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BIOEFFICACY OF NEWER INSECTICIDES AGAINST TOMATO FRUIT BORER, *HELICOVERPA ARMIGERA* (HUBNER) ON TOMATO, *LYCOPERSICON ESCULENTUM* MILL UNDER FIELD CONDITIONS

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ABSTRACT

For tomato fruit borer management six newer insecticides insecticides were taken viz., spinosad 45% SC, fipronil 5% SC, profenofos 5 % EC, indoxacarb 14.5% SC, NSKE 5% w/w and NPV. The total two numbers of sprays were done. The descending order of efficacy was as Spinosad 45% SC (45.44) > fipronil l5% SC (43.07) > Profenofos 50% EC (31.51) > indoxacarb 14.5% SC (29.56) > NSKE 5% w/w (28.59) > NPV (25.82). All the treatment differs significantly with each other except 1DAT, NSKE (20.08) and NPV (20.02), 5 DAT, Indoxacarb (34.02) and NSKE (33.41) and again, 10 DAT Indoxacarb (33.14) and NSKE (32.28) of 2nd spray were found at par with each others. In this experiment Spinosad was found most effective insecticides and fipronil, profenofos and indoxacarb was also found effective for fruit borer management.

INTRODUCTION

Tomato, *Lycopersicon esculentum* Mill, is one of the most popular and widely grown vegetables in the world, ranking second in importance next to potato. Tomato is a good source of all nutrients especially vitamin C, B and K. The highest productivity of tomato is incurred by Spain having 66.81 t/ha while India has only 17.50 t/ha. In India, Andhra Pradesh contributed maximum production (1453.50 metric tons) but highest productivity was occupied by Maharashtra (28.20 t/ha) (National Horticulture Board, 2011). Cohic (1958) listed 13 insect pests of tomato which include mainly, lepidopteran, coleopteran and hemipterans. The important insect pest of tomato are fruit borer, *Helicoverpa armigera* Hubner: whitefly, *Bemisia tabaci* Gen; jassids, *Amrasca devastans* Ishida; leaf miner, *Liriomyza trifolii* (Blanchard); potato aphid, *Myzus persicae* (Thomas) and hadda beetle, *Epilachana dedecastigma* Widemann. But in India fruit borer is one of the most important pests of tomato, limiting production and market value of crop produce. The fruit borer, *Helicoverpa armigera* (Hubner) is the most destructive pest of tomato in India, which is commonly known as gram pod borer, American bollworm and tomato fruit borer. Young larvae feed exclusively on foliage, flower buds and flowers, while the later instars of these insects bore into fruit and render them unmarketable. Season wise avoidable losses were 36.36, 37.39 and 22.39 during January-February, March-April and October-November, respectively (Tiwari and Krishnamurthy, 1984). Similar types of done by few workers (Tarak *et al*., 2014, Gadhiya *et al*., 2014 and Bhusan *et al*., 2012) on other crops. Economic significance of crop produce compelled the commercial farmers to advocate insecticidal almost in alternate days, sometimes almost double the recommended doses. Such indiscriminate use of insecticides leads to development of resurgence and resistance. So these days, there is a need to search for newer chemicals that are selective and eco-friendly which can replace older spurious chemicals on tomato. The work done on these lines in Varanasi region is scanty. Therefore, keeping the above information in view bioefficacy of newer insecticides against tomato fruit borer, *Helicoverpa armigera* (Hubner) on tomato, *Lycopersicon esculentum* Mill under field conditions was carried out.

MATERIALS AND METHODS

The experiment was carried out under field conditions during the year 2011-12 at the Vegetable Research Farm of Institute of Agricultural Sciences, BHU, Varanasi (Utter Pradesh). The experiment plot was ploughed twice with disc plough to achieve pulverized and compact transplanting beds and leveled with heavy plank. The farm yard manure (FYM) was applied just after the first ploughing in the main field. Half of the recommended dose of nitrogen fertilizer and full dose of phosphorous and pottasic fertilizers were applied at the last ploughing and just before transplantation. The rest of nitrogen fertilizer was applied through top dressing after 40 days of transplantation. Seedlings of Pusa Ruby variety of tomato were procured from Indian Vegetable Research Institute, Varanasi and were used to raise the crop. Transplantation of seedlings was done on the 18th October, 2011. Seedlings of one month old were transplanted @ two seedlings per hill at a spacing of 60 x 40 cm. gap filling was done 10 days after to ensure uniform plant population in each plot (Ramesh and Ukey, 2006). One main irrigation channel of 1meter width prepare in the experimental field and two sub-irrigation channels of 75 cm each were made to met out the irrigation requirement. Four irrigations were given to the experimental crop at an interval of 15-20 days. First irrigation was provided 10 days after transplantation. The experiment was laid out in Randomized Block Design with 7 treatments including control. Required numbers of plots having a size of 3x3m were prepared to accommodate all the seven treatments, each having 3 replications. One main irrigation channel of width was prepared at outside in the experimental field and two sub-irrigation channels were provided in between three replications. Each plot was separated by a gap of 0.75 m so that drifting of chemicals during spraying was minimized. The total two treatments were given on 18.01.2012 and 30.01.2012. The sprays were given during reproductive stage of the crop when *H. armigera* appears to be severe causing economic damage. The details about insecticides which were used during experiment were given in Table 1. The quantity of spray fluid was @ 500 liters per ha. *i.e.,* 0.6 liters per plot during first spraying and it was gradually increased and at final spraying the quantity used was @ 625 liters per ha *i.e.,* 0.75 liters per plot. Data on the fruit borer pest's population were recorded at one day before spraying as a pre treatment count and at 1, 5 and 10 days after spraying as post treatment counts. The observations were recorded on 5 randomly selected plants which were tagged in each plot leaving the border rows (Shukla *et al*., 2005). The per cent reduction over control was calculated for fruit borer damage and was analyzed using angular transformation in RBD as Panse and Shukhatme (1985). The significance was tested by referring to "F"tables of Fisher and Yates (1963).

RESULTS AND DISCUSSION

Effects of treatments against *H.armigera* on tomato after first insecticidal spray

The mean per cent fruit infestation before spray per 5 plants was recorded one day before application of insecticides revealed that the infestation of *H. armigera* as fruit borer varied from 14.25-18.05 (Table 2). One day after first spray the post treatment data recorded indicates that all the treatments were effective and significantly superior to untreated control in bringing down the fruit infestation by *H. armigera*. Among the treatments spinosad 45 SC (37.05) was found best and most effective and significantly superior to all the treatments. These results were in support with Prasad *et al*. (2009) who reported that spinosad showed promising results in reducing fruit borer infestation and increasing yield in tomato. They found that spinosad produced 100 % mortality of fruit borer after 7 and 10 days after treatment. Similar kind of results was also obtained by Singh and Yadav, (2005). The second best chemical was fipronil (32.78) per cent mean reduction and also significantly superior over to the rest of the treatments. Similarly, application of fipronil (0.0075%) was found effective for managing *Scriptothrips dorsalis* in bell pepper (Mallik *et al*., 2002).The rest of treatments that followed in the following descending order of efficacy were profenofos (25.67), indoxacarb (23.73), NSKE (6.68), NPV (4.24). After 5th day of 1st insecticidal spray per cent field efficacy was highest with spinosad (50.16) treated plots and differ significantly from other treatments that were recorded as: fipronil (48.47), profenofos (32.98), indoxacarb (30.23), NSKE (18.86), NPV (12.08). All the treatments differed significantly from each other. After 10th day of 1st insecticidal spray was continued to be highest in spinosad treated plots (49.50). The per cent field of other treatments were in the following order- fipronil (47.12), profenofos (32.28), indoxacarb (30.18) > NPV (28.33) > NSKE (27.46). At this stage NPV and NSKE was also good effective in reducing per cent fruit infestation. Efficacy of NSKE and NPV against *H. armigera* was significantly high compared to untreated control treatment. This bio-pesticide showed significant impact in reduction of fruit damage by *H.armigera*. However, their efficacy was comparatively low with the selected conventional insecticides having novel mode of action. The role of NSKE in reducing the pest population is due to its antifeedant, repellent, antibiosis and insecticidal activities. NPV is known for its selectivity and species specificity. It is also known that the virus self perpetuates in the field due to cannibalism among *H.armigera* larval population. Virus infected larvae were eaten away by the healthy larvae. Therefore, NSKE and NPV play a

Table 1: Details of various treatments and their respective manufacturers

Sr. No.	Common Name	Chemical Name	Trade Name	Dose	Manufacturer
1.	Spinosad	Mixture of naturally derived metabolites spinosyn A and D	Tracer 45 SC	0.2mL/litre	Dow agro Sciences
2.	Fipronil	(RS)-5-amino-1-[2,6-dichloro-4-(trifluoromethyl) phenyl]-4-(trifluoromethylsulfinyl)-1 H-pyrazole-3-carbonitrile	Reagent 5 SC	1 mL/litre	Bayer crop science
3.	Profenofos	O-4-bromo-2-chlorophenyl O-ethyl S-propyl phosphorothioate	Curacron 50 EC	5 mL/litre	M/S Syngenta India Limited, J. Tata Road Church gate, Mumbai-400020
4.	Indoxacarb	Methyl 7-chloro-2,5-dihydro-2-[[(methoxycarbonyl) [4-(trifluoromethoxy)phenyl]amino]carbonyl]indeno [1,2-e][1,3,4]oxadiazine-4a(3H)-carboxylate	Avuant 14.5 SC	0.4mL/litre	Tatamida By Rallis Company
5.	NSKE	Azadiractin	Achook	5 mL/litre	T. Stans and Co. Ltd. 8/23-24, Race course road, Coimbatore-641018
6.	NPV	Nuclear polyhedrosis virus	Elcar	250 LE/ha	Bio- control laboratory, BHU, Varanasi - 221005

Table 2: Field efficacy of various insecticidal treatments against *H. armigera* on Tomato (after 1st insecticidal spray)

Sr. No.	Treatments	*Mean infestation (%) per 5 leaf before spray	* Mean reduction in per cent fruit infestation after 1st insecticidal spray			
			1 DAT	5 DAT	10 DAT	Over all mean
1	Spinosad	14.25	37.05 (37.49)	50.16 (45.09)	49.50 (44.71)	45.57 (45.53)
2	Fipronil	16.85	32.78 (34.92)	48.47 (44.12)	47.12 (43.34)	42.79 (42.05)
3	Profenofos	17.70	25.67 (30.44)	32.98 (35.04)	32.28 (34.98)	30.31 (33.48)
4	Indoxacarb	18.05	23.73 (29.15)	30.23 (33.35)	30.18 (33.32)	28.04 (31.94)
5	NSKE	17.96	6.68 (9.25)	18.86 (20.18)	27.46 (31.60)	17.67 (19.01)
6	NPV	15.92	4.24 (6.73)	12.08 (13.15)	28.33 (30.05)	14.88 (15.50)
7	Control	14.70	14.98	18.03	21.74	18.25
8	SEm ±		(0.325)	(0.245)	(0.281)	
9	C.D. at 5%		(0.97)	(0.77)	(0.83)	

* Mean of three replications; DAT = days after treatment; Figures in parenthesis are per cent field efficacy values

Table 3: Field efficacy of various insecticidal treatments against *H. armigera* on Tomato (after 2nd insecticidal spray)

Sr. No.	Treatments	*Mean infestation (%) per 5 plant before spray	* Mean reduction in per cent fruit infestation after 2nd insecticidal spray			
			1 DAT	5 DAT	10 DAT	Over all mean
1	Spinosad	10.45	35.03(36.28)	52.18(46.24)	49.02(44.43)	45.44(42.31)
2	Fipronil	12.88	32.20(34.57)	49.73(44.84)	47.30(43.29)	43.07(40.90)
3	Profenofos	16.90	22.77(28.50)	36.48(37.15)	35.28(36.43)	31.51(34.02)
4	Indoxacarb	17.75	21.53()27.64	34.02(35.68)	33.14(35.14)	29.56(32.82)
5	NSKE	18.75	20.08(26.62)	33.41(35.31)	32.28(34.62)	28.59(31.18)
6	NPV	20.95	20.02(26.57)	29.21(32.71)	28.24(32.10)	25.82(30.46)
7	Control	25.40	27.19	36.81	49.62	37.87
8	SEm ±		(0.269)	(0.360)	(0.319)	
9	C.D. at 5%		(0.89)	(1.10)	(0.96)	

* Mean of three replications; DAT = days after treatment; Figures in parenthesis are per cent field efficacy values

significant role in the management of *H.armigera* as and when incorporated in the modules due to their prophylactic and curative measures with highly eco-friendly nature. Similar, kind of results was obtained by Shukla *et al*. (2005). Although they found endosulfan as a best treatment but NSKE also significantly reduce the fruit borer population. Pokharkar and Chaudhary (1997) demonstrated that NPV with combination with synthetic insecticides gave good control in fruit infestation by fruit borer. The mean reduction in fruit infestation by fruit borer after 10th day treatment in different insecticidal treated plots was varied from 27.46 - 49.50. The overview of data revealed that in all counts 1st, 5th and 10th day of 1st insecticidal spray the highest mean reduction infestation per cent was recorded in spinosad treated (45.57) plots while it was lowest in NPV treated plots (14.88). Spinosad is found effective against bud fly in reducing bud infestation 7.25 per cent and 7.81 per cent respectively compared to 27.75 per cent in control (Savita and Katlam, 2013). After 1st insecticidal spray the overall mean per cent field efficacy in various treatments was found to be in the following order- Spinosad (45.57) > fipronil (42.79) > profenofos (30.31) > indoxacarb (28.04) > NSKE (17.67) > NPV (14.88) (Table 2).

After second insecticidal spray

The mean field efficacy of the selected six insecticides along with control plot after 2nd spray was presented in Table 3. The mean per cent fruit infestation before 4th spray per 5 plants was recorded one day before 2nd application of insecticides revealed that the infestation of *H. armigera* as fruit borer varied from 10.45 – 25.40 (Table 3). One day after second the per cent field efficacy was highest in spinosad (35.03) treated plots. The results obtained during the evaluation of newer insecticides against *H. armigera* showed that all treatments were effective in checking the fruit infestation over control. Among treatments spinosad was the best and significantly superior over all the treatments. These results were in support with Prasad *et al*. (2009) who reported that spinosad and indoxacarb showed promising results in reducing fruit borer infestation and increasing yield in tomato. They found that spinosad and indoxacarb produced 100 % mortality of fruit borer after 7 and 10 days after treatment. Similar kind of results was also obtained by Singh and Yadav, (2005). The rest of treatments that followed in the following descending order of efficacy were fipronil (32.20), profenofos (22.77), indoxacarb (21.53), NSKE (20.08), NPV (20.02). At this stage NPV and NSKE was also good effective in reducing per cent fruit infestation. Efficacy of NSKE and NPV against *H. armigera* was significantly high compared to untreated control treatment. This bio-pesticide showed significant impact in reduction of fruit damage by *H.armigera*. However, their efficacy was comparatively low with the selected conventional insecticides having novel mode of action. The role of NSKE in reducing the pest population is due to its antifeedant, repellent, antibiosis and insecticidal activities. NPV is known for its selectivity and species specificity. It is also known that the virus self perpetuates in the field due to cannibalism among *H.armigera* larval population. Virus infected larvae were eaten away by the healthy larvae. Therefore, NSKE and NPV play a significant role in the management of *H.armigera* as and when incorporated in the modules due to their prophylactic and curative measures with highly eco-friendly nature. Similar, kind of results was obtained by Shukla *et al*., (2005). Although they found endosulfan as a best treatment but NSKE also significantly reduce the fruit borer population. Pokharkar and

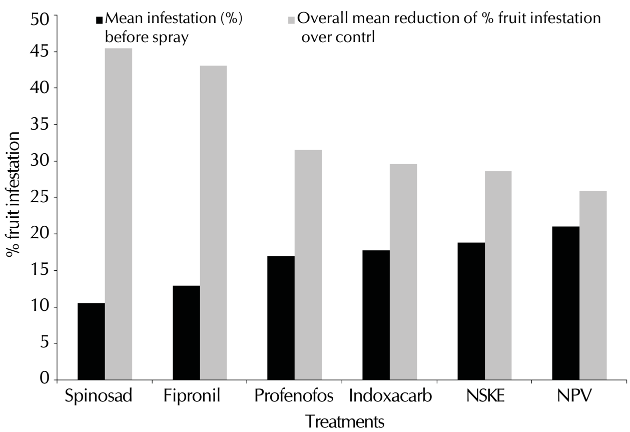

Figure 1: Over all mean field efficacy of various insecticidal treatments against *H.armigera* on tomato (after two sprays)

Chaudhary (1997) demonstrated that NPV with combination with synthetic insecticides gave good control in fruit infestation by fruit borer. All the treatments differed significantly from each other except profenofos and indoxacarb, NSKE and NPV which were at par with other. The mean reduction in fruit infestation after 1st day treatment in different treated plots varied from 20.02-35.03. After 5th day of 2nd the mean reduction in fruit infestation in various treatments varied from 29.21-52.18 per cent. The per cent field efficacy was highewst in spinosad (52.18) followed by fipronil with 49.73 per cent mean reduction and also significantly superior to the rest of the treatments. Similarly, application of fipronil (0.0075%) was found effective for managing *Scriptothrips dorsalis* in bell pepper (Mallik *et al*., 2002). The rest of treatments followed in the following descending order profenofos (36.48) > indoxacarb (34.02) > NSKE (33.41) > NPV (29.21). All the treatments differed significantly from each other. Even after 10th day of 2nd insecticidal spray spinosad (49.02) was continued to be most effective and differ significantly from other treatments that were recorded as: fipronil (47.30), profenofos (35.28), indoxacarb (33.14), NSKE (32.28), NPV (28.24). All the treatments differed significantly from each other except NSKE treated plots which was on par with indoxacarb treatment (Table 3). Thus, the overall mean per cent reduction in tomato fruit damage after two sprays against *H. armigera* was highest in plots receiving spinosad treatment (45.44) followed by fipronil (43.07). Spinosad is found effective against bud fly in reducing bud infestation 7.25 per cent and 7.81 per cent respectively compared to 27.75 per cent in control (Savita and Katlam, 2013). Profenofos and indoxacarb treated plots recorded (31.51) and (29.56) overall mean per cent reduction in fruit damage, respectively after two sprays during fruiting stage of the crop., whereas, the mean per cent reduction in fruit infestation in NPV treated plots was recorded to be 25.82 (Table 3).

The overall mean per cent field efficacy of various selected insecticidal treatments against *H. armigera* in reducing fruit infestation after 1st and 2nd (two) sprays was also depicted in Fig.1.

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