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Impact of Urea Applications on Growth Attributes and Gel Yield of *Aloe vera* L. Plant

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ABSTRACT

Although *Aloe vera* is an indigenous plant of Sudan with numerous applications in health, cosmetics and food industries in global markets, agricultural research to exploit the potential of this plant is almost lacking. This study aimed to investigate the impact of urea applications at various rates on the growth attributes and quality of *Aloe vera* plants under nursery conditions, at Shambat, Khartoum North, Sudan. Five levels of urea (0, 1.5, 3, 4.5 and 6 g/plant) were tested as soil dressings in 25X30 cm plastic bags. The study was arranged in a complete randomized design where each treatment was replicated eight times. Data were collected after 12 months. The 1.5 g urea treatment enhanced growth, leaf gel and chlorophyll contents, whereas the higher levels of urea were suppressive. The encouraging results of this study elucidated an economical potential for possible large scale production of the plant under Sudan conditions.

INTRODUCTION

Aloe vera is a medicinal plant belonging to the family Liliaceae (Hasanuzzaman, *et al*., 2008). It is indigenous to Sudan and other African countries (Grindlay and Reynolds, 1986). The exploitation of the potential of the plant is increasing with growth of cosmetic and neutraceutical markets (Danhof, 1987). This perennial succulent is drought tolerant and can thrive well under xerophytic conditions (Heber, 2007). It was officially listed as a purgative and skin protectant by U.S. pharmacopoeia in 1930 (Park and Lee, 2006). The two major products of *Aloe vera* are yellow latex and clear gel, which are obtained from the large parenchymatic cells of the leaf (Ni *et al*., 2004). The main constituents of the latex are anthraquinones including the

hydroxyanthracene derivatives, aloin A and B, barbaloin, isobarbaloin and aloeamedin (Bradley, 1992). *Aloe vera* possesses several biological and physiological activities, such as wound healing, anti-inflammation, anti-bacterial, anti-viral, anti-fungal, anti-diabetic and anti-neoplastic (Hamman, 2008; Eshun and He, 2005; Reynolds, 2004).

The uses of *Aloe vera* are diverse in Sudan. In ethno medicine it is used for skin moisturing, treatment of burns and a purgative especially for injuries in diabetic patients. Besides, it is a component of the drought tolerant ornamentals of rocky gardens. Research aiming at economic exploitation of this plant under Sudan conditions is almost lacking. In response to the international awareness about the significance of *Aloe vera* in human health and its applications in development of cosmetic products, it is important to study the means of increasing its production and quality. Hence, this study aimed to investigate the impact of urea applications on growth attributes of *Aloe vera.*

MATERIALS AND METHODS

This test was conducted in complete randomized design in the nursery of Sudan University of Science and Technology, at Shambat, Khartoum North, Sudan, for determination of the impact of urea applications on growth attributes of *Aloe vera*. Tillers, 12-15 cm long were planted in 25X30 cm plastic bags containing river Nile sedimentary silt soil. A month after establishment, they were used as test plant material. Urea (46% N) treatments were applied in rates of: 0.0, 1.5, 3.0, 4.5 and 6.0 g/plant as soil dressing. Each treatment was replicated 8 times and each plant in a bag was considered a replicate. Urea applications were repeated every 3 months and irrigation was applied according to need. Final data were collected after 12 months for number of leaves, leaf length, leaf width, leaf thickness, number of tillers, number of roots, root length, shoot fresh and dry weights, root fresh and dry weights, leaf fresh weight, leaf gel weight, leaf peel weight, and chlorophyll 'a' and 'b' contents. For dry weights, the harvested shoots and roots were subjected to sun drying for 30 days, prior to oven drying for a week at 70° C until weights were constant. For determination of leaf gel content, the leaves were cut into several portions with scalpel blades to ease gel extraction after weighing the leaves. The remaining peels were weighed separately with a portable digital balance. Determination of chlorophyll content was performed according to the method of Arnon (1949) by using the chlorophyll flourometer (Li-Cor, Lincoln, NE, USA). Two hundred milligrams of fresh leaf samples were ground with 10 ml of 80% acetone at 4^{o}C and centrifuged at 2500 rpm for 10 minutes at 4^{o}C. Three milliliters aliquots of the extract were transferred to a cuvette and the absorbance was read at 665 and 649 nm with spectrophotometer after which the chlorophyll (a) and (b) were determined by Vernon's models. The collected data were subjected to analysis of variance and means were separated by Duncan's Multiple Range Tests with the aid of MstatC computer program.

RESULTS

According to Table (1) no significant differences were observed among treatments in number of leaves. The leaf length was not significantly different between the control and urea treatments

1.5- 4.5 g/plant, although the value of the control was slightly higher. However, the highest dose of urea resulted in significant decrease in leaf length compared to the control (Table 1). The leaf width was equally increased by the different urea treatments with significant difference from the control (Table 1). On the other hand, the results of leaf thickness showed no significant differences between the treatments and the control (Table 1).

Table 1: Impact of urea levels on number of leaves, leaf length, width and thickness of (*Aloe vera* L.) plants

Urea level (g/plant)	No. of leaves	Leaf length (cm)	Leaf width (mm)	Leaf thickness (cm)
0.0	14.6 a	41.10a	3.10 b	0.94 a
1.5	14.8 a	38.36ab	4.12a	1.06 a
3.0	15.0 a	38.34ab	3.76a	1.10 a
4.5	14.4 a	40.21ab	4.02a	1.16 a
6.0	14.8 a	36.36b	4.12a	1.04 a
C.V.	8.14	9.20	10.79	19.10

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Significant differences were observed among treatments in the number of tillers/plant. The highest values were recorded for the 1.5 g urea treatment. Above that, the 3 g urea treated tillers showed no significant difference from the control. However, the 4.5 and 6 g urea treatments were inferior compared to the control (Table 2). The 1.5 g urea treatment resulted in increase in the number of roots significantly compared to other treatments. With increase in urea level the number of roots decreased steadily (Table 2). However, the least root length resulted from the 1.5 and 6 g urea treatments, while the other urea treatments performed similar to the control and ranked top (Table 2).

Table 2: Impact of urea levels on number of tillers, number and length of roots of (*Aloe vera* L.) plants

Urea level (g/plant)	No. of tillers per plant	No. of roots per plant	Root length(cm)
0.0	13.8b	24.8bc	21.08a
1.5	17.6a	36.8a	14.88b
3.0	13.2b	28.0b	21.48a
4.5	10.8c	27.8b	21.48a
6.0	10.6c	22.4c	14.82b
C.V.	13.39	12.22	10.84

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Table (3) illustrates the impact of urea treatment on fresh and dry weights of shoots and roots. Except the 3 g/plant urea treatment that was equal to the control, the other urea levels resulted in significant decrease in shoot fresh and dry weights. The 1.5 g urea treatment resulted in significant increase in the

root fresh weight compared to other treatments except the 3 g urea treatment. Again the 1.5 g urea treatment increased root dry weight significantly over the 4.5 and 6 g urea treatment but without difference from the control and the 3 g urea treatment.

Table 3: Impacts of urea levels on shoot and roots fresh and dry weights of (*Aloe vera* L.) plants

Urea level (g/plant)	Shoot fresh weight (g)	Shoot dry weight (g)	Root fresh weight (g)	Root dry weight (g)
0.0	738.4a	73.96a	29.54b	2.98ab
1.5	632.8b	63.34b	33.96a	3.36a
3.0	777.3a	77.66a	31.40ab	3.12ab
4.5	527.2c	52.76c	27.82b	2.78b
6.0	558.8c	55.98c	20.40c	2.02c
C.V.	4.93	4.57	11.37	11.12

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

Table (4) demonstrates the impact of urea treatments on leaf fresh weight, gel weight, peel weight and chlorophyll content. The highest leaf fresh weight was obtained from the 1.5 g urea treatment followed by the 3 g treatment. Regarding gel weight, the 1.5 g urea treatment also excelled other treatments that performed alike with significant decrease compared to the control. The 1.5 urea treatment also resulted in significant increase in peel weight compared to other treatment except the 3 g treatment. The 1.5 g urea treatment also increased leaf chlorophyll content significantly compared to other treatments. The highest urea dose resulted in the least chlorophyll 'a' content. However, chlorophyll 'b' content was equally enhanced by the 1.5- 4.5 g urea treatments with significant difference from the other treatments.

Table 4: Impacts of urea levels on leaf fresh weight, gel weight, peel weight and chlorophyll content of *Aloe vera* L. plants

Urea level (g/plant)	Leaf fresh weight (g)	Gel weight (g)	Peel Wt (g)	Chlorophyll	
				A	B
0.0	196.2c	113.0 b	082.2c	17.96b	08.24 b
1.5	228.2a	131.2 a	103.8a	24.38a	12.66 a
3.0	211.2b	111.0 b	100.2ab	19.64b	12.12 a
4.5	188.0c	101.6 b	089.6bc	18.58b	10.96 a
6.0	171.8d	085.8 c	079.4 c	11.76c	07.34 b
C.V.	5.16	8.25	10.16	10.84	18.24

* Means with the same letter (s) in the same column are not significantly different at 95% confidence limit according to DMRT.

DISCUSSION

Fertilizers are sources of plant nutrients that can be added to the soil or foliarly applied to maintain optimum productivity. There is usually dramatic improvement in both quantity and quality of plant growth when appropriate fertilizers are added (Sakakibara, *et al*.,

2006). According to Hernández-Cruz, *et al*. (2002), nitrogen is one of the nutrients elements that often limit growth of most plants and the need for nitrogen varies from plant to plant. Mengel and Kirkby (1987) reported that, inadequate level of nitrogen shortens plant life cycle, and decrease economic yield. Toth, *et al*., (2002) reported that nitrogen is one of the most important elements of the chlorophyll structure and low rate of photosynthesis under conditions of nitrogen limitation can too often be attributed to the reduction of chlorophyll content. Besides, they observed that, the application of nitrogen increased the chlorophyll content in leaves of the *Aloe vera* plants and the highest levels of chlorophyll 'a' and 'b' were obtained in the highest levels of nitrogen. Soil fertility management may be one of the strategies to increase yield of *Aloe vera* (Hasanuzzaman, *et al*., 2008). Urea is an accessible source of nitrogen which is the basic unit for amino acids and subsequently the biosynthesis of proteins. However, the results of this study revealed the benefits of urea addition to the potting soil of *Aloe vera* plants at low concentration as it enhanced most of growth attributes significantly. The results are in line with preceding findings as it had been reported that the application of N fertilizer enhanced the growth and yields of *Aloe vera* (Khandelwal *et al*., 2009; Van Schaik *et al*., 1997). Besides, Hazrati, (2012), reported that the application of nitrogen had positive effect on the growth and aloin concentration of *Aloe vera* plants. Nevertheless, the result is in contrast with that of Babatunde and Yongabi (2008) who observed an increase in growth parameters of *Aloe vera* plants with increase in N levels. The river Nile sedimentary silt soil used in this study seems fertile enough to meet the nutritional requirement of the plants without need for higher urea concentrations. The increase in tillers obtained by the low urea level is advantageous for propagators as tillers are the major propagation means of this plant. The increase in gel weight by the lowest urea treatment means increase in marketable yield. This enhancement may owe to the increase in chlorophyll content of leaves. This result is supported by the findings of Nahed and Aziz, (2007) who stated that, the unique role of nitrogen in photosynthesis and other important physiological processes had been related to increase in chlorophyll content, and the indirect effect on enhanced yield and concentration of aloin which is the active ingredient in *Aloe* v*era* plant. Similarly, Hazrati, (2012) showed that, the nitrogen increased growth, yield and aloin concentration in *Aloe vera* plants. The increments obtained in other parameters in this study were also supported by the findings of preceding studies. As the leaf is an important factor in yield determining in *Aloe vera* plants (Tawaraya, *et al.*, 2007, Eshun and He, 2005), showed that, shoot fresh weight of *Aloe vera* was increased by application of nitrogen in the range of 0.5-1.0 g/ plant. Besides, Hazrati, (2012), reported that, the volume of leaf increased as a result of increase in length and thickness of leaves upon nitrogen application to *Aloe vera* plants. Ji-Dong, *et al*., (2006) reported that, the nitrogen application increased leaf fresh weight and total biomass. Inasmuch as, Hernández-Cruz, *et al*., 2002), showed that, the yield of aloe gel was better with

a low frequency of watering and a adequate amount of fertilizer.

In conclusion the results of this study confirmed the need of *Aloe vera* plants to nitrogen nutrition for enhanced growth attributes and gel yield. Besides, the encouraging results of this study elucidated an economical potential for possible large scale production of the plant under Sudan conditions. Yet, further biochemical studies are needed to determine the impact of nitrogen levels on active ingredients contents, which are the critical quality determining factors.

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