

Original Research Article

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## Influence of Organic Manures and Bio-fertilizers on Growth and Yield of Indian Basil (*Ocimum sanctum* L.) cvs Cim-Ayu and Cim-Angana

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### ABSTRACT

The experiment was conducted at Horticulture Research Farm in Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, during 2017-18. The experiment was laid out in factorial R.B.D. with 12 treatments with the following combination viz. T<sub>0</sub>= Control, T<sub>1</sub>= FYM @20t/ha, T<sub>2</sub>= P.S.B @ 20t/ha, T<sub>3</sub>= Vermicompost @6.0 t/ha, T<sub>4</sub>= Neem Cake @ 3.0t/ha, T<sub>5</sub>=Azotobacter @ 6.0 kg/ha + Mycorrhiza @ 6.0 kg/ha, T<sub>6</sub>= FYM @ 10t/ha+ Vermicompost @ 3.0 t/ha, T<sub>7</sub>= Vermicompost @ 3.0 t/ha+ P.S.B @ 10t/ha, T<sub>8</sub>= FYM @ 10t/ha+ Neem Cake @ 1.5t/ha, T<sub>9</sub>= P.S.B @ 10t/ha + Neem Cake @ 1.5t/h, T<sub>10</sub>= FYM @ 10t/ha +P.S.B @ 10t/ha + Neem Cake @ 1.5t/h +Azotobacter, @ 6.0 kg/ha and T<sub>11</sub>= FYM @ 10t/ha +P.S.B @ 10t/ha + Neem Cake @ 1.5t/h +Mycorrhiza@ 6.0 kg/ha with three replications. The cultivar of Indian basil Cim-Ayu and Cim-Angana attained highest plant height per plant (1.17 m and 1.73 m) with T<sub>9</sub> followed by with T<sub>10</sub>, diameter of main stem (1.16 m and 1.71 m) with T<sub>10</sub> followed by (9.49 cm and 9.31 cm) with T<sub>9</sub>, total number of leaves per plant (1608.90 and 1547.90) with T<sub>10</sub> followed by (1524.80 and 1503.00) with T<sub>11</sub>, total number of branch per plant (17.33 and 15.63) with T<sub>10</sub> followed by (17.05 and 16.89) with T<sub>11</sub> and highest plant spread (87.88 cm and 88.74 cm) with T<sub>10</sub> followed by (80.95 cm and 81.44 cm) with T<sub>11</sub>.

### Keywords

Indian basil,  
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### Introduction

Basil was derived from Greek word “Basilica” which means royal plants. Among the *Ocimum* genus is variously known as Sweet basil, French basil or Common basil. The genus *Ocimum* belongs to the family Lamiaceae (Labiatae) which includes about 3500 species among 210 genera and numerous varieties (Blank *et al.*, 2004). It is native to Indian subcontinent, China, South-east Asia

and New Guinea (Kew garden). It was originally domesticated in India. Basil is cultivated over an area of 25,000 ha and it accounts for annual production of about 250-300 tonnes of oil, has been cultivated. *Ocimum sanctum* has widest distribution which covers the entire Indian sub-continent, ascending up to 1800 MSL in the Himalayas and in Andaman and Nicobar Islands. This plant occupies a wide range of habitats. It is an annual herb, cultivated extensively in

Indonesia, Thailand, Vietnam, USA, Cambodia, Laos, the cuisine of Taiwan, France, Egypt, Hungary, Greece, Morocco, Israel and many other regions of the world.

Basil is an erect herbaceous, much branched soft hairy plant with 50-60 cm plant height and has pink and white colour of flowers. Its ecological demands of temperature range between 7- 27<sup>0</sup>C, soil pH 4.3- 8.2 and annual rainfall 0.6- 4.2 mm, different environment condition and planting density causes different growth and yield. The useful parts of basil plant are leaf and seed. The most essential component of basil is essential oil. Essential oil ratio varies between 0.1- 4.55 based on climate conditions. Basil has three forms generally recognized as Rama tulsi with green stems and leaves, Krishna tulsi with green stems and some time leaves are purple in colour and Vana tulsi which is unmodified from its wild form.

Basil has been utilized for its stomachic, expectorant, diuretic, carminative and stimulant property in folk medicine. It is also known to be used as an insecticide, flea and moth repellent and against snake and insect bite. Recently the use of fresh and dry leaves of plant has been very common in food and spice industry. Traditionally, leaves and flower of basil has been used as medicinal plants for various ailments, such as headaches, cough, diarrhea, constipation, warts, warms and kidney malfunction, as well as for carminative, antispasmodic and anti-malarial febrifuge properties. Its essential oil are synthesized and stored in glandular hairs and are used as flavorings in food and beverages, as fragrances as toilet product, such as mouth washes and dental creams, as fungicide, or insecticide in pharmaceutical & industrial products (Mondello *et al.*, 2002).

The essential oils from *Ocimum* genus find diverse uses in perfumery and cosmetic

industries as well as indigenous systems of medicines. The essential oils of basil are extracted via steam distillation from the leaves. Extracted essential oil has also been shown to contain biologically active constituents that are insecticidal, nematocidal and fungicidal. The oil is essential microbial activity. The plant contains mainly phenols, aldehydes, tannins, saponin and fats. Essential oil constitutes Eugenol (71%), Eugenol methyl ether (20%), Methyl Chavicol (3%), Camphor and Methylcinnamates and minor portions of Nerol, Caryophyllene, Selinene,  $\alpha$ -pinene,  $\beta$ -pinene, Camphor, Cineole and linalool etc. Apart from biologically active compounds, such as, volatile oils, terpenes, flavonoids or glycoside are also valuable source of micro and macro elements.

The plant of basil was studied by many researchers to determine yield component, essential oil ratio and composition of essential oil under different ecological conditions, but only a few researches were focused on organic manure and bio fertilizers. Hence, with this background the main aim of present study was focused on evaluation of anti-microbial activity of *Ocimum sanctum* leaf extract in normal tap water and local river water.

Organic Manures plant and animal wastes are used as source of plant nutrients that release nutrients after their decomposition. The art of collecting and using wastes from animal, human and vegetable sources for improving the crop production and productivity is as old as agriculture. The material of organics Manures are derived from animal, human and plant residues which contain plant nutrients in complex organic forms. Naturally occurring or synthetic chemicals containing plant nutrients are called fertilizers. Manures with low nutrient content per unit quantity have longer residual effect besides improving soil physical properties as compared to fertilizers with high nutrient content.

Farmyard manures, its refer to the decomposed mixture of dung and urine of farm animals along with litter and left over material from roughages or other green fed to the farm animals. It contains, on an average well decomposed farmyard manure contains 0.5 percent N, 0.2 percent P<sub>2</sub>O<sub>5</sub> and 0.5 percent K<sub>2</sub>O. Usually, dung and urine of animals along with their litter and waste feed are collected and placed in bench daily and when riled in, it is covered with soil, Farm yard manure seems to act directly for increasing the crop yields either by acceleration of respiratory process with increasing cell permeability and hormonal growth action or by combination of all these processes. It supplies nitrogen, phosphorus, potassium and micronutrients like Fe, S, Mo and Zn etc. in available forms to the plants through biological decomposition and improves physico-chemical properties of soil such as aggregation, aeration, permeability, water holding capacity, slow release of nutrients, and increase in cation exchange capacity and stimulation of soil as flora and fauna.

Neem cake which is obtained from the seed kernels after extraction of the oil is needed for agricultural uses and soap production. Neem cake applications in soil have shown a stimulating effect on the blue-green algal growth, mainly by depressing predator's activity in the soil. Algae biomass was higher in treated soil than untreated situations. Neem cake is the residue obtained after the extraction of oil from neem seed. It contains more nitrogen (2-5%), phosphorus (0.5-1.0%), potassium (1 -2 %) calcium (0.5 -3%), magnesium (0.3 -1 %) sulphur (0.2 % to 3.0 %), zinc (15 ppm to 60 ppm), copper (4 ppm to 20 ppm), manganese (20 ppm to 60 ppm ) than farm yard manure or sewage sludge (Radwanski and Wickens., 1981).

Vermi-compost is organic manure which is produced as the vermicast by earth worm

feeding on biological waste material and plant residues. This compost is an odorless, clean and organic material containing adequate quantities of N, P, K and different micronutrients essential for plant growth. Vermi-compost is eco-friendly, non-toxic and consumes low energy input for composting and is a recycled biological product. Humic acids isolated from vermi-compost enhance the root elongation and formation of lateral roots in maize. Vermi-compost enhance the nutrient uptake by the plants by increasing the permeability of root cell membrane, stimulating root growth and increasing proliferation of root hairs (Pramanik *et al.*, 2007).

The nutrients content in vermi-compost vary depending on the waste materials that are being used for compost preparation. If it is the waste materials are heterogeneous one, there will be wide range of nutrients available in the compost. The common available nutrients in vermi-compost are as follows: Organic carbon 9.5-17.98%, Nitrogen 0.5-1.50 %, Phosphorous 0.1 – 0.30%, Potassium 0.15 – 0.56%, Sodium- 0.06 – 0.30%, Calcium and Magnesium 22.67- 47.60 meq/100g, Copper – 2-9.50 mg kg<sup>-1</sup>, Iron – 2-9.30 mg kg<sup>-1</sup>, Zinc – 5.70-1.50 mg kg<sup>-1</sup>, Sulphur 128-548 mg kg<sup>-1</sup>. It improves physic-chemical properties of the soil and enhances the microbial, crop growth and yield (Vasanthi and Kumaraswamy, 1999).

*Azotobacter* belongs to family *Azotobacteriaceae*, which are aerobic, free living, and heterotrophic in nature. *Azotobacter* is present in neutral or alkaline soils. *A.chroococcum* is the most commonly occurring species in aerable soils. *A. vinelandii*, *A. beijerinckii*, *A.insignis* and *A.macroclytogenes* are other reported species. The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a certain

extent. The population of *Azotobacter* is generally low in the rhizosphere of plants and in uncultivated soils.

Many heterotrophic bacteria and fungi efficiently solubilize insoluble phosphate in the soil as well as the inert phosphorus sources, its bacterial species to solubilise insoluble inorganic phosphate compounds, such as tri-calcium phosphate, dicalcium-phosphate, hydroxyl-apatite and rock-phosphate. Among the bacterial genera with this capacity are *pseudomonas*, *Bacillus*, *Rhizobium*, *Burkholderia*, *Achromobacter*, *Agrobacterium*, *Micrococcus*, *Aereobacter*, *Flavobacterium* and *Erwinia*. There are present in considerable population in soil and in plant rhizospheres. These include both aerobic and anaerobic strains, with a prevalence of aerobic strains in submerged soils. A considerably higher concentration of phosphate solubilizing bacteria is commonly found in the rhizosphere in comparison with non-rhizosphere of soil. The soil bacteria are belonging to the genera. *Pseudomonas* and *Bacillus* and *Fungi* are more common.

The term Mycorrhiza denotes “fungus roots”. It is refer to a symbiotic association between host plants and certain group of fungi at the root system, in which the fungal partner is benefited by obtaining its carbon requirements from the photosynthesis of the host and the host in turn is benefited by obtaining the much needed nutrients especially phosphorus, calcium, copper, zinc etc. which are accessible to it, with the help of the fine absorbing hyphae of the fungus.

These fungi are associated with majority of agricultural crops, except with those crops/plants belonging to families of *Chenopodiaceae*, *Amaranthaceae*, *Caryophyllaceae*, *Polygonaceae*, *Brassicaceae*, *Commelinaceae*, *Juncaceae* and *Cyperaceae*.

## Materials and Methods

The experiment entitled “Influence of organic manures and bio-fertilizers on growth and development of Indian Basil (*Ocimum sanctum* l.) cvs Cim-Ayu and Cim-Angana”. Was conducted during the year 2017-18 under agro-climatic conditions of Prayagraj at the Research Farm, Department of Horticulture, SHUATS, Prayagraj, U.P. Plants with 8-10 cm height, 6-8 leaves and 4 branches were transplanted at spacing on using sandy clay soil.

The physical analysis of the used soil revealed that it was sandy clay loam soil which contained 21 %, 25.75 % and 53.25% clay, silt and sand, respectively. The soil chemical analysis cleared that, it contained the available N, P and K values at 113, 16.10 and 215 Kg/ha respectively. The electric conductivity (EC) was 7.85 (dsm<sup>-1</sup>) with pH of 7.6

The experiment was laid out in factorial randomized block design (F.RBD) with 12 treatment and three replications. The total number of plots for Indian basil was 36. The size of a unit plot was 1.80 m×1.20 m.

## Varieties

V<sub>1</sub>: Cim – Ayu  
V<sub>2</sub>: Cim- Angana

Five plants from each plot were randomly selected and were labeled. These plants were used for recording all observations with respect to growth parameters.

The observation on following growth parameter were recorded and analyzed viz. Plant height (m), Diameter of main stem (cm), Number of Branches per plant, Number of leaves per plant and Plant spread per plant (m).

The treatments were compared with the help of critical difference, following the techniques described by Panse and Sukhatme (1985) and results were evaluated at 5% level of significance.

**Results and Discussion**

The data presented in table 2 clearly showed that the organic manure and bio-fertilizer played significant role in affecting plant height. The maximum plant height was recorded 1.17 m with T<sub>11</sub> in Cim – Ayu and 1.73 in Cim- Angana followed by 1.16 m with T<sub>10</sub> in Cim – Ayu and 1.71 m in Cim- Angana. The minimum of plant height was recorded 1.07 m with T<sub>5</sub> in Cim – Ayu and 1.24 m in Cim- Angana. The results are in close conformity with the finding of Naggar, *et al.*, 2015.

The data presented in table 2 clearly showed that the diameter of main stem was significantly influenced by different organic manures and bio-fertilizers. The maximum diameter was observed in 9.18 cm with T<sub>9</sub> in Cim – Ayu and 9.68 cm in Cim - Angana followed by treatment T<sub>10</sub> 9.49 cm in Cim –

Ayu and 9.31 cm in Cim- Angana while, the lowest diameter of main stem was recorded 7.06 cm with T<sub>5</sub> in Cim–Ayu and 6.91 cm in Cim-Angana.

The data presented in table 2 clearly showed that at 210 DAS, the maximum number of branches/plant was recorded 17.63 with T<sub>11</sub> in Cim–Ayu and 17.19 Cim-Angana followed by 17.33 with T<sub>10</sub> in Cim–Ayu and 17.03 Cim-Angana while the lowest number of branches/plant was recorded 11.34 with T<sub>5</sub> in Cim–Ayu and 11.11 in Cim- Angana. Similar results were observed by Naggar *et al.*, 2015.

The data presented in table 2 clearly showed that the organic manure and bio-fertilizer played significant role in directly affecting number of leaves. The maximum number of leaves per plant was recorded significantly 1608.90 with T<sub>10</sub> in Cim – Ayu and 1547.90 in Cim- Angana followed by 1524.80 with T<sub>11</sub> in Cim – Ayu and 1503.00 in Cim- Angana. The minimum number of leaves was recorded 1247.30 with T<sub>5</sub> in Cim – Ayu and 1229.20 in Cim- Angana. The results were in close conformity with the finding of Rahman *et al.*, (2014).

**Table.1** Treatment details

S. No	Treatment s	Treatment combinations
1.	T <sub>0</sub>	00:00 (Control)
2.	T <sub>1</sub>	FYM @ 20 t/ha.
3.	T <sub>2</sub>	P.S.B @ 20 t/ha.
4.	T <sub>3</sub>	Vermicompost @ 6.0 t/ha.
5.	T <sub>4</sub>	Neem Cake @ 3.0 t/ha.
6.	T <sub>5</sub>	<i>Azotobacter</i> @ 6.0 kg/ha + Mycorrhiza @ 6.0 kg/ha
7.	T <sub>6</sub>	FYM 10 t/ha + Vermicompost @ 3.0 t/ha.
8.	T <sub>7</sub>	Vermicompost @ 3.0 t/ha + P.S.B @ 10 t/ha.
9.	T <sub>8</sub>	FYM 10 t/ha + Neem Cake @1.5 t/ha
10.	T <sub>9</sub>	P.S.B @ 10 t/ha + Neem Cake @1.5 t/ha
11.	T <sub>10</sub>	FYM 10 t/ha + P.S.B 10 t/ha.+ Neem Cake @1.5 t/ha + <i>Azotobacter</i> @ 6.0 kg/ha
12.	T <sub>11</sub>	FYM 10 t/ha + P.S.B 10 t/ha. + Neem Cake @1.5 t/ha + Mycorrhiza @ 6.0 kg/ha.

**Table.2** Influence of organic manures and bio-fertilizers on growth and dry herbage yield of Indian Basil (*Ocimum sanctum* L.) cvs Cim-Ayu and Cim-Angana

Treatments	Height of plant (m)			Diameter of main stem (cm)			No. of Branches/Plant			No. of leaves /Plant			Dry herbage yield/plant (kg)		
	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean	V <sub>1</sub>	V <sub>2</sub>	Mean
<b>T0</b>	1.10	1.47	1.28	7.11	7.06	7.07	12.75	12.33	12.54	1377.50	1349.60	1363.55	2.21	2.11	2.16
<b>T1</b>	1.12	1.52	1.32	7.11	7.06	7.08	14.40	14.33	14.37	1446.20	1380.90	1413.55	2.38	2.31	2.35
<b>T2</b>	1.13	1.65	1.40	8.56	8.04	8.30	16.56	16.33	16.45	1537.40	1486.60	1512.00	3.21	2.89	3.05
<b>T3</b>	1.14	1.63	1.38	7.13	7.39	7.26	13.66	13.52	13.59	1395.30	1374.50	1384.90	2.15	2.19	2.17
<b>T4</b>	1.15	1.61	1.37	7.86	7.23	7.54	15.33	15.13	15.23	1454.30	1432.30	1443.30	2.58	2.43	2.51
<b>T5</b>	1.07	1.42	1.24	7.06	6.91	6.98	11.34	11.11	11.23	1247.30	1229.20	1238.25	1.98	2.03	2.01
<b>T6</b>	1.14	1.57	1.32	7.29	7.91	7.60	14.33	14.05	14.19	1464.10	1347.40	1405.75	2.37	2.09	2.23
<b>T7</b>	1.13	1.58	1.35	8.23	7.51	7.87	15.83	15.36	15.60	1475.50	1430.70	1453.10	2.58	2.52	2.55
<b>T8</b>	1.12	1.66	1.39	8.15	7.67	7.91	14.72	14.66	14.69	1469.90	1389.70	1429.80	2.45	2.32	2.39
<b>T9</b>	1.11	1.69	1.40	9.68	9.47	9.43	16.33	15.74	16.04	1517.20	1475.10	1496.15	2.93	2.75	2.84
<b>T10</b>	1.16	1.71	1.43	9.49	9.31	9.40	17.33	17.03	17.26	1608.90	1547.90	1578.40	3.24	2.96	3.10
<b>T11</b>	1.17	1.73	1.45	9.25	8.85	9.05	17.63	17.19	16.63	1524.80	1503.00	1513.90	3.19	2.88	3.06
<b>Average</b>	1.13	1.60	1.35	8.03	7.88	7.96	15.02	14.62	14.82	1459.87	1412.24	1436.05	2.61	2.46	2.53
	V	T	V x t	V	T	V x t	V	T	V x t	V	T	V x t	V	T	V x t
<b>C.D.(0.05)</b>	0.038	0.015	0.249	0.094	0.231	0.327	0.163	0.399	0.564	16.030	39.265	55.530	0.030	0.072	0.102
<b>SEm±</b>	6.69			6.95			6.59			6.70			7.01		

The data presented in table 2 clearly showed that the maximum dry herbage yield/plant (kg) of Tulsi was significantly influenced by different manures and bio-fertilizer. The maximum dry herbage yield/plant 3.24 kg/plant was obtained with T<sub>10</sub> in Cim – Ayu and 2.96 in Cim- Angana followed by 3.21 kg/plant with T<sub>2</sub> in Cim – Ayu and 2.89 in Cim - Angana. The Minimum dry herbage yield was recorded 1.98 kg/plant with T<sub>5</sub> in Cim – Ayu and 2.03 kg/plant in Cim - Angana. Similar result was observed by Patel and Kushwaha (2013).

In the view of experimental results it is concluded that the treatment T<sub>11</sub> and T<sub>10</sub> were found the best among all treatment combinations for growth and dry herbage yield of Indian basil under organic manures and bio-fertilizers. This result might be due to followings reasons.

Organic manure (FYM + Vermicompost + Neem Cake) and Bio-fertilizers (*Azotobacter* + mycorrhiza + PSB), had articulated impact on growth characters of Indian basil crop. Based on present investigation, it was accounted that the plant height was increased notably with the utilization of Organic manure + bio-fertilizers, at various treatment combinations. The expansion in vegetative growth parameters may be because of the generation of more chlorophyll content with inoculation of nitrogen fixers. The other logical explanation behind increased vegetative growth might be the creation of plant growth regulators by microorganism in rhizosphere, which are absorbed by the roots.

Vemicompost is considered as a rich source of available plant nutrients, growth regulators, enzymes, antifungal and antibacterial compound (Arancon *et al.*, 2004).

*Azotobacter* is one of the most intensively investigated free living nitrogen fixing

bacteria and apart from having ability to fix atmospheric nitrogen it is also known to synthesize biologically active PGRs such as IAA, GA etc. (Yadav *et al.*, 2013).

Besides, mentioned earlier, increased plant height might be due to *Azotobacter* and Mycorrhiza as it influences the nitrogen, which is the chief constituent of protein that is required for the formation of protoplasm that enhances the cell division as well as cell enlargement. The mechanism by which PSB augments plant growth is by dissolution of phosphate (Nowsheen *et al.*, 2006) and through biosynthesis of auxins (Sattar and Gaur, 1987) and Indole Acetic Acid (Bareae *et al.*, 1976).

It also provides protection against non-parasitic root pathogens and transforms the unavailable minerals as well as organic compounds into available forms into the soil, leading to increase in vegetative growth of the plants. This increase in plant height with the application of Organic manure (FYM + Vermicompost + Neem Cake) and Bio-fertilizers (*Azotobacter* + mycorrhiza + PSB), over the span of investigation get the support of Singh and Singh (2002), Nowsheen *et al.*, (2006) and Tripathi *et al.*, 2010. Similar results were also recorded for vegetative growth (plant height, number of branches, leaves numbers, Plant spread by Naggar *et al.*, 2015).

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