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Full Length Research Paper

Survey of chemical manure on morphological traits in Iranian *Aloe vera*

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This experiment was conducted at the Institute of National Genetic Engineering and Biotechnology in Iran to evaluate the effect of different amount of fertilizers on the leaf and plant characteristics, as well as the yield characteristics of *Aloe vera*. There were 6 different treatments viz., T_1 = 100% soil (control), T_2 = 100 PK (50% P + 50% K), T_3 = 50% K + 50% soil, T_4 = 50% N + 50% soil, T_5 = 150% NPK (50% N + 50% P + 50% K), T_6 = 50% P + 50% soil. It was observed that the plant produced the highest mature leaf length and number of tillers plant^{-1} and maximum leaf weight as well as maximum weight of largest leaves with the application of 50% P + 50% K (T_2). Different plant characters such as mature leaf breadth and breadth of the largest leaf was also found to be high with T_5 treatment when compared with the control (100% soil). The number of leaves was also significantly affected by different fertilizer treatments where the maximum effect was noticed at early stages with T_4 (50% N). It was revealed that T_3 had a little effect on the number of leaves of *A. vera* over chemical fertilizer.

Key words: *Aloe vera*, fertilizer, morphological traits, leaf growth.

INTRODUCTION

Aloe genus (family Liliaceae) consists of at least 600 known species, many of which have been used as botanical medicines in many countries for centuries (Okamura et al*.,* 1996). Species of *Aloe* which have been used as folk medicine includes: Curacao Aloe (*Aloe barbadensis* or *Aloe vera*), Cape Aloe (*Aloe ferox*) and Socotra Aloe (*Aloe perryi*). This plant species can be easily propagated from cuttings and is probably the most widely cultivated species of the genus in the world. It is widely used, not only as a folk remedy for gastrointestinal complaints, skin injuries and burns, but also as an ingredient in health foods and cosmetics (Capasso et al., 1998). Products containing *A. vera* are used for the treatment of minor cuts and burns and to heal wounds. They are also contained in a variety of cosmetics including skin creams, lotions and shampoos. Aloe gel, among other things, enhances immunity, improves liver function, prevents asthma and has anti-inflammatory, anti-ulcerous, anti-diabetic and antihypertensive properties (Dagne et al., 2000). Also, epidemiological data suggest that the intake of *A. vera* prevents human lung cancer (Sakai, 1989). The cultivation of *Aloe vera* has acquired great commercial importance for medicinal products and cosmetics processing but information are scarce about agronomic management of this crop.

The land of Iran is very fertile and seasons are variable and favorable for various medicinal plants to grow. *A. vera* is cultivated in many places in Iran, in the wild. Cultivation of *A. vera* is expanding day by day and it provides quick and regular income to the farmers. Farmers are not using any recommended farming practices for *A. vera* cultivation which resulted in poor yield. Fertility management in *A. vera* field may be one of the strategies for increasing the yield of *A. vera* (Saha et al., 2005). *A. vera* is a succulent plant and thus, it has much nutrient. However, the excess doses of chemical nutrient as well as improper sources can show negative effect of quality. Optimum chemical fertilizers are more effective in *A. vera* growth and yield. In addition, chemical

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Table 1. Geographical origins of Aloe genotypes.

Ecotype number	Region originated	Climate[a]	Latitude, N	Longitude, E	Altitude (m)
1-10	Boushehr	Warm temperate-humid	50 28 'N	27 59 'E	5
11-20	Borazjan	Warm-arid	29 15 'N	51 12 'E	94
21-30	Sar korreh	Warm-arid	28 53 'N	51 17 'E	43
31-40	Hormozgan	Warm temperate-humid	27 75 'N	56 05 'E	9
41-50	Bashagerd	Warm -arid	50 31 'N	29 34 'E	10

[a]Yearly mean temperature in warm, temperate and cool climates are respectively 30 to 50 and 0 to 24.5°C. Yearly mean rainfalls in warm-arid and warm temperate-humid climates are respectively 100 to 300 and 300 to 400 mm.

fertilizers enhance a good leaf quality. So, it may be necessary to find out a suitable recommendation for fertilization in *A. vera* farming. This study was carried out to determine the effect of fertilization levels on the growth and yield of *A. vera.*

MATERIALS AND METHODS

A total of 50 Aloe ecotypes were collected from different areas. This sampling was done according to the information of local agricultural extension offices and producers from all over Iran. Geographical origins of the 50 aloe ecotypes are listed in Table 1. This experiment was conducted at the Institute of National Genetic Engineering and Biotechnology in Iran, during 2010. The climate of this area is subtropical. The soil of the experimental site was clay loam with pH of 6.5. The experiment was laid out by randomized completely block design (RCBD) with 4 replications comprising of six different treatments viz. T_1 = 100% soil (control), T_2 = 100% PK (50% P + 50% K), T_3 =50% K + 50% soil, T_4 = 50% N + 50% soil, T_5 = 150% NPK (50% N, 50% P, 50% K), T_6 = 50% P + 50% soil. Plants collected from 5 regions (Borazjan, Sarkorreh, Boushehr, Hormozgan and Bashagerd) were planted in the greenhouse and their morphological traits were determined (Table 2). Distance between plants was 20 cm. Chemical fertilizer was used in this experiment as per treatment (Hasanuzzaman et al., 2008). The field was drop irrigated once per week. Data were recorded every 15 days starting from 15 days after planting (DAP) for measuring leaf length and breadth. Total number of days of the experiment is eight month. The final data were recorded at harvest to measure plant characters. Flexible tap and scale were used to measure leaf. Weighing was done by digital balance (Kaifeng Group Co., Ltd., China). The data were analyzed following analysis of variance (ANOVA) technique and mean separations were adjusted by the multiple comparison test using the statistical computer program MSTAT-C v.1.2 (MSTAT-C, 2000). Means were compared by using LSD test at 5% level of significance.

RESULTS

Different combinations of fertilization significantly affected the leaf characteristics of *A. vera* in this experiment (Table 3). The highest number of leaf per plant was observed in T_4 = 50% N (50% N + 50% soil) followed by T6 = 50% P (50% P + 50% soil). Concerning total leaf fresh weight per plant, the data in Table 3 indicated that all treatments significantly increased leaf fresh weight as compared to control plant.

Using 100%, PK fertilizer was the most effective in increasing leaf fresh weight per plant (7960 g). Different fertilization treatment also significantly affected the plant characteristics of *A. vera* in this study (Table 3). The highest weight of plant at harvest (7920 g) was observed in the treatment where 100% PK fertilizer was applied (T_2) which was statistically higher than other treatments. The lowest plant weight (7100 g) was observed in (T_4) 50% N (Table 4). In the case of leaf type no. 1 (from base), continuous and highest growth rate of leaf was observed in the treatment where 100% PK fertilizer was applied, but length of the largest leaf was observed in T6 (50% P). The leaf length was also highest in this case (Figure 1). This trend was also found in the treatments where comparatively more fertilizer was applied.

The growth rate in length decreased with the decrease in fertilizer percentage (Figure 1). The lowest growth rate was observed in the control treatment where no fertilizer was applied. The highest number of suckers was observed in 50% N. There were negative correlation between high-vigor, medium vigor and low vigor of suckers with all treatment.

Growth rate of mature leaf breadth is presented in Figure 2. It this case, the highest growth rate was observed in the treatments where higher amount of fertilizer was used. The lowest growth rate was observed in T_2 (100%PK) and control treatment. Higher leaf breadth and breadth of the largest leaf was also observed in the treatment T5 where 150% NPK fertilizer was applied.

DISCUSSION

In this experiment, the application of 50% N at recommended doses did not show higher results than fertilizer application which was supported by Saha et al. (2005) and Nobel et al. (1991). This trend of increased production due to increased application of fertilizer were also observed in case of single leaf weight, leaf length, number of tillers and weight of the largest leaf. The application of nutrient matter increased the cell division and elongation without hampering the nutrient uptake process which provided better results due to better nutrition. Guerrero et al. (2001) found that nutrient matter addition is a suitable technique for accelerating the

Table 2. Botanical traits of Iranian *Aloe* genotypes.

Location	Height of plant (cm)	Breadth of plant (cm)	Number of leaves plant^{-1}	Mature leaf length (cm)	Mature leaf breadth (cm)	Length of the largest leaf (cm)	Breadth of the largest leaf (cm)	Single mature leaf weight (g)	Weight of the largest leaf (g)	Number of tillers plant^{-1}
Borazjan	61.20^{ab}	20.80^{a}	25.20^{ab}	44.40^{a}	9.60^{a}	5.50^{b}	1.72^{b}	1.77^{a}	2.15^{b}	44.60^{a}
Sarkorreh	51.50^{b}	10.80^{b}	17.60^{ab}	40.70^{a}	7.83^{ab}	45.60^{b}	2.12^{a}	1.54^{ab}	1.74^{c}	42.80^{a}
Boushher	55^{b}	11.20^{b}	29.50^{a}	45.20^{a}	7.95^{ab}	49.10^{b}	2.26^{a}	1.65^{ab}	1.85^{bc}	44.70^{a}
Hormozgan	55.80^{b}	23.9^{a}	25.30^{ab}	40.80^{a}	8.80^{ab}	46.30^{b}	2.15^{a}	1.47^{b}	1.83^{bc}	42.50^{a}
Bashagerd	69.70^{a}	20.40^{a}	14.40^{b}	40.40^{a}	7.10^{b}	67.30^{a}	2.07^{a}	1.77^{a}	2.95^{a}	44a
Total	58.64	17.43	22.40	42.30	8.25	51.76	2.06	1.64	2.10	43.72

Different letters indicate statistically significant differences.

Table 3. Duncan s multiple range tests analysis for mean comparison of evaluated traits of *A. vera* plant at harvest (60DAP).

Treatment	Mean amount of fertilizer	Mean low vigor sucker	Mean medium vigor sucker	Mean high vigor sucker	Mean total number of sucker	Mean number of leaves plant^{-1}	Mean mature leaf length (cm)	Mean mature Leaf breadth (cm)	Mean length of the largest leaf (cm)	Mean breadth of the largest leaf (cm)	Mean breadth of the largest Leaf (cm)	Mean Single mature leaf weight (g)	Mean weight of the largest leaf (g)	Mean number of tillers plant^{-1}
1 (0% control)	7.47^{ab}	2.73^{a}	3.15^{a}	1.63^{a}	5.31^{ab}	13.31^{a}	25^{b}	6.24^{a}	30.94^{a}	7.05^{a}	7.05^{a}	7463.2^{a}	8846.8^{a}	43.9^{ab}
2 (100% PK)	8.2^{a}	3/20^{a}	4^{a}	1^{a}	4^{b}	13^{a}	33^{a}	5.88^{a}	31.60^{a}	6.60^{a}	6.60^{a}	7960^{a}	9020^{a}	45.80^{a}
3 (50% K)	7.22^{b}	3^{a}	2.66^{a}	1.55^{a}	4.66^{b}	12.55^{a}	29.67^{ab}	6.47^{a}	34.77^{a}	6.50^{a}	6.50^{a}	7955.6^{a}	9000^{a}	42.7^{ab}
4 (50% N)	7.44^{ab}	3.7^{a}	2.44^{a}	1.22^{a}	7.22^{a}	14.22^{a}	30.33^{ab}	6.32^{a}	34.55^{a}	7.02^{a}	7.02^{a}	7100^{a}	8344.4^{a}	41.55^{b}
5 (150% NPK)	7.44^{ab}	3.55^{a}	3.33^{a}	0.55^{a}	4.44^{b}	13.11^{a}	27.44^{ab}	6.64^{a}	36.11^{a}	7.16^{a}	7.16^{a}	7344.4^{a}	8977.8^{a}	44^{ab}
6 (50% P)	7.33^{b}	2^{a}	4^{a}	1.33^{a}	5.88^{ab}	14.11^{a}	27.88^{ab}	6.33^{a}	37.22^{a}	6.61^{a}	6.61^{a}	7577.8^{a}	9011.1^{a}	44.8^{ab}

Different letters indicate statistically significant differences.

natural recovery process of burned soils. An increased trend of plant weight was observed with the increase of fertilizer amount. It was due to the beneficial effect of nutrient matter in soil properties and plant growth (Uyanoz et al., 2002; Dexter, 1988; Tisdall and Oades, 1982). More or less similar trend was observed in the case of total plant weight along with tillers. The number of tillers per plant was highest with the treatment T_2 (50% P + 50% K) which was followed by T_5 and T_6. These results are supported by Hernández-Cruz et al. (2002).

The lowest growth rate was observed in the case of control treatment where no fertilizer was applied. The growth rate of the leaves was highest at early stages of growth which declined gradually. The growth of control treatment was lower but consistent up to 60 DAP. These findings are also in agreement with the results of Van Schaik et al. (1997) and Chatterjee et al. (1979). The highest length of leaves was observed in the

Table 4. Variance analysis for evaluated traits *A. vera.*

Parameter	df	Mean square													
		Amount of fertilizer	low vigor sucker	Med vigor sucker	High vigor sucker	Sucker	Total number of sucker	Number of leaves plant^{-1}	Mature leaf length (cm)	Mature leaf breadth (cm)	Length of the largest leaf (cm)	Breadth of the largest leaf (cm)	Single mature leaf weight (g)	Weight of the largest leaf (g)	Number of tillers plant^{-1}
Treatment	6	0.67^{ns}	3.74^{ns}	3.37^{ns}	1.63*	1.75*	10.9^{ns}	3.74^{ns}	54.29^{ns}	0.44*	31.07*	0.76*	926224.5*	605484^{ns}	17.2ns
Error	54	0.54	2.96	2.53	1.93	2	4.42	3.95	38.35	0.87	35.67	1.23	1060670.5	513094	12.71
CV (%)	-	9.9	57.74	49.72	106.96	36.60	39.30	14.84	21.88	14.80	16.71	16.15	13.68	8.09	8.15

*Significant at 5% and ns is not significant.

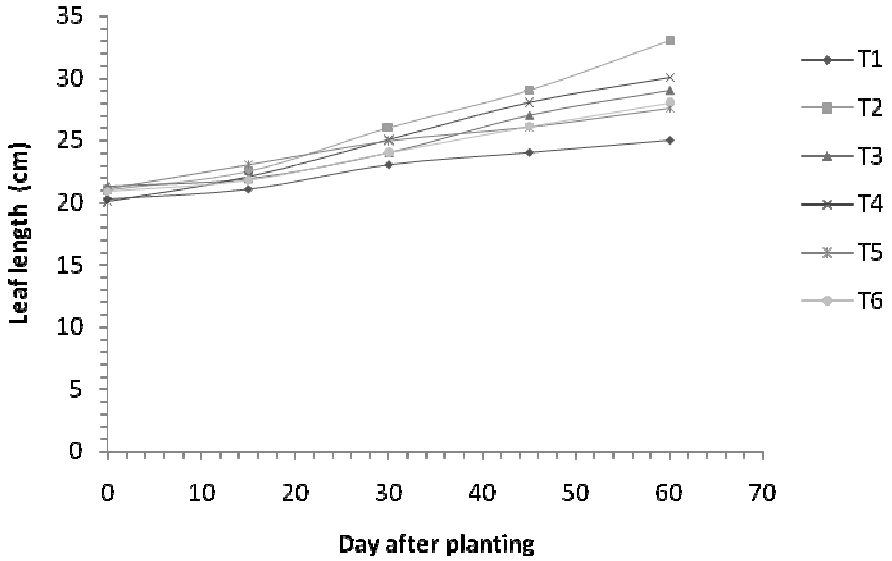

Figure 1. Leaf length of *A. vera* leaf type no.1 at different days after planting.

case of the treatment with 100% PK, but the highest length of the largest leaf was observed in 50% P fertilizer application. This dose of fertilizer improved the *A. vera* plant growth by providing the essential nutrient which results to maximum cell growth and turgidity which influenced the leaf growth. Pichgram (1987) also observed similar results in *A. vera*. The highest percentage increase in mature leaf breadth was observed in the early stage of growth, irrespective of treatments. Some regular increase in growth rate of mature leaf breadth was observed in control

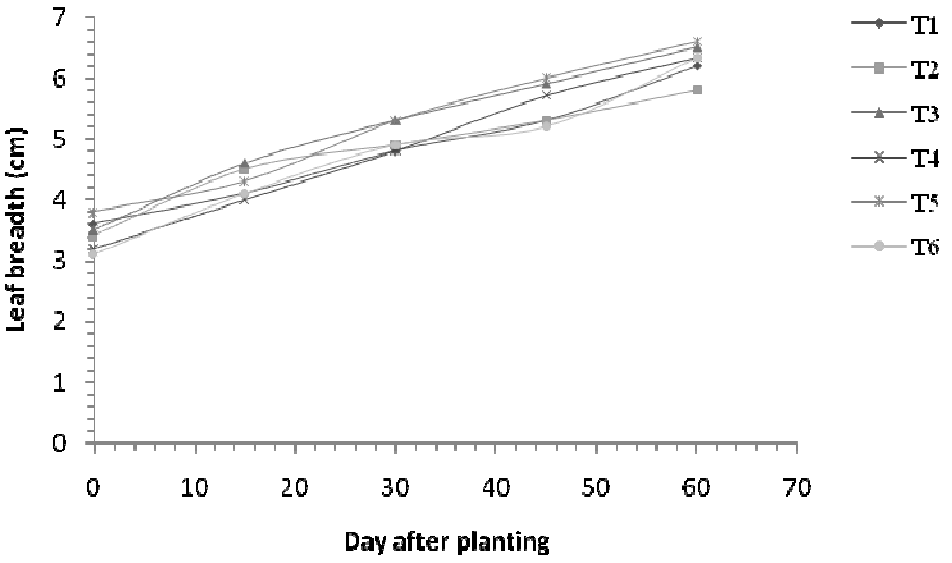

Figure 2. Leaf breadth of *A. vera* leaf type no. 2 at different days after planting.

treatment at the later stage. Van Schaik et al. (1997) observed similar results. In the case of leaf type no. 2, growth rate of leaf breadth was higher with the treatments where higher percentage of fertilizer was used (Figure 2). The percentage of increased rate was highest in the early 15 days in all the treatments. This increase gradually decreased in the later stages. The decreasing rate was highest in T2, control treatment and treatments with lower doses of fertilizer. It was due to the failure of *Aloe* plant to produce the cell expanse. This result is supported by Saha et al. (2005) and Yepes et al. (1993).

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