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Effect of organic manure on performance of *Ocimum sanctum* under peach and apricot based agroforestry system

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Abstract

An experiment was carried out under peach and apricot based agroforestry system for two consecutive years during 2016-2017 at experimental farm of Department of Silviculture and Agroforestry, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP). The experiment was laid out in randomized block design with three replications and seven treatments viz., farm yard manure (FYM) @ 15 t ha⁻¹ (T₁), Farm yard manure @ 20 t ha⁻¹ (T₂), farm yard manure (FYM) @ 25 t ha⁻¹ (T₃), Jeevamrut @ 180ml/plant (T₄), Jeevamrut @ 300ml/plant (T₅), Jeevamrut @ 420ml/plant (T₆) and control (no manure) (T₇). The results revealed that application of Jeevamrut @ 420ml/plant inside the canopy recorded significantly highest plant height (103.82cm, 103.74cm), number of branches (17.52, 17.50), number of leaflets (1815.85, 1811.68) and leaf area (5.95, 5.87 cm²) and leaf area index (3.03, 3.06) of *Ocimum sanctum* during harvesting stage under peach and apricot based agroforestry system, respectively. All the growth and yield parameters were significantly better with application of organic manure as compared to the control (no manure).

Keywords: *Ocimum sanctum*, agroforestry system, organic manure, peach, growth & yield

1. Introduction

In recent past Horticulture has undergone enormous change due to introduction of new varieties and hybrids, development of new technologies such as use of chemical fertilizers, pesticides, weedicides, growth regulators and other inputs as well as improved agricultural practices like drip irrigation. With the dawn of green revolution during mid 60's farmers were advised to take up intensive agriculture with chemicals, fertilizers, pesticides and new hybrids. As a result of this monoculture systems have been developed across the country, which led to loss of biodiversity and rampant soil degradation. Now, in many parts of the country the farmers have realized the ill effects of monoculture along with indiscriminate use of chemicals and fertilizers not only on the health of soil, but also on the society. Use of inorganic fertilizers for longer period damages the soil properties and causes environmental pollution (Albiach *et al.*, 2000) ^[1]. The government and policy makers are seriously adopting alternative methods to intensive agriculture such as organic farming, ecological farming and biodynamic farming etc. Organic farming is an integrated system that strives for sustainability, improvement of soil fertility and biological diversity. This alternative form of farming will not only provide safe as well as nutritious food but will also considerably cut down the cost of cultivation. Adoption of organic farming system can be an important effort to meet the challenge of feeding a world population of 9 billion by 2050 and this approach will also make our agriculture sustainable in the long range (Sharafzadeh and Ordookhani, 2011) ^[2]. There is growing consensus that sustainable farming is vital for reducing poverty in agriculture based economies (World Bank, 2008) ^[3]. Adoption of agroforestry system in organic farming practices is a sustainable agricultural practice which is ecologically and socio-economically feasible (Varshney and Swastik, 2016) ^[4]. Agroforestry system is also a viable option for climate change mitigation, sustainable development and has the potential to improve the socio-economic conditions of the farmers (Dutt and Thakur, 2004) ^[5]. Thus, it is necessary to popularize such unique systems among the farmers. Different agroforestry systems have been developed and numerous tree crop combinations have been tried by researchers all over the world to uplift the socio-economic situation of the farmers (Chauhan *et al.* 1997, Rao *et al.* 2004; Thakur and Kumar,

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2006; Thakur *et al.* 2007) [6, 7, 8, 9]. In the recent years, there has been emphasis on diversification and a shift from growing traditional food crops towards high value cash crops such as medicinal and aromatic plants, which are in great demand by the pharmaceutical and cosmetic industries. Cultivating medicinal & aromatic plants under multipurpose tree species can be a viable option to meet the dimensional needs of the rural people in terms of food, fuel, timber, medicines, construction materials, thereby helping them to lead a self-sustained life. Medicinal and aromatic plants constitute a major segment of the flora, which provides raw materials for pharmaceuticals, cosmetics and drug industries. Owing to the growing demand of MAP'S in different industries and health system, it is great significance to increasing the biomass production without the use of harmful chemical. Moreover, organically grown MAP's are highly acceptable in National as well as International market and also fetch premium prices than those grown with conventional farming (Aishwath *et al.*, 2003) [10].

Ocimum sanctum commonly known as Tulsi is one of such important aromatic plant which is grown worldwide for its medicinal properties. Pharmacologically, it is used as expectorant, analgesic, anticancer, anti-asthmatic, anti-emetic, anti-diabetic, hypotensive, hepatoprotective and anti-fertility properties (Ram *et al.*, 2019) [11]. The crop is highly profitable and economic value of basil oil is due to the presence of a complex mixture of volatile substances, monoterpenes, sesquiterpenes and their oxygenated analogs present at low concentrations in plants (Lucchesi *et al.*, 2004) [12]. Such essential oil has a variety of industrial applications such as therapeutic and cosmetic industries. To retain this environment friendly property of Tulsi, organic production must be encouraged. Further, growth and yield of *Ocimum sanctum* highly influenced by use of fertilizers and organic management practices. Indiscriminate use of inorganic fertilizers is deleterious to soil health and application of organic manures helps to maintain soil microbial population, soil fertility as well as enhance the oil quality of Tulsi. Considering the above facts in view, an experiment was planned to study the response of different organic manures on growth and yield of *Ocimum sanctum* under peach and apricot based agroforestry system.

2. Material and Methods

The present investigation was conducted at the experimental farm of Department of Silviculture and Agroforestry, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh (30° 51'N latitude and 76° 11'E longitude with 1250 m above mean sea level). The experiment was laid out in randomized block design with three replications and seven treatments *viz.*, farm yard manure (FYM) @ 15 t ha⁻¹ (T₁), Farm yard manure @ 20 t ha⁻¹ (T₂), farm yard manure (FYM) @ 25 t ha⁻¹ (T₃), Jeevamrut @ 180ml/plant (T₄), Jeevamrut @ 300ml/plant (T₅), Jeevamrut @ 420ml/plant (T₆) and control (no manure) (T₇). Nectarine [*Prunus persica* (L.) Batsch var. *nucipersica*] (fuzz less mutant of peach) trees were planted in East to West direction at a distance of 9 x 4m. The plot size was 3 x 3m and spacing of 45c x 45cm was maintained for *Ocimum sanctum*. Seedlings of *Ocimum sanctum* were transplanted in the month of June. Light irrigations were given after transplanting to facilitate the establishment of seedlings. The experimental plots were maintained properly and kept free from weeds. FYM was evenly spread and mixed with the soil before transplanting. Thereafter, Jeevamrut (5%) was applied as soil drench @ 30,

50, 70 ml per plant after the 30 days of transplanting. Afterwards same application was provided at 15 days interval till the final harvesting was done (full bloom stage of flowering) and total 6 applications of Jeevamrut (5%) were applied. Thus, making total application of Jeevamrut as 180 ml (Acharaya, 2017) [13], 300ml and 420 ml (Basavaraj *et al.*, 2016) [14] per plant. The different plant growth parameters were recorded. Observations were taken at three distances from the tree row (1m, 2m and 3m away from the tree) and the mean of three distances (inside the canopy) was compared with the mean of three replication of open system (outside the canopy). The plant height was taken with the help of scale from ground level to the top of plant before harvesting and expressed in cm. Leaf area index was measured with the help of pre-calibrated, preprogrammed LAI-2000 plant canopy analyzer (LICOR-USA). Each value was computed on the basis of one open and four beneath canopy readings. Thereafter, the sensor was held underneath canopy near the base of crops 2-4cm above the ground level to take 4 below canopy readings. Open and below canopy readings were taken using 45° view cap. Each value of LAI is the mean of three replications and has been expressed as unit less attribute. The leaf area of fully expanded leaf was measured by using pre-calibrated portable leaf area meter (CI-203, INC.USA). The leaves were detached from the plants, collected in envelopes and were brought to the laboratory to determine leaf area. Each leaf was placed under leaf area meter and thereafter scanned to determine the leaf area digitally. Leaves were collected before harvesting for measuring fresh and dry weight. Afterwards, whole plants were uprooted; shoots were detached from the roots and weighed with the help of electronic balance. Thereafter, weight was again taken after drying. Total fresh and dry weight of the herb was obtained by combining the weight of leaves, shoots and roots. The data were statistically analyzed by using ANOVA in accordance with the procedure outlined by Gomez and Gomez (1984) [15], where effects exhibited significance at 5 per cent level of probability and then critical difference (CD) was calculated.

3. Results and Discussion

3.1 Growth Parameters

The data of different growth parameters of *Ocimum sanctum* under peach and apricot trees has been presented in Tables 1, 2, 3, 4, 5, 6 and 7. The results revealed that growth and yield of *Ocimum sanctum* at different plant developmental stages differed significantly due to application of organic manures under peach and apricot trees. At vegetative stage, among different organic manures, maximum average plant height (26.81cm, 26.79cm), number of branches (2.55, 2.45), number of leaflets (51.76, 51.58) and leaf area index (1.23, 1.20) was recorded in T₃ (25t FYM ha⁻¹) under peach and apricot based agroforestry system, respectively. The organic liquid manures like jeevamrut provide nutrients and plant growth promoting substances but they may not be sufficient to show the early growth and development of the Tulsi crop. On contrary, leaf area (2.42 cm², 2.36 cm²) was recorded highest with application of 420ml Jeevamrut plant⁻¹ (T₆) under peach and apricot trees, respectively. Similarly, during pre-bloom stage, all the growth parameters *viz.* average plant height (91.49cm, 90.30cm), number of branches (16.76, 17.02), number of leaflets (1766.30, 1755.89) and leaf area (4.25 cm², 4.02 cm²) and leaf area index (2.31, 2.30) was registered highest with T₆ (420ml Jeevamrut plant⁻¹) under peach and apricot based agroforestry system, respectively. Similar trend was followed for harvesting stage where

average plant height (103.82cm, 103.74cm), number of branches (17.52, 17.50), number of leaflets (1815.85, 1811.68) and leaf area (5.95 cm², 5.87 cm²) and leaf area index (3.03, 3.06) was also registered highest with T₆ (420ml Jeevamrut plant⁻¹) under peach and apricot trees, respectively. Results are supported with the findings of Basavaraj *et al.*, (2016) [14] who has also reported significantly higher plant height (26.7cm and 26.6 cm), number of branches (6.93 and 6.89) and leaf area (1325 cm² and 1263 cm²) in *Phaseolus vulgaris* with soil application of Jeevamrut (1000 l ha⁻¹) and foliar spray of Panchagavya (3%), respectively over control where no Jeevamrut and Panchagavya was applied. Similarly, another authors (Kumari *et al.*, 2018) [16] have also reported maximum plant height in mulberry with application of jeevamrut which was statistically higher than all other treatments. Application of Jeevamrut as an organic input is assuming a paramount importance for maintenance of soil health as well as productivity. The usage of jeevamrut improves physico-chemical and biological properties of soil, besides improving the efficiency of applied FYM (Nileema *et al.*, 2011) [17].

Considering the different doses of FYM, all growth parameters and yield of *Ocimum sanctum* during different developmental stages was observed to be better with application of 25t FYM ha⁻¹ (T₃) as compared to the other doses except for plant height under peach at pre-bloom stage. Whereas, all the growth parameters of *Ocimum sanctum* were registered lowest in control (T₇) where no manure was applied. Increased level of FYM (30 t/ha) have also increased the plant height, number of leaves, canopy spread and number of suckers per plant in black musli as compared to other treatments (10&20t FYM/ha) (Joy *et al.*, 2005) [18]. The growth promoting effect of FYM as a source of plant nutrients and humus, which improves the soil physical condition by increasing its capacity to absorb and store water, enhancement of aeration and by favoring microbial activity is well established (Dhiman, 2020) [19].

As far as canopy distance was concerned, average maximum plant height (25.35cm, 91.00cm, 101.87cm), number of branches (2.32, 15.48, 16.65), number of leaflets (50.63, 1547.40, 1586.88), leaf area cm² (2.44 cm², 4.42 cm², 5.65 cm²) and leaf area index (1.23, 2.04, 2.87) was observed inside canopy as compared to outside canopy during vegetative, pre-bloom and harvesting stage, respectively under peach based agroforestry system. Similar trend was followed under apricot tree where values for plant height (24.98cm, 89.50cm, 101.29 cm), number of branches (2.26, 15.06, 16.35), number of leaflets (50.12, 1522.31, 1553.86), leaf area (2.38 cm², 4.13 cm², 5.40 cm²) and leaf area index (1.21, 2.03, 2.86) were registered maximum inside canopy in comparison to outside canopy under vegetative, pre-bloom and harvesting stage, respectively. However, the interaction between different organic manures and canopy under apricot and peach trees exerted a non-significant effect on plant growth in different developmental. While, interaction was significant w.r.t number of leaflets and leaf area cm² (pre-bloom stage) and leaf area index (harvesting stage) under peach trees.

3.2 Yield Parameters

The data on yield attributes and total yield of *Ocimum sanctum* under peach as well as apricot based agroforestry system has been presented in tables 8 and 9 Among different doses of organic manures, average maximum fresh leave, shoot and root weight (4.83 q/ha, 12.72 q/ha, 0.72 q/ha) was

recorded with T₆ (420ml Jeevamrut plant⁻¹) while minimum (3.14 q/ha, 8.46 q/ha, 0.39 q/ha) under peach tree. However, in case of FYM doses, the value for maximum fresh leave, shoot and root weight were 4.65 q/ha, 11.55 q/ha and 0.69 q/ha, respectively. Similarly, dry weight of leave, shoot and root was also recorded highest (1.43 q/ha, 3.72 q/ha and 0.41q/ha, respectively) when Jivamruth @ 420ml plant⁻¹ (T₆) was applied. While, lowest fresh and dry weight of leave, shoot and root was recorded with T₇ treatment in which no manure was applied. The results are in line with findings of Anuja and Archana (2011) [20]. who have also recorded significantly higher yield of bitter gourd on application of organic manures over control.

Overall with respect to canopy distance, average fresh weight (4.76 q/ha, 11.22 q/ha and 0.69q/ha) of leave, shoot and root, respectively was recorded highest inside canopy as compared to the outside canopy. However, the interaction between organic manure and distance ((T×D) showed non-significant effect for all yield attributes of *Ocimum sanctum* except dry weight under peach tree. Similar results were obtained under apricot tree where value were 4.82 q/ha, 12.58 q/ha and 0.70q/ha for fresh weight and 1.41 q/ha, 3.71 q/ha and 0.40 q/ha for dry leave, shoot and root, respectively. Similar trend was followed under apricot trees where all the yield parameters were also registered maximum with application of T₆ (420ml Jeevamrut plant⁻¹) and minimum in T₇ (no manure). Among different FYM doses, T₃ (25 t ha⁻¹) treatment was found to be better over other treatments (T₁-FYM @15 t ha⁻¹, T₂-FYM @20 t ha⁻¹) for all yield parameters of *Ocimum sanctum*. Growth and yield attributing characters of Tulsi increased with increasing level of FYM. Similarly, significantly highest growth and yield parameters have also been reported in *Withania somnifera* with the application of FYM (2t/ha) as compared to other treatment (FYM 0 and 1t/ha) (Patil *et al.*, 2014) [21].

Yield is a complex phenomena which can be controlled both by morphological and physical parameters and it can also be manipulated by either genetic factors or cultural operations. In the present study, the highest total fresh yield (18.27 q/ha and 18.09q/ha) and dry yield (5.55 q/ha and 5.52 q/ha) of *Ocimum sanctum* was recorded in T₆ (Jeevamrut plant⁻¹) under peach and apricot based agroforestry system, respectively. Similarly, (Chandrakala, 2008) [22]. has also reported significant increase in total yield (33%) in dry chilli by application of Jeevamrut over control which could be due to better availability of nutrients throughout the crop growth. Likewise, organic farming with application of Jeevamrut has been found profitable than chemical farming in Hamsa variety of rice in Chittoor district of Andhra Pradesh (Amareswari and Sujathamma, 2014) [23]. On the other hand, both fresh (11.99 q/ha, 11.83 q/ha) and dry yield (3.60 q/ha, 3.58 q/ha) was lowest with T₇ (no manure) under peach and apricot trees, respectively. With respect to the canopy distance, total fresh yield (16.67 q/ha, 16.39 q/ha) and dry yield (5.14 q/ha, 5.06 q/ha) of *Ocimum sanctum* under peach and apricot tree, respectively was recorded maximum inside canopy as compare to outside canopy. However, the interaction effect between different doses of manures and canopy failed to exert any significant effect on total yield of *Ocimum sanctum* under peach and apricot tree.

3.3 Yield and biomass production of peach and apricot

Perusal of the data presented in Table 10 revealed that effect of different doses of organic manure was found insignificant over tree height, crown spread, fruit yield and above ground

tree biomass under both agroforestry systems. However, total above ground biomass for peach tree varied from 83.46 kg/tree (T₇) to 158.17 kg/tree (T₆) whereas, values for apricot tree ranged between 29.17 kg/tree (T₇) to 58.84 kg/tree (T₅). As far as fruit yield was concerned, peach fruit yield varied

from 31.00 kg/tree (T₇) to 42.67 kg/tree (T₆). However, apricot fruit yield ranged between 4.33kg/tree (T₂, T₇) to 5.17 kg/tree (T₄, T₅). Fruit yield per hectare in capsicum had also varied significantly due to the application of jeevamrut (Boraiah *et al.*, 2017) [24].

Table 1: Effect of organic manure on plant growth parameters of *Ocimum sanctum* under Peach based agroforestry system.

Parameter / Treatment	Plant height (cm)									Number of branches								
	Vegetative stage			Pre-bloom stage			Harvesting stage			Vegetative stage			Pre-bloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	22.58	24.69	23.64	83.51	89.25	86.38	94.22	99.97	97.10	1.41	2.04	1.72	11.06	13.38	12.22	12.31	14.69	13.50
T ₂	24.99	25.53	25.26	86.19	90.60	88.40	97.94	103.40	100.67	2.01	2.25	2.13	12.38	15.37	13.87	14.27	17.46	15.87
T ₃	25.76	27.85	26.81	84.90	90.96	87.93	100.13	103.20	101.67	2.06	3.04	2.55	13.17	16.40	14.79	14.47	17.87	16.17
T ₄	22.38	24.61	23.49	84.24	91.81	88.02	97.03	101.23	99.13	1.32	1.95	1.63	11.81	14.54	13.18	12.51	14.24	13.37
T ₅	24.75	25.13	24.94	88.45	93.08	90.77	99.78	104.58	102.18	1.57	2.17	1.87	14.62	18.40	16.51	16.12	18.76	17.44
T ₆	25.56	26.08	25.82	88.85	94.12	91.49	101.66	105.97	103.82	1.98	2.95	2.47	15.43	18.09	16.76	15.40	19.64	17.52
T ₇	21.56	23.55	22.55	82.21	87.15	84.68	93.16	94.70	93.93	1.25	1.81	1.53	10.75	12.17	11.46	12.39	13.93	13.16
Mean	23.94	25.35		85.48	91.00		97.70	101.87		1.66	2.32		12.75	15.48		13.92	16.65	
CD _(0.05)	T	1.51		T	2.23		T	1.61		T	0.61		T	1.53		T	1.86	
	D	0.80		D	1.19		D	0.86		D	0.33		D	0.81		D	0.99	
	T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TxD= interaction between tree and distance.

Table 2: Effect of organic manure on number of leaflets and leaf area (cm²) of *Ocimum sanctum* under Peach based agroforestry system.

Parameter / Treatment	Number of leaflets									Leaf area (cm ²)								
	Vegetative stage			Prebloom stage			Harvesting stage			Vegetative stage			Prebloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	48.57	49.95	49.26	1,093.25	1,312.40	1,202.82	1,107.00	1,275.47	1,191.24	1.92	2.22	2.07	3.11	4.04	3.58	4.28	5.36	4.82
T ₂	49.44	51.38	50.41	1,293.28	1,554.66	1,423.97	1,331.83	1,723.13	1,527.48	2.00	2.49	2.25	3.56	4.49	4.03	4.48	5.69	5.09
T ₃	50.92	52.59	51.76	1,531.77	1,645.14	1,588.45	1,576.17	1,843.83	1,710.00	2.09	2.64	2.36	3.42	4.85	4.14	4.78	6.17	5.47
T ₄	48.32	48.96	48.64	1,133.57	1,372.43	1,253.00	1,127.53	1,372.14	1,249.83	1.99	2.31	2.15	3.19	4.31	3.75	4.24	5.54	4.89
T ₅	50.52	51.85	51.19	1,303.01	1,766.35	1,534.68	1,493.96	1,799.68	1,646.82	2.07	2.62	2.34	3.58	4.64	4.11	4.84	6.35	5.60
T ₆	51.15	51.96	51.56	1,635.03	1,897.56	1,766.30	1,664.62	1,967.09	1,815.85	2.14	2.71	2.42	3.53	4.97	4.25	5.31	6.59	5.95
T ₇	45.82	47.69	46.76	803.70	1,283.29	1,043.49	918.54	1,126.86	1,022.70	1.88	2.11	2.00	3.07	3.65	3.36	3.61	3.86	3.74
Mean	49.25	50.63		1,256.23	1,547.40		1,317.09	1,586.88		2.01	2.44		3.35	4.42		4.51	5.65	
CD _(0.05)	T	0.67		T	99.31		T	125.24		T	0.18		T	0.26		T	0.58	
	D	0.36		D	53.08		D	66.94		D	0.09		D	0.14		D	0.31	
	T×D	NS		T×D	140.44		T×D	NS		T×D	NS		T×D	0.37		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TxD= interaction between tree and distance.

Table 3: Effect of organic manure on leaf area index of *Ocimum sanctum* under Peach based agroforestry system.

Parameter / Treatment	Leaf area index								
	Vegetative stage			Prebloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	0.99	1.18	1.09	1.43	1.81	1.62	2.27	2.70	2.48
T ₂	1.06	1.28	1.17	1.96	2.13	2.04	2.37	2.81	2.59
T ₃	1.05	1.40	1.23	2.10	2.41	2.26	2.90	3.03	2.96
T ₄	1.03	1.14	1.09	1.66	1.91	1.78	2.49	2.80	2.65
T ₅	1.08	1.24	1.16	2.01	2.17	2.09	2.78	3.00	2.89
T ₆	1.06	1.34	1.20	2.21	2.41	2.31	2.96	3.11	3.03
T ₇	0.93	1.01	0.97	1.16	1.43	1.30	2.42	2.65	2.54
Mean	1.03	1.23		1.79	2.04		2.60	2.87	
CD _(0.05)	T	0.14		T	0.14		T	0.10	
	D	0.07		D	0.07		D	0.05	
	T×D	NS		T×D	NS		T×D	0.15	

*T= Tree; D=distance (out side and inside canopy); TXD= interaction between tree and distance.

Table 4: Effect of organic manure on fresh and dry weight of *Ocimum sanctum* in Peach based agroforestry system.

Parameters / Treatments	Leaves fresh weight (q/ha)			Leaves dry weight (q/ha)			Shoot fresh weight (q/ha)			Shoot dry weight (q/ha)			Root fresh weight (q/ha)			Root dry weight (q/ha)		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	3.17	4.27	3.72	0.93	1.17	1.05	8.73	10.26	9.50	2.50	3.07	2.79	0.43	0.63	0.53	0.14	0.36	0.25
T ₂	3.56	5.11	4.34	1.02	1.28	1.15	9.38	11.00	10.19	2.71	3.33	3.02	0.48	0.73	0.61	0.21	0.44	0.33
T ₃	4.09	5.21	4.65	1.03	1.42	1.23	10.90	12.20	11.55	3.14	3.60	3.37	0.60	0.77	0.69	0.19	0.46	0.33
T ₄	3.41	4.53	3.97	1.07	1.48	1.28	9.37	10.90	10.14	2.70	3.25	2.98	0.44	0.64	0.54	0.08	0.33	0.21
T ₅	4.01	5.26	4.63	1.11	1.59	1.35	10.71	11.77	11.24	3.14	3.49	3.32	0.58	0.75	0.66	0.23	0.47	0.35
T ₆	4.29	5.38	4.83	1.15	1.71	1.43	12.19	13.24	12.72	3.51	3.93	3.72	0.61	0.82	0.72	0.31	0.50	0.41
T ₇	2.71	3.57	3.14	0.76	0.95	0.86	7.77	9.14	8.46	2.23	2.82	2.53	0.31	0.47	0.39	0.13	0.30	0.22
Mean	3.61	4.76		1.01	1.37		9.87	11.22		2.85	3.36		0.49	0.69		0.18	0.41	
CD _(0.05)	T	0.21		T	0.18		T	0.32		T	0.06		T	0.08		T	0.10	
	D	0.11		D	0.09		D	0.17		D	0.02		D	0.04		D	0.05	
	T×D	NS		T×D	NS		T×D	NS		T×D	0.06		T×D	NS		T×D	NS	

*T= Tree; D=distance (outside and inside canopy); TxD= interaction between tree and distance.

Table 5: Effect of organic manure on plant growth parameters of *Ocimum sanctum* under Apricot based agroforestry system.

Parameter / Treatment	Plant height (cm)									Number of branches								
	Vegetative stage			Prebloom stage			Harvesting stage			Vegetative stage			Prebloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	22.58	24.21	23.40	83.51	88.11	85.81	94.22	99.50	96.86	1.41	1.91	1.66	11.06	12.90	11.98	12.31	14.55	13.43
T ₂	24.99	25.44	25.22	86.19	89.55	87.87	97.94	102.81	100.37	2.01	2.55	2.28	12.38	15.10	13.74	14.27	16.81	15.54
T ₃	25.76	27.81	26.79	84.90	89.68	87.29	100.79	102.67	101.73	2.06	2.83	2.45	13.17	15.88	14.52	14.47	17.61	16.04
T ₄	22.38	23.82	23.10	84.24	89.85	87.04	97.03	100.72	98.87	1.32	1.89	1.60	11.81	13.43	12.62	12.51	13.88	13.19
T ₅	24.75	25.05	24.90	88.45	90.98	89.72	99.78	104.18	101.98	1.57	2.30	1.94	14.62	17.79	16.20	16.12	18.29	17.20
T ₆	25.56	25.74	25.65	88.85	91.74	90.30	102.33	105.15	103.74	1.98	2.62	2.30	15.43	18.61	17.02	15.40	19.60	17.50
T ₇	21.56	22.79	22.17	82.21	86.57	84.39	93.16	94.03	93.60	1.25	1.72	1.49	10.75	11.75	11.25	12.39	13.72	13.06
Mean	23.94	24.98		85.48	89.50		97.89	101.29		1.66	2.26		12.75	15.06		13.92	16.35	
CD _(0.05)	T	1.54		T	2.64		T	1.80		T	0.63		T	1.52		T	1.83	
	D	0.82		D	1.41		D	0.96		D	0.33		D	0.83		D	0.98	
	T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TXD= interaction between tree and distance.

Table 6: Effect of organic manure on number of number of leaflets and leaf area (cm²) of *Ocimum sanctum* under Apricot based agroforestry system.

Parameter / Treatment	Number of leaflets									Leaf area (cm ²)								
	Vegetative stage			Prebloom stage			Harvesting stage			Vegetative stage			Prebloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	48.57	49.42	49.00	1,093.25	1,309.23	1,201.24	1,107.00	1,250.27	1,178.64	1.92	2.21	2.07	3.11	3.87	3.49	4.28	5.21	4.74
T ₂	49.44	50.77	50.10	1,293.28	1,522.82	1,408.05	1,331.83	1,660.03	1,495.93	2.00	2.42	2.21	3.56	4.33	3.95	4.48	5.38	4.93
T ₃	50.92	52.23	51.58	1,531.77	1,674.92	1,603.34	1,576.17	1,828.54	1,702.36	2.09	2.57	2.33	3.42	4.42	3.92	4.78	5.95	5.37
T ₄	48.32	48.69	48.51	1,133.57	1,377.14	1,255.36	1,127.53	1,366.90	1,247.22	1.99	2.28	2.14	3.19	4.01	3.60	4.24	5.30	4.77
T ₅	50.52	50.82	50.67	1,303.01	1,719.44	1,511.22	1,493.96	1,731.73	1,612.84	2.07	2.53	2.30	3.58	4.38	3.98	4.84	5.86	5.35
T ₆	51.15	51.57	51.36	1,635.03	1,876.74	1,755.89	1,664.62	1,958.74	1,811.68	2.14	2.58	2.36	3.53	4.50	4.02	5.31	6.43	5.87
T ₇	45.82	47.35	46.59	803.70	1,175.89	989.79	918.54	1,080.84	999.69	1.88	2.03	1.96	3.07	3.42	3.24	3.61	3.70	3.66
Mean	49.25	50.12		1,256.23	1,522.31		1,317.09	1,553.86		2.01	2.38		3.35	4.13		4.51	5.40	
CD _(0.05)	T	0.66		T	105.24		T	133.58		T	0.23		T	0.38		T	0.56	
	D	0.35		D	56.25		D	71.40		D	0.13		D	0.20		D	0.30	
	T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (outside and inside canopy); TxD= interaction between tree and distance.

Table 7: Effect of organic manure on leaf area index of *Ocimum sanctum* under Apricot based agroforestry system.

Parameter / Treatment	Leaf area index								
	Vegetative stage			Prebloom stage			Harvesting stage		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	0.99	1.17	1.08	1.43	1.75	1.59	2.27	2.62	2.44
T ₂	1.06	1.25	1.16	1.96	2.17	2.07	2.37	2.74	2.55
T ₃	1.05	1.36	1.20	2.10	2.35	2.23	2.90	3.08	2.99
T ₄	1.03	1.19	1.11	1.66	1.92	1.79	2.49	2.77	2.63
T ₅	1.08	1.24	1.16	2.01	2.22	2.12	2.78	3.06	2.92
T ₆	1.06	1.29	1.18	2.21	2.39	2.30	2.96	3.15	3.06
T ₇	0.93	0.98	0.96	1.16	1.40	1.28	2.42	2.59	2.51
Mean	1.03	1.21		1.79	2.03		2.60	2.86	
CD _(0.05)	T	0.15		T	0.15		T	0.11	
	D	0.08		D	0.08		D	0.06	
	T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TxD= interaction between tree and distance.

Table 8: Effect of organic manure on fresh and dry weight of *Ocimum sanctum* in Apricot based agroforestry system.

Parameters Treatments	Leaves fresh weight (g/ha)			Leaves dry weight (g/ha)			Shoot fresh weight (g/ha)			Shoot dry weight (g/ha)			Root fresh weight (g/ha)			Root dry weight (g/ha)		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	3.17	4.03	3.60	0.93	1.13	1.03	8.73	10.04	9.39	2.50	3.03	2.76	0.43	0.60	0.52	0.14	0.34	0.24
T ₂	3.56	4.43	4.00	1.02	1.23	1.12	9.38	11.01	10.20	2.71	3.27	2.99	0.48	0.69	0.59	0.21	0.42	0.32
T ₃	4.09	4.54	4.32	1.03	1.38	1.20	10.90	12.12	11.51	3.14	3.57	3.36	0.60	0.73	0.66	0.19	0.44	0.32
T ₄	3.41	4.78	4.10	1.07	1.44	1.26	9.37	10.94	10.15	2.70	3.21	2.96	0.44	0.61	0.52	0.08	0.30	0.19
T ₅	4.01	5.17	4.59	1.11	1.56	1.34	10.71	12.38	11.55	3.14	3.55	3.35	0.58	0.72	0.65	0.23	0.43	0.33
T ₆	4.29	5.34	4.82	1.15	1.67	1.41	12.19	12.96	12.58	3.51	3.90	3.71	0.61	0.78	0.70	0.31	0.49	0.40
T ₇	2.71	3.32	3.02	0.76	0.95	0.86	7.77	9.10	8.44	2.23	2.80	2.52	0.31	0.45	0.38	0.13	0.28	0.21
Mean	3.61	4.52		1.01	1.34		9.87	11.22		2.85	3.33		0.49	0.65		0.18	0.39	
CD _(0.05)	T	0.66		T	105.24		T	133.58		T	0.23		T	0.38		T	0.56	
	D	0.35		D	56.25		D	71.40		D	0.13		D	0.20		D	0.30	
	T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TxD= interaction between tree and distance.

Table 9: Effect of organic manure on total yield of *Ocimum sanctum* in Peach and Apricot based agroforestry system.

Parameter / Treatment	Under Peach tree						Under Apricot tree					
	Total fresh yield (g/ha)			Total dry yield (g/ha)			Total fresh yield (g/ha)			Total dry yield (g/ha)		
	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean	Outside canopy (mean)	Inside canopy (mean)	Mean
T ₁	12.34	15.17	13.75	3.56	4.61	4.09	12.34	14.67	13.50	3.56	4.50	4.03
T ₂	13.43	16.83	15.13	3.94	5.05	4.49	13.43	16.13	14.78	3.94	4.91	4.43
T ₃	15.59	18.18	16.89	4.36	5.49	4.92	15.59	17.38	16.49	4.36	5.39	4.87
T ₄	13.22	16.07	14.65	3.85	5.07	4.46	13.22	16.32	14.77	3.85	4.95	4.40
T ₅	15.30	17.78	16.54	4.49	5.55	5.02	15.30	18.26	16.78	4.49	5.54	5.02
T ₆	17.09	19.44	18.27	4.97	6.14	5.55	17.09	19.09	18.09	4.97	6.06	5.52
T ₇	10.80	13.18	11.99	3.12	4.08	3.60	10.80	12.86	11.83	3.12	4.03	3.58
Mean	13.97	16.67		4.04	5.14		13.97	16.39		4.04	5.06	
CD _(0.05)	T	0.45		T	0.26		T	0.56		T	0.28	
	D	0.24		D	0.13		D	0.30		D	0.15	
	T×D	NS		T×D	NS		T×D	NS		T×D	NS	

*T= Tree; D=distance (out side and inside canopy); TxD= interaction between tree and distance.

Table 10: Growth and biomass parameters of trees intercropped with *Ocimum sanctum*

Trees	Height (m)		Crown spread (m ²)		Branches per Tree		Fruit Yield (kg/tree)		Above ground tree biomass (kg/tree)		Total Above ground tree biomass (kg/tree)	
	Peach	Apricot	Peach	Apricot	Peach	Apricot	Peach	Apricot	Peach	Apricot	Peach	Apricot
T ₁	3.43	4.20	1.32	1.20	3.33	3.67	36.67	5.00	63.54	24.83	100.21	29.83
T ₂	3.50	5.00	1.18	1.13	3.67	3.33	36.00	4.33	69.05	35.05	105.05	39.38
T ₃	4.02	5.10	1.30	1.07	3.67	4.00	38.00	4.83	76.46	56.24	114.46	61.07
T ₄	4.13	4.93	1.25	1.33	4.00	4.67	36.33	5.17	66.90	35.77	103.23	40.94
T ₅	3.37	4.87	1.42	1.22	3.67	4.00	36.33	5.17	70.94	53.67	107.27	58.84
T ₆	3.97	4.87	1.30	1.17	4.33	3.67	42.67	5.00	115.50	45.84	158.17	50.84
T ₇	3.97	4.57	1.45	1.17	3.67	3.67	31.00	4.33	52.46	24.84	83.46	29.17
CD _(0.05)	NS		NS		NS		NS		NS		NS	

4. Conclusion

Conclusively, it emerges that organic manure significantly influenced plant height, number of branches, number of leaves, leaf area, leaf area index and yield of *Ocimum sanctum*.

However, higher dose of organic manures i.e. 25t/ha FYM and 420ml/plant Jeevamrut were more effective in improving growth and yield attributes of *Ocimum sanctum* crop intercropped under peach and apricot fruit trees.

Thus, jeevamrut @ 420ml/plant has been recommended as organic manure to improve the yield and successful production of *Ocimum sanctum* under peach & apricot based agroforestry system.

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