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RELATIVE EFFECTIVENESS OF DIFFERENT INSECTICIDES AGAINST PEA LEAF MINER (*PHYTOMYZA HORTICOLA* GOUREAU) ON PEA UNDER FIELD CONDITIONS

Muhammad Naeem, Rashad Rasul Khan[*1], Sohail Ahmed[1], Muhammad Arshad[1], Shahid Majeed[1], Muhammad Sufyan[1] and Amer Rasol[2]

[1]Department of Entomology, University of Agriculture, Faisalabad.
[1]Pest Warning & Quality Control of Pesticides, Faisalabad.

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***Corresponding Author**:
Rashid Rasul Khan

E-mail: rashadkhan@uaf.edu.pk

E-mail: muhammad.malik@fmc.com

ABSTRACT

To evaluate the comparative toxicity of various insecticides viz. chlorfenapyr 360 SL (Pirate), spinosad 240SC (Tracer), chlorantraniliprole 20SC (Coragen), bifenthrin + abamectin 56 EC (Novastar) and spintoram 120 SE (Radient) against pea leaf miner an experiment was conducted at Entomological Research Area, University of Agriculture, Faisalabad, Punjab, Pakistan during 2014-15. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. A control plot (no insecticide application) was also maintained for comparison. The insecticides applied when leaf miner infestation was reached at economic threshold level (ETL). After 1st and 2nd spray minimum infestation was recorded after 72 hours in plots treated with spintoram (4.65 and 4.94%), bifenthrin + abamectin (5.25 and 5.58%), spinosad (5.82 and 6.21%), chlorfenapyr (6.15 and 7.23%) and chlorantraniliprole (7.28 and 8.89%) respectively. Similarly after 1st and 2nd spray maximum reduction was recorded after 72 hours in plots treated with spintoram (84.02 and 85.00%), bifenthrin + abamectin (82.09 and 83.01%), spinosad (80.18 and 81.15%), chlorfenapyr (79.02 and 78.03%) and chlorantraniliprole (75.19 and 73.03%) respectively. While after 7 days of application, effectiveness of spinosad, chlorantraniliprole and spintoram was increased while bifenthrin + abamectin and chlorfenapyr were decreased. Maximum reduction was recorded where spintoram was applied i.e. 90.02% followed by spinosad (85.02%), chlorantraniliprole (80.00%) and bifenthrin + abamectin (77.87%) respectively. While minimum reduction (75.02%) was recorded where chlorfenapyr was applied.

Keywords: Pea, Leaf miner, Infestation, Efficacy, Insecticides

INTRODUCTION

Pea belongs to the Leguminosae family and is one of the world's oldest domesticated crops throughout the world (Ambrose, 1995; Zohary and Hopf, 2000). Peas are nutritional rich diet which consists of almost all the basic nutrients such as proteins and carbohydrates, which are required by our body. Vitamins, minerals, dietary fibers and antioxidant compounds are also found in peas in traces (Urbano *et al.,* 2005). Pea leaf miner (*Phytomyza horticola* Goureau (Diptera: Agromyzidae) is a serious hinder in cultivation of peas (*Pisum sativum* L.) and cause 90% damage to the crop by mining young leaves which results in stunting and low flower production (Tariq *et al*., 1991). Parella (1987) indicated that leaf miners could influence crops in various ways, among these reductions in crop yields and reducing the aesthetic value of ornamental plants are the most serious threat. The thickness of epidermal wall, densities of the palisade and spongy tissues can act as a barrier to the female oviposition (Wei *et al.,* 2000). Several generations of leaf miner may be produced during the year, with eggs being laid just lower surface of the leaf. On egg hatching the larvae come out and make the "mines" in leaf, hence called as leaf miner. Leaf miner cause damage to the plant in different ways viz., (i) punctures made by the females followed by egg laying (ii) internal mines formation by the larvae (iii) they allow pathogenic fungi to develop as it finds suitable conditions for its growth (Matteoni and Broadbent, 1988; Deadman *et al.,* 2000). Normal photosynthesis is also disturbed by the attack of leaf miner and in this way, plant growth is stunted (CABI, 2006). Integrated Pest Management (IPM) is a best technique which is used to reduce pest population below the tolerance levels using multiple pest control tactics that are economically feasible, effective, ecological compatible

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and strongly needs the attention of growers to adopt it (Pedigo, 2002, Norris *et al*., 2003). Biological control is not only the sufficient control tactic to bring this pest at low levels, but chemical control is required for the management of this pest (Fathipour *et al*., 2006). Use of pesticides is also one of the components of IPM. Different conventional insecticides as chemical control have been used against serpentine leaf miner damaging vegetables (Wakchaure, 1998; Nadagouda *et al*., 2010). Avermectins and cyromazine have been the most successful insecticides in recent years to control the population of leafminers (Trumble, 1984; Hara, 1986; Mujica *et al*., 2000) on horticultural crops (Hara, 1986) and vegetables (Schuster and Everftt, 1983; Trumble, 1984; Civelek and Weintraub, 2003). Spinosad, cyromazine and abamectin are known to be best insecticides for the control of leafminers (Ferguson, 2004; Prijono *et al.*, 2004). Spinosad has a distinctive mode of action against a diversity of target insect pests viz., flies, thrips, mites and fruit and leaf worms, and its advantage is that it is less toxic to birds and mammals (Eger and Lindenberg, 1998; Van *et al.,* 2006). Tsutomu (2004) evaluated the insecticide susceptibility of the leaf miner, *Chromatomyia horticola* on the pea crop. Results showed that isoxathion, emamectin-benzoate, spinosad, cyromazine, fipronil and chlorfenapyr produced 100% mortality of larval populations. Shindo *et al.* (2008) evaluated the effect of insecticides against the garden pea leaf miner *Chromatomyia horticola* (Goureau). The results showed that among the insecticides used, tolfenpyrad demonstrated high toxic effects on larvae of the insect and reduced the number of feeding traces of the larvae on the leaves. Spinosad, emamectin-benzoate, milbemectin, chlorfenapyr and cyromazine were also effective in managing leaf miner populations. Crop protection with chemicals is desirable and unavoidable part of integrated pest management (Mohy-ud-din *et al*., 1997). Thus to overcome the losses and to increase the yield, pesticides application is utmost important. It is important to compare the efficacy of insecticides against pests for effective pest management and to reduce the indiscriminate use of insecticides. Thus, the present study is conducted to evaluate different products available in the market for their efficacy against leaf miners on pea crop.

MATERIALS AND METHODS

Study site

The experiment was conceded at the experimental area, Department of Entomology, University of Agriculture, Faisalabad under Randomized Complete Block Design (RCBD) with five treatments and three replications. A bed to bed distance of 48 cm was maintained. Each experimental unit had a net size of 20 × 20 m^2. Agronomic practices were kept same for all the treatments.

Seed collection and sowing

The seed of peas were collected from Ayub Agricultural Research Institute (AARI), Faisalabad and hand sowing on both sides was done.

Leaf miner population density counts

Data regarding insecticides efficacy were recorded one, two, three and seven days after application of insecticides. Counting of leaf miner from pea crop was done from 15 randomly selected plants from each treatment from base of plant up to top. The percentage infestation and percentage reduction were then calculated by the formulae.

Statistical Analysis

Data collected on various attributes were statistically analyzed using analysis of variance technique (Steel *et al.*, 1997). The treatments means were compared by applying Tukey's HSD test at 5% probability level.

Insecticides/Treatments

Following insecticides were used

Sr. #	Treatments	Dose Rate/ Acre
T1	Bifenthrin+ Abamectin	500 ml/ acre
T2	Spinosad	40 ml/ acre
T3	Chlorantraniliprole	10 ml/ acre
T4	Spintoram	500 ml/ acre
T5	Chlorfenapyr	70 ml/ acre
T6	Control	----------

RESULTS

Effect of different insecticides on pea leaf miner infestation after different time intervals of 1st spray

After 1st spray, mean percentage infestation of pea leaf miner was recorded at different time intervals, after the application of five insecticides viz. Novastar 56EC (Bifenthrin+ Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr). The results presented in Table 1 revealed that all the treatments gave significant results even after 7 days of application. After 24 hours of application, the mean percentage infestation data revealed that Novastar was proved most effective insecticide with minimum infestation 8.77 followed by Radient (10.39%), Tracer (11.04%), Coragen (11.56%) and Pirate (12.36%) respectively. Radient, Tracer, Coragen and Pirate were statistically at par with each other. While maximum infestation was recorded where no control measure was applied i.e. 20.07%. After 48 hours of application minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 7.09%, followed by Novastar (7.96%), Tracer (9.56%), Coragen (10.65%) and Pirate (11.64%) respectively. Coragen, Tracer and Pirate were statistically at par with each other after 48 hours. While maximum infestation (22.88%) was recorded where no control measure was applied. After 72 hours of application maximum results were recorded of all the treatments, minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 4.65%, followed by Novastar (5.25%), Tracer (5.82%), Pirate (6.15%) and Coragen (7.28%) respectively. While maximum infestation was recorded where no control measure was applied i.e. 29.39%. While results after 7 days of application revealed that effectiveness of Tracer, Coragen and Radient was increased while Novastar and Pirate were decreased their effectiveness after 7 days of application. Minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 3.47%, followed by Tracer (5.15%), Coragen (6.93%), Novastar (7.61%) and Pirate (8.61%) respectively. While maximum

Table 1

Percentage infestation of leaf miner after different time intervals.

Treat ments	Trade name	Percentage infestation of leaf miner after			
		24 hours	48 hours	72 hours	7 days
T1	Novastar 56EC	8.77 (±0.53) efghi	7.96 (±0.61) fghijk	5.25 (±0.28) jkl	7.61 (±0.16) fghijk
T2	Tracer 240SC	11.04 (±0.36) def	9.56 (±0.23) defgh	5.82 (±0.31) ijkl	5.15 (±0.19) kl
T3	Coragen 20SC	11.56 (±0.79) de	10.65 (±0.25) def	7.28 (±0.29) ijkl	6.93 (±0.65) hijkl
T4	Radient 120SE	10.39 (±0.71) defg	7.09 (±0.17) ghijk	4.68 (±0.28) kl	3.47 (±0.53) l
T5	Pirate 360SL	12.36 (±0.64) d	11.64 (±0.38) de	6.15 (±0.30) hijkl	8.61 (±0.37) efghij
T6	Control	20.07 (±0.85) d	22.88 (±1.02) c	29.39 (±1.21) b	34.51 (±1.17) a
	LSD value @ 5%	3.4588			

Means sharing similar letters in each column are not different significantly (Tukey's HSD, p>0.05)

infestation (34.51%) was recorded where no control measure was applied.

Effects of different insecticides on pea leaf miner infestation after different time intervals of 2nd spray

After 2nd spray, mean percentage infestation of pea leaf miner was recorded at different time intervals, after the application of five insecticides viz. Novastar 56EC (Bifenthrin+ Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr). The results presented in Table 2 revealed that all the treatments gave significant results even after 7 days of application. After 24 hours of application, minimum infestation of pea leaf miner was recorded where Novastar was applied i.e. 10.85%, followed by Radient (13.97 %), Tracer (14.48%), Coragen (15.25%) and Pirate (16.30%) respectively. All these treatments including Radient, Tracer, Coragen and Pirate were statistically at par with each other and different with other treatments. While maximum infestation was recorded where no control measure was applied i.e. 25.91%. After 48 hours of application minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 9.05%, followed by Novastar (10.81%), Tracer (12.84%), Coragen (13.22%) and Pirate (14.04%) respectively. Coragen and Pirate were statistically at par with each other and different with other treatments. While maximum infestation (29.30%) was recorded where no control measure was applied (Check treatment). After 72 hours of application maximum results were recorded of all the treatments, minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 4.94%, followed by Novastar (5.58%), Tracer (6.21%), Pirate (7.23%) and Coragen (8.89%) respectively. Novastar and Radient were statistically at par with each other and different with other treatments. While maximum infestation was recorded where no control measure was applied i.e. 32.97%. While results after 7 days of application revealed that effectiveness of Tracer, Coragen and Radient was increased while Novastar and Pirate were decreased their effectiveness after 7 days of application. Minimum infestation of pea leaf miner was recorded where Radient was applied i.e. 2.88%, followed by Tracer (5.78%), Coragen (7.59%), Novastar (8.64%) and

Table 2

Percentage infestation of leaf miner after different time intervals.

Treat ments	Trade name	Percentage infestation of leaf miner after			
		24 hours	48 hours	72 hours	7 days
T1	Novastar 56EC	10.85 (±0.15) ghij	10.81 (±0.47) hij	5.58 (±0.44) no	8.64 (±0.55) jklm
T2	Tracer 240SC	14.48 (±0.24) ef	12.84 (±0.52) fghi	6.21 (±0.38) lmn	5.78 (±0.70) mno
T3	Coragen 20SC	15.25 (±0.24) ef	13.22 (±0.23) efgh	8.89 (±0.48) jklm	7.59 (±0.50) klmn
T4	Radient 120SE	13.97 (±0.35) efg	9.05 (±0.46) jkl	4.94 (±0.51) no	2.88 (±0.36) o
T5	Pirate 360SL	16.30 (±0.32) e	14.04 (±0.47) ef	7.23 (±0.53) klmn	9.75 (±0.74) ijk
T6	Control	25.91 (±0.93) d	29.30 (±1.07) c	32.97 (±0.79) b	36.15 (±0.78) a
	LSD value @ 5%	3.1290			

Means sharing similar letters in each column are not different significantly (Tukey's HSD, p>0.05)

Pirate (9.75%) respectively. While maximum infestation (36.15%) was recorded where no control measure was applied.

Effects of different insecticides on percentage reduction of pea leaf miner after different time intervals of 1st spray

After 1st spray, mean percentage reduction of pea leaf miner was recorded at different time intervals, after the application of five insecticides viz. Novastar 56EC (Bifenthrin+ Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr). The results presented in Table 3 revealed that all the treatments gave significant results even after 7 days of application. After 24 hours of application, the mean percentage reduction data revealed that Novastar was proved most effective insecticide with maximum reduction i.e. 56.33%, followed by Radient (48.31%), Tracer (44.94%) and Coragen (42.51%) respectively. While minimum reduction was recorded Pirate i.e. 38.44%. After 48 hours of application maximum reduction of pea leaf miner was recorded in Radient (68.88%) and Novastar (65.29%), both were statistically at par with each other and significantly different with other treatments, followed by Tracer (58.14%) and Coragen (53.37%) respectively. Both Coragen and Tracer were also statistically at par with each other and significantly different with other treatments. While minimum reduction (49.07%) was recorded where Pirate was applied. After 72 hours of application maximum results were recorded of all the treatments, maximum reduction of pea leaf miner was recorded where Radient was applied i.e. 84.02%, followed by Novastar (82.09%), Tracer (80.18%) and Pirate (79.02%) respectively. Both Novastar and Tracer were statistically at par with each other and significantly different with other treatments. While minimum reduction was recorded where Coragen was applied i.e. 75.19%. While results after 7 days of application revealed that effectiveness of Tracer, Coragen and Radient was increased while Novastar and Pirate were decreased their effectiveness after application. Maximum reduction of pea leaf miner was recorded where Radient and Tracer were applied i.e. 90.02 and 85.02% respectively, both were statistically at par with each other and significantly different with other treatments, followed by Coragen (80.00%) and Novastar (77.87%) respectively. While minimum reduction (75.02%) was recorded where and Pirate was applied.

Table 3

Percentage reduction of leaf miner after different time intervals.

Treatments	Trade name	Percentage reduction of leaf miner after			
		24 hours	48 hours	72 hours	7 days
T1	Novastar 56EC	56.33 (±1.30) g	65.29 (±1.18) f	82.09 (±1.09) bcd	77.87 (±1.20) de
T2	Tracer 240SC	44.94 (±0.85) ij	58.14 (±1.12) g	80.18 (±1.04) bcde	85.02 (±1.05) ab
T3	Coragen 20SC	42.51 (±1.67) jk	53.37 (±1.29) gh	75.19 (±0.91) e	80.00 (±1.21) bcde
T4	Radient 120SE	48.31 (±2.06) hi	68.88 (±1.56) f	84.02 (±1.15) abc	90.02 (±1.19) a
T5	Pirate 360SL	38.44 (±1.50) k	49.07 (±1.18) hi	79.02 (±1.11) cde	75.02 (±1.25) e
T6	Control	0.00	0.00	0.00	0.00
	LSD value @ 5%				5.8022

Means sharing similar letters in each column are not different significantly (Tukey's HSD, p>0.05)

Effects of different insecticides on percentage reduction of pea leaf miner after different time intervals of 2nd spray

After 2nd spray, mean percentage reduction of pea leaf miner was recorded at different time intervals, after the application of five insecticides viz. Novastar 56EC (Bifenthrin+ Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr). The results presented in Table 4 revealed that all the treatments gave significant results even after 7 days of application. After 24 hours of application, the mean percentage reduction data revealed that Novastar was proved most effective insecticide with maximum reduction i.e. 58.05%, followed by Radient (46.05%), Tracer (44.01%) and Coragen (41.04%) respectively. Both Tracer and Radient were statistically at par with each other. While minimum reduction was recorded where and Pirate was applied i.e. 36.99%.After 48 hours of application maximum reduction of pea leaf miner was recorded where Radient was applied i.e. 69.06%, followed by Novastar (63.05%), Tracer (56.13%) and Coragen (13.22%) respectively. Coragen and Tracer were statistically at par with each other and significantly different with other treatments. While minimum reduction (52.04%) was recorded where Pirate was applied. After 72 hours of application maximum results were recorded of all the treatments. Maximum reduction of pea leaf miner was recorded where Radient and Novastar were applied i.e. 85.00 and 83.01% respectively, both treatments were statistically at par with each other, followed by Tracer and Pirate (81.15 and 78.03%) respectively. While minimum reduction was recorded where Coragen was applied i.e. 73.03%. While results after 7 days of application revealed that effectiveness of Tracer, Coragen and Radient was increased while Novastar and Pirate were decreased their effectiveness after 7 days of application. Maximum reduction of pea leaf miner was

Table 4.

Percentage reduction of leaf miner after different time intervals.

Treatments	Trade name	Percentage reduction of leaf miner after			
		24 hours	48 hours	72 hours	7 days
T1	Novastar 56EC	58.05 (±1.05) i	63.05 (±1.74) h	83.01 (±1.79) bc	76.11 (±1.24) ef
T2	Tracer 240SC	44.01 (±1.13) kl	56.13 (±1.77) i	81.15 (±1.24) cd	84.04 (±1.74) bc
T3	Coragen 20SC	41.04 (±1.22) l	54.82 (±0.88) ij	73.03 (±1.49) f	79.01 (±1.15) de
T4	Radient 120SE	46.05 (±0.60) k	69.06 (±1.63) g	85.00 (±1.61) b	91.99 (±1.12) a
T5	Pirate 360SL	36.99 (±1.04) m	52.04 (±1.14) j	78.03 (±1.71) de	73.06 (±1.74) f
T6	Control	0.00	0.00	0.00	0.00
	LSD value @ 5%	3.6693			

Means sharing similar letters in each column are not different significantly (Tukey's HSD, p>0.05)

recorded where Radient was applied i.e. 91.99%, followed by Tracer (84.04%), Coragen (79.01%) and Novastar (76.11%) respectively. While minimum reduction (78.06%) was recorded where Pirate was applied.

DISCUSSION

Five insecticides viz., Novastar 56EC (Bifenthrin + Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr) at the rate of 500ml/acre, 40ml/acre, 10ml/acre, 40ml/acre and 70ml/acre respectively were sprayed on Meteor pea variety, when population of pea leaf miner reached to economic threshold level (ETL). There were two sprays applied in total at various time intervals against pea leaf miner to see their relative efficacy. The data regarding percentage infestation of pea leaf miner was recorded from each plot 24, 48, 72 hours and 1 week after each spray from 15 plants taken at random in each plot. For this purpose total no of leaves and infested leaves data were collected and calculated the percentage infestation and percentage reduction respectively. The findings of present study show all the treatments were applied gave significant results regarding percentage infestation and reduction of pea leaf miner even after 7 days of application. Minimum infestation and maximum reduction of pea leaf miner was recorded where Spintoram was applied followed by Spinosad, Chlorantraniliprole, Bifenthrin+Abamectin and Chlorfenapyr respectively. These findings are in conformity with those of Hafsi *et al*. (2012) they tested bio-insecticides as well as chemical insecticides against leaf miner and reported that Spintoram gave maximum results among all insecticides. Same kind of results were concluded by Hanafy and El-Sayed (2013) they tested seven insecticides against leaf miner including pyridalyl, indoxcarb, coragen, chlorfenapyr, spinetoram, spinosad and emamectin. And reported that spinetoram gave the highest toxicity against leaf miner followed by spinosad and emamectin. Our results were also confirmed by previous studies (Hara, 1986; Kawate and Coughlin, 1995; Howard, 1995; Umeda *et al.,* 1998; Weintraub and Ramihorowitz, 1998; Civelek and Weintraub, 2003; Chen *et al.*, 2004; Conroy *et al*., 2008; Saberfar *et al.*, 2012; Pawar and Patil, 2013 and Abbas *et al*., 2013) they conducted research regarding efficacy of different insecticides against pea leaf miner and they reported that Bifenthrin, Abamectin, Spinosad and Chlorantraniliprole were very effective against pea leaf miner and gave maximum results. Furthermore Conroy *et al*. (2008) tested four insecticides including abamectin, cyromazine, spinosad and chlorantraniliprole against leaf miner and reported that spinosad and chlorantraniliprole gave effective control of pea leaf miner followed by abamectin, cyromazine. The present findings are also in conformity with those of Conroy *et al*. (2008) and Pereira *et al.* (2014) they tested different insecticides against leaf miner including flubendiamide, chlorantraniliprole, emamectin benzoate, indoxacarb, chlorpyriphos, cypermethrin, abamectin, chlorfenapyr, cyromazine, spinosad and methamidophos. Among all of them they reported that chlorantraniliprole, spinosad and chlorfenapyr were very effective as compared with other insecticides.

The present findings show that Spintoram followed by Spinosad and Chlorantraniliprole were more effective than other insecticides for the control of pea leaf miner which was also confirmed by previous studies (Tsutomu, 2004; Conroy *et al*., 2008; Shindo *et al*., 2008; Santos *et al*., 2011; Hafsi *et al*., 2012; Abbas *et al*., 2013; Hanafy and El-Sayed, 2013 and Pereira *et al.*, 2014). Leaf miner is a severe pest of pea which causes significant yield losses of pea due to its attack which also affect their quality as well. Above mentioned achievements show the hidden potential of Novastar 56EC (Bifenthrin + Abamectin), Tracer 240SC (Spinosad), Coragen 20SC (Chlorantraniliprole), Radient 120SE (Spintoram) and Pirate 360SL (Chlorfenapyr) against pea leaf miner. While keeping in view the problem of leaf miner on pea, present investigation will be a milestone in this regard and further research work is needed here.

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