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Influence of Propagule Weights and Nitrogen Fertilizer Rates on Growth and Yield of Pineapple (*Ananas comosus* (L.) Merr)

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Abstract: This study was conducted to determine the effect of propagule weight and nitrogen fertilizer rates on growth and yield of pineapple in southwestern Nigeria. Pineapple whole stump were collected from the Teaching and Research Farm, University of Ado-Ekiti which were split into three different weights viz: Short Weight (SW), Medium Weight (MW) and Large Weight (LW). Nitrogen fertilizer was applied at 0, 100, 150 and 200 kg N ha^{-1}. Treatments were arranged in a split plot design with propagule weight as the main plot factor and N rates as sub-plot factor. The results indicated a significant ($p<0.05$) increase in length of D leaf, number of leaves, root length and days to 50% sprouting. Optimum fruit yield 210.03 MT ha^{-1} was obtained at 150 kg N ha^{-1}. Large weight propagules gave significant increase in yield and yield components except fruit weight, fruit diameter and fruit length which were not significant.

Key words: *Ananas comosus*, pineapple, propagule weight, nitrogen fertilizer

INTRODUCTION

Pineapple (*Ananas comosus*) is one of the important crops in Nigeria. It is cultivated predominantly for it fruits, which is either consumed fresh or as canned fruits and juice. Its medicinal use has been identified (Fouque, 1981) It is the only source of bromelain, a complex proteolytic enzyme commonly used in the pharmaceutical market and as a meat tenderizing agent (Fouque, 1981; Asoegwu, 1987). The stems and leaves of pineapple plant are also a source of fibre (Montinola, 1991).

The annual growth rate of local fruits juice industries utilizing pineapple is about 3.5% (NAFDAC Bulletin, 2005). With increasing cultivation and more raw materials available, this is sure to increase. The fresh market demand has been on the increase because of increasing demand and acceptance of local juice from pineapple. The crop is grown mostly in the rainforest zone where the rainfall ranges from 700-2000 mm per annum with 3-4 months of dry season through which the crop must grow with the attendant limiting effect on growth.

Nitrogen is the nutrient which has the greatest effect on the yield (de Geus, 1973) due to its dominant effect on growth. Its influence on fruit size and quality is pronounced as reported by Teisson *et al.* (1979) and Souza (1999). Also increases fruit size (Paula *et al.*, 1991) juice content (Reinhardt and Neiva, 1986; Veloso, 2001) but decreases total soluble solids and vitamin C, Teisson *et al.* (1979). This study was therefore undertaken to determine the appropriate level of nitrogen fertilizer rate and influence of propagule weight/size required to produce economically commercially desirable fruits in Nigeria.

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MATERIALS AND METHODS

Environmental Setting

The study was conducted at the Teaching and Research Farm, University of Ado-Ekiti between 2004 and 2006. Ado Ekiti is located on latitude 7° 31' N and longitude 5° 49' E. The area has a bimodal rainfall (Fig. 1) with mean annual rainfall of 1367 mm and average number of rainy days of about 112 per annum. Temperature is almost uniform throughout the year with little deviation from mean annual of 27°C. February and March are the hottest month with mean temperature of 28 and 27°C, respectively. The mean total sunshine hour is about 2000 h with mean annual radiation of about 130 kcal cm^{-3} $year^{-1}$. The area falls within the high forest zone where the rich tropical forests once thrived. The region has a tropical humid climate with distinct wet and dry seasons. The wet season is from late March to October with little dry season in August.

Soil Sampling and Laboratory Soil Analysis

Prior to planting soil samples were collected from the top 0-15 cm depth of the experimental plot. The samples were thoroughly mixed and were air-dried in the laboratory, ground and sieved through a 2 mm sieve. Particle-size distribution was determined by the hydrometer method (Bouyoucos, 1951). Soil pH was measured using the pH meter at 1:1 soil to water ratio. The percentage organic carbon was determined by the Walkey Black wet oxidation method (Walkley and Black, 1934) while percent total Nitrogen (N) was determined by the micro-kjeldahl technique (Jakson, 1962). The present organic matter was estimated by multiplying the percent organic carbon with a factor of 1.724. Available P was extracted by the Bray/method and determined colorimetrically (Bray and Kurtz, 1945). Exchangeable bases were displaced by NH_4^+ from neutral/NH_4OAC solution as describe by Jackson (1958). Calcium (Ca) and Magnesium (Mg) were determined by the Atomic Absorption Spectrophotometer (AAS) and potassium (K) and sodium (Na) were determined by flame emission photometry. Cation Exchange Capacity (CEC) was determined by the neutral/NH_4OAC saturation method. Base saturation was calculated with reference to the NH_4OAC-CEC. Exchangeable acidity was extracted with IMKCL and determined by titration with NaOH solution.

Planting Materials Preparation

Pineapple plants from which fruits have been harvested was collected from pineapple orchard of Teaching and Research Farm, University of Ado-Ekiti. The plants leaves were removed and the dominant auxillary bud on the stumps was exposed by removing the surrounding areal roots with a knife. The stumps were cut into anterior, central and posterior regions. The central portions were split into pieces weighing 50-100 g as Short Weight (SW), 101-150 g as Medium Weight (MW) and 151-200 g as Large Weight (LW), respectively. The stump pieces were dressed with fungicide (0.1%) mixture of Benlate and water and cure by drying under shade for 24 h before planting.

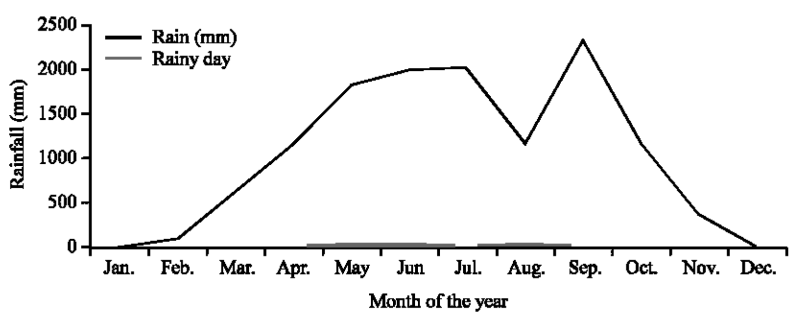

Fig. 1: Meteorological data showing rainfall distribution and pattern

Experimental Design and Treatments

The experiment was a 3×4 factorial combinations arranged in a split plot design with three replicates. Propagule weight formed the main factor while Nitrogen fertilizer rates were the sub-plot factor. The N fertilizer was 0, 100, 150 and 200 kg N ha^{-1} as urea (46%). A general dose of phosphorus at 50 kg P_2O_5 ha^{-1} and potassium 100 kg k_2O ha^{-1} were given to all plants including the control plots. Fertilizers were applied in three equal split dozes at 3, 6 and 9 months after planting.

Planting

Propagules were planted at spacing of 0.5×0.5×1.0 m in double row arrangement in plot size 3×1.5 m to give eighteen plants per plot.

Growth and Yield Measurement

Leaf area was measured by planimeter and correlated with product of length and width of D leaf (longest central leaf). Rate of leaf formation was used as an index of growth. Other parameters measured were days to 50% sprouting, number of leaves, length of D leaf, fruit length, fruit diameter, fruit weight, crown weight and days to 50% flowering.

Data Analysis

All the data collected were subjected to simple statistical analysis and analysis of variance (ANOVA) and treatment means were separated by DMRT using (SAS, 1995) procedure.

RESULTS AND DISCUSSION

Characteristics of the Soil Used

The result of the analysis of soil used for the experiment were presented in Table 1, which gave particle size as sand 826 g kg^{-1}, silt as 108 g kg^{-1} and clay as 66 g kg^{-1}. The pH of the soil was 6.1, organic carbon content was 6.15%, CEC was 1.03 cmol kg^{-1} while total N and available P were 0.07% and 6.20 mg kg^{-1}, respectively. The soil was loamy sand, Total N and available P content were very low compared with critical levels of 0.1% for N and a range of 10-12 mg kg^{-1} for available P (Adeoye and Agboola, 1985) obtained for soils in southwestern Nigeria (FMANR, 1990). Using the critical levels of 0.16-0.20 cmol kg^{-1}, exchangeable K was low (Agboola and Obigbesan, 1974; Enwenzor *et al*., 1979).

Table 1: Physico-chemical properties of surface soil used

Soil properties	Values
pH (H_2O)	6.10
Organic C (%)	6.15
Total N (%)	0.07
Available P (mg kg^{-1})	6.20
Exch. Bases (cmol kg^{-1})	
K (cmol kg^{-1})	0.17
Ca (cmol kg^{-1})	0.40
Mg (cmol kg^{-1})	0.06
Na (cmol kg^{-1})	0.14
Exch. H+Al (cmol kg^{-1})	0.26
CEC (cmol kg^{-1})	1.03
Base saturation (%)	72.10
Sand (g kg^{-1})	826.00
Silt (g kg^{-1})	108.00
Clay (g kg^{-1})	66.00
Textural class	Loamy sand

Table 2: Effect of propagule weight and Nitrogen fertilizer on growth parameters of pineapple

Propagule weights (g)	Days to 50% sprouting	No. of leaves	Length of D leaf (cm)	Leaf area (cm^2)	Root length (cm)
SW	47.00a	13.78b	11.82c	89.33c	18.61c
MW	40.08b	13.83b	13.78b	128.57b	17.00b
LW	37.31c	21.26a	25.33a	149.58a	21.43a
N (kg ha^{-1})					
0	54.73a	11.82d	10.67d	97.90	9.66d
100	33.31c	14.67c	16.26c	189.07	23.93b
150	31.90d	18.46b	20.03b	171.32	25.54a
200	40.98b	20.22a	20.96a	192.81	16.54a

Mean with same letter(s) for each factor in each column are not significantly different (p>0.05) by DMRT

Table 3: Effect of propagule weight and Nitrogen fertilizer on fruit yield and yield components of pineapple

Propagule weights (g)	Days to 50% flowering	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (kg)	Crown weight (kg)	Fruit yield (tons ha^{-1})
SW	454.23a	16.76b	11.52a	1.19a	0.13b	130.47c
MW	438.63b	17.90b	12.43a	1.22a	0.19a	149.12b
LW	437.19b	20.58a	12.43a	1.28a	0.18a	183.26a
N (kg ha^{-1})						
0	480.74a	13.76c	10.00b	0.78c	0.07d	127.84c
100	452.10b	18.40b	12.28a	1.36b	0.16c	159.50b
150	432.32c	20.84a	13.20a	1.63a	0.19b	166.87a
200	408.23d	20.66a	13.02a	1.16b	0.25a	162.91ab

Mean with same letter(s) for each factor in each column are not significantly different (p>0.05) by DMRT

Effect of Propagule Weight

Effect of propagule weight on the growth parameters of pineapple is indicated in Table 2. Propagules weights significantly affected all the parameters. Large Weight (LW) sprouted 3 and 10 days earlier than small (SW) and medium (MW) weight respectively. This is probably as a result of more food reserved available in the larger propagules which encourage early sprouting. Large weight propagules gave (37.4 days, 21.3, 25.4 cm, 149.6 cm^2 and 21.4 cm) higher day to 50% sprouting, number of leaf, length of D leaf, leaf area and root length Significant influence of nitrogen on growth parameters were also recorded (Table 2). Increasing levels of N fertilizer application decrease days to 50% sprouting but increase number of leaves, length of D leaf, leaf area and root length.

Propagule weight significantly influence the fruit yield characters (Table 3) except fruit weight and fruit diameter. LW affected all the parameters such that, the highest fruit yield of 183.6 MT ha^{-1} were obtained. Days to 50% flowering were significantly affected ($p<0.05$) by weight, those propagules that were large flowered earlier. There was however no significant increase in fruit diameter, fruit weight and crown weight. LW gave significant higher values of 20.5 cm, 12.4 cm, 1.28 kg, 0.19 kg for fruit length, fruit diameter, fruit weight and crown weight respectively. This is in agreement with (Oleghe and Fawusi, 1993) who reported that large weight propagules significantly influence growth parameters of pineapple. Comparison of the propagule weight shows that LW gave (19, 7.3 and 29%) increase in fruit length, fruit diameter and fruit yield respectively over SW propagules.

Effect of Nitrogen Fertilizer Rates

The N fertilizer rates (Table 3) produced a significant increase in yield and yield components. Days to 50% flowering were reduced as N rates increases such that the zero application rates takes about 80 days longer to flower than 200 kg N ha$^{-1.}$ However, N rates do not have effect on fruit diameter and fruit length. Nitrogen rates in excess of 150 kg N ha^{-1} produced no significant additional increase in bunch weight except for small but significant reduction in times of flower emergence. Similar

Table 4: Interaction effect of propagule weight and N fertilizer rates on fruits yield and yield components.

Treatments: Propagule weights (g)	Treatments: Nitrogen rates	Fruit yield (MT ha^{-1})	Fruit weight (kg)	Fruit length (cm)	Fruit diameter (cm)
SW	0	114.40h	0.87ef	13.27c	10.00de
	100	125.49g	1.33cd	15.93bc	11.23bcde
	150	137.80f	1.57ab	22.03a	11.97bcde
	200	144.20de	1.30cd	15.80bc	12.57abc
MW	0	129.90gf	0.60f	14.67bc	10.47cde
	100	149.17d	1.26bcd	17.07b	13.73ab
	150	152.77d	1.70a	18.20b	13.57ab
	200	164.63c	1.30bcd	21.67a	11.97bcde
LW	0	139.23e	0.87ef	13.33c	9.53e
	100	203.87a	1.50abc	22.20a	11.87bcde
	150	210.03a	1.63ab	22.30a	13.77ab
	200	179.90b	1.13cde	24.50a	14.53a

Mean with same letter(s) for each factor in each column are not significantly different ($p>0.05$) by DMRT

results have been observed in banana (Lahav *et al*., 1981). Earlier studies on Nitrogen fertilizer effect on pineapple showed that the requirement of this crop is high (De Geus, 1973; Asoegwu, 1987). Increasing N rates significantly ($p<0.05$) increased fruit yield (Tay, 1972), maximum fruit yield of 166.87 MT ha^{-1} was recorded at N rate of 150 kg ha^{-1}. Heaviest crown was obtained at 200 kg N ha^{-1}.

Interaction Effect of Propagule Weight and N Fertilizer Rates

Propagule weight and N fertilizer interaction effect on some yield characters were presented in Table 4. Irrespective of propagule weight, increasing levels of N rates significantly increase fruit yield except LW which gave a small but significant reduction at 200 kg N ha^{-1}. Fruit weight does not increase beyond 150 kg N ha^{-1} across the propagule weights, fruit length consistently increased as N rates increases but LW were not affected. However, large propagule weight gave highest yield of 210.03 MT ha^{-1} at 150 kg N ha^{-1}.

CONCLUSION

The delayed growth and stunted plant that produced small fruits in low N rates is a further confirmation that Nitrogen had a dominant effect on growth as observed in this study. However, large propagule weight as well as N fertilizer rates at 150 kg ha^{-1} had significant effects on pineapple as observed in present study hence this rate seems appropriate for optimum production of pineapple.

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