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Effect of integrated nutrient management on yield and economics of Tulsi (*Ocimum sanctum* L.) in Northern dry zone of Karnataka

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Abstract
An investigation was carried out to study "Effect of integrated nutrient management on yield and economics of Tulsi (*Ocimum sanctum* L.) in Northern Dry Zone of Karnataka" during *Kharif* season of 2018-19. The experiment was laid out in RCBD with 10 treatments in 3 replications. The integrated nutrient management treatments selected for study comprised of T_1:Control – RDF (125:75:60, N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1}), T_2:RD of NPK (125:75:60 N: P_2O_5: K_2O kg ha^{-1}) + Vermicompost 5 t ha^{-1}, T_3:75% RDN + RD P_2O_5 and K_2O+ FYM 10 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_4:75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_5:T_3+ *Azotobacter* 10 kg ha^{-1}, T_6:T_4+ *Azotobacter* 10 kg ha^{-1}, T_7:50% RDN + RD P_2O_5 and K_2O+ FYM 10 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_8:50% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_9: T_7+ *Azotobacter* 10 kg ha^{-1} and T_{10}: T_8+ *Azotobacter* 10 kg ha^{-1}. The results from the study revealed that application of 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} (T_6) recorded significantly higher fresh herbage yield (69.91 q ha^{-1}) and dry herbage yield (41.31 q ha^{-1}) with a B: C ratio of 4.11 in Tulsi (*Ocimum sanctum* L.) compared to other treatments.

Keywords: *Ocimum sanctum* L., INM, yield, economics

Introduction
Tulsi (*Ocimum sanctum* L.) distributed in entire Indian subcontinent, the species *sanctum* of the genus *Ocimum* grows in wide range rather than other species of this genus (Nadkararni and Nadkarni, 1976) [7]. *Ocimum tenuiflorum* L.f. is a synonymous name of *Ocimum sanctum* L. which belongs to family Lamiaceae (Satyavati *et al.*, 1976) [8], is a well-known medicinal plant and oftenly known as 'Tulsi' in Hindi and "Holy Basil" in English, this species is also known as Sri Tulsi and Tulsi plants with purple leaves known as Krishna Tulsi (Sarkar *et al.*, 1994) [11]. It is an herbaceous sacred plant of the Hindus and is worshipped in both homes and temples. *Ocimum sanctum* L. is medicinal herb, distributed throughout the world; various medicinal properties have been observed in *Ocimum sanctum* L. according to Mandal *et al*., 1993 [6]. The genus *ocimum* is an extremely versatile group composed of 160 species with a geographic distribution spread over the tropical, sub-tropical and temperate regions of both the hemisphere ranging from sea level to 1800 ft. Leaves and tender parts of the shoots are economic parts of this crop.

In India it is cultivated on commercial scale and it is grown in various states of the countries like West Bengal, Maharashtra, Uttar Pradesh, Madhya Pradesh, Bihar, Jammu, Assam (Darrah, 1980) [2]. Apart from India, it is also cultivated in Asia and Africa, Egypt, France, Hungary, Italy, Morocco, and USA.

In indigenous system of medicine, different parts (leaves, stem, flower, root, seeds and even whole plant) of *Ocimum sanctum* L. have been recommended to cure various ailments like bronchitis, malaria, diarrhoea, dysentery, skin disease, arthritis, eye diseases, insect bites and so on.

It was widely perceived that inorganic fertilizers were a viable means of increasing land productivity in the low fertile soils. It is also one of the most important inputs of increasing the productivity of crops (Anon., 1997) [1]. However, it has been repeatedly confirmed that continuous sole and imbalanced use of chemical fertilizers deteriorates soil health and ecological balance which leads to decrease in nutrient uptake efficiency (Saravaiya *et al.*, 2010) [10].

Unlike chemical fertilizers, organic manures are available locally at cheaper rates and used by farmers to provide nutrients for the crop plants. The integrated nutrient management system involves judicious combination of inorganic fertilizers and organic manures in building soil fertility and to improve the production potential of any crop (Khalid *et al.*, 2015) [4]. Besides this approach is reasonably cheap, technically sound and practically feasible and is capable of maintaining the sustainability in production. Keeping the views of the above aspects the present research work was undertaken to find out "Effect of integrated nutrient management on yield and economics of Tulsi (*Ocimum sanctum* L.) in Northern dry zone of Karnataka".

Materials and Methods

The field experiment was conducted at Main Horticultural Research and Extension Centre (MHREC), University of Horticultural Sciences, Bagalkot during *Kharif* season of 2018-19 which is situated in Northern Dry Zone of Karnataka (Zone-3) located at 16° 10' North latitude, 74°42' East longitude and at an altitude of 542.0 meters above the mean sea level. The field selected for the experiment was well levelled and the soil texture of experimental filed was clayey in texture, slightly sodic in nature. The temperature, relative humidity and distribution of rainfall had their impact on crop growth and development. As per the meteorological data from January, 2018 to December, 2018 the mean temperature was 27.19 ^{0}C to 33.37 ^{0}C, relative humidity 35.25 to 66.81 per cent and rain fall was 22.14 mm. were recorded during the experimental period.

The experiment was laid out in RCBD with 10 treatments in 3 replications consisting of different sources of nutrients in combination with biofertilizers with recommended dose of fertilizers. T_1:Control – RDF (125:75:60, N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1}), T_2: RD of NPK (125:75:60 N: P_2O_5: K_2O kg ha^{-1}) + Vermicompost 5 t ha^{-1}, T_3:75% RDN + RD P_2O_5 and K_2O+ FYM 10 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_4:75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_5:T_3+ *Azotobacter* 10 kg ha^{-1}, T_6:T_4+ *Azotobacter* 10 kg ha^{-1}, T_7:50% RDN + RD P_2O_5 and K_2O+ FYM 10 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_8:50% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}, T_9: T_7+ *Azotobacter* 10 kg ha^{-1} and T_{10}: T_8+ *Azotobacter* 10 kg ha^{-1}.

The whole experimental plot was brought to a fine tilth by repeated ploughings followed by harrowing by tractor drawn cultivator. Finally, it was levelled and divided into plots of required size (3 m × 3 m) and number. The recommended dose of FYM (10 t/ha), chemical fertilizers was applied as per the treatment. The biofertilizers like *Azotobacter chroococcum* and *Azospirillum lipoferum* were applied to soil by mixing with vermicompost through broadcasting.

Seeds were sown on 4th August, 2018 through line sowing immediately after sowing light irrigation was given. Germination of seedling commences from 10 days of sowing and excess seedlings were thinned out. Weeding was done at periodic intervals and subsequent irrigations were given as per the crop requirement based on soil moisture content. The crop will be ready for the harvest 120 days after sowing and crop is harvested at full bloom stage. After harvest fresh weight of herb is recorded and then the plants were left in the field for 2 days to sun dry and thereafter bundles were made. Fresh herbage yield and dry herbage yield was estimated based on yield obtained from net plot area and expressed in quintals per hectare. The benefit: cost ratio was worked out by dividing the gross income with total cost of cultivation.

Results and Discussion

The fresh herbage yield differed significantly due to integrated nutrient management practices (Table-1). Significantly, higher fresh herbage yield (69.91 q ha^{-1}) was recorded in T_6: 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} followed by T_5 (57.94 q ha^{-1}) and T_{10} (56.74 q ha^{-1}). Whereas, significantly lowest fresh herbage yield was observed in T_1 (33.92 q ha^{-1}) and T_7 (34.85 q ha^{-1}). The reason for increased fresh herbage yield might be due to mineralization of immobilized nutrients by vermicompost. Increased dosage of 'N' helps the plant for profuse vegetative growth by causing synthesized photosynthates to get metabolically converted in to protein and amino acids and there by adding to production of more vegetative tissues. The phosphorous, a constituent of ATP and phospholipids, plays a role in various metabolic process of plants. 'K' aids in the effective conversion of photosynthates for better growth and ultimately yield of plant, these 'P' and 'K' were also supplied by vermicompost. Finally, *Azotobacter* and *Azospirrilum* ability to release phytohormones similar to gibberellic acid and indole acetic acid, which could stimulate plant growth, absorption of nutrients and photosynthesis. The results are in conformity with the findings of Hemalatha and Suresh (2012), Sanjutha *et al. (*2008) [3, 9] in Kalmegh.

The dry herbage yield was influenced by integrated nutrient management practices (Table-1). Significantly, higher dry herbage yield (41.31 q ha^{-1}) was recorded in T_6: 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} followed by T_5 (34.14 q ha^{-1}), T_{10} (33.20 q ha^{-1}) and T_9 (30.66 q ha^{-1}). Whereas, significantly lowest dry herbage yield was observed in T_1 (9.81 q ha^{-1}) and T_7 (11.23 q ha^{-1}). Increase in dry herbage yield might be due to increase in fresh herbage yield and also integrated supply of nutrients encourages the several growth parameters ultimately helped in better absorption, utilization and translocation of nutrients by the plants results in higher fresh herbage yield in turn helps in increased dry herbage yield. These findings are in line with findings of Srivastava (2017) [13] in kalmegh.

The data pertaining to economic analysis of *Ocimum sanctum* L. are presented in Table 2. Highest net return (Rs. 218910/-) was recorded in T_6: 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} followed by T_5 (Rs. 173720/-) and lowest net return found in T_1(Rs. 5229/-). The highest benefit: cost ratio (4.11) was recorded in T_6: 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} followed by T_5 (3.66), while the lowest (1.08) found in T_1: Control – RDF (125:75:60, N: P_2O_5: K_2O kg ha^{-1} + FYM 10 t ha^{-1}).This may be due to the highest plant height, more number of branches and increased photo synthetically active surface area for synthesis and accumulation of photosynthates attributed to the increased fresh and dry herbage yield results in high net returns. Similar results reported by Kumar *et al.* (2010) [5] in *Phyllanthus amarus.*

Table 1: Yield parameters in Tulsi (*Ocimum sanctum* L.) as influenced by integrated nutrient management practices

Treatments	Fresh herbage yield (q ha^{-1})	Dry herbage yield (q ha^{-1})
T_1	33.92	9.81
T_2	40.23	16.23
T_3	43.04	19.22
T_4	48.25	24.23
T_5	57.94	34.14
T_6	69.91	41.31
T_7	34.85	11.23
T_8	45.40	21.61
T_9	54.38	30.66
T_{10}	56.74	33.20
S.Em ±	2.63	1.23
CD @ 5%	7.82	3.66

Table 2: Economics (Rs.) of Tulsi (*Ocimum sanctum* L.) cultivation as influenced by integrated nutrient management practices

Treatments	Total cost of Cultivation (Rs. ha^{-1})	Herbage yield (kg ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	Benefit:Cost ratio
T_1	63441	981	68670	5229	1.08
T_2	68441	1623	113610	45169	1.66
T_3	64260	1922	134540	70280	2.09
T_4	69260	2423	169610	100350	2.45
T_5	65260	3414	238980	173720	3.66
T_6	70260	4131	289170	218910	4.11
T_7	64079	1123	78610	14531	1.23
T_8	69079	2161	151270	82191	2.19
T_9	65079	3066	214620	149541	3.30
T_{10}	70079	3320	232400	162321	3.32

Conclusion

The study clearly reveals that among the different treatments utilized to investigate the effect of integrated nutrient management on yield and economics of Tulsi (*Ocimum sanctum* L.) in Northern Dry Zone of Karnataka, application of 75% RDN + RD P_2O_5 and K_2O+ Vermicompost 5 t ha^{-1} + *Azospirillum* 10 kg ha^{-1}+ *Azotobacter* 10 kg ha^{-1} (T_6) results in higher fresh and dry herbage yield (69.91 and 41.31 q ha^{-1} respectively) and benefit: cost ratio (4.11) compare to other treatments.

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