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Bio-efficacy of cyazypyr 10% OD, a new anthranilic diamide insecticide, against fruit and shoot borer on Brinjal

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Abstract
Leucinodes orbonalis Guenee (Pyraustidae: Lepidoptera) is the key pest of eggplant (also known as brinjal and aubergine). The yield loss due to this pest is to the extent of 70-92 percent. Five doses of cyazypyr 10% OD (60, 75, 90 and 105g a.i./ha in both the year 2011 and 2012) were sprayed every year for their efficacy along with fipronil 5% SC @ 60 g a.i./ha, Flubendiamide 40% SC @ 30g a.i./ ha and Profenofos 50% SC @ 500 g a.i./ ha as a standard check. In both the seasons 2011 and 2012, cyazypyr 10% OD @ 105 and 90g a.i./ha were superior to most of the other treatments in respect of percent shoot infestation. Cyazypyr @ 105g a.i./ha, however, was superior to its 90g a.i./ha dose after 10 days of 2nd and 4th spray. Flubendiamide 40% SC @ 30g a.i./ha, fipronil 5% SC@ 60g a.i./ha and profenofos 50% EC @ 500ga.i./ha were on a par among them in percent shoot damage in most of the observations. Flubendiamide, however, showed similar performance with cyazypyr 10% OD @ 90g a.i./ha in a few cases. Cyazypyr 10% OD @ 75 g and 60g a.i./ha were ineffective, and it is also safer to natural enemies.

Keywords: Brinjal**,** cyazypyr, *Leucinodes orbonalis* and natual enemies

Introduction
Brinjal (*Solanum melongena* L.) is one of the widely used vegetable crops by most of the people and is popular in many countries *viz.*, Central, South and South East Asia, some parts of Africa and Central America [4]. It is native of India and second largest brinjal producing country after China with 27.1% share. It is an important vegetable grown in all the seasons. Due to its nutritive value, consisting of minerals like iron, phosphorous, calcium and vitamins like A, B and C, unripe fruits are used primarily as a vegetable in the country. Hence, it is subjected to attack by a number of insect pests right from the nursery stage till harvesting [7]. Among the insect pests infesting brinjal, the major ones are shoot and fruit borer, *Leucinodes orbonalis* (Guen.), whitefly, *Bemicia tabaci* (Genn.), leafhopper, *Amrasca biguttula biguttula* (Ishida), and non insect pest, red spider mite, *Tetranychus macfurlanei*. Of these, L. *orbonalis* is considered the main constraint as it damages the crop throughout the year. This pest is reported from all brinjal growing areas of the world including Germany, Burma, USA, Srilanka and India. It is known to damage shoot and fruit of brinjal in all stages of its growth. The yield loss due to the pest is to the extent of 70-92 percent [1, 2, 5]. The infested fruits become unfit for consumption due to loss of quality and hence, lose their market value. Farmers largely follow the chemical method as it produces quick results. High-frequency application is the common scenario. However, these chemicals, in many cases, invited the problems of pesticide resistance, resurgence, secondary pest outbreak, environmental contamination, residual toxicity and toxicity to beneficial organisms and disturbance in homeostasis of natural populations. The new generation of pesticide molecules have been claimed to be effective as well as safer for non-target organisms [3, 6, 8, 9]. Therefore, the present study was conducted with an objective to evaluate the field efficacy of cyazypyr 10% OD against *L. orbonalis* in brinjal.

Materials and Methods
The experiment was conducted during the 2011 and 2012 in the University farm at Kalyani, West Bengal state of India. Brinjal 'Muktakeshi' was grown in plots measuring 5 m×5 m, at spacing of 1m x 0.75m with three replications during the period from mid- April to July, two years, following recommended package of practices.

The plots were set out in a randomized block design with eight treatments including an untreated check. Four doses of cyazypyr 10% OD (60, 75, 90 and 105g a.i./ha in both year 2011 and 2012) were sprayed every year for their efficacy along with fipronil 5% SC @ 60 g a.i./ha, Flubendiamide 40% SC @ 30g a.i./ ha and Profenofos 50% SC @ 500 g a.i./ ha as standard check. Cyazypyr 10% OD @ 180 and 360 g a.i./ha were tested for their effect on crop health. The crop was sprayed 5 times with the insecticides using 500 liters of water / ha at an interval of 10 days starting from 30 days after planting. Control plots were treated with equal amount of water only. Data on percent shoot damage by shoot and fruit borer was recorded from 5 row only selected fixed plants / plot before and 10 days after each spraying. Data on fruit infestation was recorded on whole plot basis at each harvest and the weight of healthy and infested fruits were recorded. The population of natural enemies was also recorded from the selected plants on the above mentioned dates.

Results and Discussions

Effect on shoot infestation

In the year 2011, before the commencement of spray, different treatments harboured 0.00 – 2.27% shoots infested by this insect, which showed no significant difference among them.

After 10 days of Ist spraying, all the insecticidal treatments, though showed variable degrees of shoot infestation (1.01 - 6.73%), were found to be statistically superior to the untreated control (14.40% infested shoots). Cyazypyr 10% OD @ 105g a.i. / ha horboured 1.01% shoot infestation, closely followed by cyazypyr 10% OD @ 90g a.i. / ha (1.07%), and these two treatments were statistically at par. Flubendiamide 40% SC @ 30g a.i. / ha produced 1.64% infested shoots and this treatment was statistically superior to rest of the insecticidal treatments. Profenofos 50% EC @ 500g a.i. / ha produced 2.42% infested shoots and this treatment, though had a relatively higher infestation than cyazypyr 10% OD @ 90 and 105g a.i. / ha and flubendiamide 40% SC @ 30g a.i. / ha, was superior to cyazypyr 10% OD @ 60 and 75g a.i. / ha (6.73 and 4.88% shoot infestation, respectively) and fipronil 5% SC @ 60g a.i. / ha (4.05% shoot infestation). Fipronil 5% SC @ 60g a.i. / ha and cyazypyr 10% OD @ 75g a.i. / ha (4.88%) was statistically at par among them in respect of shoot infestation. Cyazypyr 10% OD @ 60g a.i. / ha, however, showed 6.73% shoot infestation and was proved to be the least effective treatment.

After 10 days of 2nd spray, the insecticidal treatments followed the same trend except that cyazypyr 10% OD @ 105g a.i. / ha produced significantly lower shoot infestation (1.20%) than its 90g a.i. / ha dose (2.54%). The later, however, failed to show any significant difference from flubendiamide 40% SC @ 30g a.i. / ha (3.21%), profenofos 50% EC @ 500g a.i. / ha (3.56%) and fipronil 5% SC @ 60g a.i. / ha (4.03%) were statistically at par with flubendiamide 40% SC @ 30g a.i. / ha (3.21%). The two lower doses of cyazypyr 10% OD @ 60 and 75g a.i. / ha showed 9.20% and 7.03% shoot infestation, respectively, and these two treatments not only differed significantly among them but also from the aforesaid treatments.

After 10 days of 3rd spray, cyazypyr 10% OD @ 105g ai / ha and 90g a.i. / ha (1.73% and 2.07% infested shoots, respectively) were statistically at par and these two treatments showed significantly lower shoot damage than rest of the insecticidal treatments. Flubendiamide 40% SC @ 30g a.i. / ha (3.43% infested shoots) was on a par with profenofos 50% EC @ 500g a.i. / ha (4.13% infested shoots). The later was again on a par with fipronil 5% SC @ 60g a.i. / ha (4.57% infested shoots). Cyazypyr 10% OD @ 75g and 60g a.i. / ha produced 7.13% and 10.20% infested shoots, respectively, and these two treatments showed significant difference among them.

After 10 days of 4th spray, cyazypyr 10% OD @ 105g a.i. / ha showed no shoot infestation and was superior to rest of the insecticidal treatments. Cyazypyr 10% OD @ 90g a.i. / ha (1.57% infested shoots) was next to cyazypyr 10% OD @ 105g a.i. / ha. Flubendiamide 40% SC @ 30g a.i. / ha (2.37% infested shoots) and fipronil 5% SC @ 60g a.i. / ha (3.01% infested shoots) were statistically at par in respect of percent shoot infestation. These two treatments, though inferior to cyazypyr 10% OD @ 105g and 90g a.i./ha, were superior to rest of the treatments. Profenofos 50% EC @ 500g a.i. / ha, cyazypyr 10% OD @ 75g and 60g a.i. / ha produced 4.73, 9.20 and 11.04% infested shoots, respectively, and all these treatments differed significantly from one another.

After 10 days of 5th spray, no shoot infestation was recorded in cyazypyr 10% OD @ 105g and 90g a.i. / ha. Flubendiamide 40% SC @ 30g a.i./ ha produced 2.08% infested shoot and was at par with fipronil 5% SC @ 60g a.i. / ha (2.63% infested shoots) which was again at par with profenofos 50% EC @ 500g a.i. / ha (3.05% infested shoots). Cyazypyr 10% OD @ 75 and 60g a.i. / ha harboured 4.05% and 4.88% infested shoots and these treatments differed significantly among them. The control treatment there showed a slight decline in shoot infestation (16.60%) during observation (Table 1).

Same trend was done in 2012, only the plots that were subsequently treated with cyazypyr 10% OD @ 75g a.i. / ha showed an average of 2.40% shoot damage during the pre - treatment observation. This treatment, however, did not show any significant difference from rest of the treatments.

After 10 days of Ist spray, the percentage of shoot infestation increased in all the treatments including untreated control. Cyazypyr 10% OD @ 105g a.i./ha showed lowest shoot infestation (2.37%) and this treatment was statistically at par with cyazypyr 10% OD @ 90g a.i. / ha (2.60%), flubendiamide 40% SC @ 30g a.i. / ha (3.42%), profenofos 50% EC @ 500g a.i. / ha (3.45%) and fipronil 5% SC @ 60g a.i. / ha (3.65%). Cyazypyr 10% OD @ 75g and 60g a.i. / ha showed poor performance (13.11 and 13.97% shoot damage, respectively) and were at par with untreated control.

After 10 days of 2nd spray, all the insecticidal treatments showed marginal decline in the percentage of infested shoots except cyazypyr 10% OD @ 105g and 90g a.i. / ha which showed no shoot infestation. Flubendiamide 40% SC @ 30g a.i. / ha and profenofos @ 50% EC 500g a.i. / ha, though showed relatively higher shoot infestation (2.98 and 3.05%, respectively) than the former treatments, were superior to cyazypyr 10% OD @ 75g a.i. / ha (6.64% infested shoots) and fipronil 5% SC @ 60g a.i. / ha (4.18% infested shoots). The last three treatments, however, differed significantly from one another in respect of shoot damage.

After 10 days of 3rd spray, again cyazypyr @ 105g and 90g a.i. / ha showed no shoot infestation. Flubendiamide 40% SC @ 30g a.i. / ha (2.60% infested shoots) was on a par with profenofos 50% EC @ 500g a.i. / ha (3.00% infested shoots), which was again on a par with fipronil 5% SC @ 60g a.i. / ha (4.12% infested shoots, respectively). The performance of cyazypyr 10% OD @ 75g and 60g a.i. / ha (9.43 and 10.76%

infested shoots) was inferior to the rest of insecticidal treatments and these two treatments were statistically homogenous.

After 10 days of 4th spray, cyazypyr 10% OD @ 105g a.i. / ha produced only 1.0% shoots infestation which was statistically at par with cyazypyr 10% OD @ 90g a.i. / ha (2.05% shoot infestation). Among these two doses, cyazypyr 10% OD @ 90g a.i. / ha was statistically on a par with flubendiamide 40% SC @ 30g a.i. / ha (2.37% infested shoots) and profenofos 50% EC @ 500g a.i. / ha (3.36% infested shoots). The later two treatments were again statistically homogeneous with fipronil 5% SC @ 60g a.i. / ha (3.52% infested shoots) as in the previous observation. Cyazypyr 10% OD @ 75g and 60g a.i. / ha (10.54 and 12.71% infested shoots) were statistically at par among them. The percent shoot infestation in control treatment was 24.32%.

After 10 days of last i.e. 5th spray, cyazypyr 10% OD @ 105 and 90g a.i. / ha (1.06 and 1.01% shoot infestation) showed similar performance with flubendiamide 40% SC @ 30g a.i. / ha (1.64% shoot infestation). Fipronil 5% SC @ 60g a.i. / ha (2.00% infested shoots) was on a par with flubendiamide 40% SC @ 30g a.i. / ha (1.64% infested shoots) as well as profenofos 50% EC @ 500g a.i. / ha (3.07% infested shoots). Cyazypyr 10% OD @ 75g and 60g a.i. / ha was recorded to produce 9.49 and 10.0% infested shoots, respectively, and these two treatments were statistically inferior to the aforesaid insecticidal treatments (Table 2).

Effect on fruit infestation

The percentage of damaged fruits was calculated on the basis of number and weight during each harvest. The accumulated data shows that insecticidal treatments significantly reduced fruit damage than the untreated control (Table 1). Cyazypyr 10% OD @ 105g a.i. / ha produced lowest percentage of infested fruits (7.15%) and was superior to rest of the insecticidal treatments. Cyazypyr 10% OD @ 90g a.i. / ha closely followed the former with 8.82% infested fruits. This treatment also showed superiority over the two lower doses of cyazypyr 10% OD (75g and 60g a.i./ha) and the insecticides used as standard check. Cyazypyr @ 75g a.i. / ha, profenofos 50% EC @ 500g a.i. / ha and fipronil 5% SC @ 60g a.i. / ha were statistically homogeneous producing 17.13, 17.04, 15.90% infested fruits, respectively. Flubendiamide 40% SC @ 30g a.i. / ha produced 19.78% infested fruits and was at par with cyazypyr 10% OD @ 60g a.i. / ha (20.43% infested fruits). On the basis of weight again, cyazypyr 10% OD @ 105g a.i. / ha produced lowest fruit infestation (6.41%) followed by cyazypyr 10% OD @ 90g a.i. / ha (8.68%) and fipronil 60g a.i. / ha (13.10%). Cyazypyr 10% OD @ 75g a.i. / ha (15.95%) was statistically at par with flubendiamide 40% SC @ 30g a.i. / ha (16.13%) and profenofos 50% EC @ 500g a.i. / ha (16.42%). Cyazypyr @ 60g a.i. / ha produced the highest percentage of infested fruits (18.60%) among the insecticidal treatments.

Percent fruit infestation, as recorded on the basis of number and weight, showed that cyazypyr 10% OD @ 105g a.i. / ha had the lowest percentage of infested fruits (3.20%) and this treatment was superior to all other insecticidal treatments. Percent fruit infestation recorded in cyazypyr 10% OD @ 90g a.i. / ha (4.48%) was statistically lower than rest of the insecticidal treatments. The percent fruit infestation recorded in profenofos 50% EC @ 500g a.i. / ha (9.00%) was statically at par with flubendiamide 40% SC @ 30g a.i. / ha (9.50%), fipronil 5% SC @ 60g a.i. / ha (9.57%) and cyazypyr 10% OD @ 75g a.i. / ha (9.83%). The percent fruit infestation recorded in cyazypyr 10% OD @ 60g a.i. / ha was 12.40% which was significantly lower than the untreated control.

On weight basis, all the insecticidal treatments showed the same trend in percent fruit infestation except that, cyazypyr 10% OD @ 60g a.i. / ha (10.45%) was on a par with flubendiamide 40% SC @ 30g a.i. / ha (8.02%), fipronil 5% SC @ 60g a.i. / ha (9.46%) and profenofos 50% EC @ 500g a.i. / ha (10.52%). Flubendiamide 40% SC @ 30g a.i. / ha (8.02%) was at par with cyazypyr 10% OD @ 60g a.i. / ha (10.45%) (Table 1 and 2) [9, 5]. reported that flubendiamide was highly effective against lepidopterans and safe to non-target organisms [3]. claimed that flubendiamide was safe for coccinellids, predatory mites, parasitoids, honey bees and bumble bees and is a fast-acting pesticide with good residual activity against a broad spectrum of lepidopterans. flubendiamide gave a 87–90% reduction in eggplant fruit damage and rynaxypyr and flubendiamide were safe for natural enemies [6].

Conclusion

Cyazypyr 10% OD @ 105 and 90g a.i./ha were superior to most of the other treatments in respect of percent shoot infestation. Cyazypyr @ 105g a.i./ha, however, was superior to its 90g a.i./ha dose after 10 days of 2nd and 4th spray. Flubendiamide 40% SC @ 30g a.i./ha, fipronil 5% SC@ 60g a.i./ha and profenofos 50% EC @ 500ga.i./ha were on a par among them in percent shoot damage in most of the observations. Flubendiamide, however, showed similar performance with cyazypyr 10% OD @ 90g a.i./ha in a few cases. Cyazypyr 10% OD @ 75 g and 60g a.i./ha were ineffective, and it is also safer to natural enemies.

Table 1: Brinjal shoot and fruit borer damage in different treatments (2011)

Treatments	% shoot infested						% fruit infested	
	PT	10 DAS 1st spray	10 DAS 2nd spray	10 DAS 3rd spray	10 DAS 4thspray	10 DAS 5th spray	Number basis	Weight basis
Cyazypyr 10% OD @ 60g ai/h	0.00 (4.05)**	6.73 (15.03)	9.20 (16.64)	10.20 (18.62)	11.04 (19.85)	4.88 (13.39)	20.43 (26.87)	18.60 (25.56)
Cyazypyr 10% OD @ 75g ai/h	0.00 (4.05)	4.88 (12.75)	7.03 (14.93)	7.13 (15.47)	9.20 (18.14)	4.05 (12.34)	17.13 (24.45)	15.95 (23.54)
Cyazypyr 10% OD @ 90g ai/h	0.00 (4.05)	1.07 (5.90)	2.54 (9.15)	2.07 (8.26)	1.57 (8.26)	0.00 (4.05)	8.82 (17.24)	8.68 (16.99)
Cyazypyr 10% OD @ 105g ai/h	2.27 (7.55)	1.01 (5.74)	1.20 (6.27)	1.73 (7.56)	0.00 (4.05)	0.00 (4.05)	7.15 (15.48)	6.41 (14.45)
Profenofos 50% EC @500g ai/h	0.00 (4.05)	2.42 (8.93)	3.56 (10.83)	4.13 (11.70)	4.73 (13.21)	3.05 (10.88)	17.04 (24.26)	16.42 (23.83)
Fipronil 5% SC @60g ai/h	0.00 (4.05)	4.05 (11.59)	4.03 (11.52)	4.57 (12.33)	3.01 (10.79)	2.63 (10.19)	15.90 (23.47)	13.10 (21.10)

Flubendiamide40% SC @ 30gai/ha	0.00 (4.05)	1.64 (7.41)	3.21 (10.30)	3.43 (10.67)	2.37 (9.74)	2.08 (9.21)	19.78 (25.93)	16.13 (23.33)
Untreated control	2.23 (7.51)	14.40 (22.28)	17.88 (25.02)	21.45 (27.57)	23.73 (29.48)	19.62 (26.64)	25.33 (36.49)	23.26 (35.21)
CD (p = 0.05)	NS	1.47	1.48	1.42	1.19	0.98	1.35	1.31

**Values within parentheses are angular transformed

Table 2: Brinjal shoot and fruit borer damage in different treatment (2012)

Treatments	% shoot due infested						% fruit infested	
	PT	10 DAS 1st spray	10 DAS 2nd spray	10 DAS 3rd spray	10 DAS 4th spray	10 DAS 5th spray	Number basis	Weight basis
Cyazypyr 10% OD @ 60g ai/h	0.00 (4.05)**	13.97 (21.83)	8.20 (17.15)	10.76 (19.58)	12.71 (21.27)	10.00 (18.87)	12.40 (20.60)	10.45 (18.86)
Cyazypyr 10% OD @ 75g ai/h	2.40 (8.92)	13.11 (21.13)	6.64 (15.49)	9.43 (18.37)	10.54 (19.36)	9.49 (18.41)	9.83 (18.27)	9.07 (17.52)
Cyazypyr 10% OD @ 90g ai/h	0.00 (4.05)	2.60 (9.27)	0.00 (4.05)	0.00 (4.05)	2.05 (9.16)	1.01 (7.04)	4.48 (12.22)	4.75 (12.58)
Cyazypyr 10% OD @ 105g ai/h	0.00 (4.05)	2.37 (8.84)	0.00 (4.05)	0.00 (4.05)	1.00 (7.02)	1.06 (7.15)	3.20 (10.30)	3.97 (11.48)
Profenofos 50% EC @500g ai/h	0.00 (4.05)	3.45 (10.65)	3.05 (10.85)	3.00 (10.77)	3.36 (11.31)	3.07 (10.88)	9.00 (17.45)	10.52 (18.93)
Fipronil 5% SC @60g ai/h	0.00 (4.05)	3.65 (10.99)	4.18 (12.49)	4.12 (12.34)	3.52 (11.55)	2.00 (9.09)	9.57 (18.01)	9.46 (17.90)
Flubendiamide40% SC @ 30g ai/ha	0.00 (4.05)	3.42 (10.62)	2.98 (10.73)	2.60 (10.12)	2.37 (9.72)	1.64 (8.39)	9.50 (17.95)	8.02 (16.45)
Untreated control	0.00 (4.05)	16.58 (23.97)	20.56 (27.29)	23.58 (29.37)	24.32 (29.87)	25.51 (30.65)	22.17 (28.09)	17.32 (24.55)
CD (p=0.5)	NS	3.34	1.39	1.79	2.21	1.82	1.02	3.30

**Values within parentheses are angular transformed

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