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Growth, yield and quality of tulsi (*Ocimum sanctum* L.) as influenced by organic manures

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Abstract

A field experiment was conducted at College of Agriculture, Raichur during 2021 and 2022 to assess the growth, yield and quality of tulsi (*Ocimum sanctum* L.) as influenced by organic manures. The experiment was laid out in a factorial randomized completely block design with four replications. The results of the study inferred that variety Rama tulsi showed better performance concerning growth and yield attributes. While, the variety Krishna tulsi was found inferior. 100 percent recommended nitrogen applied through vermicompost performed better when compared to other organic treatments. Rama tulsi in combination with100 percent recommended nitrogen applied through vermicompost increased the plant height (88.26 cm), leaf area (7304.50 cm^2/plant), leaf area index (2.73), fresh herb weight per plant (574.22 g), dry herb weight per plant (189.56 g), fresh herb yield (14.92 t ha^{-1}), dry herb yield (6.44 t ha^{-1}). Therefore, 100 percent recommended nitrogen applied through vermicompost found beneficial for higher growth and yield in tulsi varieties.

Keywords: Dry herb yield, fresh herb yield, organic manure, tulsi, vermicompost

Introduction

Tulsi is one of the holiest and most cherished among the many healing and health giving herbs of the orient. Tulsi is a biennial or triennial aromatic shrub belonging to the family Lamiaceae. This herb is popularly native to tropical Asia, likely to have originated in India. It is also given other names like "the Incomparable one, mother of natural medicine and the queen of herbs." Tulsi is renowned for its religious and spiritual sanctity, as well as for its important role in the traditional ayurvedic and unani systems of medicine. Medical, religious and culinary use of tulsi has also been documented for centuries in China, the Middle East, North Africa and Australia. It is also mentioned by Charaka in the Charaka samhita - an ayurvedic text. Tulsi is naturally found in wild habitas of tropical and subtropical regions of the world. It can be grow all over India, up to a height of 2000 meters. It is grown in houses, temples and gardens. The main centers of diversity in this species are in Africa, South America (Brazil) and Asia. Tulsi is also found growing in France, Italy, Bulgaria, Egypt, Hungary, South America, Comoro Islands, Thailand, Haiti and Guatemala. In India, the cultivation of tulsi is mainly concentrated in Uttar Pradesh, Assam, Bihar, Jammu, Maharashtra, Madhya Pradesh, West Bengal, Punjab and Haryana. In Karnataka tulsi is being cultivated in an area of 603 hectares with a production of 2343 Metric tons per hectare. In India two types of *Ocimum sanctum* are under cultivation *i.e.*, Sri tulsi or Rama tulsi, which bears green leaves and Krishna tulsi, which bears purple leaves. Sri tulsi is most common type which is grown in pots in most of the traditional Hindu house holds. Krishna tulsi is preferred in the trade for its higher medicinal potency. Tulsi has been traditionally employed in hundreds of different formulations for the treatment of a wide range of disorders, including those of the mouth, throat, lungs, heart, blood, liver, kidney, stomach, metabolic, reproductive and nervous systems. Tulsi is commonly used to treat coughs, cold, flu, head and ear aches, rheumatism, arthritis, malaria, fever, allergies and various skin diseases. All parts of tulsi particularly the leaves are used in medicine. The aromatic leaves of basil is used in fresh and dried form on steam distillation which yields a bright yellow volatile oil possessing a pleasant odour. The essential oil obtained by steam distillation from shoot bio-mass has high commercial value and is used as favouring agents in food industry, fragrance, aroma therapy, traditional rituals and medicines. Organically grown sacred basil has more demand in pharmaceutical industry as it produces chemical free drugs and it is also used daily in medicines to cure many ailments, hence there is a strong need to boost the organic production of sacred basil. The cultivation of sacred basil on commercial scale provides great profit as organics increases the herb yield and maintains the quality. Tulsi plants possess immense medicinal and aromatic properties, so there is a need for its organic cultivation. The work done on cultivation of tulsi using organics is seanty. Hence the present investigation was taken up with the following objectives *i.e.*, to investigate the influence of organic manures on growth and yield of tulsi, to assess the impact of organic manures on quality (Essential oil %) of tulsi, to work out the economics of organic cultivation of tulsi.

Materials and Methods

The experiment was conducted in fields of herbal garden, Main Agricultural Research Station, University of Agricultural Sciences, Raichur for two years, which is located in the North Eastern dry zone *i.e.*, Zone - II of the region - I in Karnataka in the year of 2019. The location corresponds to 16^0 25' North latitude and 77^0 33' East longitude. The climate of the experimental location is semi-arid and average annual rainfall is 722 mm. The elevation of Raichur is 406 m above mean sea level. The experiment was laid out in a factorial RCBD design with four replications and ten treatments. The treatments consists varieties V_1: Rama tulsi, V_2: Krishna tulsi and organic manures T_1: Absolute control, T_2: 100 percent recommended nitrogen applied through inorganic manures, T_3: 100 percent recommended nitrogen applied through FYM, T_4: 100 percent recommended nitrogen applied through vermicompost, T_5: 100 percent recommended nitrogen applied through poultry manure. The land was thoroughly ploughed and brought to a fine tilth. Then the experimental site was divided into small plots and leveled within the plots, each measuring 4.2 m x 3.2 m with a spacing of 0.5 m between two plots. The replications were kept 0.5 m apart to avoid the percolation of nutrients. The recommended dose of different organic manures consists of farm yard manure, vermicompost and poultry manure were applied to each of the plot as per the experimental plan at the time of plot preparation. Thirty days old healthy, uniform sized seedlings were selected and transplanted in the experimental plots at a spacing of 60 cm between the rows and 40 cm between the plants. Five plants were tagged from each plot. Observations on growth and yield parameters were recorded from these tagged plants at 90 and 150 days after transplanting.

Results and Discussion

Growth parameters

The recorded and analysed data for growth parameters of tulsi is presented in table 1. Significantly higher plant height (82.99 cm,85.93 cm and 84.46 cm during 2021, 2022 and pooled data, respectively), leaf area (6575.85 cm^2 plant^{-1} 6629.81 cm^2 plant^{-1} and 6602.83 cm^2 plant^{-1} during 2021, 2022 and pooled data, respectively), leaf area index (2.42, 2.87 and 2.64 during 2021, 2022 and pooled data, respectively), was recorded under Rama tulsi, followed by Krishna tulsi. With respect to organic manures, 100 percent recommended nitrogen applied through vermicompost has recorded significantly higher plant height (85.95 cm, 89.45cm and 87.70 cm, during 2021, 2022 and pooled data, respectively), leaf area (7181.45 cm^2 plant^{-1} 7275.44 cm^2 plant^{-1} 7228.44 cm^2 plant^{-1} during 2021, 2022 and pooled data, respectively), leaf area index (2.64, 2.94 and 2.79 during 2021, 2022 and pooled data, respectively). This was followed by 100 percent recommended N applied through poultry manure. Rama tulsi with 100 percent recommended nitrogen applied through vermicompost produced higher plant height (86.60 cm, 89.92 cm and 88.26 cm during 2021, 2022 and pooled data, respectively), leaf area (7267.96 cm^2 plant^{-1}, 7341.05 cm^2 plant^{-1} and 7304.50 cm^2 plant^{-1} during 2021, 2022 and pooled data, respectively), leaf area index (2.68, 2.79 and 2.73 during 2021, 2022 and pooled data, respectively), While Krishna tulsi with absolute control produced lowest growth parameters. However, the combined effect of varieties and organic manures on plant height, leaf area index, plant spread remained non-significant. Presence of growth substances, nitrogen fixers, other essential nutrients and higher phosphorus by symbiotic mycorrhizal association by vermicompost leads to the increased growth parameters (Bano *et al*. 1987) [2] and these results are in accordance with Suresh *et al*. (2018) [10], Dushyant *et al*. (2014) [3], El-Sayed *et al*. (2015) [4], Zaman *et al*. (2017) [12]. The increase in growth parameters might also due to vermicompost also contains available micronutrients viz., iron, copper, zinc and manganese. In addition to this, vermicompost exercises positive biological effects such as increases in beneficial enzymatic activities, increased populations of beneficial microorganisms or the presence of biologically active plant growth-influencing substances such as plant growth regulators or plant hormones (Grappelli *et al*., 1987; Tomati and Galli, 1995; Subler *et al*., 1998) [6, 11, 9] and humic acid (Arancon *et al*., 2006) [1], these reasons could be attributed for the increased growth parameters in tulsi varieties

Yield parameters

Yield parameters like fresh herb weight per plant (g), dry herb weight per plant (g), fresh herb yield (t/ha), dry herb yield (t/ha) are presented in table 2.

Rama tulsi exhibhited the higher fresh herb weight per plant (505.12 g 515.26 g and 510.19 g during 2021, 2022 and pooled data, respectively), dry herb weight per plant (159.64 g 172.34 g and 165.99 g during 2021, 2022 and pooled data, respectively), fresh herb yield (12.76 t ha^{-1} 13.23 t ha^{-1} and 12.99 t ha^{-1} during 2021, 2022 and pooled data, respectively), dry herb yield (5.42 t ha^{-1} 5.66 t ha^{-1} and 5.54 t ha^{-1} during 2021, 2022 and pooled data, respectively) followed by Krishna tulsi. Among organic manures 100 percent recommended nitrogen applied through vermicompost produced the higher fresh herb weight per plant (553.27 g 571.25 g and 562.26 g during 2021, 2022 and pooled data, respectively), dry herb weight per plant (176 g,188.92 g and 182.46 g during 2021, 2022 and pooled data, respectively), fresh herb yield (13.89 t ha^{-1},14.44 t ha^{-1} and 14.16 t ha^{-1} during 2021, 2022 and pooled data, respectively), dry herb yield (5.93 t ha^{-1},6.73 t ha^{-1} and 6.33 t ha^{-1} during 2021, 2022 and pooled data, respectively). This was followed by 100 percent recommended N applied through poultry manure. Among the interactions higher fresh herb weight per plant (565.70 g, 582.75 g and 574.22 g during 2021, 2022 and pooled data, respectively), dry herb weight per plant (181.46 g, 197.66 g and 189.56 g during 2021, 2022 and pooled data, respectively), fresh herb yield (14.60 t ha^{-1}, 15.25 t ha^{-1} and 14.92 t ha^{-1} during 2021, 2022 and pooled data, respectively), dry herb yield (6.11 t ha^{-1}, 6.78 t ha^{-1} and 6.44 t ha^{-1} during 2021, 2022 and pooled data, respectively) was observed in Rama tulsi with 100 percent recommended N applied through vermicompost. While, Krishna tulsi with absolute control produced the lowest yield parameters. However, the combined effect of varieties and organic manures on dry herb weight per plant, fresh herb yield, dry herb yield remained non-significant. Increased in yield parameters might be due to to the fact that vermicompost improve the soil physical condition and promotes organic matter, which in turn, produce organic acids, which inhibits particularly IAA oxidase enzyme, resulting in enhancing the promotive effect of auxin-IAA, which has direct effect on herbage yield (Suresh *et al*., 2018) [10] and availability of plant nutrients for a longer period at different plant growth stages up to the maturity period which helpes in root development. Vermicompost improves the physical condition of soil and provides better condition for uptake of nutrients which thereby leads to better growth of plant. Higher nitrogen and phosphorus content of vermicompost might have beneficial effect on yield of the crop (Gaikwad *et al*., 2011) [5]. Due to these reasons the interaction of Rama tulsi with 100 percent recommended N applied through vermicompost have resulted in higher yield parameters.

Table 1: Influence of organic manures on growth parameters of tulsi varieties

Treatment	Plant height (cm)			Leaf area (cm2)			Leaf area Index		
	2021	2022	Pooled	2021	2022	pooled	2021	2022	Pooled
Varieties									
V_1	82.99	85.93	84.46	6575.85	6629.81	6602.83	2.42	2.87	2.64
V_2	80.53	84.67	82.60	6274.59	6394.74	6334.66	2.32	2.76	2.54
C.D. @ 5%	1.81	1.84	1.82	51.09	53.49	53.29	0.02	0.02	0.02
Manures									
T_1	73.00	75.58	74.29	5455.44	5667.49	5561.46	2.03	2.33	2.18
T_2	82.00	85.34	83.67	6119.40	6296.35	6207.87	2.26	2.58	2.42
T_3	82.67	84.27	83.47	6312.08	6398.54	6355.31	2.33	2.79	2.56
T_4	85.95	89.45	87.70	7181.45	7275.44	7228.44	2.64	2.94	2.79
T_5	85.17	88.56	86.86	7057.73	7148.89	7103.31	2.59	2.98	2.78
C.D. @ 5%	2.87	2.91	2.93	80.78	82.96	81.89	0.03	0.04	0.04
Interaction									
V_1T_1	73.70	74.58	74.14	5719.01	5814.55	5766.78	2.11	2.39	2.25
V_1T_2	84.50	87.15	85.82	6238.35	6298.96	6268.65	2.29	2.48	2.38
V_1T_3	84.60	88.69	86.64	6463.97	6553.88	6508.92	2.37	2.67	2.52
V_1T_4	86.60	89.92	88.26	7267.96	7341.05	7304.50	2.68	2.79	2.73
V_1T_5	85.55	89.75	87.65	7189.96	7259.74	7224.85	2.64	2.88	2.76
V_2T_1	72.30	77.43	74.86	5191.88	5281.68	5236.78	1.96	2.05	2.00
V_2T_2	79.50	84.76	82.13	6000.45	6078.54	6039.49	2.23	2.58	2.40
V_2T_3	80.75	85.55	83.15	6160.19	6284.54	6222.36	2.28	2.47	2.37
V_2T_4	85.30	87.25	86.27	7094.94	7184.77	7139.85	2.60	2.83	2.71
V_2T_5	84.80	86.73	85.76	6925.50	6996.25	6960.87	2.54	2.94	2.74
C.D. @ 5%	NS	NS	NS	114.25	121.36	118.80	NS	NS	NS

Table 2: Influence of organic manures on yield parameters of tulsi varieties

Treatment	Fresh herb weight (g)			Dry herb weight (g)		
	2021	2022	Pooled	2021	2022	pooled
Varieties						
V_1	505.12	515.26	510.19	159.64	172.34	165.99
V_2	489.01	496.71	492.86	149.57	161.87	155.72
C.D. @ 5%	3.57	3.62	3.61	1.29	1.34	1.32
Manures						
T_1	377.60	398.45	388.02	114.34	119.78	117.06
T_2	486.53	502.23	494.38	144.68	159.68	152.18
T_3	523.62	554.55	539.08	164.60	179.76	172.18
T_4	553.27	571.25	562.26	176.00	188.92	182.46
T_5	544.30	567.38	555.84	173.40	195.65	184.52
C.D. @ 5%	5.65	5.74	5.71	2.04	2.18	2.21
Interaction						
V_1T_1	384.25	390.75	387.50	118.38	125.89	122.13
V_1T_2	492.40	512.48	502.44	149.91	161.77	155.84
V_1T_3	527.35	543.32	535.33	170.32	186.58	178.45
V_1T_4	565.70	582.75	574.22	181.46	197.66	189.56
V_1T_5	555.90	569.56	562.73	178.16	198.43	188.29
V_2T_1	370.95	379.78	375.36	110.31	129.63	119.97
V_2T_2	480.67	492.93	486.80	139.45	155.48	147.46
V_2T_3	519.90	538.65	529.27	158.89	169.97	164.43
V_2T_4	540.85	562.33	551.59	170.54	189.66	180.10
V_2T_5	532.70	546.85	539.77	168.65	185.92	177.28
C.D. @ 5%	7.99	8.15	8.57	NS	NS	NS

Table 3: Influence of organic manures on yield parameters of tulsi varieties

Treatment	Fresh herb yield (t ha^{-1})			Dry herb yield (t ha^{-1})		
	2021	2022	Pooled	2021	2022	pooled
Varieties						
V_1	12.76	13.23	12.99	5.42	5.66	5.54
V_2	11.26	12.05	11.65	4.99	5.32	5.15
C.D. @ 5%	0.17	0.18	0.17	0.11	0.13	0.13
Manures						
T_1	8.79	8.99	8.89	3.97	4.52	4.24
T_2	12.07	12.86	12.46	5.15	5.65	5.40
T_3	12.34	13.09	12.71	5.27	5.87	5.57
T_4	13.89	14.44	14.16	5.93	6.73	6.33
T_5	12.96	13.96	13.46	5.70	6.23	5.96
C.D. @ 5%	0.28	0.30	0.29	0.18	0.19	0.18
Interaction						
V_1T_1	9.53	9.97	9.75	4.24	4.86	4.55
V_1T_2	12.87	13.48	13.17	5.38	5.97	5.67
V_1T_3	13.12	13.72	13.42	5.50	6.25	5.87
V_1T_4	14.60	15.25	14.92	6.11	6.78	6.44
V_1T_5	13.67	14.87	14.27	5.88	6.68	6.28
V_2T_1	8.05	9.12	8.58	3.70	4.79	4.24
V_2T_2	11.27	12.05	11.66	4.93	5.87	5.40
V_2T_3	11.56	12.96	12.26	5.04	6.94	5.99
V_2T_4	13.18	13.98	13.58	5.75	6.93	6.34
V_2T_5	12.26	13.06	12.66	5.53	6.17	5.85
C.D. @ 5%	NS	NS	NS	NS	NS	NS

Conclusion

The results of the study inferred that Rama tulsi showed the better performance considering morphological and yield attributes and by registering maximum mean values for various parameters. While Krishna tulsi was found inferior. Different organic manures showed variable results on different attributes. Results revealed that different parameters were increased with the application of vermicompost. Considering all the parameters, it may be concluded that, 100% recommended N applied through vermicompost increased the morphological characters of tulsi varieties leading to increased yield compared to other organic manures. Therefore, 100% recommended N applied through vermicompost was found to be beneficial for proper growth and development of tulsi varieties.

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