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Influence of Season and Manuring on Physiological and Growth Parameters of Aloe Vera (*Aloe barbadensis* Miller.)

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ABSTRACT

A field experiment was conducted at College of Agriculture, Rajendranagar during kharif and rabi 2003-2004 to know the influence of season and manuring on physiological and growth parameters of Aloe Vera. Among various treatments vermicompost (5t ha^{-1}) recorded significantly high number of leaves, leaf area, plant height, SPAD chlorophyll meter readings and shoot fresh weight. Irrespective of treatment, CGR was maximum at 120-150 DAP during kharif. However, in rabi CGR showed two peaks *i.e* at 150-180 DAP and at 210-240 DAP which signified the indeterminate growth habit of Aloe vera. A significant influence of season was also observed in growth and physiological characters of Aloe vera.There was a 15 , 16, and 13 per cent increase in shoot fresh weight, leaf area and plant height respectively in kharif planted Aloe vera over rabi planted crop.

Key words : Aloe vera,Growth parameters, Manure, Physiological parameters, Season.

Aloe vera (*Aloe barbadensis* Miller.) is among the few medicinal plants by virtue of its extensive medicinal and neutraceutical value enjoys a major chunk of market across the globe. About 300 species have been described in the genus Aloe. Among them Aloe vera (*Aloe barbadensis* Miller.) is the most commonly grown in the world and it is considered as an important medicinal plant in many countries (Hasanuzzaman *et al*., 2008). It is a succulent, almost sessile perennial herb growing upto one meter. The leaves are radially arranged in two or three circles. Each leaf is of 30-50 cm long and 10 cm broad at the base having an indented margin. The leaves are pea-green in colour with occurrence of white spots during early stages of growth. It produces yellow tubular flowers on an elongated spike. *Aloe vera* leaf is endowed with the property of possessing yellow latex and a clear inner mucilaginous gel. This clear inner gel is also used as a nutritional supplement. Processing of *Aloe vera* gel, from the leaf pulp has become a big industry world wide due to its usage in food industry especially in the preparation of health drinks.

Aloe vera is a potentially valuable new medicinal crop in Arid and semi-arid tracts of the country. Remarkable advantage of this plant is its Carassulacean Acid Metabolism (CAM), a specialized mode of photosynthetic carbon assimilation that has evolved in response to exceptional environmental conditions. In India, *Aloe vera* is traditionally grown in the natural habitats and there is no regular practice of its cultivation using improved agro-techniques particularly with reference to nutrient management. Fertility management in Aloe vera field may be one of the strategies for increasing of the yield of Aloe vera (Saha *et al*., 2005). There are studies reporting that application of Nitrogenous fertilizer enhanced the growth and yield of Aloe vera (Khandelwal *et al*., 2009).Despite the ideal climatic conditions for cultivation of this miraculous medicinal plant, the plant was not exploited for its medicinal value due to lack of awareness on cultivation as well as extraction protocols.

As there is a growing demand for cultivation of medicinal plants, present study was carried out to determine the influence of season and manuring on different physiological and growth parameters of Aloe vera.

MATERIAL AND METHODS

A field experiment was conducted during kharif and rabi, 2003 and 2004 at Herbal Garden, ANGRAU and at Department of Plant Physiology, College of Agriculture, Rajendranagar, Hyderabad. The experiment was laid out in a randomized block

design with three replications. The eight treatments adopted both in *khairf* and *rabi* were T_1 -control , T_2 -vermicompost (5 t ha^{-1}), T_3 - neem cake (1.2 t ha^{-1}), T_4 - FYM (10 t ha^{-1}), T_5 - NPK (0 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}), T_6 - NPK (25 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1}), T_7 - NPK (50 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}) and T_8 - NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})]. Five tons of vermicompost, 1.2 tons of neem cake and 10 tons of FYM were applied in T_2, T_3, and T_4 treatments respectively as basal dose. Inorganic fertilizers were applied in T_5 , T_6 and T_7 one day after transplantation. In T_8 Neem cake of 0.6 tons was applied as a basal dose and remaining inorganic fertilizers (25kg N through urea + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}) were applied one day after transplantation. In T_1 (control) there was no application of fertilizers.

Suckers of 10-15 cm length were collected from two years old Aloe vera plantation from Forest nursery, Mahaboobnagar. The suckers were transplanted at a distance of 60 X 30 Cm. Irrigation was provided as and when required during the crop growth period. Destructive sampling was taken at 30 days interval. Three plants selected randomly were dug out along with root system and were separated in to leaves, stem and root. The separated plant parts were dried in hot air oven at 80-90^{0}C for 52 hours till constant weight is obtained. Based on the data obtained growth parameters were analyzed as described by Sestak *et al*.(1971).

Leaf area (Cm^2) was determined with LI-3100 area meter (LI-COR, Lincoln, Nebraska, USA). In view of succulence of Aloe vera leaves, their outline was drawn on a plain paper. The outline of paper was cut and fed to the leaf area meter. Leaf bits of 3 Cm^2 were cut from the top, middle and bottom portion of the green outer rind of aloe leaf after the mucilage was scraped out. Chlorophyll content was recorded with this leaf bits by SPAD chlorophyll meter (SCMR values) at 30 days interval till harvest.

RESULTS AND DISCUSSION

Influence of season and manuring on physiological and growth parameters was investigated in this study. A significant difference was observed in plant height, shoot fresh weight, number of leaves and leaf area with different organic and inorganic sources of fertilizers. All growth parameters were significantly affected in T_1 - control and T_5- NPK (0 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}) where no nitrogen supply was provided. Increased application of nitrogen resulted in increased production of biomass. Barandozil *et al*., (2011) also reported an increase in single leaf weight, leaf length, number of tillers and weight of the largest leaf of Aloe vera with increased nitrogen application.

Among various treatments NPK (50 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}) recorded significantly higher plant height initially at 30 and 90 DAP (18.5 Cm and 32.2 Cm). However, vermicompost (5 t ha^{-1}) recorded significantly higher values for plant height over control at 150 and 210 DAP (40.6 Cm and 52.3 Cm).A similar trend was observed in case of number of leaves(9.3 and and 10.3), leaf area (567.4 Cm^2 and 756.2 Cm^2) and shoot fresh weight(610.5 g and 965.6 g) (Table 1&3). Hasanuzzmann *et al* .,(2008) also reported that different manuring treatments which include organic sources significantly affected the plant characteristics of Aloe vera.

From this study it was found that inorganic nitrogen was readily available to the plant during initial stages of crop growth. But later on, after further decomposition and mineralization, vermicompost and other organic manures released nutrients gradually which were available to the plant for a longer duration. Since all the fertilizers and manures were applied as a basal dose the effect of organic manures was clearly found from 90 DAP. Atiyeh (2000) also found that vermicompost retains nutrients for long time and deliver the required amount of macro and micronutrients including the vital NPK (nitrogen, potassium & phosphorus) to plants. Further it was demonstrated by Bachman and Metzger (2008) that the growth of ornamental plants after adding aqueous extracts from vermicompost showed similar growth patterns as with the addition of auxins, gibberellins and cytokinins through the soil.

A leaf of Aloe vera is an important yield determining factor in Aloe vera plant (Eshun and He 2005). Number of leaves and leaf area showed a positive effect on shoot fresh weight. Mc Annalley (1990) reported that Aloe vera is a

Table 1. Effect of different organic and inorganic sources of fertilizers on Plant height, Number of leaves and leaf area of Aloe vera during Kharif, 2003-04.

Treatments	Plant height (Cm)				Number of leaves				Leaf Area (Cm^2)			
	30 DAP	90 DAP	150 DAP	210 DAP	30 DAP	90 DAP	150 DAP	210 DAP	30 DAP	90 DAP	150 DAP	210 DAP
T_1 - Control	16.2	20.5	27.4	33.5	3.3	4.0	5.3	8.3	133.4	286.4	395.3	525.3
T--$_2$ - vermicompost (5 t ha^{-1})	15.3	30.9	40.6	52.3	4.0	5.3	9.3	12.3	177.5	410.3	567.4	756.2
T_3 - neem cake (1.2 t ha^{-1})	17.2	28.5	36.5	46.3	3.7	4.6	8.3	12.0	165.5	400.3	510.3	714.2
T_4 - FYM (10 t ha^{-1})	15.5	26.3	34.2	43.5	3.7	4.3	7.3	10.0	150.3	386.1	481.4	680.5
T_5 - NPK (0 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	15.8	22.1	30.3	36.6	3.3	4.0	6.0	9.3	139.0	323.4	444.5	568.6
T_6 - NPK (25 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1})	16.3	24.3	32.7	39.8	3.7	4.3	7.0	9.7	162.5	356.6	467.5	624.5
T_7 - NPK (50 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	18.5	32.2	33.6	44.8	4.3	5.7	9.0	11.3	191.2	434.2	498.6	691.5
T_8 - NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})]	16.5	31.6	37.7	47.6	3.7	4.7	8.0	12.0	153.2	391.2	553.5	726.5
SEM ±	0.6	1.0	3.4	4.6	0.4	0.5	0.7	0.8	9.6	23.9	32.1	45.9
CD (p =0.05)	1.8	3.1	10.4	14.0	NS	NS	2.0	2.3	29.0	72.5	97.4	139.3

Table 2. Effect of different organic and inorganic sources of fertilizers on Plant height, Number of leaves and leaf area of Aloe vera during rabi, 2003-04.

Treatments	Plant height (Cm)				Number of leaves				Leaf Area (Cm^2)			
	30 DAP	90 DAP	150 DAP	210 DAP	30 DAP	90 DAP	150 DAP	210 DAP	30 DAP	90 DAP	150 DAP	210 DAP
T_1 - Control	14.4	16.2	24.1	30.6	3.0	3.7	6.3	8.0	105.1	138.2	300.2	505.2
T--$_2$ - vermicompost (5 t ha^{-1})	17.8	23.6	36.8	48.5	3.7	5.3	9.7	12.3	115.3	203.2	440.3	684.2
T_3 - neem cake (1.2 t ha^{-1})	17.0	22.0	35.7	45.1	3.7	4.7	8.7	11.7	111.1	187.2	419.9	675.2
T_4 - FYM (10 t ha^{-1})	16.8	20.0	32.2	39.2	3.3	4.4	7.7	10.3	110.2	177.6	396.9	647.2
T_5 - NPK (0 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	14.7	17.9	26.2	34.2	3.0	4.0	6.3	8.7	110.1	158.9	341.2	542.2
T_6 - NPK (25 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1})	15.9	19.0	31.8	38.2	3.7	4.3	6.3	9.0	116.9	171.2	367.9	584.2
T_7 - NPK (50 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	17.8	22.0	34.4	44.5	4.0	6.0	9.3	10.7	134.5	211.2	403.4	632.1
T_8 - NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})]	18.0	21.9	35.7	45.8	3.7	5.0	8.3	10.3	120.3	178.2	425.3	669.2
SEM ±	1.3	1.5	2.3	2.6	0.3	0.5	0.6	0.7	8.5	11.6	27.5	39.4
CD (p =0.05)	NS	4.4	6.9	7.9	NS	1.4	1.9	2.1	NS	35.3	83.6	119.6

Table 3. Effect of different organic and inorganic sources on per cent water content in of Aloe vera during Kharif and rabi, 2003-04 at 210 DAP.

Treatments	SCMR values		Shoot fresh weight (g/ plant)		Shoot dry weight (g/plant)		% water content	
	Kharif	Rabi	Kharif	Rabi	kharif	Rabi	Kharif	Rabi
T_1 -Control	44.3	37.1	649.2	685.4	42.9	30.3	93.4	95.5
T_2 - vermicompost (5 t ha^{-1})	54.3	54.4	965.6	993.6	65.6	44.4	93.2	95.5
T_3 - neem cake (1.2 t ha^{-1})	56.2	52.2	897.2	902.5	71.3	46.0	92.0	94.9
T_4 - FYM (10 t ha^{-1})	49.3	44.3	748.6	800.4	68.6	47.3	90.8	94.0
T_5 - NPK (0 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	41.6	42.2	704.2	741.5	51.6	35.3	92.6	95.2
T_6 - NPK (25 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1})	43.6	43.5	716.2	788.3	54.6	38.0	92.3	95.1
T_7 - NPK (50 kg N ha^{-1}+ 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})	50.2	48.9	836.5	841.5	65.3	43.0	92.1	94.8
T_8 - NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})]	54.3	49.2	914.2	943.3	66.0	48.4	92.7	94.8
SEM ±	2.9	2.9	56.8	62.1	4.6	3.3	-	-
CD (p =0.05)	8.7	8.9	172.4	188.5	14.0	10.0	-	-

succulent plant and possesses high water content ranging from 98-99 per cent of fresh matter. However, experimental results indicated that water content ranged from 90.8 to 93.4 per cent in kharif and from 94 to 95.5 per cent in rabi (Table 3). From the results it was clear that fresh weight and dry weight of the plant was maximum with vermicompost (5 t ha^{-1}) (965.6 and 65.6g), neem cake (1.2 t ha^{-1}) (897.2 and 71.3g) and NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})](914.2 and 66.0g) . Neem cake being a rich source of N,P and K the plant might have used the excess nitrogen and potassium for the development of fibre content and a thicker rind which was evident from its high shoot dry weight compared to other treatments (Table 3).

Irrespective of the treatments, CGR was found to be maximum at 120-150 DAP during kharif. Among the treatments FYM recorded maximum CGR at 120-150 DAP which was at par with vermicompost (5 t ha^{-1}), neem cake (1.2 t ha^{-1}), NPK (50 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1}) and NPK [(50 kg N ha^{-1} (25 kg N through neem cake + 25 kg N through urea) + 50 kg P_2O_5 ha^{-1} + 50 kg K_2O ha^{-1})](Fig.1). Barandozil *et al.*, (2011) also reported that the growth rate was highest at early stages of growth in Aloe vera and it declined gradually with time. In rabi planted Aloe vera CGR showed two peaks at 150-180 DAP and at 210-240 DAP which signified the indeterminate growth habit of Aloevera.(Fig.2). Akinyele and Odiyi (2007) also reported that Aloe vera is monocotyledonous plant which grows to absolute three feet in height and it takes four to five years to mature and can live upto 25 years. As the present study was confined only to a period of eight months further investigation is needed to explain the growth behavior of Aloe vera.

A pronounced influence of season on different growth parameters was also observed in the present study. A 15 per cent increase in shoot fresh weight with vermicompost (5 t ha^{-1}) was recorded in kharif planted Aloe vera compared to rabi planted crop. Similarly high SCMR values at 150 and 210 DAP (48.4 and 56.2) were recorded with neem cake in kharif compared to rabi (Table3).Similar to that of shoot fresh weight and SCMR values, Plant height, number of leaves and leaf area were also positively influenced by the season. (Table 1&2).The results also showed that comparatively high temperatures in kharif (25.8, 26.7

Fig.1. Effect of organic manures and inorganic fertilizers on CGR at different stages of crop growth in Aloe Vera during kharif,2003-04.

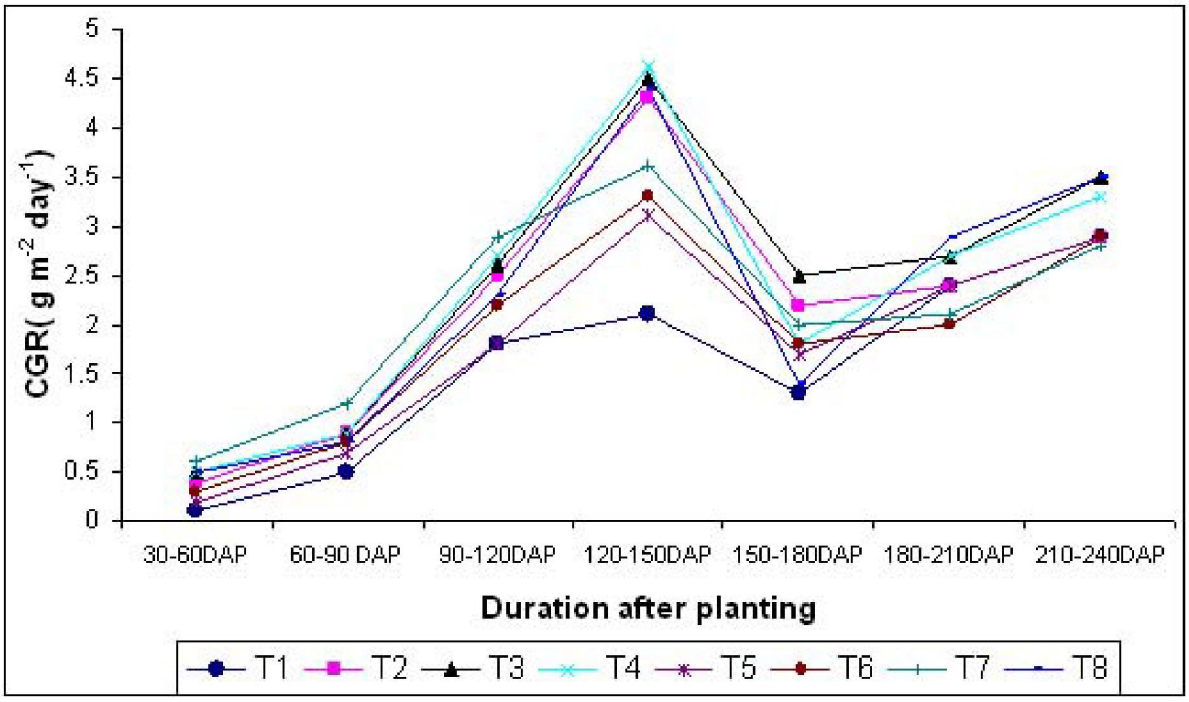
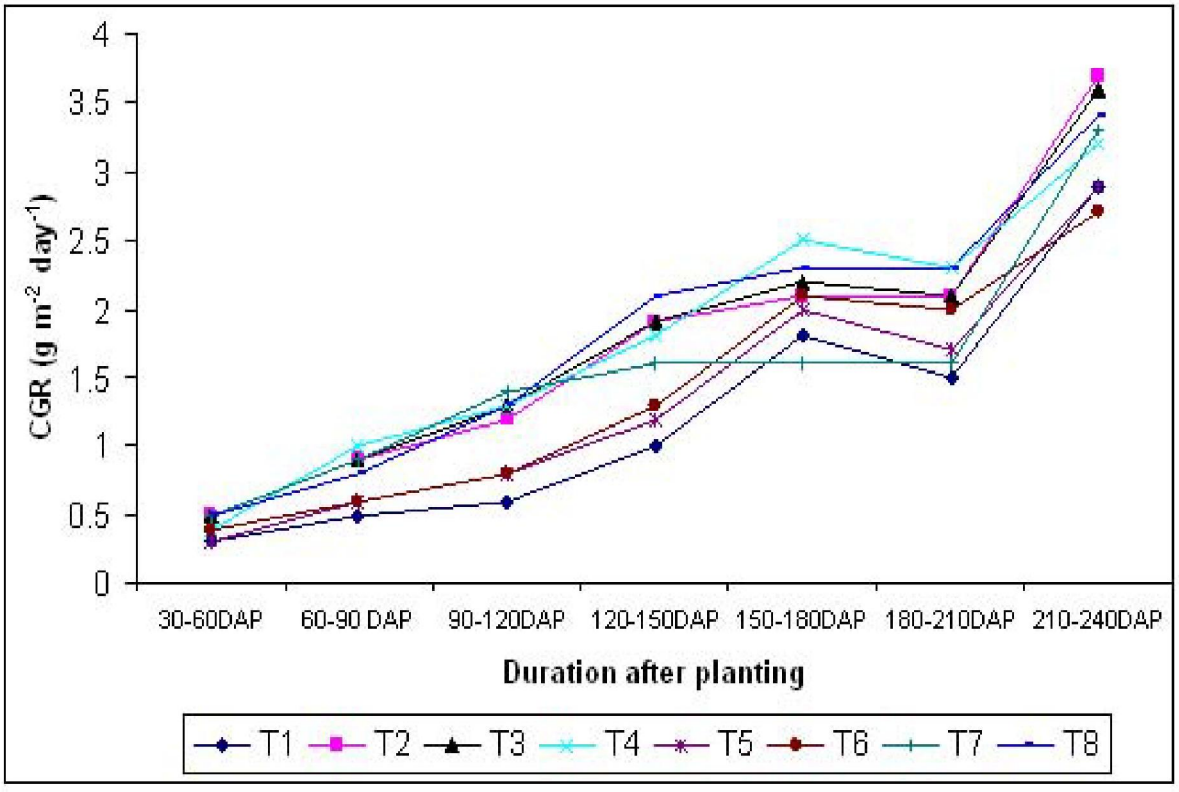


Fig.2. Effect of organic manures and inorganic fertilizers on CGR at different stages of crop growth in Aloe Vera during rabi,2003-04



and 25.1^{0}C at 30, 60 and 90 DAP respectively) during the initial periods of the crop growth favored for high biomass. Where as in rabi, low temperatures (22.4, 20.2 and 21.4 ^{0}C at 30, 60 and 90 DAP respectively) during initial periods hampered the crop growth. Such intolerance of Aloe vera to low temperatures was also reported by Morton (1961).

Aloe vera crop is generally harvested at two years. From the study it is evident that the crop growth was at its peak at 120-150 DAP. Hence, besides basal application of nitrogen a top dressing at 90-120 DAP would be beneficial for increased shoot yield, which is to be further confirmed.

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