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Effect of some insecticides on aphid population in bell pepper (*Capsicum annuum* L.)

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Abstract

The study was carried out at Department of Seed Science and Technology, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan to evaluate the effect of seed treatment, soil application and foliar spray with some insecticides on aphid population in bell pepper cultivar Solan Bharpur through different methods of applications. The treatments comprised of seed application of imidacloprid (Gaucho 600FS) and thiamethoxam (Cruiser 70WS), soil application of neem cake @ 2 q/acre and Carbofuran @ 6 kg/acre and foliar spray of imidacloprid (Confidor 200 SL), thiamethoxam (Actara 25 WS), indoxacarb @ 0.5ml/l, NSKE (neem seed kernel extract) 5% and neem formulation @ 2.5ml/l. Analysis of variance revealed that seed treatment with thiamethoxam (cruiser) @ 10 g per kg seed and two foliar sprays of thiamethoxam (Actara), (first spray after 30 days of transplanting and second spray after 15 days of first spray) were found effective in controlling aphid population in capsicum and therefore, may be recommended for bell pepper production after multiyear and multi-location trials.

Keywords: aphid population, cultivar, foliar spray, seed application, soil application

Introduction

Bell pepper (*Capsicum annuum* L.) belongs to family solanaceae, popularly known as Shimla Mirch, Sweet pepper or Capsicum is an important vegetable cash crop grown all over the world. It occupies a status of high value crops in the Indian cuisine due to its mild pungent flavour coupled with high content of ascorbic acid, other vitamins and minerals (Agarwal *et al.*, 2007) ^[1]. One hundred grams edible portion of bell pepper provides 24 Kcal of energy, 1.3 g of protein, 4.3 g of carbohydrates and 0.3 g of fat (Rubio *et al.*, 2010) ^[2]. It also finds place in fast food industry like pizza, stuffing, burger etc.

Capsicum was originated in new world tropics and subtropics (Greenleaf, 1986) ^[3] and was brought to India by Portuguese. Britishers in the 19th century introduced bell pepper in Shimla hills. In India, it is commercially grown in Himachal Pradesh, Jammu and Kashmir, Uttarakhand, Arunachal Pradesh and Darjeeling district of West Bengal during summer months and in Maharashtra, Karnataka, Tamil Nadu and Bihar as autumn crop. In Himachal Pradesh, it is extensively grown in open environment and covers an area of about 2.07 thousand ha hectares with production of about 34.13 thousand metric tonnes (Anonymous, 2014) ^[4]. The mid hills of Himachal Pradesh are blessed with mild climatic conditions during the summer season are best suited for off season cultivation of bell pepper.

In bell pepper like other vegetables, the seed yield and yield attributes are mainly affected by a number of biotic and abiotic factors. Among different biotic factors insect pests cause heavy loss to the crop of which sucking pests especially (*M. persicae*) and fruit borers are important which not only affect the seed yield but the seed quality is greatly reduced. Protections measures against these pests when taken up through seed treatment, soil application and foliar spray are known to manage these pests effectively thus enhance the seed yield and quality. Although chemical control of various insect pests of bell pepper for vegetable production is well documented yet very meager literature is available on seed treatment, soil application with synthetic insecticides and the use of botanicals for the management of insect pests and their effect on seed yield and quality are carried out in Himachal Pradesh and elsewhere in India. Considering the above said aspects the study was conducted to evaluate the effect of seed treatment, soil application and foliar spray with some insecticides on aphid population in bell pepper.

Materials and Methods

The present investigations were carried out at Department of Seed Science and Technology, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan, HP during *Kharif*, 2013. The field experiment was laid out in Randomized Block Design with three replicates. The seedlings of bell pepper var. Solan Bharpur were transplanted as per the treatments in a plot having size of 5.4 m² (2.40 m X 2.25 m). FYM and fertilizers were applied as per package of practices for vegetable crops, Directorate of Extension Education, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan (HP) (FYM @ 200 quintal/ha, CAN @ 400 Kg/ha, SSP @ 475 Kg/ha and MOP @ 90 Kg/ha).

Treatments and method of application

Seed treatment: 100 grams of each seed sample was subjected to two seed treatments viz., S₁ (Imidacloprid-Gaucho 600FS) and S₂ (Thiamethoxam-Cruiser 70WS). The chemical solution was directly poured onto 100 g of seeds placed in plastic container. After 3 days, the treated seeds were ready for nursery application.

Soil treatment: it comprised of two treatments viz., S₃ (Neem cake) and S₄ (carbofuran). Neem cake and 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.

Foliar spray: the growing crop in the field was sprayed with five foliar solutions as per treatment combination per replication first at 30 days after transplanting and second at 15 days after the first spray. The foliar treatment consist of viz., F₁ (Imidacloprid) @ 0.5ml/l, F₂ (Thiamethoxam-Actara 25 WS) @ 0.40 ml/l, F₃ (Indoxacarb) @ 0.5ml/l, F₄ (NSKE) @ 5 per cent and F₅ (Neem formulation) @ 2.5ml/l. The aphid population was recorded from three leaves from upper, middle and bottom parts of five randomly selected plants from three replications of each treatment combination and averaged to work out aphid population per plant. The statistical analysis of the data recorded was carried out as per

design of the experiment as suggested by Gomez and Gomez (1984).

Results and Discussion

Foliar spray of imidacloprid

First spray: The highest mean reduction in aphid population per plant after first foliar spray of imidacloprid (Table 1) was recorded in plots having seed treatment with thiamethoxam (76.94%) followed by seed treatment with imidacloprid (72.28%) and soil application of neem cake (70.54%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of imidacloprid was the highest on day 3 (76.38%). Interaction effect showed that on day 3 after the first spray of imidacloprid the highest reduction (82.59%) in aphid population per plant was recorded in plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (76.43%).

Second spray: In the second spray of imidacloprid (Table 1), highest reduction in aphid population was recorded in the plots with seed treatment of thiamethoxam (85.40%) followed by the seed treatment with imidacloprid (82.61%) and the soil application of neem cake i.e. 81.79. Irrespective of the soil and seed treatments, the per cent reduction in aphid population after the second foliar spray of imidacloprid was the highest on day 3 (82.95%). Among the interactions, on day 3 after the second spray of imidacloprid the highest per cent of reduction 85.88 per cent over control in aphid population was recorded in the plots having of seed treatment with thiamethoxam followed by the seed treatment with imidacloprid (83.05%).

These results are in agreement with the findings of Mandi and Senapati (2009) [6] who reported that the seed treatment with thiamethoxam and imidacloprid were effective in controlling maximum reduction of sucking pests in okra, chilli and other crops. The results are also in close conformity with earlier reports that the neonicotinoids thiamethoxam and imidacloprid are the most effective insecticides against many aphid species including *M. persicae* (Kandakoor, 2013) [8].

Table 1: Effect of seed treatment, soil application and foliar spray of imidacloprid (Confidor) on aphid population after first spray (30 days after transplanting) and second spray (15 days after first spray) in bell pepper

Seed Treatment and Soil Application	Dose	Per cent reduction over control in the indicated days after the first spray of confidor (30 days after transplanting)			Mean	Per cent reduction over control in the indicated days after the second spray of confidor (15 days after first spray)			Mean
		3 DAT*	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT	
**S ₁ - Imidacloprid (Gaucho 600FS)	12ml/kg	76.43 (60.93)	72.30 (58.22)	68.11 (55.60)	72.28 (58.25)	83.05	82.98	81.80	82.61
S ₂ -Thiamethoxam (Cruiser 70WS)	10g/kg	82.59 (65.31)	76.72 (61.13)	71.52 (57.72)	76.94 (61.39)	85.88	85.68	84.65	85.40
S ₃ -Neem Cake	2q/ acre	74.07 (59.36)	70.18 (56.88)	67.38 (55.15)	70.54 (57.13)	82.38	81.98	81.00	81.79
S ₄ -Carbofuran (Furadan)	6kg/acre	72.45 (58.32)	70.15 (56.86)	63.52 (52.82)	68.71 (56.00)	80.49	80.45	79.39	80.11
Mean		76.38 (60.98)	72.34 (58.27)	67.63 (55.32)	72.12 (58.19)	82.95	82.77	81.71	82.48
CD _{P=0.05}									
Treatment					0.18				0.12
Day					0.23				0.16
T*D					0.39				0.28

Values in parentheses are transformed

*DAS (day after spray)

**S₁, S₂- Seed treatment, S₃, S₄-Soil application

Foliar spray of thiamethoxam

First spray: The highest mean reduction in aphid population per plant after first foliar spray of thiamethoxam (Table 2) was recorded in plots having seed treatment with thiamethoxam (81.27%) followed by seed treatment with imidacloprid (76.19%) and soil application of neem cake (73.99%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of thiamethoxam was the highest on day 3 (79.36%). The interactions revealed that on day 3 after first spray of thiamethoxam the highest percent reduction (84.11%) over control in aphid population per plant was recorded in the plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (78.11%).

Second spray: In the same spray of thiamethoxam the highest mean reduction in aphid population (Table 2) was recorded in plots with seed treatment of thiamethoxam (88.40%) followed

by the seed treatment with imidacloprid (84.05%) and soil application of neem cake (81.60%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of thiamethoxam was highest on day 3 (84.53%). Interaction effect showed that on 3 day after the second spray of thiamethoxam the highest per cent reduction (88.90%) over control in aphid population was recorded in the plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (84.93%).

These results are in conformity with Iqbal *et al.* (2009) [9] who found that imidacloprid was most effective and resulted in minimum population of whitefly. Raj and Parihar (2013) [10] reported that imidacloprid 75% WS, acetamiprid 20 per cent SP and thiamethoxam 75 per cent WS were significantly superior in efficiency against thrips up to 15 DAS against *S. dorsalis* in chilli.

Table 2: Effect of seed treatment, soil application and foliar spray of thiamethoxam (Actara) on aphid population after first spray (30 days after transplanting) and second spray (15 days after first spray) in bell pepper

Seed Treatment and Soil Application	Dose	Per cent reduction over control in the indicated days after the first spray of thiamethoxam (30 days after transplanting)			Mean	Per cent reduction over control in the indicated days after the second spray of thiamethoxam (15 days after first spray)			Mean
		3 DAT*	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT	
**S ₁ - Imidacloprid (Gaucho 600FS)	12ml/kg	78.11 (62.08)	75.34 (60.20)	75.13 (60.06)	76.19 (60.78)	84.93	83.82	83.41	84.05
S ₂ -Thiamethoxam (Cruiser 70WS)	10g/kg	84.11 (66.48)	79.89 (63.33)	79.81 (63.27)	81.27 (64.36)	88.90	88.48	87.81	88.40
S ₃ -Neem Cake	2q/ acre	80.83 (64.01)	70.68 (57.27)	70.46 (57.06)	73.99 (59.44)	82.51	81.40	80.87	81.60
S ₄ -Carbofuran (Furadan)	6kg/acre	74.41 (59.58)	67.23 (55.06)	66.77 (54.77)	69.47 (56.47)	81.78	81.47	80.79	81.35
Mean		79.36 (63.04)	73.29 (58.96)	73.04 (58.79)	75.23 (60.27)	84.53	83.79	83.22	83.85
CD _{P=0.05}									
Treatment					1.13				0.17
Day					1.45				0.22
T*D					2.52				0.38

Values in parentheses are transformed

*DAS (day after spray)

**S₁, S₂- Seed treatment, S₃, S₄-Soil application

Foliar spray of indoxacarb

First spray: The highest mean reduction in aphid population per plant after first foliar spray of indoxacarb (Table 3) was recorded in the plots having seed treatment with thiamethoxam (71.13%) followed by the seed treatment with imidacloprid (68.16%) and soil application of neem cake (64.54%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of indoxacarb was the highest on day 3 (75.05%). On day 3 days after the first spray of indoxacarb the highest percent reduction (75.66%) over control in aphid population per plant was recorded in the plots having seed treatment with thiamethoxam followed by the seed treatment with imidacloprid (71.75%).

Second spray: In the second spray of indoxacarb (Table 3), the highest reduction in aphid population was recorded in plots with seed treatment of thiamethoxam (83.30%) followed by seed treatment with imidacloprid (81.28%), soil

application of neem cake (81.07%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after the second foliar spray of indoxacarb was the highest on day 3 (82.40%). Interactions revealed that on day 3 after the second spray of indoxacarb the highest per cent reduction of 84.66 per cent over control in aphid population was recorded in the plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (82.56%).

Ghosh *et al.* (2009) reported that thiamethoxam 25 WSG, acetamiprid 20 SP, fipronil 5 SC and clothianidin 50 WGD were significantly reduced the thrips population along with reduction of curly leaves. He further added that thiamethoxam was highly effective in reducing thrips population followed by acetamiprid sprays. Similar views were also given by Raj and Parihar (2013) [10] who observed that imidachloprid 75 WS, acetamiprid 20 SP and thiamethoxam 75 WS were significantly superior in efficacy against *S. dorsalis* up to 15 DAT in chilli.

Table 3: Effect of seed treatment, soil application and foliar spray of indoxacarb (Avant) on aphid population after first spray (30 days after transplanting) and second spray (15 days after first spray) in bell pepper

Seed Treatment and Soil Application	Dose	Per cent reduction over control in the indicated days after the first spray of indoxacarb (30 days after transplanting)			Mean	Per cent reduction over control in the indicated days after the second spray of indoxacarb (15 days after first spray)			Mean
		3 DAT*	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT	
**S ₁ - Imidacloprid (Gaucho 600FS)	12ml/kg	71.75 (57.87)	67.03 (54.93)	65.72 (54.14)	68.16 (55.65)	82.56	81.48	79.79	81.28
S ₂ -Thiamethoxam (Cruiser 70WS)	10g/kg	75.66 (60.42)	69.02 (56.16)	68.72 (55.98)	71.13 (57.52)	84.66	82.97	82.28	83.30
S ₃ -Neem Cake	2q/ acre	68.55 (55.87)	63.18 (52.62)	61.88 (51.86)	64.54 (53.45)	82.19	80.69	80.33	81.07
S ₄ -Carbofuran (Furadan)	6kg/acre	65.87 (54.23)	58.41 (49.82)	57.44 (49.26)	60.57 (51.10)	80.18	80.03	78.76	79.65
Mean		75.05 (60.09)	68.89 (56.08)	66.54 (54.64)	70.16 (56.94)	82.40	81.29	80.29	81.33
CD _P =0.05									
Treatment					0.88				0.36
Day					1.14				0.47
T*D					1.97				0.81

Values in parentheses are transformed

*DAS (day after spray)

**S₁, S₂- Seed treatment, S₃, S₄-Soil application

Foliar spray of NSKE

First spray: The highest mean reduction in aphid population per plant after first foliar spray of NSKE (Table 4) was recorded in the plots having seed treatment with thiamethoxam (73.90%) followed by seed treatment with imidacloprid (70.21%), and soil application of neem cake (68.68%). Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of NSKE was recorded highest on day 3 (75.05%). Interaction among the treatment showed that on 3 days after the first spray of NSKE highest percent reduction (81.41%) in aphid population per plant was recorded in plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (75.20%).

Second spray: In the second spray of NSKE (Table 4), the highest reduction in aphid was recorded in plots with seed treatment of thiamethoxam (83.00%) followed by the seed

treatment with imidacloprid (78.80%) and soil application of neem cake (77.67%). Irrespective of the soil application and seed treatments, the per cent reduction in aphid population after the second foliar spray of NSKE was the highest on day 3 (80.39%). On day 3 after the second spray of NSKE the highest per cent reduction of 83.75 per cent over control in aphid population was recorded in the plots having seed treatment with thiamethoxam followed by seed treatment with Field experiments with tomato showed that fermented plant extracts of neem and wild garlic, alone or in combination, have insecticidal properties to maintain lower population densities of whitefly and aphid. All parts of neem contain bitter compounds (Chawla *et al.*, 1995) [12] and therefore these either kill or repel the insects. Further Varghese and Giradi (2005) [13] reported that the application of neem cake (0.5 t/ha) with 50% RDF significantly lower density of chilli thrips comparable to chemical control. These reports are corroborated with the present findings.

Table 4: Effect of seed treatment, soil application and foliar spray of NSKE on aphid population after first spray (30 days after transplanting) and second spray (15 days after first spray) in bell pepper

Seed treatment and soil application	Dose	Per cent reduction over control in the indicated days after the first spray of NSKE (30 days after transplanting)			Mean	Per cent reduction over control in the indicated days after the second spray of NSKE (15 days after first spray)			Mean
		3 DAT*	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT	
**S ₁ - Imidacloprid (Gaucho 600FS)	12ml/kg	75.20 (60.11)	69.0 (56.20)	66.34 (54.52)	70.21 (56.94)	80.59	78.53	77.28	78.80
S ₂ -Thiamethoxam (Cruiser 70WS)	10g/kg	81.41 (64.44)	71.24 (57.55)	69.04 (56.17)	73.90 (59.38)	83.75	83.25	82.01	83.00
S ₃ -Neem Cake	2q/ acre	71.54(57.73)	67.89 (55.46)	66.62 (54.68)	68.68 (55.96)	78.72	78.17	76.13	77.67
S ₄ -Carbofuran (Furadan)	6kg/acre	72.06 (58.07)	67.34 (55.13)	64.15 (53.20)	67.85 (55.46)	78.50	76.45	75.21	76.72
Mean		75.05 (60.09)	68.89 (56.08)	66.54 (54.64)	70.16 (56.94)	80.39	79.10	77.66	79.05
CD _P =0.05									
Treatment					0.23				0.12
Day					0.30				0.15
T*D					0.52				0.26

Values in parentheses are transformed

*DAS (day after spray)

**S₁, S₂- Seed treatment, S₃, S₄-Soil application

Foliar spray of neem formulation (Neem Raj)

First Spray: The highest mean reduction in aphid population per plant after first foliar spray of neem formulation (Neem Raj) (Table 5) was recorded in plots recorded having seed treatment with thiamethoxam (73.86%) followed by seed

Treatment with imidacloprid (69.20%) and soil application of neem cake i.e. 68.68%. Irrespective of the soil and seed treatments, the per cent reduction in aphid population after foliar spray of neem formulation (Neem Raj) was the highest on day 3 (73.71%). Interaction revealed that on day 3 after the

first spray of neem formulation (Neem Raj) the highest per cent reduction (80.47%) over control in aphid population per plant was recorded in plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (73.97%).

Second spray: In the second spray of Neem Raj (Table 5), the highest reduction in aphid population was recorded with seed treatment of thiamethoxam (81.86%) followed by the seed treatment with imidacloprid (78.68%) and soil application of neem cake (75.05%). Irrespective of the soil and seed treatments, the per cent reduction in aphid

population after the second foliar spray of neem formulation (Neem Raj) was the highest on day 3 (79.26%). Interaction effect revealed that on day 3 after the second spray of neem formulation (Neem Raj) the highest per cent reduction of 82.51 per cent over control in aphid population was recorded in the plots having seed treatment with thiamethoxam followed by seed treatment with imidacloprid (79.73%).

Vergheese and Giraddi (2005) [13] reported that soil application of neem cake @ 500 kg/ha reduced chilli thrips *Scirtothrips dorsalis* Hood and yellow mite *Polyphagotarsonemus latus* (Banks) in chilli.

Table 5: Effect of seed treatment, soil application and foliar spray of Neem Raj on aphid population after first spray (30 days after transplanting) and second spray (15 days after first spray) in bell pepper

Seed Treatment and Soil Application	Dose	Per cent reduction over control in the indicated days after the first spray of Neem Raj (30 days after transplanting)			Mean	Per cent reduction over control in the indicated days after the second spray of Neem Raj (15 days after first spray)			Mean
		3 DAT*	7 DAT	10 DAT		3 DAT	7 DAT	10 DAT	
		**S ₁ - Imidacloprid (Gaucho 600FS)	12ml/kg	73.97 (59.30)		67.35 (55.13)	66.26 (54.47)	69.20 (56.30)	
S ₂ -Thiamethoxam (Cruiser 70WS)	10g/kg	80.47 (63.75)	71.30 (57.59)	69.79 (56.64)	73.86 (59.32)	82.51	81.88	81.19	81.86
S ₃ -Neem Cake	2q/ acre	70.71 (57.21)	65.19 (53.82)	64.75 (53.55)	66.88 (54.86)	77.79	74.69	72.67	75.05
S ₄ -Carbofuran (Furadan)	6kg/acre	69.68 (56.56)	63.73 (52.95)	63.33 (52.71)	65.58 (54.07)	77.00	73.50	72.21	74.24
Mean		73.71 (59.21)	66.89 (54.87)	66.03 (54.34)	68.88 (56.14)	79.26	77.08	76.03	77.46
CD _{P=0.05}									
Treatment					0.12				0.21
Day					0.15				0.27
T*D					0.26				0.47

Values in parentheses are transformed

*DAS (day after spray)

**S₁, S₂- Seed treatment, S₃, S₄-Soil application

Conclusion

Seed treatment with thiomethoxam (cruiser) @10 g per kg seed and two foliar sprays of thiomethoxam (Actara), (first spray after 30 days of transplanting and second spray after 15 days of first spray) were found effective in controlling aphid population in capsicum and therefore, may be recommended for bell pepper production after multiyear and multi-location trials.

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