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Effect of Different Nitrogen and Potassium Rates on Agronomic Characters of *Aloe indica*

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ABSTRACT

A field study was conducted to investigate the growth of Aloe indica with different rates of nitrogen and potassium fertilizers at the Germplasm Centre, Department of Horticulture, Bangladesh Agricultural University. Treatments consisted of 0, 200 and 300 kg nitrogen/ha and 0, 100 and 200 kg potassium/ha. The rates of nitrogen and potassium had significant effect on the leaf production of Aloe indica when compared to control. Leaf yield of Aloe indica was highest at application of nitrogen at rate 200 kg/ha and potassium at rate 100 kg/ha. Leaf protein content was 12.71% higher at 200 kg N/ha and 8.47% higher at 300 kg N/ha compared to control. Potassium application at rate of 100 and 200 kg/ha produced 4.86 % and 8.51% higher leaf protein content than the control, respectively. It is recommended to apply nitrogen at rate 200 kg/ha and potassium at rate 100 kg/ha for leaf production of Aloe indica.

Key words: Aloe indica, chemical fertilizers, leaf nitrogen, protein content, potassium content

INTRODUCTION

The exudates of *Aloe indica* have been used for numerous medical and cosmetic applications since ancient times (Morton, 1961). Thus the cultivation of *Aloe indica* has acquired a great commercial importance for its medical products and cosmetics processing. However, information on agronomic management of *A. indica* is scarce. Soil and summer season climate of Bangladesh are congenial for the cultivation of some medicinal plants, including *A. indica.* Medicinal plant, in some cases, requires large quantity of readily available nutrients (Gupta and Shukla, 1997). As a result, there is a possibility to increase yield per unit area of medicinal plants if fertilizers are rationally applied.

Nitrogen fertilizer is the most critical for increasing crop production and has appropriately been recognized as the major element (Mukhopadhy *et al.*, 1986). Nitrogen had the largest effect on yield and quality of medicinal plants than any other nutrients (Xin *et al.*, 1997). Nitrogen also promotes vegetative growth and flower and fruit set of medicinal plants (Bose and Som, 1990). Meanwhile, potassium plays an important role in the development of reproductive parts of plants. Application of nitrogen as urea and potassium as muriate of potash (MoP) increased yield of onion (Levy, 1978). However, the effect of nitrogen and potassium on *A. indica* production is limited in Bangladesh. The objective of present study was to find out the optimum requirements of nitrogen and potassium for *A. indica.*

MATERIALS AND METHODS

The experimental was carried out in Bangladesh Agricultural University Experimental Farm (BAUEF) at 24º75′N and 90º50′E, 18 m above the sea level. The BAUEF belongs to the agro-ecological region of Old Brahmaputra Floodplain (AEZ-9) that occupies the Brahmaputra sediments, deposited before the river shifted to its present channel about 200 years ago (UNDP and FAO, 1988). The experimental field was a medium high land with silty clay loam texture having pH value of 6.5-7.0.

The soil was cultivated 20 days before planting with a tractor disc plough. It was further ploughed and cross-ploughed 6 times with the country plough each time followed by laddering. Triple super phosphate (TSP) and cowdung were applied at the rate 200 kg/ha and 10 t/ha, respectively, during the final land preparation. Weeds, rubbles and crop residues were removed from the land. The plots were prepared and drainage systems were made around individual plots.

The experiment was laid out in randomized complete block design (RCBD) with three replications/ blocks. Each block was divided into nine unit plots with block-to-block distance was 75 cm. Each plot (1m x 1 m) contained three plants. The distance between two plots was 50 cm. Treatments were three levels of nitrogen (0 kg, 200 kg, 300 kg N/ha) and three levels of potassium (0 kg**,** 100 kg**,** 200 kg K/ha). Nitrogen was applied as urea (46% N) and potassium as Muriate of Potash (MOP**,** 60% K).

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Seedlings were collected from Horticultural farm and transplanted in January 20, 2005. Half of N and all potassium were applied after one month of planting and the balance was applied two months after the first application. The fertilizer was applied in a ring around the plants.

Weeding was carried out manually. The first weeding was done 20 days after planting (DAP) when the plants were 5-10 cm high and then at 25-30 days intervals. The experimental plot was irrigated twice: at 20 and 55 DAP. At the time of irrigation, care was taken to avoid the flow of irrigation water from one plot to another. *A. indica* leaves were harvested seven months after planting when the plants were fully matured. One plant was randomly selected from each plot. Plant height, total number of leaves, fresh weight of the leaves, length and width of the leaves were recorded at the final harvest.

After few days of sun drying the leaves were then oven dried at 70º C until constant weight and finally ground by using grinding machine. Prepared samples were stored in paper bags and held in desiccators until analyzed. The plant samples were digested to prepare plant extracts following the method of Jackson (1962). Chemical analysis included the estimation of protein and mineral nutrients such as nitrogen and potassium. Total leaf nitrogen content was determined by the semi-micro Kjeldahl method (Page *et al.,* 1989). Potassium concentrations in digested samples were determined directly with the use of flame photometer (Beck, 1983). Data were subject to an analysis of variance and the means were compared following the Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Results

Application of nitrogen and potassium individually had significant effect on plant height of *A. indica* (Table 1). The higher plant height was produced in a treatment of 200 kg of nitrogen while the lower was found from the control. Potassium application at rate of 100 kg K/ha produced higher plant height (27.32 cm) than those of 200 kg K/ha and the control. Table 1 shows that the combined effect of nitrogen and potassium was significant. The highest *A. indica* was found in 100 kg K/ha combined 200 kg N/ha or combined with 300 kg N/ha. Combination of higher rate of nitrogen, i.e., 300 kg/ha, and 200 kg K/ha produced the lowest plant height of *A. indica*.

Number of leaves was affected by application of nitrogen and potassium (Table 1). The number of leaves was significantly higher in the plant applied with 300 kg N/ha than other treatments. In the absence of nitrogen application, *A. indica* significantly produced the lowest leaf number (15.2). In case of potassium, the different rates of K also significantly influenced the total number of leaves per plant. Application of potassium at rate 100 kg/ha produced about 7 leaves larger than those of 200 kg K/ha and the control, respectively (Table 1). Application of nitrogen and potassium altogether was important to increase number of leaves of *A. indica*. The higher number of leaves per plant, i.e., 29.0, was found in the plant applied with 300 kg N and 100 kg K/ha, while the lower number of leaves was found in the control.

Size of leaf, i.e., length and width was affected by application rate of nitrogen and potassium. Application of nitrogen at rate of 200 kg N/ha produced the longest leaf followed by control and 300 kg N/ha, i.e., 22.1 cm, 18.9 cm and 16.4 cm, respectively (Table 1). Width of the longest leaves was neither significantly affected by nitrogen nor potassium application, i.e., 1.2 cm (data not shown). Nevertheless, there was tendency that application of nitrogen at rate 300 kg N/ha combined with 100 or 200 kg K/ha produced larger leaf than those of lower rate of nitrogen and control. In case of potassium application, it produced the longest leaf length when 100 kg K/ha was applied, while the shortest was observed from control plant that was statistically similar to that of 200 kg K/ha (Table 1). There was interaction effect of nitrogen and potassium fertilizers where the combination of 200 kg N and 100 kg K/ha produced the longest leaf, while the shortest leaf was found from 0 kg K and 300 kg N/ha combination, i.e., 26.0 cm vs. 14.7 cm, respectively (Table 1).

The fresh weight of *A. indica* leaves was significantly influenced by the different rate of nitrogen and potassium application and its combination (Table 1). The higher fresh weight, i.e., 103.05 g, was produced from 200 kg N followed by 300 kg N/ha. Application of 200 kg N/ha significantly produced 53% heavier leaf than those of control. Individual application of potassium at rate 100 kg/ha produced higher fresh weight of leaves per plant, i.e., 104.77 g as compared to other treatments. Moreover, the combined effect of nitrogen and potassium on the fresh weight of *A. indica* leaves was also significant. The best combination was obtained from both of N and K at rate 200 kg/ha (Table 1).

Table 1. Combined effect of potassium and nitrogen application on plant height, number, length and weight of leaf of *Aloe indica*

Potassium (kg/ha)	Nitrogen (kg/ha)			Means
	0	200	300	
		Plant height (cm)		
0	22.33 c	26.00 bc	27.00 ab	25.11 b
100	22.66 cd	28.66 a	28.66 a	27.32 a
200	23.66 de	26.33 bc	19.32 f	23.10 c
Means	22.88 c	27.00 a	24.99 b	
CV	4.81			
		Leaf number		
0	13.3 f	15.0 e	19.7 c	16.0 b
100	18.0 d	21.0 b	29.0 a	22.7 a
200	14.3 ef	19.0 cd	14.7 e	16.0 b
Means	15.2 c	18.3 b	21.1 a	
CV	3.75			
		Leaf length (cm)		
0	17.66 ef	20.33 bc	14.66 g	17.55 b
100	20.66 b	26.00 a	18.66 cde	21.77 a
200	18.35 de	20.00 bcd	16.00 fg	18.12 b
Means	18.89 b	22.11 a	16.44 c	
CV	5.30			
		Fresh weight of leaf (g)		
0	56.33 d	128.30 b	129.70 ab	56.16 c
100	81.33 c	41.50 e	45.66 e	104.77 a
200	71.33 c	139.30 a	81.00 c	97.22 b
Means	69.66 c	103.05 a	85.44 b	
CV	6.94			

CV-coefficient of variance (%)
Value and means with different letters differ significantly ($\alpha \leq 0.01$)

The leaf nitrogen and protein content on dry weight bases were significantly influenced by different rate of N and K. Among treatments, the higher nitrogen and protein content were found from 200 kg N/ha and those of the lower percentages from the control (Table 2). Application of potassium at rate 100 and 200 kg/ha increased nitrogen and protein content irrespective of rate of application, i.e., 0.85% of nitrogen and 5.35% of protein higher than control. Table 2 shows that higher nitrogen and protein content, i.e., 0.95% and 5.93%, respectively, were observed from 200 kg N and 200 kg K/ha combinations that were statistically similar to that combination of nitrogen application at rate 200 kg and potassium at rate 100 kg K/ha.

Both nitrogen and potassium application significantly increased potassium content in *A. indica*. Nitrogen and potassium application at rate 200 kg/ha significantly accumulated higher potassium content than that of control plants. The combined effect of high level of nitrogen (300 kg/ha) and 100 kg or 200 kg K/ha resulted in high content potassium as compared with other treatments (Table 2).

Table 2. Combined effect of potassium and nitrogen application on nitrogen, protein and potassium content of *Aloe indica*

Potassium (kg/ha)	Nitrogen (kg/ha)			Means
	0	200	300	
		Nitrogen content (%)		
0	0.72 e	0.85 bc	0.80 cd	0.79 b
100	0.75 de	0.90 ab	0.84 c	0.85 a
200	0.80 cd	0.95 a	0.82 c	0.83 a
Means	0.75 c	0.90 a	0.82 b	
CV	4.44			
		Protein content (%)		
0	4.50 e	5.31 bc	5.00 cde	4.93 b
100	4.66 de	5.62 ab	5.25 bc	5.35 a
200	5.00 cde	5.93 a	5.12 bcd	5.18 ab
Means	4.72 c	5.62 a	5.12 b	
CV	5.77			
		Potassium content (%)		
0	0.27 e	0.28 cd	0.29 c	0.28 b
100	0.28 cd	0.32 a	0.31 ab	0.30 a
200	0.30 c	0.30 c	0.35 a	0.31 a
Means	0.29 b	0.30 a	0.32 a	
CV	5.09			

CV-coefficient of variance (%)
Value and means with different letters differ significantly ($\alpha \leq 0.01$)

Discussion

Application of nitrogen at rate 200 kg/ha resulted in the higher performance of most of the parameters compared to the other treatments. However, total number of leaf per plant was higher when *A. indica* was fertilized with nitrogen at rate 300 kg/ha and potassium application at rate of 100 kg/ha, independently. Root parameters (length and dry mass), however, were favored at higher level of potassium (data not shown).

It is worthy to note that application of nitrogen and potassium increased accumulation of protein, nitrogen and potassium in the leaves of *A. indica*. The protein and nitrogen contents were high particularly when 200 kg/ha of nitrogen was combined with the application of potassium at the rate 100 or 200 kg/ha. Potassium content of leaf was high (0.35%) when 300 kg/ha of nitrogen was combined with 200 kg/ha of potassium or 200 kg N/ha was combined with 100 kg K/ha (Table 3).

Leaf fresh weight, however, was high when nitrogen of 200 or 300 kg/ha applied solely, or 200 kg N/ha combined with 200 kg K/ha. Application of K at the rate of 100 kg/ha combined with 200 or 300 kg of nitrogen/ha reduced total leaf weight. It is still unclear why those combinations caused lower leaf weight, but not other parameters.

It is likely that application of nitrogen at rate of 200 kg/ha and 100 kg of potassium/ha was sufficient for *A. indica* growing. It is in agreement with result of Hernandez-Cruz *et al.* (2002) where they reported that there are no differences in plant growth between 100 and 150 kg N/ha fertilizer application. Saha *et al.* (2002) reported that organic fertilizers application at nitrogen base were found to be effective and comparable with inorganic fertilizer for increasing gel moisture and gel ash of *A. indica*.

Since *A. indica* is a succulent plant, it is probable that higher concentration of nitrogen and potassium in root zone is beneficial for it growing. Excess nitrogen and potassium application to the soil may have limited the uptake of other essential macro and micro nutrients by the plant leading to lack of significantly differences as shown in the present study. Other possibility is urea quickly dissolves in the soil water and readily leaches below the crop root zone. Paschold *et al.* (1999) indicated that at least nitrogen fertilization should be

based on the analysis of soil nitrogen especially if organic fertilizers are used. Therefore, soil analysis is an important factor before recommending fertilizer application. Nevertheless, we did not carried out soil analysis in this study.

CONCLUSION

It is concluded that nitrogen application at the rate of 200 kg/ha and potassium at rate 100 kg/ha was sufficient for an optimum growth and leaf production of *A. indica*.

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