing root material grow less vigorously and more trees can be accommodated per unit of area. Farmers have good options to graft preferred types with high market and household consumption potential among the many mango varieties available.

The supply of good quality and sufficient planting materials of mango in tropics hinges on the development of good nursery management practices which include growing media.The growing media is most important input for healthy, uniform and quality rootstock seedling production. Apart from the selection of proper ingredients, it is also necessary to maintain the porosity of the potting mixture so that proper development of roots takes place (Srivastava *et al.,* 1998). Growing media is an important input for the container sized seedling production. It is characterized by light weight, friable, good water holding capacity, drainage, porosity, low bulk density, free from fungal spores and insects and low inherent fertility etc. (Edward*et al*., 1988). The organic obtained on composting improves the physical property *viz.,*

porosity,cation exchange capacity, water holding capacity and maintain a balance ratio of carbon and nitrogen in the mixture. The physical attribute may further improve upon by addition of inorganic compound like sand, FYM, vermicompost, vermiculite or perlite (Edward *et al.,* 1988).The production of planting stock of superior quality is the pre-requisite for plantation of an orchard. Therefore, the seedlings raised in good quality nursery media will ensure better establishment and growth when planted to the main field.

Cocopeat which is an agricultural by-product obtained from coconut husk, is considered as a good growing media component with acceptable pH, electrical conductivity and other chemical attributes (Abad *et al*.,2002). It has good physical properties, high total pore space, high water content and low shrinkage, low bulk density and slow biodegradation (Evans *et al*.,1996, Prasad, 1997).Farm yard manure (FYM) is one of the widely used organic manure. It improves soil structure by improving its aeration, water holding capacity and cation exchange capacity by providing essential elements to the plants.Vermicompost are characterized by high porosity, aeration, drainage, water-holding capacity and microbial activity.To ensure that seedlings grow well, the potting mixture should include appropriate nutrients, have a high-water holding capacityand well-drained. Nowadays, it is vital to reduce the cost of planting material manufacturing. FYM is extensively used as a plant growth medium and as a soil amendment. Sand is a fundamental potting media, as well as a coarse and finely divided particles with excellent porosity, aeration, and drainage, but it does not improve water holding capacity. All soils used as medium are not necessarily ideal for seed germination and subsequent seedling/graft growth. Plants in bags have a limited amount of soil and nutrients to grow and thrive. To promote plant growth, the growing medium should have good water retention, drainage, and other physical and chemical qualities. As a result, it is preferable to supply soil media or a mixture that meet the needs for improved seedling growth.

Biomix is a well-balanced and a unique blend of selected species of microbes*viz.,Trichoderma viridae, Aspergillus niger, Pseudomonas striata, Neumoriarelyi, Gluconacetobactor, Bacillus subtillis,* PPFM*, Tricodermaharzianum, Pseudomonas fluorescens, Beauveria bassiana, Metarhiziumanisopliae, Paecilomyceslilacinus, verticillium lecanii and Azospirillumbrasilince.*Itfix atmospheric nitrogen in the soil making it available to plants. It also contains

microbes which can solubilize residual Phosphates, Ironand Magnesium etc. from soil making them more easily available to the plants. It stimulates sprouting and helps to increase the water holding capacity of the soil. It plays a multifunctional role, as vital components of organic amendments and composts, as a means of suppressing insects and plant diseases, to improve crop quality and yields, restores soil micro flora, increases seed germination, promotes deeper rooting system, solubilize and removes phosphate residues from soil, enhances nutrient cycling. Biomix improves growth, yield and quality of crops adding to farm profitability.

The main objective of nurseryman is to achieve maximum success in propagation of planting materials. It is observed that initial sprouting of the grafts is very high but, there is heavy mortality subsequent and it could be due to various factors like use of improper growing media, management, physiological and pathological effects, skill of the operation, climatic condition etc. A successful plant propagator must understand genetics, growth characteristics and adaptability to local climate, soil biotic conditions, principles and limitations of each mode of perpetuation of plant species.Many factors influence the success and subsequent mortality of grafted seedlings. Among them growing media is one of the main parameters that determine the growth of mango grafts.

There has been very little study done in terms of alternative filling media for the normal growth of mango grafts, and a systematic and planned approach is still lacking. Furthermore, an appropriate filling media is necessary to meet the needs of seedling grafts and mango trees for regular growth. As a result, it was proposed to create a better growing medium for good mango grafts by combining FYM, vermicompost, and cocopeat with soil. Therefore, the present studywasconducted to ascertain the **"Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar"**

The information generated by such research will be of prime importance to the farmers and nursery growers in the region. This information will also serve as a valuable guideline to the research workers and nursery growers in other regions too.

With this view the present investigation was carried out with following objectives.

1) To study the effect of mixture of growing media and biomix application ongrowth, survival and success rate of mango grafts cv. Kesar.

2) To identify appropriate media for mango nurseryin order to help nurserygrowers to get healthy, uniform, well developed and more success rate of mango grafts.

CHAPTER-II
REVIEW OF LITERATURE

CHAPTER-II

REVIEW OF LITERATURE

The area under mango is increasing rapidly owing to great demand for fresh fruits as well as processed products in the international market. Even though the area under mango is increasing, the pace of development is not appreciable. The greatest bottleneck in the expansion of area under fruits is the non-availability of genuine and quality planting materials in adequate quantity from reliable nurseries.

Mango seedling propagation is primarily accomplished through asexual methods such as grafting, in which mango seedling serves as a rootstock. Seeds are used to grow rootstock. Potting media is most important and responsible input for uniform, vigorous growth and better establishment of grafts. The success and growth of grafted seedlings is dependent on the potting medium in which they grow in nursery. The choice of a suitable combination of potting media is critical, but there is little information available about the best potting media for fastening and enhancing quality mango grafts production in nursery. Hence, in present investigation entitled "Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv.Kesar"was undertaken at College of Horticulture, VNMKV Parbhani during the year 2021-22 in order to standardizeappropriate potting media for production of mango grafts in nursery. The relevant information on other fruit crops also has been reviewed to throw light on the existing research. The literatures studied in the past on the same aspect have been reviewed and presented under suitable heading as below.

2.1 Influence of growing media mixture and biomix application on growth, survival and success rate of mango grafts cv. Kesar.

Singh and Mann (1976) noticed that soil was the best medium for better vegetative growth of orange seedlings. Furthermore, they emphasized that supplementing this medium with an equal amount of FYM provides a good supply of nutrients to seedlings, resulting in better vegetative growth.

Dhakal (1979) examined stone grafting of mango and found that polybags filled with soil up to two-thirds of the lower part and sand at the top third were the best medium for seedling growth in mango.

Dengale (1980) conducted a study on stone grafting in mango and discovered that media containing soil + FYM (3:1) provided the best sprouting, survival (61-71%), and success (86%).

Nagwekar (1981) studied the survival and growth of mango grafts and found that the soil+ FYM (3:1) medium had the highest percentage of success (78 %) with good graft growth and the soil+ sand medium (1:1) had the lowest.

Sharma and Dhuria (1981) carried out research one standardization of suitable media for walnut propagation under controlled conditions. They discovered that graft success (75 %) was higher in saw dust media than in soil + FYMand sand (1:1:1).

Rai (1982) analyzed the effect of potting mixtures on the survival and growth of mango (*Mangifera indica* L.) stone grafts and discovered that media containing soil + FYM (3:1) had the highest sprouting (75.3%) and survival percentage (66.00%).

Bisla *et al*. (1984) studied the effect of growing media on ber seeds and found that ber seedling mortality was significantly lower (0.95%) in sand and soil (1:1) medium compared to (5.03%) in sand, soil and organic manure (1:1:1) growing medium.

Baghel and Sarawat (1989) investigated on effect of media on hardwood cuttings of pomegranate and observed that the highest length of shoot, number ofleaves per shoot, total number of leaves per cutting and leaf areawere obtained in potting media combination of Soil+ FYM (1:1) while Soil+ FYM+ Sand (1:1:1) had greatest length of root (32.92 cm).

Deol *et al.* (1990) investigated the effects of different rooting media on the rooting and growth of pomegranate hardwood and semi-hardwood cuttings and found that cuttings planted in river silt had the highest rooting success (76.66 %) and survival (64.99 %) of hardwood cuttings, while cuttings planted in soil + FYM (1:1) had the best shoot and root growth.

Mishra (1990) investigated the effect of growth regulators and rooting media on callusing, rooting, and survival of kagzi lime air-layers and discovered that soil + sand + leaf mould (1:1:1) and soil + sand + FYM (1:1:1) were significantly better for rooting of kagzi lime air layering.

Nasir *et al.* (1990) demonstrated that sour orange and troyer citrange seeds sown in a polythene bag containing a mixture of loam, sand, and cattle manure in 2:1:1 proportion had a significantly beneficial effect on the growth of all seedlings in terms of plant height (13.48 cm) and stem diameter (2.46 mm).

Patil and Souza (1990) observed highest survival percentageof stone grafts was obtained under treatment soil + FYM + sawdust (2: 1: 1) 75 % and 83.33% for lateritic and sandy loam soils, respectively, followed by the treatment soil + FYM (3: 1) in both soils.

Anvari*et al.*(1992) conducted an experiment on the effect of different potting media on the growth of rough lemon rootstock and discovered that media containing sand and manure produced the largest stem diameter of citrus plants. Finally, it was determined that sand + peat (1:1) is a superior potting medium for the growth of rough lemon nursery stock, followed by sand + peat + spent compost of Button mushroom (1:1:1).

Govind and Ram chandra (1993) studied the growth of khasi mandarin on different proportions of media and reported that the potting media combination of soil + sand + FYM (2:1:1) in equal proportions was found best for seedling vigour with a maximum germination percentage of 62.3%.

Shamet *et al.*(1994) studied the effect of potting mixture, mulching and fertilizer requirements of chilgoza pine and recorded a maximum plant height (23.67 cm) in the growing media of soil: sand: moss: FYM in a proportion of (1: 1: 1: 1).

Thankamani *et al.* (1996) carried out an experiment to study the response of Black pepper cuttings to propagating media such as vermicompost in comparison with soil, sand, and farm yard manure under nursery conditions and found that cuttings raised in vermicompost were significantly taller (15.90 cm) and had a greater number of leaves (5.64) than in potting mixture.

Mohandas (1997) concluded that a medium consisting of sand, coir dust, and soil in the ratio of (1:2:1) (v/v) produced the highest plant height (28.96 cm), number of leaves (12.23), graft union success (73 %) and highest girth (7.83 mm) of jackfruit grafts.

Herle (1998) conducted a study on the standardization of media for raising tamarind grafts and found that the medium sand + coir dust + soil + compost (1:1:1:1 v/v) produced the most leaves per plant (24.92), most plant height (24.34 cm)and highest graft union success (88.15 %).

Mamatha (1998) carried out an investigation on nutrition management and concluded that a medium containing sand, coir dust, soil, and compost in the ratio of 1:0.5:1:1 (v/v) produced the highest plant height (37.93 cm) and the greatest number of leaves (8.87) in cashewgrafts at 45 days after sowing.

Singh *et al.* (2000) discovered thatmixture of sand, vermicompost, and soil (1:1:2) produced the longest shoot (39.7 cm) and root lengths (37.3 cm) in *Acacia nilotica*.

Reddy *et al.* (2001) investigated alternative media to potting mixture for raising coconut seedlings in Polybags and discovered that the number of roots (16/seedling), root area (4263 cm^2/seedling) and root dry weight (36.52 g/seedling) were significantly higher in sand + vermicompost (1:1) in coconut cv. WCT.

Atiyeh *et al.* (2002) studied the influence of humic acids derived from earthwormprocessed organic wastes on plant growth. They found that the pattern of the plant growth responses observed after incorporating vermicompost into growing media with all necessary mineral nutrition was similar when mixing the growing media with increasing concentrations of humic acids derived from vermicompost, and larger concentrations typically reduced growth.

Etissa *et al.* (2003) conducted a study at the Jimma agricultural research center (Ethiopia) to assess the effect of different media types and weights on avocado seedling emergence and shoot growth and discovered that plant height (14.1 cm) and shoot diameters (0.44 cm) were all highly and significantly affected by media topsoil + FYM (3:2 v/v).

Prabhakara and Melanta (2003) investigated the effect of media on cashew rootstock and graft growth. The potting mixture of equal proportions of red soil and sand produced (1:1) the best rootstock and graft growth as well as the highest percentage of graft success (78%).

Mbakwe (2004) conducted an experiment on the effect of media on depulped and undepulped bush mango and found that sowing depulped fruits of bush mango in mixture of top soil+ sawdust (1:1) can be relied upon for obtaining a very high percentage of seed germination (85 %), because the medium is capable of absorbing and retaining a large amount of water, creating a favorable environment for seed germination, especially during the dry season.

Bachubhai (2005) investigated the effect of media and container on the growth of mango (*Mangifera indica* L.) seedlings and discovered that media had a significant effect on seedling growth, reporting maximum collar diameter (10.79 mm), more dry weight of above ground (11.35 g), underground (4.92 g)and total biomass (15.75 g) of seedlingsin soil 40%: sand 40%: FYM 20%.

Vaghamashi (2005) investigated the effect of growing media on the growth of mango seedlings and concluded that mango seeds should be grown in a media mixture of 40% soil, 40% sand, and 40% FYM.

Das *et al.* (2006) studied the impacts of potting media on air-grafting of five sapota varieties and noticed that the media soil + sand + FYM (1:1:1) produced the highest mean percentage of graft survival (96%) and plant height (6.85 cm) in sapota.

Kaur and Malhi (2006) studied the propagation in mango with epicotyl grafting carried out with seven different growth media and the result revealed that the highest sprouting (83 %) of graft scion was recorded in soil + FYM + sand (1:1:1) similarly graft survival (12.78 %) was found better in soil + FYM + sand (1:1:1) after 4 months of grafting.

Khan *et al*. (2006) studied the effect of different potting media on growth of rough lemonrootstock. The findings revealed that the growth of rough lemon (*C. jambhiri*) nursery stock in sand + peat (1:1) shows maximum plant height (13.58 cm), stem diameter (2.46 mm), number of leaves (13.14) and leaf area index (6.72) and

proved to be a superior potting medium, followed by sand + peat + spent compost of button mushroom (1:1:1).

Khandekar *et al.* (2006) conducted an experiment on the effect of rooting media on nutmeg germination and seedling growth and discovered that media*viz.*,rice bran had significantly higher germination of seeds (82.3%), less time for first emergence (27.17 days) and less time for final emergence (80.83 days). Similarly, shoot length, shoot diameter, leaf number, and leaf area were all significantly greater in these media.

Shah *et al.* (2006) conducted test on effect of different growing media on the rooting of *Ficus binnendijkii*"Amstel Queen" cuttings and found that high leaf area (84.6 cm^2),maximum numbers of leaves (7.0) andmaximum roots (15.00)were obtained in leaf mold. Whereas quickestsprouting (16.7 days) occurred in softwood cuttings that were planted in sawdust.

Rafiq*et al.* (2007) used different soil media alone and in combination to study its effects onpeach seed germination and seedling growth and concluded thatsoil media used in combination i.e.,FYM + sawdust (1:1) improved seed germination (44%) and subsequently growth such as seedling height (98.67cm) and girth (2.87 cm)compared to soil media used alone in peach nursery.

Bachman and Metzger (2008) found that incorporating up to 20% of vermicompost made from pig manure improved the shoot and root weight, leaf area, and shoot: root ratios of tomato and french marigold seedlings, but it had little effect on the growth of pepper and cornflower seedlings. When tomato, french marigold, and cornflower seedlings were transplanted into 6-cell packs, the vermicompost-added medium showed greater plant growth than the control media.

Borah *et al*. (2008) observed better stem girth results in cocopeat and leaf manure containing media, which could be attributed to improved nutrient availability leading to increased production of photosynthetically functional leaves in these media, resulting in improved plant girth.

Rajamanickam *et al.* (2008) carried out work on nursery management of papaya and concluded that papaya cv. CO-2 raised in potting mixture containing vermicompost produced the highest seedling height (28.50 cm), seedling diameter (0.639 cm), petiole diameter (0.186 cm), petiole length (6.410 cm), number of leaves

per seedling (11.65), root length (29.715 cm), root dry weight (0.392 g), shoot dry weight (1.254 g) and root shoot ratio (0.340).

Bashir*et al*. (2009) studied the growth response of rooted cuttings of jojoba raised in different potting media and revealed that the treatment combination of field soil + FYM + leaf mould (1:1:1) gave the maximum survival percentage (76.80), maximum number of shoots (3.72), the highest shoot length (7.70 cm) and the maximum number of leaves per shoot (12.60). Finally, it was determined that combinations of field soil and organic matter in the form of leaf mould or FYM are superior to media consisting solely of field soil or media containing only organic matter for the survival and growth of rooted cuttings.

Bihari *et al.* (2009) conducted an experiment to standardize suitable growing media for aonla nursery and discovered that the effect of growing media on seed germination, transplanting successand seedling mortality percentage was significant where the soil, sand, and FYM at (1:1:1) proportion showed the highest percentage of seed germination (74.00 %) and the lowest seed mortality percentage (18.00 %).

Kumar *et al.* (2009) studied the effect of application of farmyard manure and vermicompost on the vegetative and generative characteristics of *Jatropha curcas* and results showed that addition of vermicompost significantly increased plant survival (98% @ 2 months after planting), plant height (284 cm), stem diameter (94.10 mm) and number of branches/plant (9.8) over FYM and control at 14 months after planting of cutting.

Man *et al.* (2009) conducted an experiment to study the effect of growing media on seed germination and growth of aonla. The maximum seed germination (74%) and minimum mortality percentage (18%) was observed in the treatment containing soil: sand: FYM (1:1:1).

Savani (2006) observed that epicotyl grafted mango cv.Kesar had the highest number of grafts survival, leaf area, and graft growth in red (laterite soil) media + FYM (1:1).

Angrej *et al.* (2010) carried out an experiment on effect of growing media on seed germination and seedling growth of *Physalis peruviana* L. Eight different growing media were created using varying proportions of soil, sand and FYM, as well

as soil alone as a control. The soil+sand+FYM (1:1:1) treatment resulted in the highest germination rate (86.86%), seedling length (36.59 cm), and dry matter accumulation (87.82 mg) similarly leaf area and stem diameter of seedlings were greatest with soil + sand+FYM (2:1:2).

Abirami *et al.* (2010)conducted experiment onnutmeg (*Myristica fragrans*) at Indian Institute of Spice Research, Calicutt, Kerala.Result revealed that, the medium (soil: coir dust: sand: vermicompost) in 1:1:1:1 shows significantly the highest shoot fresh weight (17.70 g), shoot dry weight (8.72 g), seedling height (29.84 cm), seedling girth (0.63cm), number of leaves (21.14), shoot length (30.15 cm) and root length(18.14cm) as compared to treatment soil+sand+ FYM (3:1:1) which recorded shoot fresh weight (16.02 g) and shoot dry weight (7.12 g).

Marathe *et al.* (2010) studied the influence of different potting media on soil properties, plant nutrient contentand nutrient uptake by pomegranate and found that incorporating sand along with organic manures in soil was beneficial in promoting desirable seedling growth by supplementing adequate nutrients and aeration and concluded that soil+sand+vermicompost (1:1:0.5) or soil+sand+farmyard manure (1:1:1) could be used to raise pomegranate seedlings.

Nalage *et al*. (2010) investigated the effect of rootstock height on epicotyl grafting success in mango cv. Kesar. The media used for these grafts was soil + FYM (1:1), and it was discovered that the sprouting percentage of epicotyl grafts was significantly influenced by 6 cm rootstock height at 45, 60, 75, and 90 days of age, with 74.17, 64.17, 58.33, and 55.00 percent, respectively.

Aatla (2011) investigated the effect of pre-sowing treatments on mango growth, vigour, and graft success and concluded that the highest percentage of graft raised (71.57 %), highest height of grafts in mango (24.17 cm), highest diameter of grafts (8.85 mm)and highest number of leaves (11.72) were obtained in red soil + FYM + sand (1:1:1) at A. P. Horticultural University, Rajendranagar.

Dolor (2011) deliberates the effect of media on wild mango or bush mango germination and seedling performance. The findings revealed that there was no media effect on rooting percentage, with river sand recording (21.8%), sawdust (18.1 %),

clayey soil (17.6 %), and top soil recording (21.8%). River sand and top soil had the greatest effect on leaf area, outperforming the other treatments.

Indriyani *et al.* (2011) investigated on effect of growing media on growth of pineapple seedlings by using different potting media such as soil, soil+manure (1:1), soil+sand (1:1), soil+manure+sand (1:1:1), soil+manure+sand (1:1:2), soil +manure +sand (2:1:2). The medium of soil + manure (1:1) produced the best results in terms of plant height (39.06 cm), leaf length (32.80 cm), leaf width (3.87 cm) and leaf number (36.95).

Khan and Ishaq (2011) observed the maximum height (18 cm), number of leaves (51), root length (23 cm), dry weight of roots (10.42 g) and fresh weight of roots (58.53 g) of *Pisum sativum* which grown in Vermicompost media.

Qayom (2011) examined the effect of media composition on seed germination, growthand grafting in mango (*Mangifera indica* L.) and found that soil + sand + compost + coir pith (2:1:1:1) produced the highestplant height (17.88 cm), number of branches (4.67) and number of leaves (16.99).

Aalok*et al*. (2012) conducted an experiment on the influence of different leaf litter vermicompost substitution on the growth of eucalyptus hybrid and found that vermicompost substitution significantly increased seedling germination and plant morphology such as height (115 cm), number of leaves (66.7), number of branches (4.6), total leaf area (1577.96 cm^2), root length (34.2 cm) and number of lateral roots (7) when compared to control.

Ikram *et al.* (2012) investigated the effect of different potting media combinations on tuberose growth and vase life and recorded the maximum plant spread (10.25 cm) and number of leaves (36.09) in the media sand+ FYM (1:1). Whereas Coconut coir + FYM (1:1) increased plant height (41.25 cm), leaf area (50.55 cm^2)and spike length (70.40 cm).

Mahammad *et al.* (2012) investigated the response of ipillpil to different soil media and phosphorus fertilization and found that FYM medium had the greatest shoot length (20 cm), root length (16 cm), shoot dry weight (947 mg/plant)and root dry weight (134 mg/plant).

Parasana *et al*. (2012) studied the effect of growing media on germination and seedlings growth of mango (*Mangifera indica* L.). The outcome revealed after 60 DAS, the minimum days to germinate (27.11) and maximum germination percentage of mango stone (77.33 %) were observed in media soil + sand + farm yard manure (2:1:1). The height of seedling (51.13 cm), number of leaves per plant (15.22), length of shoot (51.13 cm), length of root (36.17 cm), root:shoot ratio (0.70), stem girth (4.07 cm), fresh weight of seedling (28.79 g), dry weight of seedling (18.90 g) and maximum survival (79.67%) were recorded by medium soil+sand+farm yard manure (2:1:1) at 180 DAS.

Rymbai *et al.*(2012) found that maximum rooting percentage (85.00 %), number of primary roots (10.80), secondary roots (22.44), length of longest root (10.78 cm), fresh (2.72 g) and dry root weight, establishment percentage (83.33), number of leaves (6.67) at 45 DAT and (13.83) at 60 DAT, and minimum (8.67) number of days for bud's sprouts were observed when coco peat + sphagnum moss (2:1) were used in air layering of guava.

Yadav *et al*. (2012) carried out an experiment by sowing freshly extracted acid lime seed into different media with or without *Azotobacter* to study their effect on growth and development acid lime seedlings. The results showed that the medium combination soil + sand + vermicompost + vermiculite + cocopeat (1:1:1:1:1) with Azotobacter performed significantly better than the other combinations with regards to height of the seedling (13.75 cm), number of leaves per seedling (22.46), diameter of the stem (3.35 mm), fresh weight (2.77 g) and dry weight of the seedling (1.18 g) were significantly higher under this treatment than under the other treatments used. Furthermore, it was found to be superior in terms of longest tap root length (19.76 cm), diameter of tap root (2.95 mm), number of secondary roots (40.66), root/shoot ratio (2.57), and seedling leaf area (1.43 cm^2).

Anjanawe *et al*. (2013) carried out an experiment onthe effect ofgrowth media and plant growth regulators on seed germination and growth vigour of papaya seedling cv. Barwani red and it was noted thatcompletion of germination (23.75), first appearance of plumule(12.69), appearance of first true leaves(18.25), plant height(17.41cm), fresh weight and dry weight of papaya roots (2.88g and 0.353g

respectively) were found to be significantly higher with FYM: soil: sand (1:1:1) in combination of GA_3 200ppm.

Bali *et al.* (2013) investigated the effect of growing media, nursery beds, and containers on seed germination and seedling establishment of *Terminalia bellirica* and found that seedlings grown in FYM had greater height (40.2 cm), collar diameter (7.1 mm)and survival percentage (90.2 %) when compared to other growing media.

Barman *et al.* (2013) investigated the effect of media and nutrition on cymbidium hybrid growth and flowering and discovered that plants grown in leaf mould + FYM + charcoal + coconut husk + rotten log (2:1:1:1) medium significantly increased the number of shoots per plants (6.11), number of pseudobulb (4.04) length of leaf (37.95 cm) and spike length (66.51 cm).

Bhagat *et al.* (2013) demonstrated the influence of organic amendments such as cocopeat, vermicompost, farmyard manure (FYM) and neem cakein growing media on growth and budability of rough lemon in which early buddable seedlings (85.9%), budding success (93.2%), maximum seedling height, stem diameter, number of leaves, leaf area and root–shoot ratio were recorded with soil+FYM+cocopeat (2:1:1) and concluded that growing media having cocopeat or vermicompost and FYM were more effective than cocopeat alone in increasing the growth, budability and budding success.

Bhardwaj (2013) carried out an experiment on the effect of growing media on seed germination and seedling growth of papaya and reveled that highest germination percent (95.27%), seedling height (23.43 cm), leaf area (349.33 cm^2), number of leaves (10.02), stem girth (3.16 mm), number of roots (17.20), root length (10.20 cm), production of total biomass (5.02 g/plant) and least root/shoot ratio (0.22 and) were observed in medium of vermicompost + sand + pond soil (1:1:1) with 2 cm cocopeat in top of the poly bags.

Patel *et al*. (2013) observed that acid lime cv. kagzi seedlings grow best in soil + cocopeat + vermicompost (1:1:1) media under net house conditions. They also noticed the minimum mortality percentage (10.8), maximum plant height (62.5 cm), number of leaves (37.8), root length (32.2), and total dry weight per plant (0.561g).

Tariq *et al.* (2013) carried out studies on the effect of planting density and growing media on strawberry growth and yield and found that strawberry plants grown in silt, sand, and FYM (1:1:1) showed a significant increase in plant height (20.22 cm), number of leaves (5.55), leaf area (63.85 cm^2), fresh weight of plant (22.21 g) and dry weight of plant (12.71 g) as compared to other media.

Tatlari *et al.* (2013) discovered that the treatment cocopeat + vermicompost (3:1) produced the greatest plant height in *Dracaena marginata* at Islamic Azad University in Iran.

Waseem *et al.* (2013) conducted a pot experiment to investigate the effect of different growing media on the growth and development of stock and discovered that significant maximum plant height(21.43 cm) was recorded in leaf mould (100 %), followed by (20.53 cm) in soil + coconut husk (50:50 %) media, and maximum leaves per plant (69.61 cm) in soil+ leaf mould + coconut husk(33:33:33 %).

Irshad *et al.* (2014) conducted a trial to determine the influence of different planting dates and media on the growth of kiwi cuttings, and the results showed that planting media silt + garden soil + FYM (2:1:1) had a significant effect on kiwi cuttings. which in turn showed,maximum survival percentage (22.46 %), number of roots per plant (12.65), plant height (40.15 cm)and minimum days to sprouting (44.17).

Kumar *et al.* (2014) investigated alternative potting media mixtures for growing quality litchi planting material in polybags. Based on the analysis thus far, riverbed soil + vermicompost (2:1)+NPK (5g/sapling) or riverbed soil + vermiculite (50g/sapling) was identified as the best potting media for mass propagation of litchi in black polyethylene bags under net house which resulted in maximum survival (76.50 %), collar girth (4.06 cm), sapling height (66.45 cm), number of leaves (9.38), and number of leaflets per saplings (35.82) at 8 months of litchi saplings.

Kumawat *et al*. (2014) conducted research on papaya seed germination and seedling growth as influenced by media and chemicals in drier tracts of Lucknow's subtropical area. The treatment combination of soil + compost + cocopeat (1:1:1) + GA_3(150 ppm) was found to be superior for early and higher germination percentage, maximum height of seedling (32.99 cm), length of root (9.76 cm), leaf area (178.35 cm^2) and fresh weight of shoot (14.3 g) in papaya cv. Coorg Honey Dew.

Mishra(2014) conducted an experiment to determine the effect of different rooting media on the survival and success of air layers in kagzi lime. The number of primary roots (34.43), root length (10.67 cm), fresh (0.86 g) and dry weight (0.16 g) of roots per air layer after planting were maximum in treatment having soil + FYM + sand (1:1:1).

Panchal *et al.* (2014) studied on effect of treatment of IBA and different growing media on seedling growth of khirni. Result showed that, at 180 DAB, maximum plant height (22.33 cm), root length (24.37 cm), number of leaves per plant (23.33), number of branches per plant (5.00), leaf area per plant (23.33 cm^2), root dry weight (0.83 g), root/shoot ratio (0.19 g), stem dry weight (4.30 g), total dry weight (5.13 g) and minimum mortality (15.67 %) were noted in treatment combination soil + coco peat + FYM (1:1:1) + IBA (1000 ppm) as compared to the rest of the combinations. With respect to crop growth rate, treatment combination soil+ sand + vermicompost (1:1:1) + IBA (1000 ppm) showed maximum value i.e., 4.44 % at 180 DAB.

Saadula (2014) discovered that red earth + FYM + sand + custard apple seed powder (1:1:1:1) resulted in a significantly higher number of leaves (8.11), leaf area (54.09 cm^2), seedling height (12.10 cm) in cashew rootstock and maximum root length (21.43 cm) were observed in red earth + FYM + sand + vermicompost in (1:1:1:1).

Sharif *et al.* (2014) conducted an experiment to standardize potting media for nursery raising of jujube seedlings and discovered that the maximum germination percentage (86.33 %), number of leaves (123.36), number of sprouted shoots (8.14), number of roots (69.11)and stem diameter (9.11mm) were all found in media composite of silt 45% + Bagasse 45 % + coconut fiber 10 %.

Edward *et al.* (2015) investigated the effect of different planting media on the development of pineapple seedlings and concluded that soil + organic manuremedium is a useful medium for accelerating the development of pineapple seedlings in terms of plant height (75.05 cm), leaf length, leaf width (35.06 cm), and leaf number (84.0) after 12 months of planting.

Gholap and Polar (2015) investigated the effect of growing media and storage of stone on the growth and development of mango. They reported that, the highest stone germination (74.26%), stem diameter (6.15 mm), length (27.19 cm) and girthof tap root (5.21 mm) and vigour index (4719.34) was recorded in potting media containing soil+FYM+leaf mould in (1:1:1) proportion.

Ilyas *et al.* (2015) studied the effect of propagation media and black polybags on the growth and survival of budded kinnow plants and discovered that the propagation media soil + sand + vermicompost in the ratio of 1:1:1 had the highest out planting performance survival percentage (93.33 %) with the highest leaf area (15.21 cm^2), number of primary roots (12.00), and secondary roots (99.67) when compared to other treatments.

Joshi *et al.* (2015) investigated vermicompost's effect on plant growth, yield, and quality and found it to be an ideal organic manure for increased seed germination, stem height, number of leaves, leaf area, leaf dry weight, root length, root number, total yieldand number of fruits/plant.

Parmar *et al.* (2015) conducted research trail on effect of growing media, structures and sowing dates on seed germination and seedling growth of custard apple. The result showed that, treatment of soil: vermicompost: paddy husk (1:2:1) had significant impact by recording maximum seed germination at (77.50 %) 30 DAS, seedling length (19.04 cm), number of leaves per seedling (18.52),leaf area (32.70 cm^2)at90 days after sowing.Theyalso recorded the maximum fresh and dry weight of the seedling.

Prawal *et al.* (2015) studied the effect of growing media on seed germination and seedling growth of pyrethrum (*Chrysanthemum cinerariaefolium*). The findings showed that the combination of vermicompost, soil and farmyard manure, in the proportions of 1:1:1 had the quickest germination (8.33 days) and highest germination percent (64%). The highest values of the plant growth parameters, including plant height (13.90 cm), number of leaves per plant (12.33), fresh weight (3.57 g), dry weight (0.87 g), number of roots per plant (14.34)and root length (10.46 cm) were observed in this medium, making it the best for growing pyrethrum seedlings. Therefore, the optimal media for pyrethrum seed germination and subsequent seedling growth was determined to be vermicompost + soil + farm yard manure (1:1:1).

Singh *et al.* (2015) undertook an investigation to study the effect of vermicompost and biofertilizers on growth, flowering and yield of strawberry. The result showed that application of vermicompost + *Azotobacter* + PSB + AM produced plant spread (25.64 cm), maximum plant height (20.26 cm), number of leaves (54.30) and leaf area (97.87 cm^2) per plant, whereas all the growth characters were found minimal in control.

Surakshitha *et al.* (2015) conducted an experiment to know the effect of media and bioinoculants on seed germination and seedling growth of jamun. The results indicated that the minimum days taken for germination (13.00 days) and other plant growth parameters *viz.*,maximum plant height (69.23 cm), number of leaves (38.67), stem diameter (8.77 mm), fresh (134.27 g) and dry weight (53.73), vigour index-I(9187.00)and II (4926.67) and root length (29.33 cm) were found to be in the medium M1 -redearth + sand + vermicompost (2:1:1) and in the bio-inoculant *Glomus fasciculatum.*

Jatav *et al.* (2016) reported that the combination of soil + cocopeat + leaf mould (1:1:1) with IBA 15,000ppm in guava air layers resulted in the maximum length of primary (4.34 cm) and secondary (2.18cm) root, the diameter of primary (2.65 mm) and secondary root (2.04mm), dry weight (1.16 mg)and callus formation (7.26 mm). The number of new sprouts (6.18), success of rooting (91.84) and air layer per cent (83.84) were also recordedsignificant in this treatment.

Karna (2016) carried out an investigation to study the effect of grafting time and height on the success of softwood grafting in mango and discovered the highest survival percentage (71.11%) and maximum shot length (14.99 cm) for grafting done on the second fortnight of September in media containing soil + FYM (2:1) in Junagadh.

Kelkar (2016) studied the effect of different agrochemicals on the morpho-physiological attributes of mango grafts cv. Alphonso and found that the top soil + FYM + vermicompost (2:1:1) media produced the highest percentage increase in plant girth (32.25 %) of mango grafts at Dapoli.

Kumar and Kathakur (2016) conducted research on effect of rootstock age and different growing media on the success of stone grafting in mango and revealed that,

the growing media used in this study, soil + FYM + sand (1:1:1)was found to be the best growing media in terms of sprouting, survival, maximum graft height (18.05 cm),maximum number of leaves (8.70), highest root length (17.00 cm) and overall performance of scion grafts over other growing media.

Ramteke *et al.* (2016) conducted an experiment to investigate the effect of GA_3 and propagation media on growth rate and leaf chlorophyll content of papaya seedlingsand the results revealed that the treatment soil: sand: cocopeat: vermicompost (1:1:1:1) had the highest absolute growth rate (0.034 g/day)and the treatment soil +FYM (1:1) had the highest relative growth rate (0.043 g/day). Finally, it was found that among propagation media, vermicompost or farmyard manure (FYM) media significantly improved growth rates and leaf chlorophyll content.

Rashmita *et al.* (2016) studied the effect of different media on rooting and survival of pear cutting cv. Patharnakh. Percentage of rooted cuttings (69.70%), numbers of leaves (29.28), success percentage (92.59%) and survival percentage (78.18%) recorded maximum in the media soil + FYM (1:1). In contrast, soil+ vermicompost (1:1) performed well for root length (21.90 cm) and shoot length (34.39 cm).

Raval *et al*. (2016) discovered that media soil+ sand+ FYM (2:1:1) was the most effective for better mango seedling growth such as highestnumber of leaves (23.40), length of root and shoot, fresh and dry weight of seedlings, leaf area as well as survival per cent of seedlings.

Manila *et al.* (2017) conducted an experiment to determine the most successful media for better vegetative growth and rooting in pomegranate cv. Kandhari. The highest rooting percentage (76.67%), maximum number of primary roots (36.33), secondary roots (67.67), length of the longest root (17.50cm), diameter of the thickest root (1.80 mm) and fresh weight (0.20 g) were observed in hardwood cuttings when vermiculite is used as growing media.

Patel and Arbat (2017) conducted epicotyl grafting propagation studies in mango and observed maximum sprouting, graft height, number of leaves, leaf area, and scion length with soil + cocopeat +vermicompost media (1:1:1).

Rathwa *et al.* (2017) studied the influence of propagation media on rooting and growth of hardwood and semi-hardwood cuttings of pomegranate cv. Bhagwa. The study revealed that medium of red soil + vermicompost (1:1) resulted in maximum shoot length (19.43), number of leaves(25.56) and number of shoots (7.28) at 120 days after planting.

Thakur and Shylla (2018) investigated the effect of different growing media on plant growth and fruit yield of strawberry cv. Chandler and discovered that cocopeat + FYM (1:1) had the highest number of leaves (16.44), highest plant height (26.51 cm), average leaf area (125.60 cm^2) and maximum root length (16.72 cm).

Gawankar*et al.* (2019) carried out research on influence of media on seed germination and seedling growth in Jackfruit and the results revealed that a mixture of media having Soil + Vermicompost + Rice husk + Cocopeat (1:1:1:1) were exhibited higher germination index (33.72%),germination value (18.58%),seed vigour (97.08%), maximum seedling vigour index (4.60%) and showed more percentage of graftable seedlings (91.13%).

Parmar *et al.* (2019) noticed that among the growing media, soil + sand + *Azotobacter* (1:1+5 g/ kg AZO) and among the seed treatment, GA_3 (50 ppm) were proved the most promising as compare to others. Among the various treatment combinations, the treatment combination (soil + sand + *Azotobacter*; 1:1+5 g/ kg AZO + 50 ppm GA_3) outperformed the others in terms of early seed germination (9.33 days), early 50% seed germination (19.66 days), maximum percentage of germination at 30 days (76.68 percent), and growth parameters such as seedling height (5.96, 7.22 and 8.36 cm) , number of leaves per seedling (7.33, 9.66 and 11.66), girth of stem (1.50, 1.85 and 2.74 mm) and survival percentage (76.66 %) at 30, 60, 90 and 120 DAS, respectively.

Pawar *et al.* (2020) carried out research work on the effect of vermicompost and biofertilizers on growth, yield and fruit quality of sweet orange cv.Mosambi and recorded maximum plant height (3.04 m) in treatmentapplication of 75% vermicompost (On N-equivalent basis of RDF) + *Trichoderma harzianum* (30-40 ml/plant) + *Azadirachtin* (1% at 3-4 ml/litre as spray) + *Pseudomonas fluorescence* (30-40 ml/plant).

Bendre*et al.* (2020) investigated oneffect of different potting media on sprouting, survival and growth performance of bush pepper. They found that, earliest sprouting of cuttings (20.00 days), highest sprouting percentage (40.00 %) and survival percentage (30.00 %) was observed media soil + rice husk + compost (1:1:1) whereas, same media with (2:1:1) composition showed maximum plant height (35.81 cm)and relative growth rate (0.006 cm).

Geethanjali *et al.* (2021) studied the effect of biofertilizers and media on seed germination and seedling vigor of aonla. Among the different treatment combinations used, media containing soil + cocopeat + vermicompost enriched with the biofertilizer mixture of *Azatobacter* + PSB + KRB has recorded maximum number of leaves per seedling (21.70), stem diameter (7.75 mm), seedling height (51.25 cm), fresh(16.82 g)and dry weight (9.66g) of shoot, survival per cent (96.96 %)and shoot: root ratio (4.20) at 90 days after sowing.

Khan*et al*. (2021) conducted an experiment on the effect of propagation media on mango seed germination sown at different depths and discovered that seeds grown in farm Soil+sand+FYM (1:1:1) had shorter days to germination (19.67 days)and longer shoots (35.22 cm).

Lad *et al.* (2021) found the performance of mango cv. Alphonso softwood grafts in different potting mixture and revealed that, significantly maximum sprouting percentage(93.33%) and (92.00%)was recorded in soil + FYM (3:1) followed by cocopeat + leaf manure + compost (1:1:1) respectively. In other hand treatment cocopeat + leaf manure + compost (1:1:2) resulted in maximum increase in plant height (124.79%), number of node (2.27), number of leaves (17.87), root length (23.46 cm) and dry weight of root (8.92 g) whereas the highest survival percentage (82.67%), percent increase in girth of graft (39.89 %), number of shoot (1.67), leaf area (678.46 cm^2) and relative growth rate (0.0237cm/day) was noted incocopeat + leaf manure + compost (1:1:1).

Mandal *et al.* (2021) studied the effect of different organic media on growth and establishment of strawberry cv. Winter Dawn. The crop was transplanted manually and different combinations of the treatments were applied. Among different treatments, maximumplant height (22.08cm), number of leaves per plant (35.00), number of runners per plant (12.33), plant spread (35.95cm^2), leaf area (29.53cm^2), days to first flowering (24.68 days) and survival percentage (100%) were recorded in the treatment containing vermicompost 50%+ NPK 50%+ *Trichoderma*.

Shrivastava*et al*. (2021) carried out an experiment to investigate the effect of different types of media and containers on germination, survival, growth and establishment of papaya and results showed that the growing media containing Soil + FYM + sand + vermicompost (1:1:1:1) was superior for the growth of papaya seedlings, as it demonstrated the highest germination and growth parameters in terms of maximum germination (92.02 %) at 30 DAS, maximum seedling height (11.28, 13.33and 14.44 cm), and maximum number of leaves (14.33, 17.00, 20.17) at 30, 45 and 60 DAS, respectively. maximum stem diameter 4.48 mm and 5.47 mm at 45,60 DAS and minimum number of days (15.00) required for last sprouting.

Tani *et al.* (2021) studied the effect of different growing media on root and shoot growth of dragon fruit cuttings. Themaximum root and shoot parameters were recorded in vermicompost + soil (1:1) and vermicompost + sand (1:1) took the shortest time (24.21 days) to root initiation similarly, maximum number of sprouts (5.60), shoot length (36.64 cm), fresh and dry weight of shoot (122.48 and 11.57 g), survival percentage (98.33%) and root to shoot ratio (0.059) was significantly recorded best under the treatment combination of vermicompost + soil (1:1) as compared to control.

Kanadal andKanzaria (2022) studied the effect of growing media on germination behavior in mango and reported that, media mixture of Soil+ Sand+ FYM (1:1:1)took significantly minimum days to germinate (16.38 days) and maximum germination percentage (72.09%).

CHAPTER-III

MATERIALS AND METHODS

CHAPTER-III

MATERIALS AND METHODS

The present investigation entitled**"Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar"** was conducted at College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during the year 2021-22. The details of material used, experimental methods followed and techniques adopted during the course of research have been described briefly in this chapter.

3.1 Experimental site

The present experiment was conducted at College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra). The experiment was initiated in the month of May 2021 and completed during January 2022.

3.2 Geographical location

Geographically Parbhani is situated between $19^0$16" North latitude and $96^0$41" east longitudes at an altitude of 408.50 meters above the mean sea level. In the east-central Maharashtra state, It lies in an upland plateau region about 10 miles (16 km) south of the Dudhna river.

3.3Climateand weather conditions

Theclimate of Marathwada region on annual basis is classified as semi-arid type.

Parbhaniisgroupedunderassuredrainfallzone.Theregionexperienceshotdrysummer(March - May), cold dry winter (October - February) and wet humidity with mediumrainfall in monsoon season (June - September). But due to vagaries of monsoon thecropproductionisalwaysatarisk.Meanrainfallreceivedinexperimentalyear 2021was 1710.7 mm which was over than average, distributed in 51 rainy days. The maximumtemperature rangeduringexperimentseasonwas from 30.95^0C to 33.65^0C in(2021), 20.4^0C to 36.8^0C in (2022) as wheremeanminimumtemperaturevariedinbetween10.77^0C to 13.24^0 C in (2021), 8.7^0C to 21^0C in (2022) and relativehumidity between29.80 % to 78.89 % during the period of investigation. Thedetails of meteorological parameters aregiveninAppendixI.

3.4 Chemical composition of soil used in the experimental plot

Soilsamples	pH	EC(dS m^{-1})	Organiccarbon	$CaCO_3$(%)	Macronutrients (kgha^{-1})		
					N	P	K
Soil	7.6	0.68	0.61	5.6	147.8	18.0	723.6
Claysoil	7.8	0.54	0.59	2.0	144.6	14.2	722.5
Laterites oil	5.8	0.21	0.25	3.6	101.5	19.0	846.9

3.5 Chemical properties ofwater used in experimental plot

Sr. No	Components	Concentration	Required	Remarks
1	pH	7.38	6.5-7.5	Good
2	EC	2.02	0.0-0.25	High salinity
3	Carbonates	0.4 mg/L	0.0-1.50	Moderate
4	Bicarbonates	3.6 mg/L	0.0-1.50	High
5	Calcium	9.2 mg/L	0.0-10	Good
6	Magnesium	9.6 mg/L	0.0-1.25	Severe
7	Chlorine	2.8 mg/L	0.0-2.00	High
8	Residual sodium carbonate	low	Less than 1.25	Good

3.6Experimental details

The experiment was laid out in a randomized block design withthirteen different treatment and threereplications. The experiment started with sowing of fresh healthy mango cv.Kesar stones in polybags contain differentmedia.

Name of crop :Mango (*Mangifera indica* L.)

Location :College of Horticulture, V.N.M.K.V. Parbhani.

Year of study : 2020-2021.

Experimental design :RBD (Randomized BlockDesign)

Number of Treatments :Thirteen (13)

Number of Replications :Three (3)

Total number of grafts per treatment : Thirty (30)

Name of the scion variety : Kesar

Name of root stock variety : Kesar

Method of grafting : Softwood grafting

Size of polythene bags : 12”x10”

3.6.1Treatment details

Treatment number	Treatment details
T_1	Soil (Control)
T_2	Soil+FYM(2:1) +Biomix1%
T_3	Soil+Biomix1%
T_4	Soil+FYM+Sand(2:1:1)+Biomix1%
T_5	Lateritesoil+Cocopeat+Vermicompost(1:1:1)+Biomix1%
T_6	Claysoil+FYM(1:1) +Biomix1%
T_7	Soil+FYM+Vermicompost(1:1:1)+Biomix1%
T_8	Soil+Sand(1:1) +Biomix1%
T_9	Soil+Vermicompost(1:1)+Biomix1%
T_{10}	Cocopeat+FYM(1:1) +Biomix
T_{11}	Soil+FYM(2:1)+PSB(0.5%)
T_{12}	Soil+FYM(2:1)+PSB(1%)
T_{13}	Cocopeat+FYM(1:1)

3.6.2PLAN LAYOUT

R I	R II	R III
T1	T13	T2
T2	T12	T4
T3	T11	T6
T4	T10	T8
T5	T9	T10
T6	T8	T12
T7	T7	T13
T8	T6	T11
T9	T5	T9
T10	T4	T7
T11	T3	T5
T12	T2	T3
T13	T1	T1

Fig. No. 1. Plan of experimental layout.

3.7 Experimental material

3.7.1 Seed material

The mango stones were procured from Central Nursery, V.N.M.K.V Parbhani.

3.7.2 Growing media

The growing media is sufficiently firm to hold the seedling or propagules during rooting and supply nutrients and moisture for the successful growth of young seedling.

3.7.3 Biomix

Biomix it's a product developed at VNMKV, Parbhani by using a 14 different bioagent mixture of *viz.,Trichoderma viridae, Aspergillus niger, Pseudomonas striata, Neumoria relyi, Gluconacetobactor, Bacillus subtillis, PPFM, Tricoderma harzianum, Pseudomonas fluorescens, Beauveria bassiana, Metarhizium anisopliae, Paecilomyces lilacinus, verticillium lecanii and Azospirillum brasilince.*

3.7.4 Container / Polybags

Black polythene bags with dimension of 12-inch length,10-inch breadth and 300gauges thickness were employed for raising of seedlings.

3.7.5 Preparation of media and bag filling

The media was prepared by combining various media elements. It was correctly mixed and placed into black polyethylene (before filling the black polyethylene, small holes were made at the base of poly bags by using punching machine).

3.7.6 Seed treatments and sowing of seeds

Mango seedlings were raised by planting mango stones of variety Kesar. The fully matured mangoes were selected from healthy, disease-free mango plants.Presoaking of seeds in water for 24 hourswas done and treated with fungicide i.e.,carbendazim. All the treated seeds were sown vertically in polybags according to treatment on6thMay 2021 and watering was administered right away after the sowing of seeds.

3.7.7Collection of scions

Scion sticks of cv. Kesar collected from well maintained, disease free and healthy mango orchard from Department of Horticulture, VNMKV, Parbhani as per requirement.

3.7.8 Preparation of scion

From sound and healthy mother trees, mature terminal shoots with full buds were chosen as scion. About 12-15 cm long, straight pencil-sized sticks and growing buds were served on scion from the mother plant. Scion sticks are made by removing the leaves from the scion sticks on the mother tree 7 to 10 days prior to grafting, leaving just the emerging buds. Before grafting, scion sticks that had broken off from the mother plant were gathered. A slant cut was then made on both sides of the lower part of the scion stick to create a V-shaped smooth cut that was the same length (4 - 4.5 cm), which was then used for soft wood grafting.

3.7.9 Preparation of the rootstock

After 150 DAS, the selected rootstock of 10-15 mm thickness was headed back about 10-30 cm above the polybag where the soft wood portion was available on the rootstock and the terminal shoot was removed with the help of sharp-edged secateurs. A deep vertical straight cut of 4 - 4.5 cm was made on the centre of the beheaded rootstock with the help of a sharp grafting knife. This vertical cut was split with the help of a grafting knife to insert a scion.

3.8 Procedure of grafting

Softwood grafting was done in mid monsoon season (september) when the rootstock started secondary soft vegetative growth which was mention by Panicker (1986).

The steps followed in grafting are given as below;

- The wedge-shapedscion is inserted into the cleft of rootstock, taking care to ensure that the cambium layers of stock and scion were in perfect contact with each other.
- The graft joint was secured by wrapping material like polythene stripe (1.5 cm wide, 200-gaugethickness).

- The grafted plants were kept under shade net to enable sprouting of the terminal buds.
- In about 2nd week onwards sprouting were started and grafts were started growing.

3.9 After care and management

3.9.1 Watering

In order to get good seed germination, a little watering by using a rose can (Jar) was supplied right away after planting the stones in the poly bags. Thereafter, at intervals of 8–10 days depending on the soil moisture status, care was taken that water would not fall on the graft junction.

3.9.2 Weeding

In order to prevent competition with the main plant for water and nutrients and to ensure adequate cleanliness, weeding was done manually by hand as and when necessary.

3.9.3 Plant protection (Pest and disease incidence)

There was an incidence of leaf eating caterpillar up to 5 % and leaf minor up to 10 %, hence spraying of Chlorpyriphos (50 % EC) + Cypermethrin (5 % EC) 1ml/l atfortnight interval during rootstock phase was done. Drenching of Carbendazim (2 g/l) was also carried out for protection against fungal attack.

3.10 Observation and Methodology

3.10.1 Graft success parameter

3.10.1.1 Days required for sprouting

After grafting the grafted plants were monitored regularly. The number of days taken by scion to show its first sign of sprouting was recorded for each plant in each replication and mean days were calculated.

3.10.1.2 Success percentage of grafts (%)

The total number of grafted seedlings survived till end of experiment under each treatment in each replication was recorded and percent success of grafts was calculatedby using the formula.

$$\text{Success percentage} = \frac{\text{Total number of survived grafts}}{\text{Total number of plants grafted}} \times 100$$

3.10.1.3 Survival percentage of grafts at 30,60,90 and 120 days after grafting (%)

The total number of survived grafted plants were calculatedafter grafting at monthly interval and the survival percentage was calculated by the formula given below and was expressed in percentage.

$$\text{Survival percentage} = \frac{\text{Number of grafts survived per treatment}}{\text{Total number of plants grafted}} \times 100$$

3.10.1.4Mortality percentage of grafts at 30,60,90 and 120 days after grafting (%)

Number of grafts died per treatment is calculated at monthly interval and the mortality percentage was calculated by the formula given below and was expressed in percentage.

$$\text{Mortality percentage} = \frac{\text{Number of grafts mortal per treatment}}{\text{Total number of plants grafted}} \times 100$$

3.10.2 Growth attributes

3.10.2.1 Height of grafts at 30, 60, 90 and 120 days after grafting (cm)

After grafting,grafts were selected from each treatment. The height of graftwas measured by meter scale from the base of the plant to the growing tip of each plant after 30, 60, 90 and 120 days after grafting and the mean value was recorded in centimeters.

3.10.2.2 Girth of scion at30,60,90 and 120 days after grafting (mm)

The diameter of scion of each graft expressed in millimeter was measured by vernier caliper at 30, 60, 90, 120 and 150 days after grafting in each treatment and the mean values were recorded.

3.10.2.3Length of scion at30,60,90 and 120 days after grafting (cm)

Grafts were selected from each treatment and length of scion was measured by measuring scale from graft union up to apical end at monthly interval of 30,60,90 and 120 days and the mean value were recorded.

3.10.3 Shoot observations

3.10.3.1 Fresh weight of shoot (g)

At the end of the experiment, the fresh weight of shoot per graft of selected grafts was recorded. Shoots were taken from plants and cleaned before being weighed on an electric digital weighing machine and stated in grams.

3.10.3.2 Dry weight of shoot (g)

Observations were made using shoots picked for fresh weight. The shoots were dried in a Hot AirOven set to 60^0 C. The weight of dry shoots as determined by an electric digital weighing machine and expressed in grammes.

3.10.3.3 Dry root to shoot ratio

At the end of the experiment dry weight of shoot and root were taken separately and ratio was calculated by using formula.

$$\text{Dry shoot to root ratio} = \frac{\text{Dry weight of root}}{\text{Dry weight of shoot}}$$

3.10.4 Leaf attributes

3.10.4.1 Number of leaves per graftat30,60,90 and 120 DAG.

The number of functional leaves per graft were counted visually at 30, 60, 90 and 120 days after graftingand mean number of leaves per seedling was calculated.

3.10.4.2 Average leaf area at 30, 60, 90 and 120 DAG (cm^2)

Three leaves were selected from each plant and average leaf area wasmeasured at30, 60, 90 and 120 days after sowing and leaf area was measured by leaf area meter.

3.10.5. Root attributes

3.10.5.1 Average length of tap root (cm)

The tagged plants were carefully uprooted without causing any damage to the root zoneand the adhering soil particles were removed by dipping in water. After cleaning, the length of the tap root was measured with a centimeter scaleand the average value for each treatment was calculated at the end of the experiment.

3.10.5.2 Number of primary roots per grafts

At the end of experiment, tagged plants were collected from each treatment. The roots were then cleaned by removing soil particles that had adhered to them, and the number of primary roots were counted and average mean value for each treatment was calculated.

3.10.5.3 Number of secondary roots per grafts

At the end of experiment, same tagged plants were used for counting number of secondary roots. The roots were then cleaned by removing soil particles that had adhered to themand the number of secondary roots per graftswas counted and average mean value for each treatment was calculated.

3.10.5.4 Fresh weight of root (g)

At the end of the experiment, the fresh weight of root per graft of selected grafts was recorded. The roots were cleaned by removing soil particles that had adhered to them. The weight of the roots was calculated using an electric digital weighing machine and expressed in grams and the average value is calculated for each treatment.

3.10.5.5 Dry weight of root (g)

Roots were taken from the same grafts as in the previous observations. The roots were dried in a Hot Air Oven at 60^0C. The weight of dry roots is calculated on andelectric digital weighing machine in gramsand the average value is computed.

3.11 Statistical analysis

Data were analyzed statically adopting the technique of analysis of variance (ANOVA) using Randomized Block Design (RBD). The level of significance of the treatment mean square at 5 % probability was tested with ‘F’ test value. The significant differences of the treatment means were further tested by using significance of critical difference a 5% level of respective degree of freedom of ‘t’ values.

CHAPTER-IV

RESULTS AND DISCUSSION

CHAPTER- IV

RESULTS AND DISCUSSION

An experiment entitled "Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar" was carried out during 2021-2022 at instructional cum demonstration farm, College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment consisting thirteen different treatments were laid out in a Randomized block design with three replications. The data collected during the experiment on various parameters *viz.,* shoot observations, root observation and leaf attributes of mango grafts were tabulated and subjected to statistical analysis. The effect of various treatments were recorded and the results obtained during the course of investigation have been discussed with supporting references in this chapters. The entire result and discussion has been presented under appropriate heads and subheads.

4.1 Days required for sprouting

The data with respect to different growing media and bioagent applications on days required for sprouting in mango grafts are statistically analysed and are presented in Table 4.1 and graphically depicted in Fig. 4.1.

The present investigation data showed that, effect of different growing media and bioagent applications on days required for sprouting observed a significant difference among the various treatments. The data given in Table 4.1 revealed that grafted seedlings in media composed of Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% (T_7) took minimum days for sprouting (10.52 days) which was found statistically at par with treatment (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (10.82 days) and (T_4) Orchard soil + FYM + Sand (2:1:1) +Biomix 1% - (11.04 days). However, maximum days taken for sprouting was recorded in (T_1) control (13.68 days).

Earliness in sprouting might be due to utilizing of stored food material present in scion, nitrogen and other factors with the aid of growth hormones present in the vermicompost (Chandramouli, 2001). Use of media like vermicompost and FYM help for increasing porosity, water holding capacity, low shrinkage, low bulk density and

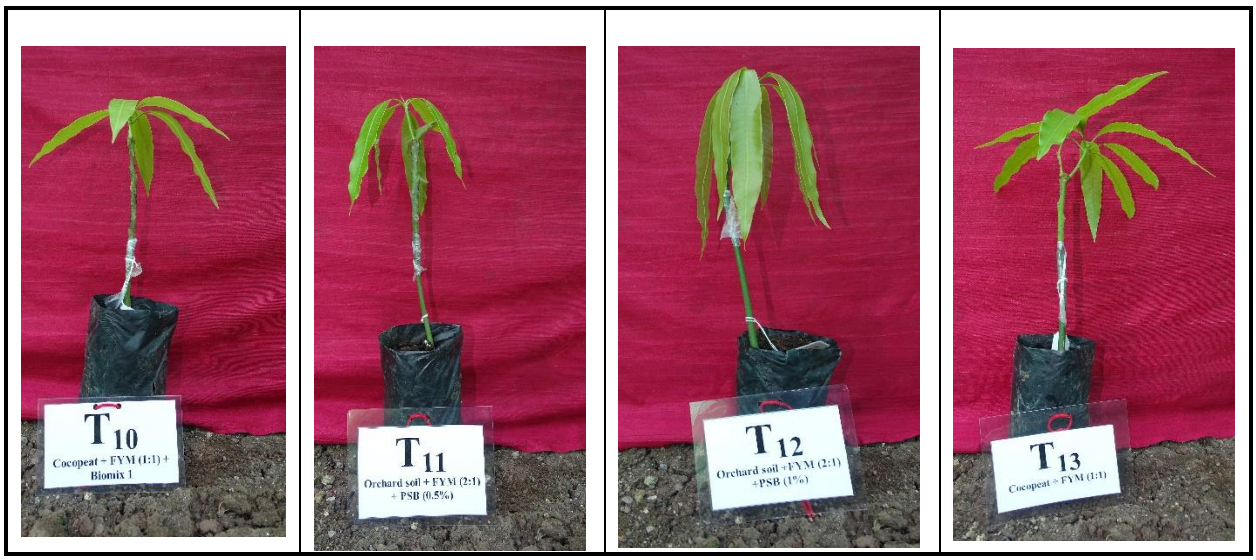
slow biodegradation of the medium which resulted in better growth of root system and root stock which ultimately makes grafted scion to sprout early.

The result is supported by the findings, Patel *et al.* (2017) in mango, Akshay *et al*. (2014) in media soil + sand + FYM + vermicompost (1:1:1:1) for black pepper cuttings, Panchal *et al.* (2014) in Khirni with Soil + Sand + Vermicompost (1:1:1) and Kaur and Malhi (2006).

Biomix contains many root colonizing bacteria including the nitrogen fixing *Azospirillum* and phosphorus solubilizing *Pseudomonas* spp. are known to produce growth hormones such as auxins. Thus, increased level of auxins (PGR's) resulted in earlier completion of physiological processes involved in rooting and sprouting of grafted plants. Slankis (1973) also reported that biofertilizer increased the level of plant growth regulators in the plants.

Table 4.1: Effect of different growing media and bioagent applications on days required for sprouting in mango grafts.

Treatments		Days required for sprouting
T_1	Orchard soil (Control)	13.68
T_2	Orchard soil + FYM (2:1) + Biomix 1%	12.67
T_3	Orchard soil + Biomix 1%	13.13
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	11.04
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	10.82
T_6	Clay soil + FYM (1:1) + Biomix 1%	12.90
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	10.52
T_8	Orchard soil + Sand (1:1) + Biomix 1%	12.28
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	11.61
T_{10}	Cocopeat + FYM (1:1) + Biomix	12.45
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	11.87
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	11.26
T_{13}	Cocopeat + FYM (1:1)	12.94
S.E(m) ±		0.66
C.D at 5%		1.99



Plates 4.1: Comparison of mango grafts raised in different potting media mixture @ 30 DAG

4.2 Success percentage (%)

An appraisal of data on success percentage of grafts as influenced by different growing media and bioagents application are statistically analysed and are presented in Table 4.2 and graphically depicted in Fig. 4.2.

Table 4.2: Effect of different growing media and bioagent applications on success percentage in mango grafts

Treatments		Success percentage of grafts
T_1	Orchard soil (Control)	54.96
T_2	Orchard soil + FYM (2:1) + Biomix 1%	61.27
T_3	Orchard soil + Biomix 1%	56.24
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	72.64
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	73.57
T_6	Clay soil + FYM (1:1) + Biomix 1%	58.18
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	74.31
T_8	Orchard soil + Sand (1:1) + Biomix 1%	64.66
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	70.15
T_{10}	Cocopeat + FYM (1:1) + Biomix	63.95
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	64.67
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	71.17
T_{13}	Cocopeat + FYM (1:1)	59.89
S.E(m) ±		3.02
C.D at 5%		8.81

The success percentage in mango grafts was found to be maximum in treatment (T_7) Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% (74.31 %) which was found to be statistically at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (73.57 %) followed by (T_4) Orchard soil + FYM + Sand (2:1:1) +

Biomix 1% (72.64 %). Whereas, the lowest success percentage (54.96 %) was found in (T_1) control.

The highest success rate might be due to the better performance of these media, such as sufficient nutrients, moisture and aeration available for the development of root system. Better plant growth is the result of a well-established root system that absorbs nutrients from the media. Similar findings were reported by Sharma and Dhuria (1981) in walnut and Savani (2006) in mango, who discovered that higher graft union success and survival could be attributed to better aeration, temperature, humidity, drainage and porosity in media. The results are in accordance with the finding of Dengale (1980) in mango, Das *et al.* (2006) in sapota, Ilyas *et al.* (2015) in kinnow mandrin, Kumar *et al.* (2009) in jatropa and Lad *et al.* (2021) in mango.

Microorganism inoculants which present in the biomix carried out biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities are made available for plants by the root associated organisms. Increased nitrogen, phosphorous and potassium content of inoculated plants at different stages of plant growth results in better development of plants have been found resulting in significant increase in growth of plants (Salisburry and Ross, 1985)

4.3 Survival percentage (%)

The data pertaining to survival percentage at different growth stages of mango grafts i.e., 30,60,90 &120 days are statistically analysed and significantly influenced by different growing media and bioagents application are presented in Table 4.3 and graphically depicted in Fig. 4.3.

The data revealed that the effect of different growing media and bioagents application had a significant effect on the survival percentage of grafted seedling. The data presented in the Table 4.3 revealed that maximum survival percentage (87.06%, 83.17 %, 78.33 % and 74.31 %) was obtained under (T_7) Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% which was found to be statistically at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (85.31 %, 82.60 %, 75.42 % and 73.57 %) and (T_4) Orchard soil + FYM + Sand (2:1:1) +Biomix 1% (85.30 %, 81.02 %, 74.86 % and 72.64 %) at 30, 60, 90 and 120 DAG respectively.

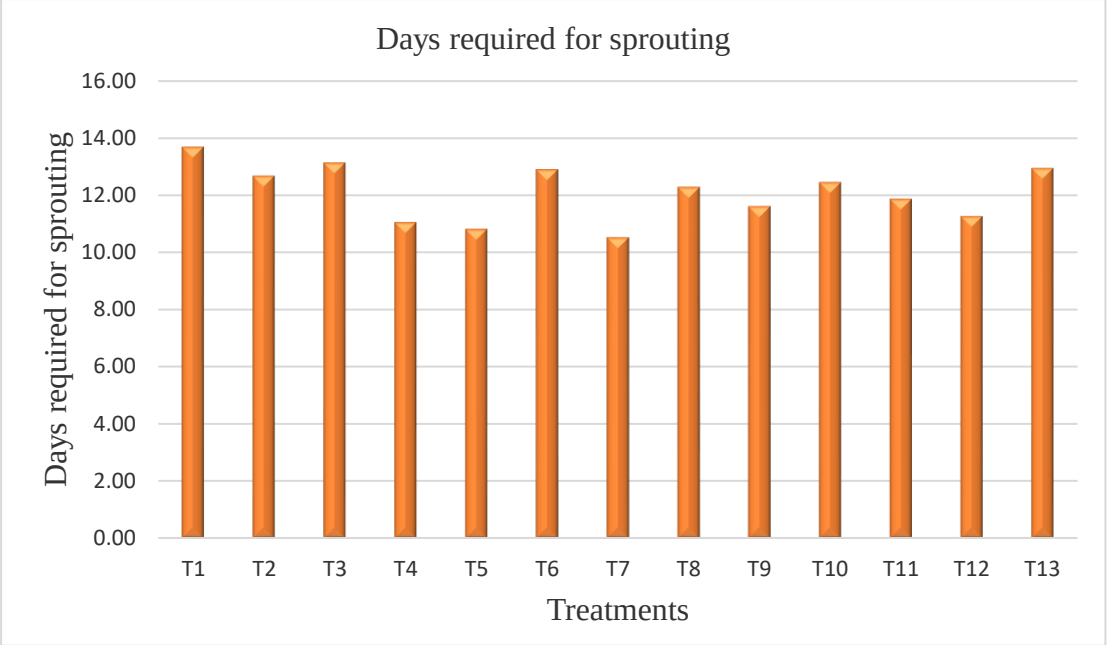


Fig 4.1: Effect of different growing media and bioagent applications on days required for sprouting in mango grafts.

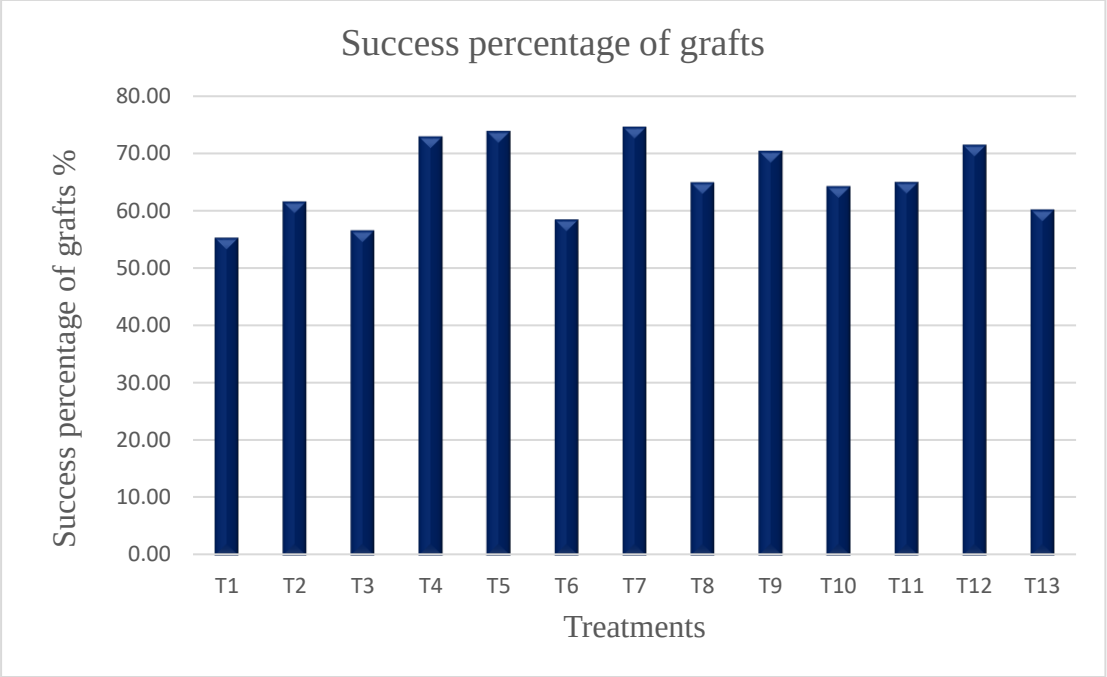


Fig 4.2: Effect of different growing media and bioagent applications on success percentage of mango grafts

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

Plates: 4.2 Comparison of mango grafts raised in different potting media mixture @ 120 DAG

However, minimum survival percentage (63.60 %, 59.95 %, 57.15 % and 54.96 %) was observed in (T_1) control treatment at 30, 60, 90 and 120 DAG respectively.

High survival percentage in the media reflected the fact that these combinations of media might have provided physical conditions and sufficient nutrients to grafted seedlings particularly for better metabolic and physiological activities as well as good root system development (Bendre *et al*., 2020). The presence of plant growth promoters such as auxins and cytokinins in vermicompost (Radha *et al.,* 1986) is responsible for cell division, cell elongation, and better callus formation in graft union, which leads to better graft survival.

It might also be due to vermicompost which stimulates to influence the microbial activity of soil, increases the availability of oxygen, maintains normal soil temperature, increases soil porosity and infiltration of water, improves nutrient content and increases growth, yield and quality of the plant (Arora *et al*., 2011). The results are also confirmed with Sharma and Dhuriya (1981) in walnut and Savani (2006) in mango.

Microorganism inoculants which present in the biomix carried out biological nitrogen fixation, solubilization of insoluble phosphates and mobilization of plant nutrients in more quantities are made available for plants by the root associated organisms. Increased nitrogen, phosphorous and potassium content of inoculated plants at different stages of plant growth results in better development of plants have been found resulting in significant increase in growth of plants (Salisburry and Ross, 1985).

4.4 Mortality percentage (%)

The information on the mortality percentage of mango grafts was statistically analysed, statistically influenced by the use of various growing media and bioagents application is shown in Table 4.4 and graphically depicted in Fig. 4.4

It was found that in the present investigation, effect of different growing media and bioagents application had a significant effect on the mortality percentage of grafted seedlings. The data presented in the Table 4.4 revealed that minimum mortality percentage (12.94 %, 16.83 %, 21.67 % and 25.69 %) was obtained under (T_7) Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% which was found to be statistically at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (14.69 %, 17.40 %, 24.80 and 26.43 %) and (T_4) Orchard soil + FYM + Sand (2:1:1) +Biomix

1% (14.70 %, 18.98 %, 25.14 % and 27.36 %) at 30, 60, 90 and 120 DAG respectively. The maximum mortality percentage (36.40 %, 40.05 %, 42.85 % and 45.04 %) was noticed in (T_1) control treatment at 30, 60, 90 and 120 DAG respectively.

It might be because of media containing organic manure possess organic acid within them. It increases the root growth, which absorbs more nutrient for survival of seedling. This might reason for reducing mortality percentage of seedling. The result is in conformity with Kaur and Malhi (2006) in mango, Bihari *et al*. (2009) in aonla, Patel *et al*. (2013) in acid lime cv. kagzi and Panchal *et al.* (2014) in khirni.

4.5 Height of grafts (cm)

The data regarding mango grafts height at different intervals are statistically analysed and significantly influenced by different growing media and bioagents application are mentioned in Table 4.5 and graphically depicted in Fig. 4.5.

The perusal of data showed that, mixture of various growing media and bioagent treatments had non-significant effect on height of grafts at 30 DAG and had significant effect on height of grafts at 60,90 and 120 DAG. At 30 DAG, there was non-significant difference in the all treatment with respect to height of grafts but, at 60, 90 and 120 DAG, there was a significant variation in graft height among the potting mixtures treatments. The maximum graft height (28.25 cm, 31.38 cm and 34.33 cm) was obtained under (T_7) Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % which was statistically comparable to (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (27.11 cm, 29.24 cm and 31.67 cm) and (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (26.55 cm, 28.68 cm and 31.04 cm) at 60, 90 and120 DAG respectively. Whereas, in control treatment (T_1), the minimum graft height (21.85 cm, 24.00 cm and 26.39 cm) was recorded at 60, 90 and 120 DAG respectively.

The increase in graft height with media containing combination of vermicompost and farm yard manure is due to nutrients in vermicompost being present in readily available forms for plant uptake, such as nitrates, exchangeable P, K, Ca and Mg which consequently increases the height of plant reported by Edwards *et al.* (1988) and vermicompost has been reported to contain bioactive principles that are thought to be beneficial for growth, which has been hypothesised to result in increased biomass and enhanced growth and development (Bachman and Metzger, 2008), as well as a

balanced nutrient composition (Zaller, 2007). Incorporation of vermicompost promotes the lush growth of plants which may be due to the presence of plant growth promoters like auxins and cytokinin's in vermicompost (Radha *et al.*, 1986), which are responsible for cell division and cell elongation.

The addition of FYM to the soil improves the physical, chemical and biological properties of the soil, resulting in improved root growth and development and as a result, increased nutrient and water uptake from a potting mixture, resulting in better plant growth (Sharma *et al*., 2021). The data also supported by the findings of Abhirami *et al.* (2010) in nutmeg with Soil + Coir dust + Sand + FYM (1:1:1:1), Khrishnamoorthy (2010) in mango, Marathe *et al.* (2010) in pomegranate, Rajamanickam *et al.* (2008) in papaya, Yadav *et al*. (2012) in acid lime, Ramteke *et al.* (2016) in papaya with soil + sand + cocopeat + vermicompost (1:1:1:1), Kaur (2017) in mango and Meena *et al* (2017) in papaya with soil + vermicompost + vermiculite (1:1:1) with 2 cm cocopeat at top as media.

The improvement in growth may be because of the use of biofertilizers that outcomes in expanded length of shoots, gracefully of all supplements so at last builds the vegetative growth of the plants. These perceptions are in congruity/conformity with those of Khan *et al.* (2009) in citrus and Khalid *et al.* (2013) in strawberry.

4.6 Girth of scion (mm)

The data obtained on the girth of scion in mango grafts was recorded and presented in Table 4.6 and depicted in Fig. 4.6.

The present investigation revealed out that the effect of mixture of various growing media and bioagent treatments had non-significant effect on girth of scion. The maximum girth of the scion (6.66 mm, 7.11 mm, 7.91 mm and 9.7 mm) was obtained under (T_7) Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % which was statistically at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (6.59 mm, 7.00 mm, 7.74 mm and 9.08 mm) and (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (6.23 mm, 6.95 mm, 7.57 mm and 9.34 mm) at 30, 60, 90 and120 DAG respectively. Whereas, in control treatment (T_1), the minimum graft height (5.47 mm, 6.11 mm, 6.52 mm and 7.74 mm) was recorded at 30, 60, 90 and 120 DAG respectively.

Table 4.3: Effect of different growing media and bioagent applications on survival percentage of grafts at 30, 60, 90 and 120 DAG.

Treatments		Survival percentage of grafts (%)			
		30 days	60 days	90 days	120 days
T_1	Orchard soil (Control)	63.60	59.95	57.15	54.96
T_2	Orchard soil + FYM (2:1) + Biomix 1%	68.37	64.25	63.47	61.27
T_3	Orchard soil + Biomix 1%	65.62	63.79	58.57	56.24
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	85.31	81.02	74.86	72.64
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	85.31	82.60	75.42	73.57
T_6	Clay soil + FYM (1:1) + Biomix 1%	67.23	63.99	61.75	58.18
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	87.06	83.17	78.33	74.31
T_8	Orchard soil + Sand (1:1) + Biomix 1%	73.75	71.31	68.25	64.66
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	83.11	79.05	73.55	70.15
T_{10}	Cocopeat + FYM (1:1) + Biomix	70.21	67.97	66.46	63.95
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	74.65	73.10	68.37	64.67
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	83.8	79.64	73.47	71.17
T_{13}	Cocopeat + FYM (1:1)	68.20	64.53	62.22	59.89
S.E(m) ±		3.70	3.42	3.18	3.02
C.D at 5%		10.81	9.97	9.28	8.81

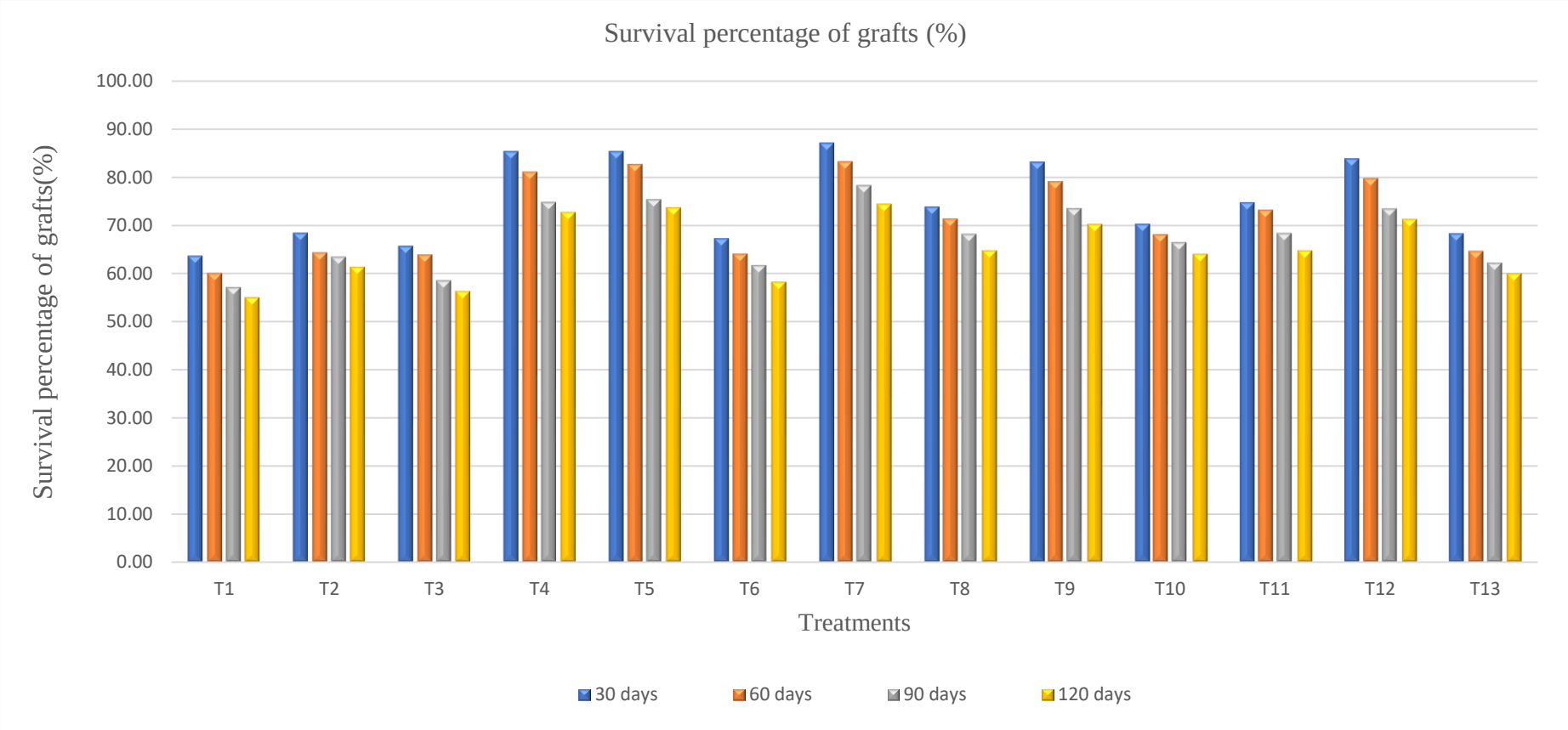


Fig 4.3: Effect of different growing media and bioagent applications on survival percentage of grafts at 30, 60,90 and 120 DAG

[T_1: control- Orchard soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

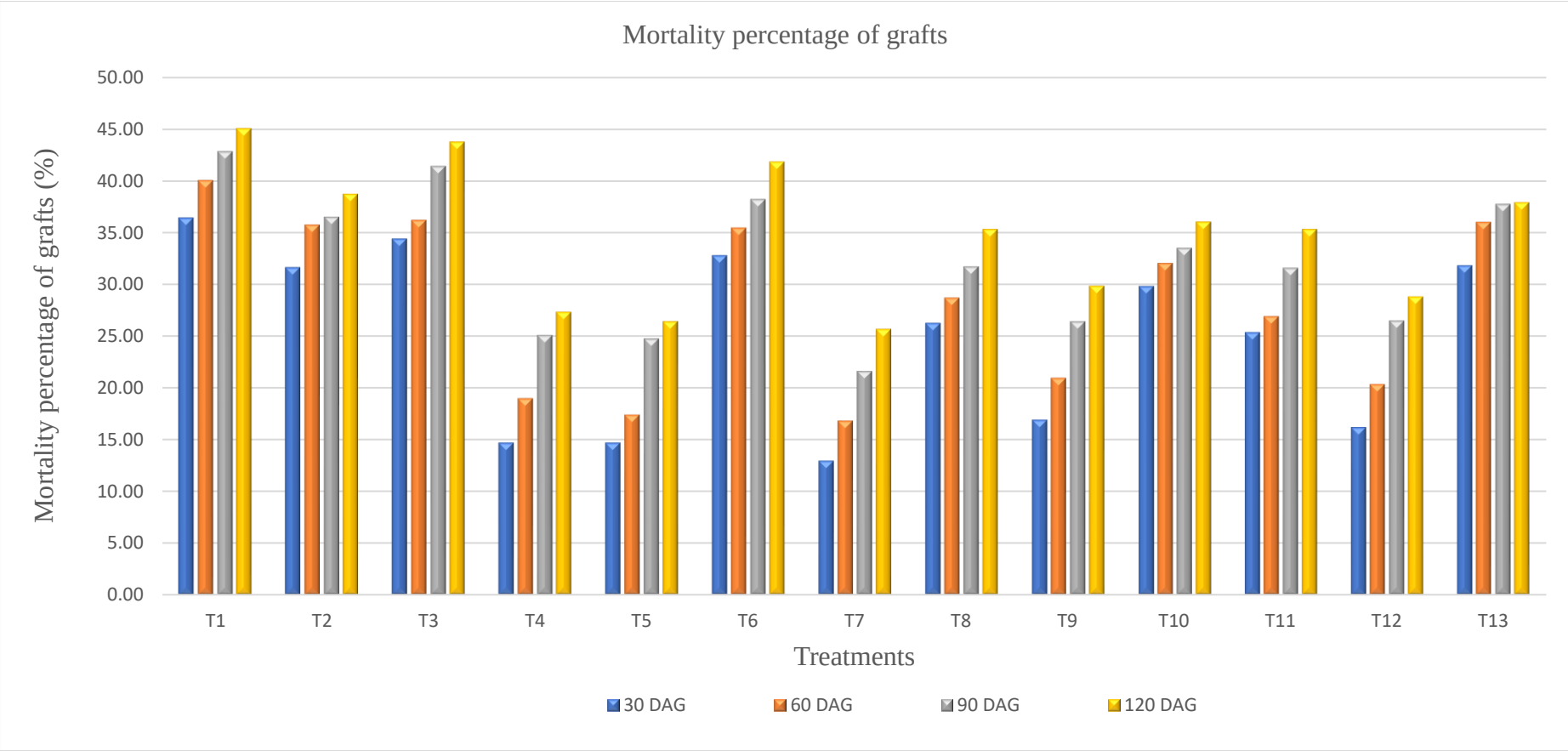


Fig 4.4: Effect of different growing media and bioagent applications on mortality percentage of mango grafts at 30, 60,90 and 120 DAG

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

Table 4.4: Effect of different growing media and bioagent applications on mortality percentage of grafts at 30, 60,90 and 120 DAG.

Treatments		Mortality percentage of grafts (%)			
		30 days	60 days	90 days	120 days
T_1	Orchard soil (Control)	36.40	40.05	42.85	45.04
T_2	Orchard soil + FYM (2:1) + Biomix 1%	31.63	35.75	36.53	38.73
T_3	Orchard soil + Biomix 1%	34.38	36.21	41.43	43.76
T_4	Orchard soil + FYM + Sand (2:1:1) +Biomix 1%	14.70	18.98	25.14	27.36
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	14.69	17.40	24.80	26.43
T_6	Clay soil + FYM (1:1) + Biomix 1%	32.77	35.47	38.25	41.82
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	12.94	16.83	21.67	25.69
T_8	Orchard soil + Sand (1:1) + Biomix 1%	26.25	28.69	31.75	35.34
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	16.89	20.95	26.45	29.85
T_{10}	Cocopeat + FYM (1:1) + Biomix	29.79	32.03	33.54	36.05
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	25.35	26.90	31.63	35.33
T_{12}	Orchard soil +FYM (2:1) +PSB (1%)	16.20	20.36	26.53	28.83
T_{13}	Cocopeat + FYM (1:1)	31.80	36.01	37.78	37.91
S.E(m) ±		1.10	1.45	1.58	1.64
C.D at 5%		3.22	4.23	4.62	4.81

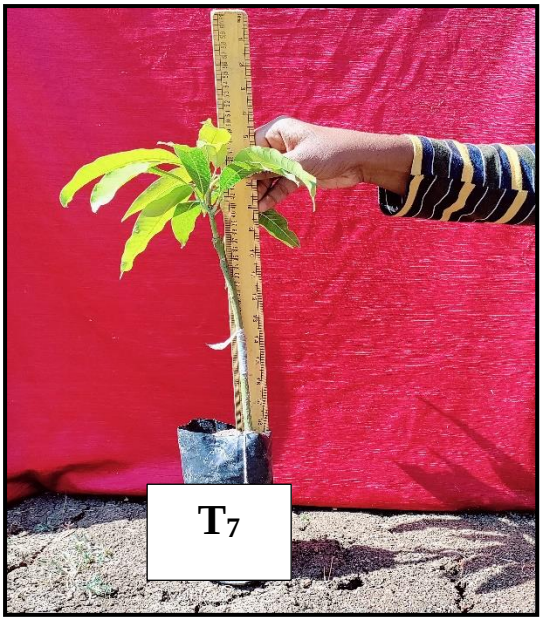
4.7 Length of scion (cm)

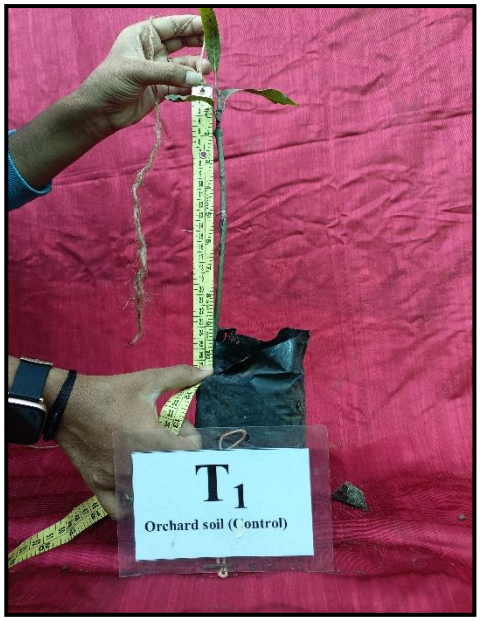
The data regarding effect of different potting mixtures on length of scion have shown in Table 4.7 and depicted in Fig. 4.7.

The present investigation data showed that, mixture of various growing media and bioagent treatments had non-significant effect on length of scion at 30 DAG and had significant effect on length of scion at 60,90 and 120 DAG. At 30 DAG, there was non-significant difference in the all treatment with respect length of scion but, at 60, 90 and 120 DAG, there was a significant variation in length of scion among the potting mixtures treatments. The maximum length of scion was observed in treatment T_7 (20.16 cm, 23.39 cm and 24.58 cm) i.e., Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 %) which was statistically at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (19.62 cm, 22.57 cm and 23.66 cm) and (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (18.78 cm, 21.59 cm and 22.61 cm). Whereas, from the control group (T_1), the minimum length of scion (15.82 cm, 18.06 cm, 19.09 cm) was recorded at 60, 90 and 120 DAG respectively.

This could be because vermicompost is a microbiologically active, nutrient-rich organic manure that provides plants with macronutrients, particularly nitrogen, for healthy root and shoot growth. Vermicompost promotes seedling growth and development while also stabilising the nutrient composition of media (Zaller, 2007 in tomato). Higher levels of auxin activity result from humic-containing vermicompost, which leads to more cell division and growth in terms of height. The results are in line with those obtained by Mirza *et al.* (2015) in karonda and Singh *et al.* (2015) in stevia. Vermicompost improve the soil physical condition and promotes organic matter, which in turn, produce organic acids, which inhibits particularly IAA oxidase enzyme, resulting in enhancing the promotive effect of auxin-IAA, which has direct effect on plant growth, herbage yield. In addition, such media enhanced apical meristematic activity and also triggered cambial division.

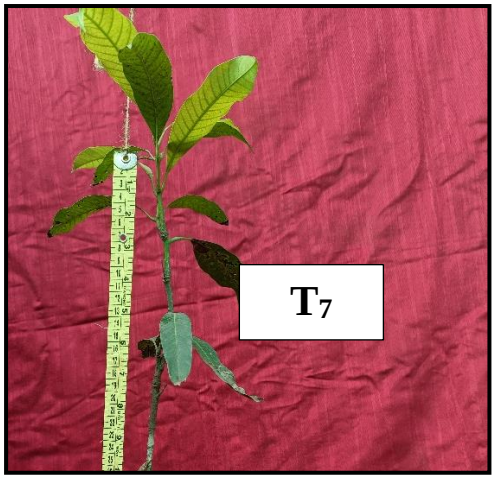
The increase in length of scion may attributed to general improvement in the physical and chemical properties of the rooting medium due to availability of FYM (Dileep *et al*., 1994). The presence of biomix in media, which is a unique blend of selected species of microbes that make nitrogen in the soil media available to plants in turns increase the length of scion.





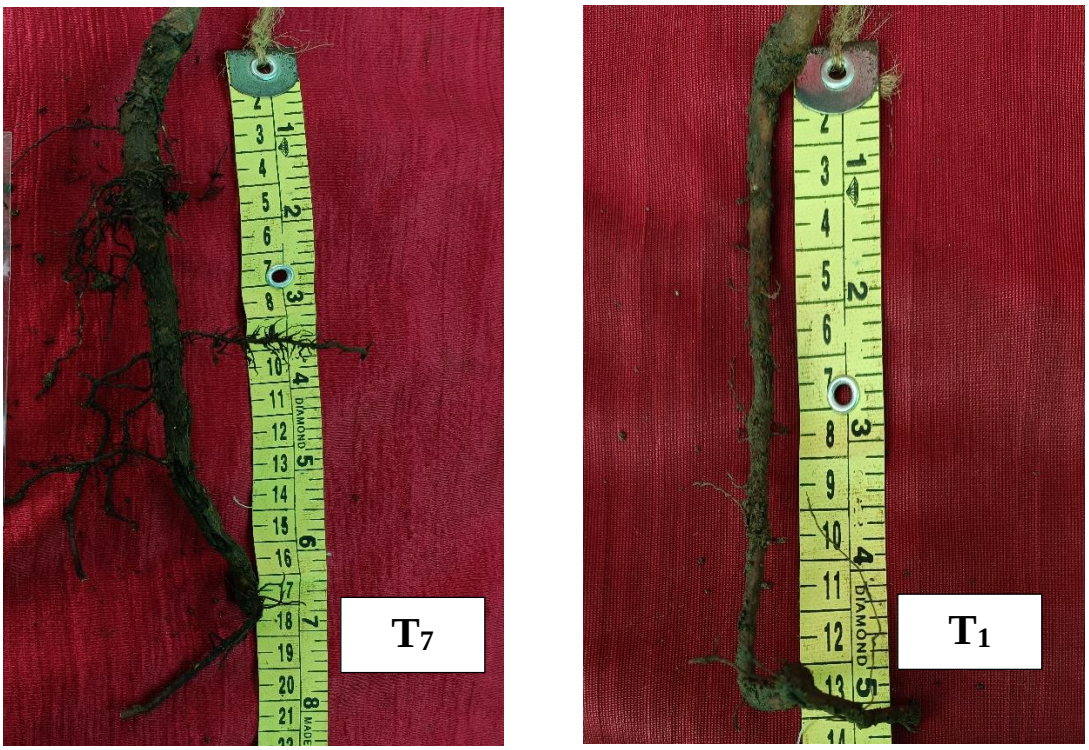
Plates 4.3: Effect of growing media and bioagent application on height of mango grafts at 120 DAG

Plates 4.4: Effect of growing media and bioagent application on girth of scion of mango grafts at 120 DAG



Plates 4.5: Effect of growing media and bioagent application on length of scion of mango grafts at 120 DAG

Plates 4.8: Effect of growing media and bioagent application on leaf area of mango grafts at 120 DAG



Plates 4.9: Effect of growing media and bioagent application on length of tap root of mango grafts at 120 DAG

Table 4.5: Effect of different growing media and bioagent applications on height of mango grafts at 30, 60, 90 and 120 DAG.

Treatments		Height of grafts (cm)			
		30 days	**60 days**	**90 days**	**120 days**
T_1	Orchard soil (Control)	19.66	21.85	24.00	26.39
T_2	Orchard soil + FYM (2:1) + Biomix 1%	22.18	24.04	26.09	28.50
T_3	Orchard soil + Biomix 1%	21.47	22.93	25.04	27.48
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	23.53	26.55	28.68	31.04
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	23.82	27.11	29.24	31.67
T_6	Clay soil + FYM (1:1) + Biomix 1%	21.42	23.53	25.63	27.99
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	24.24	28.25	31.38	34.33
T_8	Orchard soil + Sand (1:1) + Biomix 1%	22.64	24.79	26.94	29.26
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	22.92	25.65	27.76	30.22
T_{10}	Cocopeat + FYM (1:1) + Biomix	22.61	24.04	26.17	28.60
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	22.64	25.15	27.26	29.70
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	22.94	26.02	28.28	30.70
T_{13}	Cocopeat + FYM (1:1)	21.62	23.71	25.92	28.33
S.E(m) ±		1.09	1.21	1.31	1.40
C.D at 5%		NS	3.52	3.83	4.09

Table 4.6: Effect of different growing media and bioagent applications on girth of scion at 30, 60, 90 and 120 DAG

Treatments		Girth of scion (mm)			
		30 days	60 days	90 days	120 days
T_1	Orchard soil (Control)	5.47	6.11	6.52	7.74
T_2	Orchard soil + FYM (2:1) + Biomix 1%	5.66	6.28	7.17	8.45
T_3	Orchard soil + Biomix 1%	5.79	6.36	6.91	7.90
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	6.23	6.95	7.57	9.34
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	6.59	7.00	7.74	9.08
T_6	Clay soil + FYM (1:1) + Biomix 1%	5.61	6.27	7.15	8.12
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	6.66	7.11	7.91	9.70
T_8	Orchard soil + Sand (1:1) + Biomix 1%	5.74	6.32	7.24	8.42
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	5.90	6.45	7.29	8.50
T_{10}	Cocopeat + FYM (1:1) + Biomix	5.75	6.31	6.98	8.19
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	5.78	6.31	6.85	8.06
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	6.12	6.90	7.08	8.30
T_{13}	Cocopeat + FYM (1:1)	5.72	6.30	6.87	8.11
S.E(m) ±		0.31	0.30	1.00	1.22
C.D at 5%		NS	NS	NS	NS

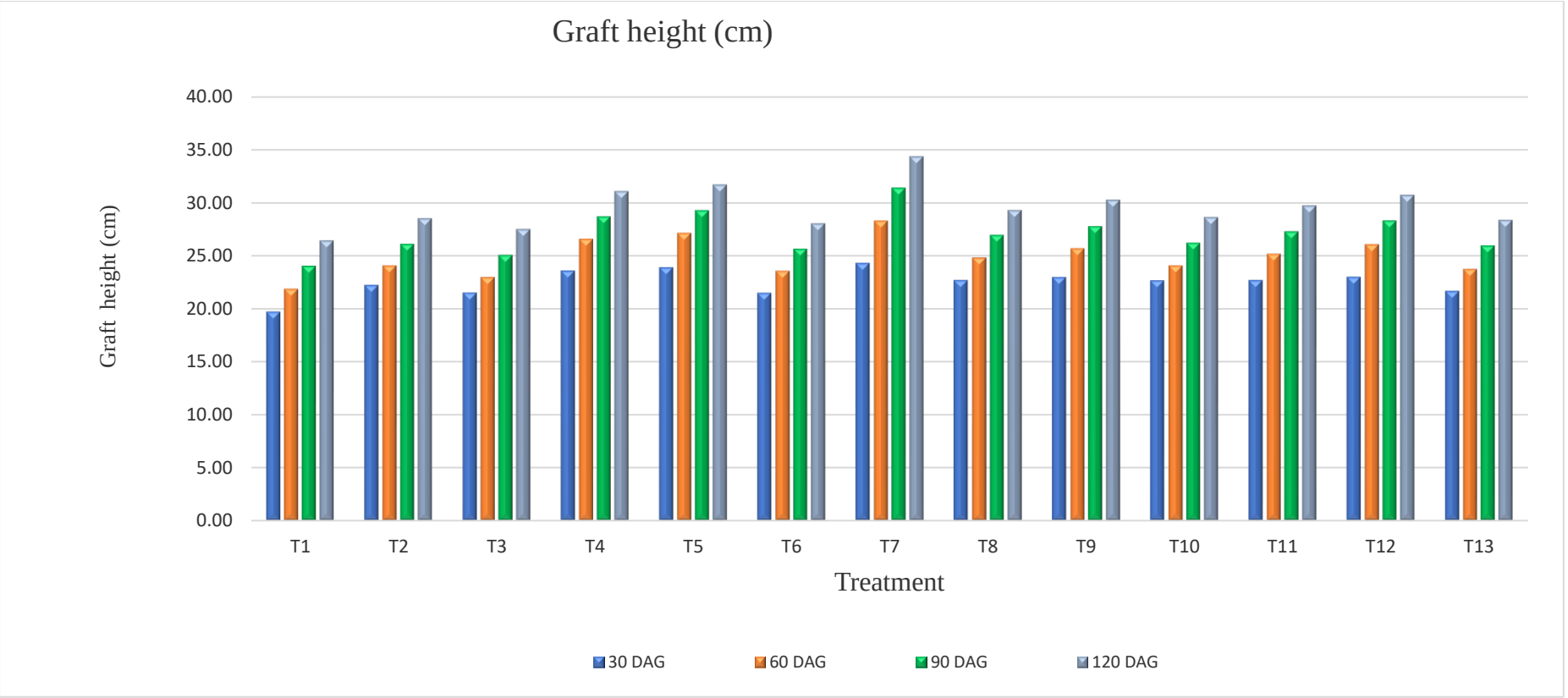


Fig 4.5: Effect of different growing media and bioagent applications on height of mango grafts at 30, 60,90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

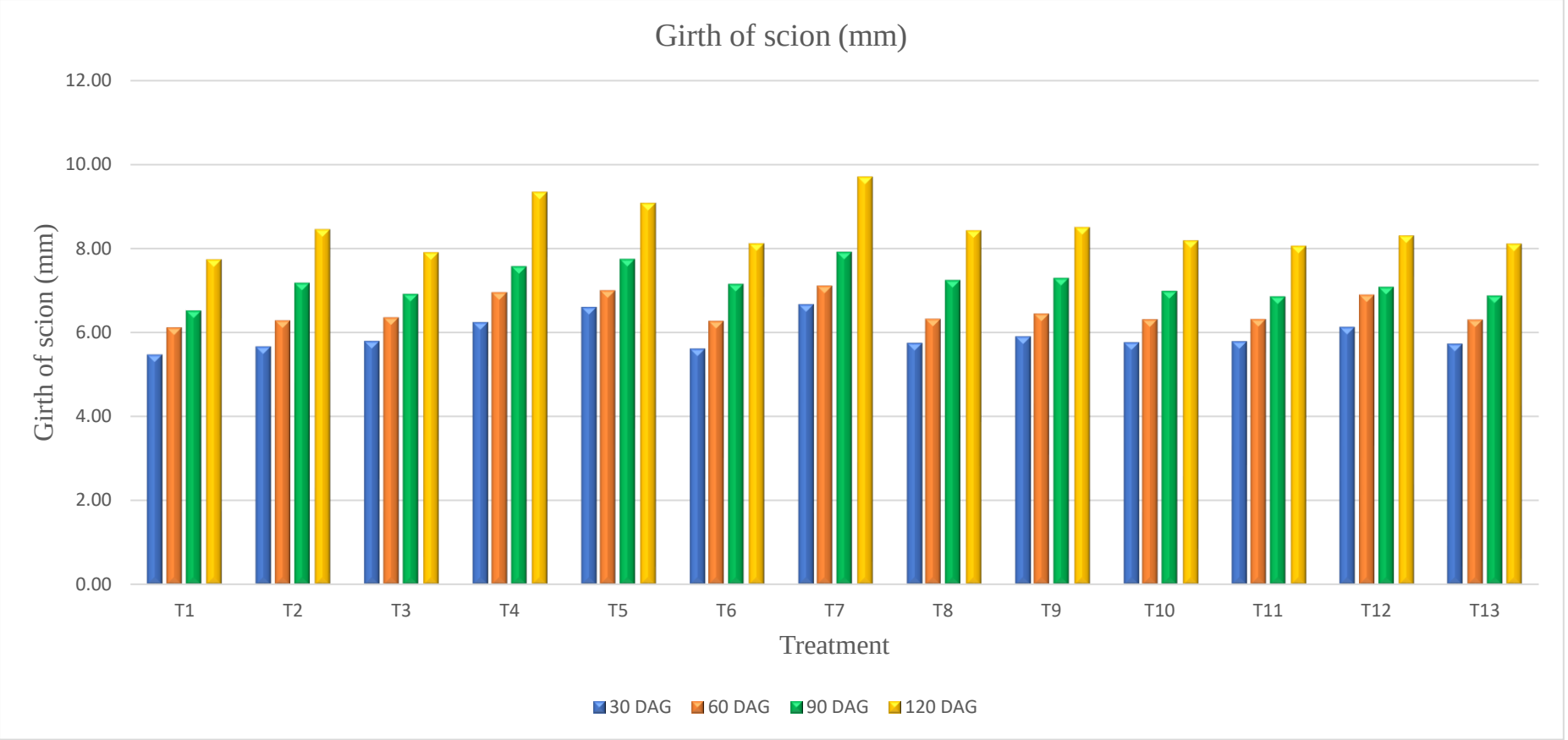


Fig 4.6: Effect of different growing media and bioagent applications on girth of scion at 30, 60,90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

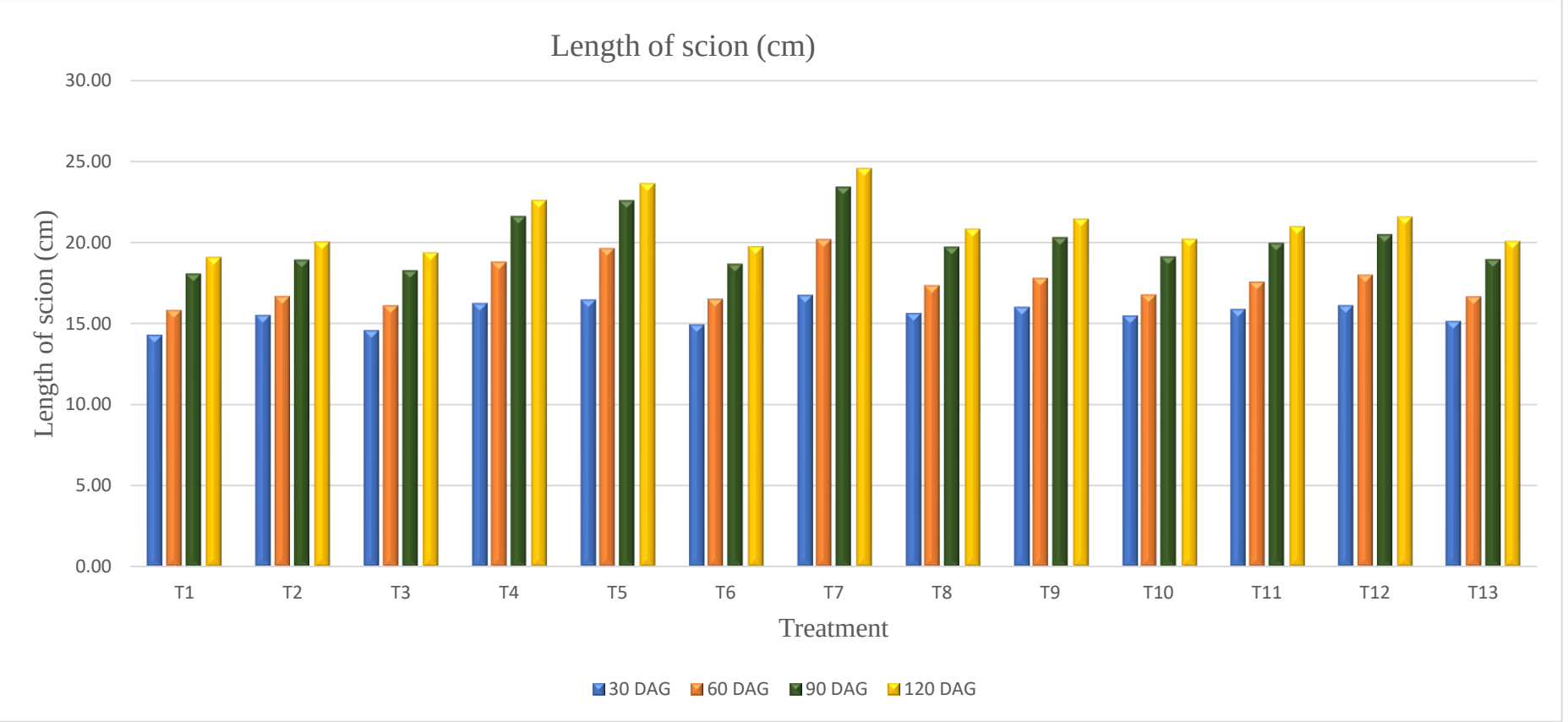


Fig 4.7: Effect of different growing media and bioagent applications on length of scion at 30, 60,90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

The results are in accordance with finding of Rajputh *et al.* (2019) in nutmeg with media containing soil + FYM + vermicompost + rice husk at 1:1:1:1 proportion with 2.54 cm cocopeat at top.

The improvement in growth may be because of the use of biofertilizers that outcomes in expanded length of shoots, gracefully of all supplements so at last builds the vegetative growth of the plants. These perceptions are in conformity with those of Khan *et al.* (2009) in citrus and Khalid *et al.* (2013) in strawberry.

4.8 Number of leaves per graft

The data pertaining to number of leaves per graft was computed and statistically analysed. The result is put forth in Table 4.8 and depicted in Fig. 4.8.

It was found that in the present investigation, the effect of mixture of various growing media and bioagent treatments had a significant effect on the number of leaves per graft. The maximum number of leaves per graft (7.33, 10.72, 13.78 and 15.69) was obtained under (T_7) Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% which was at statistically par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (7.07, 10.16, 13.20 and 15.22) followed by (T_{10}) Cocopeat + FYM (1:1) + Biomix (6.40, 9.83, 12.94 and 14.96) at 30, 60, 90 and 120 DAG respectively. Whereas, minimum number of leaves (3.47, 6.33, 8.03 and 9.36) was observed in T_1 (control) treatment at 30, 60, 90 and 120 DAG respectively.

This could be attributed to general improvements in the physical and chemical properties of rooting medium, which may have accelerated the process of cell division, differentiation, and better nutrient availability, resulting in higher production of photosynthetically active functional leaves and plant growth by media. The outcomes are consistent with Savani (2006). Parasana *et al.* (2013) reported similar results in mango, where the incorporation of FYM in the growing media significantly increased the number of leaves, root dry weight, and seedling dry weight due to increased photosynthetic activity.

The increased in number of leaves may be due to positive benefits of bio-fertilizers (Biomix) which increase the N uptake with increased nitrate reductase activity in the plant which is in conformity with the findings of Wani (1990) obtained positive benefit from *Azospirillum* inoculation in cereals.

4.9 Leaf area (cm^2)

The data on leaf area in grafts as influenced by different treatments are statistically analysed and are presented in Table 4.9 and graphically illustrated in Fig. 4.9.

The results revealed that the influence of various treatments had a significant effect on leaf area of graft. The maximum leaf area (13.36 cm^2, 19.75 cm^2, 23.56 cm^2 and 28.79 cm^2) was recorded in treatment (T_7) Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1% which was at par with (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (12.59 cm^2, 19.27 cm^2, 23.44 cm^2 and 28.09 cm^2) and (T_{10}) Cocopeat + FYM (1:1) + Biomix 1% (12.10 cm^2, 18.82, 23.10 and 27.68) at 30, 60, 90 and 120 DAG respectively. Whereas, minimum leaf area (8.71 cm^2, 15.322 cm^2, 17.93 cm^2 and 22.44 cm^2) was obtained in T_1 (control) at 30, 60, 90 and 120 DAG respectively.

The physiological changes observed in vermicompost treated plants could be attributed to the humic substances and nutrients, especially microelements like Zn present in vermicompost. The vermicompost increased leaf area and biomass in various plants have been reported by some previous researchers (Bachman and Metzger, 2008 and Wang *et al*., 2010). Combined application of vermicompost and FYM in the treatment showed significant effect on seedling growth parameter and plant biomass probably due to the synergistic combination of both the factor in improving the physical condition of media and nutritional factor. This result is akin to finding of Campos mota *et al*. (2009) and Abhiram *et al.* (2010) who suggested that vermicompost when used in combination with other nutrient media provides better growth medium for plant establishment. The results are in accordance with finding of Abhirami *et al.* (2010) with soil + coir dust + sand + vermicompost (1:1:1:1) in nutmeg, Gholap and Polara (2015) in mango having media containing soil + FYM + leaf mould (1:1:1) and Rajputh *et al* (2019) in nutmeg with media having soil + FYM + vermicompost + sand 1:1:1:1 with 2.54 cm cocopeat.

The increase in leaf area might be due to the application of biomix as it ia mixture of nitrogen fixer bacteria, phosphorous solubilising bacteria and potassium solubilising bacteria which helps for increasing growth of the leaves. Similar, results were reported by Singh *et al.* (1977), Tiwary *et al.* (1998), Yadav *et al*, (2012) and Mandal *et al.* (2021).

Table 4.7: Effect of different growing media and bioagent applications on length of scion at 30, 60, 90 and 120 DAG.

Treatments		Length of scion (cm)			
		30 days	**60 days**	**90 days**	**120 days**
T_1	Orchard soil (Control)	14.29	15.82	18.06	19.09
T_2	Orchard soil + FYM (2:1) + Biomix 1%	15.50	16.67	18.90	20.06
T_3	Orchard soil + Biomix 1%	14.57	16.10	18.25	19.38
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	16.25	18.78	21.59	22.61
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	16.45	19.62	22.57	23.66
T_6	Clay soil + FYM (1:1) + Biomix 1%	14.92	16.49	18.65	19.76
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	16.75	20.16	23.39	24.58
T_8	Orchard soil + Sand (1:1) + Biomix 1%	15.63	17.33	19.71	20.84
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	16.01	17.78	20.29	21.45
T_{10}	Cocopeat + FYM (1:1) + Biomix	15.47	16.77	19.10	20.22
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	15.88	17.54	19.94	20.98
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	16.11	17.98	20.48	21.59
T_{13}	Cocopeat + FYM (1:1)	15.14	16.64	18.94	20.08
S.E(m) ±		0.75	0.88	1.11	1.08
C.D at 5%		NS	2.57	3.23	3.17

Table 4.8: Effect of different growing media and bioagent applications on number of leaves per grafts at 30, 60, 90 and 120 DAG

Treatments		Number of leaves per grafts			
		30 days	**60 days**	**90 days**	**120 days**
T_1	Orchard soil (Control)	3.47	6.33	8.03	9.36
T_2	Orchard soil + FYM (2:1) + Biomix 1%	5.40	7.29	9.33	11.89
T_3	Orchard soil + Biomix 1%	4.93	6.98	8.64	9.98
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	5.53	8.68	10.45	12.91
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	7.07	10.16	13.20	15.22
T_6	Clay soil + FYM (1:1) + Biomix 1%	5.47	7.77	9.88	12.32
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	7.33	10.72	13.78	15.69
T_8	Orchard soil + Sand (1:1) + Biomix 1%	5.27	7.41	8.98	11.21
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	5.33	7.52	9.11	11.45
T_{10}	Cocopeat + FYM (1:1) + Biomix	6.40	9.83	12.94	14.96
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	6.07	9.13	12.12	13.84
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	5.93	8.98	10.89	13.28
T_{13}	Cocopeat + FYM (1:1)	6.27	9.56	12.65	14.38
S.E(m) ±		0.31	0.49	0.61	0.69
C.D at 5%		0.91	1.44	1.78	2.02

Table 4.9: Effect of different growing media and bioagent applications on leaf area of mango grafts at 30, 60, 90 and 120 DAG

Treatments		Leaf area (cm^2)			
		30 days	**60 days**	**90 days**	**120 days**
T_1	Orchard soil (Control)	8.71	15.22	17.93	22.44
T_2	Orchard soil + FYM (2:1) + Biomix 1%	9.77	16.48	20.56	24.10
T_3	Orchard soil + Biomix 1%	8.98	15.94	18.61	23.00
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	10.85	17.14	21.46	25.43
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	12.59	19.27	23.44	28.09
T_6	Clay soil + FYM (1:1) + Biomix 1%	10.33	16.79	20.78	24.61
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	13.36	19.75	23.56	28.79
T_8	Orchard soil + Sand (1:1) + Biomix 1%	9.11	16.10	19.42	23.65
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	9.56	16.45	20.12	23.26
T_{10}	Cocopeat + FYM (1:1) + Biomix	12.10	18.82	23.1	27.68
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	11.43	17.89	22.12	26.16
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	11.26	17.68	21.95	25.88
T_{13}	Cocopeat + FYM (1:1)	11.94	18.44	22.54	26.38
S.E(m) ±		0.57	0.92	1.18	1.36
C.D at 5%		1.67	2.68	3.45	3.98

4.10 Fresh weight of shoot (g)

The data pertaining to fresh weight of shoot as influenced by different growing media and bioagents application are presented in Table 4.10 and graphical form in Fig. 4.10.

The present investigation data showed that various treatment has significant effect on fresh weight of shoot. The grafts of treatment (T_7) Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % recorded maximum fresh weight of shoot (24.53 g) which showed superiority over other treatments followed by (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (23.77 g) and (T_4) Orchard soil + FYM + Sand (2:1:1) +Biomix 1% (22.72 g). Control (T_1) recorded minimum (16.42 g) fresh weight of shoot at 120 DAG.

This is because FYM has a high-water retention capacity and sufficient porosity. Similarly, vermicompost provides adequate nutrients and plant growth hormones (Soegiman, 1982). Higher shoot weight is caused by a higher concentration of growth-promoting nutrients, proper aeration and FYM increased moisture supplying capacity. This increases grafted seedling vegetative growth by increase in plant height, number of leaves and stem diameter, which in turn increases fresh weight of shoot. Hence general improvement in physical and chemical properties of rooting media which improve fresh weight of grafted seedling (Dileep *et al.,* 1994). The results are in agreement with the findings of Bhardwaj (2013) with vermicompost + sand + pond soil (1:1:1) in papaya, Prasanna *et al*. (2012) with soil + sand + FYM (1:1:1) in mango and Kaur (2017) with soil + sand+ vermicompost (1:1:2) medium in mango,

Increase in fresh and dry weight of the aerial part by application biomix is due to the enhanced nitrogen-fixing, better absorption of nutrients especially N, secretion of growth promoting substances. This is in agreement with the results obtained by Umar *et al*. (2009). Gluconoacterobacter an organism present in biomix has nitrogen fixing ability and also known to synthesis indole-3-acetic acid which promote the growth of the associated plant species and in turn increase the biomass of shoot (Jambotkar *et al.,* 2008).

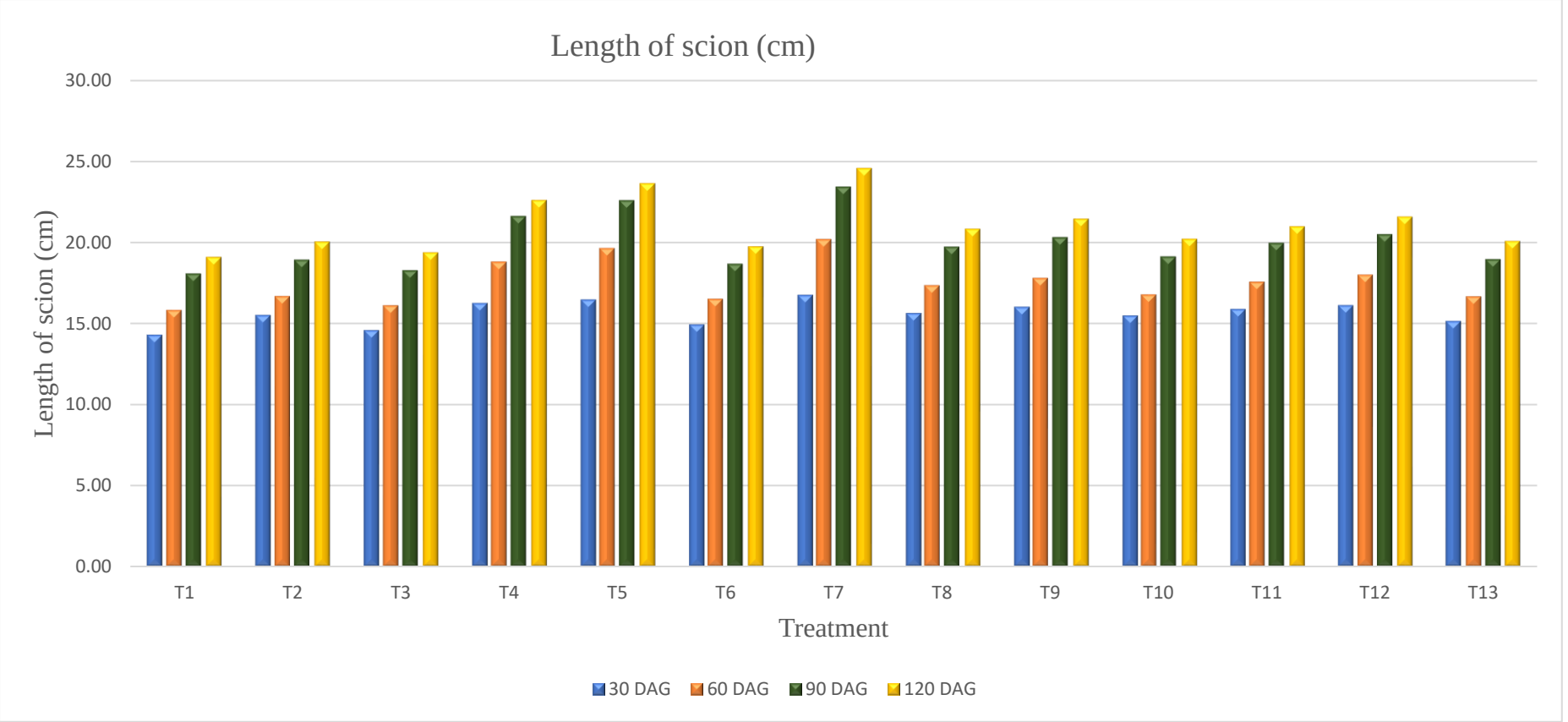


Fig 4.7: Effect of different growing media and bioagent applications on length of scion at 30, 60,90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

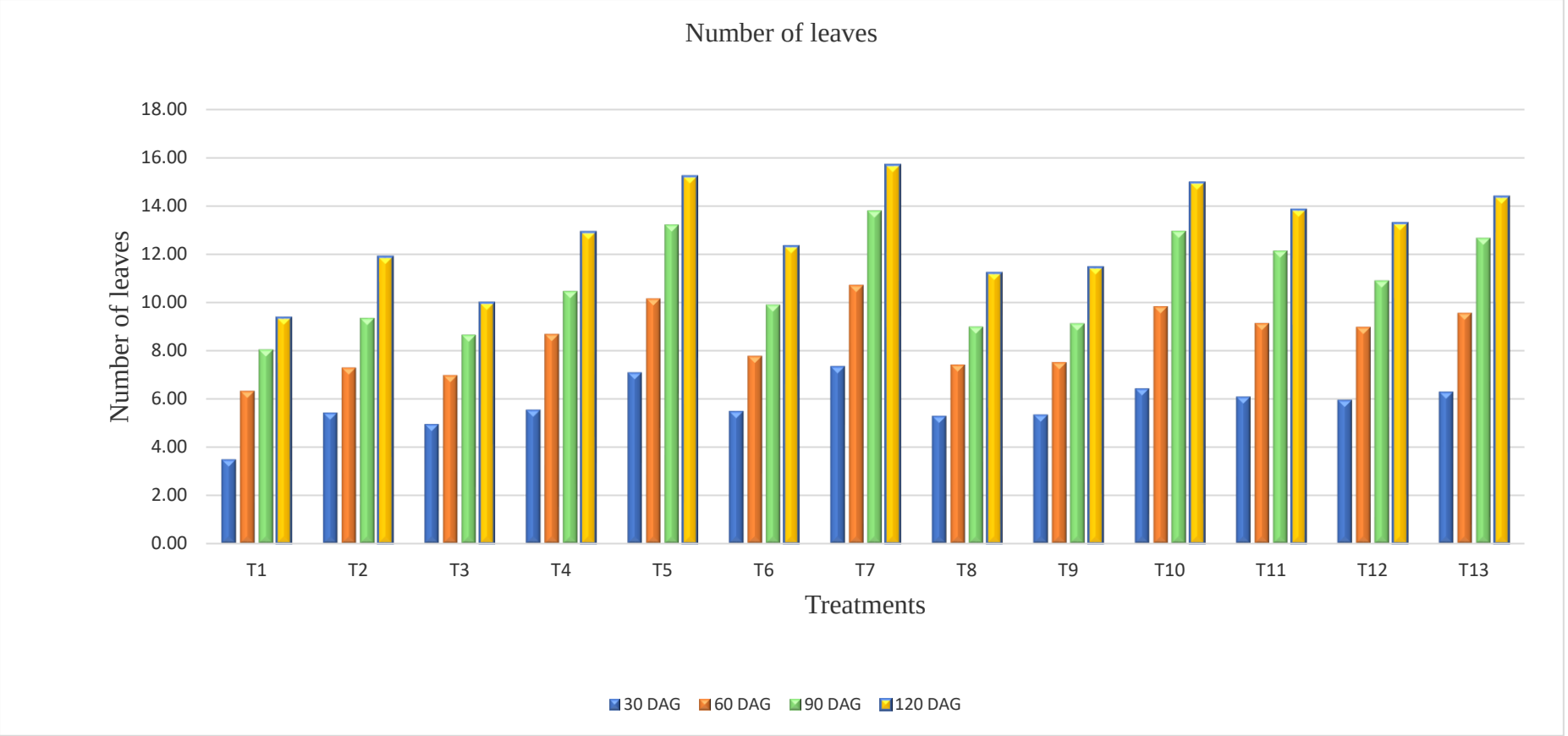


Fig 4.8: Effect of different growing media and bioagent applications on number of leaves per grafts at 30, 60, 90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

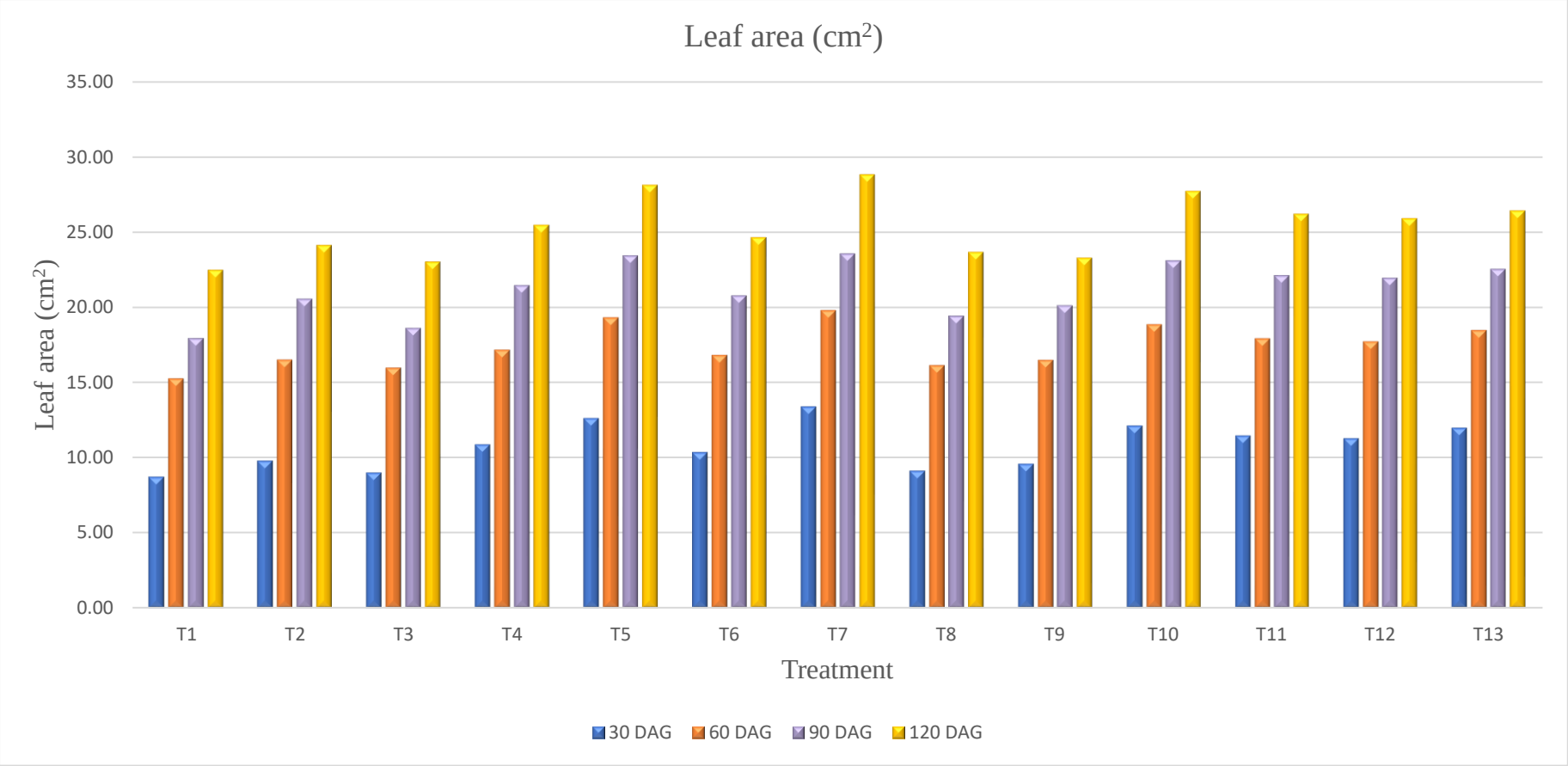


Fig 4.9: Effect of different growing media and bioagent applications on leaf area of mango grafts at 30, 60, 90 and 120 DAG.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T_7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:

Table 4.10: Effect of different growing media and bioagent applications on fresh shoot weight of graft

Treatments		Fresh weight of shoot (g)
T_1	Orchard soil (Control)	16.42
T_2	Orchard soil + FYM (2:1) + Biomix 1%	17.37
T_3	Orchard soil + Biomix 1%	16.73
T_4	Orchard soil + FYM + Sand (2:1:1) +Biomix 1%	22.72
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	23.77
T_6	Clay soil + FYM (1:1) + Biomix 1%	17.19
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	24.53
T_8	Orchard soil + Sand (1:1) + Biomix 1%	18.58
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	21.23
T_{10}	Cocopeat + FYM (1:1) + Biomix	18.56
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	19.60
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	22.35
T_{13}	Cocopeat + FYM (1:1)	17.35
S.E(m) ±		1.10
C.D at 5%		3.21

4.11 Dry weight of shoot (g)

The data regarding dry weight of grafted mango shoots as influenced by different growing media and bioagents application are presented in Table 4.11 and graphical form in Fig 4.11.

There was significant effect of various treatments on dry weight of shoot. The treatment (T_7) Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % recorded maximum dry weight of shoot (17.25 g) which was at par with treatment (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% (16.81 g) and (T_4) Orchard soil + FYM + Sand (2:1:1) +Biomix 1% (16.22 g). Whereas, control (T_1) recorded minimum (8.55 g) dry weight of shoot at 120 DAG.

The increase in dry weight of shoot could be attributed to vermicompost, which contains plant growth regulating substances like humic acid and plant growth regulators like auxin, gibberellins and cytokinins, which are responsible for enhanced growth of grafted seedlings and thus increased dry weight of shoot (Atiyeh *et al.*, 2002).

The results are in accordance with the findings of Bhardwaj (2013) in papaya, Ramteke *et al*. (2016) in papaya, Kaur (2017) in mango and Prajapathi *et al*. (2017) in kagzi lime.

Table 4.11: Effect of different growing media and bioagent applications on dry shoot weight of graft.

Treatments		Dry weight of shoot (g)
T_1	Orchard soil (Control)	8.55
T_2	Orchard soil + FYM (2:1) + Biomix 1%	11.16
T_3	Orchard soil + Biomix 1%	9.44
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	16.22
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	16.81
T_6	Clay soil + FYM (1:1) + Biomix 1%	10.39
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	17.25
T_8	Orchard soil + Sand (1:1) + Biomix 1%	12.21
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	14.45
T_{10}	Cocopeat + FYM (1:1) + Biomix 1%	11.34
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	12.65
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	15.49
T_{13}	Cocopeat + FYM (1:1)	10.49
S.E(m) ±		0.71
C.D at 5%		2.08

Increase in fresh and dry weight of the aerial part by application of biomix is due to the enhanced nitrogen-fixing, better absorption of nutrients especially N, secretion of growth promoting substances. This is in agreement with the results obtained by Umar *et al*. (2009). Gluconoacterobacter an organism present in biomix has nitrogen fixing ability and also known to synthesis indole-3-acetic acid which promote the growth of the associated plant species and in turn increase the biomass of shoot (Jambotkar *et al.*, 2008).

4.12 Dry root to shoot ratio

The examination of data on dry root to shoot ratio of mango grafts as influenced by different growing media and bioagents application are presented in Table 4.12 and graphical form in Fig 4.12.

The perusal of results depicted in Table 4.12 clearly indicated that different treatments under study had non-significant effect on dry root to shoot ratio of mango grafts at 120 DAG.

Table 4.12: Effect of different growing media and bioagent applications on dry root to shoot ratio of graft.

Treatments		Dry root to shoot ratio
T_1	Orchard soil (Control)	0.41
T_2	Orchard soil + FYM (2:1) + Biomix 1%	0.44
T_3	Orchard soil + Biomix 1%	0.46
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	0.51
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	0.52
T_6	Clay soil + FYM (1:1) + Biomix 1%	0.43
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	0.55
T_8	Orchard soil + Sand (1:1) + Biomix 1%	0.46
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	0.45
T_{10}	Cocopeat + FYM (1:1) + Biomix 1%	0.45
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	0.48
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	0.46
T_{13}	Cocopeat + FYM (1:1)	0.42
S.E(m) ±		0.02
C.D at 5%		NS

4.13 Length of tap root

The data pertaining to length of tap root as influenced by different treatments are presented in Table 4.13 and graphical form in Fig 4.13.

Table 4.13: Effect of different growing media and bioagent applications on length of tap root (cm) of graft.

Treatments		Length of tap root (cm) at 120 DAG
T_1	Orchard soil (Control)	16.93
T_2	Orchard soil + FYM (2:1) + Biomix 1%	19.00
T_3	Orchard soil + Biomix 1%	17.87
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	22.96
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	22.60
T_6	Clay soil + FYM (1:1) + Biomix 1%	18.44
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	24.60
T_8	Orchard soil + Sand (1:1) + Biomix 1%	19.69
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	21.61
T_{10}	Cocopeat + FYM (1:1) + Biomix 1%	19.20
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	20.96
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	22.20
T_{13}	Cocopeat + FYM (1:1)	20.15
S.E(m) ±		1.16
C.D at 5%		3.38

It was found in the present study that, the use of different growing media and bioagents application had a significant effect on the length of tap root. Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % (T_7) had the highest tap root length (24.60 cm) and which was statistically comparable to the treatment (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (22.96 cm) and (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (22.60 cm). However, the control (T_1) treatment recorded lowest tap root length (16.93 cm) at 120 DAG.

Fig 4.10: Effect of different growing media and bioagent applications on fresh shoot weight of grafts.

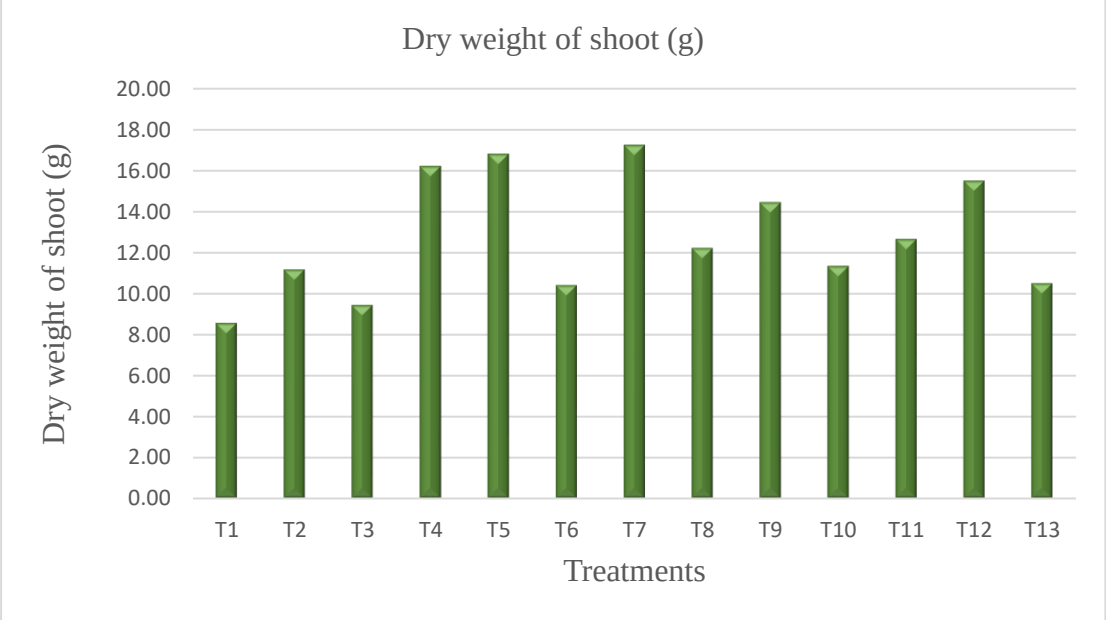


Fig 4.11: Effect of different growing media and bioagent applications on dry shoot weight of graft.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

Plates 4.6: Effect of growing media and bioagent application on fresh weight root of mango grafts at 120 DAG

Plates 4.7: Effect of growing media and bioagent application on fresh weight of shoot of mango grafts at 120 DAG

In context with present findings the root length is directly proportional to the penetration, which on the other hand depends upon porosity and friability of the medium. The increase in root length may be attributed to organic matter present in FYM acts as a glue for soil aggregate and a source of soil nutrients. Granules of vermicompost have the potential to form soil aggregates and granules. Soil aggregation will improve the permeability and air movement in the polybags and helps in better growth of tap root. Vermicompost may reduce soil temperature fluctuations, allowing for better root growth to a specific depth and improving water and nutrient absorption. Organic matter can also help with nutrient availability and phosphorus absorption. All of these conditions are favourable for better root development, resulting in greater root length. The results are in confirmation with Singh *et al*. (2015) in stevia. Further, when growing media consist of vermicompost, the soil gains more EC, which enhance water and nutrient retention capacity, better aeration and also provides growth regulating substances as well as beneficial microorganisms (Moradi *et al*., 2014). All of these factors influenced root length positively. This is consistent with the findings of Rasool *et al.* (2008). The results are in accordance with finding of Gholap and Polar (2015) in mango, Parmar *et al.* (2015) in custard apple and Kaur (2017) in mango.

The increase in length of tap root is due to presence of microorganism such as *Azospirillum brasilense* in a biomix, a inoculation can change the root morphology via producing plant growth regulating substances (Bashan *et al.*, 2004) and through siderophore production (Sahoo *et al*., 2014). It also increases the number of lateral roots and enhances root hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012).

4.14 Number of primary roots per graft

The data regarding number of primary roots per graft as influenced by different growing media and bioagents application are tabularized in Table 4.14 and graphically delineated in Fig 4.14.

Among all the treatments conducted Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % (T_7) had put forth a greater number of primary roots per grafts (2.64) and was statistically at par with (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (2.01) and (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix

1 % (1.98). The minimum number of primary roots per grafts (1.48) was recorded in (T_1) control.

Table 4.14: Effect of different growing media and bioagent applications on number of primary roots per graft.

Treatments		Number of primary roots per grafts at 120 DAG
T_1	Orchard soil (Control)	1.48
T_2	Orchard soil + FYM (2:1) + Biomix 1%	1.55
T_3	Orchard soil + Biomix 1%	1.57
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	2.01
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	1.98
T_6	Clay soil + FYM (1:1) + Biomix 1%	1.48
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	2.64
T_8	Orchard soil + Sand (1:1) + Biomix 1%	1.57
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	1.97
T_{10}	Cocopeat + FYM (1:1) + Biomix	1.59
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	1.67
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	1.74
T_{13}	Cocopeat + FYM (1:1)	1.62
S.E(m) ±		0.10
C.D at 5%		0.29

The increased number of primary roots can be attributed to the use of potting media containing vermicompost and FYM, as vermicompost contains bioactive components that promote root growth, resulting in better root development, increased biomass and improved growth and development. (Bachman and Metzger, 2008) and a balanced nutrient composition (Zaller, 2007), as well as higher phosphorus by a symbiotic mycorrhizal association, as reported by (Bano *et al.,* 1987). FYM is essential for the maintenance of the physical and biological conditions of the soil, as well as the supply of nutrients to crops and the preservation of humic substances in the soil.

Fig 4.12: Effect of different growing media and bioagent applications on dry root to shoot ratio of grafts.

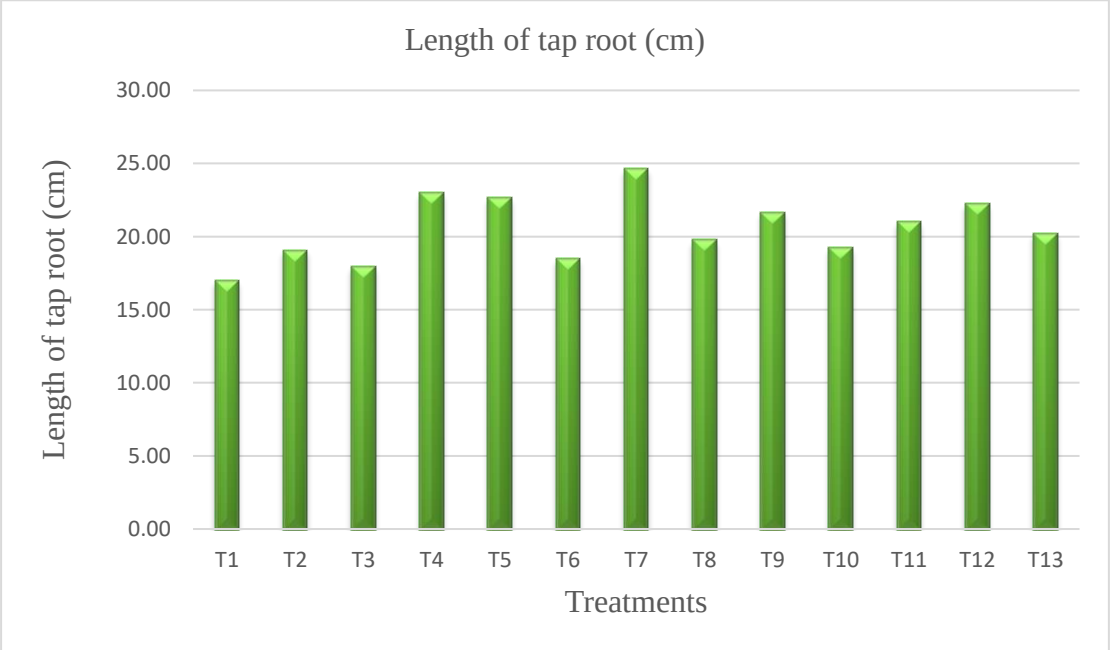


Fig 4.13: Effect of different growing media and bioagent applications on length of tap root (cm) of graft.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

As a result, the rooting media, which was a combination of two media, performed better than their individual applications. This could be due to the combinations of higher concentration of growth-promoting nutrients, proper aeration, and moisture-retaining capacity. Singh and Nair (2003) discovered similar results in ornamental plants, Bashir *et al.* (2009) in jojoba cuttings and Mathowa *et al.* (2014) discovered similar results in african baobab. The results are in accordance with finding of Thakriya *et al.* (2017) by using vermiwash in mango and Kaur (2017) in mango.

The biomix might have played important role along with growing media for increasing in number of primary root due to presence of microorganism such as *Azospirillum brasilense* which can change the root morphology via producing plant growth regulating substances (Bashan *et al.,* 2004) and siderophore production (Sahoo *et al*., 2014). It also increases the number of lateral roots and enhances root hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012).

4.15 Number of secondary roots per graft

The results obtained regarding the number of secondary roots per graft was recorded and presented in Table 4.15 and depicted in Fig. 4.15.

The use of different growing media and bioagents application had a significant effect on the number of secondary roots per grafts. Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % (T_7) had the highest number of secondary roots per graft (43.38) and was at par with (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (40.83) and (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (39.73). The control (T_1) obtained lowest number of secondary roots per graft (29.20) at 120 DAG.

The significant results obtained in terms of number of secondary roots per seedling could be attributed due to improved aeration, excellent drainage, high organic matter content and good water holding capacity of rooting medium as well as auxin content in vermicompost. All of these factors could be attributed to callus-forming tissues such as phloem, pericycle and cambium cell division. These tissues generated the root primordial, resulting in improved rooting (Rashmitha *et al.,* 2016). The results are in accordance with finding of Akshay *et al*. (2014) in black pepper by using media soil +

sand + FYM + vermicompost (1:1:1:1), Kaur (2017) in mango and Thakriya *et al.* (2017) by using vermiwash in mango.

Table 4.15: Effect of different growing media and bioagent applications on number of secondary roots per graft.

Treatments		Number of secondary roots per grafts at 120 DAG
T_1	Orchard soil (Control)	29.20
T_2	Orchard soil + FYM (2:1) + Biomix 1%	35.00
T_3	Orchard soil + Biomix 1%	31.67
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	40.83
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	39.73
T_6	Clay soil + FYM (1:1) + Biomix 1%	32.07
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	43.38
T_8	Orchard soil + Sand (1:1) + Biomix 1%	35.70
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	37.67
T_{10}	Cocopeat + FYM (1:1) + Biomix	35.20
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	35.97
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	37.91
T_{13}	Cocopeat + FYM (1:1)	36.67
S.E(m) ±		1.94
C.D at 5%		5.65

The increase in number of secondary root may be due to presence of biomix in growing media which can change the root morphology *via* producing plant growth regulating substances (Bashan *et al.*, 2004) and siderophore production (Sahoo *et al*., 2014). It also increases the number of lateral roots and enhances root hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012).

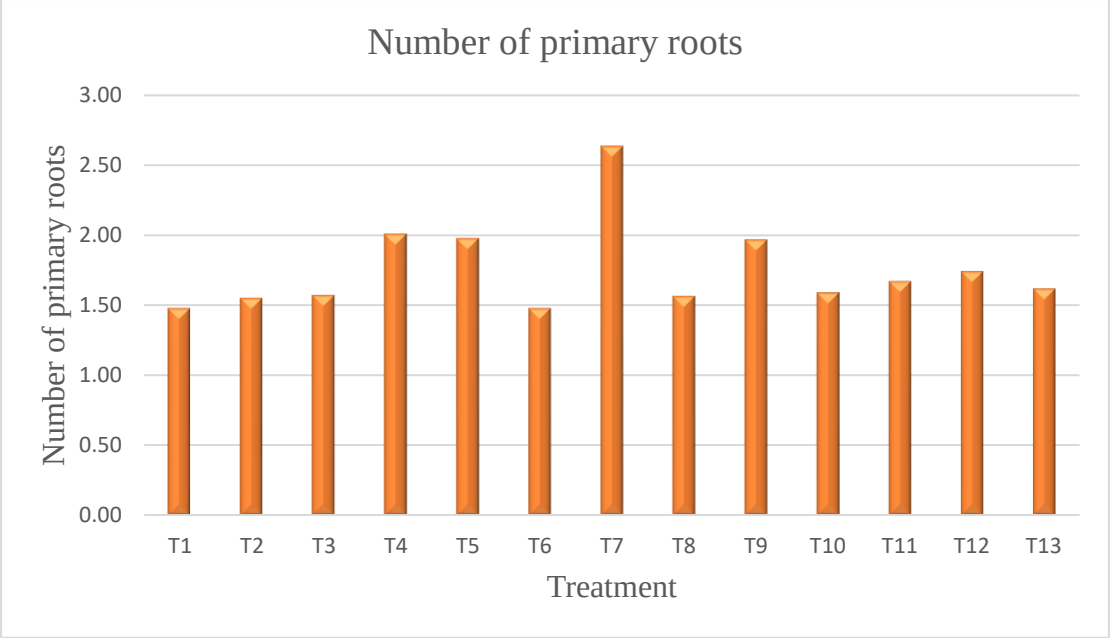


Fig 4.14: Effect of different growing media and bioagent applications on number of primary roots per mango graft.

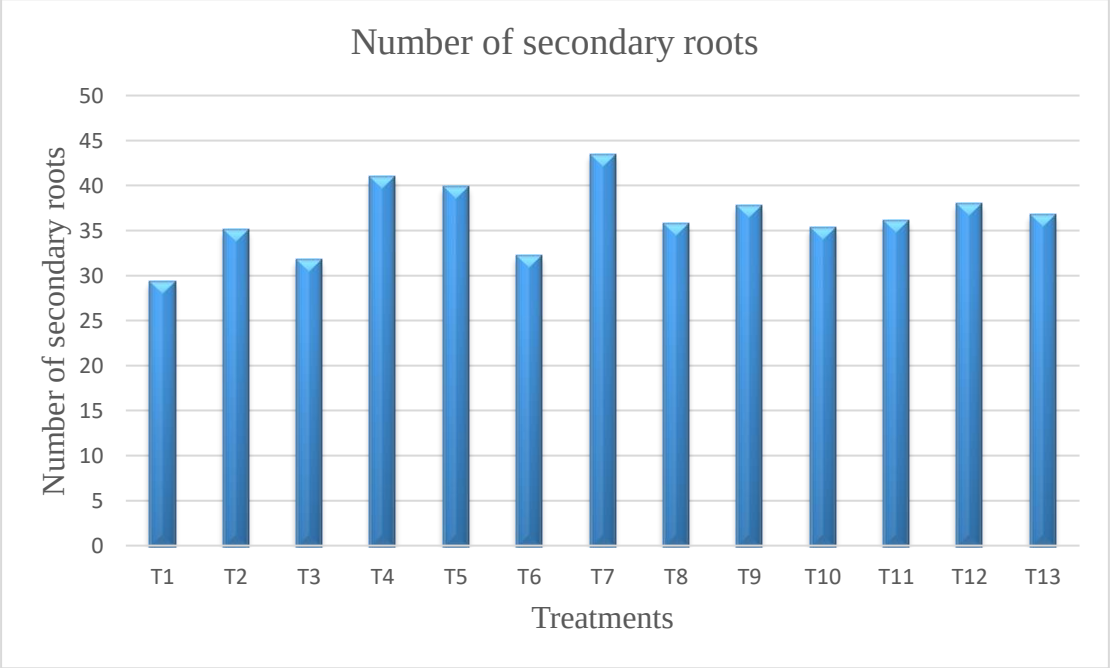


Fig 4.15: Effect of different growing media and bioagent applications on number of secondary roots per mango graft.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

4.16 Fresh weight of roots (g)

The data obtained on the fresh weight of roots in mango grafts was recorded and presented in Table 4.16 and depicted in Fig. 4.16.

Based on the present investigation done on influence of different growing media and bioagents application on fresh weight of roots resulted in significant difference among the treatments with maximum fresh weight of root obtained in treatment Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % (T_7) had maximum fresh weight of root (14.38 g) and was at par with (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (13.34 g) and (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) Biomix 1 % (12.71 g). The control (T_1) obtained minimum fresh weight of roots (6.58 g) at 120 DAG.

The higher fresh weight of roots might be due to a higher concentration of growth-promoting nutrients, proper aeration and more moisture supplying capacity of FYM. Rapid elongation and division of the cells modifying the physiological process supports the faster roots growth in terms of number, length and weight (Sejal *et al.*, 2022 in khirni).

It might also be due to more vegetative part in the shoot leads to the synthesis of more photosynthates, which move through the phloem and accumulate in the roots, resulting in an increase in root biomass. Vermicompost contains bioactive components that are favourable to roots growth, resulting in better root development, increased biomass, and improved growth and development of roots (Bachman and Metzger, 2008). These results are in accordance with the findings of Akshay *et al*. (2014) in black pepper by using media soil + sand + FYM + vermin-compost (1:1:1:1), Kaur (2017) in mango and Thakriya *et al.* (2017) by using vermiwash in mango.

Increase in fresh weight of roots is due to biomix which contains an inoculation *Azospirillum brasilense* which increases biomass content in roots by increases the number of lateral roots and also enhances root hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012). It also due to *Trichoderma,* which makes better provision of soil minerals and hormones to plant roots.

Table 4.16: Effect of different growing media and bioagent applications on fresh weight of root (g) in mango grafts.

Treatments		Fresh weight of roots (g) at 120 DAG
T_1	Orchard soil (Control)	6.58
T_2	Orchard soil + FYM (2:1) + Biomix 1%	7.59
T_3	Orchard soil + Biomix 1%	6.99
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	13.34
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	12.71
T_6	Clay soil + FYM (1:1) + Biomix 1%	7.52
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	14.38
T_8	Orchard soil + Sand (1:1) + Biomix 1%	9.45
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	10.68
T_{10}	Cocopeat + FYM (1:1) + Biomix	8.63
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	10.24
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	11.47
T_{13}	Cocopeat + FYM (1:1)	10.47
S.E(m) ±		0.53
C.D at 5%		1.55

4.17 Dry weight of roots (g)

The data on dry weight of roots per graft as influenced by different treatments are statistically analysed and are presented in Table 4.17 and graphically depicted in Fig. 4.17.

Table 4.17: Effect of different growing media and bioagent applications on dry weight of root (g) in mango grafts.

Treatments		Dry weight of root (g) at 120 DAG
T_1	Orchard soil (Control)	3.92
T_2	Orchard soil + FYM (2:1) + Biomix 1%	4.29
T_3	Orchard soil + Biomix 1%	4.24
T_4	Orchard soil + FYM + Sand (2:1:1) + Biomix 1%	8.08
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	7.98
T_6	Clay soil + FYM (1:1) + Biomix 1%	4.15
T_7	Orchard soil + FYM +Vermicompost (1:1:1) + Biomix 1%	8.72
T_8	Orchard soil + Sand (1:1) + Biomix 1%	4.51
T_9	Orchard soil + Vermicompost (1:1) + Biomix 1%	6.41
T_{10}	Cocopeat + FYM (1:1) + Biomix	4.40
T_{11}	Orchard soil + FYM (2:1) + PSB (0.5%)	4.57
T_{12}	Orchard soil + FYM (2:1) + PSB (1%)	6.99
T_{13}	Cocopeat + FYM (1:1)	4.93
S.E(m) ±		0.29
C.D at 5%		0.87

The results revealed that, Orchard soil + FYM + Vermicompost (1:1:1) + Biomix 1 % (T_7) had maximum dry weight of roots (8.72 g) which was at par with (T_4) Orchard soil + FYM + Sand (2:1:1) + Biomix 1 % (8.08 g) and (T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1 % (7.98 g) whereas, the treatment control (T_1) recorded minimum dry weight of roots (3.92 g) at 120 DAG.

The increase in dry weight of roots may be owing to the presence of vermicompost in potting media which resulted in improved physical, chemical and biological properties of soil (Arancon *et al*., 2004). Which supplies many plant nutrients, enzymes, antibiotic, vitamins, growth hormones and beneficial microorganisms in available form and helps in stimulating cell division, cell elongation, auxin metabolism, cell wall plasticity and permeability of cell membrane leading to enhanced growth of roots (Suresh *et al.,* 2018). It could be because of the addition of FYM, which contains many macro and micro nutrients such as (N, P, K, Ca and Mg), where phosphorous plays an important role in root development and biomass, resulting in more dry weight of roots.

Increase in dry weight of root is due to biomix which contains an inoculation *Azospirillum brasilense* which increases biomass content in root by increases the number of lateral roots and also enhances root hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012). It also due to *Trichoderma*, which makes better provision of soil minerals and hormones to plant roots.

Addition of biomix along with media resulted in increasing in biomass content in root by increases the number of lateral roots which is due to presence of bioagent *Azospirillum brasilense* and it also enhances the roots hairs formation to provide more root surface area to absorb sufficient nutrients (Mahdipour *et al*., 2012). Biomix also contains *Trichoderma*, which makes better provision of soil minerals and hormones to plant roots.

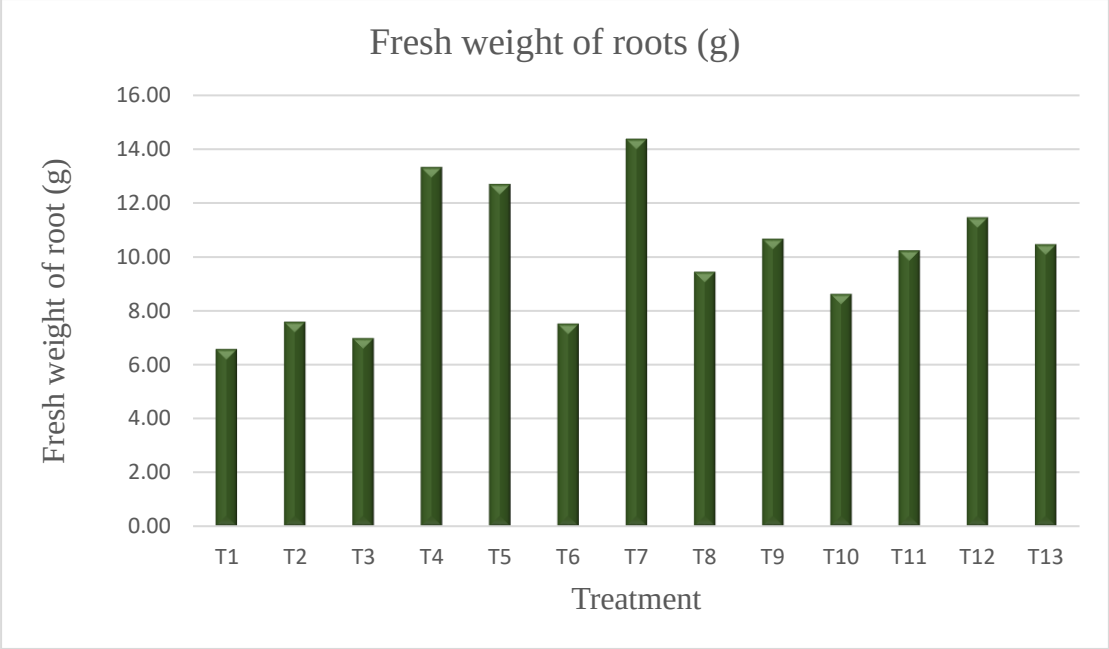


Fig 4.16: Effect of different growing media and bioagent applications on fresh weight of roots (g) in mango grafts.

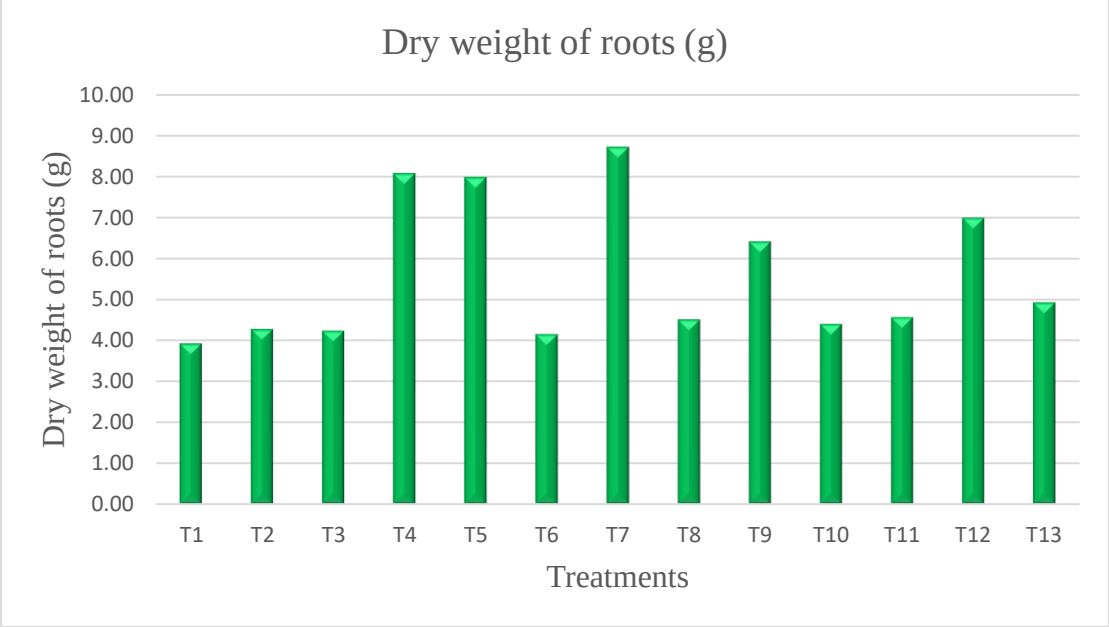
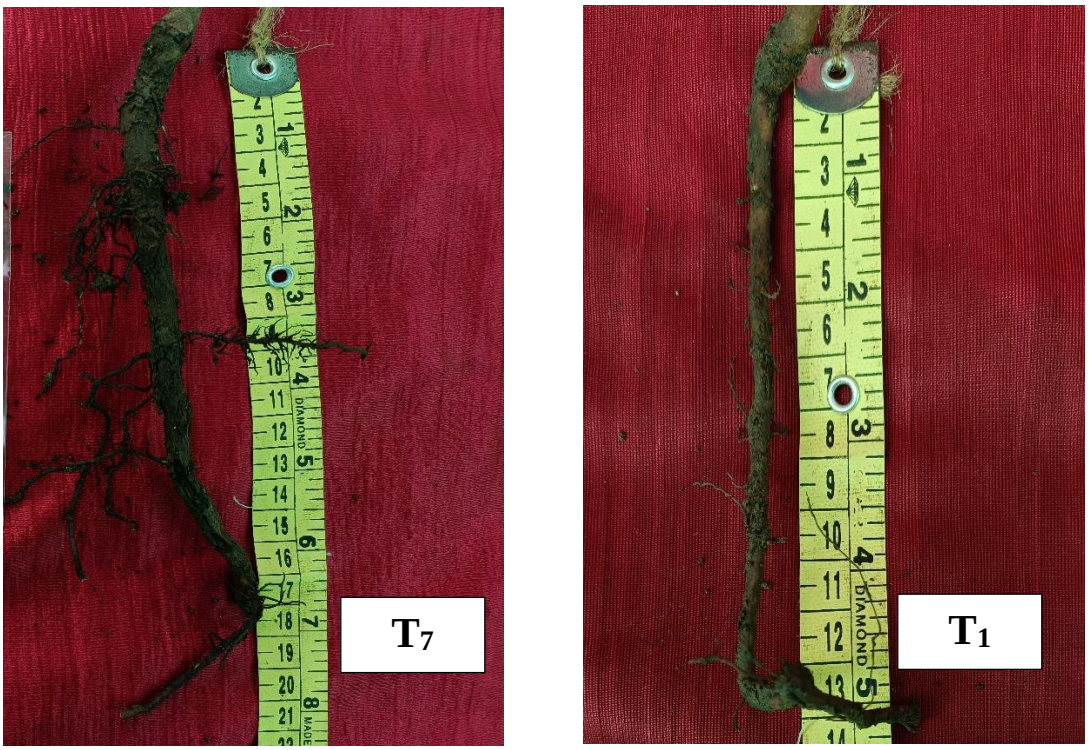


Fig 4.17: Effect of different growing media and bioagent applications on dry weight of roots (g) in mango grafts.

[T_1: control- Soil, T_2: Soil+ FYM (2:1) + Biomix 1%), T_3: Soil+ Biomix 1%, T_4: Soil+ FYM + Sand (2:1:1) + Biomix 1% , T_5: Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%, T_6: Clay soil + FYM (1:1) + Biomix 1%, T7: Soil+ FYM +Vermicompost (1:1:1) + Biomix 1%, T_8: Soil+ Sand (1:1) + Biomix 1%, T_9: Soil+ Vermicompost (1:1) + Biomix 1% , T_{10}: Cocopeat + FYM (1:1) + Biomix, T_{11}: Soil+ FYM (2:1) + PSB (0.5%), T_{12}: Soil+ FYM (2:1) + PSB 1%, T_{13}: Cocopeat + FYM (1:1)]

Plates 4.8: Effect of growing media and bioagent application on leaf area of mango grafts at 120 DAG



Plates 4.9: Effect of growing media and bioagent application on length of tap root of mango grafts at 120 DAG

CHAPTER-V

SUMMARY AND CONCLUSIONS

CHAPTER-V

SUMMARY AND CONCLUSIONS

5.1 SUMMARY

The present investigation entitled “Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar”was conducted at instructional cum demonstration farm, College of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra) during the year 2021-22.

The experiment was conducted with following objectives

1) To study the effect of mixture of growing media and biomix application on growth, survival and success rate of mango grafts cv. Kesar.

2) To identify appropriate media for mango nursery in order to help nursery growers to get healthy, uniform, well developed and more success rate of mango grafts.

The experiment was laid out in randomized block design, consisting of thirteen treatments with three replications. The important findings of the present investigation are summarized as below.

5.1.1 Graft success parameters

The different potting media and biomix treatments were found to have a significant effect on graft success parameters.

It was observed that significantly minimum number of days (10.52 days) were taken to sprouting of grafts under(T_7)Soil + FYM + Vermicompost (1:1:1) + biomix 1 %which was at par with T_5 (10.82 days) and T_4(11.04 days). Whereas, maximum number of days (13.68 days) were taken forsprouting under T_1 (control) treatment.

The significantly highest success percentage of grafted seedling (74.31%) was recorded under (T_7)Soil + FYM + Vermicompost (1:1:1) + Biomix 1 %which was at par with T_5 (73.57 %) and T_4 (72.64 %) whereas, minimum success percentage (54.96 %) was found under T_1 (control) treatment at 120 DAG.

The significantly maximum survival percentageof the grafts (87.06 %, 83.17 %, 78.33 % and 74.31 %) was recorded under T_7 (Soil + FYM + Vermicompost (1:1:1) + biomix 1 %)whereas, minimum(63.6 %, 59.95 %, 57.15 % and 54.9 %) was recorded under T_1(control) treatment at 30, 60, 90 and 120 DAG respectively.

The significantly minimum mortality percentage of the grafted seedling (12.94 %, 16.83 %, 21.67 % and 25.69 %) was recorded under T_7 (Soil + FYM + Vermicompost (1:1:1) + biomix 1 %) whereas, maximummortality percentage of grafted seedlings (36.40 %, 40.05 %, 42.85 % and 45.04 %) was recorded under T_1 (control) treatment at 30, 60, 90 and 120 DAG respectively.

5.1.2Growth attributes

At 30 DAG, there was non-significant difference in all the treatments with respect to height of grafts. The maximum graft height was observed in treatment T_7 (24.24 cm) i.e., Soil + FYM + Vermicompost (1:1:1) + Biomix 1%. Whereas, minimum graft height (19.66 cm) was found in treatment control (T_1). The significantly highest Graft height (28.25 cm, 31.38 cm and 34.33 cm) was obtained under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 % whereas, lowest height of grafts (27.11 cm, 29.24 cm and 31.67 cm) was recorded under T_1 (control) treatment at 60, 90, 120 and 150 DAG respectively.

The treatments were found non-significant with respect to girth of scion where maximum girth of scion (6.66 mm, 7.11 mm, 7.91 mm and 9.7 mm) was observed in (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 %. whereas, minimum girth of scion (5.47 mm, 6.11 mm, 6.52 mm and 7.74 mm) was recorded under T_1 (control) treatment at 30, 60, 90 and 120 DAG respectively.

At 30 DAG,there was non-significant difference in all the treatments with respect to length of scion. The maximum length of scion was observed in treatment T_7 (16.75 cm) i.e., Soil + FYM + Vermicompost (1:1:1) + Biomix 1%. Whereas, minimum length of scion (14.29 cm) was found in treatment control (T_1). The significantly highest length of scion (20.16 cm, 23.39 cm and 24.58 cm) was obtained under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 % whereas, lowest length of scion (15.82 cm, 18.06 cm and 19.09 cm) was recorded under T_1 (control) treatment at 60, 90, 120 and 150 DAG respectively.

5.1.3 Leaf attributes

The significantly maximum number of leaves per grafted seedlings (7.33, 10.72, 13.78 and 15.69) were recorded under (T_7) Soil + FYM +Vermicompost (1:1:1) + Biomix 1% whereas, minimum number of leaves (3.47, 6.33, 8.03 and 9.36) was obtained in T_1 (control) treatment at 30, 60, 90 and 120 DAG respectively.

The significantly maximum leaf area (13.36 cm^2, 19.75 cm^2, 23.56 cm^2 and 28.79 cm^2) were recorded under (T_7) Soil + FYM +Vermicompost (1:1:1) + Biomix 1% whereas, minimum leaf area (8.71 cm^2, 15.322 cm^2, 17.93 cm^2 and 22.44 cm^2) was obtained in T_1 (control) treatment at 30, 60, 90 and 120 DAG respectively.

5.1.4 Shoot parameter

The significantly maximum fresh weight of shoot (24.53 g) was recorded under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 % whereas, minimum fresh weight of shoot (16.42 g) was recorded under T_1 (control) at 120 DAG.

The maximum dry weight of shoot (17.25 g)was found significantly under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1% whereas, minimum dry weight of shoot (8.55 g) was recorded under T_1 (control) at 120 DAG.

The treatments were found non-significant with respect to dry root to shoot ratio where maximum (0.55) was recorded under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1% whereas, minimum dry root to shoot ratio(0.41)was recorded under T_1 (Control) treatment at 120 DAG.

5.1.5 Root attributes

Among the treatments (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1% shows significantly maximum length of tap root (24.60 cm) while minimum length of tap root (16.93 cm)was noticed in T_1 (control) at 120 DAG.

The significantly highest number of primary roots per graft (2.64) was noted in (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1% and least number of primary roots per graft was observed in T_1 (Control)(1.48) at 120 DAG.

The number of secondary roots per graft was significantly influenced by different potting media. Highest number of secondary root (43.38) was observed under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1% whereas, minimum number of secondary roots per graft (29.20) recorded under T_1 (Control) treatment at 120 DAG.

The significantly maximum fresh weight of root (14.38 g) was recorded under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 % whereas, minimum fresh weight of root (6.58 g) was recorded under T_1 (control) at 120 DAG.

The maximum dry weight of root(8.72 g)was found significantly under (T_7) Soil + FYM + Vermicompost (1:1:1) + Biomix 1 % whereas, minimum dry weight of shoot (3.92g) was recorded under T_1 (control) at 120 DAG.

5.2 CONCLUSION

In summing up the present investigation based on obtained results it may concluded that, the different growing media and bioagent application positively influenced on growth, success and survival of mango grafts as compared to control treatment.

The growing media combination of Soil + FYM + Vermicompost (1:1:1) with Biomix 1% found to be at par with treatments(T_5) Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1% and (T_4) Soil + FYM + Sand (2:1:1) +Biomix 1% for obtaining highest growth, success and survival percentage inmango grafts cv. Kesar.

Therefore, it may be advisable for large scale use in the nurseries.Hence in nutshell it can be concluded based on the research findings of present investigation that, use of growing media combination of Soil, FYM, vermicompost with the application of bioagent (Biomix) for vigorous growth and better success of mango grafts. However before commercial application, we must be caution enough not to rely solely in a single study. As a result, a few more trials to be conducted in order to reach a proper conclusion.

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APPENDIX

APPENDIX-I

Weekly weather data for the year 2021-22 at Parbhani.

WEEK	RF	Temperature °C		Humidity (%)		EVP (mm)	BSS (Hrs.)	WS (Kmph)
		Max	Min	RH1	RH2			
02 may-08 may	0.0	31.6	13.9	83	34	8.7	8.7	4.2
09 may-15 may	0.0	31.7	13.7	83	34	8.9	8.3	4.1
16 may-22 may	3.0	31.7	13.6	83	34	9.4	7.6	7.8
23 may-29 may	0.0	31.5	13.9	82	34	11.9	8.4	7.2
30 may-05 June	71.1	31.7	13.6	83	34	7.6	6.1	5.5
06 june-12 June	154.4	31.7	14.4	84	34	3.3	5.7	3.5
13 June-19 June	102.6	31.1	15.3	82	35	4.6	6.0	5.8
20 June-26 June	9.70	30.7	15.2	79	35	4.7	5.5	5.4
27 June-03 July	35.3	30.6	15.2	79	34	4.6	5.6	5.2
04 July-10 July	41.1	30.4	14.8	78	33	5.3	5.9	4.2
11 July-17 July	389.7	30.4	13.7	79	32	1.1	2.4	3.7
18 July-24 July	126.7	30.3	12.9	78	29	3.0	5.7	4.1
25 July-31 July	9.9	30.2	12.3	76	27	3.4	4.5	5.3
01 Aug-07 Aug	1.4	30.4	12.3	74	26	3.3	2.7	5.8
08 Aug-14 Aug	2.3	30.3	11.8	75	24	4.9	6.2	4.2
15 Aug-21 Aug	48.5	30.0	11.0	73	24	3.6	4.7	4.6
22 Aug-28 Aug	5.9	30.0	10.8	70	21	3.1	5.2	2.9
29 Aug-04 Sep	48.8	30.1	11.0	66	20	3.0	3.4	2.8
05 Sep-11 Sep	233.1	30.2	11.3	66	20	1.6	3.9	3.3
12 Sep-18 Sep	44.4	30.5	11.6	64	19	3.4	6.6	4.3
19 Sep-25 Sep	48.6	30.9	11.2	66	19	4.0	5.1	3.7
26 Sep-02Oct	133.9	31.5	11.7	66	19	1.6	2.2	3.6
03Oct-09Oct	112.9	32.3	12.3	68	18	3.5	7.3	2.4
10 Oct-16 Oct	3.0	32.8	13.1	70	20	4.4	7.8	2.3
17 Oct-23 Oct	45.8	32.8	13.6	73	22	4.2	7.0	2.9
24Oct-30Oct	0.0	32.4	14.3	76	24	5.0	9.4	2.1
31 Oct- 6 Nov	0.0	30.7	14.4	81	33	5.5	8.5	3.7
07 Nov- 13 Nov	0.0	30.0	14.2	84	37	5.0	7.6	3.3
14 Nov-20 Nov	0.0	29.7	14.0	87	39	4.1	4.5	4.6
21 Nov-27 Nov	1.2	29.4	14.1	89	41	4.0	6.5	4.3
28 Nov-04 Dec	0.0	29.2	13.7	92	41	5.0	5.9	3.9
05 Dec-11 Dec	4.2	29.5	13.5	94	41	3.1	3.5	3.0
12 Dec-18 Dec	0.0	30.3	13.0	93	40	3.4	5.2	2.5
19 Dec-25 Dec	0.0	32.5	13.0	91	33	0.0	0.0	0.0
26 Dec- 1Jan	0.0	33.7	13.4	87	28	0.0	0.0	0.0
2 Jan- 08 Jan	0.0	29.4	13.0	89	39	3.0	6.3	2.5
09 Jan- 15 Jan	0.0	26.5	15.9	87	55	3.0	4.1	4.6
16 Jan- 22 Jan	0.0	27.2	11.8	92	44	2.9	5.9	2.8
23 Jan – 29 Jan	0.0	26.1	9.9	78	34	4.5	7.6	4.2
30 Jan- 05 Feb	0.0	30.2	8.0	83	19	4.8	9.6	2.8

Appendix-I: Cost of raising Mango grafts (var. Kesar)

I. Fixed Cost (A)			
S. No.	**Particulars**	**Rate (Rs.)**	**Cost (Rs./ha)**
1.	Cost of seedling	Rs. 3/seedling	300
2.	Poly bags	Rs. 0.5/bag	50
a)	Poly bag filling (1 labour)		250
b)	Grafting operation (3 labours)		750
c)	Irrigation and insecticides spraying - (03 labours)		750
3.	Pesticides		200
a)	Imidachloprid at 3 ml/ 1 lit	Rs. 150	
b)	Bavistin at 30 g/ 15 lit	Rs. 50	
Total fixed cost			2300

Cost of the media components

Sr. No	**Media**	**Cost**
1	Vermicompost	Rs. 15/kg
2	Coco peat	Rs. 10/kg
3	Bio mix	Rs. 200/l
4	FYM	Rs. 1000/tn
5	PSB	Rs. 800/l

S. No.	**Treatments**	**Cost (Rs. /ha)**
T_1	Orchard soil (Control)	0
T_2	Orchard soil + FYM (2:1) + Biomix 1%	230
T_3	Orchard soil + Biomix 1%	200
T_4	Soil + FYM + Sand (2:1:1) + Biomix 1%	260
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	950
T_6	Clay soil + FYM (1:1) + Biomix 1%	230
T_7	Soil + FYM +Vermicompost (1:1:1) + Biomix 1%	680
T_8	Soil + Sand (1:1) + Biomix 1%	220
T_9	Soil + Vermicompost (1:1) + Biomix 1%	650
T_{10}	Cocopeat + FYM (1:1) + Biomix	530
T_{11}	Soil + FYM (2:1) + PSB (0.5%)	120
T_{12}	Soil + FYM (2:1) + PSB (1%)	240
T_{13}	Cocopeat + FYM (1:1)	330

Economics (₹ per 100 plants) of mango grafts as influenced by different treatments

	Treatment	**Gross monetary Returns (₹ ha^{-1})**	**Cost of cultivation (₹ ha^{-1})**	**Net monetary returns (₹ ha^{-1})**	**Benefit: Cost ratio**
T_1	Soil (Control)	3240	2300	940	1.40
T_2	Soil + FYM (2:1) + Biomix 1%	3660	2530	1160	1.42
T_3	Soil + Biomix 1%	3360	2500	860	1.34
T_4	Soil + FYM + Sand (2:1:1) + Biomix 1%	4320	2560	1760	1.68
T_5	Laterite soil + Cocopeat + Vermicompost (1:1:1) + Biomix 1%	5120	2452	2668	2.08
T_6	Clay soil + FYM (1:1) + Biomix 1%	3480	2530	950	1.37
T_7	Soil + FYM +Vermicompost (1:1:1) + Biomix 1%	5500	2345	3155	2.30
T_8	Soil + Sand (1:1) + Biomix 1%	3840	2520	1320	1.52
T_9	Soil + Vermicompost (1:1) + Biomix 1%	4200	2950	1250	1.42
T_{10}	Cocopeat + FYM (1:1) + Biomix	3780	2830	950	1.33
T_{11}	Soil + FYM (2:1) + PSB (0.5%)	3800	2420	1380	1.58
T_{12}	Soil + FYM (2:1) + PSB (1%)	4260	2420	1840	1.76
T_{13}	Cocopeat + FYM (1:1)	3540	2630	910	1.34

CURRICULUM VITAE

CURRICULUM VITAE

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Title of the thesis	:	Effect of different growing media and bioagent applications on growth and survival of mango grafts (*Mangifera indica* L.) cv. Kesar

Academic qualification

Course / Degree	Name of College / Institute	University / Boar	Year of Passing	Percentage (%)/ CGPA	Class / Grade
SSLC	Bharathmatha High School, Koppa	KSEEB	2014	86.5	Distinction
PUC	Vishwamanava PU college, Mandya	Department of Pre-university Education	2016	90.5	Distinction
B.Sc.	College of Horticulture, Mysuru	UHS Bagalkot	2020	8.5	Distinction

Place:Parbhani

Date: 16/11/2022 **(AMBRISH S.)**