International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 3043-3045

Received: 24-09-2020
Accepted: 28-10-2020

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Effect of bio fertilizer and organic manure on growth, flowering and yield of Salvia (*Salvia Splendens)*

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DOI: https://doi.org/10.22271/chemi.2020.v8.i6aq.11997

Abstract
A field experiment entitled "Effect of bio fertilizer and organic manure on growth flowering and yield of Salvia (*Salvia Splendens)*" was carried out in Department of Horticulture, National Post Graduate College, Badhalganj, Gorakhpur (U.P.) during the winter season of the year 2019-2020. The experiment was laid out in randomized block design with 12 treatments and 3 replications. Among the all treatments, treatment T_8 [Vermi Compost (25%) + Azotobacter (50%) + PSB (25%)] proved to be the best in terms of plant height (23.70 cm), number of leaves (80.08), Plant spread N-S (19.24 cm), Plant spread E-W (33.24 cm), Length of flower spike (15.60 cm), Life cycle of flower spike (17.00 days) and Vase life of cut spike (14.84 days). Whereas T_9 [Vermicompost (25%) + Azotobacter (25%) + VAM (50%)] was found best in terms of Days taken to first flower (20.83 days) and Days to 50% flowering (39.83 days), and for the yield related traits T_3 [Phosphate Solubilizing Bacteria (PSB)] recorded as best treatment in terms of No. of flower spike per plant (10.33), No. of spike/plot (82.64) and No. of spike/ha (206,000); while the minimum results were recorded with T_0 (control).

Keywords: Salvia, Azotobacter, Vermi Compost, Phosphate Solubilising Bacteria, VAM

Introduction
Salvia is a large genus with more than 900 species family (Lamiaceae) worldwide including annuals, biennials, perennials, herbs, and shrubby plants. Commonly referred to as salvia or sage, they occur naturally in grasslands, woodlands, and mountainous places. The preponderance of tender salvias available to North American gardeners are New World natives of warm regions in Mexico, Brazil, Bolivia, Peru, and the United States. Additionally, hundreds of varieties and hybrids have been bred or selected for cultivation. The tubular flowers feature an upper and a lower lip, although the length of the tube as well as the size and shape of the lips varies by species. Flowers come in many shades of blue, lavender, purple, magenta, pink, red, orange, yellow, and white, or may be bicolor. Each showy flower sits in a colorful two-lipped calyx, which can be an analogous or a contrasting hue to the flower, and typically remains vibrant and persistent after the flowers have fallen away. Biological activity in soil is an important index of soil fertility which can be improved by the application of bio fertilizers (Singh, 1998) [7]. Mycorrhiza fungi are among the most important microorganisms which can be applied in soil as bio fertilizer. They form symbiotic relation with 83% of the dicotyledonous and 79% of the monocotyledons; only a few field crops are not able to accept mycorrhizal symbiosis (Gianinazzi, 1991) [3].

Producing food in natural forms, developing biodiversity, increasing biological activities, and improving the environmental quality are considered as other advantages of these fertilizers. The main group of bio fertilizers is related to plant growth promoting rhizobacteria (PGPR) (Sturz and Christie, 2003) [8] and it includes a large variety of free-living and collective bacteria existing in soil causing nitrogen fixation and phosphate solution and also producing growth regulators, such as axons, gibberellin, and cytokines, and biological control for pests and plant growth (Vessey, 2003) [12].

Vermicompost is a bioorganic fertilizer that is a mixture of biologically highly active bacteria, enzymes, plant residues, animal manure, and capsules of earthworm, which leads to the continuation of decomposition of soil organic matter and an increase of a microbial activity in

the plant growth media (Bremness, 1999) [1]. Use of inorganic mineral fertilizers during large period of time has been leaded to the environmental pollution mainly in water and soil that threaten human society. Sustainable agriculture based on using organic and biological fertilizers is an effective solution for overcoming these problems Ekin *et al.* (2009) [9].

Materials and Methods

The details of the various materials used and methods adopted during the experiment are presented below.

Experimental Site

The experiment entitled "Effect of Bio fertilizer and organic manure on growth, flowering and yield of Salvia (*Salvia Splendens)*" conducted at the Department of Horticulture, National Post Graduate College, Badhalganj, Gorakhpur (U.P.) India – 273402.

Experimental details

The experiment was tested in Randomized Block Design (RBD) with three replications and consisted of 12 treatments. The observations was recorded on plant height (cm), plant spread (cm) E_W and N-S, number of leaves/ plant, No. of flower spike per plant, Flower spike length (cm), Flower spike life cycle (days), Vase life of cut spike (days), Days to 1st flowering, Days to 50% flowering, Total No. of spike/plot, Total No. of spike/ha. The required quantity of bio fertilizers was applied during field preparation along with Vermicompost.

Treatment details

Vermi compost (V.C.): 5 TN/ha
Azotobacter: 3 lit/ha
Phosphate Solubilizing Bacteria (PSB): 6 kg/ha
Vesicular Arbuscular Mycorrhizae (VAM): 10 kg/ha

Table 1: Treatment details

T_0	Control (No fertilizers, Organic manures and Bio-fertilizers)
T_1	Vermi compost (V.C.) 100%
T_2	Azotobacter 100%
T_3	Phosphate Solubilising Bacteria (PSB) 100%
T_4	Vesicular Arbuscular Mycorrhizae (VAM) 100%
T_5	Vermi Compost (50%) +Azotobacter (50%)
T_6	Vermi Compost (50%) + PSB (50%)
T_7	Vermi Compost (50%) + VAM (50%)
T_8	Vermi Compost (25%) + Azotobacter (50%) + PSB (25%)
T_9	Vermi Compost (25%) + Azotobacter (25%) + VAM (50%)
T_{10}	Vermi Compost (25%) + PSB (50%) + VAM (25%)
T_{11}	VermiCompost (25%) + PSB (25%) + VAM (25%) + Azotobacter (25%)

Results and discussion

The perusal of table-2, reveals that the growth related traits of salvia plant significantly influenced by the use bio fertilizer in combination with vermicompost and resulted maximum with treatment T_8 (Vermi Compost (25%) + Azotobacter (50%) + PSB (25%)) in terms of plant height (23.70cm), number of leaves (80.08), plant spread N-S (19.24cm), plant spread E-W (33.24cm), length of flower spike (15.60cm), life cycle of flower spike (17.00 days) and vase life of cut spike (14.84 days) whereas minimum values for growth traits were noted with T_0 (Control). The increase in plant growth during research may be due to use of bio fertilizers and organic manure. It was reported that vermicompost significantly stimulates the growth of wide range of plant species including aromatic and medicinal plants due to several direct and indirect beneficial effects. Bio fertilizers may also influence plant growth directly via the supply of plant growth regulating substances (PGRs) (Zahir, 2004 and Molla, 2001) [13, 6].

From the table-2, it is evident that the minimum Days taken to first flower (20.83 days) and Days to 50% flowering (39.83) was observed in treatment T_9 (Vermicompost (25%) + Azotobacter (25%) + VAM (50%)) and T_0 (control) has taken more days to flower. Whereas in terms of yield related traits, the maximum no. of flower spike per plant (10.33), No. of spike/plot (82.64) and No. of spike/ha (206,000) was recorded with (Phosphate Solubilizing Bacteria (PSB) @ 100%) while the treatment T_0 (control) reflected as poor performer for these traits due to the lack of recommended dose of fertilizer.

The reason for increasing flowering character might be due to the influence by nutrients (such as nitrogen and phosphorus). Vermicompost generally converts organic matter to the more uniform size, which gives the final substrate a characteristic earthy appearance, whereas the materials resulting from composting usually has a more heterogeneous appearance (Tognetti *et al.*, 2005) [11].

From the table-3, It is depicted that the Maximum cost of cultivation (Rs. 119,060) was observed in treatments T_1 (Vermi compost 100%) and minimum cost of cultivation (Rs. 101,060) was recorded in treatment T_0- Control. Whereas the Maximum gross return (Rs. 1,031,000) was observed in treatments T_3- (Phosphate Solubilizing Bacteria (PSB) 100%) and minimum gross return (Rs. 605,000) was recorded in treatment T_0- Control and The maximum benefit cost ratio (9.33:1) was recorded under treatments T_3- (Phosphate Solubilizing Bacteria (PSB) 100%). The minimum benefit cost ratio (5.33:1) was recorded in treatment T_1-(Vermi compost 100%).

Table 2: Effect of Bio fertilizer and organic manure on growth, flowering and yield of Salvia

Treatments	Plant height (cm)	Number of leaves	Plant spread (cm) N-S	Plant spread (cm) E-W	No. of flower spike per plant	Flower spike length (cm)	Flower spike life cycle (days)	Vase life of cut spike (days)	Days to 1st flowering	Days to 50% flowering	Total No. of spike/plot	Total No. of spike/ha
T_0	17.16	61.54	24.13	25.82	6.05	10.26	11.33	8.67	28.00	47.06	48.4	121,000
T_1	19.43	73.48	28.40	29.39	6.38	11.44	13.25	12.43	27.20	46.33	51.04	127,000
T_2	21.03	71.86	29.86	29.80	7.25	13.58	13.00	11.19	22.96	41.86	58	145,000
T_3	21.69	70.33	29.00	30.28	10.33	17.93	15.01	13.69	25.93	44.30	82.64	206,000
T_4	20.16	69.07	29.38	30.83	9.06	13.80	15.36	13.08	24.86	43.20	72.48	181,200
T_5	21.36	74.66	28.77	30.08	7.70	14.13	14.07	13.33	23.60	42.06	61.6	154,000
T_6	20.47	80.08	27.20	28.71	9.35	12.65	14.66	14.41	23.83	42.66	74.8	187,000
T_7	19.08	71.40	28.13	27.94	8.39	13.00	13.76	12.00	26.56	45.30	67.12	167,800
T_8	23.70	88.46	31.80	33.24	8.07	15.60	17.00	14.84	21.50	40.36	64.56	161,400
T_9	21.96	77.50	27.46	27.53	10.01	14.38	14.39	11.66	20.83	39.83	80.08	200,200
T_{10}	20.74	66.26	26.90	26.09	8.97	14.73	16.10	12.86	24.96	45.86	71.76	179,400
T_{11}	19.89	72.13	27.93	28.91	6.91	13.36	15.85	14.00	22.00	41.03	55.28	138,200
F-test	S	S	S	S	**S**	**S**	**S**	S	**S**	**S**	**S**	**S**

C. D. at 0.05%	2.17	2.20	1.29	2.95	0.88	1.47	1.56	1.35	1.12	1.99	5.74	3716.8
S.Ed (+)	1.05	1.06	0.62	1.42	0.43	0.71	0.75	0.65	0.54	0.96	1.95	1267.2

Conclusion

Considering the present investigation it is concluded that the treatment T_3 (Phosphate Solubilizing Bacteria (PSB) 100%) was found the best in terms of maximum No. of spike/ha (1,031,000) of salvia with maximum benefit: cost ratio (9.33:1). So it can be recommend to growers after few more conjunctive trials.

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