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Germination and seedling growth response of mango (*Mangifera Indica* L.) cultivars to different nursery potting media

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Abstract

Background: Mango is an important cash crop greatly contributing for food security of fruit growers in northwestern parts of Tigray region, northern Ethiopia. However, information was critically lacking with respect to germination and growth response of mango rootstock to varying compositions of growing media in the region. Thus, *an experiment was conducted* during 2018 *to evaluate* germination and seedling growth *response* of mango cultivars to different combinations of nursery potting media in a net house at Indasellassie. Seeds of Local, Dodo and Keitt cultivars of mango were sown in full top soil (M1); top soil: sawdust: sand (3:2:1)(M2); top soil: FYM (Farmyard manure): sand (3:2:1) (M3); and top soil: FYM: sawdust: (3:2:1)(M4). Randomized complete block design in a factorial arrangement with three replications were used. Data on germination and growth parameters were collected and analyzed using GenStat software.

Results: The findings of the experiment revealed that mango cultivar had significantly affected most of the germination and growth parameters except shoot number. Moreover, potting media affected most of the parameters except days to germination, germination percentage, stem diameter, root number, and shoot number. Interaction effects of cultivar and growing media significantly affected all parameters except internode length, shoot number and stem diameter. Accordingly, interactions of local mango cultivar and M3 media combination gave the highest for most of the parameters with the order of M3 = M1 = M4 > M2 for germination percentage, M3 = M1 > M4 = M2 for plant height, M3 > M1 > M2 = M4 for leaf number, M3 > M1 > M4 > M2 for leaf area, M3 = M1 > M2 = M4 for stem diameter, M3 = M1 > M2 > M4 for root number, M3 > M2 > M1 = M4 for root length, M3 > M1 > M2 = M4 for fresh weight, M3 > M1 = M2 = M4 for dry weight and Vigorosity II of mango.

Conclusion: Considering better mango performance on seed germination, seedling growth and establishment in the study area, mango growers should use Local mango cultivar with soil potting media combinations of top soil: FYM: sand in the ratio of 3:2:1 for improving productivity and food security.

Keywords: Farmyard manure, Mango, Monoembryonic, Rootstocks

Background

Mango (*Mangifera indica* L.) is a tropical fruit known as "king of fruits" belongs to genus Mangifera, family Anacardiaceae which is grown almost all parts of the world. It is believed to have originated from South East Asia and more than 1000 varieties have been identified all over the world [1]. Currently, mango is produced in tropical and sub-tropical climates, in more than 85 countries

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worldwide [2]. Mango is known as the king of the fruits due to its excellent flavor, delicious taste and high nutritive values that makes the crop valued for both food and nutritional security especially for developing countries like Ethiopia where the realization of food and nutritional security is still a challenge [3]. The crop can be consumed as a raw, canned, or juice which provides sufficient amount of dietary antioxidants, such as ascorbic acid, carotenoids, and phenolic compounds and additionally a remarkable amount of dietary fiber, and vitamin A [4]. Mango is one of the most widely grown among the fruit crops cultivated in Ethiopia preceded only by banana in terms of economic importance [5]. In Tigray region, the potential area for mango production is in estimated at about 118.2 hectare [4]. According to Mekonnen [6], an attractive and delicious tropical and temperate fruits including mango are much in demand in the local markets in Tigray (Additional file 1).

The productivity of mango in Ethiopia is very low compared to the crop potential, about 20–30 ton/ha [7, 8]. Various factors govern crop productivity but, genetic and environmental are well known. Nowadays, the government has been introducing new improved varieties in Ethiopia. However, as compared to different mango growing nations, varieties of improved mango seedlings distributed to farmers for commercial production in Ethiopia are few [9]. Moreover, the supply of suitable root-stock mango seedlings in Tigray region is very limited [10]. Consequently, nursery potting media believed to have contributed to low viability and productivity of mango in the region. Mango plants are multiplied asexually through grafting and each plant is made up of the rootstock which provide root system and the scion forming the tree canopy. Both of these parts play an equally vital role in the life of a tree. The rootstock has great influence on the vigour, longevity and productivity of the scion variety [11]. Moreover, quality and composition of fruits also been affected by the root stock [11]. Thus, raising good quality rootstocks is very important for sustainability of the orchard. Similarly, nursery potting medium 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 [12]. In North-western zone of Tigray region orchard owners usually use varied levels and types of nursery potting media although majority use top soil: FYM: sand in the ratio of (3:2:1) together with local cultivar mango seedling root stock. Likewise, in the study area, there was limited research based information on germination and growth performance of existing and available mango rootstock cultivars to different nursery potting media compositions. Hence, it was high time to consider the evaluation of nursery potting media combinations on germination, seedling growth and establishment of mango cultivars in the study area. Therefore, the experiment was aimed at evaluating germination and seedling growth response of mango root stock cultivars to different potting media combinations and identifying the best combinations of cultivar and potting medium that had good germination and growth performance.

Materials and methods

Description of the study area

The experiment was conducted from April to September 2018 at a net-house in Indaselassie (ATVET) College farm, Northwestern zone of Tigray region, Ethiopia. The area is located at about "300 km" from Mekelle city which is the capital of the region. The site is located at 130 88′36″ to 140 08′ 57″ N latitude and 380 04′30″ to 380 17′ 02″ E longitudes at an altitude of 1915 m above sea level [13].

According to the agro-climatic classifications of Ethiopia, the climatic zone of the study area is generally subtropical with an extended dry period of 9–10 months. A maximum effective rainy season of 50–60 days with average annual rainfall of 885 mm which varies between 758 and 1440 mm. The area has average temperature of 20.92 °C with a mean maximum temperature of 30.97 °C in April and minimum temperature of 11.4 °C in January [13]. The soil type of the district is sandy clay loam with pH of 6.57 [14]. The major crops grown include are Onion, Tomato, Teff, Maize, Sorghum, and Finger millet [13] (Fig.1).

Treatments and experimental design

The experiment consisted of 3×4 factorial combination of three mango cultivars vis-a-vis local cultivar/Kebabi mango in the local tigrina language (C1), Dodo (C2) and Keitt (C3) and four levels of soil potting media with full top soil (M1), ([top soil: sawdust: sand (3:2:1) (M2)]) ([top soil: FYM(Farmyard manure): sand (3:2:1) (M3)]) and ([top soil: FYM(Farmyard manure): sawdust (3:2:1) (M4)]). Randomized complete block design (RCBD) in a factorial arrangement with three replications was used. In the experiment, local mango cultivar together with full top soil was used as a control treatment as the top soil was considered to possess poor physical properties such as poor aeration, water holding capacity etc. compared to those treatments having FYM(Farmyard manure), sawdust and sand. The total area of the experimental was 70 m^2 (4 m by 17.5 m).

Experimental procedure

Fresh mango fruits of three cultivars were gathered in consultation with experts from the district office of

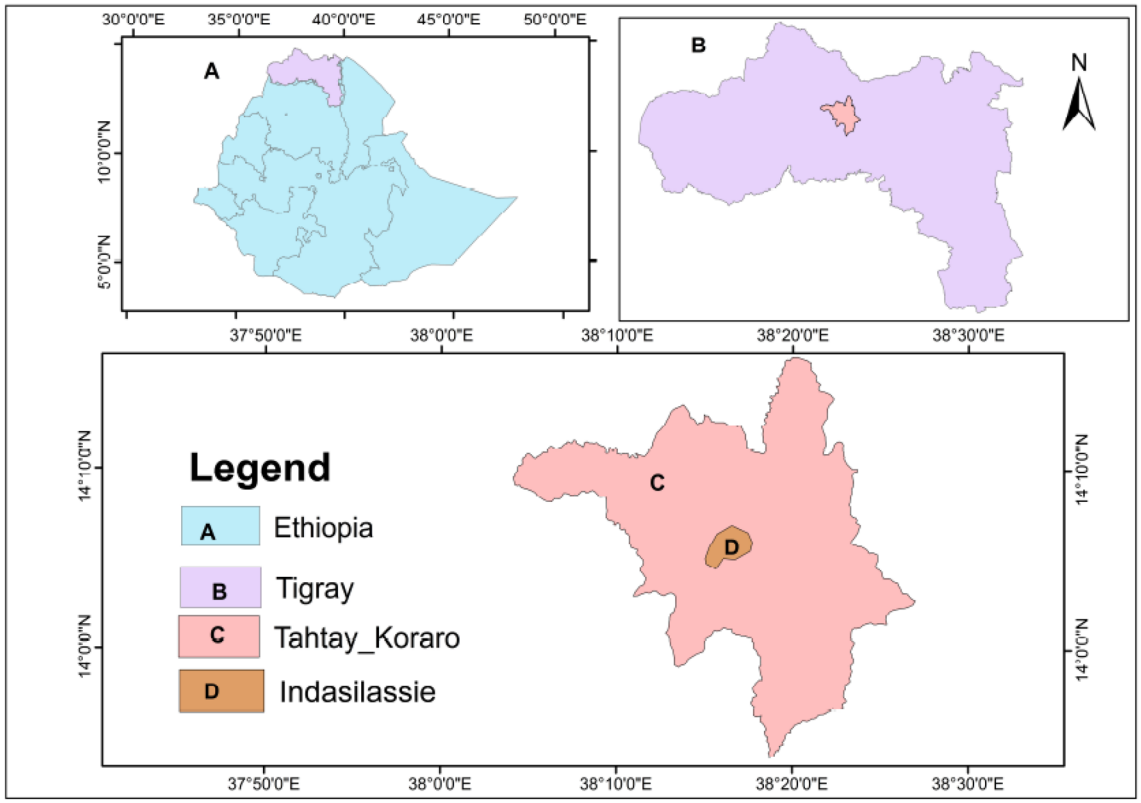

Fig. 1 Location map of the experimental site

agriculture and rural development. About 360 healthy and mature mango fruits of each of the cultivars were selected from and taken to Indaselassie ATVET College nursery site. Immediately, freshly extracted seeds were cleaned with tap water then the healthy seeds within the same weight range were selected. The sowing of each cultivar seeds were done on the same day in the four different growing media combinations. One treatment within a block occupies 30 seedlings. Pot mixtures were prepared as per the ratio determined consisting of sand, soil, FYM and sawdust. FYM was obtained from dairy farm of Indaselassie Agricultural, Technical, Vocational, Educational and Training College. It was produced in a pit underneath shade to keep away from loss of nutrients through evaporation. The FYM was decomposed for about 6 months. Bi-product of *Cordia africana* wood saw-dust was collected from house furniture manufactures in Indaselassie town. Sand was collected from the upper river basin of the surrounding area. All media used for growing the seedlings were once sieved through mesh screen to obtain 1 mm to 5 mm ranged particles.

Physico-chemical properties of the nursery potting media were carried out. Media containing organic manures possess more available moisture or water holding capacity and some acids [15]. The seeds were sown at the depth of 2 cm in the media filled on black color polythene bags of 15 cm × 25 cm size [15]. Seeds were irrigated immediately after sowing and irrigation was continued every 2 days until the seeds start to germinate [16]. After start of germination, the seedlings were irrigated twice a week and allowed to grow for 120 days in the nursery. Moreover, simple shade structure was constructed using wood poles to support a roof of mesh wire upon which a thin layer of thatching grass to give protection against strong sunlight. Media were exposed to temperature/heat treatments to avoid nematode, insects and pathogens by putting 20 cm layer of media separately under a thin black plastic under the sun for a consecutive 3 days.

Data collection

Number of days for seed emergence: was recorded by counting the number of days taken from sowing till 50% of the seeds per plot start to emerge.

Germination percentage (%): The percentage of seeds germinated per plot was calculated by dividing number

of germinating seedlings to total number of seeds and expressed in percent.

Plant height (cm): Ten seedlings were randomly selected from each plot and plant heights were measured from the base to the tip of the shoot using a meter scale at 120 days after sowing seeds and the average height of ten plants were used for statistical analysis.

Number of leaves per plant: Numbers of leaves were recorded by counting leaves of ten randomly selected seedlings at 120 days after seeding and the average number of leaves were used for statistical analysis**.**

Number of stems per plant: Numbers of shoots per plant were counted at completion of germination from the ten randomly selected seedlings 120 days after planting and the average value was used for statistical analysis.

Internode length (cm): Internode length was recorded from all ten randomly selected seedlings using meter scale at 120 days after planting from node to another node of a seedling and it was summed up and the average of ten seedlings were used for statistical analysis.

Stem diameter (cm): Stem diameter was measured using digital caliper from ten randomly selected seedlings 120 days after sowing and their average value was used for statistical analysis.

Leaf area (cm): The leaf area was measured from ten randomly selected seedlings using meter scale at 120 days after seeding the seeds and computed using the formula developed by [17]:

$$\mathrm{LA} = 0.2452\,[(L * W) * N].$$

where, LA = Leaf area, W = width, L = Length, N = number of leaves.

Number of roots per plant: Numbers of roots were measured by counting the number of roots (tap and fibrous) from ten randomly selected seedlings at 120 days after sowing and the average was used for analysis.

Length of primary root (cm): Length of tap root was measured using a ruler at the end of 120 days after sowing from ten randomly selected seedlings of each plot which were carefully removed by cutting the polythene bags of seedlings and removing soil adhering to the roots of the seedlings.

Fresh weight of seedlings (g): Fresh weight of the whole parts of seedling (roots and shoots) was measured by weighing the weight of ten randomly selected seedlings per plot using sensitive balance at the end of the study period, 120 days after planting.

Dry weight (g): Dry weight of the whole parts of seedling was measured by drying ten randomly selected seedlings in an oven at 72 °C for 48 h [18] and dry biomass was weighted using sensitive balance and the average was used for statistical analysis.

Seedling vigour: Was determined according to the formula of [19];

$$\mathrm{Vigorindex(VI)-I(cm)} = \text{Mean seedling length} \times \text{percent germination}$$

$$\mathrm{Vigorindex(VI)-II(g)} = \text{Dry weight of seedling} \times \text{percent germination}$$

Media analysis

Top soil samples collected from a depth of 0–30 cm were taken before the implementation of the experiment. The collected samples were air dried, mixed and ground to pass through 2 mm sieve to remove large particles, debris, and stones. Then, the samples were taken to Mekelle soil testing laboratory. Particle size distribution was analyzed using hydrometer procedure [20]. The pH of the soil was measured in water at soil to water ratio of 1:2.5 using pH meter [21]. Organic carbon was determined using wet oxidation method [22]. Total nitrogen was analyzed by wet oxidation procedure of Kjeldahl method [23]. Available phosphorus was analyzed using the procedure of [24]. Cation exchange capacity (CEC) was analyzed using NH_4 acetate method [25]. Farmyard manure and saw dust were also analyzed for the different parameters considered.

Data analysis

Collected data were subjected to Analysis of Variance (ANOVA) using standard procedure [26]. Fisher's LSD test at 5% probability level was used to separate the means. Pearson's correlation was done to examine the degree of association among the different parameters. Data analysis carried out using GenStat discovery 16th edition statistical software.

Results and discussion

Characteristics of the experimental nursery potting media

Table 1 highlighted the characteristics of the experimental nursery soil, FYM and sawdust before planting. The textural class of the experimental soil was sandy clay loam having pH of 6.8 and classified as neutral as per the ratings of Horneck et al. [27]. The total nitrogen (N) content of the soil was 0.30%, which was high based on the rating of Hart et al. [28] which is in contrary to the reports where the soil of the study area are characterized with poor in fertility [29, 30]. Available phosphorus (P) content was 6.10 ppm which is low as per the ratings of Olsen [24] which is similar with the reports where soils of the study area are poor

Table 1 Physico-chemical properties of the experimental top soil, FYM and Sawdust before sowing

Physico-Chemical Properties	Soil	Rating	FYM	Rating	Sawdust	Rating
Particle size						
Sand (%)	48%	40				
Silt (%)	22%	25–40				
Clay (%)	30%	40–50				
Chemical Properties						
pH	6.80	Neutral	8.00	Moderately alkaline	6.70	Neutral
Organic carbon (%)	1.08	Low (1.5–2.5%)	3.64	High (1.5–2.5%)	3.67	High (1.5–2.5%)
CEC (meq/100 g)	49.57	very high (> 40)	41.1	Very high (> 40)	22.2	Moderate (12–25)
EC (ms /cm)	0.50	Low salinity	2.95	Low salinity (0–2)	1.27	Low salinity (0–2)
Nutrient availability						
Total N (%)	0.30	High (0.25–0.50)	0.50	Very-high > 0.5	0.59	Very high > 0.5
Available P(ppm)	6.10	Low < 20	372.4	Excessive (> 100)	106.1	Excessive (> 100)
Available K(ppm)	193.0	Medium (150–250)	865.0	Excessive (> 250)	775.00	Excessive (> 250)

CEC Cation Exchange Capacity, *EC* Electrical Conductivity

soil fertility [29, 30]. Moreover, the available potassium (K) content of the experimental soil found to be 193 ppm which is rated as medium based on the ratings of Khan et al. [31] and is in line with the existing notion that Ethiopian soils are rich in potassium [32]. The cation exchange capacity was 49.57 meq/100 g of soil which is rated high based on the ratings of Hazelton and Murphy [33] and the organic carbon content was 1.08%, which is deficient according to Maria and Yost [34]. Generally, it is reported that soils in Tigray region where the study area is located, are characterized to be shallow, low in fertility, with high run-off, and low infiltration capacity which is attributed to high nutrient losses through soil erosion, and extremely low use of external nutrient inputs [29, 30].

Except organic carbon, EC and available phosphorus of the experimental soil are suitable for the growth and development of mango seedlings. The addition of well decomposed FYM and sawdust can improve soil physical properties and there by enhance root development of mango seedling through improved aeration [31, 35]. Similarly, Usman et al. [36] suggested on the use and positive of organic input on citrus seedlings. Therefore, soil fertility management in the study should focus on conditions that improve soil organic carbon and potassium through application of optimum levels of organic manure which thus improve soil physico-chemical properties [35].

Germination and growth response of mango to soil growing media and cultivar

Days to germination

Days to germination had significantly affected by the main effect of cultivar and its interaction of growth media while main effect of growing media did not Table 2. Local cultivar in combination with full top soil germinated earlier (22 days) although statistically at par with the combinations of local cultivar together with soil media composition in the ratio of Top soil: FYM: Sand (3:2:1). Conversely, Keitt cultivar in combinations with media composition in the ration of Top soil: Sawdust: Sand (3:2:1) germinated late (32 days) and is

Table 2 Interaction effect of soil media and cultivar on days to germination and germination percentage of mango

Potting media	Days to germination			Germination percentage		
	C1	C2	C3	C1	C2	C3
M1	22.00f	28.88c	30.44b	97.80a	52.20de	61.13c
M2	23.33e	27.7 cd	32.40a	90.00b	61.13c	53.33de
M3	22.00f	27.04d	32.00a	95.53ab	57.77cde	56.67cde
M4	22.67ef	27.31d	32.33a	92.23ab	58.90 cd	51.13e
LSD		1.27			7.65	
CV(%)		2.7			6.5	

C1 local cultivar, C_2 dodo, *C3* keitt, *M1* full top soil, *M2* top soil: sawdust: sand (3:2:1), *M3* top: FYM: sand (3:2:1), *M4* top soil: *FYM* sawdust (3:2:1), *LSD* least significant difference at 5%, and *CV%* coefficient variance

statistically at par with combinations of Keitt cultivar with Top soil: FYM: Sawdust (3:2:1) (Table 2). Parasana et al. [37] reported similar findings where a combination of Soil: FYM: Sand (2:1:1) soil media with Master royal local cultivar of mango which resulted in early days to germination of 24.0 days. Moreover, Abdul [38] indicated similar findings. The probable reason for such findings in mango could be due to genetic differences and different media compositions [19, 39].

Germination percentage

Main effect of cultivar and soil medium as well as their interactions had significantly ($P \leq 0.05$) affected germination percentage of mango seedlings (Table 2). Germination percentage was highest (97.8%) at the treatment combinations of local mango cultivar with full top-soil and is statistically at par with local mango cultivar in combination with top soil: FYM: sand (3:2:1). However, treatment combinations of Keitt cultivar and soil media composition of Top Soil: Sawdust: Sand (3:2:1) gave minimum (51.13) percent germination (Table 2). In contrary, Parasana et al. [37] indicated highest germination percent of 81% at treatment combination of Master royal mango stone cultivar together with top soil: sand: FYM (2:1:1). Genetic variation, content of cotyledons /endosperm weight and hard nature of seed coat might affect the percent germination of mango. Many researchers reported varietal difference on seedling performance of mango [19, 39, 40].

Plant height

There was a significant difference in plant height of mango seedlings due to cultivar, soil media and their interactions (Table 3). Full top soil in combination with local cultivar of mango gave the highest plant height of 37.90 cm although statistically similar with treatment combinations of local mango cultivar and potting media compositions of Top soil: FYM: Sand (3:2:1) (Table 3). However, Keitt cultivar in combination with Top soil: Sawdust: Sand (3:2:1) potting media compositions gave the shortest plant height of 15.78 cm although statistically at par with treatment combination of Keitt cultivar and potting media composition of Top soil: FYM: Sawdust: Sand (3:2:1) which gave 17.29 cm plant height (Table 3). In line with the findings, local Nekkare cultivar in combinations with potting media composition of Soil: Sand: Compost: Coir pith (1:1:1:1) gave the highest plant height of 29.60 cm [38]. Meena et al. [41] similarly, reported maximum plant height of 28.48 cm at soil potting media compositions of Soil: FYM: Sand (1:1:1). This could be due to the nutrient supply of the different combinations of soil potting media which might have helped in improving the rooting zone soil physico-chemical properties and thus increased nutrient assimilation initiate cell division, differentiation and enhanced nutrient availability leading to higher production of photo synthetically functional leaves and growth of plant [19, 41].

Number of leaves

Number of leaves had significantly ($P \leq 0.05$) affected by the main effect of cultivar, soil potting media as well as their interaction effects (Table 3). Local mango cultivar in combination with soil media composition of Top soil: FYM: Sand (3:2:1) gave the highest (18) number of leaves while Keitt cultivar in combination with soil media composition of Soil: FYM: Sawdust (3:2:1) gave the lowest (8) number of leaves (Table 3). Master-royal mango cultivar in combination with soil potting media of composition of Soil: Sand: FYM (2:1:1) resulted in higher number of leaves [37]. Many researchers reported similar findings on different mango cultivars [17, 42, 43]. High soil nutrient availability in the potting media can improve nutrient availability and water for growth of mango seedlings [31].

Table 3 Interaction effect of growing soil media and cultivar on plant height, leaf number, Leaf area and stem diameter of Mango

Potting media	Cultivar											
	Plant height (cm)			Leaf number			Leaf areat(cm)			Stem diameter (cm)		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
M1	37.90a	27.57bc	24.32 cd	15.07b	13.47bc	9.87efg	67.14b	31.06efg	33.85efg	072a	0.61bcd	0.65b
M2	29.27b	22.25d	15.78e	11.47def	10.60defg	9.20 fg	28.40efg	25.50 fg	24.08 g	0.66b	0.55d	0.44e
M3	37.46a	24.67 cd	18.42e	17.6a	12.00cde	11.67cde	86.68a	59.77bc	40.23de	0.75a	0.57 cd	0.47e
M4	29.43b	26.00bc	17.29e	11.40def	12.60 cd	8.40 g	49.35 cd	38.19def	23.11 g	0.62bc	0.60bcd	0.46e
LSD		3.55			2.45			13.46			0.06	
CV (%)		8.1			12.1			18.8			5.9	

C1 local cultivar, C_2 dodo, *C3* keitt, *M1* full top soil, *M2* top soil: sawdust (3:2:1), *M3* top: FYM: sand (3:2:1), *M4* top soil: *FYM* sawdust (3:2:1), means with the same letter(s) are statistically similar at $P \leq 0.05$, *LSD* least significant difference at 5%, and *CV%* coefficient variance

Leaf area

Cultivar, soil potting media and their interactions had significantly ($P \leq 0.05$) affected leaf area of mango seedlings (Table 3). Maximum leaf area of 86.68 cm was observed at the treatment combinations of soil media with compositions of Top soil: FYM: Sand (3:2:1) and local cultivar. However, the minimum leaf area of 23.11 cm was observed at combinations of Keitt cultivar together with soil media of composition of Top soil: Sawdust: Sand (3:2:1) (Table 3). Abbas et al. [44] reported similar findings where combination of soil media with a composition of sand: peat moss: vermiculite (1:2:1) and local cultivar of mango gave the highest leaf area of 101.56 cm^2. Better nutrient availability might led to improved production of functional leaves [37].

Stem diameter

Mango cultivar showed significant difference on stem diameter while, main effect of soil media and its interaction with cultivar did not (Table 3). Maximum stem diameter of 0.75 cm was obtained at combinations of soil media composition with Soil: FYM: Sand (3:2:1) and local cultivar while combinations of soil media with compositions of Top soil: FYM: Sawdust (3:2:1) and Keitt cultivar gave the minimum stem diameter of 0.44 cm (Table 3). In line with the findings, maximum stem diameter of 0.79 cm was reported at 120 days after germination at combinations of Nekkare mango cultivar and soil media of composition of Soil: Sand: Compost: Coir pith (1:1:1:1) [38]. Moreover, Parasana et al. [37] indicated maximum stem diameter at combinations of Master royal cultivar of mango and soil media composition of Soil: Sand: FYM (2:1:1) at 180 days of germination. Difference in mango rootstock performance might have resulted in differences stem diameter characteristics [45, 46].

Internode length

Local cultivar of mango gave longer internode length of 7.48 cm while Keitt cultivar gave the shortest with 3.63 cm. Moreover, full top soil gave longer internodes length of 6.84 cm while soil media composition of Top soil: Sawdust: Sand (3:2:1) gave the shortest with 4.15 cm (Table 4). However, there was no significant interaction effect of cultivar and growth media (Table 4). Higher (10.38 cm) internode length of mango seedlings were reported at soil media composition of Soil: Sand: Compost: Coir pith (1:1:1:1) with Neelum mango cultivar [38]. The relationship of media with seedling cultivar demonstrate massive growth in all vital plant growth parameters including, net plant growth, stem diameter, internode distance, number and size of leaves, root length and number of roots [36].

Table 4 Effects of cultivar and media on internodes length and stem number of mango seedlings

Potting media	Internode length (cm)	Stem number
M1	6.84a	1.84b
M2	4.15c	2.44a
M3	5.50b	2.19ab
M4	5.02b	2.00ab
LSD	0.71	0.51
Cultivar		
C1	7.48a	2.33a
C2	5.03b	2.22ab
C3	3.63c	1.81b
LSD	0.62	0.44
CV(%)	13.6	24.6

C1 local cultivar, *C2* dodo, *C3* keitt, *M1* full top soil, *M2* top soil: sawdust (3:2:1), *M3* top: FYM: sand (3:2:1), *M4* top soil: *FYM* sawdust (3:2:1), means with the same letter within a column are statistically non-significant, *LSD* least significant difference at 5%, and *CV%* coefficient variance

Stem number

Higher shoot number of 2.33 was observed at local mango cultivar while the lowest number of 1.81 was observed at Keitt cultivar of mango. Similarly, soil media combinations at compositions of top soil: Sawdust: Sand (3:2:1) gave higher shoot number of 2.44 while soil media combination with proportions of Top soil: FYM: Sawdust: (3:2:1) gave the lowest (2.0) stem number (Table 4). The variation in stem number among mango seedlings could be due to seed polyembryonic nature that contains several embryos produced by nuclear embryos which grow to numerous plants commercially grown as cultivars [47].

Root length

Table 6 indicates response of primary root length as affected by the main effects of cultivar and soil potting media and their interactions. The maximum root length of 30.40 cm was observed at combinations of local mango cultivar and soil media combination of Soil: FYM: Sand (3:2:1) while combinations of Keitt cultivar and soil media of full top soil gave the shortest root length of 21.2 cm (Table 5). In conformity Abdul [38] indicated higher (27.86 cm) root length of mango seedlings at combinations of Nekkare cultivar and media composition of Soil: Sand: Compost (1:2:1). Damodarana et al. [48] reported similar findings. Soil media might have attributed to such findings and enhanced growth of the seedling, including enhanced root system development [49] (Table7).

Root number

Root number of mango seedlings had significantly affected by main effect of cultivar and its interaction with potting media while soil media did not (Table 5). Local

Table 5 Interaction effect of soil media and cultivar on root number, root length, fresh and dry weight of mango

Potting media	Cultivar											
	Root number			Root length			Fresh Biomass			Dry Biomass		
	C1	C2	C3	C1	C2	C3	C1	C2	C3	C1	C2	C3
M1	5.00a	2.87bcde	2.27ef	26.39bc	23.07efg	21.20g	39.29b	23.94d	12.17fg	17.01b	10.53c	5.82de
M2	3.60b	3.21bc	1.56f	27.33b	26.07bcd	22.14fg	32.71bc	22.93de	9.57g	15.36b	9.86c	3.84e
M3	5.16a	2.40de	2.20ef	30.40a	25.47bcde	23.73defg	52.75a	27.43cd	16.66ef	22.35a	11.22c	6.45d
M4	3.47b	3.07bcd	2.60cde	24.87bcde	24.09cdef	24.13cdef	33.51bc	24.89d	11.23fg	15.03b	11.31c	4.77de
LSD(5%)		0.79			2.64			7.06			2.57	
CV(%)		15			6.3			16.3			13.6	

C1 local cultivar, *C2* dodo, *C3* keitt, *M1* full top soil, *M2* top soil: sawdust: sand (3:2:1), *M3* top: FYM: sand (3:2:1), *M4* top soil: FYM: sawdust (3:2:1), Means with the same letter within a column are statistically non-significant at $p \leq 0.05$, *LSD* least significant difference at 5%, and *CV*% coefficient variance

Table 6 Interaction effect of soil media and cultivar on vigoursity of mango

Potting media	Cultivar					
	Vigoursity I			Vigoursity II		
	C1	C2	C3	C1	C2	C3
M1	37.05a	14.39d	13.74d	16.61b	5.48de	3.1ef
M2	26.25c	13.60d	8.38e	13.8c	6.00d	2.66f
M3	34.30b	14.31d	10.49e	21.34a	6.48d	3.14ef
M4	27.10c	15.32d	9.48e	13.92c	6.67d	2.43f
LSD		2.41			2.41	
CV(%)		7.6			16.8	

C1 local cultivar, *C2* dodo, *C3* keitt, *M1* full top soil, *M2* top soil: sawdust (3:2:1), *M3* top: FYM: sand (3:2:1), *M4* top soil: FYM: sawdust (3:2:1), Means with the same letter are statistically significant at $P \leq 0.05$, *LSD* least significant difference at 5%, and *CV*% coefficient variance

Table 7 Simple liner correlation for germination and growth parameters of mango

	DG	GP	IN	LA	LN	PH	RL	RN	SD	SN	VI1	VI2	WD	WF
DG	–													
GP	− 0.91**	–												
IN	− 0.81**	0.77**	–											
LA	− 0.62**	0.60**	0.71**	–										
LN	− 0.62**	0.56**	0.76**	0.83**	–									
PH	− 0.88**	0.81**	0.96**	0.73**	0.79**	–								
RL	− 0.56**	0.53**	0.44**	0.57**	0.50**	0.50**	–							
RN	− 0.78**	0.76**	0.82**	0.65**	0.69**	0.86**	0.65**	–						
SD	− 0.79**	0.72**	0.88**	0.64**	0.66**	0.91**	0.50**	0.77**	–					
SN	− 0.36*	0.29sn	0.10sn	0.09sn	0.10sn	0.23sn	0.27sn	0.42**	0.32sn	–				
VI1	− 0.92**	0.95**	0.90**	0.70**	0.69**	0.93**	0.57**	0.87**	0.83**	0.26sn	–			
VI2	− 0.93**	0.93**	0.83**	0.75**	0.73**	0.88**	0.68**	0.86**	0.78**	0.33sn	0.95**	–		
WD	− 0.92**	0.83**	0.84**	0.75**	0.76**	0.89**	0.71**	0.85**	0.81**	0.36*	0.90**	0.96**	-	
WF	− 0.89**	0.80**	0.82**	0.79**	0.79**	0.88**	0.71**	0.84**	0.77**	0.35*	0.88**	0.96**	0.99**	–

* significance at $P \leq 0.05$, **highly significant at $P \leq 0.1$, and *ns* non-significant at $P \leq 0.05$, *DG* Date of Germination, *GP* Germination of percentage, *PH* plant height, *SD* seedling diameter, *A* Leaf area, *LN* Leaf number, *RL* Root length, *RN* Root number, *SN* Shoot number, *FW* Fresh weight, *DW* Dry weight, *V1* Vigoursity I, *V2* Vigoursity II

mango cultivar in combination with soil potting media at proportions of Soil: FYM: Sand (3:2:1) gave the highest root number of 5.16 while Keitt cultivar in combination with full top soil gave the lowest with 1.56 root number (Table 5). Nekkare mango cultivar in combination with soil media compositions of Soil: Sand: Compost (1:2:1) results in the highest number of roots of 7.6 [38]. The findings obtained at the current study might be due to the desirable effects of media combinations on retaining regular moisture supply, root respiration and encouraging growth of mango seedling [50].

Biomass

Main effect of cultivar and potting media as well as their interaction effects significantly ($P<0.05$) affected fresh and dry biomass of mango seedlings (Table 5). Maximum fresh and dry weight of 52.75 g and 22.35 g were observed at a combinations of local mango cultivar together with soil potting media of Soil: FYM: Sand (3:2:1) while the minimum fresh and dry weight of 9.57 g and 3.84 g, respectively, were obtained at combinations of Keitt cultivar and soil potting media of Top soil: FYM: Sawdust (3:2:1) (Table 5). Maximum fresh weight was reported at combinations of mango Master-royal cultivar and soil media compositions of Soil: Sand: FYM (2:1:1) at 180 days after germination [37]. Similarly, soil media combinations of Top soil: FYM: leaf mould (1:1:1) and local cultivar gave the highest (41.83 g) fresh weight at 90 days after germination mango [35]. Moreover, it was reported that the highest dry weight of 31.25 g was observed with combinations of soil media compositions of Soil: Sand: FYM (1:1:1) and Dusehri cultivar of mango [49]. In conformity, maximum dry weight of 23.23 g of mango seedlings were observed with combinations of soil media of Soil: Sand: FYM (2: 1: 1) and Master-royal cultivar at 180 days after germination of seeds [37]. Meena et al. [51] indicated that the positive effect proper media composition on soil physico-chemical properties might be due to increased dry biomass of the seedlings.

Vigour index (VI)-I and II

Table 6 indicates the interaction effect of mango cultivar and soil potting media on Vigour index (VI)-I and II.Vigour index (VI)-I was highest (37.05 cm) at combinations of mango local cultivar together with full top while the minimum (8.38 cm) was observed at combinations of Keitt cultivar of mango and Top soil: FYM: Sawdust soil potting media (3:2:1). Moreover, maximum vigour index (VI)-II of 21.34 g was observed at local cultivar of mango in combination with potting media proportion of Soil: FYM: Sand (3:2:1) while the minimum vigor index (VI)-II of 2.43 g was recorded at Keitt cultivar of mango in combination with soil potting media compositions of top Soil: FYM: Sawdust (3:2:1) (Table 6). Bappakka mango cultivar in combination with soil media composition of Sand: Red earth: FYM gave the highest vigor index [19]. Moreover, hormone GA_3—100 ppm in combination with Varikka mango cultivar gave higher vigour index (VI)-I and II of 36.37 cm and 22.99 g, respectively [52]. The difference might be due to poorness or richness of the soil potting media and weight of seeds. Many investigators suggested more favorable media containing organic manures possess organic acid that might help in making available moisture and some acids might have helped in yielding minimum days and better germination percentage and particularly good root system development [37].

Conclusion and recommendation

Mango is a potential fruit crop contributing greatly to the improvement of nutritional and health of the Ethiopian society. In the study area, the crop is contributing significantly to the livelihoods and food security of the local growers. Despite its potential for food and nutrition security its productivity is very low. However, suitable root stock cultivar and nursery potting media play a great lot in improving its productivity. Local mango cultivar in combination with growth media at a combination of top soil: FYM: sand (3:2:1) gave better mango seed germination, seedling growth and establishment in the study area. Accordingly, the treatment is recommended for improving productivity of mango in the study area.

Abbreviations

FYM: Farmyard manure; ATVET: Agricultural Technical Vocational and Educational Training.

Supplementary Information

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Additional file 1. Experimental data.

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GG contributed in research proposal writing, data collection, data analysis and interpretation. NT contributed in research proposal writing, data analysis, data interpretation and article writing. BM contributed in research proposal writing, data analysis, and data interpretation. All authors read and approved the final manuscript.

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Declarations

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Consent for publication
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Competing interests
The authors declare that they have no competing interests.

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