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Research Communication

Growth and yield of *Ocimum sanctum* in response to integrated nutrient management and plant spacing

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ABSTRACT

The present study was carried out during 2010 to work out the optimum integrated nutrient management and plant spacing in *Ocimum sanctum* L. under Jammu subtropics. The experiment was laid out in factorial randomized block design with six fertilizer treatments and two plant spacings. Results from the study reveals that the conjunctive use of N @ 60 kg/ha and vermicompost @ 3 t/ha recorded maximum plant height (66.80 cm), number of branches (16.97), fresh and dry weight of leaves (77.92 and 16.36 g), fresh and dry weight of inflorescence (46.16 and 13.84 g/plant), fresh herb yield (8.92 t/ha), and essential oil yield (16.02 litre/ha). Out of two plant spacing closer plant spacing recorded maximum fresh herb yield (8.09 t/ha) and essential oil yield (13.37 litre/ha). Integrated dose of N @ 60 kg/ha and vermicompost @ 3 t/ha with a plant spacing of 40 cm × 40 cm recorded maximum fresh herb and essential oil yield of 10.91 t/ha and 19.88 litre/ha respectively.

Key words *:* Integrated nutrient management*, Ocimum sanctum*, Spacing, Vermicompost

Ocimum sanctum is distributed throughout the tropical and subtropical climates of Indian subcontinent up to an elevation of 900 m. The economic parts of the plant include leaves, flowers, seeds and fruits. Leaves are the richest source of essential oil followed by the inflorescence and stem (Choudhuri, 1979). Essential oil finds extensive role in pharmaceutical preparations, perfumes, cosmetics and as flavoring agent in food items mainly due to the presence of eugenol. The species is traditionally used in the health care as expectorant, analgesic, anticancer, antidiabetic, antistress, antioxidant and wound healing. Though the production of the species can be increased by supplying the nutrients through chemical fertilizers alone but continuous use of the same on long-term basis may lead to the degradation of the soil quality. Besides this, in order to increase the quality of crops especially medicinal and aromatic plants (MAPs) organic fertilization is more acceptable than chemical fertilizers. However, complete replacement of inorganic fertilizers by the organic manures is not advisable owing to their very low nutrient concentration and in turn requirement in huge quantities which may not be possible due to scarcity of such materials. In this endeavor, a blend of organic and inorganic fertilizers is important not only for increasing yield but also for sustaining soil health and maintaining favorable ecological conditions on long-term basis. Keeping this in view, investigation of effect of integrated nutrient management (INM) and plant spacing on the growth and yield of *Ocimum sanctum* was taken up under Jammu subtropics.

The experimental site falls under sub-tropical zone of Jammu region of Jammu and Kashmir state, with hot dry summers, hot humid rainy and cold winter months. The soil of the study site is sandy clay loam in texture. The soil pH is 7.81 and the available nitrogen, phosphorus and potassium content of the soil was 237.2, 16.3 and 12.8 kg/ha respectively. The experiment was laid out in three times replicated factorial randomized block design with two levels of plant spacing [60 cm × 60 cm (S_1) and 40 cm × 40 cm (S_2)] and six fertilizer/manure levels {(N @ 120 kg/ha (T_1), Framyard manure [(FYM) @ 24 t/ ha (T_2), Vermicompost (VC) @ 6 t/ ha (T_3), FYM @ 12 t/ ha + ½ RDN (T_4), VC @ 3 t/ ha + ½ RDN (T_5) and Control (T_6)]. The size of the plot was 4.8 m x 2.4 m. Transplanting of four week old seedlings was done in the plots in last week of April, 2010 which was immediately followed by irriga-

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tion. Thereafter, irrigation was done at fortnightly during dry spell of May-June. Different doses of organic and inorganic fertilizers were applied 15 days after transplanting. Observations were recorded at complete flowering stage (Ist week of August) and final harvest (single cut). For essential oil extraction fresh leaf samples weighing 400 gm were given hydro-distilled treatment using a Clevenger apparatus for a period of 5 hours (Quereshi *et al.*, 2011). The essential oil recovered was treated with anhydrous sodium sulphate to remove the traces of water. The percentage of oil was calculated on volume by weight (v/w) basis. Essential oil yield was calculated by the product of oil content (%) and yield of fresh leaves (t/ha) which is expressed in litres/ha. Chemical composition of composite essential oil samples was determined by Gas chromatography-Mass spectrometry (GC-MS) at Indian Institute of Integrative Medicines (CSIR) Jammu. Varian Gas chromatograph model 4000 (GS 3800 & MS 4000) with capillary column hp-5 MS (30 m x 0.25 mm x 0.254 u thick film) was used for GC-MS. Temperature of column was programmed for 50°C with a hold time of 5 min, 250°C @ 3°C/minutes with a hold time of 7 minutes, injector temperature was 280 °C and the split ratio was 1:50. Helium was used as a carrier gas with a flow rate of 1ml/minute.

Application of fertilizer and manures either alone or in combination produced significantly taller plants as compared to control. Maximum (66.80 cm) plant height was recorded with (Vermicompost @ 3 t/ha + ½ RDN) followed by 62.07 cm with (farmyard manure @ 12 t/ha + ½ RDN), whereas it was minimum (49.97 cm) in control. Number of primary branches per plant also followed the same trend being maximum (16.97) with (Vermicompost @ 3 t /ha + ½ RDN) and minimum (11.82) in control. The effect of plant spacing was found to be statistically non-significant on both the characters (Table 1). Fresh and dry weight of leaves was maximum (77.92 and 16.36 g respec-

Table 1. Growth, development and herb yield of *Ocimum sanctum* as influenced by integrated nutrient management (INM) and plant spacing

INM	Spacing	Plant/ height (cm)	Primary branches per plant	Fresh leaf weight (g/plant)	Dry leaf weight (g/plant)	Fresh inflor-escence weight (g/plant)	Dry inflore-scence weight (g/plant)	Fresh herb yield (t/ha)	Dry herb yield (t/ha)	Essential oil yield (l/ha)
T_1 (N_2@120 Kg/ha)	S_1 (60x60 cm)	59.07	15.13	76.73	15.57	47.47	14.50	6.00	1.67	9.64
	S_2 (40x40 cm)	61.00	14.47	51.30	10.03	28.33	8.37	8.60	2.26	14.40
	Mean	60.03	14.80	64.01	12.80	37.90	11.43	7.32	1.96	12.03
T_2 (FYM@24t/ ha)	S_1 (60x60 cm)	54.07	14.87	63.33	12.63	45.33	13.37	5.12	1.34	8.18
	S_2 (40x40 cm)	56.07	13.80	37.60	7.23	27.50	8.23	6.71	1.79	10.80
	Mean	55.07	14.33	50.47	9.93	36.41	10.80	5.92	1.57	9.49
T_3 (VC@ 6 t/ha)	S_1 (60x60 cm)	57.00	15.60	66.67	13.03	49.00	14.43	5.47	1.49	8.85
	S_2 (40x40 cm)	59.07	14.53	42.00	8.23	31.00	9.43	7.46	2.08	10.65
	Mean	58.03	15.07	54.33	10.63	40.00	11.93	6.46	1.78	9.75
T_4 (FYM@12t/ha ½ T_1)	S_1 (60x60 cm)	61.00	16.57	80.73	16.77	49.93	15.00	6.30	1.74	10.71
	S_2 (40x40 cm)	63.13	15.40	56.20	11.83	32.00	9.50	9.55	2.61	16.65
	Mean	62.07	15.98	68.47	14.30	40.97	12.25	7.93	2.17	13.68
T_5 (VC@ 3 t/ ha +½ T_1)	S_1 (60x60 cm)	65.47	17.47	90.17	18.93	54.43	15.72	6.94	1.93	12.17
	S_2 (40x40 cm)	68.13	16.47	65.67	13.79	37.90	11.97	10.91	3.08	19.88
	Mean	66.80	16.97	77.92	16.36	46.16	13.84	8.92	2.50	16.02
T_6 (control)	S_1 (60x60 cm)	48.93	12.47	50.00	10.87	43.33	12.83	4.38	1.19	6.29
	S_2 (40x40 cm)	51.00	11.17	28.67	6.10	26.00	8.07	5.37	1.47	7.87
	Mean	49.97	11.82	39.33	8.48	34.67	10.45	4.87	1.33	7.08
Mean	S_1 (60x60 cm)	57.59	15.35	71.27	14.63	48.24	14.30	5.70	1.56	9.30
	S_2 (40x40 cm)	59.73	14.30	46.90	9.53	30.45	9.26	8.09	2.21	13.37
SEm±	INM	1.32	0.70	3.15	0.64	0.69	0.29	0.26	0.08	0.64
	Spacing	0.76	0.41	1.81	0.37	0.39	0.17	0.15	0.04	0.37
CD (P=0.05)	INM	3.88	2.06	9.25	1.88	2.03	0.84	0.77	0.24	1.89
	Spacing	NS	NS	5.34	1.08	1.17	0.49	0.44	0.14	1.09

FYM-Farm yard manure, VC-Vermicompost, NS-Non-significant

tively) with (Vermicompost @ 3 t/ha + ½ RDN), whereas minimum (39.33 g and 8.48 g) was recorded in control. The fresh and dry weight was increased significantly in the crop planted at 60 cm × 60 cm spacing with an average weight of 71.27 g and 14.63 g respectively as compared to 40 cm × 40 cm with an average weight of 46.90 g and 9.53 g, respectively (Table 1).

The observation recorded on fresh and dry weight of inflorescence per plant revealed that maximum (46.16 and 13.84 g/plant respectively) fresh and dry weight of inflorescence was recorded with (vermicompost @ 3 t /ha + ½ RDN), whereas, minimum (34.67 and 10.45 g/plant respectively) fresh weight of inflorescence was recorded in control (Table 1). Out of the two plant spacing, 60 cm × 60 cm resulted in significantly higher (48.24 and 14.30 g/plant) fresh and dry inflorescence weight as compared with 40 cm × 40 cm (Table 1).

Maximum growth with vermicompost @ 3 t /ha + ½ RDN may be attributed to the increased nutrient availability as a result of enhancement in microbial activity and improvement in physico-chemical and biological properties of soil owing to addition of vermicompost (Atiyeh *et al*., 2000). The increased growth in response to integrated use of fertilizers and manures have also been reported by Suresh *et al.* (2010) in *Coleus forskohlii.*

Maximum (8.92 t/ha) and minimum (4.87 t/ha) fresh herb yield was recorded with vermicompost @ 3 t /ha + ½ RDN and control, respectively. Dry herb yield also followed the same trend (Table 1). Higher herb yield in response to fertilization have also been reported by Anwar *et al.* (2005) in *Ocimum basilicum* L. As far as the effect of plant spacing is concerned, crop planted at closer spacing produced significantly higher fresh and dry herb yield (8.09 t/ha and 2.21 t/ha respectively as compared to wider plant spacing. This may be attributed to increase in number of plants per unit area and optimum utilization of above and below ground resources at closer spacing. The results are in agreement with those reported by Ram *et al.* (2002) in *Ocimum canum* and *O. basillicum*. Maximum (10.91 t/ha) fresh herb yield was recorded with vermicompost @ 3 t /ha + ½ RDN with closer spacing. The results are in agreement with the observations reported by Arularasu *et al.* (2008) in *O. sanctum.*

Essential oil content (%) was found to be more or less unaffected in response to fertilization and plant spacing. Negligible difference in oil content signifies that the character may be genetically controlled. The results are in agreement with the findings reported by Dey and Choudhuri (1984) and Asthana and Gupta (1984) in *Ocimum sanctum* L. However, essential oil yield (litre/ha) significantly increased due to application of different treatments with maximum of 16.02 litre/ha with vermicompost @ 3 t/ha + 1/2 RDN (Table 1). It may be attributed to the increased yield of leaves. Data regarding the effect of spacing showed that closer spacing produced significantly higher (13.37 litre/ha) essential oil yield as compared to wider spacing, which recorded an essential oil yield of 9.30 litre/ha (Table 1). This may be attributed to higher number of plants per unit area at closer plant spacing.

Chemical analysis of the essential oil of *Ocimum sanctum* showed the presence of four major chemical compounds constituting about 99% of total essential oil. Highest (80.32%) composition was of 1, 3, 4-eugenol follo**w**ed by beta caryophyllene (15.45%), germacrene-D (1.98%) and alpha caryophyllene (1.07%), respectively. It was further observed that chemical constituents were not significantly influenced by integrated nutrient management treatments. However, 1, 3, 4-eugenol (principal constituent) was found to be maximum (82.25%) with vermicompost @ 3 t/ha + ½ RDN, whereas non eugenolic compounds (beta-caryophyllene, germacrene–D and alpha caryophyllene) were maximum (16.20, 2.35 and 1.22 percent respectively) with N @ 120 kg/ha. The results are in conformity with Pareek *et al*. (1980) as they did not find any remarkable change in the eugenol content by the application of nitrogenous and phosphatic fertilizers.

Based on the current study it is implicit that vermicompost @ 3 t/ha+N @ 60 kg/ha may be applied at closer spacing (40 cm x 40 cm) for maximum herb and essential oil yield.

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