Industrial Crops and Products 55 (2014) 225–229

Contents lists available at ScienceDirect

Industrial Crops and Products

journal homepage: www.elsevier.com/locate/indcrop

Integrated nutrient management in Indian basil (*Ocimum basilicum*)

Kambod Singh*, Sukhmal Chand, Mohd. Yaseen

Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow 226015, India

ARTICLE INFO

Article history:
Received 31 July 2013
Received in revised form
20 December 2013
Accepted 9 February 2014
Available online 15 March 2014

Keywords:
Ocimum basilicum
Essential oil
Integrated nutrient management
FYM
Vermicompost
Soil fertility

ABSTRACT

Indian basil (*Ocimum basilicum*), is an economical essential oil producing industrial crop used in flavour and fragrance industries. Integrated nutrient management is an important approach to use the organic manure with optimum level of NPK fertilizers, as it will not only improve the nutrient status, but also sustained the crop yield. Field experiments were conducted at research farm of Central Institute of Medicinal and Aromatic Plants, Lucknow, India during 2009 and 2010 to study integrated nutrient management in Indian basil. Application of 50% inorganic fertilizers (50:20:20 NPK kg ha^{-1}) + 50% farm yard manure (10.0 Mg ha^{-1}) produced significantly higher fresh herb and essential oil yields over other treatments and also increased the organic carbon status, available N, P_2O_5 and K_2O by 0.16%, 62.4, 54.7 and 29.3 kg ha^{-1} in the post harvest soil from their initial values, respectively. The major constituents in the essential oil namely methyl chavicol and linalool did not change significantly due to treatments. Thus it is concluded that combined application of 50% each of inorganic fertilizers (50:20:20 NPK kg ha^{-1}) and FYM (10.0 Mg ha^{-1}) produced significantly higher herb, oil yields and improved the soil fertility.

1. Introduction

Indian basil (*Ocimum basilicum*) is a foliage rich plant of family *Lamiaceae* cultivated throughout the world. Essential oil obtain through hydro distillation of fresh herb is used in flavour and fragrance industries. Besides, oil is also used in several medicinal preparations and also has several insecticidal, nematicidal, fungicidal and antimicrobial properties. It is high value economical and short duration (75–90 days) industrial crop. Presently India is occupying about 60% (3000 ha) of the world's area (5000 ha) while producing 70% (350 t) oil annually against the world's production of about 500 t (Sanganeria, 2010). Continuous use of inorganic fertilizer often lead to unsustainability in crop production and creating deficiency of certain nutrients in the soil and environmental pollution. In response to these concern, there is world wide concerted efforts to use green manuring, legumes and organic manures to produce the same amount of food with less inorganic fertilizer. In India, integrated nutrients supply to plants through organic and inorganic sources is becoming an increasingly important aspect of environmentally sound sustainable agriculture (Meelu et al., 1995). The present study was undertaken to evaluate the effect of combined applications of organic manure (FYM/vermicompost) and inorganic fertilizer (NPK) in different proportions on the yield of Indian basil.

* Corresponding author. Tel.: +91 9450456290; fax: +91 522 2342666.
E-mail addresses: kambods@yahoo.co.in, kambod.singh@cimap.res.in (K. Singh).

http://dx.doi.org/10.1016/j.indcrop.2014.02.009

2. Materials and methods

2.1. Experimental site

A field experiment was carried out for two years 2009 and 2010 during July–October at the research farm of the Central Institute of Medicinal and Aromatic Plants, Lucknow, India, located at 26°5′ N latitude, 80°5′ E longitude with an elevation of about 120 m above mean sea level. The experimental site classified as semi-arid sub-tropical climate with severe hot summers and fairly cool winters. About 80% of the monsoon rains are received during July to September. Winter also experiences some rains due to cyclonic disturbances in Arabic sea. Mean maximum and minimum temperature fluctuated from 24.5 to 44.5 °C and 6.9 to 27.5 °C, respectively. The temperature was lowest during mid December to end of January and an increasing trend in mean temperature was noticed from first week of February and reached to highest in mid May. The soil of the experimental site was sandy-loam (Fluvisol) in texture having pH 8.2 and low in organic carbon (OC) 0.20% and available nitrogen (N) 135 kg ha^{-1}, medium in available phosphorus (P_2O_5) 13.7 kg ha^{-1} and potassium (K_2O) 150 kg ha^{-1}.

2.2. Treatment and experimental design

The treatments consisted of ten different combinations of organic and inorganic fertilizers (Table 1) were laid out in

Table 1
Details combinations of FYM and vermicompost and inorganic fertilizers applied under different treatments.

Treatments	Fertilizer (kg ha^{-1})			Manures (Mg ha^{-1})
	N	P_2O_5	K_2O	
T1	0	0	0	–
T2	100	40	40	–
T3	–	–	–	FYM 20.0
T4	–	–	–	Vermicompost 10.0
T5	75	30	30	FYM 5.0
T6	50	20	20	FYM 10
T7	25	10	10	FYM 15
T8	75	30	30	Vermicompost 2.5
T9	50	20	20	Vermicompost 5.0
T10	25	10	10	Vermicompost 7.5

T1 – control, T2 – N:P_2O_5:K_2O::100:40:40 kg ha^{-1}, T3 – FYM 20.0 Mg ha^{-1}, T4 – vermicompost 10.0 Mg ha^{-1}, T5 – 75% N:P_2O_5:K_2O + FYM at 5.0 Mg ha^{-1}, T6 – 50% N:P_2O_5:K_2O + FYM 10.0 Mg ha^{-1}, T7 – 25% N:P_2O_5:K_2O + FYM 15 Mg ha^{-1}, T8 – 75% N:P_2O_5:K_2O + vermicompost 2.5 Mg ha^{-1}, T9 – 50% N:P_2O_5:K_2O + vermicompost 5 Mg ha^{-1}, T10 – 25% N:P_2O_5:K_2O + vermicompost 7.5 Mg ha^{-1}.

randomized block design with three replications and individual gross and net plot size of 4 × 4 and 3.5 m × 3.5 m, respectively.

2.3. Raising of crops

Raised nursery beds were prepared and FYM @ 2 kg m^{-2} was properly mixed in the soil and seeds were sown in the mid of June using 10 g seeds m^{-2}. To ensure proper germination and growth light irrigations were applied. After primary tillage operations in main fields, full doses of P, K, FYM (0.5% mineralized N, 0.25% P_2O_5 and 0.5% K_2O) and vermicompost (1.0% mineralized N, 0.5% P_2O_5 and 1.0% K_2O) were applied as per treatment and mixed properly manually. Thirty days old healthy seedlings of *O. basilicum* variety CIM-Saumiya were transplanted in the field plots at 45 cm × 30 cm spacing in second week of July 2009 and 2010. Nitrogen in the form of urea was top dressed in two equal splits at 20 and 50 days after transplanting (DAT) as per treatments. Plots were irrigated immediately after transplanting for proper establishment of the crop. All the inter culture operations were done as and when required.

2.4. Essential oil extraction and harvesting of crop

Before harvesting, 200 g fresh plant samples were collected from each plots and were hydro distilled in Clevenger type apparatus. The oil yield was calculated by multiplying the herb yield with oil content and 0.9 (approximate specific gravity of oil). The crop was harvested in mid of October during both the years and fresh herb yield were recorded in each plots.

2.5. Chemical profile of essential oil

The essential oil was analyzed by gas chromatography (Hewlett Packard G.C: H.P 5890) using FID and 15 mm × 0.53 mm, B.P-20 capillary column, oven temperature programmed at 40 and 220 °C @ 5°/min with initial hold of 5 min and hydrogen gas as a carrier at 30 ml/min. Injector and detector temperature were 200 and 240 °C, respectively. Data were processed on an H.P.3396 integrator. Only two major constituents i.e. methyl chavicol and linalool were identified based on retention time of standard compounds.

2.6. Plant and soil sampling and analysis

At the time of harvest representative fresh plant sample of 100 g from each plot was taken. The plant samples were shade dried, oven dried, ground and chemically analyzed for elemental composition following the standard procedures described by Jackson (1973).

After harvest of basil crop, soil samples were collected from three randomly selected sites from 0 to 15 cm depth in each plot. The soil samples were mixed, homogenized, sieved (2 mm) and a composite sample of approximately 500 g was obtained. Samples were dried in shade and stored in plastic bags. Samples were analyzed for organic carbon (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), 0.5 M $NaHCO_3$ extractable P and 1 N ammonium acetate extractable K (Jackson, 1973).

2.7. Statistical analysis

The data recorded were analyzed statistically using the techniques described by Panse and Sukhatme (1985). Critical difference

Table 2
Effect of integrated nutrient management on herb and oil production of Indian basil.

Treatments	Fresh herb yield (Mg ha^{-1})			Essential oil yield (kg ha^{-1})		
	I year	II year	Mean	I year	II year	Mean
T_1	12.12	11.50	11.81	90.9	83.9	87.4
T_2	16.72	16.00	16.36	122.1	115.2	118.7
T_3	19.30	18.60	18.95	140.9	133.9	137.4
T_4	15.94	15.20	15.57	114.8	109.4	112.1
T_5	17.50	16.70	17.10	127.8	120.2	124.0
T_6	21.33	20.45	20.89	157.8	147.2	152.5
T_7	18.63	18.60	18.62	137.9	133.9	135.9
T_8	19.53	18.85	19.19	142.6	135.7	139.2
T_9	20.20	19.50	19.85	147.5	140.4	144.0
T_{10}	15.94	15.20	15.57	132.7	109.4	121.1
CD 5%	1.23	1.16	1.19	9.84	8.35	9.10

T1 – control, T2 – N:P_2O_5:K_2O::100:40:40 kg ha^{-1}, T3 – FYM 20.0 Mg ha^{-1}, T4 – vermicompost 10.0 Mg ha^{-1}, T5 – 75% N:P_2O_5:K_2O + FYM at 5.0 Mg ha^{-1}, T6 – 50% N:P_2O_5:K_2O + FYM 10.0 Mg ha^{-1}, T7 – 25% N:P_2O_5:K_2O + FYM 15 Mg ha^{-1}, T8 – 75% N:P_2O_5:K_2O + vermicompost 2.5 Mg ha^{-1}, T9 – 50% N:P_2O_5:K_2O + vermicompost 5 Mg ha^{-1}, T10 – 25% N:P_2O_5:K_2O + vermicompost 7.5 Mg ha^{-1}.