

Effect of Seed Treatment, Soil Application and Foliar Spray with Some Insecticides on Growth of Bell Pepper (*Capsicum annuum* L.)

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Abstract An experiment was carried out during *kharif* season 2013 to evaluate the effect of seed treatment, soil application and foliar spray with some insecticides on crop growth of bell pepper using cultivar Solan Bharpur. The treatments comprised of seed application of imidacloprid (Gaucho 600FS) @ 12 ml/kg and thiamethoxam (Cruiser 70 WS) @ 10g/kg seed, soil application of neem cake @ 2 q/acre and carbofuran @ 6 kg/acre and foliar sprays of imidacloprid (Confidor 200 SL) @ 0.5 ml/l, thiamethoxam (Actara 25 WS) @ 0.40 g/l, indoxacarb 14.5 SC @ 0.5 ml/l, NSKE (neem seed kernel extract) 5%, neem formulation (Neem raj) @ 2.5 ml/l and control (without any spray). Treatments were imposed as per treatment combinations. Crop was sprayed two times, first after thirty days of transplanting and second after fifteen days of first spray. The results revealed that treatment combination viz., seed treatment and foliar spray with thiamethoxam (S²F²) recorded significantly increased crop growth parameters like

higher plant height at harvest (81.90 cm), number of branches/plant at harvest (7.65), no of ripe fruits/plant (18.88), ripe fruit length (6.70 cm), ripe fruit width (5.38 cm) and also seed yield of crop (714.46 kg) over all other treatment combinations.

Keywords Bell pepper, Foliar spray, Fruit length and width, Plant height, Seed treatment.

Introduction

Bell pepper (*Capsicum annuum* L.) Popularly known as shimla mirch, sweet pepper or capsicum is an important solunaceous vegetable crop grown throughout the world. It is an important vegetarian food because of its high nutritional value, particularly of vitamin-C ranging from 150-180 mg/100 g green bell pepper fruit and vitamin-A constituting up to 12% of total pigment content [1].

Capsicum is native of Mexico with its secondary center of origin in Guatemala [2, 3] and was introduced to Asian continent through Portuguese explorers and in India by the Britishers in the 19th century in Shimla hills. In India, bell pepper is cultivated in an area of about 32 thousand ha with an annual production of about 179 thousand MT [4]. In Himachal Pradesh, it is extensively grown as cash crop (June-October). The mid hills of Himachal Pradesh bestowed with mild climate with humid environmental condition during the summer season are best suited for off season cultivation of bell pepper. There is a good

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demand for its export, however, supply is inadequate due to low productivity of the crop [5].

In bell pepper like other vegetables, the growth and yield are influenced by a number of biotic and abiotic factors. Among the biotic factors insect pests are important of which sucking pests and fruit borers are major pests of bell pepper. Plant protection measures when taken up through seed treatment, soil application and foliar spray are known to manage insect pests effectively. Since there are no such studies on the management of insect pests of bell pepper and their effect on growth and yield, the present studies has been taken up to evaluate the effect of seed treatment, Soil application and foliar spray of different insecticides on growth and seed yield of capsicum.

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Materials and Methods

The field experiment was laid out on 17th April, 2013 at Khaltoo experimental farm, of Department of Seed Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, HP during *kharif*, 2013 in randomized complete block design with three replicates in plots of 2.40 × 2.25 m² with spacing of 60 × 45 cm². FYM and fertilizers were applied as per recommended package of practices (FYM @ 200 quintal/ha, CAN @ 400 kg/ha, SSP @ 475 kg/ha and MOP @ 90 kg/ha).

Treatments consist of two factors viz. seed treatment and soil application (S) with four levels (S₁ - Imidacloprid (Gaucho 600 FS) @ 12 ml/kg – seed treatment, S₂ – Thiamethoxam (Cruiser 70 WS) @ 10 g/kg – seed treatment, S₃ - neem cake @ 2 q/acre - soil application and S₄ - Carbofuran @ 6 kg/acre - soil application) and foliar spray (F) with six levels (F₁ - Imidacloprid (Confidor 200 SL) @ 0.5 ml/l, F₂ - Thiamethoxam (Actara 25 WS) @ 0.40 g/l, F₃ - Indoxacard 14.5 SC @ 0.5 ml/l, F₄ - NSKE (neem seed kernel extract) 5%, F₅ - Neem formulation (Neem Raj

300 ppm) @ 2.5 ml/l and F₆ - Control). There were 24 treatment combinations with three replications. 100 grams of seeds were subjected to each seed treatment. The mixture was shaken, shade dried and kept for 3 days before sowing. Soil applications viz., S₂ (neem cake) and S₄ (carbofuran) were applied directly to the prepared plots in the field @ 270 g/plot (13.5 g/plant) and 8.1 g/plot (0.405 g/plant), respectively at the time of seedling transplantation. The growing crop in the field was sprayed with five foliar spray solutions as per treatment combination first at 30 days after transplanting and second at 15 days after the first spray.

The observations were recorded on five randomly selected plants from each plot of the experiment. The growth characters observed were plant height (at the time of final harvesting), number of branches per plant (at harvest), number of ripe fruits/plant, ripe fruit length, ripe fruit width (cm) (measured with digital vernier caliper) and seed yield. The statistical analysis of the observations was done as per suggested design [6].

Results and Discussion

Plant growth characters are important attributes which determines the final yield of the plants. The different insecticidal treatments viz. seed treatment, soil application and spray individually as well as in combinations showed significant effects on the plant growth characters as depicted in Table 1. Individually, the seed treatment of thiamethoxam (S₂), soil application of neem cake (S₂) and foliar spray of thiamethoxam (F₂) recorded significantly higher plant heights (74.83 cm, 70.01 cm and 78.63 cm, respectively) at the time of final harvesting. The treatment combination seed treatment and foliar spray of thiamethoxam (S₂F₂) recorded significantly higher plant height (81.90) at harvest. This might be due to the extraordinary growth of plants which were not infested with the insects. The whole of the metabolites of the plants diverted to the final growth. These results are in close agreement with the earlier reports that the seed treatment with thiamethoxam increased the plant height, number of leaves and fruiting bodies without any phytotoxic effect [7].

The data on number of branches per plant re-

Table 1. Effect of seed treatments, soil applications and foliar sprays on growth parameters of bell pepper. *Foliar spray (F), ** Seed treatments (S₁) Imidacloprid (Gaucho 600 FS), (S₂) Thiamethoxam (Cruiser 70WS), *** Soil application (S₃) Neem cake, (S₄) Carbofuran (Furadon 3G).

Foliar application* Dose	Plant height				Number of branches				Number of ripe fruits/plant							
	Seed **		Soil ***		Seed		Soil		Seed		Soil					
	S ₁	S ₂	S ₃	S ₄	Mean	treatment	application	Mean	treatment	application	Mean					
F ₁ - Imidactoprid (confidor)	0.5ml/l	77.95	79.91	72.91	75.85	76.65	7.46	7.52	7.40	7.33	7.43	17.70	17.91	17.55	17.05	17.55
F ₂ -Thiamethoxam (actara)	0.40g/l	79.81	81.90	77.95	74.85	78.63	7.51	7.65	7.44	7.39	7.50	17.91	18.88	17.63	17.33	17.94
F ₃ -Indoxacarb (avaunt)	0.5ml/l	70.84	73.85	69.77	68.59	70.76	7.25	7.28	7.20	7.14	7.22	16.77	16.94	16.70	16.49	16.73
F ₄ -NSKE (neem seed kernel extract)	5%	75.71	78.66	73.85	71.85	75.02	7.36	7.44	7.31	7.27	7.35	17.00	17.20	16.80	16.57	16.89
F ₅ -Neem Raj (neem formulation)	2.5ml/l	72.91	73.74	70.74	69.77	71.79	7.32	7.36	7.26	7.20	7.28	16.92	17.24	16.78	16.57	16.88
F ₆ -Control		55.6	60.92	54.84	50.91	55.57	7.13	7.20	7.05	6.94	7.08	12.63	13.26	12.50	12.28	12.67
Mean		72.14	74.83	70.01	68.64	71.40	7.34	7.41	7.28	7.21	7.31	16.49	16.90	16.33	16.05	16.44
CD <i>p</i> = 0.05																
F							0.14					0.02				0.10
S							0.10					0.01				0.08
F*S							0.28					0.04				0.21

Table 1. Continued.

Foliar application*	Dose	Ripe fruit length (cm)					Ripe fruit width (cm)				
		Seed treatment		Soil application		Mean	Seed treatment		Soil application		Mean
		S ₁	S ₂	S ₃	S ₄		S ₁	S ₂	S ₃	S ₄	
F ₁ - Imidactoprid (confidor)	0.5ml/l	6.45	6.52	6.12	6.00	6.27	5.38	5.31	5.25	5.20	5.29
F ₂ - Thiamethoxam (actara)	0.40g/l	6.57	6.70	6.33	6.12	6.43	5.31	5.38	5.27	5.23	5.30
F ₃ -Indoxacarb (avaunt)	0.5ml/l	6.07	6.15	5.89	5.83	5.98	5.15	5.20	5.13	5.02	5.12
F ₄ -NSKE (neem seed kernel extract)	5%	6.42	6.52	6.35	6.22	6.38	5.23	5.28	5.17	5.13	5.20
F ₅ -Neem Raj (neem formulation)	2.5ml/l	6.13	6.20	6.07	6.60	6.25	5.20	5.24	5.13	5.06	5.16
F ₆ -Control		5.88	6.09	5.70	5.65	5.83	4.78	4.88	4.63	4.57	4.71
Mean		6.25	6.37	6.07	6.07	6.19	5.18	5.22	5.10	5.04	5.13
CD <i>p</i> = 0.05											
F						0.10					0.04
S						0.08					0.03
F*S						0.20					0.07

recorded at harvest of crop as influenced by seed treatment, soil application, foliar spray and their interaction are presented in Table 1. Seed treatment with thiamethoxam (S₂) recorded significantly higher number of branches (7.41) per plant at harvest followed by seed treatment with imidacloprid (S₁) 7.34, soil treatment of neem cake (S₃) 7.28 and soil treatment of carbofuran (S₄) 7.21. Foliar spray with thiamethoxam (F₂) recorded significantly higher number of branches

per plant at harvest (7.50), whereas control (F₆) recorded minimum number of branches (7.08). The treatment combination seed treatment and foliar spray of thiamethoxam (S₂F₂) recorded significantly higher number of branches per plant at harvest (7.65). The healthy plants of the bell pepper have extended life and thus produce more number of branches.

Number of fruits per plant is the important char-

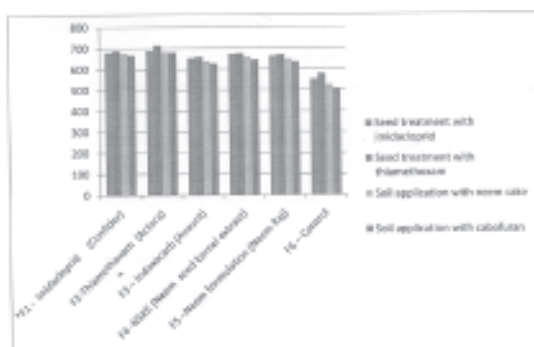


Fig. 1. Effect of seed treatment, soil application and foliar spray of insecticides on seed yield (kg/ha) of bell pepper.

acter which counts for the final yield. Number of ripe fruits per plant differed significantly due to be treatments and their interactions. Seed treatment with thiamethoxam (S_2) recorded significantly higher number of ripe fruits/plant (16.90) followed by seed treatment with imidacloprid (S_1) 16.49, soil application neem cake (S_3) 16.33 and soil application of carbofuran (S_4) 16.05. Foliar spray with thiamethoxam (F_2) recorded significantly higher number of ripe fruits/plant (17.94), whereas, least were recorded with control (F_6) 12.67. The treatment combination seed treatment and foliar spray of thiamethoxam (S_2F_2) recorded significantly higher ripe fruits/plant (18.88). The insect pest free plants grow healthy and produce more number of branches due to extended life which in turn leads to more number of fruits. This increased number of the fruits will contribute to final yield and income of the grower. Seed treatment with imidacloprid at 12 ml/kg resulted in higher number of fruits [8].

Fruit length and width determines the size and weight of the fruit which finally contribute to the yield. Seed treatment with thiamethoxam (S_2) recorded significantly higher ripe fruit length (6.37 cm) followed by seed treatment with imidacloprid (S_1) 6.25 cm, soil application of neem cake (S_3) 6.07 cm and soil application of carbofuran (S_4) 6.07 cm. Foliar spray with thiamethoxam (F_2) recorded significantly higher ripe fruit length (6.43 cm). Next best treatment was neem seed kernel extract (F_4) recording ripe fruit length 6.38 cm followed by imidacloprid (F_1) 6.27 cm, neem formulation (F_5) 6.25 and indoxacarb (F_3) 5.98 cm. The

control without foliar spray (F_6) recorded minimum (5.83 cm) ripe fruit length. The treatment combination viz., seed treatment and foliar spray of thiamethoxam (S_2F_2) recorded significantly higher ripe fruit length (6.70 cm). Healthy and insect pest free plants lead to the production of larger sized fruits thus having more length and width characters. In a study seed treatment with imidacloprid @ 12 ml/kg resulted in maximum fruit length [8].

Similarly, seed treatment with thiamethoxam (S_2) recorded significantly higher ripe fruit width (5.22 cm) followed by seed treatment with imidacloprid (S_1) 5.18 cm, soil application of neem cake (S_3) 5.10 cm and soil application of carbofuran (S_4) 5.04 cm. Foliar spray with thiamethoxam (F_2) recorded significantly higher ripe fruit width (5.30 cm). The treatment interaction viz., seed treatment and foliar spray of thiamethoxam (S_2F_2) recorded significantly higher ripe fruit width (5.38 cm). All the insecticides applied showed significant effect on the growth characters over control but thiamethoxam performed best as seed treatment as well as foliar application. These insecticides effectively controlled the insect pests at various growth stages of the bell pepper and ultimately lead to the healthy crop with better plant growth parameters.

All the treatment combinations gave higher seed yield over indicated quantity (75-100 kg/ha) for bell pepper in the package of practices. Directorate of Extension, Dr YS Parmar University of Horticulture and Forestry, Nauni - Solan. However, the treatment combination seed treatment and foliar spray of thiamethoxam (S_2F_2) recorded significantly higher seed yield (714.46 kg/ha) whereas lowest (506.28 kg/ha) recorded in soil application with carbofuran without any foliar spray (S_4F_6) (Fig. 1). Seed treatments with imidacloprid and thiamethoxam were found effective in controlling leaf hoppers and resulted in higher seed yield in okra [9]. Higher seed yield with imidacloprid @ 12 ml/kg may be attributed to better growth and yield component such as number of fruits and fruit length [8]; whereas, in another study highest yield of green chilli was recorded with thiamethoxam [10].

Conclusion

It can be concluded from the present study that seed

treatment with thiamethoxam (Cruiser) @ 10 g per kg seed and two foliar sprays of thiamethoxam (Actara) @ 0.40 g/l, first spray after thirty days of transplanting and second spray after fifteen days of first spray, were found effective in controlling aphids and resulted better crop growth and seed yield in bell pepper. It may be recommended after multiyear and multi-location trials on bell pepper.

References

1. Vyrodova AP, Andryshenko VK, Zatuliverter VI (1988) Content of beta carotene in various vegetables. *Fiziol Biokhim Kul T Rast* 20 : 167—171.
2. Bukasov SM (1930) The cultivated plants of Mexico, Guatemala and Columbia. *Bul App Bot Gen and Pl Breed* 47 : 261—273.
3. Smith PG, Heiser CB (1957) Breeding behavior of cultivated peppers. *Proceed Am Soc Hort Sci* 10 : 286—290.
4. Anonymous (2015) Area and production estimates for horticulture crops. Nat Hort Bd, Gurgaon, Haryana. www.nhb.gov.in.
5. Brandt K, Mabgaard (2001) Organic agriculture does it enhance or reduce the nutritional value of plant foods. *J Sci Food Agric* 81 : 924—931.
6. Gomez KA, Gomez AA (1984) Statistical procedures for agricultural research. New York John Wiley and Sons, pp 690.
7. Prasanna AR, Bheemanna M, Patil BV (2004) Evaluation of thiamethoxam 70 WS as seed treatment against leaf miner and early sucking pest on hybrid cotton. *Karnataka J Agric Sci* 18 : 238—241.
8. Praveen KS, Sajjan AS, Patil RK, Dharmatti PR, Kurdikeri MB (2007) Influence of seed treatment and foliar spray with insecticides and neem products on growth and seed yield in okra (*Abelmoschus esculentus* L Moench). *Karnataka J Agric Sci* 20 : 388—390.
9. Sajjan SA, Praveen PK (2008) Studies on leaf hopper and fruit borer management as influenced by seed treatment and foliar spray in Bhendi (*Abelmoschus esculentus* L. Moench) seed production. *Agric Sci Dig* 28 : 170—73.
10. Ghosh A, Chatterjee ML, Chakraborti K, Samanta A (2009) Field evaluation of insecticides against chilli thrips (*Scirtothrips dorsalis* Hood). *Ann Pl Protec Sci* 17 : 69—71.