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EFFECT OF SALINITY LEVELS, WATER REGIMES AND NITROGEN ON CROP GROWTH AND YIELD OF ALOE

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ABSTRACT

The experiment was conducted during 2008-10 to study the effect of salinity levels, water regimes and nitrogen on crop growth, yield and economics of aloe (Aloe barbadensis Mill.) at Bichpuri (Agra). The results revealed that the crop growth parameters (plant height and plant spread), yield attributes (number of harvested leaf, weight of leaf, leaf length, width and thickness of leaf), and number of suckers were significantly affected with individual treatment.There was a significant increase in yield of leaves/ha (17.8%) and number of suckers arises (38.1%) due to irrigation scheduled at 1W: CPE ratio 0.2 over 1W: CPE ratio 0.1 in pooled basis, respectively. The yield of leaves was significantly reduced at higher salinity level (8 dS m^{-1}) but there was no significant difference in ECiw 4.6 and best available water in respect of leaf yield. The application of higher doses of N increased the yield of aloe leaves significantly.

Keywords: Aloe, irrigation, salinity, nitrogen, growth, yield

INTRODUCTION

Aloe (*Aloe barbadensis Mill.*) is an important and traditional medicinal plant belonging to family Liliaceae. Aloe is a crassulacean acid metabolism (CAM) plant. It possesses the succulent habit. The succulent plant (Aloe) accumulates large quantities of water and uses it slowly during dry periods. For this reason the plants are resistant to drought condition to much extent. Aloe despite being identified as a new plant resource with the most promising prospects in the word remains a disregarded plant. Indian aloe is a rich source of vitamins, sugars, calcium, sodium, nitrogen, amino acid, enzyme, acids and minerals. Traditionally, aloe is extensively used for medicinal purpose, particularly for urine-related problems, pimples and ulcers. Aloin and its gel are used as skin tonic and have a cooling and moisturizing effect so it is used in preparation of creams, lotions, shampoo and allied products (Singh *et al.*, 1995). Generally, crop is raised under rainfed condition with low input management under marginal and sub-marginal soils having low organic matter and poor soil fertility status. So water stress and nutrients are the most important factors for lower productivity of this crop. Scheduled irrigation not only increases the productivity and quality of leaf but also help in synchronized, uniform growth and the sucker production of aloe crop. Van Schaik *et al.* (1997) reported that irrigation is an essential factor for continuous vegetable growth and high yield of Aloe barbandensis Mill when drought stress was severe. According to Singh (2002), the water use efficiency of different crops was increased when irrigation scheduled on the basis of IW: CPE ratio. Application of nitrogen is essential for proper plant growth and development of Aloe (Massiah *et al.* 1998, Pareek *et al.* 1999). Keeping in view the above facts, an experiment was conducted to study the effect of salinity levels, water regimes and nitrogen on crop growth, yield and economics of Aloe for for maximizing economic returns.

MATERIALS AND METHODS

The field experiment was carried out on one-year old aloe plants during 2008-10. The soil was sandy loam in texture having pH 8.1, organic carbon 2.8 g kg^{-1}, available N 128 kg ha^{-1}, P 13.8 kg ha^{-1} and K 162 kg ha^{-1}. The treatments comprised 32 treatment combinations consisting of two levels of irrigation (0.1 and 0.2 IW: CPE) in main plots, 4 levels of nitrogen (0,50,100 and 150 kg ha^{-1}.) in sub plots and four salinity levels (BAW, 4, 6 and 8 dSm^{-1}) in sub-sub plots. The experiment was conducted in split-plot design with three replications. The sub-sub plot size was 4.0 m x 4.0 m^2 with 60 cm x 60 cm spacing between rows and plants. Irrigation was applied based on the ratio by depth of irrigation water (IW) application and cumulative pan evaporation (CPE). Irrigation with the measured quantity of 5.0 cm water in each irrigation was given at different cumulative pan evaporation values under different irrigation treatments. Nitrogen was applied in the

form of urea in four equal doses, one basal dose and three split doses, i.e. one week after each picking (three month interval) of pods. Salinity water was synthesized by dissolving the required quantities of sodium chloride, calcium chloride, and magnesium chloride and magnesium sulphate in canal water. All the observations on vegetative growth and yield parameters were recorded at the time of harvest from randomly selected five plants in each plot for data collection. The pods were harvested quarterly. The annual total pod yield obtained in four pickings during a year has been presented on hectare basis.

RESULTS AND DISCUSSIONS

Effect of water regimes (IW: CPE ratio)

Different frequency of water regimes significantly affected the plant height and plant spread. There was a significant increase in plant height (15.6%) and plant spread (11.7%) due to irrigation scheduled at IW: CPE ratio 0.2 over IW: CPE ratio 0.1 (Table 1). The higher available moisture status in soil favourably influences the uptake of nutrients which maintains the cell turgidity, cell elongation, photosynthesis and respiration at optimum level, leading to favorable growth and development of plant in terms of plant height and spread. Singh *et al.* (2001) strongly supported this finding that fresh bio-mass production of palmarosa (*Cymobopogon martini* L.) was increased with increase in number of irrigations. Neeraja *et al.* (2001) also reported that basil irrigated at 0.75 IW: CPE ratio of 200 kg N ha^{-1} gave maximum herbage. Significantly highest number of leaves/plant (11.11), number of harvested leaves/plant (4.5), average weight of leaf (278.3 g), length of leaf (45.3 cm), width of leaf at centre (6.85 cm), thickness of leaf at centre 0.92 cm), yield of leaves/ha 2485.7 q ha^{-1}, number of suckers arise $plant^{-1}$ (5.8) were recorded with irrigation. Significant increase was observed due to application of frequent irrigations (0.2 IW :CPE) as compared to delayed irrigation (0.1 IW : CPE) with respect to number of leaves/plant (26.4%), average weight of leaf (46.7%), length of leaf (19.8%), width of leaf at centre (12.7%), thickness of leaf at centre (13.8%), yield of leaves (17.8%) and number of suckers (38.1%). This might be due to maintenance of soil moisture at higher level which enhanced the uptake of nutrients by the plants. The greater uptake of nutrients, higher photosynthesis and biosynthesis of assimilates and their translocation to lower parts of leaf, ultimately enhancing the leaf size, weight, thickness contributed to increase yield/plant and per unit area. These results are in agreement with the findings of Singh *et al.* (1996) who reported that irrigation at 0.1 IW: CPE gave significantly higher herbs yield of geranium (*Pelargonium* sp.) Singh (2002) reported that sweet basil irrigated at 0.75 IW: CPE ratio gave maximum herbage and oil yield. The frequent irrigation (0.2 IW:CPE) gave higher net return (Rs 91,422.5 ha^{-1})and highest benefit: cost ratio (3.04) as compared to delayed irrigation (0.1 IW : CPE) (Table 2). Frequent irrigation maintains soil moisture at optimum level resulting higher yield of leaves. These results are in agreement with findings of Bharadawaj (2011).

Table 1: Effect of water regimes, salinity levels and nitrogen levels on crop growth parameters and yield attributes of Aloe

Treatment	Plant height (cm)	Plant Spread (cm)	Leaves/ plant	Harvested leaves/plant	Average weight of leaf (g)
IW : CPE ratio					
0.1	39.2	40.1	8.11	3.8	189.7
0.2	45.3	44.8	10.25	4.5	278.3
CD (P=0.05)	3.1	2.9	1.9	0.3	15.2
ECiw levels (dSm^{-1})					
BAW	44.8	43.7	11.11	4.8	278.9
4	40.2	41.2	9.01	4.3	270.5
6	40.1	40.7	8.98	4.1	265.8
8	39.6	39.6	8.89	4.1	262.6
CD (P=0.05)	NS	NS	1.7	0.2	NS
Nitrogen (kg ha^{-1})					
0	39.1	37.5	8.11	3.3	248.7
50	41.5	39.4	9.12	3.6	255.8
100	46.7	44.6	10.17	4.5	275.9
150	47.1	45.8	10.50	4.7	281.8
CD (P=0.05)	5.9	4.8	1.7	0.2	22.2

Effect of salinity levels

Application of saline water at higher salinity (8 dS m^{-1}) significantly decreased the plant height and plant spread over the control (BAW) treatment. However, salinity levels 4, 6 and 8 dSm^{-1} were found statistically at par with respect to plant height and plant spread (Table-1). Further, higher salt concentration (8 dSm^{-1}) registered minimum plant height (39.6 cm) and plant spread (39.2 cm) with a decrease of 7.6 and 7.4 % over control. The plants irrigated with BAW water significantly increased the leaves/plant, harvested leaves/plant, average weight of leaf, length of leaf, width of leaf of centre, thickness of leaf at centre and leaf yield and suckers arises $plot^{-1}$. But use of saline water with salinity of 4, 6 and 8 dS m^{-1} decreased all these characters of aloe. No significant difference among ECiw 4, 6 dS/m and BAW was noted in attributes as well as yield. The net profit of aloe was maximum in BAW irrigation treatment (Rs 89,176.5 ha^{-1}) and lowest (Rs 79,477.5 ha^{-1}) in ECiw 8 dS m^{-1} irrigated crop. The increased salinity levels decreased net profit and benefit cost ratio.

Table 2: Effect of water regimes, salinity levels and nitrogen on yield attributes, yield and sucker of Aloe (average of two years)

Treatments	Length of Leaf (cm)	Width of Leaf at centre (cm)	Thickness of leaf at centre (cm)	Yield (q ha^{-1})	Suckers arises/ plant	Net profit (Rs ha^{-1})	Benefit: cost ratio
IW : CPE ratio							
0.1	37.8	6.08	0.81	208.5	4.2	63,613.0	2.54
0.2	45.3	6.85	0.92	285.7	5.8	91,422.5	3.04
CD (P=0.05)	3.9	0.71	0.08	2.8	0.6	-	-
ECiw levels (dSm^{-1})							
BAW	48.6	7.11	0.91	285.1	5.7	89,167.5	2.78
4	43.3	6.65	0.82	270.2	4.2	82,835.0	2.59
6	40.2	6.21	0.79	268.5	4.8	82,112.5	2.57
8	41.3	6.12	0.78	262.3	4.7	79,477.5	2.48
CD (P=0.05)	4.2	0.68	0.11	2.5	0.5	-	--
Nitrogen level (kg ha^{-1})							
0	38.8	5.83	0.81	295.6	5.2	95,630.0	3.18
50	44.7	6.98	1.09	320.8	6.0	1,06,840.0	3.61
100	47.3	7.01	1.02	325.7	6.1	1,08,922.5	3.69
150	48.5	7.25	1.05	345.6	6.3	1,15,380.0	3.66
CD (P=0.05)	4.2	0.68	0.11	2.5	0.5	-	-

Effect of nitrogen

Application of 150 kg ha^{-1} significantly enhanced the plant height and plant spread over the control. However, 50, 100 and 150 kg N ha^{-1} levels were found statistically at par with respect to plant height and plant spread (Table 1). Further higher N level (150 Kg ha^{-1}) registered maximum plant height (47.1 cm) with an increase of 20.5% in plant height and plant spread (22.1%) over control. The enhancement in plant height and plant spread as a result of application of nitrogen might be due to the fact that nitrogen is involved in the chlorophyll synthesis and protein metabolism resulting in deep green colour of the foliage which might have favoured photosynthesis activities in the leaves leading to the formation of amino acids, proteins, chlorophyll, alkaloids and amides. These complex compounds are responsible for building up of new tissue and are associated in a number of metabolic processes, which is turn, favours better development of plant. These results are in close agreement with the observations of Farroqui *et al.* (1991) in davana (*Artemisia pallens* Wall.) Khandelwal *et al.* (2003) in henna (*Lawsonia inermis* L.). The plants treated with 150 kg N ha^{-1} exhibited higher crop growth and yield. Significant increase was observed due to application of 150 kg N ha^{-1} as compared to control with respect to number of leaves/plant (29.5%), number of harvested leave/plant (42.4%), average weight of leaf (13.3%) length of leaf (25.0%), width of leaf at centre (24.4%), thickness of leaf at centre (29.6%), yield of leaves/ha (25.4%) and number of suckers/ plant (17.5%). The positive response of various yield attributes to nitrogen fertilizer could be ascribed to overall improvement in growth attributes such as plant height and plant spread. Significant increase in yield attributes and yield might also be due to the fact that nitrogen supply helped in the fully expansion of leaf and chlorophyll content which might have accelerated the photosynthetic rates subsequently increased the supply of carbohydrates to the plants or better availability of nitrogen might have also favored

the metabolism and auxin activities in the plant and ultimately resulted in increased number of leaves, size of leaves and finally total yield of leaves. Application of 150 kg N ha^{-1} proved profitable and showed maximum net return (Rs 1,15,380 ha^{-1}) and benefit cost ratio 3.66. This treatment was significantly superior to rest of the treatments as reported by Bhardawaj (2011) in aloe crop.

It may be concluded that the aloe showed significant increase up to 6 dS m^{-1} in economic yield. Irrigation at IW: CPE ratio 0.2 gave maximum production and highest economic return with benefit : cost ratio. The maximum net returns were recorded at 150 kg N ha^{-1}.

REFERENCES

Bharadwaj, R.L. (2011) Effect of water regimes, nitrogen and phophorus on crop growth, yield and economics of aloe. *Indian Journal of Agricultural sciences* 81: 44-49.

Farooqui, A.A., Devish, K.A., Vasundhara, M., Raju, B. and Dasharatha, Rao. N.D. (1991) Effect of nutrients on growth, yield and essential oil content in davana (*Artemisia pallens* Wall.) *Indian Perfumer* 35: 63-68.

Khandelwal, S.K., Gupta, N.K .and Nagda, C.L. (2003) Effect of application of different levels of nitrogen and phosphorus on growth, yield and quality of henna (Lawsonia *imermis* L.). *Journal of Medicinal and Aromatic Plant Science* 25: 984-88.

Massiah, M., Pire, D. and Crane, J. H. (1998) Effect of N.P.K Ca and Mg deficiencies on the dimensions and colouration of leaves of Aloe (Aloe barbadenesis Mill) plant grown in sand. *The Interamerican Society for Tropical Horticulture* 42: 55-9.

Neeraja, G., Reddy, K.M., Reddy, M.S. and Rao, V.P. (2001) Influence of irrigation and nitrogen levels on bulb yield, nutrient uptake and nitrogen use efficiencies in rabi onion (*Allium cepa* L.). *Indian Journal of Agricultural Sciences* 71: 109-112.

Pareek, O.P., Sharma, B.D., Nath, V., Singh, R.S. and Bhargava, R. (1999) Effect of nitrogen and phosphorus, fertilization and organic manure on growth and yield of Indian Aloe (*Aloe barbadmiss* Mill). *Annals of Arid Zone* 38: 85-9.

Singh, B.M., Srivastava, V.K., Kidwai, M.A. and Gupta, S. (1995) Aloe (Aloe *barbadnsis* Mill.) Psoralea and Mucuna. *Advances in Horticulture* 11:513-25.

Singh, M. (2002) Effect of nitrogen and irrigation regimes on the yield and quality of sweet basil (*Ocimum basilicum* L.). *Journal of Spices and Aromatic crops* 11:151-4.

Singh, M., Chandrashekhara, G., Ganesh, Rao.R.S. and Parkasa, Rao.E.VS.(1996). Effect of irrigation and levels nitrogen on herb and oil yield of geranium (*Pelargonium* sp.) under semi-arid tropical. *Indian Journal of Essential oil Research* 8:653-56.

Singh, S., Singh, A., Singh, V.P., Singh, M. and Singh, K. (2001) Studies on the frequency and time of irrigation application on herb and oil yield of palmarosa (*Cymbopogon martini* L.) variety Motia. *Journal of Medicinal and Aromatic Plans Science* 22: 491-3.