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Growth Performance of *Aloe vera* as Influenced by Irrigation and Nitrogen

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Abstract: *A research experiment was conducted at the ICAR-Indian Institute of Water Management, Bhubaneswar to investigate the growth performance of Aloe vera under different irrigation and nitrogen treatments. The results revealed that with the increase in frequency of irrigation (from irrigation interval of 14 days to 7 days), the plant height, number of leaves, mature leaf length, leaf breadth, leaf weight, leaf area and total leaf weight of Aloe vera have shown a significant increase. This has also resulted in significantly higher dry matter production and crop growth rate at higher frequency of irrigation. In case of nitrogen treatments, the plant height, number of leaves, mature leaf length, leaf breadth, leaf weight, leaf area, total leaf weight and dry matter accumulation of Aloe vera were found to be superior when vermicompost was applied as a source of nitrogen fertilizer compared to that of chemical (urea) fertilizer and control treatment (no fertilizer).*

Keywords: *Aloe vera, nitrogen, vermicompost, irrigation.*

INTRODUCTION

Indian agriculture has been facing several challenges from time to time. From a mere of 51 million tones of food grain production at the time of independence in 1947, there is a quantum jump in food grain production which reached 265 million tones in the year 2013-14. However the rate of increase in food grain production has become stagnant in the recent years. The productivity of rice and wheat has almost become saturated inspite of release of innumerable high yielding varieties. In addition, the market price of food grain has not been satisfactory leading to poor economic status of farmers in India. This necessitates the diversification of crops in the form of high value medicinal plants.

Medicinal plants contain precious chemical ingredients that are highly essential for curing human diseases (Burccoft and Myskja, 2003). As the demand for drugs in medical treatment is on increasing trend, the market value of medicinal plant is expected to be stable. Moreover, the major soil groups in India are suitable for cultivation of medicinal plants. Though several species of medicinal plants are suitable to be grown in Odisha, thorough research investigation on packages of practices including water management is scanty. This necessitates the standardization of cultivation aspect of suitable medicinal plants.

Aloe vera is one of the most important medicinal plants with its medicinal properties deposited in its leaves which become succulent and helps immensely in improving the immune system in human beings (Plaskett, 1998 ; Morton, 1961). It can control diseases like AIDS by enhanced immune system (Davis, 1997). *Aloe vera* is rich in some chemicals that provide healing effect to human beings. It has other several medicinal properties. The exudate of *Aloe vera* L., Liliaceae, is used for numerous medical and cosmetic applications since ancient times (Morton, 1961). More recent research and clinical use has shown even wider applications for this amazing plant including enhancing immunity, balancing blood sugar and providing

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pain relief. Under scarce water situation this plant can adopt will due to its succulent nature. This provides a platform for cultivating *Aloe vera* under rainfed condition which in turn increases water productivity. Its can be grown under slight acidic, neutral, slightly alkaline soils.

The cultivation of *Aloe vera* has acquired great commercial importance due to above mentioned medicinal properties. Owing to its fair market price, the commercial cultivation of *Aloe vera* has to be taken up in large scale in India for achieving self reliance in agriculture. However, information is scanty about agronomic management including water and fertilizer management of this crop. Keeping these factors in consideration, a research experiment was initiated to study the effect of different water and nitrogen treatments on growth performance of *Aloe vera.*

MATERIALS AND METHODS

The pot experiment was conducted at the ICAR-Indian Institute of Water Management during January -May of 2009. The climate of this area is subtropical. The soil of the experimental site was sandy clay loam with pH of 6.2. The experiment was laid out by Split plot Design with 3 replications comprising three main plot treatments (Irrigation) viz. M_1: No irrigation, M_2: Irrigation at 14 days interval, M_3: Irrigation at 7 days interval and three sub plot treatments (Fertilizer Nitrogen) viz. S_1: No nitrogen, S_2: Nitrogen @ 100 kg ha^{-1} through chemical fertilizer, S_3 : Nitrogen @ 100 kg ha^{-1} through vermicompost. The size of the pot used in the experiment was 12 inches in diameter and of 14 inches in height. Seedlings of around 6 weeks age were collected from Regional Plant Research Centre, Bhubaneswar. Urea was applied as source of nitrogen @ 100 kg ha $^{-1}$. Vermicompost was also applied as source of nitrogen @ 100 kg ha^{-1} based on N equivalent value. Single seedling was planted in every opened pot. The pots were irrigated according to the treatments. Data were recorded every 15 days interval starting from 15 days after planting (DAP) for measuring plant height, leaf length, leaf number, leaf breadth, leaf area and leaf breadth. Final data were recorded at harvest to measure plant characters. Flexible tape and scale were used to measure leaf. Weighing was done by digital balance. The data were analyzed following Analysis of Variance (ANOVA) technique (Gomez and Gomez, 1984) using the statistical computer programme NPRCSTAT. Means were compared by using LSD test at 5% level of significance.

RESULTS AND DISCUSSION

PLANT HEIGHT

With the increase in frequency of irrigation, the plant height has shown a rise. Irrigation at 7 days interval and irrigation at 14 days interval resulted in significantly higher plant height (31.2 cm) compared to that of control treatment where no irrigation was provided (Table 4.1). However, the difference between these two irrigation treatments was not found to be significant statistically. In case of fertilizer treatments, the plant height was found to be superior when vermicompost was applied as a source of nitrogen fertilizer (31.2 cm) compared to that of chemical (urea) fertilizer and control treatment (no fertilizer). The variation recorded between the two fertilizer treatments was not statistically significant. The positive effect of fertiliser application on plant height of *Aloe vera* in comparison to that of control treatment was also reported by Saha et al.,(2005).The superiority of vermicompost was also found in increasing plant height which might be due to better cell division and cell elongation with out hampering nutrient uptake compared to chemical fertilizer application.

NUMBER OF LEAVES

Number of leaves was found to be highest when irrigation was supplied at 7 days interval followed by irrigation at 14 days interval (Table 1). The number of leaves recorded at irrigation at 7 days interval was significantly superior (11.1) to control treatment but on par with that of irrigation at 14 days interval. There is no significant variation between the irrigation treatments. The number of leaves was found to be highest when vermicompost was supplied as source of nitrogen (11.7) followed by urea application and control treatment. The number of leaves recorded with vermicompost was also found be significantly superior to that of urea

fertilizer application. The superiority of organic manures relative to that of chemical fertilization in terms of number of leaves of plant was also confirmed by the findings of Guerrero et al (2001).

MATURE LEAF BREADTH

Mature leaf breadth was found be superior when irrigation was provided at 7 days interval (3.51) followed by that of irrigation at 14 days interval and control treatments (Table 1). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the mature leaf breadth was found be significantly superior (3.52) to that of control treatment, but there was no significant variation between the two fertilizer treatments.

MATURE LEAF LENGTH

The mature leaf length *of Aloe vera* was found to be highest when irrigation was applied at 7days interval (20.5 cm) followed by followed by that of irrigation at 14 days interval and control treatments (Table 4.2). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the mature leaf length was found be significantly superior (21.1 cm) to that of control treatment, but there was no significant variation between the two fertilizer treatments.

Table 1
Plant height, number of leaves and mature leaf length of *Aloe vera* as influenced by irrigation and fertilizer

Treatment	*Plant height (cm)*	*Number of leaves*	*Mature Leaf breadth (cm)*
Irrigation			
M_1	25.3	10.4	3.32
M_2	29.5	10.9	3.44
M_3	30.2	11.1	3.51
LSD (0.05)	1.4	0.63	0.106
Fertilizer			
S_1	23.3	9.2	3.31
S_2	30.5	11.1	3.44
S_3	31.2	11.7	3.52
LSD (0.05)	1.2	0.52	0.094

LEAF AREA

Leaf area was found be superior when irrigation was provided at 7 days interval (432.6 cm^2) followed by that of irrigation at 14 days interval and control treatments (Table 2). There was significant difference between the two irrigation treatments also. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the leaf area was found be significantly superior (460.6 cm^2) to that of control treatment, and there was significant variation between the two fertilizer treatments too.

MATURE LEAF WEIGHT

Mature leaf weight was found be superior when irrigation was provided at 7 days interval (31.6 g)followed by that of irrigation at 14 days interval and control treatments (Table 2). There was significant difference between the two irrigation treatments also. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the mature leaf weight was found be significantly superior (32.4 g) to that of control treatment, and there was significant variation between the two fertilizer treatments too. The advantage of organic source of nutrients over inorganic source in terms of plant weight might be attributed to the beneficial effect of organic matter in soil properties and plant growth (Dexter, 1988; Tisdall and Oades, 1982; Uyanoz *et al.*, 2002).

Table 2
Mature leaf length, Leaf area and mature leaf weight of *Aloe vera* as influenced by irrigation and fertilizer

Treatment	*Mature Leaf length (cm)*	*Leaf area (cm^2)*	*Mature Leaf weight (g)*
Irrigation			
M_1	18.6	414.5	27.7
M_2	19.8	430.2	29.7
M_3	20.5	432.6	31.6
LSD (0.05)	0.96	4.87	1.78
Fertilizer			
S_1	16.8	359.7	25.7
S_2	21.1	457.0	31.0
S_3	21.1	460.6	32.4
LSD (0.05)	0.61	3.50	1.33

LEAF LENGTH OF BEST LEAF

The leaf length of best leaf of *Aloe vera* was found to be highest when irrigation was applied at 7days interval (22.1 cm) followed by followed by that of irrigation at 14 days interval and control treatments (Table 3). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the leaf length of best leaf was found be significantly superior (22.7 cm) to that of control treatment, but there was no significant variation between the two fertilizer treatments.

LEAF BREADTH OF BEST LEAF

The leaf breadth of best leaf of *Aloe vera* was found to be highest when irrigation was applied at 7days interval (3.6 cm) followed by followed by that of irrigation at 14 days interval and control treatments (Table 3). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the leaf breadth of best leaf was found be significantly superior (3.63 cm) to that of control treatment, and there was significant variation between the two fertilizer treatments also.

LEAF WEIGHT OF BEST LEAF

The leaf weight of best leaf of *Aloe vera* was found to be highest when irrigation was applied at 7days interval (34 g) followed by followed by that of irrigation at 14 days interval and control treatments (Table 4). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the mature leaf length was found be significantly superior (35.2 g) to that of control treatment, and there was significant variation between the two fertilizer treatments also.

TOTAL LEAF WEIGHT

The total leaf weight of *Aloe vera* was found to be highest when irrigation was applied at 7days interval (349.5 g) followed by followed by that of irrigation at 14 days interval and control treatments (Table 4). However, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the total leaf weight was found be significantly superior (379.6 g) to that of control treatment, and there was significant variation between the two fertilizer treatments also. The total leaf weight was found to be significantly superior under vermicompost treatment compared to that of urea treatment. The superiority of organic nutrition on plant growth and development was also noticed by Nobel *et al* (1991) and Hernández-Cruz *et al.* (2002).

Table 3
Leaf length of best leaf and leaf breadth of best leaf of *Aloe vera* as influenced by irrigation and fertilizer

Treatment	*Leaf length of best leaf (cm)*	*Leaf breadth (cm) of best leaf*
Irrigation		
M_1	20.1	3.44
M_2	21.3	3.52
M_3	22.1	3.60
LSD (0.05)	1.10	0.09
Fertilizer		
S_1	18.3	3.40
S_2	22.4	3.53
S_3	22.7	3.63
LSD (0.05)	0.61	0.08

Table 4
Leaf weight of best leaf and total leaf weight of *Aloe vera* as influenced by irrigation and fertilizer

Treatment	*Leaf weight of best leaf (g)*	*Total leaf weight (g)*
Irrigation		
M_1	30.4	288.8
M_2	31.5	322.7
M_3	34.0	349.5
LSD (0.05)	3.40	27.1
Fertilizer		
S_1	28.2	237.1
S_2	32.5	344.4
S_3	35.2	379.6
LSD (0.05)	2.07	19.4

DRYMATTER ACCUMULATION

The dry matter production of *Aloe vera* at all the growth stages was found to be highest when irrigation was applied at 7days interval followed by followed by that of irrigation at 14 days interval and control treatments (Table 5).

Table 5
Dry matter production of *Aloe vera* at different crop growth periods as influenced by irrigation and fertilizer

Treatment	*Dry matter production at 30 DAP*	*Dry matter production at 60 DAP*	*Dry matter production at 90 DAP*
Irrigation			
M_1	146.2	286.5	352.6
M_2	165.4	302.4	378.4
M_3	185.6	332.1	392.4
LSD (0.05)	12.3	23.1	30.6
Fertilizer			
S_1	119.4	222.5	289.5
S_2	176.9	318.4	390.4
S_3	200.9	380.1	443.5
LSD (0.05)	10.9	21.4	25.5

The dry matter production recorded when irrigation was supplied at 7 days interval was found to be significantly superior to that of irrigation at 14 days interval at 30 DAP and 60 DAP but on par at 90 DAP. At 90 DAP, there was no significant difference between the two irrigation treatments. When vermicompost and urea were applied as source of nitrogen @ 100kg ha^{-1}, the dry matter production was found be significantly superior to that of control treatment, and there was significant variation between the two fertilizer treatments also at all the crop growth stages. *Aloe vera* also responded more positively with the application of nitrogen through vermicompost relative to that of urea and it might be attributed to the beneficial effect of organic matter in soil properties and plant growth as described by Tisdall and Oades (1982) and Uyanoz *et al.,* (2002).

It may be concluded that with the increase in frequency of irrigation (from irrigation interval of 14 days to 7 days) in combination with application of vermicompost resulted in superior plant height, number of leaves, mature leaf length, leaf breadth, leaf weight, leaf area and total leaf weight which in turn resulted in significantly higher dry matter production and crop growth rate of *Aloe vera*.

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