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Growth and Biomass production Response of Pineapple (*Ananas Comosus*) Seedling to Compost with Top Soil Ratio Nursery Media Preparation

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ABSTRACT

Pineapple production mainly lies on the production and supply of quality planting material with desirable root and shoot growth characteristics. Farmers in the South Ethiopia, uses different parts of pineapple like ground sucker, slips, and also crown sucker to transplant to the permanent fields. The fertilization practices were also not common, some farmers use to apply organic fertilizers like animal dung at the permanent field while there is no any media information generated to seedling production. Therefore, this study was conducted to determine the best soil growth media before transplanting to the field to raise the pineapple seedling at the nursery stage at Awada Agricultural Research sub-center nursery site. This research was arranged in randomized complete block design (RCBD) with three replication and six treatments. Six treatment combinations of compost to topsoil ratio in (0:1), (1:1), (1:2), (1:3) (1:4) and compost only (1:0). All the relevant pineapple seedling growth parameters were collected and computed using SAS software. Treatment means were separated using LSD at 5% probability. The results revealed significant variation among the treatments that indicated, the soil-based nursery media of compost (1:0) and (1:1) ratio of compost to topsoil responded the best growth of pineapple seedling in terms of plant height, leaf length, leaf width, leaf area, leaf fresh weight, leaf dry weight, root number, root dry weight and total plant dry biomass. This result suggested that compost (1:0) and or compost to topsoil in (1:1) ratios was useful media to produce the best growth of pineapple seedling before transplanting to its production field.

Keywords: *Compost, Compost to topsoil ratio, Nursery media, Pineapple, Biomass.*

INTRODUCTION

Pineapple (*Ananas comosus* L.) is an important fresh fruit that is widely cultivated intropical and subtropical areas. It is a major tropical fruit with an estimated about 24.78 million metric tons of global pineapple production in 2013 was reported (FAO, 2013). Pineapple is one of the horticultural crops and the third most important tropical fruit in the world after banana and citrus (Hassan *et al.*, 2011), contributing to the world's production of tropical fruits by over 20% (UNCTAD, 2012). Pineapple plants are most productive under dry environments where low rainfall is supplemented by irrigation in well-drained soils. Pineapple plants require sandy soils and good drainage to prevent water logging and well drained loamy soil with high organic matter and a pH of 4.5-6.5 is best for pineapple cultivation (Bartholomew *et al.*,2003).

In developing countries like Ethiopia, it is produced by small holder farmers on pieces of land mainly in South and South-Western parts of the country. Pineapple successfully grows in South and Southwestern parts of Ethiopia, as small-scale farming and the average yield of the crop is low about 45 tons/ha (Wondifraw T, *et al.*, 2006) as compared to global average fruit yield of 67.5 t/ha (FAO, 2000).

This low yield is partly due to low fertility status of the soil when the pineapple grows, resulting from depletion by proceeding crops (Hermann *et al.*, 2013), lack of improved pineapple technologies for diverse environmental conditions, longer maturity, poor marketing system, presence of diseases and insect pests, technologies are a few to mention (Tewodros *et al.*, 2014).Besides, lack of sufficient information on the nutritional requirement of pineapple, leads low productivity (IAR, 1996) which also includes the managements for pineapple at seedling stage in nursery before transplanting to the permanent fields, and non-availability of planting material (Gesesse *et al., 2019).*

Different research studies were conducted in Ethiopia to determine the rate of pineapple nutrients requirements such as nitrogen (N), phosphorus (P) and potassium (K) for crop production at field condition that determine 281.00 kg N ha^{-1} and 134.80 kg P2 O5 ha^{-1} application rate at Jimma Agricultural Research Center (Tewodros *et al.*, 2018) but still now there is a gap to determine the best soil growth media and appropriate planting material used to raise the pineapple seedling at the nursery stage. Farmers in the south Ethiopia, uses different parts of pineapple like ground sucker, slips, and also crown sucker to transplant to the permanent fields and the fertilization practices were not common, some farmers use to apply organic fertilizers like animal dung at its early growth stage (Gesesse *et al.*, 2019) and others use compost to raise the seedling before transplanting to the permanent field. The production constraints of pineapple in the area has been inadequately studied and not well documented for both field and nursery condition nevertheless, so far there is no information is available in the effect of media on the growth of pineapple seedling in Ethiopia. Therefore, the current study was aimed to investigate the role of organic compost-based nursery media preparation on seedling production pineapple seedling production and to determine the best soil growth media used to raise the pineapple seedling at the nursery stage.

MATERIAL AND METHODS

Description of Experimental Area

The study was conducted at Awada Agricultural Research Center (AARC). The center is located at 6°3'N Latitude and 38°E Longitude at an altitude at an elevation of about 1740 meter above sea level. The average minimum and maximum air temperatures are 22C and 28.40C, respectively. The major soil types of the center are *Nitisol* and chromatic-cambisols that are highly suitable for maize, banana and coffee production (Mesfin and Bayetta, 2008).

Experimental Materials

Improved Pineapple variety *smooth cayenne* ground slip was used as the seedling source. The selected plants were collected from the seed orchard found at the center and their leaves were cleaned by cutting off the entire length of leaves except for the basal sheath portion. The selected slips were sectioned into two and prepared for plantation on the prepare soil-based nursery growth media. Top soil was collected from the surface of cultivable lands at 0-15cm depth, dried crushed by pestle and mortar and sieved by 2mm square-mesh sieve. Compost was prepared from fresh coffee husk biomass with maize straw was added at the bottom of the prepared pit in about 5cm thicknesses to keep a good ventilation; Immediately on the maize straws, fresh coffee husk residue was added to a thickness of about 20cm.

Farmyard manure in 5cm thickness to accelerate composting process and make the compost to have better nutritional composition and have abundant microorganism was added. Water was sprinkled after each layer as required to make the layers moist but not wet or soggy. The steps were repeated until the pit filled with the composting materials. Finally, the pit was covered with broad leaves banana and Enset leaves until every 21 days the materials was mixed and turned to next pit. After two times turning, i.e., after 63 days the compost was well decomposed and ready as suggested by (Solomon, 2006).

After that, the prepared compost was air dried under shade, crushed, blended into powder and screened through 2 mm sieve and applied to the experiment. To determine its quality, initial chemical analysis for major plant nutrients and soil analysis was done.

Experimental Design and Management Practices

The experiment was arranged in a randomized complete block design (RCBD) with three replications to provide estimates of treatment effects or differences among treatment effects. Six treatment combinations of compost to topsoil ratio in (Top soil only, One to one, one to two, one to three, one to four and Compost only) ratios by (v/v) were used as the experimental treatments.

The top soil (0:1) and compost were used as a control for the treatments. Then the potting media prepared for the treatment was adjusted as the desired treatment and randomization result. Topsoil was mixed with compost in various ratios according to the desired treatment and filled into the pots.

The pots filled with media were arranged on the nursery bed following treatment randomization. The plots were arranged four rows with five plants per row and then planting was conducted in August 2019. All management practices like weeding, watering, were applied throughout the study period until the seedling attains its transplanting stage.

Data Collection

The destructive and nondestructive data were recorded at the end of the experiment in January 2020. Pineapple seedling growth parameters were recorded using appropriate measurement materials. Accordingly, plant height was measured for each seedling in a plot using meter. Then mean heights were calculated and the results expressed in centimeters per seedling. The destructive data were also recorded to evaluate growth of each plant part. Shoot and root parts of the seedlings were separated by cutting plant at the collar point using scissors and their fresh and dry weights were measured by sensitive balance and expressed in gram per plant. The number ofroot was counted.

Data Analysis

Finally, all the measured growth parameters and produced biomass were summarized and subjected to analysis of variance (ANOVA) appropriate to RCBD were done using the General Linear Model (GLM).

List Significant difference (LSD) at 5% probability level was used to mean separation when analysis of variance indicated the presence of significant differences.

Result and Discussion

Physico-Chemical Properties of Topsoil

The initial soil characterizations result showed that the sand content of the soil was 63%, while clay and silt contents were 26 and 11%, respectively (Table 1).

Accordingly, the textural class of the study soil was sandy clay loam. The soil has a pH of 4.82, thus, the soil reactions fall under strongly acidic category.

Table1. *Selected physicochemical properties of experimental compost*

S.N	Parameter	Compost
1	Sand (%)	63
2	Clay (%)	26
3	Silt (%)	11
4	Textural class	Sandy clay loam
5	pH (H_2O)	4.82
7	Organic carbon (%)	2.81
8	Organic matter (%)	4.84
9	Total Nitrogen (%)	0.31
10	Available phosphorus (ppm)	19.48
12	C: N ratio	9.10

Seedling Growth Indicating Parameters

Plant Height and Leaf Length (cm)

Average plant height was highly significantly (P<0.001) affected by the treatments. The growth medium prepared from compost only gave the largest plant height (12.83cm) followed by the one-to-one ratio of compost to top (11.19cm) soil used to raise pineapple seedling which were statistically different from those of the lower ratio of compost to top soil with the corresponding values of (9.85), (9.83), (9.82) and (9.77) in cm, respectively (Table2). Therefore, this study indicates as the media composition could significantly affected seedling heights of pineapple seedlings.

Ogboi, and Nmor (2015) also found the significant differences in seedling height between media with organic manure and media without organic manure. The study was also in line with Akanbi (2012) that indicated the seedlings transplanted on growth media with organic manure were generally higher than those transplanted on the media without organic manure.

The effect of compost to topsoil was also showed significant variation (P<0.05) for average Leaf length of pineapple seedlings. The medium used to raise the seedling from compost only resulted in larger leaf length of (31.52cm), that were statically different from the medium prepared from one to two, one to three, one to four ratios of compost to topsoil and topsoil only with the corresponding value of (29.50), (27.59), (27.56), (27.42) and (27.11) in cm, respectively (Table 3).

This observation may be attributed to organic matter impact acting as auxin in stimulating growth in plant (Hiliter, 2008) and was also in line with Waksman (2009) observation who established that organic manure application increases leaf numbers and growth capacity of plants. Ramy (2010), observed increment in pineapple height and leaf length when nourished with organic matter.

Table2. *Mean Result of Plant height, and Leaf length of pineapple seedling*

Treatments	Plant height (cm)	Leaf length (cm)
Compost	12.83[a]	31.52[a]
One to one	11.19[b]	29.50[ab]
One to two	9.85[c]	27.59[bc]
One to three	9.83[c]	27.56[bc]
One to four	9.82[c]	27.42[c]
Top soil	9.77[c]	27.11[c]
CV (%)	4.69	3.97
LSD (0.05)	0.901	2.05

Means with the same letter are not significantly different.

Leaf Width (cm), Leaf Number and Leaf Area (cm^2)

Analysis of variance revealed that, the seedling growth media prepared from compost to topsoil ratio were highly significantly (P<0.001) and significantly (P <0.05) affected leaf width and leaf area of pineapple seedlings respectively.

The highest leaf width (4.78) and (4.21) were recorded for only compost followed by one-to-one ratio of compost to top soil ratio and statically similar, while the lowest leaf width was recorded for one to three (4.00), one to four (2.79) and the medium prepared from topsoil/-without compost (2.76) respectively (Table 3). The leaf number of pineapple seedling was not statically affected by the applied compost to top soil ratio.

The medium prepared from only compost (102.29) and topsoil enhanced by one to one (55.88) ratio of compost to topsoil were significantly (p< 0.05) exhibited higher leaf area than did topsoil alone (51.41), one to four (51.88), one to three (51.91) and one to two (52.35), ratio of compost to top soil, respectively (Table 3).

This observation was in line with (Dileas, 2012) who observed increment tin width of seedling leaf of pineapple grown in soil with organic manure medium.

Table3. *Mean Result of Leaf width (cm), Leaf number/plant, and Leaf Area (cm^2)*

Treatments	Leaf width (cm)	Leaf Number/plant	Leaf Area (cm^2)
Compost	4.78[a]	20.66[a]	102.29[a]
One to one	4.21[ab]	20.55[a]	55.88[b]
One to two	4.00[b]	20.54[a]	52.35[b]
One to three	2.79[c]	20.50[a]	51.91[b]
One to four	2.78[c]	20.48[a]	51.88[b]
Top soil	2.76[c]	20.40[a]	51.41[b]
CV (%)	13.10	0.73	14.25
LSD (0.05)	0.742	0.27	15.81

Means with the same letter are not significantly different.

Average Root Number per Plant and Root Length (Cm)

The analysis of variance (ANOVA) of the mean result indicate that, the root number of pineapple seedling were significantly (P<0.05) affected due to the applied compost to top soil treatments.

Statically the highest mean root number were recorded from the plot treated by only compost (18.47) as compared to the seedling mean root number raised on the mixture of one to one (17.89), one to two (17.58), one to three (17.49), one to four (17.43) and only topsoil (17.40) ratio of medium while there were no medium effects observed on the recorded root length among each treatment (Table 4).

This observation agrees with Akanbi (2012) who observed that better relationship exist between organic manure and rooting rather than conventional soil mix and less pre-dispose the seedlings to soil borne pests and diseases.

The root length of pineapple seedling was not statically affected by the applied compost to top soil ratio.

Table4. *Mean Result of Root number, and Root length of pineapple seedling*

Treatments	Root Number	Root Length (cm)
Compost	18.47^{a}	11.88 ^{a}
One to one	17.89^{ab}	11.85 ^{a}
One to two	17.58^{ab}	11.83 ^{a}
One to three	17.49^{b}	11.83 ^{a}
One to four	17.43^{b}	11.82 ^{a}
Top soil	17.40^{b}	11.77 ^{a}
CV (%)	2.88	0.53
LSD (0.05)	0.93	NS

Means with the same letter are not significantly different.

Average Leaf Fresh and Dry Weight (g)

The analysis of variance (ANOVA) of the mean result indicate that, Leaf fresh and weight (g) of pineapple seedling were significantly (P<0.05) affected due to the applied compost to top soil treatments. Statically the highest mean leaf fresh weight was recorded from the plot treated by only compost (128.62) as compared to the seedling mean leaf fresh weight raised on the mixture of one to one (106.66), one to two (93.23) one to three (92.19), one to four (91.06) and only topsoil (89.36) ratio of medium (Table 5). Similarly, there was a medium effect observed on the recorded leaf dry weight among each treatment (Table 5). The highest leaf dry weight was recorded from the plot treated with the soil medium prepared from compost only (30.04) followed by the plot treated by one to one (21.66) ratio of compost to top soil application while the minimum leaf dry weight was recorded from the plot treated with topsoil only (9.94) (Table 5).

Table5. *Mean Result of Leaf fresh and dry weight biomass production of pineapple seedling*

Treatments	Leaf fresh weight (g)	Leaf dry weight (g)
Compost	128.62^{a}	30.04^{a}
One to one	106.66^{b}	21.66^{b}
One to two	93.23^{c}	17.66^{c}
One to three	92.19^{c}	10.22^{c}
One to four	91.06^{c}	10.11^{c}
Top soil	89.36^{c}	9.94^{c}
CV (%)	4.36	10.94
LSD (0.05)	7.95	3.30

Means with the same letter are not significantly different.

Root Fresh Weight, Root Dry Weight and Total Plant Dry Biomass (G)

Mean Result of Root fresh weight of pineapple seedling was significantly (P<0.05) affected by compost to top soil application ratio of soil medium used to raise the pineapple seedling. The largest and significantly different root fresh weight was collected from the medium prepared from only compost (3.55g) treatment followed by one to one (2.72g) ratio of compost to top soil prepared medium. On the other hands, the medium prepared without compost and or top soil (1.95g) was able to respond the minimum root fresh weight as compared to other treatment (Table 6).

The root mean dry fresh weight of pineapple seedling was also highly significantly (P<0.01) affected by compost to top soil application ratio of soil medium used to raise the pineapple seedling (Table 7). The largest root dry weight was collected from the medium prepared from only compost (0.79g) treatment followed by one to one (0.60g) and one to two (0.60g) ratio of compost to top soil prepared medium. One the other hand, the medium prepared without compost and or top soil (0.39g) was able to respond the minimum root dry weight as compared to other treatment (Table 6).

Mean Result of total plant dry biomass of pineapple seedling was significantly (P<0.01) affected by compost to top soil application ratio of soil medium used to raise the pineapple seedling. Similar to the other growth indicating parameters, the largest (30.85g) total dry biomass was record from the plot treated with the soil medium prepared from compost only followed by one to one (22.26g) ratio of compost to top soil medium while the minimum was recorded from the only topsoil (10.34g) medium used to raise the seedling (Table 6).

Table6. *Mean Result of Root fresh and dry weight (g) of pineapple seedling*

Treatments	Root fresh weight (g)	Root dry weight (g)	Total plant dry biomass (g)
Compost	3.55[a]	0.79[a]	30.85[a]
e to one	2.72[b]	0.60[b]	22.26[b]
One to two	1.99[c]	0.60[b]	18.26[c]
One to three	1.95[c]	0.43[c]	10.65[d]
One to four	1.91[c]	0.40[c]	10.52[d]
Top soil	1.87[c]	0.39[c]	10.34[d]
CV (%)	12.55	4.52	10.62
LSD (0.05)	0.53	0.044	3.31

Means with the same letter are not significantly different.

CONCLUSION AND RECOMMENDATION

The nursery media composition used for this trail was influenced the growth performance of pineapple seedling at nursery stage before transplanting to the permanent field. The result generated from this work, indicate that, there isa significant differences among the treatments used (compost, a ratio of compost to top soil and topsoil only) growth media used to raise the pineapple seedling in plant height, leaf length, leaf width, leaf area, leaf fresh weight, leaf dry weight, root number, root dry weight and total plant dry biomass.

Therefore, it is recommendable that compost and or compost to top soil in one to one (1:1) ratio mixture media could be used to grow the best performed pineapple seedling in south ecological zone.

The overall results revealed that media supplemented with fresh coffee husk compost gave higher parameters of growth compared to media without compost. Therefore, this result suggested that compost should be mixed in media to attain better growth of pineapple seedling before transplanting to the permanent fields.

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