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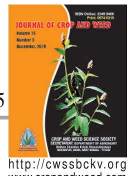

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Organic management of mint (*Mentha arvensis* L.) towards improving productivity and quality

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ABSTRACT

An experiment was conducted at Horticultural Research Station, Mondouri, BCKV, WB during pre-kharif season of two consecutive years (2019-2020 and 2020-2021) to observe the role of organic amendments on yield and quality of mint (Mentha arvensis L.) *under New Alluvial Zone of West Bengal. Twelve treatments viz.* T_1*-100% farmyard manure (30 t ha*$^{-1}$*),* T_2*-100% vermicompost (15 t ha*$^{-1}$*),* T_3*-100% poultry manure (7.5 t ha*$^{-1}$*),* T_4*-100% neem cake (2.5 t ha*$^{-1}$*),* T_5*-50% FYM+ 50% VC,* T_6*-50% FYM + 50% PM,* T_7*-50% VC+50% PM,* T_8*-25 % FYM+25% VC +25% PM + 25% NC,* T_9*-50% FYM+ 50% NC,* T_{10}*-50%VC+ 50% NC,* T_{11}*-50% PM+ 50% NC and* T_{12}*-Control(150:60:60 NPK kg ha*$^{-1}$*) were evaluated in RBD with three replicates. The mean maximum plant height (23.98 cm), number of primary branches plant*$^{-1}$ *(5.52), secondary branches plant*$^{-1}$ *(16.84), leaf length (3.14 cm), leaf width (1.95 cm), spread in North-South (29.33 cm), East-West (29.49 cm), fresh herbage yield (3.38 kg plot*$^{-1}$*), projected fresh herbage yield (125.06 q ha*$^{-1}$*), essential oil content (1.61 ml 100 g*$^{-1}$ *dry leaves), net profit (Rs. 224077 ha*$^{-1}$*) and B:C ratio (2.53:1) were obtained under* T_8*(25% of FYM + 25% of VC +25% of PM + 25% of NC) which proved to be the best performing treatment combination with respect to higher production, profit and reduction in environmental hazards due to use of chemical fertilizers.*

***Keywords*: Essential oil, FYM, growth, mint, organic amendments, B: C ratio

Japanese mint (*Mentha arvensis* L.), belonging to the family Lamiaceae, is grown for its leaves which are widely used as a flavoring agent in various types of confectionaries and pharmaceutical industries. It is mostly grown in tropical and subtropical climates. Menthol and other constituents like terpenes, iso-menthone, menthone, methyl acetate, etc. are present in the essential oil of mint which is widely used in different industries (Gohary *et al*., 2014). It is commonly used for various digestive ailments and is also used for respiratory tract problems like common colds, bronchitis, sore mouth, and throat infections. Use of compost amendments in soil offers many advantages (Stamatiadis *et al*., 1999). Farmyard manure is reported to increase crop yield by metastasis. Vermicompost is a rich source of mineral nutrients, which act as a chelating agent and regulate the supply of metallic micronutrients to plants (Natrajan, 2002). Poultry manure is also reported to be effective against microorganism degradation, but its accessibility remains an important issue because of its voluminous nature, whereas high-value inorganic chemicals are not anymore at the reach of resource-poor farmers (Rahman, 2004). Neem cake is also a very good source of organic nitrogen and other substances, being effective against different pest infestations (Jinsa *et al*., 2012).

Keeping the above facts in view, this experiment was conducted to study the impact of organic amendments on the vegetative parameters, yield parameters, and essential oil content of Japanese mint.

MATERIALS AND METHODS

The present experiment was carried during February–May in two consecutive years (2019-20 and 2020-21) at the Horticultural Research Station, Bidhan Chandra Krishi Viswavidyalaya, Mondouri, Nadia in the New Alluvial Zone of West Bengal, located at 23.5^0 N latitude and 89^{0}E longitude, with an altitude of 9.75 m above the mean sea level. The soil of the experimental field was well-drained clay loam with 52.40% sand, 30.80% silt, and 16.20% clay in the 0-15 cm layer of soil, having soil pH 7.2 with good water holding capacity. Twelve treatments *viz*. T_1-100% farmyard manure (FYM) at 30 t ha^{-1}, T_2-100% vermicompost (VC) at 15 t ha^{-1}, T_3-100% poultry manure (PM) at 7.5t ha^{-1}, T_4-100% neem cake (NC) at 2.5 t ha^{-1}, T_5-50% FYM+ 50% VC, T_6-50% FYM + 50% PM, T_7-50% VC+50% PM, T_8-25 % FYM+25% VC +25% PM + 25% NC, T_9-50% FYM+

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50% NC, T_{10}-50%VC+ 50% NC, T_{11}-50% PM+ 50% NC and T_{12}-control (150:60:60 NPK kg ha^{-1} as recommended dose of fertilisers, RDF) were laid out in a Randomized block design with three replications. Healthy cuttings were prepared from mother plants raised under the nursery during the last week of December. Later healthy cuttings having good roots were uprooted for transplanting in the main field during the first fortnight of February. Experimental plots were demarcated into 36 plots of 1.8 m x 1.5 m dimension with 30 cm wide ridges around the plots. Irrigation channels of 50 cm wide were also made. Twenty cuttings were planted in each plot at a spacing of 45 x 30 cm. Organic amendments and fertilizers were applied in the plots as per treatments just before the transplanting of mint in the experimental plots. Necessary package of practices was followed. Five plants in each plot per replication were tagged to record various characters like the height of plant (cm), primary branches plant^{-1}, secondary branches plant^{-1}, leaf length (cm), leaf width (cm), spread in North-South (cm), and spread in East-West (cm) direction. After four months of planting (end of May), the crop was harvested with the help of sickle. Fresh herbage yield (kg plot^{-1}) and projected fresh herbage yield (q ha^{-1}) were recorded. The harvested leaves as per treatments were oven-dried for 2-3 days. Extraction of essential oil from mint leaves was done under the Clevenger apparatus. The benefit: cost (B:C) ratio was calculated by dividing the net return by the cost of production. Statistical analysis was done as per the standard procedures (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth parameters

The results in Table 1 revealed significantly maximum plant height (22.79 cm), number of mean primary branches plant^{-1} (4.08), secondary branches plant^{-1} (14.69), and plant spread in East-West direction (28.01 cm) and North-South direction (28.12 cm) at 60 days after transplanting (DAT) in T_1, where 100% VC (15 t ha^{-1}) was applied. However, the mean maximum leaf length (2.54 cm) and width (1.82 cm) were significantly higher in T_3 (sole treatment) where 100% PM (7.5 t ha^{-1}) was applied. Maximum plant height (23.03 cm), number of primary branches plant^{-1} (5.29), secondary branches plant^{-1} (16.63), plant spread in East-West direction (28.75 cm), North-South direction (29.03 cm), leaf length (2.90 cm) and width (1.86 cm) at 60 DAT were observed under T_7 (50% VC + 50% PM). The overall mean maximum plant height (23.98 cm), number of primary branches plant^{-1} (5.52) and secondary branches plant^{-1} (16.84) at 60 DAT were found under FYM (25%) + VC (25%) + PM (25%) + NC (25%)as in T_8. The mean maximum plant spread in East-west direction (29.49 cm), North-South direction (29.33 cm), leaf length (3.14 cm), and leaf width (1.95 cm) were observed under T_8. However, the mean least plant height (20.65 cm), number of primary branches plant^{-1} (3.09), secondary branches plant^{-1} (13.71), plant spread in East-west direction (26.44 cm), North-South direction (26.06 cm), length of leaf (2.19 cm) and width of the leaf (1.66 cm) were observed in control plots (T_{12}).

Yield parameters

Data in Table 2 revealed that mean maximum fresh herbage yield (2.97 kg plot^{-1}) and essential oil content (1.40 ml 100 g^{-1} dry leaves) were obtained from T_2 (100% VC). Among the combinations, mean maximum essential oil content (1.54 ml 100 g^{-1} dry leaves) was obtained from T_7 (50% VC +50% PM). Among all the treatments, mean maximum fresh herbage yield (3.38 kg plot^{-1}) and essential oil content (1.61 ml 100 g^{-1} dry leaves) were obtained from T_8.

Economics

Data in Table 2 recorded the mean highest gross return (Rs.312650 ha^{-1}), net return (Rs.224077 ha^{-1}) and B: C ratio (2.53:1) in T_8 treatment (25% of FYM + 25% VC + 25% PM + 25% NC). Application of VC, VC+PM, FYM+ VC+ PM+NC significantly increased the productivity of mint. Vermicompost could ameliorate the plant growth by suppressing the diseases, increasing porosity and microbial activity in the soil, and producing hormones like auxin and gibberellins that might regulate and promote plant growth in the present experiment. Poultry manure, being rich in NPK and calcium, could improve the nutrient status of the soil. Neem cake produced healthy plants as it protected the crops from insects, bacteria, and nematodes and reduced the alkalinity of soil by producing organic acids, and might be compatible with soil microbes and the rhizosphere. FYM, being enriched with all the macronutrients and micronutrients, brought about crop growth and development in a better way. These results were in consonance with the findings of Singh and Shahi (2013). The herbage yield reached to the maximum under the plots treated with VC. Bajeli *et al*. (2015) reported maximum heightof the plant, primary and secondary branches plant^{-1}, and fresh herbage yield under 33% FYM + 33% VC + 33% PM application in *Mentha arvensis* L.. Yaldyz *et al*. (2019) reported that the nutrient content of sweet basil (*Ocimum basilicum* L.) varied significantly due to application of PM, which accumulated higher concentrations of potassium (K) and magnesium (Mg). Prabhu and Shakila (2013) reported

Table1: Impact of organic amendments on growth parameters of mint (pooled data of 2 years)

Treatments	Plant height (cm)		Primary branches plant^{-1}		Secondary branches plant^{-1}		Plant spread in East-West direction (cm)		Plant spread in North-South direction (cm)		Leaf length (cm)	Leaf width (cm)
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	60 DAT	60 DAT
T_1	11.77	21.35	3.00	3.90	7.95	14.62	11.82	27.79	14.09	27.66	2.38	1.81
T_2	12.18	22.79	3.15	4.08	8.11	14.69	12.83	28.01	14.14	28.12	2.39	1.77
T_3	11.46	21.43	3.09	3.90	7.83	14.60	12.09	27.35	13.84	27.50	2.54	1.82
T_4	12.07	21.39	2.96	3.58	7.85	14.11	12.17	26.82	13.47	26.90	2.38	1.80
T_5	12.69	21.34	3.25	4.01	8.34	15.49	12.96	28.36	13.67	28.24	2.84	1.83
T_6	11.96	21.96	3.18	3.87	8.41	16.60	12.33	27.99	14.72	27.80	2.74	1.81
T_7	13.58	23.02	4.06	5.29	8.72	16.63	13.63	28.75	14.75	29.03	2.90	1.86
T_8	14.31	23.98	4.43	5.52	8.82	16.84	13.84	29.49	15.01	29.33	3.14	1.95
T_9	11.74	21.43	3.15	3.92	8.33	15.49	12.00	28.36	14.31	28.36	2.80	1.77
T_{10}	11.80	21.51	3.25	3.99	8.42	16.10	11.79	27.57	14.35	27.61	2.75	1.77
T_{11}	13.50	22.08	3.24	3.99	8.49	15.74	11.64	28.37	14.21	28.59	2.69	1.82
T_{12}	11.16	20.65	2.48	3.09	7.18	13.71	11.05	26.44	13.33	26.06	2.19	1.66
SEm(±)	**0.32**	**0.31**	**0.12**	**0.12**	**0.22**	**0.08**	**0.31**	**0.23**	**0.18**	**0.26**	**0.03**	**0.02**
LSD(0.05)	**1.02**	**0.97**	**0.37**	**0.39**	**0.69**	**0.28**	**0.97**	**0.72**	**0.58**	**0.81**	**0.11**	**0.07**

(T_1-100% FYM 30 t ha^{-1}, T_2-100% VC 15 t ha^{-1}, T_3-100% PM 7.5 t ha^{-1}, T_4-100% NC 2.5 t ha^{-1}, T_5-50% FYM + 50% VC, T_6-50% FYM + 50% PM, T_7-50% VC + 50% PM,T_8-25 % FYM + 25% VC +25% PM + 25% NC, T_9-50% FYM+ 50% NC, T_{10}-50% VC+ 50% NC,T_{11}-50% PM+ 50% NC and T_{12}-Control (150 : 60 : 60 NPK kg ha^{-1}-RDF)

Table 2: Impact of organic amendments on yield, essential oil content and economics of mint (pooled data of 2 years)

Treatments	Fresh herbage (kg plot^{-1})	Yield dry (g plot^{-1})	Projected fresh herbage (q ha^{-1})	Essential oil content (ml 100 g^{-1} dry leaves)	Cost of production (Rs. ha^{-1})	Net profit (Rs. ha^{-1})	Benefit:Cost ratio
T_1	2.78	652.15	108.30	1.38	96698.00	174056.00	1.80: 1
T_2	2.97	763.34	110.23	1.40	96698.00	178892.00	1.85: 1
T_3	2.92	662.85	94.86	1.36	74198.00	202882.00	1.81: 1
T_4	2.54	607.40	94.33	1.35	86698.00	149120.00	1.76: 1
T_5	2.92	728.43	108.16	1.48	96698.00	173702.00	1.80: 1
T_6	2.63	626.15	97.41	1.43	85448.00	158078.00	1.92: 1
T_7	2.98	766.48	110.63	1.54	85448.00	191127.00	2.23: 1
T_8	3.38	803.17	125.06	1.61	88573.00	224077.00	2.53: 1
T_9	2.87	652.88	105.38	1.43	91698.00	171482.00	1.86: 1
T_{10}	2.79	719.04	103.43	1.48	91698.00	166890.00	1.82: 1
T_{11}	2.48	621.19	92.03	1.44	80448.00	149633.00	1.86: 1
T_{12}	1.35	405.50	50.20	1.32	44498.00	81002.00	1.82: 1
SEm(±)	**0.06**	**13.78**	**2.33**	**0.02**	**-**	**-**	**-**
LSD(0.05)	**0.19**	**43.40**	**7.03**	**0.06**	**-**	**-**	**-**

(T_1-100% FYM 30tha-1, T_2-100% VC 15t ha^{-1}, T_3-100% PM 7.5t ha^{-1}, T_4-100% NC 2.5t ha^{-1}, T_5-50% FYM+ 50% VC, T_6-50% FYM + 50% PM, T_7-50% VC+50% PM,T_8-25 % FYM+25% VC +25% PM + 25% NC, T_9-50% FYM+ 50% NC, T_{10}-50% VC+ 50% NC,T_{11}-50% PM+ 50% NC and T_{12}-Control(150:60:60 NPK kg ha^{-1}- RDF)

that vermicompost showed a good yield in Japanese mint. Application of vermicompost improved physical, chemical, and biological properties of soil and increased root activity inside the soil. In a study on the rationalization of FYM and plant spacing in *Mentha piperita* L., Gopichand *et al.* (2012) reported that yield was significantly increased under a highest quantity of FYM (45 t ha^{-1}). The oil content ranged from 0.2 to 0.3%, and application of 45 t FYM ha^{-1} recorded significantly higher content of menthone. Costa *et al.* (2013) reported that application of cattle manure at 9.0 kg m^{-2} and PM at 8.3 kg m^{-2} recorded the highest dry biomass, whereas maximum essential oil yield was recorded with the application of 11.8 kg PM m^{-2}. Mahboobeh *et al.* (2014) reported that 10 t VC ha^{-1}, 10 t urban waste compost ha^{-1}, and 50 t FYM ha^{-1} produced 14.9, 13.9, and 24% more height respectively than inorganic fertilizers in pepper mint (*Mentha piperita* L.). Ghosh *et al.* (2009) recorded maximum plant height, leaf number, primary and secondary branches plant^{-1}, root weight, and individual plant weight under 50% VC + 50% urea as compared to control plots in ashwagandha under the new alluvial zone of West Bengal.

Based on the above findings, it might be concluded that the FYM (7.5 t ha^{-1}) + vermicompost (3.75 t ha^{-1}) + poultry manure (1.875 t ha^{-1}) + neem cake (0.675 t ha^{-1}) would be an effective combination of nutrient sources for achieving higher production, besides ensuring reduced environmental hazards due to negative use of chemical fertilizers.

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