Research Article

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Studies on standardization of organic production technology for Aloe (*Aloe barbadensis*) cultivation in semi-arid region

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ABSTRACT

This present study was conducted to standardize the nutrient requirement of plant through different organic sources for optimum growth and yield and quality of Aloe (*Aloe barbadensis* Mill.) plant during 2018-19 and 2019-20 at CCS HAU, Hisar for cultivation under arid and semi-arid conditions of Haryana. Results achieved during 2018-19, revealed that maximum plant height (59.70 cm), suckers per plant (4.50); numbers of leaves per plant (10.35) and leaf length (47.40 cm) were recorded in T_5 (Vermicompost 7.5 t ha^{-1}) which was significantly higher than treatments T_1 (Control) and T_6 (Neem cake 1.5 t ha^{-1}). However, leaf yield and gel yield were found highest in T_5 (36667 & 20449 kg ha^{-1}, respectively) that was statistically superior with rest of treatments except T_3 and T_7. Likewise, the results achieved during 2019-20, revealed that maximum plant height (59.1 cm), suckers per plant (4.0), numbers of leaves per plant (10.80) and leaf length (57.6 cm) were registered with T_5 which was significantly higher than treatments T_1 and T_6. However, leaf yield was found significantly higher with T_5 (83117 kg/ha) that was statistically at par with T_3 and T_4. Gel yield was found significantly higher with T_5 (43377 kg/ha) that was statistically at par with T_3. Therefore, application of vermicompost 7.5 t ha^{-1} is recommended in aloe for commercial cultivation under arid and semi-arid region of Haryana.

Introduction

The demand of organic medicinal products is increasing over the year throughout the world after the COVID 19. The increasing demand of the medicinal plant-based products converts the traditional cropping to the high value medicinal cropping by marginal and low land holding farmers. It is requirement of the time to develop the suitable organic farming model or package of practice for emerging medicinal crop specially without application of chemicals and to motivate the farmers for adoption of such crops in a sustainable manner (Arya *et al*., 2021a).

Aloe (*Aloe barbadensis* Mill.) is also called as "Ghrith Kumari" in Hindi. It is an evergreen xerophytic perennial, CAM plant. (Liu *et al*., 2011; Silva *et al*., 2014). It originated from southern Africa, (Zheng *et al*., 2005). It found as well adapted in almost all part of India (Kiran and Tirkey, 2018). In India, this crop is adopted in different states of the country such as Rajasthan, Gujarat, Andhra Pradesh, Maharashtra Tamil Nadu and Himachal Pradesh. *Aloe vera* contains so many active constituents like minerals, vitamins, sugars, enzymes, saponins, lignin, amino acids and salicylic acids (Atherton, 1998). This crop is specially known for its use in beauty, heath and skin care products (Liu *et al*., 2011). This crop is not much adopted so the data on area and production is not available but the production of *Aloe vera* is about 294 q/ ha with gross return Rs 140536/ ha and net return Rs. 64708/- ha (Thakur *et al.,* 2023).

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It is an important medicinal plant which has an enormous demand in food, medicinal, and cosmetic industries (Alagukannan and Ganesh, 2016). As aloe has therapeutic, cosmetic and nutraceutical properties. The dried latex of aloe known as aloin, it is laxative in nature. The gel obtained from aloe is widely used in cosmetic industry as a skin care product (Rajeswari *et al*., 2012). It is utilized to sooth the rashes, insect bites, burn pains and other skin irritations (Reddy *et al*., 2011; Arya *et al*., 2021b).

It is a well-known fact that chemical constituents of medicinal plants do not have any kind of side effect or adverse effect on health and environment (Heywood, 2002). The aloe crop is adaptable to the wide range of climatic conditions, the aloe germplam or accession have variability in genetic constituents as well as medicinal properties (Deore and Samantaray, 2015; Rana and Kanwar, 2017; Arya *et al*., 2021c). Keeping these aspects in view, the proposed study was undertaken to standardize organic production technology for cultivation of aloe specially under arid and semi-arid conditions of Haryana.

Material and Methods

In present investigation, eight different treatments were applied to aloe (*Aloe barbadensis* Mill.) genotype HAV-05-8 during 2018-19 and 2019-20 in the experimental area of the Medicinal and aromatic plants, Department of Genetics & Plant Breeding, CCS HAU, Hisar which is located 29^{o} 10' N latitude and 75^{o} 46' E longitude with the elevation from mean sea level 215.2m. The soil type of the experimental location was found sandy loam (Typic Ustochrepts), it contains medium range of organic carbon (0.046%), available N (191 kg/ha) and P (14 kg/ha), whereas high range of available potassium (340 kg/ha). Weekly weather parameters data recorded from Research Farm of CCS Haryana Agricultural University, Hisar during year 2018-19 and 2019-20 given in Fig. 1 & 2. Field experiment was conducted with eight different sources and levels of nutrient {T_1- Control, T_2- FYM 10 t ha^{-1}, T_3- FYM 15 t ha^{-1}, T_4- Vermicompost 5 t ha^{-1}, T_5- Vermicompost 7.5 t ha^{-1}, T_6- Neem cake 1.5 t ha^{-1}, T_7- Neem cake 2.5 t ha^{-1} and T_8- NPK (50:50:50 kg ha^{-1}) through inorganic fertilizers}to standardize the requirement of organic manures for proper growth, economical yield and quality of aloe. The experiment was laid out in RBD design with 4 replications at research farm, MAP Section, CCS HAU Hisar with plot size 4.8 × 2.7 m^2 and plant spacing was 60 cm x 45 cm. All the recommended package of practices was followed to raise a good healthy crop. The planting of crop was done by transplanting the suckers during June 2017. As this crop takes time to establish due to its slow growing nature, therefore, harvesting of leaves was started from next season. The plant observations for plant height (cm), number of leaves / plant, leaf length (cm), leaf width (cm), fresh leaf yield (q/ha) and gel (Mucilage) content (%) were recorded during both the years from each replication of randomly selected plants. The data was analyzed statistically as per standard procedure to compare the level of significance of data.

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Results and Discussion

Field experiment was conducted to standardize organic production technology for cultivation of *Aloe barbadensis* for better performance of plant and higher economic yield contributing traits and economical yield of aloe. The results of present experiment are presented and discussed under following sub-headings:

Growth contributing characters

Results achieved during 2018-19, revealed that maximum plant height (59.7 cm), suckers per plant (4.5), were observed in T_5 which was significantly higher than treatments T_1 and T_6 (Table 1-4). Results achieved during 2019-20, presented in Tables 1-4 revealed that maximum plant height (59.1 cm), suckers per plant (4.0), were obtained in T_5 which was significantly higher than treatments T_1 and T_6. However, the results achieved during 2018-19, revealed that maximum leaf width was observed in T_5 (6.92cm) followed by T_3 (6.85cm) and T_4 (6.84cm) but there was no significant difference. Results achieved during 2019-20, revealed that maximum leaf width was observed in T_5 (7.80cm), T_3 (7.80cm) and T_4 (7.80cm) but statistically there was no difference.

The results based on average basis of both the years also presented in (Table 1) revealed that maximum plant height (59.40 cm); suckers per plant (4.25) were observed with T_5 which was significantly higher than treatments T_1 and T_6. Application of 7.5 t ha^{-1} vermicompost recorded significantly higher plant height and number of suckers. The organic manures not only supply the nutrients to the plants but also enhance the fertility status, water holding capacity, availability of nutrients for better growth of the plants. According to Alagukannan *et al*., 2008, the plants which received more levels of vermicompost produce active substances more than those receiving lower levels of vermicompost. Higher levels of vermicompost lead to the increase in alkaloid production in the leaves, it enhances the active substances. Organic manures increased the availability of major and minor nutrients and also improves biological properties of the soil, which ultimately enhance the growth and yield of the plant. Shams *et al*., (2012) found the similar results of increasing fresh weight of Matricaria chamomile due to the combination of organic and chemical fertilizer. Kumar *et al*., (2006) observed the increase in growth and flower yield of marigold with the application of vermicompost as N source.

Yield contributing characters

The means values of both the years also presented in (Tables 2 & 3) revealed that maximum leaf length (52.50 cm); leaf width (7.36); numbers of leaves per plant (10.58) were observed in T_5 which was significantly higher than T_1 and T_6 treatments. Alam *et al*., 2007 found the similar results in red amaranth (A. tricolor) i.e. plant vigour, leaf number, length and breath, stem length and breath, weight

of the plant, percentage of dry matter of plant and yield with the application of vermicompost in combination with inorganic fertilizers. In brinjal and tomato also observed maximum leaf number by application of vermicompost (Garg and Bhardwaj, 2000; Rajkumar *et al*., 2006). Kumar *et al*., (2007) observed that application of N thorough organic sources increased yield, nutrients and chlorophyll content of marigold. The organic manure in the soil is gradually discharged through mineralization to maintain the supply of nutrients to the plant for prolonged period resulted in increase in plant weight, leaf weight and leaf thickness. The increase in uptake or availability of nutrients enhance the biological weight or over all yield of the plant.

Leaf yield and gel yield

Results achieved during 2018-19, revealed that, leaf yield and gel yield were found highest in T_5 (36667 & 20449 kg ha^{-1}, respectively) that was statistically superior with rest of treatments except T_3 and T_7 (Table 3-4, Fig. 1). Results achieved during 2019-20**,** observed that, leaf yield was found significantly higher with T_5 (83117 kg/ha) that was statistically at par with T_3 & T_4. In similar way, gel yield was found significantly higher with T_5 (43377 kg/ha) that was statistically at par with T_3. Plant height, number of suckers, leaf weight and leaf length have strong and positive correlation with the gel yield. The increase in growth parameters resulted in increased production of gel (Fig. 2).

However, the results based on average of both the years presented in Tables 3-4, showed that leaf yield was found significantly higher with T_5 (59892 kg/ha) that was statistically at par with T_3 & T_4. Gel yield was found significantly higher with T_5 (31913 kg/ha) that was statistically at par with T_3. Using manure was most effective in increasing leaf weight per plant was supported by findings of Saha *et al*. (2005). Data on growth and production of *Aloe vera* with the application of different levels of vermicompost and nitrogen fertilizer as analyzed by Nejatzadeh (2019). He revealed the similar results with the application of vermicompost and nitrogen fertilizer in *Aloe vera* cultivation. Vermicompost plays an important role in the production and enhancement of sucker and plant yield mentioned. Integrated nutrient management increase the growth and yield of cumin (Kumar *et al*., 2025). However, Rao *et al*., (2024) observed best growth, yield and quality of carrot with the application of poultry manure @ 4t/ha + $ZnSO_4$ @ 0.75 %.

Table 1. Plant growth and number of suckers per plant under different organic practices

Treatments	Plant height (cm)			No. of suckers/ plant		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T_1- Control	49.30	52.80	51.05	3.00	3.15	3.08
T_2- FYM 10 t ha^{-1}	56.60	54.70	55.65	4.25	3.35	3.80
T_3- FYM 15 t ha^{-1}	59.00	57.40	58.20	4.25	3.90	4.08
T_4- Vermicompost 5 t ha^{-1}	58.00	56.50	57.25	4.25	3.60	3.93
T_5- Vermicompost 7.5 t ha^{-1}	59.70	59.10	59.40	4.50	4.00	4.25
T_6- Neem cake 1.5 t ha^{-1}	54.20	54.50	54.35	3.25	3.50	3.38
T_7- Neem cake 2.5 t ha^{-1}	57.20	56.30	56.75	4.25	3.55	3.90
T_8- NPK (50:50:50 kg ha^{-1})	56.00	55.10	55.55	4.25	3.45	3.85
SEm±	1.59	0.88		0.33	0.13	
CD (5%)	4.72	2.60		0.98	0.38	

Table 2. Effect of organic manures on performance of leaf length and width

Treatments	Leaf length (cm)			Leaf width (cm)		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T_1- Control	40.40	47.50	43.95	6.65	7.30	6.98
T_2- FYM 10 t ha^{-1}	41.90	54.60	48.25	6.70	7.50	7.10
T_3- FYM 15 t ha^{-1}	46.00	57.00	51.50	6.85	7.80	7.33
T_4- Vermicompost 5 t ha^{-1}	43.90	56.00	49.95	6.84	7.80	7.32
T_5- Vermicompost 7.5 t ha^{-1}	47.40	57.60	52.50	6.92	7.80	7.36
T_6- Neem cake 1.5 t ha^{-1}	41.60	52.30	46.95	6.69	7.30	7.00
T_7- Neem cake 2.5 t ha^{-1}	43.20	55.20	49.20	6.82	7.60	7.21
T_8- NPK (50:50:50 kg ha^{-1})	42.50	54.10	48.30	6.73	7.50	7.12
SEm±	0.90	1.40		0.21	0.10	
CD (5%)	2.92	4.16		NS	NS	

Table 3. Effect of organic organic manures on number of leaves per plant and leaf yield

Treatments	Number of leaves/ plant			Leaf yield (kg/ha)		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T_1- Control	9.60	9.00	9.30	22815	65780	44298
T_2- FYM 10 t ha^{-1}	9.75	10.00	9.88	33659	74040	53850
T_3- FYM 15 t ha^{-1}	10.30	10.70	10.50	35093	80382	57738
T_4- Vermicompost 5 t ha^{-1}	10.25	10.50	10.38	34015	77676	55846
T_5- Vermicompost 7.5 t ha^{-1}	10.35	10.80	10.58	36667	83117	59892
T_6- Neem cake 1.5 t ha^{-1}	9.70	9.90	9.80	24818	70986	47902
T_7- Neem cake 2.5 t ha^{-1}	9.95	10.20	10.08	35000	74470	54735
T_8- NPK (50:50:50 kg ha^{-1})	9.90	10.10	10.00	34280	73153	53717
SEm±	0.16	0.26		792	2352	
CD (5%)	0.47	0.76		2346	6966	

Table 4. Effect of organic manures on gel yield (kg/ha) and percent gel content

Treatments	Gel yield (kg/ha)			Percent gel content		
	2018-19	2019-20	Mean	2018-19	2019-20	Mean
T_1- Control	12210	31558	21884	53.52	47.98	50.75
T_2- FYM 10 t ha^{-1}	17213	33812	25512	51.14	45.67	48.40
T_3- FYM 15 t ha^{-1}	18881	39624	29252	53.80	49.29	51.55
T_4- Vermicompost 5 t ha^{-1}	18584	34991	26787	54.63	45.05	49.84
T_5- Vermicompost 7.5 t ha^{-1}	20449	43377	31913	55.77	52.19	53.98
T_6- Neem cake 1.5 t ha^{-1}	14573	33471	24022	58.72	47.15	52.94
T_7- Neem cake 2.5 t ha^{-1}	18889	34397	26643	53.97	46.19	50.08
T_8- NPK (50:50:50 kg ha^{-1})	17586	33109	25347	51.30	45.26	48.28
SEm±	548	2124		-	-	
CD (5%)	1623	6290		-	-	

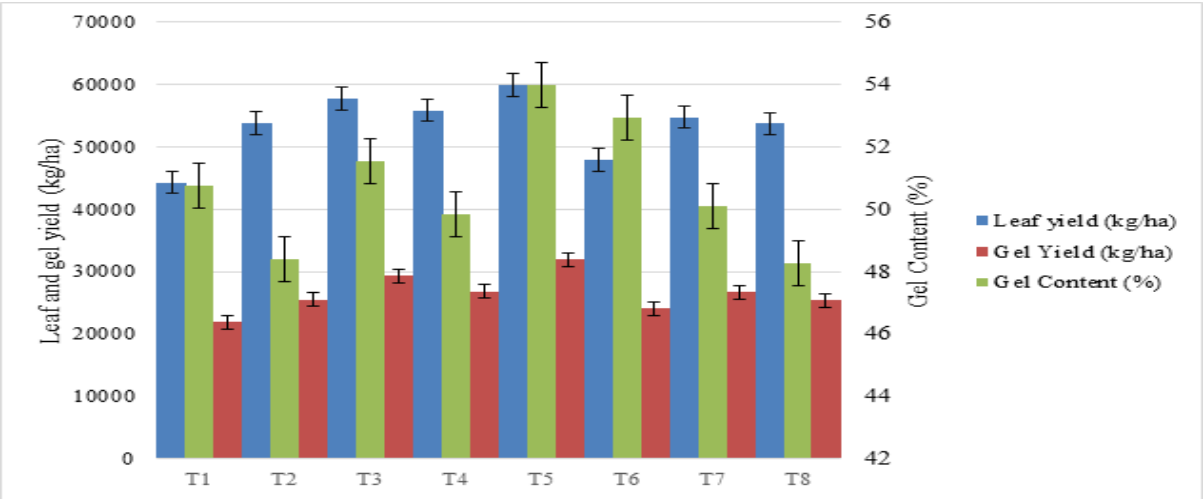
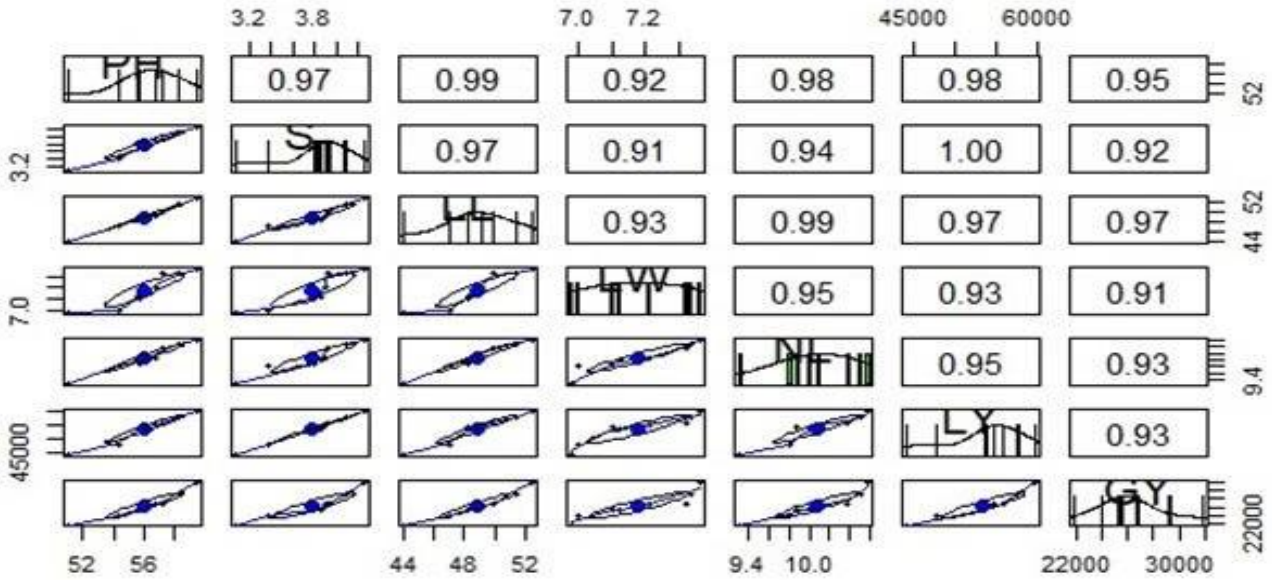


Fig. 1. Bar graphs of leaf yield, gel yield and gel content



Note: PH- Plant height, S- Number of suckers, LL- leaf length, LW -Leaf weight, GY- Gel yield

Fig. 2. Pearson correlation of different growth parameters for gel yield

Conclusions

It was concluded from the study that the application of vermicompost @ 7.5 t ha^{-1} had significantly enhanced the plant height, suckers per plant, numbers of leaves per plant and leave length of *Aloe vera*. Leaf yield was also found significantly higher with vermicompost @ 7.5 t ha^{-1} (59892 kg/ha) which was statistically at par with T_3 & T_4. Likewise, gel yield was also found significantly higher with T_5 (31913 kg/ha) that was statistically at par with T_3. Therefore, application of vermicompost 7.5 t ha^{-1} is recommended for commercial cultivation of aloe under arid and semi-arid region of Haryana.

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Conflict of Interest

The authors have no conflict of interest.

Data Sharing

All relevant data are within the manuscript.

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