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Yield and quality of sweet basil (*Ocimum basilicum* L.) as affected by organic manures at Telanagana

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Abstract
Basil is a fragrant edible herb with abundant minerals, micronutrients, and pharmacological activities. The effect of organic manures on the crop biomass, essential oil yield and composition, and antioxidant activity in *Ocimum basilicum* was studied under field conditions. The field study reveals that the combined use of farmyard manure (FYM), vermicompost (VC) and neem cake (NC) gives higher crop yield in basil. The experiment was laid out in Randomized block design (RBD) with 3 replications and 11 treatments. Data on fresh yield per plot, fresh yield per hectare, seed yield per hectare, essential oil ratio and essential oil yield were collected and analysed. The analysis of variance revealed that there were highly significant effect of organic manures for all parameters tested. The maximum fresh yield per plot (26.43 kg), fresh yield per hectare (132.15 q) and seed yield per hectare (630.00 kg) were obtained from the T_{10} treatment (Vermicompost 750 Kg/ ha +Farmyard Manure 3.75 t/ha +Neem cake 375 Kg/ha). While, the highest essential oil ratio (0.61%) and essential oil yield (38.28 Kg) were recorded with the T_6 treatment (Neem cake 1 t/ha). The parameters like composition of essential oil and antioxidant activity shows non significant effect due to different organic manures and combinations of organic manures.

Keywords: FYM, vermicompost, neem cake, yield, essential oil yield, composition of essential oil and antioxidant activity

Introduction
The word basil is derived from the Greek word “Basilica” which means the Royal plant. Basil is the popular name given to the aromatic herbs belonging to the genus *Ocimum*. An *Ocimum species* namely *Ocimum basilicum* var. Glaborata was used by the royal people of the Greece to flavour their special dishes. Thus, *Ocimum basilicum* is also called as sweet basil or French basil or common basil. Basil (Ocimum or sweet basil) has 3000 years of history and culture of old Europe and Asia as it is used by the people in traditional religious ceremonies and rituals (Omid beigi, 1379) [10].
The medicinal value of *Ocimum species* has been described in the most ancient medical literature of Hindus “Charak Samhit” and “Sushruta Samhita” (about 1000 B.C). As a herb, it is used in indigenous system of medicines owing to its antifungal, antibacterial and insecticidal properties. Some species are used in traditional medicines for different application especially in many Asian and African countries. The leaves and flowering tops of sweet basil are used as carminative, galactagogue, stomachic, and antispasmodic in folk medicine.
Due to the general inclination towards herbal remedies, the demand for medicinal and aromatic plants and their cultivation has significantly increased. In recent times, the demand for organic food products has grown due to health and sustainable environment considerations. Further, the search for safe and potent natural antioxidants from plant sources has gained impetus. Meanwhile, the food industry has emerged as the second largest consumer of essential oils. The organic amendments are a good source of essential macro- and micro-nutrients. Further, they increase the water holding and cation exchange capacity of the soil.
Keeping above in view, we designed a field experiment on yield and quality of sweet basil (*Ocimum basilicum* L.) as affected by organic manures at Telangana.

Materials and Methods
The study site was the experimental farm of Medicinal and Aromatic Plants Research Station, Rajendranagar, Telangana. The experiments were conducted during the year 2020 -2021. Three organic amendments, namely, Vermicompost (VC), Neem cake (NC), and Farmyard Manure (FYM) were investigated for the cultivation of the basil.

We evaluated 11 treatments comprising various combinations of organic amendments. The different manure applications, their combinations T_1 - Vermicompost 1 t/ha, T_2 - Vermicompost 2 t/ ha, T_3 - Farm yard manure 5 t/ha, T_4 - Farm yard manure 10 t/ha, T_5 - Neem cake 500 Kg/ha, T_6 - Neem cake 1 t/ha, T_7 - Vermicompost 750 Kg/ ha + Farmyard manure 3.75 t/ha, T_8 - Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha, T_9 - Farm yard manure 3.75 t/ha + Neem cake 375 Kg/ha, T_{10} - Vermicompost 750 Kg/ ha +Farmyard manure 3.75 t/ha +Neem cake 375 Kg/ha and T_{11} - Control.
The experiment was conducted in a randomized block design with eleven treatments and three replications in a plot size of 5 M X 4 M. The seedlings of *O. basilicum* were grown for four weeks in a nursery. Seedlings were transplanted into plots during rabi 2020 to 2021 with a spacing of 60 cm X 40 cm. The plots were irrigated immediately after transplanting for the proper establishment of the crop in the field. All intercultural operations were carried out as per need. Biomass yield per plot, seed yield, essential oil ratio, essential oil yield, composition of oil and antioxidant activity was recorded.

Data Collected

Fresh yield per plot (kg)

At the time of harvest the whole net plot was harvested and weighed by using the electronic balance and the mean was worked out and expressed in terms of kilograms (kg) per plot.

Fresh yield per hectare (q)

The yield per hectare was computed by multiplying the fresh yield per plant with the number of plants that can be accommodated in one hectare and was expressed in quintals per hectare.

Seed yield per hectare (Kg)

The number of plants per hectare was calculated and multiplied with seed yield per plant and expressed in kilograms.

Essential oil ratio (%)

Oil recovery was estimated by hydro distillation method using Clevenger apparatus. To estimate the oil recovery (%) 1000 g of fresh herbage sample, comprising of leaves, inflorescence and small twigs, was taken. The chopped sample was put in 5000 ml capacity round bottom flask half filled with water. Distillation was done for about 2 to 3 hours. The oil being lighter than water got collected in the burette and reading was recorded which were later transferred into a test tube and was recorded as oil recovery %. The essential oil was dried over anhydrous sodium sulphate and stored at 4 - 6 ºC, until analyzed.

The essential oil content was calculated by using formula:

$$\text{Essential oil ratio (\% Volume/ Weight basis)} = \frac{\text{Quantity of essential oil (ml)}}{\text{Weight of herb (g)}} \times 100$$

Essential oil yield (Kg/ha)

The values obtained from essential oil content percentage are used for calculating the essential oil yield in kg / ha by using the formula:

Total oil yield kg/ha = Total dry biomass (kg/ha) x Essential oil ratio

Composition of essential oil

The Varian CP-3800 gas chromatograph was equipped with a 30 m 0.25 mm, 0.25 mm film thickness DB-5 capillary column. The carrier gas (H2) was used as mobile phase with an average flow of 0.5 ml/min in the split ratio of 1:25, makeup flow (N2 gas) at 28 ml min−1 flow; the temperature of S/SL injector and detector (FID) was 280 ℃. A 1 ml headspace syringe was utilized to draw the sample from vial. The column oven was programmed from 120℃ to 280℃ at the rate of 8 ℃ min−1 by the final hold time of 2 min. Sample was injected in split mode, injector and detector temperature being at 250 ℃ and 280 ℃ respectively. The peaks generated in the total ion chromatogram are identified standard reference peaks.

Antioxidants

DPPH (2, 2-diphenyl-1-picrylhydrazyle) method – The antioxidants present in seed were analyzed as suggested.
The antioxidant activity was determined by the ability of extract to scavenge DPPH (2, 2- diphenyl-1- picryl-hydrazyl) radical. This method was described. DPPH is reduced by antioxidant present in the sample. The optical absorbance of this purple coloured solution of DPPH in methanol is measured at 517 nm. This change is detected by the UV spectrophotometer. The reduction of the DPPH radical was determined by measuring the absorption of the resulting oxidised solution at 517 nm against methanol blank. To 1ml of methanol, 3ml of DPPH was added and used as control. Methanol was used as blank. Total Antioxidant capacity of sample by DPPH assay was expressed as Trolox Equivalents mg/100 g sample.

$$\text{Per cent inhibition} = \frac{AC - AE}{AE} \times 100$$

Where
AC - Absorption of control
AE - Absorption of extract or standard

$$\textbf{TAC by DPPH assay TE mg/100g} = \frac{\text{Std. conc. x sample \% inhibition x volume made up x 100}}{\text{Sample \% inhibition x aliquot taken x Sample weight (g) x 1000}}$$

Results and Discussion

The results of the present investigation regarding the response of organic manures on yield and quality parameters have been discussed and interpreted in light of previous research work in India. The results of the experiment are summarized below.

Fresh yield per plot (Kg)

The maximum fresh yield per plot in was recorded in treatment T_{10} (Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha) (26.43 Kg) which was statistically on par with T_6 (Neem cake 1 t/ha) (26.01 Kg) followed by T_8 (Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha) (25.70 Kg). While minimum fresh yield per plot per plant (14.49 Kg) was recorded in T_{11} (Control). The increase in fresh yield might be due to better vegetative growth in terms of plant height, number of branches through different sources per plant and widen plant spread of T_{10} over other treatments. Moreover, it was due to the application of optimum and balanced nutrients through combined

application of FYM, VC and NC, promoted better photosynthetic activity that resulted in increased carbohydrate synthesis. Higher fresh herb yield is also related to higher nutrient uptake and bioactive substances. These results are in accordance with that of Chandana *et al.*, (2018) [2] in Kalmegh, Smitha *et al*., (2019) [15], Teofil Gavric *et al*., (2021) [16] in *Ocimum sps*., Salem (2021) [13] in *Mentha piperita.*

Fresh yield per hectare (q)

The treatment T_{10} (Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha) recorded maximum fresh yield per hectare (132.15 q) which was statistically on par with T_6 (Neem cake 1t/ha) (130.05) and T_8 (Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha) (128.50), whereas treatment T_{11} (Control) recorded minimum fresh yield per hectare (72.45 q). In the present study increased fresh yield per hectare with application of Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha could be attributed to increased plant height, number of branches, plant spread, number of leaves, leaf area and dry matter accumulation with this treatment. Organic manures, which are the rich sources of humus besides promoting higher N-fixation, P-solubilization which have ability to mobilize the nutritionally important elements from non-usable to usable form through biological processes. Higher dry matter accumulation obtained in these treatments might be due to accelerated mobility of photosynthates from the source to the sink as influenced by the growth hormone release or synthesized due to the application of organic manures. The present investigation was in consistent with other reports of Kourosh *et al*., (2011) [8]. Raina *et al*., (2013) [12], Hossain *et al*., (2015) [6] in *Ocimum sps.* Muruganandam (2011) [9] in Ambrette, Umesha *et al*., (2011) [17] in *Solanum nigrum.*

Seed yield per hectare (Kg)

All treatments differed significantly with respect to seed yield per hectare. Among the treatments, T_{10} (Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha) recorded maximum value (630.00 kg), followed by T_6 (Neem cake 1t/ha) (600.00 kg), T_8 (Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha) (510.00 kg), while T_{11} (Control) recorded minimum value (235.00 kg). In the present study, the plants provided with a combination of FYM, VC and NC (T_{10}) recorded the highest seed yield per hectare. Increased seed yield in these treatments could be attributed to good vegetative growth, a greater number of branches, leaves, production of a greater number of inflorescences, which were positively contributed towards seed yield. Moreover, it might be due to application of optimum quantity of different nutrient sources improved soil physical, chemical and biological properties resulted in higher fertilizer use efficiency, ultimately led to more seed yield. The present findings are comparable with that of Daneshian *et al*., (2009) [3] in Sweet basil.

Essential oil ratio (%)

All treatments differed significantly with respect to Essential oil ratio (%). Among the treatments, T_6 (Neem cake 1t/ha) recorded significantly maximum essential oil ratio (%) (0.61%) which was statistically on par with T_5 (Neem cake 500 Kg/ha) (0.59%) and followed by T_8 (Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha) (0.50%), and T_{10} (Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha) (0.55%), while minimum value (0.20%) was recorded in T_{11} (Control). In the present study, the plant supplied with T_6 (Neem cake 1t/ha) recorded significantly the highest essential oil ratio compared to T_{11} (Control) which recorded the least percentage of oil. Increase in essential oil ratio in response to application of Neem cake may be due to enhanced availability of nutrients especially Sulphur (0.2 to 3.0%) which will be the main constituent of terpenes which are responsible for synthesis of essential oils. Furthermore, it has been observed that N favoured the synthesis of many organic compounds such as proteins, enzymes, amino acids etc. the last two substances have a key role in the biosynthesis of many constituents of essential oils (Sarrou *et al*., 2016) [14]. The results confirmed with the findings of Baraa *et al*., (2019) [1] in *Ocimum sps*., Hamed *et al*., (2018) [4] in Pepper mint.

Essential oil yield (Kg/ha)

The results indicated that application of organic manures had significant influence on Essential oil yield. Among the treatments, T_6 (Neem cake 1t/ha) recorded significantly maximum essential oil yield (38.28 kg) followed by T_{10} (Vermicompost 750 Kg/ ha + Farm yard Manure 3.75 t/ha + Neem cake 375 Kg/ha) (34.95 kg), T_5 (Neem cake 500K/ha) (34.89 kg) and with T_8 (Vermicompost 750 Kg/ ha + Neem cake 375 Kg/ha) (33.10 kg), while minimum value (7.70 kg) was recorded in T_{11} (Control). It may be due to the enhance in essential oil yield by using of FYM, VC and NC may be due the higher supply of N, which could lead to higher essential oil yield and dry matter (Pandey and Patra, 2015) [11]. The synthesis of essential oils is dependent on photosynthetic activity. Providing of photosynthetic nutrient boost and metabolic processes correlated to cell division and elongation (Hatwar *et al*., 2003). According to Pandey and Patra (2015) [11] nitrogen plays a key role in the division, growth and development of cells that stimulate essential oil accumulation via higher density of oil glands due to the improvement in biomass yield. Thus, it is useful to combine organic fertilizer or apply in pure form for optimum basil productivity and essential oil yield. Kandeel *et al*. (2002) [7] focused on the effect of organic fertilizers and their combinations on yield and oil composition of basil. They showed that when combined, nitrogen supply increased oil yield (mainly composed by terpenoid-like compounds) compared to plants fertilized with inorganic nitrogen alone.

Composition of essential oil (%)

Non-significant differences were observed among the treatments on this parameter. The major constituent present is Methyl Chavicol with a range of 60.42% to 60.46%. Next compound observed in this majorly was Linalool, followed by Limonene, Methyl Eugenol, Caryophyllene, β elemene and Eugenol.

Antioxidants (%)

Non-significant differences were observed with the application of Vermicompost, Farmyard manure and Neem Cake on this parameter.

Table 1: Effect of Vermicompost, Farmyard Manure and Neem Cake on fresh yield per plot (Kg), fresh yield per hectare (q), seed yield per hectare (Kg), essential oil ratio (%), essential oil yield (Kg) in Sweet basil during Rabi 2020-21

	Fresh yield/ plot (Kg)	Fresh yield/ hectare (q)	Seed yield/ hectare (Kg)	Essential oil ratio (%)	Essential oil yield (Kg/ha)	Antioxidants
Treatments						
T_1= Vermicompost 1 t/ha	19.35	96.75	360.00	0.43	23.93	53.60
T_2 = Vermicompost 2 t/ha	20.67	103.35	380.00	0.48	27.14	53.33
T_3 = Farmyard Manure 5 t/ha	17.34	86.70	320.00	0.30	16.17	52.06
T_4 = Farmyard Manure 10 t/ha	18.93	94.65	350.00	0.35	19.20	54.70
T_5 = Neem Cake 500 kg/ha	24.48	122.24	470.00	0.59	34.89	52.46
T_6= Neem Cake 1 t/ha	26.01	130.05	600.00	0.61	38.28	52.93
T_7= Vermicompost 750 kg/ha + Farmyard Manure 3.75 t/ha	21.39	106.95	405.00	0.42	24.57	54.19
T_8= Vermicompost 750 kg/ha + Neem Cake 375 kg/ha	25.70	128.50	510.00	0.50	33.10	55.10
T_9= Farmyard Manure 3.75 t/ha + Neem Cake 375 kg/ha	22.69	113.45	440.00	0.45	26.91	53.97
T_{10}= Vermicompost 750 kg/ha + Farmyard Manure 3.75 t/ha + Neem Cake 375 kg/ha	26.43	132.15	630.00	0.55	34.95	51.90
T_{11}= Control	14.49	72.45	235.00	0.20	7.70	50.56
S.Em±	0.31	1.44	8.02	0.006	0.50	0.64
CD at 5%	0.95	4.31	24.97	0.018	1.58	NS

Table 2: Effect of vermicompost, farmyard manure and neem cake on composition of essential oil (%) in Sweet basil

	Limonene	Linalool	Methyl Chavicol	Eugenol	Methyl Eugenol	β Elemene	Caryophyllene
Treatments							
T_1= Vermicompost 1 t/ha	5.66	19.30	60.43	0.33	4.01	0.64	0.92
T_2 = Vermicompost 2 t/ha	5.64	19.32	60.44	0.34	4.02	0.63	0.93
T_3 = Farmyard Manure 5 t/ha	5.63	19.30	60.42	0.36	4.00	0.62	0.91
T_4 = Farmyard Manure 10 t/ha	5.63	19.31	60.46	0.34	4.00	0.62	0.93
T_5 = Neem Cake 500 kg/ha	5.64	19.31	60.45	0.35	4.02	0.63	0.94
T_6= Neem Cake 1 t/ha	5.67	19.29	60.46	0.33	4.01	0.64	0.92
T_7= Vermicompost 750 kg/ha + Farmyard Manure 3.75 t/ha	5.67	19.31	60.42	0.36	4.01	0.64	0.91
T_8= Vermicompost 750 kg/ha + Neem Cake 375 kg/ha	5.66	19.30	60.44	0.34	4.00	0.63	0.91
T_9= Farmyard Manure 3.75 t/ha + Neem Cake 375 kg/ha	5.64	19.32	60.43	0.35	4.02	0.62	0.92
T_{10}= Vermicompost 750 kg/ha + Farmyard Manure 3.75 t/ha + Neem Cake 375 kg/ha	5.67	19.30	60.46	0.36	4.02	0.64	0.94
T_{11}= Control	5.63	19.29	60.43	0.33	4.01	0.62	0.93
S.Em±	0.08	0.32	0.97	0.005	0.05	0.007	0.01
CD at 5%	NS	NS	NS	NS	NS	NS	NS

Fig 1: Effect of Vermicompost, Farmyard Manure and Neem Cake on essential oil ratio in sweet basil

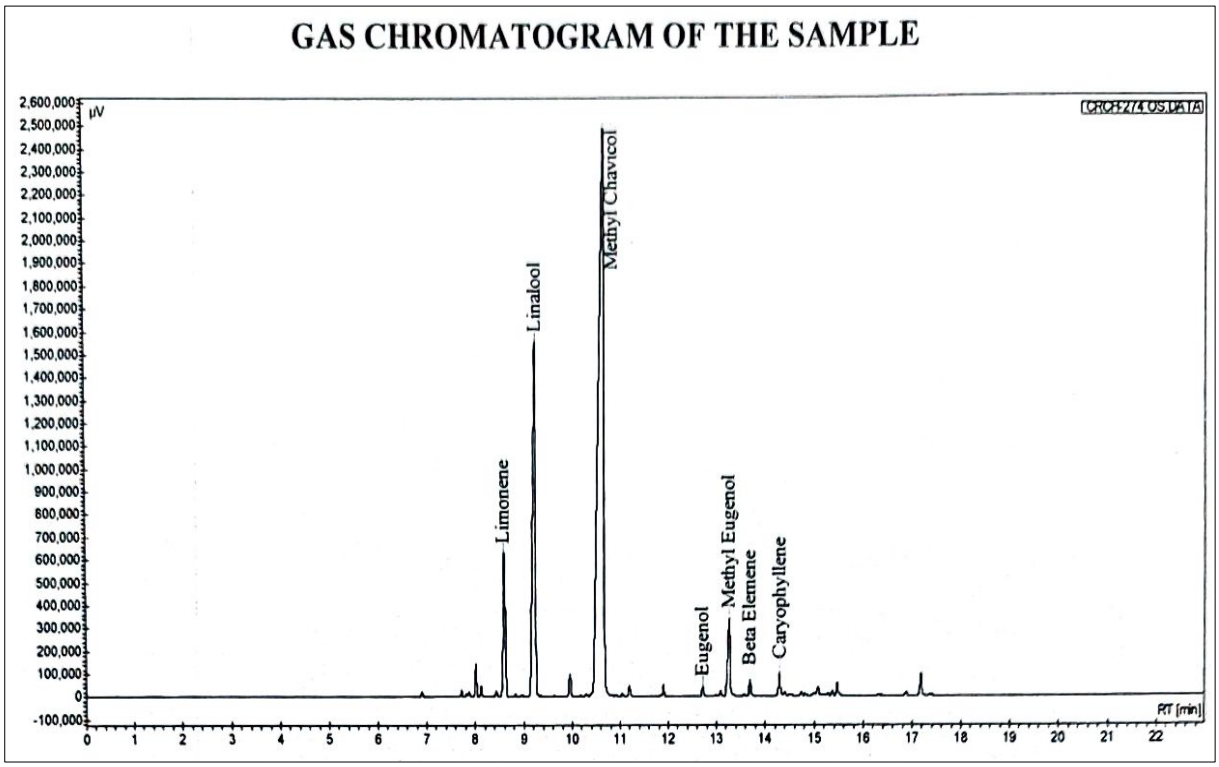

Fig 2: GC for the effect of Vermicompost, Farmyard manure and Neem cake on the essential oil composition of *Ocimum basilicum* plants during Rabi 2020-21

Conclusion

From the studies on different organic manures and there combinations revealed that, the yield and quality of Sweet basil were influenced by different organic manures. The combined application of Farm Yard Manure, Vermicompost and Neem Cake has recorded the best results in terms of yield and quality parameters.

References

1. Baraa Al-Mansour, Vasundhara M. Essential Oil Content and Composition of Sweet Basil (*Ocimum basilicum*. L) Under Integrated Nutrient Management. Global Journal of Agricultural Innovation, Research & Development. 2019;6:38-45.
2. Chandana M, Veena J, Lakshminarayana D, Vijaya D. Effect of organic treatments and spacing on yield parameters of Kalmegh (*Andrographis paniculata*) var. cim-megha. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):1355-1358.
3. Daneshian A, Bilal G, Belgin C, Arif I. Chemical Components of Essential Oils from Basil (*Ocimum basilicum* L.) Grown at Different Nitrogen Levels. International Journal of Natural and Engineering Sciences. 2009;3(3):09-13.
4. Hamed Keshavarz, Seyed Ali Mohammad Modarres Sanavy & Maryam Mahdipour Afra. Organic and Chemical Fertilizer Affected Yield and Essential Oil of Two Mint Species. Journal of Essential Oil Bearing Plants. 2018;21(6):1674-1681.
5. Hatwar GP, Gondane SU, Urkude SM, Gahukar OV. Effect of micronutrients on growth and yield of chili. Soils Crops Journal. 2003;13:123-125.
6. Hossain ME, Haque ANA, Rahman KM, Rahman MA, Karim MR. Combined effect of fertilizer and manures on growth and yield of Tulsi (*Ocimum santum*) and Pudina (*Mentha arvensis*) in Rabi season at Bangladesh agricultural Farming area of Mymensing District. Bangladesh Journal of Environmental Sciences. 2015;28:85-88.
7. Kandeel AM, Naglaa SAT, Sadek AA. Effect of biofertilizers on the growth, volatile oil, yield and chemical composition of *Ocimum basilicum*, L. plants. Annals Agric., Sci., Ain Shams Univ., Cairo. 2002;47(1):351-371.
8. Kourosh Ordookhani, Shahram Sharafzadeh, Mahdi Zare. Influence of PGPR on growth, essential oil and nutrients uptake of sweet basil. Advances in Environmental Biology. 2011;5(4):672-677.
9. Muruganandam, C. Influence of Organic Manures, Consortium Biofertilizer and Bio stimulants On Growth Ambrette (*Abelmoschus Moschatus* Medic.). International Journal of Development. 2011;1(4):5-7.
10. Omid- beigi R. Capabilities in the production of medicinal plants and herbal ways. Proceedings of the First International Conference on Traditional Medicine and Materia Medica, Tehran; c1379. p. 6.
11. Pandey V, Patra D. Crop productivity, aroma profile and antioxidant activity in *Pelargonium graveolens* L. Her. under integrated supply of various organic and chemical fertilizers. Industrial Crops Production Journal. 2015;67:257-263.
12. Raina NS, Rafiq M, Sood KK, Bali AS, Gupta SK, Sehgal S. Growth and yield of *Ocimum sanctum* in response to integrated nutrient management and plant spacing. Indian Journal of Agronomy. 2013;58(1):129-132.
13. Salem M, Al-Amri. Response of growth, essential oil composition, endogenous hormones and microbial activity of *Mentha piperita* to some organic and bio-fertilizers agents. Saudi Journal of Biological Sciences.

2021;28(14-0):5435-5441.
14. Sarrou E, Paschalina C, Theodoros KV, Stavros K. Herbage yield and essential oil composition of sweet basil (*Ocimum basilicum* L.) under the influence of different mulching materials and fertilizers. Journal of Medicinal Plants Studies. 2016;4(1):111-117.
15. Smitha GR, Basaka BB, Thondaimana V, Ajoy S. Nutrient management through organics, bio-fertilizers and crop residues improves growth, yield and quality of sacred basil (*Ocimum sanctum* Linn). Industrial Crops & Products. 2019;128:599-606.
16. Teofil Gavric, Josip Jurkovic, Drena Gadzo, Lejla Cengic, Emina Sijahovic, Fejzo Basic. Fertilizer effect on some basil bioactive compounds and yield. Ciência e Agrotecnologia. 2021;45:3121-3129.
17. Umesha K, Soumya SP, Smitha GR, Sreeramu BS. Influence of organic manures on growth, yield and quality of makoi (*Solanum nigrum* L.). Indian Journal of Horticulture. 2011;68(2):235-239.