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DETERMINATION OF OPTIMUM NITROGEN FERTILIZER RATES FOR ALOE VERA GROWTH, YIELD AND NUTRIENT COMPOSITION.

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ABSTRACT

Aloe vera (L) Burm. f. is an important medicinal plant with little information on agronomic requirements for its enhanced growth and nutrient composition. Two years field trial was conducted during 2010 and 2011 planting seasons at experimental field of the Teaching and Research Farm, Ladoke Akintola University of Technology Ogbomoso, Oyo State. The field trials comprising six levels of nitrogen (0, 25, 50, 75, 100, and 125 kgN/ha) applied as urea a month after transplanting and arranged in a Randomized Complete Block Design with four replicates and monitored for two consecutive years. Data were obtained on growth, yield, nutrient uptake and proximate composition of the plant. Data were analyzed using analysis of variance (ANOVA) at 5% probability level while the differences between the means were separated using LSD. The results showed that growth, yield and proximate values varied with quantities of Kg N applied. Leaf volume (14 cm^3) and number of suckers (4.5) were significantly enhanced at 75 kgN/ha compared with the control (11.8 and 1.8 respectively) at the first year. Highest values were observed at the second year for number of suckers (9.7), leaves (11.3), protein (5.8%) and fat (2.9%) at125 kgN /ha. The optimum KgN/ha fertilizer for *Aloe vera* established and recommended is between 75 and 125 kgN/ha for high growth, yield and proximate composition.

Keyword: *Aloe vera*, Optimum rates, Proximate composition, Nitrogen, Nutrient uptake

INTRODUCTION

Aloe vera (L) Burm. f. is an important medicinal plant that belongs to the family Liliaceae. *Aloe vera* is a monocotyledonous plant which grows to about 1m in height. It is known as first aid plant. The Yorubas in Nigeria call it *Eti Erin*. *Aloe vera* contains a unique organic phytochemical in its leaves that favours human health. It can be used to control or cure many human diseases i.e. for controlling gastric injuries, for anti-microbial activity, for curing acne, for anti-inflammatory activity and other medical characters (Adesumilli *et al.*, 2004).

The interactions of environment and nutrient influence the performance of crops. The nutrient status of the soil coupled with nutrient requirements of the crop form basis for the amount of fertilizer to be added for optimal performance. Both major and minor elements

are essential for crop production. Little work has been done in Nigeria on nutrient requirements of *Aloe vera* for optimal performance. There are reports that some Aloes need nitrogen and potassium fertilizer application at the rate of 100 kg potassium plus 200 kg nitrogen/ha for increased growth and leaf yield (Hossain *et al.,* 2007). Wabuyele *et al.* (2006), also reported that application of nitrogen may result in higher gel yields, faster leaf formation and higher gel yields per leaf but application of large amount of nitrogen may reduce gel quality. It was noted that, although aloes will require soil nutrient replenishment, the amounts and source of nitrogen to be used to grow Aloes for commercial purpose without compromising the aloe product quality was still very unclear. With the recent drive towards the multipurpose use of *Aloe vera* in Nigeria the judicious use of production inputs like fertilizer among others for optimum yield need to be examined, hence this study was undertaken to determine the optimum nitrogen rate for optimum yield and nutrient composition of *Aloe vera*.

MATERIALS AND METHODS

Field experiment was carried out in May 2010 to December 2011 at Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Oyo State (8^0 15' N, 4^0 25' E). The climate of Ogbomoso is mostly influenced by the North east trade wind and South west trade wind. The former is cold with drying effect which starts from November to march while the latter is warm and very moist. It starts from April to October.

Soil sampling and analysis

Prior to the commencement of the experiment in 2010, surface soil samples (0 – 15 cm) were taken with auger randomly from the experimental sites. The soil samples were bulked, air dried and sieved using a 2mm sieve and analyzed for the physical and chemical properties as follows: Soil particle size was determined by Bouyoucous method. Soil pH in H_2O (1:1) was determined using the custom laboratory apparatus. Soil organic carbon was determined by Walkley and Black method using the dichromate wet oxidation method. Total N was determined by micro- Kjeldahl digestion method, available P was determined by Bray – 1 extraction followed by Molybdenum blue colorimetry. Exchangeable K, Ca and Mg were extracted using 1.0 N ammonium acetate. Thereafter, K was determined using a flame photometer and Ca and Mg using atomic absorption spectrophotometer.

The treatment consisted of six levels of nitrogen (0, 25, 50, 75, 100 and 125 kg N/ha) applied as urea and laid out in a Randomized Complete Block Design with three replicates and monitored for two years. *Aloe vera* suckers collected from Ogbomoso were transplanted on May 2010. A 3 x 4 m bed was constructed and replicated thrice for each of the treatment at a spacing of 50 x 60 cm apart between and within rows to give a plant population of 33,333 plants/ha. Each bed contained 25 suckers. Fertilizer treatments were applied at 3weeks after transplanting the suckers by side placement and dribbling into the soil at their respective rates.

Growth parameters assessed were number of leaves, number of suckers, leaf width, leaf thickness, leaf length, weight gained and leaf volume. The meter ruler was used for measuring from base to the tips of the leaves, while number of suckers and leaves were counted, Venier caliper was used to measure the thickness. Leaf volume was calculated as V = (L/12)3.142WT (Hermandez- Cruz *et al.*, 2002). The proximate composition and plant uptake were also assessed. *Aloe vera* was harvested at the first and second year and freeze dried at 50 ^{0}C till constant weight was obtained. The freeze dried samples were milled with a Wiley mill and passed through a 0.5mm sieve for tissue analysis. Total P was determined by the vanadomolybdate method, K and Ca were determined by flame

photometry and Mg and Fe were determined by atomic absorption spectrophotometer. Total N was analyzed by the micro – Kjeidahl procedure and crude protein was obtained by multiplying the total N by a factor of 6.25. Concentrations of nutrient were expressed on the basis of percentage of dry leaf material. The nutrient uptake was calculated by multiplying the nutrient content by the dry matter weight.

All data were subjected to analysis of variance (ANOVA) and means were separated by the least significant difference at 0.05 level of probability.

RESULTS AND DISCUSSION

The test soil was loamy sand in texture, with a pH of 5.9, the organic carbon, total nitrogen and available phosphorus were 4.8g kg^{-1}, 0.03g kg^{-1} and 5.34g kg^{-1} respectively. The exchangeable base K, Ca, Mg and Na are 0.10, 7.65, 0.76, and 0.14 Cmol/kg respectively. The total Nitrogen, available P and exchangeable K were low in the soil. The implication here is that the soil is inherently low in major elements and fertility and would therefore, inevitably cannot support most crops. *Aloe vera*, not an exception. In Nigeria, soil fertility status is low as a result of many years of continuous cropping and lack of proper soil conservation techniques. Hence, fertilizer application is essential for enhancing soil nutrient status and increasing crop yield as well as quality of crops.

In the first year, highest number of suckers was observed at 75 kgN/ha and 125 kg N/ha in the second year, and this was significantly different from the control. While weight gained and leaf volume were significantly higher than the control at 125 kgN/ha (Table 1 and 2). Proximate and mineral composition at the second season shows highest protein at 125 kgN/ha, highest fat, Mn and lowest ash at 75 kgN/ha and highest Ca was observed at 25 kgN/ha while higher value of copper and iron was obtained at 50 kg N/ha (Table 3 and 4).

The significant response of growth parameters and number of offshoot production to increasing N rates demonstrated the high demand for this element. These results agree with the findings of Hossain *et al.* (2007) and Popoola (2002), for *Aloe vera*, who observed that *Aloe vera*, responded significantly to applied N rates for increased growth and yield. The increase in all the growth parameters measured, leaf length, leaf width, leaf thickness, number of suckers, number of leaves and dry matter yield as the N rate increased confirmed the importance and contribution of N to the vegetative growth of the crop plants. Maximum growth parameters were obtained at the highest rate of 75 kg N/ha at the first year after transplanting but in the second season highest were obtained at 125 kg N/ha. This might be due largely to the low level of mineralizable N of the native soils as a result of the low organic matter content. Therefore, nitrogen must be adequately supplied to increase leaf volume and leaf yield. The effect of N on the *Aloe vera* showed that N increased yield by increasing number of offshoot production and leaf volume per plant. This positive contribution of yield components to the number of suckers produced might be due to the improved growth parameters caused by the increased number of leaves, leaf length, leaf width, leaf thickness, dry matter yield which would amount to increased leaf area per plant in fertilized plots.

The measured parameters (leaf volume and number of offshoot) responded significantly to N rates, and a rate of 75 kg N/ha appeared optimum at the first year for the *Aloe vera* plant. At the second year the leaf width, number of suckers, weight gained and leaf volume were significantly higher at 125 kg N/ha. Therefore, *Aloe vera* responded to increasing N fertilizer rates until a peak (75 kg N/ha) is reached at the first year (Kramer,

1979), and thereafter, over fertilization led to reduced yield.

CONCLUSION

Application of 125 kg N/ha is optimum for economic yield and proximate composition. Highest values were observed at the second year for protein (5.8 %) and fat (2.9 %) at 125 kg N/ha.

Table 1: Effect of levels of nitrogen fertilizer application on growth and yield of *Aloe vera* grown on the field in the first year. (2010)

Treatment kgN/ha	Number of suckers	Number of leaves	Weight gained (g^{-1}plant)	Leaf volume (cm^3)	Leaf thickness (cm)	Leaf width (cm)	Leaf length (cm)
0	1.77b	7.33b	20.91a	11.71b	2.16b	1.52b	12.77a
25	2.88ab	8.89a	39.37a	12.98ab	2.33ab	1.67ab	12.61a
50	3.33ab	9.22a	35.91a	11.35b	2.25ab	1.50b	13.94a
75	4.55a	8.89a	38.40a	14.48ab	2.24ab	1.82ab	13.52a
100	3.00ab	8.75a	35.66a	13.26ab	2.23ab	1.71ab	13.29a
125	1.33b	8.55a	40.47a	17.81a	2.00a	2.00a	12.57a

Means having the same letter within the same column are not significantly different using Duncan Multiple Range Test at 5% probability level.

Table 2: Effect of nitrogen level on growth and yield of *Aloe vera* grown on the field in the second year (2011)

Treatment KgN/ha	**Number of suckers**	**Number of leaves**	**Leaf thickness (cm)**	**Leaf width (cm)**	**Leaf length (cm)**
0	5.00c	9.44b	2.74a	2.95a	23.87a
25	6.77abc	9.55b	2.74a	3.04a	24.07a
50	7.22abc	9.66ab	2.75a	3.21a	24.47a
75	7.50abc	9.88ab	2.83a	3.24a	24.75a
100	8.88abc	10.00ab	2.70a	3.32a	25.02a
125	9.66a	11.33a	2.75a	3.38a	25.14a

Means having the same letter within the same column are not significantly different using Duncan Multiple Range Test at 5% probability level.

Table 3: Effect of levels of nitrogen fertilizer application on proximate composition of *Aloe vera* at the second season after transplanting (2011)

Treatment KgN/ha	Protein	Fat	Ash	Moisture	Carbohydrate
		(%)			
0	4.83a	1.58b	7.60ab	10.01a	74.92
25	5.19a	2.64ab	7.76ab	8.72a	75.17
50	5.37a	2.67ab	7.12ab	7.62a	78.31
75	5.40a	3.16a	6.10b	9.45a	74.91
100	5.56a	3.48a	7.82a	7.20a	76.75
125	5.82a	4.14a	8.60a	8.45a	73.65

Means having the same letter within the same column are not significantly different using Duncan Multiple Range Test at 5% probability level.

Table4: Effect of levels of nitrogen fertilizer application on mineral composition of *Aloe vera* grown on the field at the second season after transplanting (2011)

Treatment KgN/ha	N	P	K	Ca	Mg	Zn	Mn	Cu	Fe
			(%)					(ppm)	
0	0.77a	0.11ab	0.26a	2.44a	0.55a	26.1a	170.34a	4.33a	127.10a
25	0.83a	0.12ab	1.10a	2.16a	0.38bc	23.9a	172.17a	3.89a	109.96
50	0.85a	0.12ab	0.06a	1.73a	0.32c	30.1a	160.27a	6.11a	189.90a
75	0.86a	0.12ab	0.13a	2.39a	0.49ab	26.1a	174.12a	3.88a	150.94a
100	0.89a	0.15a	0.16a	1.96a	0.36bc	25.1a	159.66a	4.33a	123.73a
125	0.93a	0.10a	0.16a	3.72a	0.52ab	25.00a	165.50a	3.56a	141.91a

Means having the same letter within the same column are not significantly different using Duncan Multiple Range Test at 5% probability level.

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