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GROWTH INDICES OF ALOE VERA AS INFLUENCED BY NITROGEN AND PHOSPHORUS FERTILIZERS IN OXISOLS OF RAIN FOREST ZONE, NIGERIA

Egbuchua, C. N. & Enujeke E. C.
Department of Agronomy, Delta State University, Asaba Campus, PMB 95074, Asaba, Nigeria.
Corresponding Author's e-mail: enujeke@yahoo.com

ABSTRACT
Pot experiment was carried out at the back of the Department of Agronomy, Delta State University, Asaba Campus. The aim was to investigate the effects of different levels of nitrogen fertilizer N (0, 25, 50, 75 Kg N/ ha) and phosphorus fertilizer P (0, 20, 40 kg P/ha) on some growth indices of Aloe vera. Results showed that leaf length, leaf width, number of leaves, thickness of leaves and fresh weight of plant were significantly ($P < 0.05$) influenced by the different levels of N and P fertilizer application. Nitrogen application at 75 Kg N/ha and phosphorus application at 40 Kg P/ha gave the best growth indices of leaf length 18.8 cm, number of leaves 10.30 and fresh weight of plant 18.5 kg/ha compared to the control. Phosphorus application at 40 kg P/ha also produced higher leaf length of 10.8, number of leaves 9.68 and fresh weight of plant 14.3 Kg/ha at 5 months after planting. There was no significant effect on N X P interaction, depicting the roles of nitrogen and phosphorus in crop production and the synergy of both nutrient elements in promoting growth and development of plants.

KEYWORDS: Growth indices of Aloe vera; nitrogen and phosphorus fertilizers; oxisols of Nigeria.

INTRODUCTION

Aloe vera, variously called 'the wonder plant', 'Plant of immortality' and 'nature powder' belongs to the family *Liliaceae* (Anselm, 2004; Aloe India, 2007) It is an all-purpose herbal or medicinal plant (International Aloe Science Council, 2007). The word 'Aloe' is derived from Arabic word *Alloeh*, meaning "shinning bitter substance". Morphology of the plant (Fig. 1) shows that the plant is dwarf, leaves are stiff and mottled, and in some cases fleshy with glabrous surfaces having sharp apices and spiny edges. The leaf of the plant is widely known to contain a number of organic phyto-chemicals that produce a unique gel with herbal efficacies. Recent studies on the plant have indicated the medicinal/herbal values of the plant. For instance, Ajabnoor (1990) reported that Aloe vera has the tendency to reduce blood glucose levels in alloxan diabetic patients. Yusuf *et al.* (2004) reported that the plant has the potential of secreting gastric acid on gastric mucosal injury. Moody *et al.* (2004) reported that the gel from the leaves when combined with a weed *Agerantum conyziodes* enhances anti-microbial activity perculiar with African traditional medicinal soaps widely used in many countries for cleansing purposes. Orafidiya *et al.* (2004) in similar studies reported that the plant has effective control on ache, especially when the gel is thoroughly mixed with *Occimum gratissimum*. Vasquez *et al.* (2004) equally reported the anti-inflammatory activity of extracts from the plant gel. Okonkwo *et al.* (2009) also reported that the gel from it when combined with some African medicinal leaves has the potential of controlling body rashes, mouth odour, running nose, itching, soar throat and such veneral diseases as gonorrhea, staphylococcus and vaginal discharge. Because of the widely perceived potencies of Aloe vera in alleviating/curing a wide range of human ailments that have defiled orthodox medicine, the plant has become a household plant that is planted around many homesteads. The plant is even used world - wide in the pharmaceutical, food and cosmetic industries thus, the increasing demands of the plant's gel. Agronomists have identified nitrogen and phosphorus as most limiting nutrients in oxisols which have been reported to be characteristically highly weathered, low in nutrient reserve, highly leached, though rich in sesquioxides that can promote soil activity (Egbuchua, 2011). Nitrogen and phosphorus are among the essential plant nutrients and major soil fertility determinants in crop production system. It is therefore the objective of this study to evaluate the effects of different levels of nitrogen and phosphorus fertilizers on some growth indices of Aloe vera in oxisols of rainforest zone, Nigeria.

MATERIALS & METHODS

A potted experiment was conducted during the raining periods of the months of May to September, 2012 at the make shift botanical garden of the Department of Agronomy, Delta State University, Asaba Campus. The site lies on Latitude 06° 49¹ and Longitude 06° 14¹, 358 m above sea level, in the rainforest ecological zone of Nigeria. Rainfall received during the period of experimentation increased from 1,250 mm in the month of May to 1,650 mm in the month of September. The relative

humidity during the same period was between 75 and 82.4%, while the temperature range during the period was between 32% and 33.7%. The geology of the study area is made up of coarse-grained pegmatites which are derived from basement complex that are largely acid than base (Egbuchua, 2011). The general landscape is undulating and crop production is based on rainfed agriculture. The soil is of the oxisols order (Soil Survey Staff, 1996). It is characterized by high contents of sesquioxides low in nitrogen 0.07 gkg^{-1}, organic carbon 1.25 gkg^{-1} and available phosphorus 2.34 $mgkg^{-1}$ (Egbuchua, 2011).

Experimentation

A total of 30 black pots with holes at the base were used for the study. Each pot has a diameter and depth of 16 x 24 cm and a volume of about 7,800 cm^2. The pots were filled with 5kg of top soil that was air-dried and sieved. The treatment consisted of 4-levels of nitrogen N (0, 25, 50 and 75 Kg N/ha) and 3 levels of phosphorus P (0, 20 and 40 kg P/ha). The treatments were factorially combined and laid out in a Randomized Complete Block Design with 3 replicates. Rates of Nitrogen fertilizer in the form of Urea (46% N) and phosphorus fertilizer in the form of single superphosphate (18% P_2 O_5) were weighed as per treatment and later incorporated into the various pots. Phosphorus was incorporated at planting, while urea, was incorporated two weeks after pubbing. The various fertilizer rates for each pot were calculated using the furrow-slice method thus:

$$R = \frac{YxW}{2{,}000{,}000}$$

Where:
R = Weight of fertilizer/pot
W = Weight of soil in each pot
Y = Fertilizer rate on per hectare basis
2,000,000 = equivalent weight of soil from 1 ha of land

Pups of Aloe vera were removed from the matured parent plant with several sets of true leaves and potted on the 18th day of May, 2012. The pots were kept weed free during the period of the study.

Data Collection and statistical analysis

Data for leaf length leaf width, number of leaves, leaf thickness, number of lateral roots and fresh weight of plant were collected at 5 months after potting the pubs. All the data collected were statistically analysed and where the F-values were significant, the treatment means were separated using Duncan Multiple Range Test (DMRT) Duncan (1955). Nitrogen and phosphorus fertilizers and growth components measured were studied using correlation coefficient.

RESULTS

Leaf length/Width of leaf

The effects of the rates of nitrogen fertilizer on the growth indices of Aloe vera are shown in Table 1. The length and width of leaf were significantly ($P < 0.05$) influenced by the different levels of nitrogen fertilizer application. Both morphological characters were found to have increased correspondingly with increased rates of nutrient application. At 50 and 75 Kg N/ha application rates, leaf length increased from 17.2 cm to 18.8 cm as compared to the control. In other words increasing N rates from 0 – 75 Kg N/ha significantly increased leaf length (Table 1).

Leaf width of Aloe vera

The width of leaf also followed the same trend. Increasing rates of application correspondingly increased the width of leaves. Fertilizer application rates of 50 and 75 Kg N/ha leaf width increased significantly from 1.87 cm in plots without treatment (control) to 3.65 cm and 4.06 cm at 50 kg N/ha and 75 Kg N/ha, respectively.

TABLE 1: Effects of nitrogen fertilizer on the growth attributes of Aloe vera 5 months after pubbing

Treatment Nitrogen (Kg N/ha)	Leaf length (cm)	Leaf width (cm)
0	9.5	1.87
25	12.7	2.73
50	17.2	3.65
75	18.8	4.06
SE ±	2.58	0.59
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

Number of leaves/leaf thickness

The responses of number of leaves and leaf thickness of Aloe vera to Nitrogen fertilizer are shown in Table 2. The number of leaves and thickness of leaves were also significantly enhanced by treatment application rates when compared to plots without treatment application. For instance, the number of leaves and thickness of leaves increased from 8.06 (control) to 9.88 and 10.30 at 50 Kg N/ha and 75 Kg N/ha, respectively, showing a significant influence of nutrient application.

Similarly, leaf thickness also increased from 1.88 cm in the control experiment to 3.11 cm and 4.55 cm respectively at 50 Kg N/ha and 75 Kg N/ha rates of N-application. In other words increasing rates of N-applications affected the parameters by enhancing their numbers and thickness.

TABLE 2: Effects of nitrogen fertilizer on number of leaves and leaf thickness of Aloe vera at 5 months after pubbing

Treatment Nitrogen (Kg N/ha)	Number of leaves	Leaf thickness (cm)
0	8.06	1.88
25	8.65	2.11
50	9.88	3.11
75	10.30	4.55
SE ±	0.24	0.39
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

Number of lateral roots/fresh weight of plant

The number of lateral roots and fresh weight of plants as influenced by Nitrogen fertilizer application is shown in Table 3. Total number of lateral roofs and fresh weight of plant were significantly promoted by N application. The number of lateral roots at O and 25 Kg N/ha applications rates, though not significantly different (P < 0.01) however, increased rates of application at 50 Kg N/ha and 75 Kg N/ha positively enhanced the number of lateral roots from 5.24 (control) to 6.82 and 7.69. Fresh weight of plant was also significantly promoted by rates of 50 kg N/ha and 75 Kg N/ha which gave the best values of fresh weight of plant 18.05 Kg/ha and 18.15 Kg/ha even when they are not statistically significant (P < 0.01).

TABLE 3: Effects of nitrogen fertilizer on number of lateral roots and fresh weight of Aloe vera

Treatment Nitrogen (Kg N/ha)	Number of lateral roots	Fresh weight of plant Kg/ha
0	5.24	9.85
25	5.82	13.86
50	6.82	18.05
75	7.69	18.15
SE ±	0.10	0.40
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

Effects of phosphorus application on vegetative parameters, lateral root growth and fresh weight of Aloe vera plants

Phosphorus fertilizer applications significantly enhanced the vegetative parameters measured in the study. Increased rates of P-application correspondingly increased the measured parameters (Tables 4, 5 and 6). There were no significant differences in leaf length, leaf width, number of leaves and leaf thickness. Application rate of 40 Kg P/ha resulted in significantly greater leaf length of 10.8 cm, and leaf width of 3.09 cm, (Table 4), number of leaves of 9.68 and thickness of leaf of 3.52 cm (Table 5) which were all higher than their control counterparts in all the mentioned growth parameters.

A similar trend was observed in the number of lateral roots and fresh weight of the plant which were not significantly (P>0.05) affected by P-fertilizer application. The general fresh weight of N-fertilizer application was higher at 50 Kg N/ha (18.05 Kg/ha) and 75 Kg N/ha (18.15 Kg/ha) than P-fertilizer application at 40 Kg P/ha (14.3 Kg/ha).(Table 6). The same trend was observed in all the parameters assessed statistically, all the measured parameters in both nutrient applications were not significantly difference at P >0.05 levels of probability.

TABLE 4: Effects of phosphorus fertilizer on leaf length of Aloe vera at 5 months after pubbing

Treatment Nitrogen (Kg N/ha)	Leaf length (cm)	Leaf width (cm)
0	8.7	1.92
20	10.0	2.82
40	10.8	3.09
SE ±	0.65	0.33
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

TABLE 5: Effects of phosphorus fertilizer on number of leaves and leaf thickness of Aloe vera at 5 months after pubbing

Treatment Nitrogen (Kg N/ha)	Number of leaves	Leaf thickness (cm)
0	7.78	2.14
20	7.82	3.10
40	9.68	3.52
SE ±	0.30	0.36
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

TABLE 6: Effects of phosphorus fertilizer on number of lateral roots and fresh weight of Aloe vera

Treatment Nitrogen (Kg N/ha)	Number of lateral roots	Fresh weight of plant Kg/ha
0	6.20	10.8
20	6.28	13.2
40	6.72	14.3
SE ±	0.09	0.62
LSD (P = 0.05)	NS	NS

NS = Not Significant at 5% probability level

Effects of interaction of nitrogen and phosphorus fertilizers on fresh weight of Aloe vera at 5 MAP

The interaction of nitrogen and phosphorus fertilizers on fresh weight of the plant (Table 7) was significant. The highest level of N and P significantly gave the best fresh weight of Aloe vera at 5 MAP.

TABLE 7: Interaction of nitrogen and phosphorus levels of fertilizers on fresh weight of Aloe Vera at 5 MAP

	Phosphorus (Kg P/ha)		
Treatment	0	20	40
Nitrogen (Kg N/ha)			
0	12.86	14.77	16.69
25	16.58	19.18	21.78
50	21.18	22.89	24.61
75	22.06	23.51	24.97
SE ±	0.98	0.80	0.51
INTERACTION			
N x P	NS	NS	NS

Means followed by the same letter (s) within a treatment group are not significantly different at 5 percent levels of significance using DMRT, NS = Not significant

DISCUSSION

The positive relationship between the treatments at different rates on some morphological characters could be attributed to the roles of N and P as macronutrients in plant nutrition. Nitrogen is known to play a significant role in plant photosynthetic activity thereby resulting in increase in leaf length and width, and number of leaves (Acquaah, 2006). Phosphorus on the other hand, plays a functional role in formation of more roots thereby, enhancing uptake of nutrients. Most of the measured parameters responded positively to nitrogen fertilization, with optimum values obtained at 90 Kg N/ha, indicating that the plant needs nitrogen as a major nutrient. The non-significant effects of the applied nutrient element in some of the measured parameters could be attributed to inability of Aloe vera to utilize the added nutrient especially phosphorus due to the transformation of parts of the added nutrient element to unavailable forms in the soil. This fact has been reported by Majanbu *et al.,* (1986) in their studies of crop response to N and P fertilizer application. The positive interaction of N x P on fresh weight of Aloe vera was an indication of the importance of the two nutrient elements in plant nutrition. It is also a measure of inter dependency between the parameters evaluated. These findings are consistent with earlier findings of Mankar and Satao, (1995), Ray *et al.,* (2003), Babaji *et al.,* (2006), and Abdulsalam and Ogunsola (2006) in the their studies of N and P fertilizers on crop production.

CONCLUSION

The study showed that the application of N and P fertilizers has positive relation with growth and development of Aloe vera. Higher application rates were found to have enhanced the morphological growth characters evaluated. There was also a positive interaction between the two nutrients applied, depicting the synergy of N and P in promoting growth and development of plants.

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