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Effect of Potting Media and Variety on Growth, Yield and Quality of Hot Pepper (*Capsicum annuum* L.) Under Jimma Condition, South West Ethiopia

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Abstract: A greenhouse experiment was conducted at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) during the season of 2016/2017. The rapid population increase and land scarcity calls for an alternative of crop production for sustenance of the human race. Productivity of Hot pepper is limited due to Lack of improved, good quality and well adapted varieties, nutrient depletion (poor soil fertility) and inappropriate fertilizer utilization. Treatments consisted of four hot pepper varieties (Mareko Fana, Melka Shote, Melka Awaze and Local Variety) and five potting media mixture (Topsoil, FYM + Top soil + Sand, Compost + Top soil + Sand, Compost + FYM + top soil and Top soil +Sand). The result of the study showed in most cases all the studied growth parameters were significantly higher in pot treated by compost +FYM + top soil and control treatment was significantly reduced the all the plant growth parameter. Accordingly, the tallest and lowest plant height was recorded from variety Melka shote and Local variety respectively. Also the study revealed that higher significant ($p<0.05$) interactions between potting media and varieties on days to 50% flowering, days to 50% fruit set, days to 50% fruit maturity, days to first harvest, mean number of flowers per plant, mean number of primary branches, number of fruit per plant, number of seed per fruit, pericarp thickness, fruit length and fruit diameter. As a result, the earliest variety to attain days to 50% flowering, days to 50% fruit set and days to 50% fruit maturity and also days to first harvest was recorded from Mareko Fana in PM4. The highest number of fruits per plant was from Melka Shote with mixture of PM4, while Mareko Fana was the highest fruit weight per hak and number of seed per fruit in the potting media of PM4. Similarly, the longest, widest, thickest fruit size and highest cost benefit ratio was attained from Mareko Fana with in PM4. In addition, Mareko Fana were highly preferred and accepted by consumers and this may be attributed to its high quality, larger fruits size and diameter. As results from the study revealed, PM4 could be successfully used to obtain better growth, yield and quality of hot pepper. However, further testing is required in different locations on different potting media.

Keywords: Hot Pepper, Potting Media, Yield, Quality, Compost, FYM, Top Soil

1. Introduction

Hot pepper (*Capsicum annuum* L.) is a member of the Solanaceous family. The genus *Capsicum* is the second most important vegetable crop of the family after tomato in the world [31, 5]. *Capsicum* originated from tropical America; Peru and Mexico and spread to Europe where it grows as a shrub. From here, it spread to other parts of the world such as African, Caribbean and Pacific countries. Hot pepper is produced in all continents of the world except Antarctica, and is historically associated with the voyage of Columbus [16].

Hot pepper is an important agricultural crop, not only because of its economic importance, but also due to the nutritional and medicinal value of its fruit. The fruit is an excellent source of natural colours and antioxidant compounds whose intake is an important health protecting

factor by prevention of widespread human diseases. Pepper fruit is consumed as a fresh vegetable or dehydrated for use as a spice after changing to powder. Its consumption is increasing and may be an important source of vitamins for world population. The antioxidant vitamin A, C and E are present in high concentrations. Peppers are warm season crops that do best with a long, frost-free season to produce good quality and high yields [4].

Hot pepper is part of the daily diet of most Ethiopian societies. The average daily consumption of hot pepper by Ethiopian adult is estimated to be 15g, which is higher than tomatoes and most other vegetables [24]. It is used as spice in the preparation of soup and stew. In spite of its importance, the hot pepper production system for green and dry pod has stayed as low input and low output with the average marketable yield in state farms was 0.3 - 0.9 t/ha whereas under research condition 1.8-2.5 t dried pepper /ha and 15 - 20 t/ha green pepper [22]. Total production area under the crop is 10,284.52 and 147,216.20 hectares for Green and Red peppers respectively while the total production 11, 706.03 and 26,960.53 (tones) of green and red respectively [7].

Lack of improved, good quality and well adapted varieties, nutrient depletion (poor soil fertility), inappropriate fertilizer utilization (due to an increase in the price of fertilizers), poor agronomic practices [10]. Zekarias S. [39] reported that unimproved local varieties, namely Mareko (in Omo Nada) and Kolesh (in Gojeb) are used in southwest Ethiopia and yet characterized by low productivity and poor product quality. Availability of varieties with high productivity and quality for green and dry pepper that are widely adaptable and resistant/tolerant to major diseases and insect pests were lacking.

Previous studies showed that growth, crop yield and quality production in growing medium depend on the plants species as well as the types and amount of organic amendments being applied such poultry manure, animal waste, and use of compost or with the inorganic fertilizers [1, 18, 17].

Throughout the world, the raw materials used vary based on their availability, cost and social acceptance [34]. Cattle manure, compost, coir dust, sand or gravel, peat, vermiculite, perlite, sawdust are normally used materials for preparation of growing media mixtures. Among these, cattle manure, Compost, sand and sawdust are locally available in study area and user-friendly cheaper organic manures and those materials contain certain amount of major nutrients (N, P and K). organic manure plays a direct role in plant growth as a source of nutrients and improving physical, chemical and biological properties of soils with a positive effect on root growth. Therefore, selecting the effective organic material used as mixture for plant production is very important for sustainable agriculture production.

Therefore, selecting the best growing media between the various materials is imperative for pepper productivity to provide sufficient food demanded. In addition to this, the present situation indicates that in study area there is need to more research work on evaluation of hot pepper, which enables growers to select best performing varieties in the different potting media. Therefore, evaluation of selected varieties for their agronomic performance is one of the considerations to ease the existing problems of obtaining best adaptable varieties for which the output of the study will likely to assist and sensitize hot pepper growers.

2. Materials and Methods

2.1. Description of the Study Area

Study was carried out during 2016/2017 growing season at Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) inside an experimental greenhouse. Jimma University College of Agriculture and Veterinary Medicine (JUCAVM) is situated 356 km to South west of Addis Ababa. The College is located at 7°42" N latitude and 36°50" E longitudes and at an altitude of 1710 m.a.s.l. The mean maximum and minimum temperatures are 28.9°C and 11°C respectively. The mean annual rainfall recorded is above 1500 mm. The soil texture is well drained clay loam to silt clay [6]. The experiment was performed under natural ventilated greenhouse condition with an area of 99m^2. Average of day and night temperatures in greenhouse was 30°C and 20°C, respectively and maximum and minimum relative humidity were 78% and 50% respectively.

2.2. Experimental Material

2.2.1. Potting Media

Five different growing media types consisting of top soil alone, FYM + top soil + sand, Compost + top soil + sand, Compost + FYM + top soil, and top soil + sand intentionally blended from Compost, FYM, topsoil and Sand were used for the study. Compost made from coffee husk, vegetable waste and sawdust, FYM made from decomposed cow dung and poultry manure, top soil from field (production field) and sand used (construction sand). They were combined in different ratios to up five potting media as shown in Table 1.

Table 1. *Different potting media and their ratio.*

Trt	Potting media	Ratio of media
1	Top soil	Solo
2	FYM + Top soil + Sand	1:1:1
3	Compost + top soil + Sand	1:1:1
4	Compost + FYM + top soil	1:1:1
5	Top soil +Sand	2:1

2.2.2. Potting Media Analysis

The potting media was analyzed in order to study the nutritious status of the media such as nitrogen and phosphorus, and same important chemical property inside the media such as pH and EC. Potting media sample was air dried and ground to pass through 2 mm sieve for analysis. Total nitrogen was measured. Available phosphorus was extracted using Bray No 1 solution and the phosphorus in the extract was assayed calorimetrically by the molybdenum blue method. For determination of pH and EC, each 100 g of substrate was

added only enough distilled water to wet the sample to saturation, shaken for 15 min and left for 60 min and was filtered before the measurements were made using pH meter and EC meter. The result of the analysis is shown in Table 2.

Table 2. *Nutrient and chemical characteristic of different substrates.*

Parameter	Compost	FYM	Top soil	Unit
pH	7.8	7.98	6.68	
EC	2.12	3.78	0.38	dS/m
Total N	2.03	1.67	1.13	%
Available P	4533	3848	687	mg/Kg
Organic mater	40.58	33.33	26.26	%

2.2.3. Planting Materials

All hot pepper varieties excluding the local variety were collected from Melkasa Agricultural Research Centers. The varieties used were Mareko Fana, Melka Shote, Melka Awaze and local variety. Local variety obtained from Jimma market (Bishishe). Seeds were sown in September 2016 on a seed tray that contains seventy seedlings per tray. The seed tray was covered with mulch for 15 days. Watering was done with a fine water can, and was hand weeded practice for weed management. Other pertinent agronomic and horticultural practices applicable to hot pepper were also followed in the greenhouse.

Table 3. *Hot pepper varieties used for the study.*

Variety	Year of Release	Adaptation m.a.s.l	Temperature (°C) Max & min	Rain Fall (mm)	Seed Source	Maintainer
Mareko Fana	1976	1400-2200	20/29	600-1337	MARC	MARC
Melka Awaze	2006	1000-2200	15/28	900-1300	MARC	MARC
Melka Shote	2006	1000-2200	15/27	900-1300	MARC	MARC

Source: [26, 28].

2.3. Experimental Method

To evaluate potting media on pepper productivity, a pot experiment was conducted during 2016/2017 in plastic pots having five-liter volume of pot was selected and Media mixed well. The four hot pepper varieties including the local check was sown in seed trays of 72 cells per seed tray evaluate under different potting media. The growing media was analyzed for nutrient, PH and EC content of the media, the mixture of media was filled into pot until 5cm from the top. Only one seedling was transplanted into each pot. The plants were irrigated with water can three times per weeks and irrigated when required depend up on weather condition. The growth parameters: plant heights, stem diameter and leaves number were recorded on 1, 2, 3 and 4 MAT and selected yield and quality parameters was done at allowed time for data collection.

2.4. Experimental Design

As depicted below (Table 4) in total, there were twenty treatment combinations (five potting media mixes combined with four varieties). The five potting media mixtures consisted of top soil, FYM + top soil + Sand, Compost + top soil + Sand, Compost + FYM + top soil, and top soil +Sand. While the four varieties were comprised of Mareko Fana, Melka Shote, Melka Awaze and Local variety of pepper. The study was laid out in 5×4 factorial experiment in Randomized Complete Block Design with twenty treatments in three replications. Pots were placed randomly in the greenhouse and transplanting was done when the seedlings attained 20 to 25 cm height and or at 45 days after sown. Each treatment contained three pots, each replication contained sixty pots and each pot contained one plant and totally one hundred eighty pots in the study.

Table 4. *Details of treatment combinations.*

Varieties	Potting Media				
	PM1	PM2	PM3	PM4	PM5
V1	V1 PM1	V1 PM2	V1 PM3	V1 PM4	V1 PM5
V2	V2 PM1	V2 PM2	V2 PM3	V2 PM4	V2 PM5
V3	V3 PM1	V3 PM2	V3 PM3	V3 PM4	V3 PM5
V4	V4 PM1	V4 PM2	V4 PM3	V4 PM4	V4 PM5

PM1 = Top soil PM2 = FYM + Top soil + Sand PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil PM5 = Top soil +Sand V1 = Mareko Fana V2 = Melka Shot V3 = Melka Awaze V4= local variety.

2.5. Management Practices

As to other agronomic practices, water was applied twice per day to the transplants using watering can to facilitate plants establishments. Then based on the environmental conditions watering was done three times a week afterwards. Hand weeding was done frequently as per the emergence of the weeds. Plant protection was part of plant management and the Incidence of pests was minimal hence was controlled manually. Aphids have been occurred during the early seedling establishments and flowering stage on few varieties.

2.6. Data Analysis

For each measured response variables, analysis of variance (ANOVA) mean separation procedure was carried out. The classical fixed effect analysis of variance model that includes the main effects of potting media, varieties together with interaction effects of potting media and varieties were used. The ANOVA model used for the analysis was:

$$Yij=\mu+Vi+Lj+(VL)ij+\varepsilon ij$$

Where, *Yij*= the mean value of the response variable of the With variety at the j^{th} potting media and the right hand side of the equation gives the grand mean value (μ) and the respective main and interaction effects of varieties and potting media. *εij* is a random error term due to those uncontrolled factors.

After fitting ANOVA model for those significant interactions or main effects a mean assumption procedure using LSD mean methods were carried out at required levels of probability. Simple correlation analysis between different characters was also computed to observe associations between characters. In order to assess the associations between those measured response variables a Pearson correlation procedure was carried out. All the statistical analysis was carried out using SAS-9.1 statistical software package.

3. Results and Discussion

The analysis of variance indicated significant difference between growing media and among different tested hot pepper varieties and there was also interaction effect with respect to vegetative growth, yield and quality parameters. Hence, the results are presented and discussed here below.

3.1. Phenology and Growth Parameters

3.1.1. Plant Height (cm)

Significant difference was observed between potting media and varieties at ($p<0.05$) based on the selected parameters, but there was not interaction effect of potting media with varieties (Table 5). The tallest plant height was recorded from Compost + FYM + Top soil was found to be significantly superior over other treatments in respect of plant height at all the stages. Whereas, the least plant height was recorded from control treatment (top soil). Accordingly, the tallest plant height was recorded from variety Melka shote (30.11, 43.88, 60.55 and 85.33^{c} mat 1, 2, 3 and 4 MAT respectively) whereas, the shortest plant height was attained from Local variety (22.38, 27.33, 34.72 and 49.5cm respectively). Pepper plants increased in size with time such that most of the growth occurred between 3 and 4 MAT.

The increase in plant height could mainly be due to better aeration, water holding and availability of nutrients in the growing media, especially Nitrogen and Phosphorus which have enhancing effect on the vegetative growth of plants by increasing cell division and elongation and the varietal variability to absorb the nutrients from the soil [38, 9]. The result of this study confirms the finding of [12] who reported that organic manure and inorganic fertilizer supplied most of the essential nutrients at growth stage resulting in increase of growth variables including plant height.

Table 5. *Mean values of plant height as affected by potting media with variety in 2016/17.*

Treatment	Plant height at 1mat	Plant height at 2mat	Plant height at 3mat	Plant height at 4mat
Variety				
MF	27.59^{ab}	37.05^{ab}	49.99^{b}	66.34^{b}
MS	28.19^{a}	38.54^{a}	52.79^{a}	73.89^{a}
MA	26.58^{b}	36.19^{b}	46.36^{c}	63.08^{bc}
LV	26.22^{b}	35.79^{b}	44.85^{c}	61.92^{c}
LSD (0.05)	1.57	1.99	2.74	4.0
Potting media				
PM1	24.09^{c}	31.19^{e}	38.5^{e}	53.12^{d}
PM2	26.64^{b}	36.47^{c}	50.86^{c}	67.6^{b}
PM3	28.80^{ab}	40.0^{b}	54.36^{b}	72.19^{ab}
PM4	30.18^{a}	42.73^{a}	57.65^{a}	76.05^{a}
PM5	24.18^{c}	33.99^{d}	41.14^{cd}	62.58^{c}
LSD (0.05)	1.7	2.0	3.0	4.5
CV (%)	7.9	7.33	7.64	8.25

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand. MF = Mareko Fana MS = Melka Shot MA = Melka Awaze LV= local variety. MAT = month after transplant.

3.1.2. Stem Diameter (cm)

Stem diameter at 1, 2, 3 and 4 months after transplant Significant difference was observed between growing media and varieties at ($p<0.05$) based on the selected parameters, but there was not interaction effect of growing media with varieties (Table 6). Among the treatments Compost + FYM + Top soil was found to be significantly superior over other treatments in respect of stem diameter at all the stages whereas, control treatment (top soil) was the leaststem diameter recorded. Accordingly, the wideststem diameter was recorded from variety Melka shote (0.36, 0.6, 0.73 and 0.9^{c} mat 1, 2, 3 and 4 MAT respectively) whereas, the least stem diameter was attained from Local variety (0.2, 0.34, 0.35 and 0.47^{c} mat 1, 2, 3 and 4 MAT respectively).

The increase in the stem diameter of Melka Shote due to the genetic make-up of the varieties or direct role in plant nutrition in potting media that increase the height and stem diameter of the crop proportionally. the result agree with [31] also reported similar findings by indicating that taller heights were positively correlated with thicker stem girths in pepper cultivars. increase in stem width often accompanied increase in height and caused a reduction in lodging.

Table 6. *Mean values of stem diameter as affected by potting media with variety in 2016/17.*

Treatment	stem diameter at 1mat	stem diameter at 1mat	stem diameter at 1mat	stem diameter at 1mat
Variety				
MF	0.27[a]	0.44[a]	0.54[ab]	0.69[a]
MS	0.28[a]	0.44[a]	0.56[a]	0.69[a]
MA	0.24[b]	0.40[b]	0.51[b]	0.61[b]
LV	0.23[b]	0.38[b]	0.51[b]	0.59[b]
LSD (0.05)	0.02	0.03	0.034	0.05
Potting media				
PM1	0.22[c]	0.34[d]	0.42[c]	0.52[c]
PM2	0.25[b]	0.39[c]	0.54[b]	0.69[b]
PM3	0.29[a]	0.48[b]	0.64[a]	0.75[ab]
PM4	0.31[a]	0.53[a]	0.66[a]	0.76[a]
PM5	0.21[c]	0.32[d]	0.39[c]	0.51[c]
LSD (0.05)	0.024	0.03	0.04	0.06
CV (%)	11.37	8.	8.8	11.0

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand. MF = Mareko Fana MS = Melka Shot MA = Melka Awaze LV= local variety. MAT = month after transplant.

3.1.3. Number of Leaves Per Plant

Significant difference was observed between potting media and varieties at ($p<0.05$) based on the selected parameters, but there was not interaction effect of potting media with varieties concerning number of leaves. The data on number of leaves at different stages 1, 2, 3 and 4 months after transplant of crop growth as influenced by growing media and variety are shown in (Table 7). Among the treatments Compost +FYM +Top soil was found to be significantly superior over other treatments in respect of number of leaves at all the stages. Whereas, control treatment (top soil) was the least number of leaves recorded. Accordingly, the highest number of leaves was recorded from variety Melka Shote (9, 42.33, 95.55 and 195.94 at 1, 2, 3 and 4 MAT respectively). Whereas, the smallest number of leaves was attained from Mareko Fana (7.11, 17.22, 33 and 71.88 at 1, 2, 3 and 4 MAT respectively). Law-Ogbomo KE et al. [20] reported that uptakes and utilization of applied fertilizers significantly enhanced number of plant leaves. The enhancement in the number of leaves by organic matter application was a precursor to greater amount of assimilate and thus allowing more translocation to the berry. Changes in number of leaves are bound to affect the overall performance of the plant as the leaves serves as the photosynthetic organ of the plant. Increase in number of leaves leads to better utilization of solar radiation [20].

Increase in the number of leave in Melka Shote due to the genetic make-up of the varieties or direct role in plant nutrition in potting media, the result also agree with [19] who reported that organic manure having high nitrogen that improve the vegetative growth and make the nutrient available to the plant under stress condition. In addition, [27] reported that organic manure has been found to enhance the number of leaves in lettuce by providing sufficient amount of nutrients that accelerate the growth of leaves.

Table 7. *Mean values of Number of leaves as affected by potting media with variety in 2016/17.*

Treatment	Leaves number at 1mat	Leaves number at 2mat	Leaves number at 3mat	Leaves number at 4mat
Variety				
MF	7.82[b]	22.33[b]	45.11[c]	101.38[b]
MS	10.5[a]	29.19[a]	64.06[a]	149.26[a]
MA	10.48[a]	28.48[a]	60.30[a]	135.89[a]
LV	8.44[b]	23.49[b]	52.241[b]	120.64[b]
LSD (0.05)	0.9	3.94	5.06	23.19
Potting media				
PM1	8.25[b]	18.33[c]	35.45[c]	88.19[b]
PM2	8.58[b]	23.8[b]	60.30[b]	135.89[a]
PM3	10.55[a]	32.30[a]	69.72[a]	160.94[a]
PM4	11.58[a]	35.72[a]	74.27[a]	161.29[a]
PM5	7.60[b]	19.13[c]	37.37[c]	102.11[b]
LSD (0.05)	1.04	4.4	5.65	25.93
CV (%)	13.55	20.65	12.36	24.23

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand. MF = Mareko Fana MS = Melka Shot MA = Melka Awaze LV= local variety. MAT = month after transplant.

3.1.4. Leaf Area (cm^2)

Significant difference was observed between potting media and varieties at ($p<0.05$) based on the selected parameters, but there was not interaction effect of potting media with varieties (Figure 1). The statistical analysis of the data showed that potting media and Variety was significantly affect leaf area. Among the treatments, Compost +FYM + top soil was found

to be significantly over other treatments in respect of leaf area. Whereas; control treatment (top soil) was the least leaf area recorded. Accordingly, the highest leaf area (38.12cm^2) was recorded by Mareko Fana. While, the lowest leaf area (34.12cm^2) was recorded with Melka shote. However, as this indicated, the highest leaf area did not commensurate the number of leaves. Because Mareko Fana had the highest leaf area but it had the smallest leaf number and Melka shote had highest number of leaf but recorded smallest leaf area in the study due to small size.

Accordingly, The highest leaf area was recorded in the treatment could be due to genetic make-up of the varieties or efficient nitrogen availability in potting media, as a result the plant uptake more nitrogen and in turn larger leaves were observed. The results also agreed with the [9]. They studied that manure influenced growth, yield and nutritional quality of containerized aromatic pepper. They concluded that the manure increased the leaf area due to sufficient nitrogen availability, which in turn improves the vegetative growth of the crop these finding are also confirmed by [36] who found greater leaf area with the application of poultry manure.

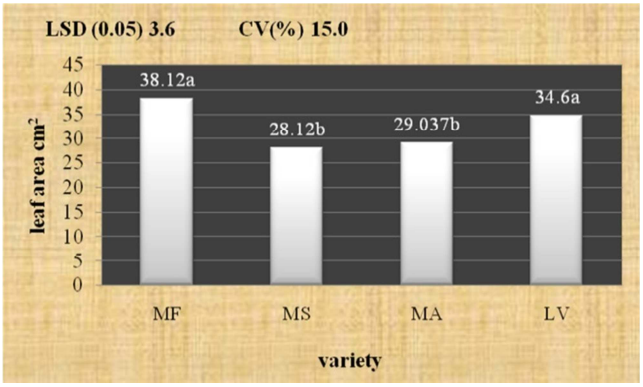

Figure 1. *Effect of potting media on leave areas of hot pepper varieties.*

3.1.5. Number of Primary Branches

The interaction effect of potting media by variety for the number of primary ($p<0.05$) indicated significant variations between hot pepper varieties and potting media (Table 8). The highest number of primary branches were attained from variety Melka shote (10.0) in Compost + FYM + Top soil. Whereas, the least number of primary branches was recorded from local Varity (3.33) in Top soil.

Number of branches of pepper is significantly affected by potting media and variety. Pepper growing on amended soil performed better than the plant on the control treatment. This shows that Organic manure to the media was readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plant. This support the findings of [21] who reported that number of branches associated with various soil amendments were at par and significantly different from control.

Generally, the differences observed in branching of pepper plants might have been due to genetic variations existed between varieties and or due to favorable influence of organic nutrients present in the media and media water holding capacity or the growing environment which goes in line with the findings of [9] that stated the presence of adequate amount of organic nutrients in the soil improves growth of pepper plants. Organic nutrients increase the biomass of pepper plants, as supported by report of Johnson and [29] who observed similar effects by application of different levels of organic manure into the hot pepper growing soils.

3.1.6. Days to 50% Flowering

Interaction effect of potting media by varieties on days to 50% flowering showed significant ($p<0.05$) under this study (Table 8). An earliest day to reach 50% flowering was observed from variety Mareko Fana (52.33 days) inCompost + FYM + Top soil. While, the longest days to attain 50% flowering was recorded from Melka Awaze (74 and 73.33 days) in Top soil and Top soil + sand respectively.

The Earliness or lateness in the days to 50% flowering of pepper to different sources of potting media might be due to acceleration of the vegetative phase through the simulative effect of the absorbed nutrients on photosynthesis process which certainly reflected positively on both vegetative and flowering initiation. The longest day to flowering was as a result of insufficient P and K. [9] reported that a deficiency of major nutrients results in longer days to flowering. Fe, Zn and Mn encourages vegetative growth, total chlorophyll and the photosynthetic rate of plants which enhance flowering and fruiting thus leading to an increase early flowering and fruit maturity.

Table 8. *Mean values of number of primary branch and days to 50% flowering affected by the interaction of potting media with variety in 2016/17.*

Potting media	Number of Primary branch				Days to 50% Flowering			
	Mareko Fana	Melka Shote	Melka Awaze	Local variety	Mareko Fana	Melka Shote	Melka Awaze	Local variety
PM1	4.0^{ef}	7.0^{cd}	3.66^{ef}	3.33^{ef}	71.3^{abc}	73.0^{ab}	74.0^{a}	70.0^{abcd}
PM2	5.0^{ef}	9.33^{ab}	4.33^{ef}	3.66^{ef}	64.0^{ef}	70.3^{abcd}	72.7^{ab}	66.3^{bcde}
PM3	7.66^{bc}	9.66^{ab}	4.0^{ef}	4.66^{ef}	60.7^{f}	68.0^{bcde}	71.3^{abc}	65.7^{def}
PM4	9.33^{ab}	10.0^{a}	5.0^{ef}	5.33^{de}	59.3^{f}	68.0^{bcde}	69.33^{abcde}	62.0^{f}
PM5	4.66^{ef}	7.33^{c}	3.66^{fe}	4.0^{ef}	70.0^{abcd}	70.3^{abcd}	73.3^{ab}	69.0^{abcde}
LSD (0.05)		2.12				5.9		
CV (%)		4.11				5.2		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand MF = Mareko Fana MS = Melka Shot MA = Melka Awaze LV= local variety.

3.1.7. Number of Flowers Per Plant

Interaction effect of potting media by varieties on number of flowers showed significant ($p<0.05$) under this study (Table 9). Accordingly, the highest number of flowers per plant was recorded from variety Melka shote (113.55) with Compost + FYM + Top soil. Whereas, the least numbers of flowers per plant was also observed from the local variety (38.66) with top soil. This result is in agreement with the work of [35]. He reported that the highest number of flowers per plant was recorded from variety Melka Shote (159.67).

These variations could be due to the lack of optimum soil moisture at the time of flowering nutrient content of the media. But, as this indicated, the number of flowers did not commensurate the number of fruits per plant. Moreover, the primary cause of poor flowering and fruit set as well as marketable yield loss could be due to the physical and chemical property of the mixed media, diseases, High temperature flowering in decreasing effective pollination that resulting in loss of potential fruit, frost causes flower and fruit damage and loss of yield.

3.1.8. Days to 50% Fruit Set

Interaction effect of potting media by varieties days to 50% fruit set showed highly significant ($p<0.05$) under this study (Table 9). There were significant effect of potting media and variety interactions for number of days to 50% fruit set. Mareko Fana with Compost + FYM + Top soil was recorded the shortest time to achieve 50% fruit set (73.66 days). While, Melka Awaze with Top soil and Top soil + sand was taken (88.66 days) the longest time to achieve 50% fruit set. The earliness or lateness in the days to 50% fruit set could be due to their inherited characters and the early adaptation to the growing media to enhance their growth and development. This agrees with report of [35] also observed that earliness to flowering and fruiting is related to variety differences.

Table 9. *Mean values of number of flowers per plant and days to 50% fruit set as affected by the interaction of potting media with variety in 2016/17.*

Potting media	Number of flowers per plant				Days to 50% fruit set			
	Mareko Fana	Melka Shote	Melka Awaze	Local variety	Mareko Fana	Melka Shote	Melka Awaze	Local variety
PM1	42.38^{de}	45.9^{cde}	52.5^{cde}	38.66^{e}	$85.0b^{cd}$	92.0^{a}	88.7^{ab}	86.0^{bcd}
PM2	50.05^{cde}	97.99^{a}	78.2^{b}	56.8^{bcde}	84.66^{bcd}	85.7^{bcd}	86.7^{bcd}	83.66^{def}
PM3	57.1^{bcde}	113.0^{a}	99.5^{a}	73.9^{b}	76.66^{g}	86.0^{bcd}	87.33^{bcd}	80.0^{efg}
PM4	75.7^{b}	113.55^{a}	107.1^{a}	74.9^{b}	73.66^{g}	84.0^{cde}	85.33^{bcd}	79.33^{fg}
PM5	45.5^{cde}	61.7^{bcd}	66.3^{bc}	46.0^{cde}	85.3^{bcd}	87.0^{bcd}	88.66^{ab}	87.0^{bcd}
LSD (0.05)		8.87				1.82		
CV (%)		16.26				2.75		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand.

3.1.9. Days to 50% Maturity

Interaction effect of potting media by varieties days to maturity showed significant ($p<0.05$) under this study (Table 10). The highest and lowest days to maturity were recorded in Melka Awaze and Mareko Fana respectively. Melka Awaze was late matured (137 days) in Top soil. While, Mareko Fana was early matured varieties (95.66 days) in Compost + FYM + Top soil.

This variation ascribed to the differences due to sufficient amount of nutrients in the growing media and/or genetic make-up of the varieties. This agrees with the report of [35]. Moreover, this finding was in agreement with [14] who reported that days to maturity were significantly affected by pepper varieties. However, this result was in contrary to the finding of [37] who reported those days to maturity was not significantly different due to varieties.

3.1.10. Days to First Harvest

The interaction effect of potting media by varieties indicated significant variation ($p<0.05$) on hot pepper (Table 10) on days to first harvest. Accordingly, the shortest number of days to first harvest was recorded from variety Mareko Fana (99.66 days) with in Compost + FYM + Top soil. The longest day to attain days to first harvest was recorded from variety Melka Awaze (138 day) in control treatment (Top soil). Which is in line with the works of [26] that reported cultivars like Melka Awaze are later than others to mature.

Table 10. *Mean values of Days to 50% maturity and days to first harvests affected by the interaction of potting media with variety in 2016/17.*

Potting media	Days to 50%maturity				days to first harvest			
	Mareko Fana	Melka Shote	Melka Awaze	Local variety	Mareko Fana	Melka Shote	Melka Awaze	Local variety
PM1	108.3^{efg}	122.0^{ab}	137.0^{a}	112.66^{cde}	112.3^{gh}	129.0^{b}	138.7^{a}	117.0^{ef}
PM2	104.7^{g}	115.7^{c}	130.0^{b}	109.0^{def}	106.7^{h}	122.7^{cd}	136.7^{a}	114.7^{fg}
PM3	97.7h	114.0^{cd}	128.0^{b}	107.33^{g}	101.7^{i}	121.0^{cde}	135.7^{a}	112.3^{gh}
PM4	95.7^{h}	116.0^{c}	124.7^{ab}	105.0^{g}	99.7^{i}	121.7^{cde}	134.7^{b}	110.0^{h}
PM5	106.7^{fg}	117.0^{c}	135.0^{a}	114.33^{cd}	110.6^{gh}	125.0^{cb}	136.7^{a}	119.0^{def}
LSD (0.05)		2.02				2.21		
CV (%)		2.22				2.35		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand.

The variations in days to first harvest (maturity) could be due to the genetic make-up of the varieties and/ or due to the sufficient amount of nutrients in potting media and due to less weed competition that result in early maturity of the crop. These finding are confirmed by [36] who studied that Swiss chard crop treated with organic manure take less time to harvest due to nutrients availability, improve organic status and electrical conductivity of the soil that result in rapid maturity of the crop.

3.2. Yield Parameters

3.2.1. Number of Fruits Per Plant

Results of analysis of variance indicated highly significant interaction ($p<0.05$) among the potting media and varieties in terms of number of fruits per plant (Table 11). Variety Melka Shote had the highest number of fruits (60.99) in Compost + FYM + Top soil. While, the least number of fruits per plant was recorded from local variety (25.5) in both Top soil and top soil + sand.

The variations in fruit yield might be due to the influence of the growing media, associated with traits like canopy diameter that could limit the number of branches. Because, as a number of primaries, secondary and tertiary branches increased, there could be a possibility of increasing the number of fruit producing buds, which are the locations for fruit production. Moreover, the variations in fruit development among potting media and varieties could also be due to the nutrient availability of the growing media and the capability of each variety to with stand the stress especially on the reproductive development stage than vegetative development. differential in yields of crops could be attributed to the choice of cultivar grown and its specific genetic make-up and effects of nutrient sources on number of fruits per plant. The increase in number of fruits could be also attributed to the ability of nutrient sources to promote vigorous growth, increase meristematic and physiological activities in the plants due to supply of plant nutrients and improvement in the potting media properties, thereby, resulting in the synthesis of more photo-assimilates, which is used in producing fruits [2].

3.2.2. Fresh Fruit Yield (g)/Plant

Interaction effect of potting media by variety showed highly significant difference ($p<0.05$) on fresh fruit Yield (g)/plant (Table 11). The heaviest fruit weight (313.56g/p) was recorded in Mareko Fana with in Compost + FYM + Top soil. The next heaviest fruit weight (311.43 g/p) was recorded in Melka shote in Compost + FYM + Top soil. The lightest fruit weight (148.7 g/p) was recorded for the Melka Awazewith in Top soil. The more number of fruit is not commensurate that the heaviest weight. Because, Mareko Fana had lower fruit number per plant than Melka shote, but it had wider fruit diameter and longest length. Melka shote was high number fruits producing varieties in terms of green fruit yield performance. However, these varieties are characterized by narrower in diameter and shorter in length than Mareko Fana.

The result implies that the better growing media content of organic nutrient, the better the fruit setting characteristics of the plant with well-developed larger sized fruits as their content is directly related with the amount of nutrients taken from the media. This study is in conformity with the work of [15, 13] who reported that pod dry matter content of peppers was directly related to the amount of nutrient taken from the soil, which was proportional to the nutrients present in the soil or the amount of organic and inorganic fertilizers applied to the soil.

Table 11. *Mean values of Number of fruit per plant and Fresh fruit weight (g)/ plant as Affected by the interaction of potting media with variety in 2016/17.*

Potting Media	Number of fruit per plant				Fresh fruit weight (g)/ plant			
	Mareko Fana	Melka Shote	Melka Awaze	Local variety	Mareko Fana	Melka Shote	Melka Awaze	Local variety
PM1	26.7 ^{hi}	34.8^{cdefg}	30.5^{efghi}	25.5^{i}	189.8^{ghi}	196.5^{hi}	148.7^{i}	191.7^{ghi}
PM2	30.7^{fghi}	51.7^{b}	37.3^{cde}	32.7^{defgh}	290.86^{b}	244.66^{cd}	209.6^{cde}	242.6^{cd}
PM3	38.6^{cdef}	59.4^{a}	49.3^{b}	37.6^{cd}	305.56a	301.63^{ab}	231.86	246.8^{cd}
PM4	40.99^{c}	60.99^{a}	50.3^{b}	40.2^{c}	313.56a	311.43^{a}	258.43^{c}	266.6^{c}
PM5	29.5^{ghi}	37.3^{cde}	32.99^{defgh}	25.5^{i}	192.06^{ghi}	205.9^{cde}	177.8^{hi}	200.0^{cde}
LSD (0.05)		2.84				10.29		
CV (%)		9.39				7.83		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand.

3.2.3. Fresh Fruit Yield (kg/ha)

A highly significant ($p<0.05$) interaction effect was observed on total fresh yield kg/ha (Table 12). Accordingly, the highest total fresh fruit yield (10961.89kg/ha) was recorded from Mareko Fana with in Compost + FYM + Top soil. While, the least total fruit yield kg/ha was recorded from Melka Awaze (5652.38 and kg/ha) in top soil. The variations in total fruit yield between the variety points to the fact that fruits with larger sizes tend to possess more weight than those with smaller sizes. The differences among treatment may be due to varietal differences in nutrient absorption efficiency, especially nitrogen and phosphorus which have enhancing effect on vegetative growth by increasing cell division and elongation thereby create the possibilities of flowering and fruit bearing [9]. The other decisive factor is also the ability to adapt the existing environmental factors; such as soil type [11].

On the other hand, the increase in total fruit yield could be due to variation in plant height, as well as formation of more

primary, secondary and tertiary branches that increase potential of pods bearing buds and also leaf area that maximizes photosynthetic capacity and assimilate partitioning to the pods. This result is further consolidated by the findings of [33] who reported positive impact of vegetative growth up on yield and yield components of hot pepper. Benson GAS et al. [4] also pointed out that primary and secondary branches were locations of fruit buds and thus foundations of new fruit bud development in bell peppers. Their report is in conformity with the present result, consolidating the role of branches in determining pepper total pod yield.

3.2.4. Number of Seeds Per Fruit

Interaction effect of potting media by variety showed a highly significant difference ($p<0.05$) on number of seeds per pods (Table 12). The highest number of seeds was recorded from Mareko Fana (160.67) in Compost + FYM + Top soil. Whereas, the least numbers of seeds were recorded from Melka Awaze (46.38) in top soil. Pepper plants that exhibited high vegetative growth due to effects of treatments have gained high leaf area, increased photosynthetic capacity and assimilate partitioning that resulted large pod size and hence in greater seed number per pod and large pod size. This result is in line with [25, 23] who pointed that seed number per pod is one factor that determine pod size. They observed a linear increase in individual fruit size and weight with seed number. Furthermore, this report is consistent with that of [32, 3] who observed positive relationship between seed number and pod size, where fruit weight increased linearly with seed number in sweet pepper.

Table 12. *Mean values of Fresh Fruit Yield (kg/ha) and Number of Seed per fruit as affected by the interaction of potting media with variety in 2016/17.*

Potting media	Fresh Fruit Yield (kg/ha)				Number of Seed per fruit			
	Mareko Fana	Melka Shote	Melka Awaze	Local variety	Mareko Fana	Melka Shote	Melka Awaze	Local variety
PM1	6498.4^{gh}	5717.5^{h}	5652.4^{gh}	6309.5^{gh}	107.1^{dc}	65.2^{ef}	55.99^{f}	96.7^{d}
PM2	10188.9^{ab}	8471.4^{de}	6761.9^{fg}	8584.1^{d}	125.8^{b}	68.9^{ef}	67.7ef	106.8^{cd}
PM3	10707.9^{a}	9646.0^{bc}	7547.6^{ef}	8704.8^{cd}	127.99^{b}	72.4^{e}	66.9^{ef}	118.7^{bc}
PM4	10961.9^{a}	10741.3^{a}	8901.6^{cd}	9238.1^{cd}	152.9^{a}	78.3^{e}	70.9e	119.9^{bc}
PM5	6995.2^{fg}	5993.6^{gh}	6292.5^{gh}	6192.1^{gh}	108.0^{dc}	67.3^{ef}	56.7^{f}	97.8^{d}
LSD (0.05)		489.95				7.58		
CV (%)		7.83				8.9		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand.

3.3. Quality Parameters (Physical Quality)

3.3.1. Fruit Length (cm)

A highly significant ($p<0.05$) interaction was observed between growing media and varieties in terms of their fruit length (Table 13). Consequently, the longest fruits were recorded from variety Mareko Fana (12.14cm), followed by Melka shote (10.23cm) in Compost + FYM + Top soil. The shortest length was recorded from Local variety (7.75cm) and followed by Melka Awaze (7.81) in top soil. The result is in line with the finding of [26] who reported that the longest (15cm) and the shortest (7cm) pod lengths recorded in the varieties Mareko Fanaand local variety respectively. The variation recognized was due to availability of organic matter in the growing media and the nutrient uptake efficiency of variety as compared with the remain three varieties. According to [38], nitrogen and phosphorus can increase fruit length. This result in agreement with [12] who also reported organic and inorganic fertilizers supplied most of the essential nutrients at growth stage resulting in increase of growth variables including fruit length. Delelegn S. [8] also reported that he determined significant variation of fruit length among varieties.

3.3.2. Fruit Diameter (cm)

A Highly significant ($p<0.05$) interaction effect of growing media with variety was recorded on fruit diameter (Table 13). The widest fruit was obtained from variety Mareko Fana (2.0), followed local variety (1.66) in Compost + FYM + Top soil, while the least fruit width was observed from Melka Awaze (0.9) in top soil. This result is in line with [26] who showed that variety Mareko Fana had a fruit diameter of 2 cm. The fruit width difference among varieties could be due to different dry matter partitioning ability of plants and the fertility status of the growing media.

3.3.3. Fruit Pericarp Thickness (mm)

The analysis of variance indicated a highly significant interaction effect of potting media with varieties ($p<0.05$) on fruit pericarp thickness (Table 13). The thickest pericarp (1.32) was observed from Mareko Fana in Compost + FYM + Top soil. On the other hand, the thinnest thickness was observed from Melka Awaze (0.11) in control treatment (top soil). These differences might be due to the fact that; the varieties assimilate partitioning capacity that might be resulted in thickest or thinnest fruit pericarp. larger onion bulbs were the result of the accumulation of high photosynthetic products and high photo assimilate partitioning ability of the crop that could be considered as one of the hot peppers' quality attribute among several factors. The results are also similar to those of [30] who reported larger fruits of bell pepper with thicker pericarp thickness, when grown in plastic tunnels with different growing media.

Table 13. *Mean values of fruit Length, fruit diameter and fruit pericarp thickness as affected by the interaction of potting media with variety in 2016/17.*

Potting	Fruit Length (cm)				Fruit Diameter (cm)				Fruit pericarp thickness (mm)			
Media	MF	MS	MA	LV	MF	MS	MA	LV	MF	MS	MA	LV
PM1	8.8^{cdef}	8.5^{efg}	7.8^{g}	7.9^{fg}	1.3^{cde}	1.02^{gh}	0.96^{gh}	1.34^{cde}	1.0^{ef}	0.7^{jk}	0.63^{j}	0.86^{fgh}
PM2	9.2^{bcde}	9.4^{bcd}	8.5^{efg}	8.4^{efg}	1.5^{abc}	1.1^{fgh}	1.05^{fgh}	1.4^{cd}	1.13^{cd}	0.8^{ghi}	0.66^{ij}	0.9^{fg}
PM3	9.5^{bc}	9.9^{b}	9.1^{bcde}	8.6^{efg}	1.6^{ab}	0.91^{g}	1.05^{fgh}	1.46^{bc}	1.31^{ab}	0.93^{fg}	0.73^{hij}	1.0^{ef}
PM4	11.1^{a}	9.94^{b}	8.7^{cdef}	8.6^{efg}	1.7^{a}	1.1^{efg}	1.12^{fg}	1.5^{abc}	1.35^{a}	1.2^{bc}	0.83^{gh}	1.06^{e}
PM5	9.1^{bcde}	8.8^{cdef}	8.3^{efg}	8.1^{fg}	1.4^{cd}	0.94^{g}	0.99^{gh}	1.23^{def}	1.1^{cde}	0.7^{ijk}	0.66^{k}	0.8^{fgh}
LSD (0.05)		0.39				0.09				0.83		
Cv (%)		5.85				9.7				18.3		

PM1 = Top soil, PM2 = FYM + Top soil + Sand, PM3 = Compost + Top soil + Sand PM4 = Compost + FYM + top soil, PM5 = Top soil +Sand.

4. Conclusions and Recommendation

The result of the study revealed that almost all of the parameters considered were significantly affected by the treatments or their interaction effects. There were variations between varieties for plant height, Stem diameter and leaf number at the different growth stages. Of the four varieties, Melka shote produced taller height, widest stem diameter and more leaf number plants at all growth stages (1, 2, 3 and 4 MAT) with incompost + FYM + top soil. Analysis of variances (ANOVA) revealed that differences in days to 50% flowering, fruiting set and maturity among varieties. Mareko Fanain potting media mixed with compost + FYM + top soil was decreased number of days taken to 50% flowering, fruiting set and maturity. Whereas, Days to 50% flowering, fruiting set and maturity increased in Melka Awaze with intop soil. The poor result obtained from the top soil (control) was an indication that no significant production could be made without correct of nutrient states, aeration and water holding capacity of the potting media.

There were significant interactive effects of varieties and potting media for mean number of fruit per plant, fresh fruit yield per plant, and total fruit yield per hectare. The highest number of fruit per plant was recorded from Melka Shote with in Compost + FYM + Top Soil and the highest fresh fruit yield per plant, and total fruit yield per hectare was recorded from Mareko Fana with in Compost + FYM + Top Soil, while the fresh fruit yield per plant and total fruit yield per hectare was obtained from Melka Awaze with in Top Soil. The variations in fruit number per plant is affected by the canopy architecture; because, as the number of branches increased, there might be a possibility of increasing the number of fruit producing buds which are the positions for fruit production. The variations in fruit weight and total fruit yield between the cultivars points to the fact that fruits with larger sizes tend to possess more weight than those with smaller sizes. Mareko Fana which produced 10961.89 yield kg/ha appeared to be better varieties in experimental site. The positive influence of potting media on the growth, yield and quality of the pepper might be due to the release of the balanced of nutrient contained, aeration and water holding of the media and or due to the heritable traits of these varieties.

Fruit length, fruit diameter, fruit pericarp thickness and number of seed exhibited significant difference for interaction effects of the potting media and varieties. The highest fruit length, fruit diameter, fruit pericarp thickness and number of seedwas recorded from Mareko Fana with in Compost +FYM + Top Soil, while the lowestfruit length, fruit diameter, fruit pericarp thickness and number was obtained from Melka Awaze within Top Soil. The variations were most probably the growing media suitable for the crop or being attributed to their inherited traits. In this research, we found a significant and positive correlation between the growth, yield and quality parameter.

However, this study demonstrates that Mareko Fana were highly preferred and accepted by consumers and this may be attributed to its high quality. While Melka Awaze has no consumer acceptance when compared with other variety, Moreover, the selection criteria of their yield include fruit size, Brightness and Glossiness as components of good quality, which was highly demanded under study area condition.

Finally, consumer demand for Mareko Fana is very high, since high quality fresh pepper is produced and available all year round compared to other variety. Furthermore, these varieties could be used for further research activities in different organic mix media. Based on findings obtained from the study maximum growth, yield and quality of pepper was observed in Compost + FYM + Top soil amended potting media. Moreover, Compost + FYM + Top soil potting media may be advised to obtain better quality and yield for hot pepper cultivars and plant nutrient sources for sustainable pepper cultivation in the study area. Although Compost + topsoil + sand have shown potential in sustainable crop production but further studies are required to determine the long-term effects of Compost + topsoil + sand application in field conditions. It appears to be worthy of considering further trials particularly: Different source of potting media evaluation in different potential areas of the zone using different varieties of hot pepper.

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