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J Cheena
Medicinal and Aromatic Plant Research Station, Rajendranagar, Hyderabad, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet, Telangana, India

V Krishna Veni
Medicinal and Aromatic Plant Research Station, Rajendranagar, Hyderabad, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet Dist., Telangana, India

M Sreenivas
College of Horticulture, Mojerla, Wanaparthy, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet, Telangana, India

Corresponding Author:
J Cheena
Medicinal and Aromatic Plant Research Station, Rajendranagar, Hyderabad, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet, Telangana, India

Effect of different organic manures and biofertilizers on growth and yield of aloe (*Aloe barbadensis*)

J Cheena, V Krishna Veni and M Sreenivas

Abstract
An investigation was carried out at Medicinal and Aromatic Plant Research Station Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet Dist., Telangana State during the period of 2018-21 to determine the effect of different organic manures and biofertilizers on growth and yield of Aloe. The study was conducted with 9 different levels of organic manures and biofertilizers which were used as treatments. The maximum number of leaves/plant (14.21) Number of suckers/plant (5.55), Mature Leaf length (62.27cm), Mature Leaf width (8.40cm), Mature Leaf thickness (1.33cm), Leaf yield/plant (2.46kg), Gel yield/leaf (100.09g), Gel yield/plant (0.78kg), was found in treatment T_8 i.e, application of Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha.

Keywords: Aloe, vermicompost, azotobacter, PSB, organic manures, gel yield

Introduction
Aloe vera is a popular medicinal plant. It belongs to Lilliaceae family. The leaves are long, thick and juicy with a wheel like phyllotaxy. Among species of *Aloe*, *Aloe barbadensis*is the most commonly grown in the world and it is considered as an important medicinal plant also (Hazrati, 2012) [6]. The *Aloe* pulp had proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds, small organic compounds and carbohydrates (Hamman, 2008) [5]. Aloe is used in preparation of many herbal products used for cosmetic and health purpose. The residues may affect the quality of the produce. Hence, there is a need to give the recommendation of use of organic manures. Liontakis and Tzouramani (2016) reported that one of the most promising alternative crops that have been recently established in Greece is the organic *Aloe vera* crop. The results indicate that organic aloe farming is a promising alternative to "traditional" crops, particularly for family farms in rural areas.
Biofertilizer are more important as it is environmental friendly, harmless, non-toxic, and also can be used to reduce the level of soil and water pollution. Biofertilizers are necessary for sustainable agriculture and support developing organic agriculture. They can deliver a viable eco-friendly weapon to marginal and small farmers to increase crop productivity (Moorthy and Malliga, 2012) [14]. Bio-fertilizer application means inoculation of microorganisms capable of converting the non-usable form nutrient elements to a usable form through the biological process (Bandara *et al*., 2019) [2].
Organic manures improve soil organic matter, which is important for sustaining favourable plant growth and soil fertility for crop production (Madrid, Lopez & Cabrera, 2007). Agricultural supplies from organic farming are good for human health. Provision of the nutrient through bio- fertilization sustains soil fertility and moisture (Bandara *et al*., 2019) [2]. Saha *et al.,* (2005) [15] reported that organic source of fertilizer in the form of vermicompost and vermiwash was found to be effective comparable with inorganic source of fertilizer in increasing content of gel moisture, gel ash and aloin. The organic *Aloe vera* thus produced is expected to be a better marketable product. Guleria *et al.,* (2013) [18] studied that the effect of organic fertilizers such as FYM and vermicompost on various morphological parameters of Aloe vera. Results showed that plant grown in Vermicompost and FYM pre-treated soil exhibited maximum increase in all morphological parameters such as root length, shoot length and number of root branches and number of shoot branches.
Vermi-composts are organic materials broken down by interactions between earthworms and micro-organisms, in a mesophilic process (up to 25 °C), to produce fully stabilized organic soil amendments with low C: N ratios. They contain both plant growth hormones and humic acids which can act as plant growth regulators (Sourabh *et. al*.) [16].

Azotobacter is a N_2 fixer bacteria that can produce gibberellin, cytokinin and indole acetic acid, the compounds can stimulate root growth.

Material and Methods

The experiment entitled "Effect of different organic manures and biofertilizers on growth and yield of Aloe (*Aloe barbadensis*)" was carried out for three years (2018-2021) at Medicinal and Aromatic Plant Research Station, Rajendranagar, SKLTSHU, Hyderabad. The meteorological data was collected from the Agricultural Research Institute, Rajendranagar. It comes under sub tropical zone and is situated at latitude of $17^{0}30^{1}$ N and longitude of $78^{0}42^{1}$ E. It was normal weather data on total rainfall, maximum and minimum temperature, relative humidity, that prevailed during the period of experimentation. The land used under the experimental layout was red with good drainage and low water holding capacity with uniform texture. The soil characteristics were, pH 7.20, electrical conductivity 0.67 dSm-1, organic carbon 0.32%, Available Nitrogen 120 kg/ha, Available Phosphorus 48 kg/ha, Available Potassium 60 kg/ha.

The experiment was designed in Randomised Block Design with three replications with the spacing of 60 * 45 cm. The experimental plots were given organic manure and biofertilizers *viz*. FYM, vermicompost, neem cake, PSB, Azotobactor as single basal dose at the time of earthing up in their respective replications. A total of 9 different levels of organic manures and biofertilizers were used as treatments *viz*., T_1- Control (without manures and biofertilizers, T_2- FYM 5 t/ha, T_3- Vermicompost 2.0 t/ha, T_4- Neem cake 1.5 t/ha, T_5- Biofertilizer PSB @ 10kg/ha, T_6- Azotobactor @10 kg/ha, T_7 - FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha, T_8 - Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha, T_9- Neem cake 1.5 t/ha + PSB 10 kg/ha + Azotobactor10 kg/ha. Observations were recorded for 5 plants/plot which were randomly selected.

Results

The results pertaining to number of leaves/plant, Number of suckers/plant, Mature Leaf length, Mature Leaf width, Mature Leaf thickness, Leaf yield/plant, Gel yield/leaf, Gel yield/plant was significantly influenced by the addition of organic manures and biofertilizers of the present study.

The highest number of leaves/plant (14.21) was recorded in Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) and it was on par with treatment Neem cake 1.5 t/ha (T_4) (13.32), the highest number of suckers/plant (5.55) was recorded in treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) and it was followed by treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (5.35). The treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) showed significantly maximum mature leaf length (62.27 cm) and it was on par with treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (60.67 cm), the treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) recorded significantly maximum mature leaf width at base (8.40 cm) and it was followed by treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (8.31 cm), the treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) recorded significantly maximum mature leaf thickness at base (1.33 cm) and it was on par with treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (1.30 cm), the treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) recorded significantly highest leaf yield/plant (2.46 kg) and it was on par with treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (2.10 kg), the treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) recorded significantly highest gel yield/leaf (100.09 g) and it was followed by treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (92.40 g), the treatment Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) recorded significantly highest gel yield/plant (0.78 kg) and it was on par with treatment FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_7) (0.72 kg) and the minimum number of leaves/plant, number of suckers/plant, mature leaf length, mature leaf width at base, mature leaf thickness at base, leaf yield/plant, gel yield/leaf, gel yield/plant was recorded in treatment (T_1) Control (without manures and biofertilizers).

Discussion

The pooled data indicate that Aloe's growth parameters significantly influenced the yield parameters as recorded in treatment T_8 (Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha) as shown in Table 1. The numbers of leaves is an important morphological character which is directly related to gel yield. The application of vermicompost, PSB and Azotobactor (treatment combination of Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8)) increased the number of leaves thus increased leaf yield/plant, gel yield/leaf and gel yield/plant.

In the study of Moorthy and Malliga, (2012) [14] observed significant improvement in growth, yield and gel quality of *Aloe spp* by the application of biofertilizers. Eshun and He (2005) [3] also observed that organic manures and biofertilizers gives positive impact on increasing nutrients access of roots at Rhizosphere which helps in increase the number of leaves in *Aloe spp*. Increased nutrient uptake from the soil by the root system could be the reason for its more gel content (Ganesh and Alagukannan 2009) [4]. Higher availability of nutrients due to residual effect of organic sources thereby improving physiological and metabolic functions inside the plant might have been responsible for better nutrient uptake. The findings confirm the reports of Mahapatra *et al*. (2007) [11] and Manhji *et al.* (2014). Organic manures also contain plant growth regulators like humic acid, auxins, gibberlins and cytokinins which are responsible for plant growth and yield in many crops (Kumari, Shweta & Upadhyay, 2016) [9]. The combined application of organic manures and biofertilizers improved the Aloe plant growth by providing the essential nutrients resulting in maximum cell growth and turgidity which influenced the leaf growth. Vermi-compost (compost made from earthworm waste) application significantly increased growth and yield of strawberry (Arancon *et al*., 2003) [1]. Manjunath *et al*. (2002) [12] also observed that inoculation of biofertilizers influenced the morphological characters of patchouli plants, resulting in their improved growth and development. This may be due to enhanced availability of nutrients along with production of some growth promoting substances which might have caused cell elongation and multiplication. In a trial conducted by Rajendran and Gnanvel (2008) [17] the highest leaf yield of Aloe vera was obtained with the application of neem cake @ 1.5 t/ha.

Table 1: Effect of different Organic manures and Biofertilizers on growth, yield and quality of Aloe (*Aloe barbadensis*) – pooled data from 2018-19 to 2020-21

Treatments	No. of leaves/ plant	Number of suckers/plant	Mature Leaf length (cm)	Mature Leaf width at base (cm)	Mature leaf thickness at base (cm)	Leaf yield/plant (kg)	Gel yield/leaf (g)	Gel yield/plant (kg)
T_1	8.36	1.66	39.30	4.61	1.17	0.89	62.11	0.44
T_2	12.13	3.72	53.38	6.59	1.26	1.47	83.31	0.6
T_3	12.33	4.57	54.09	6.97	1.24	1.69	86.53	0.65
T_4	13.32	4.69	58.28	7.02	1.28	1.80	89.72	0.7
T_5	10.60	2.61	44.58	5.33	1.27	1.13	71.59	0.50
T_6	11.59	3.08	49.19	5.78	1.27	1.17	76.3	0.57
T_7	13.18	5.35	60.67	8.31	1.30	2.10	92.40	0.72
T_8	14.21	5.55	62.27	8.40	1.33	2.46	100.09	0.78
T_9	11.74	3.05	52.70	6.90	1.26	1.16	81.14	0.61
SEM+-	1.58	0.09	4.09	0.09	0.17	0.13	5.54	0.10
C.D 5%	0.70	0.01	2.02	0.12	0.01	0.38	5.58	0.1

T_1- Control (without manures and biofertilizers)
T_2- FYM 5 t/ha
T_3- Vermicompost 2.0 t/ha
T_4- Neem cake 1.5 t/ha
T_5- Biofertilizer PSB @ 10kg/ha
T_6- Azotobactor @10 kg/ha
T_7 - FYM 5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha
T_8 - Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha
T_9- Neem cake 1.5 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha

Conclusion

From this investigation, it can be concluded that application of different organic manures and biofertilizers significantly influenced the growth and yield of Aloe in the treatment combination of Vermicompost 2 t/ha + PSB 10 kg/ha + Azotobactor 10 kg/ha (T_8) which recorded highest in all attributes. Improvement in leaf yield automatically increases the gel yield. The organic gel is expected to fetch high marketable price.

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