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RESEARCH ARTICLE

Effectiveness of different pest management modules on plant growth and yield of bell pepper (*Capsicum annuum* L.)

■ **Rinkey Arya and R.S. Rana**

SUMMARY

An investigation was carried out at experimental farm of Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) on bell pepper (*Capsicum annuum* L.) having nine different treatment combinations. The trial conducted in two consecutive years (2018 and 2019) with Randomized Complete Block Design. The experimental results revealed that all the treatment combination performed significantly superior than control. The treatment T_2: Seed treatment with *Trichoderma* spp. @ 10 g/kg seed + vermicompost @ 50 q/ha + *Neem* cake application @ 12g/plant + foliar application of NPV @ 1 g/l once in 7 days (after borers appearance) recorded highest plant height (62.59 cm), higher number of branches per plant (5.77), highest number of fruits per plant (21.02), maximum fruit weight (49.85) and highest fruit yield (1047.73 g/plant, 9.43 kg/plot and 310.44 q/ha) as compared to the control. In overall investigation, the results concluded that the application of *Trichoderma* sp. along with vermicompost, neem cake and NPV gives better results in bell pepper cultivation to obtain higher crop growth and yield.

Key Words : Bell pepper, *Trichoderma* sp., Vermicompost, *Neem* cake, Yield

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Bell pepper (*Capsicum annuum* L.) popularly known as Shimla Mirch which belongs to the family Solanaceae. It is native of Mexico with secondary centre of origin in Guatemala (Heiser and Smith, 1953). Bell pepper was first introduced in India by Britishers in 19th Century in Shimla hills, Himachal Pradesh and Nilgiri hills of Tamil Nadu (Greenleaf, 1986). China, Mexico, Spain, Romania, Italy, Yugoslavia,

Table A : Details of different treatment combinations

Sr. No.	Treatment combinations
T_1	Seed treatment with *Trichoderma* spp. @ 10 g/kg seed + Soil treatment with *Trichoderma* spp. @ 1 kg/q FYM + seedling dip in *Trichoderma* formulation + foliar spray of neem oil @ 3% at 30 and 45 DAT
T_2	Seed treatment with *Trichoderma* spp. @ 10 g/kg seed + vermicompost @ 50 q/ha + *Neem* cake application @ 12g/plant + foliar application of NPV @ 1 g/l once in 7 days (after borers appearance)
T_3	Soil application of *Beauveria bassiana* @ 250 g/25 kg FYM + foliar application (two spray at weekly interval) of *Beauveria bassiana* @ 500 g/100 l of water at the time of appearance of insect pest
T_4	Seed treatment with beejamrit (10%) + soil application with jeevamrit (10%) + foliar spray with neemastra (9%) (20, 35 and 50 DAT)
T_5	Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed + seedling dip in *Trichoderma* formulation + use of delta traps + foliar spray of Emamectin benzoate 5 SG @ 200 ml/ha in 500 l water at flowering and fruiting stage
T_6	Seed treatment with *Pseudomonas fluorescens* @ 10 g/kg seed + use of yellow sticky traps @ 5 traps/100 m^2 + spray of NSKE 5% (2-3 times at 15-20 DAT) + spray of spinosad 45 SC @ 160 ml/ha in 600-700 l of water (after appearance of insect pests)
T_7	Seed treatment with Imidacloprid @ 5 g/kg seed + foliar spray of imidacloprid @ 0.3 ml/l of water at 30 DAT + foliar application of propargite 57 EC @ 2.5 ml/l at 40 DAT + foliar spray of spinosad 2.5 SC @ 0.3 ml/l at 50 DAT
T_8	Seed treatment with Captan @ 2 gm/ kg seed + installing pheromone traps + spray of neem oil @ 3% at 25 DAT + application of Imidacloprid @ 0.5 ml/l, propargite 57 EC @ 2.5 ml/l and quinalphos 25 EC @ 2 ml/l thrice at fortnightly interval
T_9	Control

Bulgaria, USA, Hungary, India, Hong Kongand other European, Central and South American countries are the major capsicum growing countries in the world. In India, it is mainly cultivated in Himachal Pradesh, U.P., J & K, parts of West Bengal, Maharashtra and Karnataka (Chadha, 2005). Capsicum is also used for the treatment of dropsy, colic, toothache, and cholera (Peirce, 1987). Hundred gram of edible portion of capsicum provides 24 k cal of energy, 1.3 g of protein, 4.3 g of carbohydrate and 0.3 g of fat (Anonymous, 2001).

The growers are not in a position to produce good quality bell pepper with high productivity due to various biotic (pest and diseases), abiotic (rainfall, temperature, relative humidity and light intensity) and crop factors (flower and fruit drop). Farmers used to apply minimum of 25 to 30 rounds of pesticide sprays to manage these insect pests. This not only increases the cost of cultivation but often cause problems like resistance to insecticides, resurgence of target insects and secondary pest outbreak. In addition to wide spread killing of non-target organisms, the residues in foods, beverages and contamination of ground water adversely affect human health and environment (Halder *et al*., 2013 and 2014). To overcome these health hazards and environmental problems in the cultivation of crops, there is an urgent need for developing an effective and eco-friendly pest management approach. Organic amendments provide an eco-technological stability in pest management and are a vital component of sustainable agriculture.

MATERIAL AND METHODS

A field experiment was conducted at the research farm of Department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during the year 2018 and 2019. Experiment was laid out on bell pepper cv. Solan Bharpur with Randomized Complete Block Design having nine different treatments. Seeds were treated as per treatment combinations and sown on prepared nursery beds. The healthy seedlings from each treatment were transplanted in main field on different plots (1.80 x 1.35 mt^2) during second fortnight of April with a spacing of 60 cm × 45 cm. The details of different treatments are given in Table A. The observations were recorded different growth and yield parameters *viz*., plant height (cm), number of branches per plant, fruit weight (g), number of fruits per plant, fruit yield per plant (g), fruit yield per plot (kg) and fruit yield per hectare (q) and analyzed statistically.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth parameters:

The analyzed data of two consecutive years presented in Table 1 revealed that all the treatment combinations showed a significant effect on different growth parameters of bell pepper. The results indicated that all the treatment combinations had a significant increase on plant height and number of branches per plant when compared to the untreated control. However, the treatment T_2 having seed treatment with *Trichoderma*

Table 1 : Effect of pest management modules on plant height (cm) and number of branches per plant

Treatments	Plant height (cm)			Number of branches per plant		
	2018	2019	Pooled	2018	2019	Pooled
T_1	64.74	59.12	61.93	5.87	5.40	5.63
T_2	66.17	59.02	62.59	5.73	5.80	5.77
T_3	62.45	57.66	60.06	6.07	5.07	5.57
T_4	65.33	58.90	62.12	5.73	5.67	5.70
T_5	60.74	56.10	58.42	5.60	5.07	5.33
T_6	59.45	53.62	56.53	5.67	4.87	5.27
T_7	57.26	52.85	55.06	5.07	4.87	4.97
T_8	58.93	51.99	55.46	5.07	5.07	5.07
T_9	55.57	49.20	52.39	4.47	4.27	4.37
Mean	61.18	55.38	58.28	5.47	5.12	5.30
C.D. (P=0.05)	Treatment		1.83	Treatment		0.28
	Year		0.41	Year		0.06
	T x Y		NS	T x Y		NS

NS=Non-significant

spp. @ 10 g/kg seed + vermicompost @ 50 q/ha + neem cake application @ 12g/plant + foliar application of NPV @ 1 g/l once in 7 days (after borers appearance) recorded highest plant height and higher number of branches per plant (62.59 cm and 5.77, respectively) followed by in both years as compared to the untreated control *i.e.* T_9 (52.39 cm and 4.37, respectively) whereas, the treatment T_4 having seed treatment with beejamrit (10%) + soil application with jeevamrit (10%) + foliar spray with neemastra (9%) (20, 35 and 50 DAT)] and T_1 having seed treatment with *Trichoderma* spp. @ 10 g/kg seed + Soil treatment with *Trichoderma* spp. @ 1 kg/q FYM + seedling dip in *Trichoderma* formulation + foliar spray of neem oil @ 3% at 30 and 45 DAT) were statistically at par T_2 for plant height and number of branches (62.12 cm, 5.70 and 61.93 cm, 5.63, respectively). The treatment T_3 having soil application of *Beauveria bassiana* @ 250 g/25 kg FYM + foliar application (two spray at weekly interval) of *Beauveria bassiana* @ 500 g/100 l of water at the time of appearance of insect pest was also significantly at par for number of branches per plant. The effect of all the treatments was significantly higher during the trial conducted in 2018 as compared to 2019. However, the interaction between both the years and treatments was non-significant.

The increased plant height and number of branches per plant with vermicompost might be due to the

Table 2 : Effect of pest management modules on number of fruits per plant and average fruit weight (g)

Treatments	Number of fruits per plant			Average fruit weight (g)		
	2018	2019	Pooled	2018	2019	Pooled
T_1	21.69	18.47	20.08	49.57	47.36	48.47
T_2	22.82	19.23	21.02	51.33	48.37	49.85
T_3	21.83	17.69	19.76	48.57	46.73	47.65
T_4	21.99	18.82	20.41	51.67	47.66	49.67
T_5	20.50	17.46	18.98	47.34	45.99	46.67
T_6	19.89	16.18	18.03	47.93	43.73	45.83
T_7	17.98	15.94	16.96	42.47	41.69	42.08
T_8	19.02	16.42	17.72	45.60	41.99	43.80
T_9	13.32	11.97	12.64	38.04	36.66	37.35
Mean	19.89	16.91	18.40	46.95	44.46	45.71
C.D. (P=0.05)	Treatment		1.45	Treatment		1.43
	Year		0.32	Year		0.32
	T x Y		NS	T x Y		NS

NS=Non-significant

availability of macro and micro nutrients at all the stages and enables the plant to consume them throughout their period of growth and development. In addition, vermicompost also contains all the beneficial soil bacteria like *Actinobacteria* sp*., Proteobacteria, Pseudomonas* etc. which helps to promote plant growth (Sinha *et al.,* 2010) while *Trichoderma* especially improves the plant nutrient uptake and its transport from root to aerial parts together with the produced plant stimulators, might result in higher photosynthetic rates required for producing enough energy which is used to derive the enhanced growth response. Similar observations were also reported by Dileep, 2005; Gundannavar *et al.,* 2007; Singh *et al.,* 2014 and Marthandan and Sundarlingam**,** 2016 in chilli. Smitha (2002) also reported the influence of vermicompost and neem cake on different yield attributing characters.

Yield parameters:

The pooled data presented in Table 2 pertaining to number of fruits per plant and average fruit weight revealed that all the treatment combinations performed significantly superior over untreated control. All the treatments resulted in increase in number of fruits per plant and average fruit weight as compared to control. Maximum No. of fruits per plant was 21.02, recorded in T_2 [Seed treatment with *Trichoderma* spp. @ 10 g/kg seed + vermicompost @ 50 q/ha + Neem cake application @ 12g/plant + foliar application of NPV @ 1 g/l once in 7 days (after borers appearance)] which was statistically at par with T_4 (20.41) [Seed treatment with beejamrit (10%) + soil application with jeevamrit (10%) + foliar spray with neemastra (9%) (20, 35 and 50 DAT)], T_1 (20.08) (Seed treatment with *Trichoderma* spp. @ 10 g/kg seed + Soil treatment with *Trichoderma* spp. @ 1 kg/q FYM + seedling dip in *Trichoderma* formulation + foliar spray of neem oil @ 3% at 30 and 45 DAT) and T_3 (19.76) [Soil application of *Beauveria bassiana* @ 250 g/25 kg FYM + foliar application (two spray at weekly interval) of *Beauveria bassiana* @ 500 g/100 l of water at the time of appearance of insect pest]. The average fruit weight was also maximum in treatment T_2 (49.85 g) followed by T_4 (49.67 g) and T_1 (48.47 g). Marthandan and Sundarlingam (2016); Bhat *et al.* (2017), Reddy *et al.* (2017) and Hameedi *et al.* (2018) also reported the similar findings in *Capsicum annuum.* The percentage of fruit set might be due to the immediate availability of nutrients to the plant from inorganic source. Edwards *et al.* (2004) also supported the effect of vermicompost on fruiting of vegetable crops. The increase in number of fruits per plant may be due to better root proliferation with more uptakes of nutrients and water, more photosynthesis and enhanced food accumulation. *Trichoderma* as a seed treatment also improve the plant nutrient uptake and its transport to increase photosynthetic rate in plants. Similar findings were also reported by Wange and Kale (2003) in okra; Dileep and Sasikala (2009); Deshpande *et al.* (2010); Singh *et al.* (2014); Jayanti *et al.* (2014) and Mudidanti *et al.* (2015) in chilli.

The pooled data presented in Table 3 indicated that all the treatment combinations had significantly better performance as compared to control. Highest fruit yield per plant (g), fruit yield per plot (kg) and fruit yield per

Table 3 : Effect of pest management modules on fruit yield per plant, fruit yield per plot and fruit yield per hectare

Treatments	Fruit yield/plant (g)			Fruit yield/plot (kg)			Fruit yield/ha (q)		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1	1069.53	868.55	969.04	9.63	7.82	8.72	316.90	257.35	287.12
T_2	1173.42	922.05	1047.73	10.56	8.30	9.43	347.68	273.20	310.44
T_3	1065.49	826.01	945.75	9.59	7.43	8.51	315.70	244.74	280.22
T_4	1138.88	895.77	1017.32	10.25	8.06	9.16	337.45	265.41	301.43
T_5	964.33	808.47	886.40	8.68	7.28	7.98	285.73	239.55	262.64
T_6	956.80	706.89	831.85	8.61	6.36	7.49	283.50	209.45	246.47
T_7	765.95	666.23	716.09	6.89	6.00	6.44	226.95	197.40	212.17
T_8	874.43	686.44	780.43	7.87	6.18	7.02	259.09	203.39	231.24
T_9	502.03	436.82	469.42	4.52	3.93	4.22	148.75	129.43	139.09
Mean	945.65	757.47	851.56	8.51	6.82	7.66	280.19	224.44	252.31
C.D. (P=0.05)	Treatment		72.25	Treatment		0.65	Treatment		21.41
	Year		16.06	Year		0.14	Year		4.76
	T x Y		NS	T x Y		NS	T x Y		NS

NS=Non-significant

hectare (q) were recorded in treatment combination T_2 (1047.73 g, 9.43 kg and 310.44 q, respectively) followed by treatment combination T_4 (1017.32 g, 9.16 kg and 301.43 q, respectively). However, the treatment T_9 (untreated control) recorded lowest number of fruits per plant (12.64), minimum average fruit weight (37.35 g), lowest fruit yield per plant, fruit yield per plot and fruit yield per hectare (469.42 g, 4.22 kg and 139.09 q, respectively). The effect of all the treatments was significantly higher during the trial conducted in 2018 as compared to 2019 but the interaction effect between years and treatments was found non-significant. Similar observation were also reported by various workers in different crops (Fung *et al*., 1994; Corrales *et al.,*1991; Abd-El-Aty 1997; Sunitha, 2000 and Anitha *et al.,* 2003). This can be attributed to the fact that vermicompost is a rich source of macro and micro nutrients which are released into the soil slowly over a period of time, enabling the plants to consume these nutrients throughout their life cycle. Influence of neem cake and vermicompost on different yield attributing characters and yield is well documented by Smitha (2002). These results also supported by similar findings of Bhat *et al.* (2017) and Reddy *et al.* (2017).

Conclusion:

The application with treatment combination of *Trichoderma* sp. along with vermicompost, neem cake and NPV showed a significant effect on different growth and yield parameters of bell pepper. It is cleared from the present investigation that the vermicompost and *Trichoderma* sp. are effective source of nutrients to increasing the potential to improve crop yield while neem cake and NPV also shows a vital effect on fruit yield by minimizing the fruit damage.

REFERENCES

Abd-El-Aty, S.A. (1997). Influence of some organic fertilizers on growth and yield of pepper plants (*Capsicum annuum* L.) cultivated under plastic houses. M.Sc. Thesis, Faculty, Agriculture, Ain Shams University, Cairo, Egypt. 81p.

Anitha, S, Jyothi, M.L., Narayanan, M.C. and Nari, L. (2003). Evaluation of various organic manures as components in the integrated nutrient management of oriental pickling melon (*Cucumis melo* Var. *conomon*). *Prog. Hort.,* **35**:155-157.

Anonymous (2001). Chilli research and development in India. A Status Report, Indian Institute of Spices Research, Calicut, Kerala, India. 110p.

Bhat, T.A., Wani, K.P., Sheikh, A.A., Mushtaq, F., Asif, M.R., Ejaz, A. and Dar, M.S. (2017). To study effect of organic sources and pruning patterns on growth and yield of sweet pepper (*Capsicum annuum* var. *Grossum*) cv. Shalimar hybrid-2 under protected conditions. *Internat. J. Chemical Studies,* **5** :1771-1774.

Chadha, K.L. (2005). *Handbook of Horticulture*, 368-371 pp.

Corrales, O., Vorgas, E. and Moreira, M.A. (1991). The effect of organic matter on control of root rot in sweet pepper (*Capsicum annuum*) caused by *Phytophthora capsici*. *Agronomic- Costarricense*, **14** : 9-13.

Deshpande, R.P., Soniya, T., Anita, D. and Sujata, D. (2010). Effect of organic and inorganic manures on growth and yield of chilli. *Internat. J. Forestry & Crop Improvement*, **1** : 146-148.

Dileep, S.N. and Sasikala (2009). Studies on the effect of different organic and inorganic fertilizers on growth, fruit characters, yield and quality of chilli (*Capsicum annuum* L.) cv.K-1. *Internat. J. Agric. Sci. & Res.,* **5** : 229-232.

Dileep, S.N. (2005). *Studies on effect of organic manures on the productivity and quality of chilli CV K1,* M.Sc. (Hort) (Doctoral dissertation, Thesis. TNAU, Coimbatore).

Fung, H.C., Kuonan, C.F. and Hsu, K.N. (1994). Effect of organic manures on the growth and yield of sweet pepper. *Bull. Taichung Distt*. *Agricultural Improvement* Station, **42**:1-10.

Greenleaf, W.H. (1986). Pepper Breeding.**In**: *Breeding Vegetable Crops*. M J Bassett ed., AVI, Westport. pp. 67-134.

Gundannavar, K.P., Giraddi, R.S., Kulkarni, K.A. and Awaknavar, J.S. (2007). Development of integrated pest management modules for chilli pests. *Karnataka J. Agric. Sci.,* **20** : 757-760.

Halder, J., Rai, A.B. and Kodandaram, M.H. (2013). Compatibility of neem oil and different entomopathogens for the management of major vegetable sucking pests. *National Academy Science Letters,* **36** : 19-25.

Halder, J., Rai, A.B. and Kodandaram, M.H. (2014). Parasitization preference of Diaeretiella rapae (McIntosh) (Hymenoptera: Braconidae) among different aphids in vegetable ecosystem. *Indian J.*

Agric. Sci., **84** : 1431-1433.

Heiser, C.B. and Smith, P.G. (1953). The cultivated capsicum peppers. *Economic Bot.,* **7**:214-227.

Jayanthi, L., Sekara, J., Ameer, B.S. and Parthasarathi, K. (2014). Influence of vermifertilizer on soil quality, yield and quality of chilli (*Capsicum annuum* L.). *Internat. Interdisciplinary Res. J.*, **4** : 2249-9598.

Marthandan, V. and Sundarlingam, K. (2016). Effect of organic sources of nutrients on growth parameters and seed yield in chilli cv. PKM 1. *Internat. J. Agric. Sci. & Res.,* **6** : 235-240.

Mudiganti, R.K.R, Sathish, K.M. and Neema, K.J. (2015). Comparative yield analysis of chilli (*Capsicum annuum* L.) by application of vermicompost and Panchagavya. *J. Chemical & Pharmaceutical Res.*, **7**: 319- 323.

Peirce, L.C. (1987). Vegetable Characteristics, Production and Marketing. New York, John Wiley and Sons. 325p.

Reddy, G.C., Venkatachalapathi, V., Reddy, G.P.D. and Hebbar, S.S. (2017). Study of different organic manure combination on growth and yield of chilli (*Capsicum annuum* L.). *Plant Archives,* **17** : 472-474.

Singh, C.K, John, S.A. and Jaiswal, D. (2014). Effect of organics on growth, yield and biochemical parameters of chilli (*Capsicum annum* L.). *J. Agric. & Vet. Sci*., **7**:2319-2372.

Sinha, J., Biswas, C.K., Ghosh, A. and Saha, R. (2010). Efficency of vermicompost against fertilizers on Cicer and Pisum and on population diversity of N2 fixing bacteria. *J. Environmental Bio*., **31** : 287-292.

Smitha, A. (2002). Management of yellow mite, *Polyphagotarsonemus latus* (*Banks) (Acari; Tarsonemidae)* on chilli. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Dharwad, India.

Sunitha, N.D. (2000). Insecticidal and growth regulatory activity of vermicompost. Proggrame report for 1999-2000. Agricultural College, Bijapur, University of Agriculture Science, Dharwad, Karnataka, India. *Green Farming*, **4**:42-47.

Wange, S.S. and Kale, R.H. (2003). Response of okra and bitterguard to diazotrophs and graded level of nitrogen. *J. Soils & Crops*, **13** : 271-274.