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Research Article

Response of Aloe Vera Growth and Gel Production to Organic Manures and Irrigation Intervals

Zia Gul[1], Muhammad Sajid[1], Muhammad Noman Khan[1*], Faheem ul Haq[1], Zohra Nawaz[1], Muhammad Bakhtiar[2], Sajid Siddique[1], Komal Aslam[3] and Muhammad Irshad[1]

[1]Department of Horticulture, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; [2]Department of Biology and Environmental Sciences, Alama Iqbal Open University, Islamabad, Pakistan; [3]Horticultural Research Institute, Ayub Agriculture Institute Faisalabad, Pakistan.

Abstract | An experiment on Response of Aloe vera growth and gel production to organic manures and irrigation intervals was carried out at Ornamental Nursery, Department of Horticulture during the year 2014. The experiment was consisted of two factors, Factor A was irrigation intervals I_1 =15 days, I_2 =30 days and I_3=45 days interval which was assigned to main plots, while Factor B was organic manures (control as O_1, Leaf compost (LC) as O_2, Poultry manure (PM) as O_3 and Mushroom compost (MC) O_4) which was assigned to sub plots and each were applied at the rate of 20 tons ha^{-1}. Randomized Complete Block Design (RCBD) with split plot arrangement was used as an experimental design with three replications. The analysis of data showed that organic manure and irrigation intervals significantly affected most of the growth and yield parameter of Aloe vera plant. However, irrigation intervals exhibited the highest leaves (number) (9.9) $plant^{-1}$, plant height (34.5 cm), leaf length (36.8cm), leaf area (173.5 cm^2), leaf breadth (4.0 cm), leaf thickness (3.1 cm) leaf weight (181.3 g), number of suckers (5.5) $plant^{-1}$, amount of gel (149.3 g) $leaf^{-1}$, and survival percentage (80.8) was recorded when plants were irrigated at 15 days interval. While regarding organic manures, the maximum number of leaves (11.0) $plant^{-1}$, plant height (41.6cm), leaf length (39.5 cm), leaf area (247.8cm^2) leaf breadth (4.7 cm), leaf thickness (3.5 cm) leaf weight (207.3 g), number of suckers (4.1) $plant^{-1}$, amount of gel (174.7 g) $leaf^{-1}$ and survival percentage (71.5) was recorded in plants fertilized with poultry manure .The interaction of organic manures and irrigation intervals had significant affect maximum growth andyield parameters. However, poultry manure (PM) application with 15 days irrigation interval significantly increased number of leaves (11.7) $plant^{-1}$, plant height (43.3 cm), leaf length (46.3 cm), leaf area (270.6 cm^2), leaf breadth (5.2 cm), leaf thickness (4.0 cm), leaf weight (227.3 g), amount of gel (189.3 g) $leaf^{-1}$. Results showed that poultry manure (PM) could be applied with irrigation interval of 15 days to enhance growth and gel percentage of Aloe vera under the agro-climatology of Peshawar.

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***Correspondence** | Muhammad Noman Khan, Department of Horticulture, The University of Agriculture, Peshawar, Khyber Pakhtunkhwa, Pakistan; **Email:** nomanhort@aup.edu.pk
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1. Introduction

Aloe vera *Aloe barbadensis* M. is one the famous member of family Liliaceace, onion and garlic are also included in this family. Aloe vera plant is xerophytic, pea green color, perennial, shrubby and succulent plant. The Aloe vera plant is comprise of long leaf up to 5-6 inches wide and about 20 inches long, which is triangular, fleshy and having spikes along boundaries (Surjushe *et al*., 2008). There are 600 known species in the Aloe vera genus (Okamura *et al*., 1996). Aloe vera is grouped in the xeroids as having ability to avoid water loss by closing stomata completely (DeHertogh, 1992). Aloe vera can life span reached up to 25 years and matures in five years (Davis *et al*., 2000). it can be propagated via seeds or suckers (Duke, 1987).

Aloe vera plants having virtual importance throughout the world, eight enzymes are isolated from Aloe vera up till now, which includes peroxidase, lipase, catalase, cellulose, corboxypeptidase, alkaline phosphatase, amylase and alliase. Most of the enzymes present in Aloe vera help to breakdown food sugars and fats, while enzymes like carboxypeptidase help to inactivate bradykinins which produce anti-inflammatory effect. Two important hormones are known from Aloe vera that are auxin and gibberellin. Both hormones play an important role but auxin is important regarding wound healing while both auxin and gibberellin also having anti- inflammatory effect. Aloe vera also contains many vitamins, except vitamin D, but includes vitamin A, B (the thiamine, Riboflavin, Niacin, B12), C, E, F, Folic acid and Choline (Ahmed *et al*., 2004) Aloe vera primarily grown for its fresh gel, which is actually 0.9% (dry matter) mesophyll cells (and water (99.1%) which can be differentiated in to three parts *i.e.* cell wall (16.2%), liquid gel (0.7%) and micro particles (83.1%) of dry pulp (w/w). Aloe vera plants are an attractive ornamental plant with foliage beauty. Under shade conditions Aloe vera produces spotted leaves while in full sunlight it produces green leaves. Green leaves of Aloe vera having aesthetic value in homes and gardens (Sofowara, 1984). Most of the Aloe vera species have being used as medicines. Aloe barbadensis, or aloe vera (*Curacao aloe*), Aloe Ferox (*Cape aloe*), and aloe perryi (*Socotra aloe*) are the species used as folk medicine. Most common uses of aloe vera in the world includes as a cure for skin ailments, gastrointestinal issues and burns. It is extensively being used in cosmetics industry (Cummings *et al*., 1981). Its products are being used to treat minor cuts and burns and also for the purpose of wounds healing. Aloe vera can be used in different cosmetics i.e. creams used for skin, Aloe vera production depends up on several factors, in which irrigation and optimum nutrients availability are having important consideration. Irrigation is important for the growth and gel production of Aloe vera, as water is used in the physiological and biochemical reactions that took place within a plant body. For plant growth irrigation is one of the most critical factor. Water act as a medium for uptake and transport of materials within plant via Xylem cells. It is essential component in biochemical reactions. It helps to maintain plant turgidity and a component in photosynthetic activity; crucial process to keep plant alive (Hebrank, 1997). Without water nutrients uptake is difficult for the plants as these nutrients are absorbed in solutionform (Lamb *et al*., 1994). Vegetative production depends upon irrigation as suckers devolvement is reduced by drought (Kambooh, 1984).

Organic media increases the rate of organic matter and provides strength to microorganisms to feed themselves and make good soil structure and texture. These media can also enhance the water holding capacity of soil and play role in long term fertility (Van *et al*., 1997).

Growing media is used around the world for the better production of plants, especially for the commercial production. Organic media having great importance as it provides that range of mineral nutrients to the plants which are required for the growth and yield (Shah *et al*., 2006). Growing media helps in the development of suckers. Soilless media are used to promote sewerageand avert diseases. For better production and development of plants organic fertilizers are used as it provides satisfactory environment to plant. It grants abundant nutrients, enough water holding capacity, and excellent aeration to plants. For the development of house plants straight garden soilis not good as it fails to drain the excess water, low in mineral nutrients and also contain pathogens like nematodes and fungi etc. In order to make excellent growing media we needed to incorporate organic media (like compost, filler, peat or pine or any other supplement) in garden soil. Before adding these media few things should be kept in mond that these should be well decomposed, preserved and light in weight (Aranconet *al*., 2004).

Mushroom compost is used as a growth media which is collected from mushroom farms. It is anagurated from the fertilizer waste like ground chalk, wheat straw, horse manure and dried blood, cotton seed meal, poultry manure, gypsum and cocoa shell. It is an affluent source of humus, it also includes the satisfying amount of familiar nutrients i.e., it contains 0.7% of nitrogen, 0.3% phosphorous and 0.3% potassium and an plenty amount of trace elements along with good soil conditioner. Mushroom compost is alkaline due to the presence of chalk content. It may also consist of pesticides slits i.e., organ chlorides which is helpful against fungus. It has high nutrient and water holding capacity and displays no nitrogen leaching difficulty. As manure it constrains artillery fungus (Bradley, 2004).

Leaf compost is produced by the fungal degradation of tree and shrub leaves. The leaves are commonly very dry, acidic and nitrogen smug is extremely low for bacterial degradation. As compared to other compost constituents the leaves breakdown is very low because of slow rotting quality of high carbon smug. The fungal action can be expectant by placing the wet leaves in significantly made bins or in plastic bags. Protect the leaves from wind drying in order to quicken the fungal break down. Excellent media should have a pH that is supportive for the plant growth anda medium that facilitate water dispersion, gas exchange and gives good aeration (Larson, 1980).

Cow urine, dairy waste, waste straw and cow dung are generally used for the preparation of farmyard manure (FYM). It is very useful source of nutrients. Balance nourishment is available to the plant when the cow dung and urine combines together. Nitrogen is directly available to the plants in lesser amount while high amount is available by the complete decay of FYM. Phosphorous and potassium from FYM is available to the plant as similar from inorganic source. Growing media should have good drainage to enable root aeration and avoid water logging. It should have the capacity to provide proper nutrients and water retention (Jacobs *et al.*, 2009). Both of the factors i.e., Water and organic manures plays vital role in the production of Aloe vera gel, growth and its foliage beauty. Whereas Aloe vera gel has medicinal values therefore it is used in medicines and the leaves overall are used for aesthetic purpose.

Keeping in view the significance of the Aloe vera plant, the present experiment was performed to evaluate growth response of Aloe vera (*Aloe barbadensis* M.) to different irrigation intervals and organic manures. Main objectives of the current study were; to evaluate the best irrigation interval required for better growth and gel production of Aloe vera, to find out the most suitable organic manure used for better growth and gel production of Aloe vera and to study the interactive effect of organic manures and irrigation intervals for better growth and gel production of Aloe vera.

2. Materials and Methods

An experiment entitled "Response of Aloe vera growth and gel production to organic manures and irrigation intervals was performed during the year 2014 at Ornamental Horticulture Nursery, Department of Horticulture, The University of Agriculture Peshawar.

2.1 Experimental design

The research was laid out in randomized complete block design (RCBD) with two factors having split plot arrangement and with three replications. Irrigation intervals as factor A were placed in Main Plot and Organic Manures as factor B was assigned to subplot. Organic manures were applied @20 t ha^{-1} (Sanwal *et al.*, 2005). With control there were 12 treatments in each replication. Each plot was comprise of size 1.5 × 22.5 m^2 and the entire experimental field was divided in 12 plots. Every plot was divided into 4 rows and 5 plants were transplanted in each row. Total 20 plants were transplanted in each bed. Plastic tunnels were used in the experiment to control rain and irrigation intervals (Factor A) ultimately.

2.2 Gel extraction method

For gel extraction first Aloe vera leaves was washed with distilled water and cleaned and dried with the help of cloth. Leaves of Aloe vera were cut at the base to split crosswise into the two or three sections easily. The Aloe vera gel was extracted into a beaker using back side of the knife.

2.3 Soil analysis

Before the application of organic manures, soil sample up to 25 cm depth were collected (randomly) from five different locations and analyzed the following physio-chemical parameters.

Table 1: Shows detail of treatments.

Factor A	Factor B
Irrigation intervals (Main-plot)	Organic manures (Sub-plot)
15 days	Control
30 days	Leaf compost
45 days	Poultry manure
	Mushroom compost

Table 2: Shows physio-chemical analysis of experimental soil at 25 cm depth.

Before transplantation		After harvesting	
Determination	**Quantity**	**Control**	**Organic**
Nitrogen (%)	0.042	0.031	0.060
Phosphorous (mg kg^{-1})	9.00	6.00	13.33
Potassium (mg kg^{-1})	110	90	130
Organic matter (%)	0.83	0.61	1.20
pH	7.3	7.2	6.9
Texture Class	Clay loam	Clay loam	Clay loam

Table 3: Shows chemical analysis of farmyard manure, poultry manure and mushroomcompost before application to the field.

Media	Leaf compost	Poultryc manure	Mushroom compost
Nitrogen (%)	0.37	2.14	0.7
Phosphorus (%)	0.18	1.09	0.3
Potassium (%)	0.71	1.23	0.3

2.4 Studied parameters

1. The following attributes were studied:
2. Number of leaves $plant^{-1}$
3. Plant height (cm)
4. Leaf length (cm)
5. Leaf area (cm^2)
6. Leaf breadth (cm)
7. Leaf thickness (cm)
8. Number of suckers $plant^{-1}$
9. Amount of gel $Leaf^{-1}$ (g)
10. Leaf weight (g)
11. Survival percentage

2.5 Statistical analysis

The mean values were subjected to Analysis of Variance (ANOVA) used for RCBD design having split plot arrangement. Means were analyzed by using Least Significance Differences (LSD) test when F values were significant. The Statistical software Statistix 8.0 was used to analyze ANOVA and LSD (Steels *et al.*, 1997).

3. Results and Discussion

3.1 Number of leaves $plant^{-1}$

The mean data recorded for number of leaves $plant^{-1}$ is described in (Table 4). ANOVA revealed that there was significant affect with organic manures and irrigation intervals on number of leaves $plant^{-1}$ of Aloe vera, while its interaction had no significant affect. Means regarding irrigation intervals showed that irrigation at 15 days intervals produced more number of leaves (9.9) $plant^{-1}$ followed by irrigation at 30 days interval with 8.7 number of leaves $plant^{-1}$, while the Aloe vera plants irrigated at 45 days intervals produced less number of leaves (8.4) $plant^{-1}$. Similarly mean of organic manures showed that more number of leaves (11.00) $plant^{-1}$ were noted in the plants to which Poultry manure was applied. While plants of control treatment resulted in less (6.1) number of leaves per plant. Regarding irrigation intervals, the reason behind the more number of leaves per plant be the fact that when the plants irrigated at 15 days interval provides the optimum range of moisture for plants to uptake more nutrients from soil, resulted in more growth ultimately more number of leaves $plant^{-1}$. Similar results were found, when short irrigation is given to *Agave sisalana* (Manassah *et al.*, 1981; McDaniel, 1985). Vegetative growth depends upon nitrogen which promotes chlorophyll formation in plants. To allocate that amount of chlorophyll plants increase its number of leaves, hence for this Poultry manure act as a rich source of nitrogen which resulted in increased number of leaves $plant^{-1}$. These results are also supported by different researchers who published that Nitrogen application increased leaves in Aloe vera plant (Tawaraya *et al.*, 2007). Chlorophyll content of leaves was also increased by nitrogen (Nahed and Aziz, 2007).

3.2 Plant height (cm)

The mean data regarding plant height (cm) is given in (Table 4). The statistical analysis of data showed that organic manures and irrigation intervals had significantly affected the plant height of Aloe vera while its interaction had no significant affect. Tallest plants (34.5 cm) were recorded with irrigation at 15 days intervals followed irrigation at 30 days intervals with 32.4 cm plant height. While the minimum plant height (31.7 cm) was noted in plants irrigated at 45 days intervals. Mean data showed that the organic manures significantly influenced the plant height (cm) of Aloe vera. Farmyard manure application resulted in

the tallest (41.6 cm) plants, followed by plant height (36.6 cm) recorded in plants treated with Mushroom compost. In plots where no organic manure was added (control) resulted in lowest plant height (24.3 cm). Presence of optimum range of nitrogen in poultry manure that caused high photosynthates production might be the possible reason for increased plant height. Nitrogen is a vital element of amino acids which are the structural component of proteins. Increase amount of nitrogen results in more amino acids and proteins formation. So, the utilization of these rich food contents enhanced cell division and elongation and resulted in maximum plant height with better vegetative growth. While small heighted plants in control treatment might be due to dietetic statuses which resulted deter growth and low height. Findings of the present research are in accordance to prior experimental results, which reported that high nitrogen rate resulted in improved vegetative growth (Babatunde *et al.*, 2008; Sing, 2000). Regarding irrigation intervals (15 days interval) produced tallest plants which might be due the reason that plant take more nutrients (nitrogen) through roots in water which results in better plant height. The frequent irrigation provides sufficient amount of water to the plants to uptake more nutrients from soil and utilized them for better vegetative growth and ultimately increased the plant height (Tawfik *et al.*, 2001).

3.3 Leaf length (cm)

The mean data related to leaf length (cm) is tabulated in (Table 4). The statistical analysis of data indicated that organic manures and irrigation intervals significantly affected the leaf length of Aloe vera while its interaction has no significant affect. The maximum length (36.8 cm) was recorded in plants irrigated at 15 days intervals followed by leaf length (32.0 cm) when irrigated at 30 days intervals. While the minimum leaf length (24.6 cm) was noted in plants irrigated at 45 days intervals. In organic manures the lengthy leaf (39.5 cm) was recorded in plants fertilized with poultry manure, followed by leaf length (33.0 cm) recorded in plants treated with Mushroom compost. While shorter leaves (25.6 cm) was noted in plants of control treatment. Improvement in length of leaves with poultry manure might be due to the presence of optimum range of nitrogen which is essential for chlorophyll and vegetative growth. Nitrogen is an integral component of amino acids and these amino acids are crucial component of proteins. Increase amount of nitrogen results in more amino acids and proteins formation. So, utilization of these rich food contents increases cell division and elongation enhanced which ultimately resulted in increased leaf length with better vegetative growth. While lowest leaflength in control treatment might be due to dietetic statuses which resulted deter growth and low height. Findings of the present research are in accordance to prior experimental results, which reported that high nitrogen rate resulted in improved vegetative growth (Babatunde and Youngabi, 2008).

Table 4: Number of leaves plant^{-1}, plant height (cm) and leaf length (cm) of Aloe vera as affected by organic manures and irrigation intervals.

Irrigation intervals	Number of leaves plant^{-1}	Plant height (cm)	Leaf length (cm)
15 days	9.9 a	34.5 a	36.8 a
30 days	8.7 b	32.4 b	32.0 b
45 days	8.4 b	31.7 b	24.6 b
LSD (0.05)	0.64	1.45	1.30
Organic manures			
Control	6.1 d	24.3 d	25.6 c
Leaf compost	8.7 c	29.6 c	26.5 c
Poultry manure	11.0 a	41.6 a	39.5 a
Mushroom compost	10.2 b	36.6 b	33.0 b
LSD (0.05)	0.70	1.46	1.37
Interaction			
Irrig.Int*Org.Man	NS	NS	NS

The mean values with different alphabets are significantly variant at 5% probability level

3.4 Leaf area (cm^2)

The mean data pertaining leaf area (cm^2) is tabulated in (Table 5). The statistical analysis of data showed that organic manures and irrigation intervals had significant results on leaf area, while interaction had non-significant affect. Leaf with more area (173.5 cm^2) was recorded in plants irrigated at 15 days intervals followed by leaf area (153.5 cm^2) when irrigated at 30 days intervals. While the minimum leaf area (140.4 cm^2) was noted in plants irrigated at 45 days intervals. Mean data showed that the organic manures significantly influenced the leaf area (cm^2) of Aloe vera. Leaf with more area (247.8 cm^2) was recorded with poultry manure application, followed by leaf area (195.8 cm^2) noted in plants treated with Mushroom compost. While lowest leaf area (37.6 cm^2) was recorded in plants of control treatment. Irrigation interval (15 days) and organic manure (poultry manure) resulted in high leaf area of Aloe vera plant, which might be due to the fact that short irrigation interval provides optimum level of water

to plants which cause plenty amount of nitrogen uptake which in turn improve chlorophyll content and photosynthesis. This help in more production of gel by the leaf. Hence, increase in the gel contents resulted in leaves expansion and increased the leaf area. These results are in accordance with the study of prior scientists, who reported increased rate of leaf area of Aloe vera as perceived when treated with high rate of nitrogen (Tawfik *et al*., 2001; Saradhi *et al*., 2007; Yepez *et al*., 1993; Wyman, 1997).

3.5 Leaf breadth (cm)

The irrigation intervals and organic manures had significantly influenced the leaf breadth (cm) of Aloe vera, while its interaction was found non significant (Table 5). Leaf with more breadth (4.0 cm) was recorded in plants irrigated after 15 days, closely followed by leaf breadth (3.1 cm) in plants irrigated after 30 days. However, the minimum leaf breadth (3.0 cm) was recorded when plants were irrigated after 45 days. The analysis of variance showed that the leaf with more breadth (4.7 cm) was recorded in plants treated with organic manure (Poultry manure) followed by leaf breadth (3.4 cm) noted when plants treated with Mushroom compost. By contrast the plants of control treatment had the lowest leaf breadth (2.6 cm). Irrigation interval (15 days) and organic manures (Poultry manure) resulted in high leaf breadth of Aloe vera plant, which might be due to the fact that short irrigation interval provides optimum level of water to plants which cause more uptake of nutrients in form of nitrogen, phosphorus, potassium from soil which improve chlorophyll content and so the process of photosynthesis. Hence more carbohydrates production improves the expansion of leaves through cell expansion. These results are in accordance with the study of prior researchers, who reported increased rate of leaf breadth of Aloe vera as perceived when treated with high rate of nitrogen (Saradhi *et al*., 2007; Yepez *et al*., 1993; Wyman, 1997).

3.6 Leaf thickness (cm)

The mean data about leaf thickness (cm) is given in (Table 5). Analysis of data showed that organic manures and irrigation intervals significantly affected plant thickness of Aloe vera, while the interaction effect had non significant affect. Means regarding irrigation intervals indicated that the leaf with more thickness (3.1 cm) was recorded in plants irrigated at 15 days intervals, followed by leaf thickness (2.5 cm) obtained in plants of Aloe vera irrigated after 30 days. However, leaf with less thickness (1.9 cm) was produced when Aloe vera was irrigated after 45 days intervals. A significant difference was recorded for leaf thickness of Aloe vera regarding the application of organic manures. The mean data showed that the maximum leaf thickness (3.5 cm) was recorded in plants grown under the application of poultry manure, followed by leaf thickness (2.9 cm) recorded in plants treated with Mushroom compost. While the lowest leaf thickness (1.4 cm) was noted in plants of control treatment. The leave thickness has a positive relation with gel leaf^{-1}. When gel leaf^{-1} increases the leaf thickness also increases. Similarly, when plants produce maximum vegetative growth with high content of photosynthate, ultimately resulted in higher leaf thickness. The highest leaf thickness in plants treated with poultry manure, might be owing to the disposal of relatively good amount of mineral nutrients particularly nitrogen, hence produced more photosynthates and resulted in maximum gel production with higher leaf thickness. As nitrogen plays an important role during physiological process and increased the chlorophyll content in the leaves. Hence, increased chlorophyll content resulted in enlargement of leaves with higher leaves thickness. Similar findings were observed, when high dose of nitrogen was applied on *Codiaem variegatum* L., resulted in increased chlorophyll content (Nahed and Aziz, 2007). While regarding irrigation intervals, short irrigation provides sufficient amount of water to the plants to uptake more nutrients from soil and to utilize them for better vegetative growth (Yepez *et al*., 1993; Wyman, 1997).

Table 5: Leaf area (cm^2), leaf breadth (cm) and leaf thickness (cm) of aloe vera as affected by organic manures and irrigation intervals.

Irrigation intervals	Leaf area (cm^2)	Leaf breadth (cm)	Leaf thickness (cm)
15 days	173.5 a	4.0 a	3.1 a
30 days	153.5 b	3.1 b	2.5 b
45 days	140.4 c	3.0 b	1.9 c
LSD (0.05)	7.27	0.32	0.06
Organic manures			
Control	37.6 d	2.6 d	1.4 d
Leaf compost	141.8 c	2.8 c	2.3 c
Poultry manure	247.8 a	4.7 a	3.5 a
Mushroom compost	195.8 b	3.4 b	2.9 b
LSD (0.05)	4.17	0.22	0.17
Interaction			
Irrig.Int*Org.Man	NS	NS	NS

The mean values with different alphabets are significantly variant at 5% probability level.

3.7 Number of suckers plant^{-1}

Data regarding number of suckers plant^{-1} is given in (Table 6). The statistical analysis of data indicated that organic manures and irrigation intervals showed positive affects regarding number of suckers plant^{-1} of Aloe vera, while interaction exhibited non-significant results. Irrigation intervals from the mean table exposed that irrigation after 15 days produced maximum number of suckers (5.5) plant^{-1} followed by number of suckers (2.1) plant^{-1} was recorded in plants having irrigation after 30 days, while irrigation after 45 days produced lowest number of suckers (1.6) plant^{-1}. In different organic manures, more suckers (4.1) plant^{-1} was produced by plants treated with poultry manure, followed by suckers (3.7) in plants treated with Mushroom compost. While low number (1.6) of suckers plant^{-1} was recorded in control treatment. Aloe vera plants are sensitive to cold winter injuries and its number of suckers can be affected negatively in severe frost. In such conditions Aloe vera plants hardly survive and in such conditions epidermis change its color. Hence, the upper portions of such leaves get dry which restrict the production of suckers (Sacks *et al.*, 1995). The highest number of suckers plant^{-1} of Aloe vera is due to the availability of more nutrients particularly Nitrogen in Poultry manure. Nitrogen is an indispensable factor in amino acids and these amino acids are component of proteins. Increase amount of nitrogen results in more amino acids and proteins formation. It has also an important role in photosynthesis and hence increases the content of chlorophyll, which results in increase numberof suckers and yield (Nahed and Aziz, 2007). Similar results were reported by another researcher, who reported high rate of nitrogen produced more number of suckers plant^{-1} (Hazarati *et al.*, 2012). These results are in accordance with Nahed and Aziz (2007) who noted that application of high dose of nitrogen resulted in maximum number of offsets.

3.8 Amount of gel leaf^{-1} (g)

The irrigation intervals and organic manures significantly influenced theamount of gel leaf^{-1} of Aloe vera, while its interaction was found non-significant (Table 6). Leaves with more amount of gel (149.3 g) leaf^{-1} was recorded when plants were irrigated after 15 days, closely followed by amount of gel (136.8 g) leaf^{-1} when plots were irrigated after 30 days, while plots irrigated after 45 days produced less amount of gel (127.4 g). The analysis of variance indicated that highest amount of gel (174.7 g) leaf^{-1} was recorded with the application of Poultry manure followed by amount of gel (151.2 g) leaf^{-1} in plants treated with Mushroom compost. By contrast the plants grown under control conditions had the lowest amount of gel (106.3 g) leaf^{-1}. More nutrients particularly nitrogen are available in Poultry manure that results in higher vegetative growth and amount of gel leaf^{-1} by improving photosynthesis. The present findings of the research are in accordance to the prior results of experiments, which reported that, higher amount of gel leaf^{-1} might be due to more nitrogen uptake from soil by Aloe vera plants (Hernandez *et al.*, 2002). Regarding irrigation intervals short interval provides optimum level of water to the plants which improves photosynthesis and carbohydrate formation which in turn improves gel production. These results are in accordance with the study of prior publishers, who noted better gel yield of Aloe vera in short irrigation interval with high rate of nitrogen (Ji-Dong *et al.*, 2006).

3.9 Leaf weight (g)

The mean data pertaining leaf weight is tabulated in (Table 6). The statistical analysis of data showed that organic manures and irrigation intervals significantly affected leaf weight of Aloe vera, while its interaction was found non significant. Mean values regarding irrigation intervals showed that leaves with highest weight (181.3 g) was recorded when plants were irrigated after 15 days, followed by leaf weight (166.8 g) in plants irrigated after 30 days, while the plants irrigated after 45 days intervals produced minimum leaf weight (157.4 g). The maximum leaf weight (207.3 g) was recorded in plants grown under the poultry manure condition, followed by leaf weight (181.2 g) in plants treated with mushroom compost. While leaves with less weight (136.3 g) was noticed in plants of control treatment. Nitrogen is important for the synthesis of chlorophyll. The optimum dose of nitrogen produced more chlorophyll contents with better vegetative growth and more leaf weight ultimately. Higher biomass production of plants closely related with the highest rate of photosynthesis because of higher level of nitrogen (Ji-Dong *et al.*, 2006). As poultry manure is rich source of macro (nitrogen) and micro nutrients hence resulted in improved vegetative growth and more leaf weight of Aloe vera (Khandelwal *et al.*, 2009). The 15 days irrigation interval provides optimum amount of water to plants so can uptake more nutrients for better vegetative growth and maximum leaf weight

(Manassah *et al*., 1981). Similar results of high fresh weight of Aloe vera were observed when treated with short (8 days) irrigation interval (Ji-Dong *et al*., 2006).

Table 6: Number of sucker's plant^{-1}, amount of gel leaf^{-1} (g), leaf weight (g) and survival percentage of Aloe vera as influenced by organic manures and irrigation intervals.

Irrigation intervals	Number of suckers plant^{-1}	Amount of Gel leaf^{-1} (g)	Leaf weight (g)	Survival percentage
15 days	5.5 a	149.3 a	181.3 a	80.8 a
30 days	2.1 b	136.8 b	166.8 b	61.2 b
45 days	1.6 b	127.4 b	157.4 c	56.0 b
LSD (0.05)	0.85	7.2	6.1	30.5
Organic manures				
Control	1.6 b	106.3 d	136.3 d	58.9
Leaf compost	2.8 ab	119.2 a	149.2 c	62.0
Poultry manure	4.1 a	174.7 a	207.3 a	71.5
Mushroom compost	3.7 a	151.2 b	181.2 b	71.7
LSD (0.05)	1.27	6.5	7.4	NS
Interaction				
Irrig.Int*Org.Man	NS	NS	NS	NS

The mean values with different alphabets are significantly different at 5% probability level.

3.10 Survival percentage

The Table 6 shows data regarding survival percentage. The analysis showed that the irrigation intervals significantly influenced plant survival percentage of Aloe vera, while Organic manures and interaction exhibited non-significant results. The highest plant survival percentage (80.8) was recorded in plants irrigated after 15 days, followed by survival percentage (61.2) recorded in plants irrigated after 30 days. While the less plant survival percentage (56.0) was noticed in plants irrigated after 45 days interval. During dry conditions Aloe veras remain green and it has the great potential to adopt itself with climate change. These findings are in harmony with those of (Wabuyel *et al*., 2006) who also reported that organic manures did not affected survival percentage of Aloe vera varieties. Irrigation intervals (15 days) results in more survival percentage, this might be due to the reason that suckers of Aloe vera plants could survive efficiently when optimum amount of water is available to them. Survival ability of the Aloe vera plants decreases under drought conditions while optimum amount of water can result in better suckers production. Van *et al*. (1997) stated that drought resulted in reduced suckers and vegetative production of Aloe vera plants.

Conclusions and Recommendations

It is concluded that Poultry manure application and irrigation interval of 15 days significantly improved number of leaves plant^{-1}, plant height (cm), leaf breadth (cm), leaf thickness (cm), leaf weight (g), amount of gel leaf^{-1} (g) and number of suckers plant^{-1}. Hence it may be recommended that Poultry manure application and irrigation at 15 days interval may be practiced for the best growth and gel production of Aloe vera.

Novelty Statement

The present study will be very helpful to understand the Influence of organic manures and irrigation intervals on the growth and gel production of Aloe vera for agriculturists and plant scientists.

Author's Contribution

Zia Gul and Muhammad Sajid: Conceived and designed the experiment.
Zia Gul, Muhammad Sajid and Muhammad Noman Khan: Performed the experiment.
Faheem ul Haq, and Zohra Nawaz: Analyzed the data.
Muhammad Bakhtiar, Sajid Siddique, Komal Aslam and Muhammad Irshad: Contributed reagents, materials, analysis tools.
Zia Gul and Muhammad Noman Khan: Wrote the paper.

Conflict of interest

The authors have declared no conflict of interest.

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