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Rahul Singh Yadav
Research Scholar, Department of Horticulture, Faculty of Agricultural Sciences and Technology A.K.S. University, Sherganj, Satna, Madhya Pradesh, India

Mandwade Vaibhav
Research Scholar, Department of Horticulture, Faculty of Agricultural Sciences and Technology A.K.S. University, Sherganj, Satna, Madhya Pradesh, India

Balaji Vikram
Assistant Professor, Department of Horticulture, Faculty of Agricultural Sciences and Technology A.K.S. University, Sherganj, Satna, Madhya Pradesh, India

Corresponding Author:
Mandwade Vaibhav
Research Scholar, Department of Horticulture, Faculty of Agricultural Sciences and Technology A.K.S. University, Sherganj, Satna, Madhya Pradesh, India

Effect of vermicompost and Biochar on growth, yield and economics of chilli (*Capsicum annum* L.) cv. Kashi Anmol-2

Rahul Singh Yadav, Mandwade Vaibhav and Balaji Vikram

Abstract
A field experiment was conducted during winter season of 2019-20 at the Instructional Farm, A.K.S. University, Satna (M.P.) to study the effect of vermicompost and Biochar on growth, yield and economics of chilli cv. Kashi Anmol-2. It may be concluded that out of the twelve integrated nutrient management treatment, the treatment T_{12} having 100 kg N + 80 kg P + 100 kg K+1 t/ha Vermicompost + 80 kg/ha Biochar emerged as the best treatment for the growth, yield-attributes and yield of chilli var. Kashi Anmol-2 to suit the environmental condition of Satna region the yield was 2.60 t/ha and net income Rs. 155580/ha. However the second and third equally best treatments were T_9 (100 kg/ha N + 80 kg/ha P+1 t/ha Vermicompost + 80 kg/ha Biochar) and T_{10} (100 kg/ha N +100 kg/ha K+ 1 t/ha Vermicompost + 80 kg/ha Biochar). The yield was 2.58 to 2.59 t/ha with net income Rs. 255780 to Rs. 157500/ha.

Keywords: Scholar, vermicompost, chilli cv. Kashi Anmol-2

Introduction
Chilli (*Capsicum annum* L.) is among the largest commercial vegetable (spice) crops in India belonging to the Solanaceae family. Chilli being a heavy feeder and exhaustive crop responds well towards nutrients application. The long-term use of chemical fertilizers is known to degrade physico-chemical and biological properties of soil and soil health. The organic sources of nutrients gaining global importance in crop production and are required to be integrated with chemical fertilizers (Altaf *et al*., 2019) [3]. Vermicompost is a rich source of mineral nutrients and acts as a chelating against and regulates the availability of metallic micronutrients to the plants.

Moreover, in terms of plant growth and soil health, vermicompost plays an important role in improving soil texture, aeration, soil compaction and thus enhances more water and nutrients uptake by plants from their surrounding areas of root zone. There is much evidence that the activity of earthworms accelerates organic matter mineralization, decomposition of polysaccharides, increase the humus in the soil and oppositely reduce the availability of toxic heavy elements to plants (Kashem *et al*. 2015) [1]. Biochar is a carbon-rich organic material and a by-product derived from biomass by the process of pyrolysis under high temperature and low oxygen conditions. It basically involves heating of biomass (such as wood, manure or leaves) with oil and gases a co-products. Looking to all these facts the present research was taken up to boost the productivity of chilli in this region.

Materials and Methods
The experiment was conducted during winter season of 2019-20 at the Instructional Farm, A.K.S. University, Satna (M.P.). The soil of the experimental field was silty clay-loam having pH 7.5, electrical conductivity 0.28 dSm^{-1}, organic carbon 4.5 g kg^{-1}, available N 188 kg ha^{-1}, available P_2O_5 12.5 kg ha^{-1}, and available K_2O 200 kg $^{-1}$. The winter rains received were 2.88 mm. The treatments comprised twelve integrated nutrient management (INM) practices (Table 1). The experiment was laid out in a randomised complete block design with three replications. Seedlings of chilli (Kashi Anmol-2) were transplanted on 10 November, 2019 with 45 x 30 cm distance. The sources of NPK were urea, DAP (Diammoniun phosphate) and MOP (Muriate of Potash), respectively. The NPK were applied in the ratio of 100:80:100, respectively in split doses. At the time of transplanting, half amount of NPK was applied, while the rest amount was applied after 50 days of transplanting.

The vermicompost @ 1 t/ha and Biochar @ 80 kg/ha were applied 15 days before transplanting. The picking of fruits was done thrice during the month of March, 2020.

Results and Discussion

Growth parameters: The data in Table 1 indicate that out of the INM treatments, T_{12} (N_{100} P_{80} K_{100} + 1t VC/ha + 80 kg Biochar /ha resulted in significantly maximum plant height (62.63 cm), leaves 96.24/plant internodal length 6.91 cm and stem diameter 4.48 cm except T_{10} (N_{100} K_{100} + 1t VC/ha + 80 kg Biochar /ha). The third best treatment was T_9 ((N_{100} P_{80} + 1t VC/ha + 80 kg Biochar /ha). This was due to increased supply of essential plant nutrients in optimum quantity during the entire growth period. Moreover the organic sources of nutrients improved soil aeration, root development and increased microbial and biological activities in the rhizosphere. All these beneficial factors available to the crop plant augmented the photosynthates production and their translocation towards the vegetative parts of the plant. These results are in close conformity with those of Veena *et al.* (2017) [8], Reddy *et al.* (2017) [4], Mishra and Dayal (2018) [5] and Kumar *et al.* (2019) [6].

Table 1: Growth and phenological parameters as influenced by INM practices

Treatments		Plant height (cm)	Number of leaves per plant	Internodal length (cm)	Diameter of stem (cm)	Days to first flower appearance	Days to fist fruit appearance	Number of flowers /plant
T_1	Without Fertilizers (Control)	33.72	52.89	5.37	3.53	53.43	58.05	256
T_2	100 kg N + 80 kg Biochar /ha	50.24	76.61	6.02	4.01	45.29	50.17	272
T_3	80 kg P + 80 kg Biochar /ha	40.49	68.28	5.71	3.79	47.03	52.31	263
T_4	100 kg K + 80 kg Biochar /ha	39.67	67.56	5.43	3.67	47.50	52.67	261
T_5	100 kg N + 80 kg P + 100 kg K + 80 kg Biochar/ha	58.86	88.26	6.30	4.25	43.47	48.06	282
T_6	100 kg N + 1 t VC + 80 kg Biochar/ha	57.04	90.71	6.24	4.23	43.65	47.92	278
T_7	80 kg P + 1 t VC + 80 kg Biochar/ha	48.30	76.06	8.83	3.85	46.08	51.58	267
T_8	100 kg K + 1 t VC + 80 kg Biochar/ha	56.67	69.39	5.87	3.98	45.72	49.67	269
T_9	100 kg N + 80 kg P + 1 t VC + 80 kg Biochar/ha	59.06	92.22	6.44	4.31	43.15	47.67	287
T_{10}	100 kg N + 100 kg K + 1 t VC + 80 kg Biochar/ha	59.57	94.78	6.86	4.43	42.39	44.89	290
T_{11}	80 kg P + 100 kg K + 1 t VC + 80 kg Biochar/ha	52.11	84.44	6.21	4.15	4.12	48.14	275
T_{12}	100 kg N + 80 kg P + 100 kg K + 1 t VC + 80 kg Biochar/ha	62.83	96.24	6.91	4.48	40.51	42.62	294
	S.Em+	1.15	1.10	0.32	0.21	1.01	1.10	1.10
	C.D. (5%)	2.39	2.29	0.66	0.44	2.09	2.28	2.27

VC= Vermicompost

Phenological parameters

The best treatment (T_{12}) brought about earliest first flower and fruit appearance by 13 and 15 days, respectively, thereby flowers formation, increased up to 38/plant. This trend was observed in all other treatments which may be owing to varied nutrients composition applied to the crop plants. Consequently vegetative growth period shortened to carry out earthier start of reproductive period, consequently the flowers formation was increased.

Yield attributes, yield and net income

The data in Table 2 apparently indicate that the treatments T_{12}, T_9 and T_{10} continued to be the equally best in yield attributes (31.1 to 33.2% fruits set, 121.8 to 127.5 fruits /plant, 8.69 to 9.74 cm fruit length and 4.17 to 4.21 kg total fruit weight /plant). Consequently the equal yields were obtained (2.58 to 2.60 t/ha). Thus the productivity of chilli was exactly in accordance with the yield attributes under these treatments. The present results agree with those of Chandraprabha *et al*. (2018) [9], Malathi (2019) [7] and Mishra *et al*. (2019) [2].

Amongst the INM treatments having applied higher nutrient levels as in T_5, T_6, T_9, T_{10} and T_{12} treatments gave equal net income (Rs. 150500 to Rs. 157780/ha) with B:C ratio 3.97 to 4.36. The lowest income (Rs. 98400/ha) was noted from the control treatment. The wide differences in net income due to applied INM treatments were owing to the similar differences in their chilli production which fetched the market price up to the same extent. From the results, it may be concluded that the combined applied of vermicompost (1 t/ha) and Biochar (80 kg/ha) with higher doses of NPK proved the best INM treatment for Satna region of Madhya Pradesh.

Table 2: Yield attributes, yield and economics of chilli as influenced by INM practices

Treatments		Fruits set (%)	No. of fruits /plant	Length of fruit (cm)	Total fruit weight (kg/plant)	Yield of chilli (t/ha)	Net income (Rs. /ha)	B:C ratio
T_1	Without Fertilizers (Control)	20.3	84.4	6.23	2.81	1.74	98400	3.41
T_2	100 kg N + 80 kg Biochar /ha	25.2	106.6	7.72	3.57	2.19	132300	4.08
T_3	80 kg P + 80 kg Biochar /ha	22.2	101.3	6.97	3.36	2.07	120880	3.70
T_4	100 kg K + 80 kg Biochar /ha	21.6	97.1	6.95	3.21	2.02	119400	3.83
T_5	100 kg N + 80 kg P + 100 kg K + 80 kg Biochar/ha	29.4	114.2	8.48	4.15	2.56	157780	4.36
T_6	100 kg N + 1 t VC + 80 kg Biochar/ha	28.9	111.7	8.27	4.02	2.48	150500	4.14
T_7	80 kg P + 1 t VC + 80 kg Biochar/ha	23.0	103.3	7.03	3.39	2.10	118280	3.38
T_8	100 kg K + 1 t VC + 80 kg Biochar/ha	24.7	105.8	7.42	3.42	2.11	121600	3.58
T_9	100 kg N + 80 kg P + 1 t VC + 80 kg Biochar/ha	30.6	121.8	8.69	4.20	2.59	155780	4.03
T_{10}	100 kg N + 100 kg K + 1 t VC + 80 kg Biochar/ha	31.1	122.9	9.41	4.17	2.58	157500	4.22
T_{11}	80 kg P + 100 kg K + 1 t VC + 80 kg Biochar/ha	26.4	108.3	8.01	3.58	2.21	126080	3.49
T_{12}	100 kg N + 80 kg P + 100 kg K + 1 t VC + 80 kg	33.2	127.5	9.74	4.21	2.60	155580	3.97

	Biochar/ha							
	S.Em+	0.59	1.19	0.42	0.19	0.12	-	-
	C.D. (5%)	1.22	2.46	0.88	0.40	0.25	-	-

VC= Vermicompost

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