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Performance of pineapple *(Ananas comosus* (L.) *Merr)* plantlets as influenced by types and weights of propagule.

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Inadequate supply of pineapple planting materials is one of the major constraints to the expansion of its large scale cultivation in South-West, Nigeria. The effects of types and weight of propagule on the performance of pineapple *(Ananas comosus)* plantlets was evaluated at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Nigeria. Treatments consisted of two propagule types (PT) i.e. Stump, S and Crown, C and three propagule weights (PW); 20-25 g as light weight (LW); 30-35 g as medium weight (MW) and 40-45 g as heavy weight (HW). The experiment was laid out in a randomized complete block design in four replications. The results showed that irrespective of types of planting material used, propagule weights significantly (P<0.05) increased number of pineapple plantlets, length of D-leaf, number of leaves, leaf area and root length. Heavy weight (40-45g) stumps produced the highest number of pineapple plantlets (11) compared to the least (2) produced by LW stump as well as 3, 6 and 8 produced by LW, MW and HW crowns, respectively. HW Stump produced significantly (P<0.05) higher plantlet biomass weight of 310g compared to other classes of the propagules. It is evident that the use of heavy weight stump could enhance the growth of pineapple plantlets therefore, it is recommended as planting material for the production of plantlets in pineapple cultivation.

Keywords: Pineapple, plantlet, propagule weight, propagation, sprouts.

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INTRODUCTION

Pineapple (*Ananas comosus* (L.) Merr) is a leading edible member of the family Bromeliaceae. It is cultivated predominantly for its fruits that can be consumed fresh or as canned fruit and juice (Batholomew and Kadzimin, 1977). It dominates the world trade of tropical fruits, accounting for 50.7% of the world global fruit market (FAO, 2008). The total production of pineapple was 14.2 million tonnes in 2009 (FAO, 2010). The supply of pineapple juice is concentrated mainly in Philippines and Thailand with 65% of the juice available (SAHR, 2004) while Indonesia supplies 70% of the concentrate juice. However, canned pineapple is the most important product in pineapple world trade. Its consumption rises yearly due to Christmas salads and a greater demand by fast food outlets (Swete-Kelly, 2003). Nevertheless, single strength and concentrated juice have greater price per tonne. Thailand, Philippine and Indonesia cover nearly 80% of the canned pineapple supply in the world market while USA and Germany acquire most of the available product. The demand of such countries fluctuates continuously (Coveca, 2002). Pineapple rank sixth in the list of fruit producers on commercial scale globally (FAO, 2010) and it is grown in an extensive area in the tropics. It is the only source of bromelain, a proteolytic enzyme that digest protein and it is commonly used in medicine (worldhealth, 2005), the pharmaceutical industry and as a meat tenderizing agent

(Fougue, 1981). However, only 5% percent of the output is exported by producing countries and for Nigeria, fruit are not exported commercially (FAO, 2010).

The output of pineapple has increased globally due to application of technology developed from extensive research studies on yield enhancement (Maxwell, 1984). Unfortunately, commercial pineapple planting that would have benefited from such studies is in its infancy in Nigeria. The policy of local resource-based industrialization should have supported large-scale pineapple plantation and its subsequent exploitation as an industrial raw material for the food and beverages sector or export commodity to earn foreign exchange. Unfortunately, there is no commitment to the implementation of this policy as the relevant industries rely on raw materials (concentrates) imported from overseas.

Pineapple is gaining popularity and it demand is increasing gradually in Nigeria as a result of ban on its fruit juice importation. However, there are several constraints to the expansion of its cultivation in Nigeria; one being the non-availability of propagation materials in quantities required for large scale cultivation due to low rate of multiplication and lack of high quality propagule. The multiplication rate through natural suckering can only produce one or two sucker per plant per year (Heenkenda, 2003). The mother plants usually produce one or two suckers after harvest between 8-10 months of growth. However, there are different types of planting material for plantlets preparation which includes: (i) sucker arising from leaf axils (ii) slips arising from stock beneath the fruits. (iii) crowns or top of the fruits (iv) ratoons from underground parts of the stem. One such technologies that can be used to produce plantlets is the in-vitro technique, plant tissue culture (Thiémélé *et al.,* 2013). Plants from these techniques are usually healthy, vigorous and free from diseases but this method requires skilled labour and it is expensive. The inability to get the planting material for establishment of new orchards is therefore, a major challenge to farmers. Hence, the need for an alternative technology that is cheap and easy to generate planting materials and to make it grow uniformly in order to meet up with the appropriate weight desirable for transplanting to the field. Thus, this research effort sought to explore the use of pineapple parts as planting materials to provide a sustainable means of propagating pineapple plants for large-scale production. Therefore, the objective of this study was to evaluate the effects of types and weights of propagule on the early growth of pineapple plantlet in the nursery.

MATERIALS AND METHODS

Location of Experiment

The study was conducted at the Experimental site of the Teaching and Research Farm, Ekiti State University, Ado-Ekiti. Ado-Ekiti (long. 7º47'N and lat. 5º13'E) is located in the dry forest zone and experiences a warm sub-humid tropical climate with long term mean annual rainfall of 1,367 mm received in 112 days between March and November. The surface layer (0-15cm) soil sample indicated sandy loam and its characterization showed pH 5.8 in water, 0.08 g kg^{-1} N, 2.20 g kg^{-1} organic C, 3.50 mg kg^{-1} available P and 0.38 cmol kg^{-1} K.

Soil Sampling and Analysis

Before sampling, ten core soil samples randomly collected from 0-15 cm top-soil were bulk to form a composite. Samples were air dried, crushed and allowed to pass through a 2mm sieve. Particle size distribution was carried out by the Hydrometer method, while soil pH in soil solution ratio 1:2 in 0.01M CaCl2. Soil organic carbon was determined by the Walkey and Black (1934) method and the total N by the micro-kjeldahl digestion method (Bremner and Mulvaney, 1982). Available P was determined by Bray and Kurtz (1955) extraction method; Exchangeable bases were extracted with neutral 1M NH40AC at a soil solution ratio of 1:10 and measured by flame photometry. Magnesium was determined with an atomic absorption spectrophotometer. Exchange acidity was determined by titration of 1M KCl extract against 0.05M NaOH to a pink end point using phenolphthalein as indicator (McLean, 1982)

Preparation of Planting Material

Smooth Cayenne pineapple plants from which fruits have been harvested was used for the study. The plants were defoliated and the axiliary buds were first exposed by removing the aerial roots surrounding them with a knife. The stumps were removed and cut into anterior, central and posterior regions. The central portions were split into pieces in three different categories weighing 20–25g as light weight stump (LW); 30-35g as medium weight stumps (MW); and 40-45g as heavy weight stumps (HW), respectively as described by oleghe and Fawusi (1993); Omotoso and Akinrinde, (2007). Each stump piece had an average of five dormant buds whether small, medium or heavy. Pineapple crowns were also collected from harvested pineapple fruits and each crown was split vertically into four. The leaves were removed and the appropriate sizes were obtained, as was done for stumps. The stump and crown pieces were dressed with 0.1% mixture of benlate and water and cured by drying under shade for 24 hours before planting.

Experimental Design and Treatments

The experiment was laid out in a randomized complete block design in four replications. The treatments consisted of two propagule types, PT (Stump, S and Crown, C) and three propagule weights, PW (20-25g as light weight, LW;

Table 1. Effects of types and weights of propagule on number of sprouts and D-leaf length of plantlets

Propagule		Weeks After Planting				
Types	Weights	4	6	8	10	12
				Number of Sprouts		
Crown	Light	0.00a	0.67c	2.00bc	2.31bc	2.61d
	Medium	0.93a	2.30abc	3.89ab	4.82b	6.05bc
	Heavy	1.67a	3.33ab	4.00ab	4.66b	7.73b
Stump	Light	0.33a	2.00bc	1.32c	1.42c	2.41d
	Medium	0.67a	1.67bc	2.00bc	3.00bc	4.33cd
	Heavy	1.00a	4.96a	5.90a	9.03a	11.10a
Mean		0.77	2.49	3.19	4.21	5.71
SE±		NS	0.04	0.02	0.31	1.23
				D-leaf Length (cm)		
Crown	Light	12.30d	13.30a	14.60d	18.76d	19.33e
	Medium	14.00c	16.11ab	22.63ab	26.61b	29.73b
	Heavy	16.10a	17.60bc	21.27bc	26.93ab	27.40c
Stump	Light	9.40f	11.97d	16.10d	21.20c	22.06d
	Medium	10.43e	17.90ab	19.61c	22.56c	22.83d
	Heavy	15.03b	18.30a	24.46a	28.94a	33.97a
Mean		12.88	15.86	19.78	24.17	25.89
SE±		0.32	0.75	0.82	0.67	0.47

Means followed by the same letter(s) in each column are not significantly different (P<0.05) by DMRT. NS = Not significant

30-35g as medium weight, MW; and 40-45g as heavy weight, HW). Sixteen (16) pieces in each propagule weight categories were sown in plastic pot (50x20x40cm) containing 20kg top soil. There were five (5) sampling times, at two-week intervals starting from 4 weeks after planting (WAP). Observation were made on the following growth parameters: number of pineapple plantlets/sprouts, number of leaves, D-leaf length (cm), root length (cm) at 6 and 8 WAP, leaf area (cm^2), total plantlet fresh biomass weight (g/plant) at 8 and 12 WAP.

Data Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using Generalized Linear Model (GLM) (SAS, 2006) and the differences between treatment means separated using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

The effects of types and weights of propagule on number of pineapple sprout are presented in Table 1. The result showed that irrespective of the type and weight of propagule, there was no significant difference at 4 WAP on pineapple sprouts. The average number of sprouts ranged between 0.67-2.61 and 0.33-2.41 when established with light weight crown (LWC) and light weight stump (LWS) respectively. Sprouts from medium weight crowns (MWC) and medium weight stumps (MWS) ranged between 0.93-6.05 and 0.67-4.33 while heavy weight crown (HWC) and heavy weight stumps (HWS) ranged between 1.67-7.73 and 1.0-11.10 respectively. At 12 WAP, a significantly ($P<0.05$) higher number of plantlets (11) was produced by HWS than HWC (7.7). This is contrary to Agogbua and Osuji (2011) who reported that crowns split into 4 had the highest number of suckers (543) six months after planting followed by crowns split into 2 (375), the more the crowns were split, the more the plantlets produced. They attributed this to the fact that splitting the crowns reduced the apical dominance per split and allowed more buds to sprout which would otherwise have been suppressed from sprouting by an emerging sucker in the un-split crowns.

However, medium weight crown was higher than medium weight stump. Both LWC and LWS gave the lowest values in each of the propagule weight. The Heavy weight stumps which produced the highest number of sprouts was 76, 45, 30, 78 and 61 % increase over those of LWC, MWC, HWC, LWS, and MWS respectively. The differences in the number of pineapple sprouts observed in this study could be attributed probably to the amounts of food or nutrient reserves in each class of the propagule. Earlier investigation according to Butler (1960), have shown that sucker or corm of banana is a nutrient reserve which could support growth for some time prior to foliage development

Table 2. Effects of types and weights of propagule on mean number of leaves and leaf area of plantlets

Propagule		Weeks After Planting				
Types	Weights	4	6	8	10	12
			Number of leaves			
Crown	Light	10.00a	13.33a	15.00a	15.40c	16.03c
	Medium	12.33a	15.33a	17.33a	19.10a	20.66ab
	Heavy	12.67a	15.67a	16.00a	16.74c	18.10bc
Stump	Light	11.00a	14.33a	16.33a	16.73c	17.00c
	Medium	12.00a	15.33a	16.33a	17.05b	17.67bc
	Heavy	13.66a	15.00a	16.44a	18.90ab	21.65a
Mean		11.94	14.83	16.24	17.32	18.56
SE±		NS	NS	NS	NS	0.93
			Leaf area (cm^2)			
Crown	Light	30.41d	60.30c	77.17c	117.10c	129.82d
	Medium	44.31c	69.35b	105.85b	131.65b	182.07c
	Heavy	61.82a	80.14a	157.60a	241.00a	268.62b
Stump	Light	34.17d	61.23b	80.83c	125.07c	136.03d
	Medium	50.10b	68.03c	121.51b	239.53a	265.23b
	Heavy	61.36a	85.18a	110.01b	241.00a	300.07a
Mean		47.02	70.71	108.82	182.56	213.64
SE±		1.29	1.72	7.47	13.67	5.34

Means followed by the same letter(s) in each column are not significantly different (P<0.05) by DMRT. NS = Not Significant

while Baiyeri, (1996) reported that the development of plantain peepers to sucker for field planting did not respond to added N fertilizer treatment but rather dependent on the nutrients reserved in the planting material. This result is also consistent with Selemat and Ramlah (2003) who reported that the amounts of starch reserve in the pieces, the amount of leaf material present and freshness of the piece of material have significant effects on growth of the plants. Chang-ChingChyn, (1998) also reported that mean fruit weight of "Tainung No 4" pineapple harvested from lightest weight of propagule materials was lower than the heaviest planting materials. While the potential yield of Gandul pineapple increased from about 81.4 to 99.2t/ha by using bigger planting material (240g instead of 120g). Comparing the various type of planting materials consequently, there still remains some controversies over the relative performance of the types of planting materials. Ramkhelawan and Baksh (1997) reported that large stems (20cm long, 10cm in diameter and 42g weight) taken from a third ratoon crop of sweet cayenne pineapple produced the highest average number and largest mean fresh weight of suckers. Mean fresh weights of suckers from half stems (as large stems but cut in half) were significantly higher than those from small stem (20cm long and 4.5cm in diameter taken from a first ratoon crop).

The length of D-leaf significantly ($P<0.05$) increased irrespective of the type of propagule as the propagule weight increased during the growth period (Table 1). Length of D-leaf of pineapple planted ranged between 12.30-19.33, 14.00-29.73 and 16.10-27.40cm in LW, MW and HW crown respectively, while those established with stumps ranged between 9.40-22.06, 10.43-22.83 and 15.03-33.97cm, in LW, MW, and HW stump respectively. Heavy weight stump gave the longest D-leaf value of 33.97 cm which was an increase of 76, 14, 24, 54 and 49% over those of LWC, MWC, HWC, LWS and MWS respectively. This observation is consistent with the report of Singh and Yadav, (1980) who studied quick multiplication of pineapple and found that the rate at which leaves grown after planting increased regularly with the propagule types and age of the plant when stumps are used as planting material. However, when crowns are used, leaves can attain 7 to 8cm during the course of the first few months and subsequently there is a decrease in the rate of growth, after 4 to 5 months when the type of shoot used as planting

material no longer has any noticeable influence. He further maintained that the differences in behaviour between the two types of shoot after planting have more to do with the growth of individual leaves and of the stem than with the ability of the meristem to differentiate leaves. During the first few weeks of this study, the leaves of pineapple plantlet grown from stump were longer and heavier than plants grown from crowns. Denton, (2000) reported that large propagules for propagation produced a higher number of plantlets compared to small weight propagules, This was attributed to the number of eyes (buds) that were present on the propagule and also because the large-sized material tended to withstand rotting within the medium.

The leaf area of pineapple plantlets increased with age (Table 2). LWC produced the least leaf area (129.8cm^2) which was not significantly different from that of LWS. Leaf area in

Table 3. Effect of types and weights of propagule on mean root length (cm) of pineapple plantlets.

Propagule		Weeks After Planting	
Types	Weights	6	8
Crown	Light	11.52c	13.83c
	Medium	10.70c	15.07bc
	Heavy	26.00a	35.83a
Stump	Light	11.25c	13.33c
	Medium	17.70b	21.31b
	Heavy	30.65a	38.89a
Mean		17.9	23.0
SE±		1.85	2.18

Means followed by same letter(s) in each column are not significantly different (P<0.05) by DMRT.

Table 4. Effect of types and weights of propagule on Biomass weight of pineapple plantlets.

Propagule		Weeks After Planting	
Types	Weights	8	12
		Biomass (g/plant)	
Crown	Light	136c	172d
	Medium	138c	259c
	Heavy	156b	287b
Stump	Light	149bc	183d
	Medium	147bc	263c
	Heavy	234a	310a
Mean		160	246
SE±		6.85	7.18

Means followed by same letter(s) in each column are not significantly different (P<0.05) by DMRT

MWC and MWS were also not significantly different in size at 6 and 8WAP. However, leaf area value of (300.07 cm2) was observed with HWS at 12WAP which was 11.4% higher than HWC.

The effects of types and weight of propagule on root length of pineapple plantlets were presented in Table 3. Maximum root length (38.9cm) was obtained in HWS which was not significantly different from HWC (35.83cm) at 8 WAP. Length of roots obtained with LWC and LWS were at par. However, the mean root length of plantlet from MWS (21.3 cm) was significantly (P<0.05) higher than MWC (15.1cm). The root length from HWS was 64, 61, 66 and 45% more than LWC, MWC, LWS and MWS respectively.

The plantlet biomass weight was higher in heavy weight stump (HWS) with the values of (234g.plant^{-1} and 310g.plant^{-1}) while the least weight was recorded with light weight crown (LWC) with the value of (136g.plant^{-1} and 172g.plant^{-1}) at 8 and 12WAP respectively (Table 4). This is consistent with Omotoso and Akinrinde, (2012) who reported that the highest biomass production (approx. 304 g, was just within the 300-400g desirable range for transplanting to the field). Selemat, (1997) reported that mean fresh weight harvested from light weight of planting material was 1.32kg whereas the heavy weight planting material was 1.60kg. The decreased biomass weight by LWC propagule weights in this study was probably due to the reduction of the number of leaves and components of the leaf, which eventually resulted in poor overall plant biomass, since the leaf is the major source of carbohydrates required for growth.

CONCLUSION

The length of D-leaf was significantly increased irrespective of the types of propagule while the number of leaves, leaf area and root length were significantly increased by propagule weights. Heavy weight (40-45g) stumps produced the highest number of pineapple plantlets (11) compared to the least (2) produced by light weight stump and plantlet biomass of 310g.plant^{-1} which falls within the 300-400g desirable range for transplanting. It is

evident that the use of heavy weight stump propagule enhanced the growth of pineapple plantlets and therefore, pineapple farmers may consider using this material for plantlets production in establishment of pineapple orchards.

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