

EFFECT OF FERTILIZER TREATMENTS ON THE GROWTH OF *ALOE VERA* L.

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Abstract

The aim of the present study was to find out the effect of various doses of three fertilizers. The results revealed that the number of leaves were non-significant at various applied fertilizers (urea, diammonium phosphate (DAP) and farmyard manure (FYM). The leaf length of *Aloe vera* showed significant differences and it was due to increased urea and DAP fertilizers while FYM showed non-significant results. DAP application had significant effects on average leaf breadth while urea and FYM had non-significant results. The average leaf area was significantly increased under different fertilizers like urea and DAP. FYM had non-significant effects on the average leaf area in the present case. There were significant differences in dry weight of total leaves under various doses of fertilizers. The fertilizers non-significantly affected the total leaves moisture contents under various doses of fertilizers. It was observed that urea and DAP were more effective for the growth of this plant. If extensive cultivation of this plant is started it will help the pharmaceutical industries to prepare different herbal products that can be exported to other countries. Its cultivation can be started in the drier regions as well.

Key words: *Aloe vera* growth, Fertilizer, Urea, DAP, Farmyard manure

Introduction

Aloe vera is a shrubby or arborescent, perennial, xerophytic, succulent, pea- green color plant and has been used in dermatology (Balasubramanian & Narayanan, 2013). Plant is indigenous to eastern and southern Africa, also cultivated in Europe, India including northwest Himalayan region (Mukesh *et al.*, 2010). In Pakistan, plant is planted in gardens in Sind and Punjab also found in Goi in Poonch (Stewart, 1972). World trade worth about 80 million US\$ dollars exists now and this is likely to increase by 35-40 (%) within 5 years. USA dominates the market (65%) while India and China have a share of 10 (%) each which could be enhanced by its commercial cultivation (Biswas, 2010).

The cultivation of *Aloe vera* has gained great commercial importance for medicinal products and cosmetics processing. Its cultivation is expanding as it provides quick and regular income to the farmers (Moorthy & Malliga, 2012). The *Aloe* pulp had proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds, small organic compounds and carbohydrates (Hamman, 2008). Plant contained vitamins A, C, E, vitamin B12, folic acid, a glycoprotein, C-glucosylchromone, anthraquinones, aloin, emodin, fatty acids and salicylic acid (Surjushe *et al.*, 2008).

Aloe gel could improve wound healing (Hamman, 2008). Plant reduces severe joint and muscle pain associated with arthritis, as well as pain related to tendinitis and injuries (Kumar *et al.*, 2010). Anthraquinones act as a laxative. It increases intestinal water content, stimulates mucus secretion and increases intestinal peristalsis. The two fractions from *Aloe* that are claimed to have anti-cancer effects include glycoproteins (lectins) and polysaccharides (Haque *et al.*, 2012).

Today, the *Aloe* industry in USA and Mexico has established high ethical standards for businesses and *Aloe* products (Saeed *et al.*, 2003-4). The leaves of *Aloe* are eaten as vegetable. Leaves are helpful in indigestion and

constipation. Cosmetic companies add sap or other derivatives from *Aloe vera* to products such as makeup items, moisturizers, soaps, sunscreens, shaving cream, and shampoos (Nandal & Bhardwaj, 2012). It is available in a variety of products such as medicated cream, hand and body lotion, heat rub, pure *Aloe vera* juice, mini lift mask, medicated jelly, and moisturizer etc. Commercially *Aloe* can be found in pills, sprays, ointments, lotions, liquids, drinks, jellies and creams to name a few of the thousands of products available (Haque, 2012).

This plant can be grown in arid and tropical areas such as Africa, Europe and India. But in Pakistan this plant is not cultivated on large scale. So an experiment was conducted to study the effect of various fertilizers on the growth of this plant.

Materials and Methods

The experimental work was started in November 2012, to observe the effect of various doses of three different fertilizers on the growth of *Aloe vera*. The applied fertilizers were urea, diammonium phosphate and farmyard manure. The experimental work consisted of the following parts.

a) *Aloe vera* seedlings were obtained from Hayatabad nurseries, Peshawar. b) Transplantation, *Aloe vera* seedlings having the height of about 5-6 (cm) were transplanted to earthen pots of equal size (21cm long and 24 cm wide) on 23-11-2012 and pots were filled with (5 kg) loamy soil and five healthy seedlings were left in each pot. They were uniform and equally distributed in pots. Each replicate was labeled with a specific dose (1, 1.5, 2g). The small *Aloe vera* cutting was kept in soil about 1-inch deep to keep it firm in the soil. Irrigation was done at the time of transplantation with tap water. There were three replicates for each dose of each fertilizer used and three pots were used as control having no fertilizers. Pots were organized in Completely Randomized Design (CRD) and kept under uniform open environment. c)

Fertilizers application, when the healthy seedlings were sufficiently stronger and established the root system and attained a height of about 6-8cm. The three different fertilizers were applied to all the pots on 22. 12. 2012. Each dose was replicated three times with five seedlings in each pot. These doses were 1.0 g, 1.5 g, and 2.0 g of urea, DAP and FYM. Each dose of urea and DAP was dissolved in 40 ml of distilled water before application while the three doses of FYM were applied directly to all the seedlings. The pots were kept in the net house of Botany Department, University of Peshawar and protected from rain or dew by polyethylene sheets. *Aloe vera* is a xerophytic plant and did not require water regularly so irrigation was done after one week interval. The irrigation was done moderately in early days and the plants were kept away from heavy rainfall because heavy rain water could cause leaching of fertilizers.

First weeding was done on 1st March, 2013 and weeds like *Poa annua*, *Stellaria media*, *Euphorbia helioscopia*, *Oxalis corniculata*, *Sisymbrium irio* and some grasses were removed. Another weeding was done after three weeks. First hoeing was done when the plants attained the height of about 8 to 12 (cm) after 1st weeding on 1st March. Other hoeings were done after each weeding.

In March, all the plants showed improvement in growth and all fertilizers showed its effects. When the plants attained full maturity and ready for harvest the growth parameters were taken. The growth parameters included plant height, number of leaves, leaf length, leaf breadth, leaf area, length, breadth and area of the largest leaf. When the plants were mature they were harvested on 26-5-2013, *Aloe vera* leaves were harvested carefully and its fresh weight was taken. The leaves were packed separately in envelopes and were dried in oven at 65°C for 72 hours for dry weight determination. The moisture contents of various plant parts were determined on fresh weight (wet) basis. Percentage of moisture contents was calculated using the following formula, and followed the method of (Kumar *et al.*, 2013; Ali *et al.*, 2011; Norimi *et al.*, 2012).

$$\text{Moisture content (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight}} \times 100$$

Statistical analysis

The results of effects of various doses of different fertilizers were subjected to one way analysis of variance (ANOVA) and significant differences between samples were determined by F-test using (SAS, 1999) program. In the present study ($p < 0.05$) was regarded as statistically significant (Yadegari *et al.*, 2012).

Results

Effect on plant height (cm): ANOVA revealed that plant height was significantly enhanced only by DAP doses and urea and FYM exhibited non-significant differences (Table 1). The minimum plant height was observed in control while DAP showed significant increase in plant height (Table 2; Fig. 1; Figs. 15a, b).

Effect on number of leaves: ANOVA showed that the number of leaves were non-significant due to the application of three fertilizers (Tables 1 & 2; Fig. 2; Figs. 15a, b, c).

Effect on leaf length (cm): ANOVA showed that leaf length revealed significant differences and it was due to increased urea and DAP fertilizers doses and FYM effect was non-significant (Tables 1 & 2; Fig. 3; Figs. 15a, b, c).

Effect on leaf breadth (cm): The statistical results showed significant effects for average leaf breadth due to only DAP application (Tables 1 & 2; Figs. 4; Figs. 15b, c).

Effect on leaf area (cm²): ANOVA showed that the average leaf area was significantly enhanced by different fertilizers like urea and DAP. FYM had non-significant effects on the average leaf area (Tables 1 & 2; Fig. 5; Figs. 15a, b, c).

Effect on total leaves fresh weight (g): ANOVA showed non-significant results for total leaves fresh weight due to urea, DAP & FYM (Tables 1 & 2).

Effect on total leaves dry weight (g): The statistical results showed significant differences for dry weight of total leaves due to the use of doses of fertilizers (urea, DAP & FYM) (Tables 1 & 2).

Effect on total leaves moisture content (%): ANOVA revealed that the differences in the total leaves moisture contents were non-significant (Tables 1 & 2)

Effect on largest leaf length (cm): ANOVA indicated that significant results were observed for largest leaf length due to the application of urea and DAP while FYM produced non-significant effects (Tables 1 & 2; Fig. 9; Figs. 15a, b).

Effect on largest leaf breadth (cm): ANOVA showed significant effects for largest leaf breadth due to fertilizers doses (urea, DAP & FYM) (Tables 1 & 2; Fig. 10; Figs. 15a, b, c).

Effect on largest leaf area (cm²): ANOVA exhibited that largest leaf area was significantly increased due to the application of fertilizers (urea, DAP & FYM) (Tables 1 & 2; Fig. 11; Figs. 15a, b).

Effect on largest leaf fresh weight (g): ANOVA showed that the largest leaves fresh weight was significant only at DAP while urea and FYM showed non-significant results (Tables 1 & 2).

Effect on largest leaf dry weight (g): The results revealed non-significant differences for largest leaf dry weight due to the application of fertilizers (urea, DAP & FYM) (Tables 1 & 2).

Effect on largest leaf moisture content (%): ANOVA showed non-significant results for moisture contents due to the application of different doses of fertilizers (urea, DAP & FYM) (Tables 1 & 2).

Table 1. Mean squares of analysis of variance for various parameters of *Aloe vera* L.

Doses	SOV	d.f	Plant height (cm)	No of leaves	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm ²)	Total leaves fresh weight (g)	Total leaves dry weight (g)	Total leaves moisture contents(%)	Largest leaf length (cm)	Largest leaf breadth (cm)	Largest leaf area (cm ²)	Largest leaf fresh weight (g)	Largest leaf dry weight (g)	Largest leaf moisture contents (%)
U	Doses	3	20.3	16.3	8.2*	0.01	10.2*	4899.0	41.5*	5.6	34.4*	0.3*	113.4*	806.8	1.2	14.6
R	Errors	6	11.9	12.2	0.5	0.04	2.1	2570.5	7.01	1.6	5.2	0.06	14.0	221.9	0.5	7.2
E	F-values		1.7	1.33	14.87	0.20	4.94	1.91	5.91	3.4	6.6	4.95	8.09	3.6	2.5	2.0
A	Total	9														
(g)	COV (%)		20.9	33.7	8.7	11.8	17.9	41.5	28.5	1.4	15.6	11.1	22.3	36.5	21.8	2.9
D	Doses	3	38.3*	9.1	7.6*	0.4*	18.8*	11585.6	114.4*	7.2	44.0*	1.2*	220.3*	625.5*	2.2	7.3
A	Errors	6	5.7	3.1	0.4	0.06	2.5	2710.5	8.9	6.3	2.4	0.2	22.9	69.1	0.7	3.3
P	F-values		6.7	2.9	20.9	5.31	7.5	4.3	12.8	1.13	18.6	6.4	9.6	9.05	3.3	2.3
(g)	Total	9														
	COV (%)		13.3	19.2	7.1	12.8	18.2	34.2	22.9	2.8	9.5	15.8	20.8	20.6	25.5	1.9
F	Doses	3	13.7	5.6	6.1	0.1	8.5	4117.8	103.1*	29.4	12.9	0.4*	65.4*	310.3	2.5	0.6
Y	Errors	6	5.2	2.3	1.8	0.2	15.9	1906.1	12.7	6.9	5.1	0.01	9.4	73.8	2.4	5.01
M	F-values		2.6	2.3	3.4	0.4	0.5	2.2	8.1	4.3	2.5	59.9	6.9	4.2	1.1	0.13
(g)	Total	9														
	COV (%)		14.5	16.7	16.0	23.6	50.3	36.7	29.1	2.9	16.9	3.2	17.9	24.4	43.1	2.5

*= Significant at 5% level; FYM = Farmyard manure; DAP = Diammonium phosphate; COV = Coefficient of variation; SOV = Source of variation

Discussion

Effect on plant height (cm): The ANOVA showed that plant height was significantly increased only by DAP doses while urea and FYM showed non-significant differences (Table 1). The lowest plant height (12.9 cm) was observed in control while DAP showed significant increase in plant height with every increasing dose. It attained the maximum plant height (21.1 cm) at (2.0 g) and (19.7 cm) at 1.5 g of DAP followed by (18.8 cm) at 1.5 g urea (Table 2; Fig. 1; Figs. 15a, b). Hossain *et al.*, (2007) reported that N fertilizers increased the plant height of *Aloe vera*. Vetayasuporn, (2006) reported significant increase in plant height of *Allium cepa* by P fertilizers which agrees with the present results. In a field studies, Khan *et al.*, (2012) reported that availability of nutrients increased the biomass of plants.

Effect on number of leaves: ANOVA indicated that the number of leaves were non-significant at various applied fertilizers (urea, DAP and FYM) (Table 1). Average number of leaves were (7.9) in control and highest number (13.5) of leaves were observed at (1.5 g) urea followed by (11.01) at (1.5 g) FYM and (10.7) at 2.0 g DAP (Table 2; Fig. 2; Figs. 15a, b, c). Abdissa *et al.*, (2011) reported that P fertilizers had non-significant effects on *Allium cepa* leaves number which agrees with the present findings. Yoldas *et al.*, (2011) observed that N and P and manure fertilizers had non-significant effects on number of *Allium cepa* leaves and it agrees with the present results. Nori *et al.*, (2012) also reported that N fertilizers had non-significant effects on *Allium sativum* leaves number and it agrees with the present findings.

Effect on leaf length (cm): ANOVA revealed that leaf length showed significant differences and it was due to increased urea and DAP fertilizers doses while FYM showed non-significant results (Table 1). The leaf length was (6.4 cm) in control, while urea showed maximum (10.5 cm) leaf length at 1.0 g followed by (9.9 cm) at 1.0 g DAP and (9.8 cm) at 1.5 g FYM (Table 2; Fig. 3; Figs. 15a, b, c). Barandoziet *et al.*, (2011) observed increase in leaf length of *Aloe vera* under N and P fertilizers which agrees with the present findings. Hoseini *et al.*, (2013) reported that organic fertilizers increased leaf length of *Aloe vera* but the present results of farmyard manure are statistically non-significant and did not agree with this study.

Effect on leaf breadth (cm): ANOVA indicated significant effects for average leaf breadth due to only DAP application while urea and FYM had non-significant effects (Table 1). The control showed (1.8 cm) average leaf breadth while it gradually increased with the application of DAP and with increasing doses of DAP it reached to maximum (2.46cm) at 2.0 g and (2.06cm) at 1.5 g while FYM showed the same height (2.1cm) at 2.0 g and (2.06) at 1.5 g doses (Table 2; Figs. 4; Figs. 15b, c). Barandozi *et al.*, (2011) showed that N and P fertilizers increased leaf breadth of *Aloe vera* which agrees with present DAP effects on plant but did not agree with urea effects

Table 2. Effect of various doses of fertilizers on various growth parameters of *Aloe vera* L.

Fertilizers	Doses	Plant height (cm)	# of leaves	Leaf length (cm)	Leaf breadth (cm)	Leaf area (cm ²)	Total leaves fresh weight (g)	Total leaves dry weight (g)	Total leaves moisture contents (%)	Largest leaf length (cm)	Largest leaf breadth (cm)	Largest leaf area (cm ²)	Largest leaf fresh weight (g)	Largest leaf dry weight (g)	Largest leaf moisture contents (%)	
U R E A (g)	Control	12.9	7.9	6.4 C	1.8	5.6 B	64.1	4.4 B	92.7	10.6 C	2.0 B	10.6 B	20.2	2.2	89.3	
	1	17.9	10.1	10.5 A	1.9	10.2 A	131.5	8.3 AB	93.2	18.3 A	2.6 A	24.9 A	58.6	3.5	93.4	
	% of Control	138.7	129.2	162.7	105.4	179.4	205.1	187.9	100.5	171.8	133.3	233.4	290.9	159.7	104.5	
	1.5	18.8	13.5	8.8 B	1.8	8.2 AB	157.8	11.8 A	92.4	16.3 AB	2.16 B	17.7 AB	47.6	3.1	93.4	
	% of Control	145.7	170.3	137.3	100	144.6	246.1	266.9	99.6	153.1	108.4	166.5	236.4	138.8	104.5	
	2.0	16.1	9.8	8.5 B	1.8	8.1 AB	135.2	12.5 A	90.13	13.2 BC	2.0 B	13.7 B	36.9	3.5	89.8	
	% of Control	124.8	123.8	133.2	98.2	143.5	210.8	282.7	97.2	123.7	100	129.0	183.3	158.2	100.6	
	LSD values	NS	NS	1.5	NS	2.9	NS	5.3	NS	NS	4.5	0.5	7.5	NS	NS	NS
	Control	12.9 B	7.9	6.4 C	1.8 B	5.6 B	64.1	4.4 B	92.7	10.6 B	2.0 B	10.6 B	20.2 B	2.2	89.3	
	1.0	17.9 A	7.4	9.9 A	1.7 B	8.7 AB	153.3	15.4 A	90.6	19.5 A	2.5 AB	23.5 A	47.0 A	3.36	92.7	
% of Control	139.3	93.7	154.4	101.9	154.7	239.0	347.4	97.6	182.5	123.4	223.0	233.2	150.7	103.7		
1.5	19.7 A	10.6	8.1 B	2.1 AB	8.5 B	186.9	13.6 A	92.7	17.3 A	3.2 A	28.2 A	41.1 A	3.0	92.5		
% of Control	152.7	133.8	81.5	121.2	151.2	291.4	308.3	99.9	162.5	161.6	264.6	203.9	137.3	103.6		
2.0	21.1 A	10.7	9.5 A	2.46 A	11.8 A	203.4	18.9 A	89.6	17.4 A	3.3 A	29.4 A	53.5 A	4.4	91.8		
% of Control	163.3	138.6	148.5	142.4	208.2	317.2	424.1	96.7	163.1	166.7	275.3	265.3	195.8	102.8		
LSD values	4.7	NS	1.2	0.5	3.16	NS	5.9	NS	NS	0.07	0.8	9.5	16.6	NS	NS	
Control	12.9	7.9	6.4	1.8	5.6	64.1	4.4 B	92.7	10.6	2.0 C	10.6 B	20.2	2.2	89.3		
1.0	15.43	8.9	8.6	1.9	9.2	141.1	14.4 A	89.3	13.3	2.6 B	17.3 A	38.9	3.9	90.2		
% of Control	119.6	112.5	134.7	103.5	162.9	220.0	325.5	96.3	124.4	130.0	161.8	193.2	174.6	100.9		
1.5	17.9	11.01	9.8	2.06	7.6	142.30	11.8 A	91.16	15.6	2.7 AB	21.3 A	42.4	4.2	90.36		
% of Control	139.0	138.2	152.8	110.7	134.1	221.8	226.2	98.3	146.2	136.6	199.9	210.1	186.6	101.2		
2.0	16.6	10.0	8.6	2.1	9.16	127.7	18.3 A	85.5	14.1	2.7 A	19.5 A	39.5	4.1	89.8		
% of Control	128.6	125.9	134.2	37.1	161.9	90.5	413.5	92.2	132.5	138.4	183.4	196.0	183.6	100.5		
LSD values	NS	NS	NS	NS	NS	NS	7.12	NS	NS	NS	0.2	6.15	NS	NS	NS	

NS = Non-significant, FYM= Farmyard manure. DAP= Diammonium phosphate.

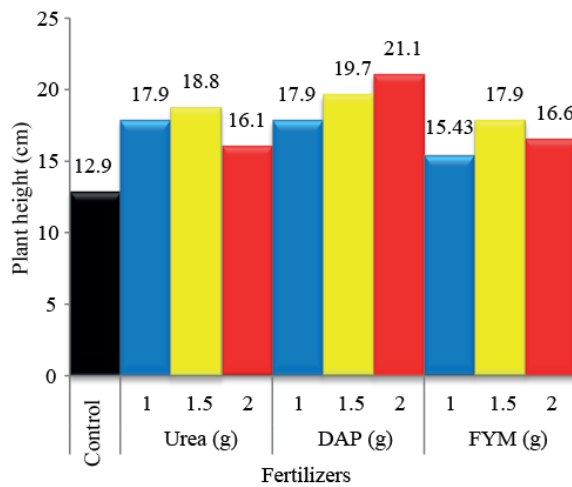


Fig. 1. Effect of various doses of three different fertilizers on plant height (cm) of *Aloe vera* L.

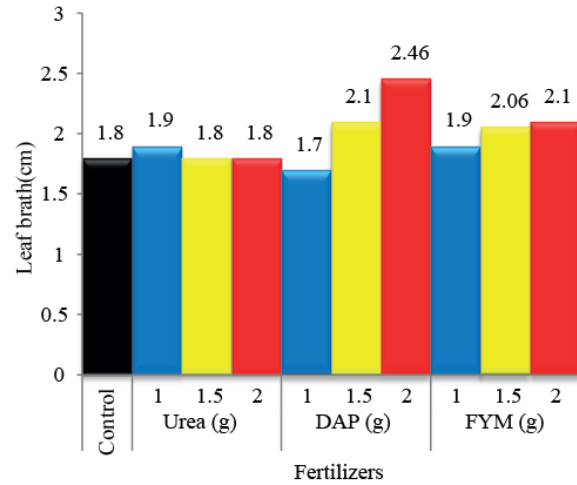


Fig. 4. Effect of various doses of three different fertilizers on leaf breadth (cm) of *Aloe vera* L.

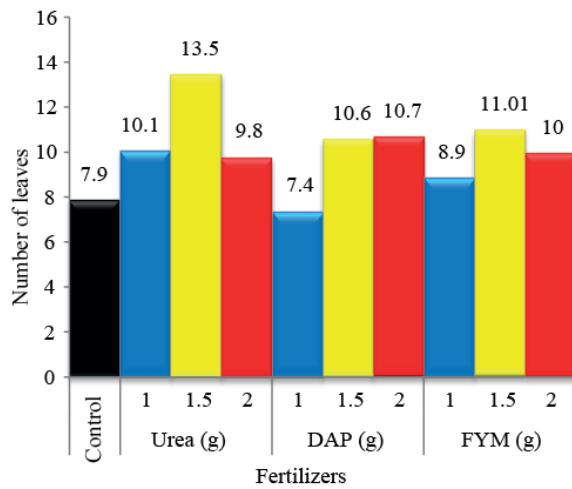


Fig. 2. Effect of various doses of three different fertilizers on number of leaves of *Aloe vera* L.

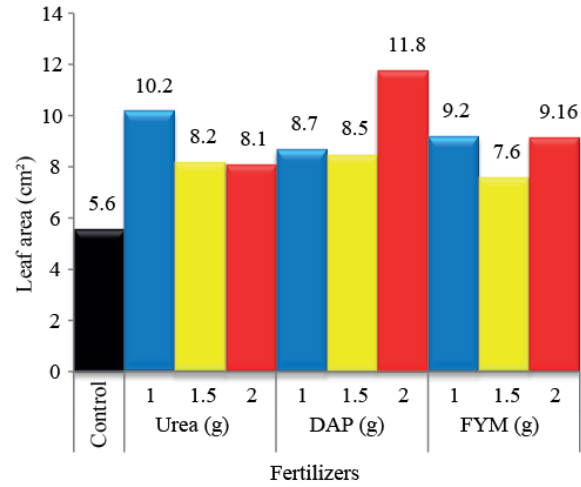


Fig. 5. Effect of various doses of three different fertilizers on leaf area (cm²) of *Aloe vera* L.

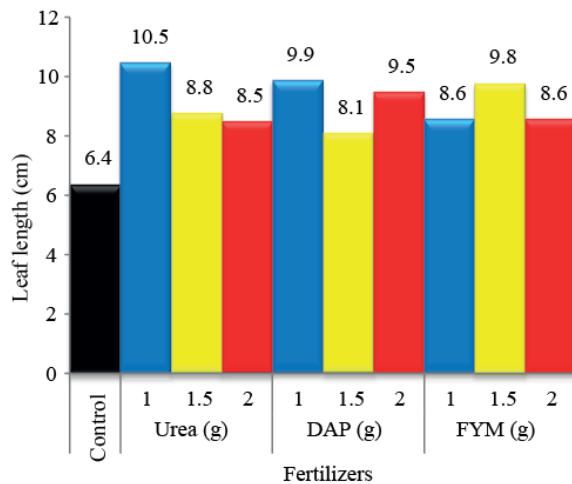


Fig. 3. Effect of various doses of three different fertilizers on leaf length (cm) of *Aloe vera* L.

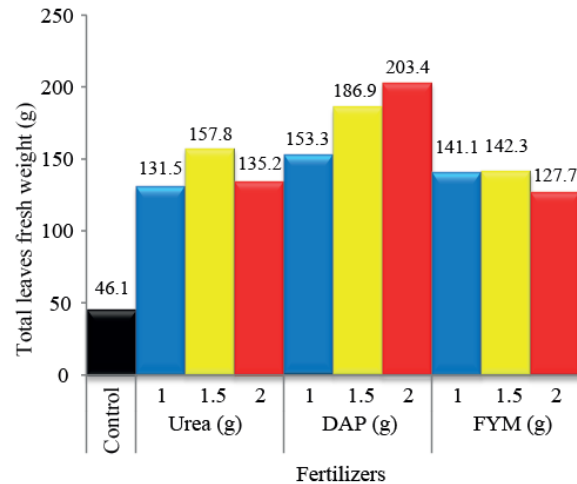


Fig. 6. Effect of various doses of three different fertilizers on total leaves fresh weight (g) of *Aloe vera* L.

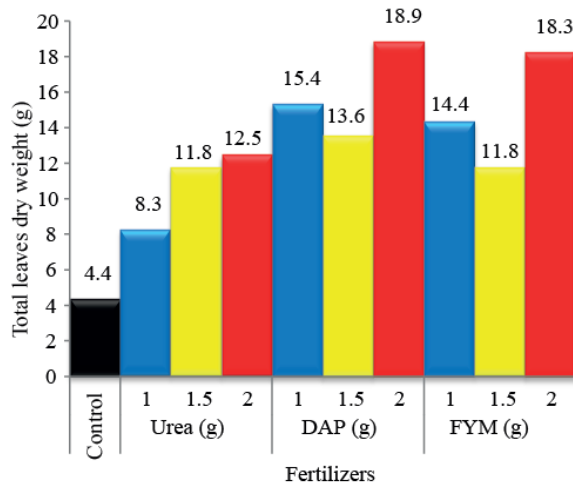


Fig. 7. Effect of various doses of three different fertilizers on total leaves dry weight (g) of *Aloe vera* L.

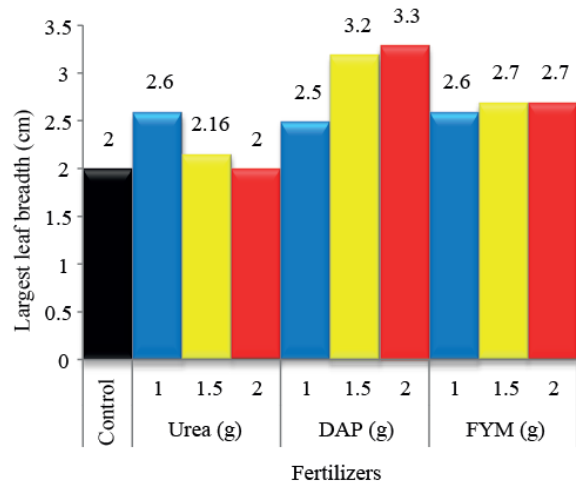


Fig. 10. Effect of various doses of three different fertilizers on largest leaf breadth (cm) of *Aloe vera* L.

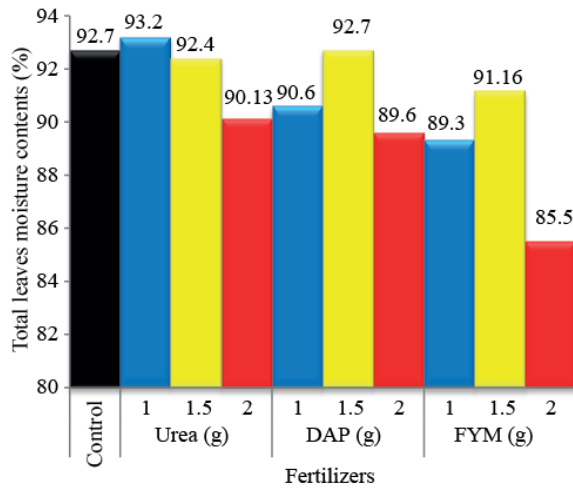


Fig. 8. Effect of various doses of three different fertilizers on total leaves moisture content (%) of *Aloe vera* L.

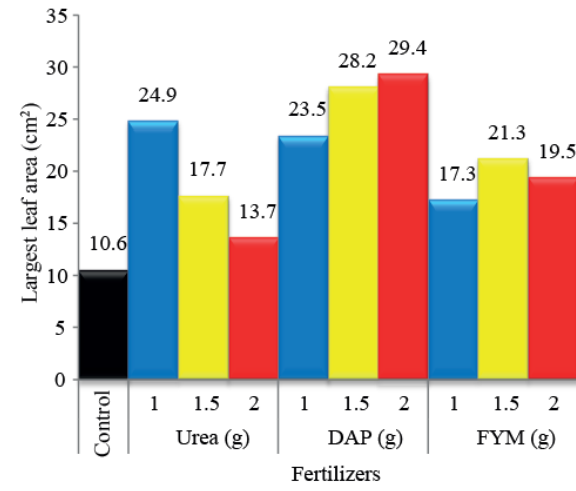


Fig. 11. Effect of various doses of three different fertilizers on largest leaf area (cm²) of *Aloe vera* L.

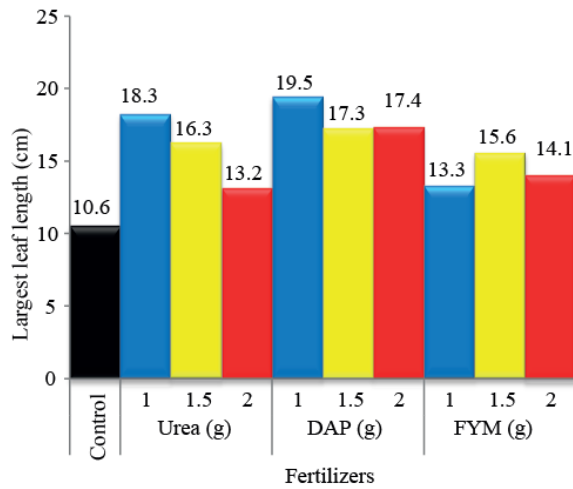


Fig. 9. Effect of various doses of three different fertilizers on largest leaf length (cm) of *Aloe vera* L.

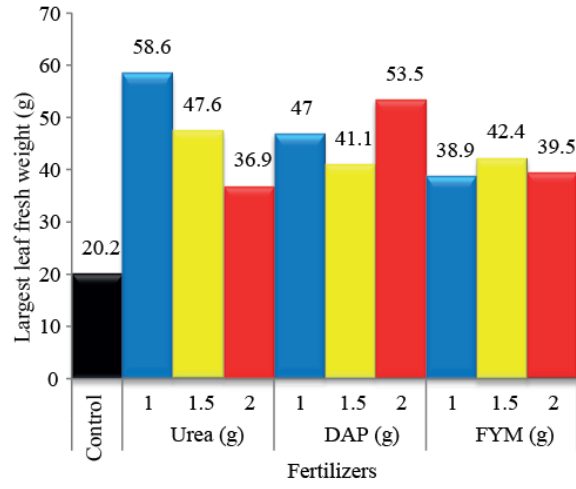


Fig. 12. Effect of various doses of three different fertilizers on largest leaf fresh weight (g) of *Aloe vera* L.

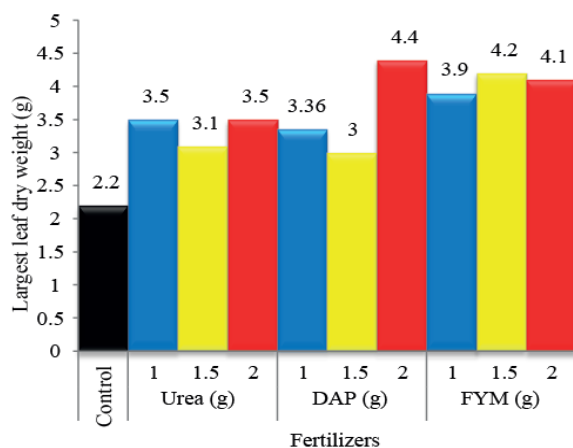


Fig. 13. Effect of various doses of three different fertilizers on largest leaf dry weight (g) of *Aloe vera* L.

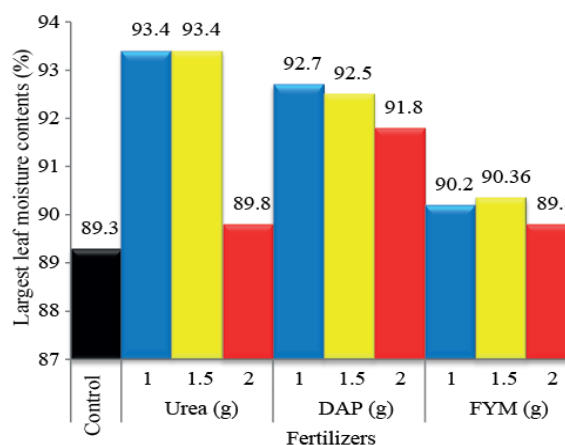


Fig. 14. Effect of various doses of three different fertilizers on largest leaf moisture content (%) of *Aloe vera* L.

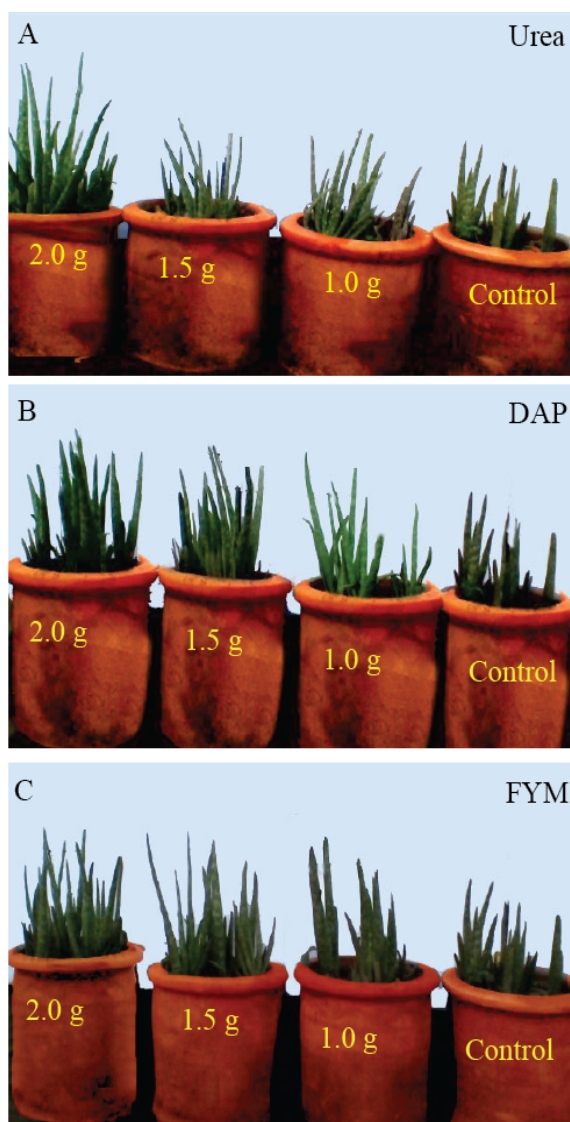


Fig. 15(a, b, c) Effect of various doses of three different fertilizers on the growth of *Aloe vera* L.

Effect on leaf area (cm²): ANOVA revealed that the average leaf area was significantly increased due to different fertilizers urea and DAP. FYM showed non-significant effects on the average leaf area (Table 1). The lowest leaf area (5.6cm²) was observed in control while DAP showed the highest leaf area (11.8 cm²) at 2.0g due to DAP followed by (10.2cm²) at 1.0g urea and (9.2cm²) of FYM at 1.0g (Table 2; Fig. 5; Figs. 15a, b, c). Abdulsalam & Hamaiel (2004) reported that N and P fertilizers increased the leaf area of *Allium cepa* with increasing fertilizers doses and this agrees with present findings. Abbas (2009) observed significant effects of N and P fertilizers on leaf area of *Mentha spicata* which is in conformity with present results. Hosenpor *et al.*, (2013) observed that N fertilizers significantly increased the leaf area of *Calendula officinalis* and it agreed with present results.

Effect on total leaves fresh weight (g): ANOVA revealed non-significant results for total leaves fresh weight under various applied fertilizers (urea, DAP & FYM) (Table 1). Fresh weight was (64.1 g) in control. The fresh weight increased under different fertilizer doses and it reached to maximum (203.4 g) at 2.0 g followed by (186.9 g) at 1.5 g DAP and (157.8 g) at 1.5 g urea doses (Table 2). Goussous & Mohammad (2009) reported an increase of leaves fresh weight of *Allium cepa* due to N and P fertilizers. Hasanuzzaman *et al.*, (2008) showed that organic fertilizers increased leaf fresh weight of *Aloe vera* and it is not in line with the present results.

Effect on total leaves dry weight (g): ANOVA showed significant differences for dry weight of total leaves under various doses of fertilizers (urea, DAP & FYM) (Table 1). The lowest dry weight (4.4 g) was observed in control while the highest dry weight (18.9g) were observed in DAP at 2.0g followed by (18.3g) at 2.0g FYM and (15.4g) at 1.0g DAP (Table 2). Hossain *et al.*, (2007) observed that N fertilizers significantly increased the dry weight of *Aloe indica* leaves and it agrees with the present findings.

Effect on total leaves moisture content (%): ANOVA showed that the differences in the total leaves moisture contents under various doses of fertilizers were non-

significant (Table 1). The control showed (92.7%) moisture contents while all doses of all fertilizers showed reduction in moisture contents except at 1.0 g urea where it increased upto (93.2g) (Table 2). Moisture content (MC) amount in crop and agriculture products is very important constituent due to its influences in quality, stability and processing. Moisture content is an important quality feature that directly influences storability of fruits and vegetables but also during long-term storage of product causes direct economic loss because of decrease in saleable weight (Ali *et al.*, 2011).

Effect on largest leaf length (cm): ANOVA indicated that significant effects were observed for largest leaf length due to effects of urea and DAP while FYM showed non-significant effects (Table 1). It was minimum (10.6cm) in control. While the largest length (19.5cm) of leaf was observed at 1.0g DAP followed by (18.3cm) of urea at 1.0g and again (17.4cm) of DAP at 2.0g (Table 2; Fig. 9; Figs. 15a, b). Hoseni *et al.*, (2013) observed that organic fertilizers increased the leaf length of *Aloe vera* which disagrees with present findings. Vetayasuporn (2006) reported significant effects of N and P fertilizers on the largest leaf length of *Allium cepa*. These findings are in agreement with the present study.

Effect on largest leaf breadth (cm): ANOVA indicated highly significant differences for largest leaf breadth under various fertilizer doses (urea, DAP & FYM) (Table 1). The lowest leaf breadth (2.0cm) was observed in control. It gradually increased with increasing fertilizer doses of DAP and reached to maximum (3.3cm) at 2.0g and (3.2cm) at 1.5(g) while FYM showed significant increase of leaf breadth (2.7cm) at 1.5 and 2.0 g doses (Table 2; Fig. 10; Figs. 15a, b, c). Hasanuzzaman *et al.*, (2008) reported significant effects of organic fertilizers on the largest leaf breadth of *Aloe vera* which agrees with the present results.

Effect on largest leaf area (cm²): ANOVA showed that largest leaf area was significantly increased due to doses of applied fertilizers (urea, DAP & FYM) (Table 1). The control had minimum (10.6 cm²) leaf area. The leaf area gradually increased with increasing fertilizers doses and reached to maximum (29.4cm²) at 2.0g and (28.2cm²) at 1.5g of DAP doses followed by (24.9cm²) at 1.0g urea (Table 2; Fig. 11; Figs. 15a, b). Alsafar & Hassan (2009) reported that N and P fertilizers increased the leaf area of *Mentha longifolia* and it agrees with the present findings. Devkota & Jha (2013) observed that urea and manure significantly improved the leaf area of *Centella asiatica* which agrees with the present results. Etich *et al.*, (2013) observed the significant effects of urea fertilizers on the leaf area of the *Cucurbita pepo* which agrees with the present results.

Effect on largest leaf fresh weight (g): ANOVA showed that the largest leaves fresh weight was significant only at DAP while urea and FYM showed non-significant results (Table 1). The fresh weight was minimum (20.2g) in control while urea had maximum fresh weight (58.6g) at 1.0g while DAP showed (53.5g) at 2.0g and (47.0g) at 1.5g (Table 2). Barandozi *et al.*, (2011) observed that N and P

fertilizers significantly increased the largest leaf fresh weight of *Aloe vera*. The results of P fertilizers are similar with the present findings but that of N are not similar.

Effect on largest leaf dry weight (g): ANOVA revealed non-significant differences for the largest leaf dry weight for all used fertilizers (urea, DAP & FYM) (Table 1). It was minimum (2.2g) in control while maximum (4.4g) at 2.0g DAP followed by (4.2g) and (4.1g) of FYM at 1.5g and 2.0g doses, respectively (Table 2). Alireza *et al.*, (2011) reported that manure fertilizers increased the dry weight of *Nigella sativa* leaves. Khourang *et al.*, (2012) reported that P fertilizers increased the dry weight of *Satureja hortensis* leaves and it agrees with the present results. Siswanto *et al.*, (2010) suggested that N fertilizers increased the dry weight of *Artemisia annua* leaves.

Effect on largest leaf moisture content (%): ANOVA showed non-significant results for all doses of applied fertilizers (urea, DAP & FYM) for moisture contents (Table 1). It was minimum (89.3%) in control while fertilizers increased it. Urea had maximum (93.4%) at 1.0g and 2.0g doses followed by DAP (92.7%) at 1.0g and (92.5%) at 1.5g (Table 2).

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