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Assessing INM on sweet pepper (*Capsicum annuum* L.) for productivity, quality, disease incidence and microbiological properties of soil in the mid-hills of Himachal Pradesh

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Abstract

The present investigation was conducted to develop integrated nutrient management system on sweet pepper for higher productivity, quality, disease incidence and microbiological properties of soil. The experiment laid out in RBD comprised of 15 different integrated combinations including a recommended practice, all replicated thrice. The study concluded that the conjoint use of 75 % recommended dose of NP + combined application of Vermicompost and enriched compost @ 2.5 t/ha + PGPR (T_{14}) along with full recommended potash and FYM as basal application resulted in highest pepper fruit yield (371.01 q/ha), TSS (4.94 ^{0}B) and Ascorbic acid content (180.54 mg/100 g) and less than 6.5 percent incidence of diseases. Beside this, the T_{14} also enhanced soil health as envisaged through the enhanced microbiological properties of the soil.

Keywords: Bio-fertilizer; enriched compost; INPS; PGPR; soil health

Introduction

The basic concept underlying the principles is the maintenance and improvement of soil fertility for sustaining crop productivity on a long-term basis, which can be achieved through the combined use of various sources of nutrients and by managing them scientifically for optimum growth, yield and quality of crop. Sweet pepper is one of the most important vegetable grown under open as well as protected condition throughout the world. Sweet pepper (*Capsicum annuum* L.) is a high value solanaceous vegetable crop originated in New World Tropics and subtropics and was introduced to India by the British in the in the 19th century in Shimla hills of Himachal Pradesh (Greenleaf, 1986) [1].

In India, sweet pepper is cultivated over an area of 30 thousand hectares with its annual production of 172 thousand metric tonnes. While in Himachal Pradesh, the area under bell pepper cultivation is 2.07 thousand hectares with annual production of 34.13 metric tonnes (Anonymous, 2016).

Population growth and urbanisation are creating increased demand of food and there is growing concern of malnutrition. To meet the full dietary needs of common man, to eliminate malnutrition, deficiency diseases and to relieve overstress on cereals, there is greater need of enhanced vegetable production.

Use of chemical fertilizer alone increased the crop yield in the initial year but adversely affected the sustainability subsequently. The cost of chemical fertilizers is also increasing day by day. Therefore, to reduce dependence on chemical fertilizers along with sustainable production are vital issues in modern agriculture which can be achieved possible through integrated nutrient supply. Among the various factors of production of vegetables, nutrient management is more important with regard to sustain the production and productivity. Integrated nutrient sources increase the nutrient use efficiently and soil fertility thus enhance the productivity of sweet pepper. In view of the above, the present investigation was conducted to assess the effect of INMS (integrated nutrient management system) on sweet pepper (*capsicum annuum* L.) for productivity, quality, disease incidence and microbiological properties of soil in the mid-hills of Himachal Pradesh.

Materials and Methods

Experiment was carried out at Dr YSP University of Horticulture and Forestry, Nauni Solan, (HP) during the year 2015 to evolve *INPS* system for higher productivity, profitability and soil health. The experiment was laid out in RBD with 03 replicates comprising 15 combinations of inorganic and organics including PGPR viz. T_1: RPF = (RDF (100 N: 75 P: 55 K kg/ha) + FYM 20 t/ha)), T_2: 75 % NP + VC@ 2.5 t/ha, T_3: 50 % NP + VC@ 2.5 t/ha, T_4: 75 % NP + EC@ 2.5 t/ha, T_5: 50 % NP + EC@ 2.5 t/ha, T_6: 75 % NP + PGPR, T_7: 50 % NP + PGPR, T_8: 75 % NP + VC@ 2.5 t/ha + PGPR, T_9: 50 % NP + VC@ 2.5 t/ha + PGPR, T_{10}: 75 % NP + EC@ 2.5 t/ha + PGPR, T_{11}: 50 % NP + EC@ 2.5 t/ha + PGPR, T_{12}: 75 % NP + VC and EC@ 2.5 t/ha, T_{13}: 50 % NP + VC and EC@ 2.5 t/ha, T_{14}: 75 % NP + VC and EC@ 2.5 t/ha + PGPR and T_{15}: 50 % NP + VC and EC@ 2.5 t/ha + PGPR.

Bio-inoculated/un-inoculated seeds/seedlings of sweet pepper cv. 'Solan Bharpur' were soaked in culture broth of bacterium (*Bacillus subtilis*)/ sterilized water in sterilized Petri-plates for 3-4 hours before sowing/transplanting in different growing media as per treatment. Seeds were sown in the nursery on 10^{th} March, and subsequently; seedlings transplanted on 21^{st} April during 2015, respectively in the treatment plots each measuring 3.0 m x 1.8 m, following a spacing of 60 cm x 45 cm. The NPK fertilizers were applied through – Urea, SSP and MOP, respectively. N & P as per treatments and full K were given to all the plots as basal dressing. N was given in three spilt doses, $1/3^{rd}$ as basal dressing and rest further at one month interval. Recommended dose of FYM to all the plots and the other manures (vermicompost (VC) and enriched compost (EC)) as per treatments were incorporated at the time of preparation of individual plot manually. The data were recorded on yield, quality attributes, incidence of *Phytophthora* fruit rot, leaf blight severity along with post-harvest microbiological status (microbial count and microbial activity) of the soil.

Productivity

Yield per plot (kg) and / hectare (q)

On account of transforming per plot yield potential to hectare basis, integrated module T_{14} with an yield outlay of 371.01 q/ha statistically excelled the recommended practice (230.60 q/ha) as well as all the other integrated modules. The treatment combination T_6 (75 % NP + PGPR) even without any compensation by way of any organics (VC and EC) for reduced synthetic content (NP) seems to have worked well as evident through its 2^{nd} highest record of yield (329.30 q/ha) after T_{14}. In general, the increase in yield was more pronounced primarily in vermicompost related modules (T_2, T_8, T_{12}, T_{14}, and T_{15}) vis-a-vis those supplemented with enriched compost (T_4, T_5, T_{10} and T_{11}) with or without bio-inoculants. Overall, seven integrated modules *viz.* T_{14}, T_6, T_8, T_{15}, T_2, T_7 and T_{12} exerted highest positive influence on yield and yielding attributes which significantly surpassed the recommended package (RPF) comprising 100 % inorganic (NPK) along with 20 t/ha FYM (T_1). The increased yield of 60.89, 42.80, 35.25, 32.56, 26.05, 21.91 and 16.15 per cent, respectively was primarily observed through the above modules on account of increase in components of yield.

The findings suggested that reduction of 25 % recommended inorganic (NP) is possible through their substitution primarily with VC and/or bio-inoculation of planting material with plant growth promoting rhizobacteria (*Bacillus subtilis*). Vermicompost (VC) has been shown to have high levels of total and available macro and micro nutrients, microbial and enzyme activities and growth regulators. Arancon *et al.* (2005) confirmed the positive effect of VC on growth and yield of pepper in the field. Increased growth and yield of peppers were attributed to a number of positive effects of application of VC in field soils. One of these is the improvement of the biological properties of soil such as increased microbial biomass and activity and in sustained supply of macronutrients such as phosphorus.

The highest yield of capsicum through treatments supplemented with vermicompost alone or along with enriched compost in the present study could also be the result of regulated liberalization and balanced supply of nutrients, tilting microbial dynamics in favour of growth and creation of salutary soil environmental conditions for crop growth. In addition, besides its better nutrient contents, it could have increased the efficiency of added chemical fertilizers by its temporary immobilization, which reduces leaching of plant nutrients (Das *et al.*, 2006) [8, 9].

Further, the PGPR can provide biologically fixed nitrogen to plants by meeting requirement up to 15-20 kg N/ha and secretes beneficial growth promoting substances like IAA, GA, kinetin, riboflavin, and thiamine, which can result in better plant growth (Malik *et al.*, 2005). Dass *et al.*, (2008) [8, 9]. observed higher number as well fruit weight of bell pepper and consequently the significantly higher yield from the plot treated with 50 % RPF + 5 t/ha VC and 50 % RPF + VC @ 2.5 t/ha + CM @ 5 t/ha than recommended rate of synthetic fertilizers (NPK). Rani *et al*., (2015) also recorded higher green chilli yield on account of higher fruit number and weight when 150 % of recommended dose of nitrogenous fertilizer was sourced half through inorganic and another half from organic sources *viz.* FYM (25 %) and Neem Cake (25 %) as basal and vermicompost as top dressing (50 %). The reasons for increased fruit yield in chilli were attributed to the increased solubilization effect and availability of nutrient by the addition of organics and increased physiological activity leading to the buildup of sufficient food reserves for the developing sinks and better portioning towards the developing fruits.

Quality Characters

In our investigations integration of organic and inorganic alone or in the presence of PGPR inoculation of seed and seedling root dip had significant effect on quality parameters *viz*. total soluble solids and ascorbic acid content. A judicious use of organic manures and bio-organics along with inorganic fertilizers may be effective not only in sustaining crop productivity and soil health but also in supplementing quality composition of the crops. There are several reports which show that the combined and sole application of organic manures and biofertilizers increase yield and influence quality attributes in vegetables (Bahadur *et al*., 2006) [4, 5].

Total soluble solids (^{0}B) and Ascorbic acid (mg/100 g)

Total soluble solids (TSS) content in the fruit is an important quality parameter. In the present study, maximum TSS (4.94 ^{0}B) was recorded through integration of 75 % NP with 2.5 t/ha of combined VC and EC along with *Bacillus* inoculation (T_{14}). In general, all the integrated treatments comprising of inorganic (50 or 75 % N and P) along with organics (EC and VC) alone or in the presence of *Bacillus* inoculation exhibited higher TSS vis-a-vis recommended package of fertilization (4.40 ^{0}B) which utilized 100 % recommended NPK (100:75:55 kg/ha) along with 20 t/ha FYM (T_1). Ascorbic acid content (180.54 mg/100 g) was also recorded highest in T_{14} (75 % NP + VC and EC@ 2.5 t/ha + PGPR). Again, majority of the integrated modules comprising of 50 or 75 % inorganic (N and P) along with organics (EC, and VC) or/and PGPR depicted higher ascorbic acid vis-a-vis T_1 (176.22 mg/100 g), which is a recommended practice utilizing 100 %

recommended NPK (100:75:55 kg/ha) along with 20 t/ha FYM. The obtained results are in accordance with similar reports by Lal and Kanaujia (2013) [12]. in capsicum.

In our study, both TSS and vitamin 'C' were significantly or at least numerically higher in reduced inorganics vis-à-vis larger inorganic doses (75 or 100 %) irrespective of form of organic applied or inoculation or no-inoculation with bacteria. The higher TSS and vitamin 'C' at reduced inorganic may be due to the reason that when a plant is exposed to more of N, it increases protein content and reduces carbohydrates synthesis. Since vitamin 'C' is synthesized from carbohydrates, its level is also reduced. In case of organically managed soils, plant is generally exposed with comparatively lower amount of N and several plant nutrients are released slowly over time. Therefore, organic or predominately organic fed crop would be expected to contain higher vitamin 'C' and less protein (Worthington, (2001) [15]. and Bahadur *et al.*, (2003)).

Disease Incidence

Incidence of Phytophthora fruit rot and Leaf blight severity

The incidence of *Phytophthora* was noted to be less than 6.5 per cent in the present investigation. However, statistically, variations among different modules were significant which ranged between 3.37 (T_{14}) to 6.36 (T_5) as depicted through Table1. Like fruit rot, the leaf blight also appeared to be in a very low proportion (less than 5 %) in different treatments under present study. Primarily, integrated modules comprising of VC and PGPR observed low incidence of both the diseases which may be attributed to the protection provided by vermicompost against various plant diseases and also the secretion of some antibiotics by bio-bacteria (Chaoui, 2002 and Arancon *et al*., 2002) [4, 5].

Microbiological Properties

Total Microbial Count (cfu/g) and Total Microbial Activity (CO_2 evolution/g of soil)

The different integrated modules observed significant variations in bacterial population as evident from the Table 2. The module comprising of 75 % NP + VC and EC @ 2.5 t/ha + PGPR (T_{14}) recorded maximum microbial count (2.94×10^7 cfu/g soil) closely followed by T_8 (2.79×10^7 cfu/g) while minimum microbial count (1.66×10^7 cfu/g) was observed in case of bio inoculated plant population supplied with 50 % of recommended nitrogenous and phosphatic fertilizers (T_7). Overall, except for the treatments T_5, T_7 and T_{13} which noted significantly low microbial count, all the remaining combinations with reduced synthetic fertilizers counted at par with recommended module (T_1) which utilized 100 % of recommended NPK dose along with 20 t/ha FYM. The remarkably high population of bacteria with different organics/PGPR or combination of both with synthetic fertilizers might be due to the fact that the composts are materials with high organic carbon which might have increased porosity, drainage, and water holding capacity leading to the congenial conditions to harbour more microbes (Edwards and Burrows, 1988). Similar improvement in biological properties of soil with organic nutrition has also been reported by Dubey and Agrawal (1999). The superiority of VC related treatment over FYM or EC organic component might be due to its high microbial and enzymic activity as explained by Chaoui *et al*., (2003) leading to high microbial count. The production of CO_2 was measured as indicator of soil microbial activity. The rate of CO_2 evolution in all the modules increased up to 24 hours and then followed a sudden decrease and remains in decreasing trend with further increase in incubation period as evident from the Table 1. The rate of CO_2 evolution was maximum (0.87) under treatment T_{14} while minimum (0.28) was with T_1 after 24 h of incubation period. This might be ascribed to increase in microbial population by conjoint application of bacterium with chemical fertilizers and organic manures.

On the basis of present investigation it is concluded that the crop sown in 21st April with application of 75 % NP + VC and EC @ 2.5 t/ha + PGPR (T_{14}) showed better performance in terms of yield, quality and microbiological status of soil and observed as most promising treatment for sweet pepper under the mid hills of Himachal Pradesh.

Table 1: Effect Integrated Nutrient Management on sweet pepper for fruit yield, TSS, Ascorbic acid, Incidence of *Phytophthora* fruit rot, leaf blight (severity), and Total microbial count and Microbial Activity in sweet pepper rhizosphere

Treatment code	Yield per hectare (q)	TSS (^{0}Brix)	Ascorbic Acid (mg/100 g)	Incidence of Phytophthora fruit rot (%)	Leaf blight (severity)	Total microbial count × 10^7 cfu/g soil	Total Microbial Activity (CO_2 evolution/g soil)			
							12 hrs	24hrs	48hrs	72hrs
T_1	230.60	4.40	177.98	5.31 (2.51)	3.18 (2.04)	2.44	0.26	0.28	0.20	0.16
T_2	290.68	4.60	177.34	5.60 (2.57)	2.83 (1.96)	2.67	0.37	0.42	0.31	0.28
T_3	228.71	4.81	178.49	5.85 (2.62)	3.73 (2.17)	2.60	0.48	0.50	0.40	0.43
T_4	232.44	4.46	176.78	5.29 (2.51)	4.04 (2.24)	2.29	0.42	0.45	0.31	0.29
T_5	221.21	4.74	177.98	6.36 (2.71)	3.70 (2.17)	1.92	0.45	0.48	0.42	0.34
T_6	329.30	4.63	177.46	4.17 (2.27)	2.41 (1.85)	2.55	0.75	0.77	0.73	0.68
T_7	281.13	4.88	179.23	5.20 (2.49)	2.56 (1.89)	1.66	0.56	0.58	0.53	0.43
T_8	305.69	4.52	176.23	3.43 (2.10)	2.71 (1.93)	2.79	0.74	0.76	0.69	0.66
T_9	248.28	4.71	177.80	4.91 (2.42)	3.39 (2.09)	2.62	0.69	0.78	0.64	0.63
T_{10}	235.38	4.57	177.14	5.68 (2.58)	2.88 (1.97)	2.42	0.74	0.80	0.67	0.64
T_{11}	203.58	4.85	178.61	5.08 (2.47)	4.38 (2.32)	2.37	0.78	0.67	0.64	0.62
T_{12}	267.86	4.69	177.61	5.38 (2.52)	2.59 (1.89)	2.26	0.73	0.77	0.65	0.63
T_{13}	229.61	4.79	178.35	5.79 (2.60)	2.23 (1.80)	1.73	0.73	0.75	0.63	0.57
T_{14}	371.01	4.94	180.54	3.37 (2.09)	2.27 (1.81)	2.94	0.86	0.87	0.74	0.70
T_{15}	311.88	4.90	179.65	4.26 (2.29)	2.47 (1.86)	2.48	0.62	0.64	0.57	0.54
Mean	265.82	4.70	178.08	5.05 (2.45)	3.02 (2.11)	2.38				
$CD_{(0.05)}$	26.47	0.17	1.23	0.19	0.13	0.24				

* Figures in the parenthesis are square root transformed values

Refrences

1. Greenleaf WH. Pepper breeding. In: Breeding Vegetable Crops. AVI, West Port, 1986, 67-134.
2. Arancon NQ, Edwards CA, Bierman P, Metzger JD, Lucht C. Effect of vermicompost produced from cattle manure, food waste and paper waste on the growth and yield of peppers in the field. Pedobiologia. 2005; 49(4): 297-306.
3. Arancon NQ, Edwards CA, Yardim E, Lee S. Management of plant parasitic nematodes by applications of vermicomposts. The Brighton Crop Protection Conference – Pest and Diseases. Brighton, London. 8B-2:705-716 Aromatic Crops. 2002; 11(1):58-61.
4. Bahadur A, Singh J, Singh KP, Upadhyay AK, Rai M Effect of organic amendments and biofertilizers on growth, yield and quality attributes of Chinese cabbage (*Brassica pekinensis*). Indian Journal of Agricultural Sciences. 2006; 76(10):596-598.
5. Bahadur A, Singh J, Upadhyay AK, Singh KP Effect of organic manures and biofertilizers on growth, yield and quality attributes of broccoli. Vegetable Science. 2003; 30(2):192-194.
6. Chaoui H, Edwards CA, Brickner A, Lee S, Arancon NQ the BCPC Conference - Pest and Diseases. Brighton, London. 2002; 8B-3, 711-716.
7. Chaoui I, Zibiliske M, Ohno T. Effects of earthworm casts and compost on soil microbial activity and plant nutrient availability. Soil Biology and Biochemistry. 2003; 35:295-302.
8. Das A, Prasad M, Gautam RC, Shivay YS. Productivity of cotton (*Gossypium hirsutum)* as influenced by organic and inorganic sources of nitrogen. Indian J Agri. Sci. 2006; 76:354-357.
9. Dass A, Lenka NK, Patnaik US, Sudhishri S. Integrated nutrient management for production, economics and soil improvement in winter vegetables. Int. J Veg. Sci. 2008; 14(2):104-120.
10. Dubey SK, Agrawal S. Effect of phosphate solubilizing microorganisms as single and composite inoculants on rainfed soybean in Vertisol. Indian Journal of Agricultural Sciences. 1999; 69(8):611-613.
11. Edwards CA and Burrows I. The potential of earthworm composts as plant growth media in Neuhauser, CA (Ed), Earthworms in Environmental and Waste Management, SPB Academic Publishing, The Hague, the Netherlands, 1988, 211-220.
12. Lal S, Kanaujia SP. Integrated nutrient management in capsicum under low cost polyhouse condition. Annals of Hort. 2013; 6(2): 170-177
13. Malik BS, Paul S, Sharma RK, Sethi AP, Verma OP Effect of Azotobacter chroococcum on wheat (*Triticum aestivum*) yield and its attributing components. Indian J Agri. Sci. 2005; 75:600-602.
14. Rani PL, Balaswamy K, Rao AR, Masthan SC. Evaluation of integrated nutrient management practices on growth, yield and economics of green chilli cv. Pusa Jwala (*Capsicum annuum* L.). International Journal of Bio-resource and Stress Management. 2015*;* 6(1):076-080.
15. Worthington V. Nutritional quality of organic versus conventional fruits, vegetables, and grains. J Alternative & Complementary Medicine. 2001; 7(2):161-173.