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Original Research Article

EFFECT OF DIFFERENT NURSERY POTTING MEDIA ON THE GERMINATION AND DEVELOPMENT OF MANGO (*MANGIFERA INDICA* L.) SEEDLINGS

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Abstract: *Mango is a valuable income crop that significantly contributes to the food security. However, there was a severe shortage of information on the growth, production and developmental behavior of different rootstock of mango in different growing media combinations. Accordingly, a study was conducted in 2019–20 at the Mango Research Institute in Multan, Pakistan, used a net house to test the efficacy of several pot media for nursery with different compositions on the seedling growth and development of plants. Mango seeds were planted in top soil (PM1), Sawdust (PM2), Farmyard manure (PM3) and FYM/Sawdust (PM4). The independent trial was conducted using a randomized complete block design. Parameters of emergence and development were measured and studied. The results showed that all of the emergence and growth characteristics, except for shoot number, had a substantial influence on the outcome of the experiment. However, emergence rate, stem diameter, shoot number, root number, and days to germination were not impacted by the potting medium. Except for stem diameter, shoot number, and internode length, the interaction effect of growth medium had a substantial impact on all other metrics. Mango nurserymen would benefit from using most recommended pot media with the combination of farmyard manure: soil: sand with the ratio of 3:2:1 to increase emergence and development of seedlings.*

Keywords: *Mangifera indica*, farmyard manure, germination, potting soil, sawdust

Introduction

Mango (*Mangifera indica* L.) is one of the most valuable fruit crops in the tropical and subtropical regions, especially in Asia, where it's always been known as the "king of fruits" (Murtaza *et al.*, 2020). The area under mango cultivation in Pakistan is 158512 hectares and the production is of 1.68 million tonnes. The cultivated area and production in province Punjab is 98349 ha and 1.30 million tonnes respectively. The cultivated area and production in province Sindh is 59109 ha and 329300 tonnes respectively (MNFSR, 2019-20). The main exportable mango cultivars in Pakistan include Sindhri, Chenab Gold, Chaunsa SB, Sufaid Chaunsa, and Azeem Chaunsa which are available from May to September. These cultivars attain maturity as early, mid and late-season, the availability period for different mango cultivars is five months. The area under various mango cultivars in Punjab province are Chaunsa Sammar Bahisht 36%, Sindhri 18%, Sufaid Chaunsa 16%, Azeem Chaunsa 3% and Chenab Gold 2% (Iqbal, 2022). The mangoes from Pakistan has achieved a strong position in rising marketplaces such as China, Japan, and Singapore, which need fruit of good size and better color development. Sufaid Chaunsa is a late-season mango cultivar that reaches physiological maturity in the Multan region after 15 August (Iqbal *et al.*, 2021), hence enhancing its favorable position for export to several locations (Bibi *et al.*, 2019).

The salinity of agricultural soils is a serious challenge. It significantly reduces agricultural production and output. In addition, excessive salinity degrades qualitative characteristics, which considerably reduces the market value of agricultural commodities Harhash *et al.*, 2022). In Pakistan, salinization and the conversion of fertile agricultural area into non-productive lands are mostly caused by the improper use of fertilizers (Ali *et al.*, 2022), and brackish irrigation water, poor management of cultural practices and excessive transpiration (Safdar *et al.*, 2019). While salinity is seen as a significant barrier to crop development, it may be handled using an integrative strategy to induce improved plant growth with no apparent salt damages to the leaves (Zaghum *et al.*, 2021a). The excessive salt concentration of soil and irrigation water may cause

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inhibited growth and reduced plant height, as well as leaf margin and tip burning (El-Dengawy *et al.*, 2021).

In tropical climates, the soil environmental parameters associated with acidity (pH, electrical conductivity, base saturation and nutrient unavailability) are the most detrimental to crop productivity (Safdar *et al.*, 2019). Under these circumstances, calcium shortage and aluminum toxicity are the principal chemical restrictions to root development (Ali *et al.*, 2021), resulting in slower elongation, thickening and abnormal branching (Lechaudel and Joas, 2007). As a consequence, plants are less able to absorb water and nutrients, making them more susceptible to yield loss (Javed *et al.*, 2022), particularly in locations with lengthy droughts during the rainy season (Zuazo *et al.*, 2021). In acidic soils with high aluminum concentration, liming increases soil pH, suppresses harmful Aluminum (Al^{3+}), and increases Calcium (Ca^{2+}) and Magnesium (Mg^{2+}) creating favorable circumstances for root system development and nutrient and water absorption by plants (Correia *et al.*, 2018). Furthermore, according to Correia *et al.*(2018), although it is a known helpful technique in acid soils, it is not often implemented correctly and consequently useless.

The inappropriate use of pesticides and fertilizers has negative impact on mango production (Paguia H.M *et al.*, 2019). Utilizing fertilizers carefully, based on soil analysis, is the key to mineral feed of plants (Kiran *et al.*, 2021). An additional purpose for plant analysis is to identify suspected nutrient shortages and toxicity and to evaluate fertilizer dosage effectiveness (Gaballah *et al.*, 2020). In order to boost mango plant growth, it is important to concentrate on the soil nutrient availability and other nutrient-related qualities (Correia *et al.*, 2018). The total nitrogen, phosphorus, potassium, and Sulphur content of soils, as well as their uptake by plants, are essential soil fertility characteristics (Ammar *et al.*, 2022). Mango soil nutrient is an integral aspect of orchard management strategies (Mponela *et al.*, 2016). Necessary nutrients have significant purpose in life cycle of plants and their presence is required for the plant to mature (Zuazo *et al.*, 2021). These controlled conditions properly contribute to the growth and development of seedlings (Zaghum *et al.*, 2021b). Relevant data on micronutrients status in mango plant can contributes in nutritious problem diagnosis and estimate of fertilizer requirements. To find out these things, need to look at both the soil and the plants. The knowledge of the nutritional state of both the soil and the plant aids in the fertilization of the orchards (Naik and Bhatt, 2017). Therefore, this study was conducted to determine the response of different potting media combination on mango stone germination, emergence and seedling growth. And evaluate the best pot media combination that had significant effect on maximum emergence to improve germination and other morphological aspects.

Methodology

Experimental site

This study was performed in a net-house at the Certified Mango Nursery in Mango Research Institute Multan in 2020. There was an average yearly rainfall of 186.6 mm and a GPS coordinate of 30°09′12.0′N and 71°26′43.10′E at the site. The climate zone of the research region is predominantly sub-tropical, with 9 to 10 months dry spell, approximately 175 mm of rain per year. The avg. temperature in the region is 25.6°C. The soil is clay loam with a pH of 8. Cotton, Maize, Wheat, Pulses, and Sugarcane are the primary crops cultivated.

Treatments and experimental design

The study comprises of four different soil medium types: Total soil (PM1), soil: sand: sawdust (3:1:2) (PM2), farmyard manure: soil: sand (2:3:1) (PM3) and top soil: sawdust: FYM (Farmyard manure) (3:1:2) (PM4) with implementation of randomized complete block design (RCBD) with three replications in layout. Full top soil was chosen as the control treatment in the experiment because the total soil was thought to have poorer condition with poor physical properties i.e. poor water retention and poor aeration, when compromised with sawdust, sand and farmyard manure.

In light of the significance of potting media, the purpose of this study was to analyze and choose the best indigenous waste material for use as potting medium. Utilizing local solid waste as potting soil may significantly help to ecological waste management and improve farming techniques. To enhance the physical properties of potting soil, an emphasis was placed on developing a superior potting medium from waste products.

Experimental procedure

About 40 stones of mango were selected from Mango Research Station, Shujabad. The mango stones were washed with water and gently cleaned from all the unwanted material and healthiest stones were selected. The stones were planted in all four growing medium combinations. The seed was sown in each of the four different growing media with a total of ten replications. A total of five plants that germinated were chosen from each treatment and utilized in the future analysis. According to the determined ratio, pot mixtures comprised of sawdust, soil, farmyard manure and sand. The farmyard manure was sourced from a dairy farm. Sawdust of wood was arranged from house furniture manufactures in Multan. All of the media used to cultivate the seedlings were sieved to obtain 1 to 5 millimeter-sized particles. The mango stones were sowed at the depth of 2 cm in the medium contained in 15 cm wide and 25 cm long black polythene bags. The mango stones were irrigated after seeding, and then irrigated when required. The seedlings were given 120 days in the nursery to mature after germination, during which time they were watered when required.

Data collection

The data was collected on following parameters, in order to determine how many days it takes for seeds to germinate; researchers tracked how long it took for half of the seeds planted in each plot to sprout. At 120 days following planting, 10 randomly selected seedlings from each treatment were used to measure the height of the plants from the soil to the top of the shoot using a meter scale. One hundred and twenty days after germinating the seeds, ten randomly selected seedlings had their leaves counted, and the average number of leaves was used for statistical analysis. The number of leaves was determined by counting the leaves of 10 randomly chosen seedlings 120 days after germination, and the average number of leaves was utilized for statistical analysis. At the conclusion of germination, the average number of shoots per plant from 10 randomly selected seedlings 120 days following planting was utilized for statistical analysis. At 120 days following planting, the internode length of each of ten randomly selected seedlings was measured using a meter scale from node to node, sum, and the average of 10 seedlings was utilized for statistical analysis. Stem diameter was measured using a digital caliper at 120 days post-germination for 10 randomly chosen seedlings. The average value was then taken for statistical analysis. At 120 days after sowing the seeds, the leaf area of 10 randomly selected seedlings was measured using a meter scale and calculated using the devised method (Minja *et al.*, 2017).

Tap and fibrous root counts were taken from 10 randomly chosen seedlings at 120 days post-planting, and the average was used for analysis. At 120 days following planting, 10 uniformly selected seedlings were taken from each plot by cutting the polythene bags and gently shaking off any soil still adhering to the roots. The tap root length was measured using a ruler. We weighed ten randomly selected seedlings per plot using a sensitive balance after 120 days of planting, to provide an accurate representation of the fresh weight of the complete seedling. Dry biomass was measured using a sensitive balance, and the mean was used for statistical analysis after ten uniformly chosen seedlings were dried in the oven at 72 °C for 48 hours.

Media analysis

Before to the implementation of the experiment, 0–30 cm-deep topsoil samples were collected. The samples were air-dried, homogenized, and crushed to pass through a 2-millimeter screen in order to exclude big particles, dirt, and pebbles. The specimens were sent to the Soil testing laboratory. The distribution of particle sizes was examined using the hydrometer method. Using a pH meter, the soil's pH was tested in water at a soil-to-water ratio of 1:2.5. The organic carbon content was measured using the wet oxidation technique. The NH_4 acetate technique was used to determine the cation exchange capacity (CEC). Additionally, farmyard manure and sawdust were examined for the various factors mentioned.

Data analysis

Analysis of Variance (ANOVA) was performed on the gathered data per protocol. The means were split using the Fisher's LSD test at the 5% significance level. The level of relationship between the various factors was analyzed using Pearson's correlation. Statistical software GenStat discovery 16th edition is used for data analysis.

Results and discussion

Characteristics of potting media

To prepare for planting, the soil, FYM, and sawdust used in the experimental nursery were summarized in Table 1. The soil used in the experiment was sandy clay loam had 6.8 pH was considered normal according to the scales used by (Bagheri Bodaghabadi *et al.*, 2019). Although the total nitrogen (N) concentration of 0.30% was sufficient based on the evaluation (Ma *et al.*, 2022). According to Rani *et al.*, (2020)assessments, the phosphorus concentration was 6.12 ppm, which is insufficient and consistent with data indicating that the soils in the studied region are low in fertility. In addition, 193 ppm was discovered to be the accessible potassium (K) level of the experimental soil, placing it in the medium range according to the evaluations (Ma *et al.*, 2022). Salomao *et al.*, (2018)found that the soil had a high cation exchange capacity of 49.57 meq/100 g, whereas Song *et al.,* (2022) found that it had a low organic carbon content of 1.08%. Mango seedlings may thrive in the experimental soil because of its ideal pH, EC, and accessible phosphorus levels. Soil physical qualities can be enhanced by adding well-decomposed FYM and sawdust, which in turn promotes root growth of mango seedlings via enhanced aeration (Bagheri Bodaghabadi *et al.*, 2019). Neware *et al.*, (2017) made similar recommendations on the usage of organic inputs in citrus seedling germination. Furthermore, optimal quantities of organic manure should be applied as part of the soil fertility management in order to boost the soil's organic carbon and potassium levels, which in turn boosts the soil's physical properties qualities (Ma *et al.*, 2022)

Table 1. Determination of properties of top soil, farm yard manure and sawdust before the use in experiment

Properties	Soil	Range	Farm Yard Manure	Range	Saw dust	Range
			Particle size			

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Sand (%)	50%	43				
Silt (%)	20%	27–42				
Clay (%)	30%	42–52				
Chemical Properties						
pH	7%	Neutral	8.30%	Moderately Alkaline	6.50%	Neutral
Organic carbon (%)	1.12	Low (1.25–2.25%)	3.64	High (1.5–2.5%)	3.67	High (1.5–2.5%)
CEC (meq/100 g)	50.22	very high (> 40)	43.2	Very high (> 40)	21.5	Moderate (12–25)
EC (µS/cm)	0.7	Low salinity	2.7	Low salinity (0–2)	1.33	Low salinity (0–2)
Nutrient availability						
Total N (%)	0.5	High (0.25–0.50)	0.7	Very-high > 0.5	0.6	Very high > 0.5
Available P (ppm)	6.8	Low < 20	306.4	Excessive (> 100)	122.5	Excessive (> 100)
Available K (ppm)	175	Medium (150–250)	788	Excessive (> 250)	745	Excessive (> 250)

Soil growing media responses to growth and germination

Days to germination

The number of days needed for seed to germinate was determined by the major effect of cultivar and its interaction with growing medium (Table 2). It took 22 days for a mango seed to germinate in top soil, but the same ratio of top soil to forest yard mulch and sand produced statistically equivalent results for germination times (3:2:1). Media combinations with a sawdust: total soil: sand (2:3:1) composition grow later (32-33 days) and were statistically equivalent to those with a farmyard manure: total soil: sawdust (2:3:1) composition (Table 2). Using the same soil: FYM: sand (2:1:1) soil medium and the mango cv. Master royal, Mngomba *et al.*, (2010) found an accelerated time to germination of 24.0 days. In addition, Medany *et al.*, (2009) also pointed to related results. Similar results have not been seen in other fruit trees (Neware *et al.*, 2017). This may be related to genetic variations or to the use of alternative media.

Germination percentage

Mango seedling germination was significantly (P 0.05) influenced by soil media and the relationship between different media combinations (Table 2). The treatment that included all topsoil had the highest germination rate (98.2%), and it was also considerably comparable to the treatment that included FYM and sand (3:2:1). However, the soil mixture of sand: sawdust: total soil (1:2:3) resulted in the lowest germination rate (51.13 percent) (Table 2). In contrast, the stone of cv. Master royal combined with farmyard manure: sand: total soil had the greatest germination percentage (81%) in a study by Medany *et al.*, (2009). Mango seedling germination rate might be affected by factors such as genetic diversity, the ratio of cotyledon to endosperm weight, and the toughness of the seed coat. Multiple studies (Mngomba *et al.*, 2010; Song *et al.*, 2022) found differences in mango seedling performance between different mango varieties.

Plant height

Soil media and their combinations significantly influenced the final height of mango seedlings (Table 2). Although Top soil: fungicide: microorganism sand (3:2:1) treatment combinations showed statistically identical plant heights, full top soil produced the tallest plants at 37.90 cm (Table 2). However, the treatment combination of farmyard manure: sand: total soil (2:1:3) produced the tallest plants at 17.29 cm, whereas the combination of sand: soil: sawdust (1:3:2) produced the lowest plants at 15.78 cm (Table 2). Similarly, Rani *et al.*, (2020)found that soil potting medium compositions of Soil: FYM: Sand resulted in a maximum plant height of 28.48 cm (1:1:1). The increased production of photo synthetically functional leaves and plant growth may be attributable to the improved physico-chemical properties of the rooting zone soil brought about by the nutrient availability of the various soil potting media combinations.(Ma *et al.*, 2022).

Table 2. Effect of different potting media on germination percentage, days of germination and plant height of mango seedlings

Potting media	Days to germination	Germination percentage	Plant height (cm)
PM 1	27.32 a	51.8 a	28.1a
PM 2	26.33 b	60.13b	21.8b
PM 3	26.4bc	56.2cd	25.1bc
PM 4	26.23bc	59.1d	26.2cd
LSD%	3.21	7.33	3.23

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CV%	7.9	6.2	7.6

Means with identical letters are statistically significant at P 0.05, LSD at 5%, and CV% at coefficient variance

Number of leaves

The primary impact of soil potting media and also their interaction effects on leaf number were statistically significant (P ≤ 0.05) (Table 3). The largest number of leaves (18) was produced by a plant grown in Top soil composed of sand: farmyard manure (3:1:2), while the lowest number of leaves was produced by a plant grown in soil composed of FYM: sawdust (3:2:1) (Table 3). Similar results were seen across many studies of various mango varieties (Fischer *et al.*, 2016). Mango seedlings can benefit from increased water and nutrient uptake if they are planted in potting medium with a high soil nutrient availability (Salomao *et al.*, 2018).

Leaf area

Leaf area of mango seedlings was significantly (P 0.05) influenced by soil potting medium and the interaction between the two (Table 3). When using a soil media mix of Sand: farmyard manure: soil (1:2:3) and the largest leaf area measured 86.68 cm_2. Sand: sawdust: soil (3:2:1) mixtures had the smallest leaf areas (23.11 cm^2) (Table 3). The highest leaf area (101.56 cm^2) was reported by Rani *et al.*, (2020) for a similar composition of soil potting medium with a mixture of vermiculite: peat moss: sand (1:2:1). Higher quality leaves may have been produced as a result of increased nutrition availability (Fischer *et al.*, 2016).

Stem diameter

The major influence of soil medium and their interaction on stem diameter was statistically significant (Table 3). Compositions of sawdust: farmyard manure: soil and sand: farmyard manure: soil (1:2:3) yielded maximum stem diameters of 0.75 cm and 0.75 cm, respectively (3:2:1). Soil medium with a combination of coir pith: compost: sand: soil (1:1:1:1) yielded a greater diameter of stem of 0.82 cm at 120 days after germination (Gawankar *et al.*, 2020). In addition, Dubey *et al.*, (2021) found that the mango cv. Master royal with a soil potting medium mix of farmyard manure: sand: soil (1:1:2) produced the largest stem diameter 180 days after germination. A possible explanation for the observed variation in mango stem diameter is that rootstock performance varies from cultivar to cultivar (Salomao *et al.*, 2018).

Internode length

With full top soil, internode length was 6.84 centimeters, while with a 3:2:1 ratio of top soil, sawdust, and sand, the shortest length was 4.15 centimeters (Table 3). However, growth media interactions were not statistically significant (Table 3). Mango seedlings grown in a soil media composed of Soil: Sand: Compost: Coir pith (1:1:1:1) had an internode length of 10.38 centimeters (Ma *et al.*, 2022). All of the most important aspects of plant development net plant growth, stem diameter, internode distance, leaf number and area, root length and number increase dramatically as a function of media and seedling cultivar (Deivasigamani *et al.*, 2019).

Stem number

Many such media that make up the top soil and their respective compositions: Compared to soil media combinations with proportions of Top soil: Compost: Sawdust, the former produced a greater shoot number (2.44). Sawdust (3:2:1) had the smallest stem number (2.0) when used as FYM (Table 3). The poly-embryonic character of mango seeds, which contain several embryos derived from a single nuclear embryo and give rise to a wide variety of cultivars, may account for the observed variance in stem number among mango seedlings (Dubey *et al.*, 2021).

Root length

Primary root length response to soil potting medium major effects and interactions are shown in Table 6. Combinations of soil media consisting of Soil: FYM: Sand (3:2:1) produced the longest root length (30.40 cm), whereas complete top soil resulted in the smallest root length (21.2 cm) (Table 3). A combination of the Nekkare mango cultivar and a medium consisting of soil, sand, and compost resulted in a root length of 27.86 centimeters (Deivasigamani *et al.*, 2019). These results may have been caused, at least in part, by the fact that seedlings grown in soil medium had faster overall growth rates and stronger root systems (Dubey *et al.*, 2021).

Table 3. Effect of different potting media on leaf area, leaf number, stem diameter, root number and root length of mango seedlings

Potting media	Leaf number	Leaf area	Stem diameter	Root number	Root length
PM 1	13.8 a	32.1 a	0.17 a	3.12 a	22.8 a
PM 2	11.2 b	26.3 ab	0.57 ab	3.43 b	25.75 ab
PM 3	12.4bc	60.4 c	0.58 b	2.8 c	26.2 c
PM 4	13.2 cd	39.1d	0.62bc	3.1bd	24.8bd
LSD%	2.75	12.88	0.05	0.81	2.75
CV%	11.8	19	6.2	15.3	6.5

Means with identical letters are statistically significant at P 0.05, LSD at 5%, and CV% at coefficient variance

Root number

In contrast to soil, the total number of root grows from mango stone were considerably impacted by the

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major influence of different potting medium mixtures (Table 4). The maximum root number (5.16 per pot) was achieved with soil medium composition of sand: farmyard manure: soil (1:2:3), while the lowest number of roots (1.56 per pot) was achieved with a complete top soil composition (Table 4). The optimal combination of the mango cv. Nekkare with a soil potting media composition of compost: sand: soil (1:2:1) yields a root density of 7.6 (Deivasigamani *et al.*, 2019). Factors such as plant metabolism, chlorophyll formation, respiration, nitrogen fixation and reduction, hormone synthesis, enzyme activity (Zaghum *et al.*, 2022). The positive effects of medium mixtures on maintaining a steady moisture supply, root respiration, and stimulating development of mango seedlings (Fischer *et al.*, 2016) may explain the results of the current investigation.

Biomass

Both the fresh and dry biomass of seedling mango plants were significant (P 0.05) influenced by the major effect of different soil potting media combinations, and also their interaction (Table 4). Combinations with potting medium of farmyard manure: soil: Sawdust (2:3:1) yielded the lowest fresh weight (9.57 g) and dry weight (3.84 g), respectively (Table 4). At 180 days post-germination, soil potting media combination of farmyard manure: sand: soil (1:1:2) were found to produce the maximum fresh weight (Mngomba *et al.*, 2010). Mangoes with the highest fresh weight (41.83 g) at 90 days following germination were grown in soil potting media mixtures of leaf mould: farmyard manure: soil (1:1:1) and a local cultivar. Furthermore, it has been revealed that the farmyard manure: sand: soil (1:1:1) and mango cv. Dusehri combination has the maximum dry weight, at 31.25g (Kaur, 2017). Consistently, 180 days after seed germination, mango seedlings grown in a mixture of farmyard manure: sand: soil (1:1:2) and the mango cv. Master-royal had a dry weight of 23.23 g (Reshma and Simi, 2019a). It was suggested by Medany *et al.*, (2009) that the increased dry biomass of the seedlings might be responsible for the beneficial effect correct medium composition has on soil physio-chemical characteristics.

Vigor index (VI) -I and II

Soil potting media interacted in terms of VI-I and VI-II, as shown in Table 4. The whole top soil had the greatest Vigor Index (37.05 cm), whereas the Top soil + FYM + sawdust soil mixtures had the lowest (at 8.38 cm) (3:2:1). Additionally, the best results were achieved when using a soil media composition of sand: soil: farmyard manure (1:3:2), while the worst results were obtained when using a potting media composition of sawdust: farmyard manure: soil (1:2:3) (Table 4). The maximum vigor index was achieved when the Bappakka mango cultivar was used in conjunction with a soil medium mix of Sand: Red earth: FYM(Reshma and Simi, 2019b). The vigor index (VI)-I was 36.37 centimeters and the VI-II was 22.99 grams when the hormone GA_3 100 ppm was added to the Varikka mango cultivar (Reshma and Simi, 2019a). It's possible that the soil potting media's richness and the seeds' weight have a role in the disparity. Researchers have shown that organic manure-rich media has a higher proportion of germinating seeds, a higher percentage of germinated seeds that survive, and better root system development, all in less time.

Table 4. Effect of different potting media on fresh biomass, dry biomass, vigousity I and Vigoursity II of mango seedlings

Potting media	Fresh Biomass	Dry Biomass	Vigoursity I	Vigoursity II
PM 1	24.4 a	11.3 a	15.2 a	5.5 a
PM 2	23.32 b	10.2 b	14 b	6.32 b
PM 3	28.2 c	11 ac	14.7 c	6.68bc
PM 4	25.2bd	11.21 ad	15.76 cd	6.9 cd
LSD%	6.9	3.1	3.12	3.15
CV%	16	13	7.5	16

Means with identical letters are statistically significant at P 0.05, LSD at 5%, and CV% at coefficient variance

Conclusion

The mango has considerable potential as a fruit crop, and its increased availability has led to a rise in the fruit's popularity. Growers' incomes and food security have benefited greatly from the crop in the region under investigation. Productivity is poor, despite the fact that it has the capacity to ensure sufficient food and nourishment for everybody. However, the potting medium used in the nursery make a huge difference in the yield. Seed germination, seedling development, and establishment were all enhanced when grown in media mixture of top soil, FYM, and sand with a 3:2:1 ratio.

Conflict of interest

The authors declared absence of conflict of interest.

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