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EVALUATION OF INSECTICIDAL TOXICITY AGAINST APHID, *LIPAPHIS ERISIMI* (KALTENBACH) AND COCCINELLID, *HIPPODAMIA* (ADONIA) *VARIEGATE* GOEZE

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ABSTRACT

Investigations on toxicity of different insecticides against aphid and coccinellid in mustard was carried out at Instructional farm, Junagadh Agricultural University, Junagadh during *Rabi* 2020. Different nine insecticides were evaluated for their toxicity against aphid and coccinellids. Insecticide efficacy tests on the aphid, *L. erisimi*, showed that cyantraniliprole 10.26 OD @0.014% and afidopyropen 5 DC @0.007% effectively managed aphid populations, keeping them below the economic threshold level (ETL) of 1.50 aphid index (A.I.). Other insecticides such as spinetoram 11.7 SC @ 0.011%, flonicamid 50 WG @ 0.015%, beta-cyfluthrin + imidacloprid 8.49 + 19.81 OD @ 0.011% and spirotetramate + imidacloprid 11.01 + 11.01 SC @ 0.022% were effective but less satisfactory, showing mediocre results. Dimethoate 30 EC @ 0.03%, sulfoxaflor 21.8 SC @ 0.0087% and acetamiprid 20 SP @ 0.02% did not provide adequate protection against aphids. When assessing the impact on coccinellids, afidopyropen 5 DC @0.007%, flonicamid 50 WG @ 0.015%, cyantraniliprole 10.26 OD @ 0.014% and spinetoram 11.7 SC @ 0.011% were identified as safer options. Sulfoxaflor 21.8 SC @ 0.0087% and spirotetramate + imidacloprid 11.01 + 11.01 SC @ 0.022% were classified as slightly harmful, while beta-cyfluthrin + imidacloprid 8.49 + 19.81 OD @ 0.011%, acetamiprid 20 SP @ 0.02% and dimethoate 20 SP @ 0.02% were found toxic to coccinellids. Regarding mustard seed yield, cyantraniliprole (51.85%) and afidopyropen (50.31%) significantly reduced yield loss. Other insecticides also improved yield to varying extents: spinetoram (33.38%), flonicamid (32.87%), beta-cyfluthrin + imidacloprid (31.33%), and spirotetramate + imidacloprid (30.31%). Dimethoate, sulfoxaflor and acetamiprid had minimal yield increases of 13.38%, 11.84% and 7.22%, respectively. Overall, afidopyropen 5 DC at 0.007% was the most effective treatment according to the ranking method.

Key words : Coccinellids, *Hippodamia* (Adonia) *variegata*, *Lipaphis erisimi*, Mustard, Toxicity.

Introduction

Indian mustard (*Brassica juncea*) is a key oilseed crop in Asia, particularly in India, with the highest acreage and production among the Brassica group. It plays a vital role in global agriculture, especially in regions with diverse climates, as it is adaptable and resilient to various environmental conditions. Mustard cultivation contributes to food security and provides a valuable source of income for smallholder farmers. However, mustard crops face significant threats from pests, diseases and environmental stress, which impact yield and quality. A major pest affecting mustard is the aphid (*Lipaphis erysimi*), which feeds on various plant parts, causing significant damage (Singh and Singh, 1987). Aphids are notorious pests in mustard cultivation, leading to severe yield losses by feeding on plant sap, transmitting viruses and impairing plant health. Integrated Pest Management (IPM) is a recognized approach to control pests in crops and among its techniques, biological control stands out for its use of natural enemies like predators and parasites. Entomophagous insects, especially from the Coccinellidae family, play a crucial role in IPM by preying on harmful pests.

Hippodamia variegata is a well-known predator of aphids, psyllids and other soft-bodied insects in its larval and adult stages, making it economically important for pest control (Franzman, 2002). *H. variegata* has great economic importance as a predator in their larval and adult stages with the ability to predate aphids and many soft bodied insects (Hippa *et al.*, 1978; Kring *et al.*, 1985). This predator can significantly reduce aphid populations, particularly *L. erysimi*. However, despite the benefits of biological control, insecticides remain a primary tool in IPM strategies to combat pests. This disrupts biological control dynamics, potentially leading to a resurgence of aphid populations and fostering pesticide resistance. Therefore, understanding the effects of these insecticides on beneficial predators like *H. variegata* is crucial for balancing pest management while conserving natural enemies, ensuring sustainable crop protection in mustard cultivation aiming to assess the balance between pest control efficacy and the preservation of beneficial insect populations.

Materials and Methods

In order to study the toxicity of different insecticides against coccinellids occurrence on mustard, the experiment was laid out in a Randomized Block Design with three replications having plot size of 3.00 × 3.00 m^2 during *Rabi* 2020 at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh. Mustard variety Varuna was sown at a spacing of 60 × 30 cm in November, 2019. All agronomical practices were adopted as per the recommendation in vogue. Nine different insecticides were evaluated *viz.*; Dimethoate 30 EC 0.03% @10 ml, Acetamiprid 20 SP 0.02% @10 gm, Flonicamid 50 WG 0.015% @3 gm, Afidopyropen 5 DC 0.007% @ 14 ml, Spinetoram 11.7 SC 0.011% @10 ml, Cyantraniliprole 10.26 OD 0.014% @14 ml, Sulfoxaflor 21.8 EC 0.0087% @4 ml, Beta cyfluthrin 8.49 + imidacloprid 19.81 OD 0.011% @4 ml and Spirotetramat 11.01 + imidacloprid 11.01 SC 0.022% @ 10 ml per 10 litre of water and a control (untreated).

Mustard crop was raised by following standard agronomic practices. First spray was carried out when the pest crossed its economic threshold level (ETL) *i.e.*, 1.5 aphid index (A.I.) and subsequent sprays were given at 20 days interval. Observations on number of aphids from 10 cm terminal twigs from five randomly selected plants were recorded from the net plot before first spray and at 3, 7, 10 and 14 days after each spray. To record the observation on coccinellids, number of larvae and adults were recorded from the net plot before first spray and at 3, 7, 10 and 14 days after each spray. Mustard seed yield was recorded from the net plot area in each treatment. The observations on aphid index from 10 cm terminal twigs from five randomly selected plants were recorded from the net plot prior to first spray and 3, 7, 10 and 14 day(s) after each spray. The data obtained were statistically analysed after following appropriate transformation. Number of coccinellid beetles was recorded from randomly selected five plants. Mustard seed yield (Kg /ha) was recorded from the net plot area in each treatment. Further, the toxicity of different insecticidal treatments was adjudged based on per cent reduction in the population of aphid over control in the population of aphid and coccinellids.

With a view to ascertain the effect of different insecticides on aphid, *H. variegata* in mustard, the seed yield was recorded separately from each plot. The yield was then converted on hectare basis. The per cent increase in yield over control was calculated by using the following formula.

$$\text{Per cent increase inyield over control} = \frac{\text{Yield of treatment} - \text{Yield of control}}{\text{Yield of treatment}} \times 100$$

Results and Discussion

Effect of different insecticides on aphid population

First spray

The incidence of aphid, *L. erisimi* crossed its ETL (1.5 aphid index) after 9^{th} week of sowing of the mustard crop. The bioefficacy of various insecticides has been adjudged based on pooled over periods. The data of pooled over periods (Table 1) on mean aphid index after first application of insecticides revealed that all the treatments recorded significantly lower damage [1.00 to 2.80 A.I. /plant] than control [4.43 A.I. /plant]. Among different insecticides, cyantraniliprole 10.26 OD @ 0.018% found significantly superior [1.00 A.I. /plant] to the rest of the treatments and it was found at par with afidopyropen 5 DC @ 0.007% [1.09]. The next best treatments were spinetoram 11.27 SC @ 0.011% [1.59], flonicamid 50 WG @ 0.015% [1.65], beta-cyfluthrin + imidacloprid 8.49+ 19.81 OD @ 0.011% [1.72] and spirotetramate + imidacloprid 11.01 +11.01 SC @ 0.022% [1.83] as they were found mediocre in their effectiveness against *L. erisimi* and were at par with each other. While, dimethoate 30 EC @ 0.03% [2.59], sulfoxaflor 21.8 SC @ 0.0087% [2.70] and acetamiprid 20 SP @ 0.02% [2.80] were found least effective insecticides against *L. erisimi* and were at par with each other.

Table 1 : Toxicity of different insecticides against ladybird beetles (coccinellids) in mustard after first spray.

S. no.	Treatments	Pooled over periods	
		Aphid index /plant	Coccinellid /plant
1	Dimethoate 30 EC	1.61 (2.59)	1.10 (1.20)
2	Acetamiprid 20 sp	1.68 (2.80)	1.22 (1.48)
3	Flonacamid 50 WG	1.29 (1.65)	2.24 (5.02)
4	Afidopyropen 5 DC	1.05 (1.09)	2.28 (5.21)
5	Spinetoram 11.7 SC	1.26 (1.59)	2.15 (4.63)
6	Cyantraniliprole 10.26 OD	1.00 (1.00)	2.21 (4.89)
7	Sulfloxaflor 21.8 EC	1.65 (2.70)	1.88 (3.53)
8	Beta cyfluthrin 8.49 + Imidacloprid 19.81 OD	1.31(1.72)	1.39(1.92)
9	Spiroteramate 11.01 +Imidacloprid 11.01 SC	1.35 (1.83)	1.80 (3.24)
10	Control (No Spray)	2.11(4.43)	2.55(6.49)
ANOVA			
	S.Em. ± T	0.03	0.06
	P	0.02	0.04
	T x P	0.07	0.08
	C. D. @ 5% T	0.10	0.18
	P	0.06	0.11
	T x P	NS	0.23
	C. V. %	8.94	7.54

Notes: NS: Non significant
Figures in parentheses are retransformed values; those outside are square root transformed value.

Table 2 : Toxicity of different insecticides against ladybird beetles (coccinellids) in mustard after second spray.

S. no.	Treatments	Pooled over periods	
		Aphid index /plant	Coccinellid /plant
1	Dimethoate 30 EC	1.36 (1.83)	1.68 (2.81)
2	Acetamiprid 20 sp	1.42 (2.02)	1.77 (3.13)
3	Flonacamid 50 WG	1.13 (1.27)	2.54 (6.47)
4	Afidopyropen 5 DC	0.78 (0.60)	2.57 (6.62)
5	Spinetoram 11.7 SC	0.98 (0.95)	2.48 (6.15)
6	Cyantraniliprole 10.26 OD	0.67 (0.45)	2.52 (6.33)
7	Sulfloxaflor 21.8 EC	1.39 (1.93)	2.26 (5.10)
8	Beta cyfluthrin 8.49 + Imidacloprid 19.81 OD	1.16 (1.34)	1.84 (3.39)
9	Spiroteramate 11.01 +Imidacloprid 11.01 SC	1.20 (1.42)	2.13 (4.55)
10	Control (No Spray)	2.19 (4.79)	2.92 (8.54)
ANOVA			
	S.Em. ± T	0.02	0.04
	P	0.03	0.02
	T x P	0.06	0.10
	C. D. @ 5% T	0.13	0.14
	P	0.08	0.07
	T x P	0.17	NS
	C. V. %	8.53	7.59

Notes: NS: Non significant
Figures in parentheses are retransformed values; those outside are square root transformed value.

Second spray

The second spray was carried out just after the 20 days of first spray as the pest population is very high at particular stage. The data of pooled over periods on mean aphid index after second application of insecticides (Table 2) revealed that all the treatments recorded significantly lower damage [0.45 to 2.02 A.I. /plant] than control [4.79 A.I. /plant]. Out of different insecticides, cyantraniliprole 10.26 OD @ 0.018% found significantly superior [0.45 A.I. /plant] to the rest of the treatments but it was found at par with afidopyropen 5 DC @ 0.007% [0.60]. The next best treatment was spinetoram 11.7 SC @ 0.011% [0.95] which was at par with flonicamid 50 WG @ 0.015% [1.27], beta-cyfluthrin + imidacloprid 8.49 + 19.81 OD @ 0.011% [1.34] and spirotetramate + imidacloprid 11.01 + 11.01 SC @ 0.022% [1.42] and found at par with each other which was found mediocre in their effectiveness. While, dimethoate 30 EC @ 0.03% [1.83], sulfoxaflor 21.8 SC @ 0.0087% [1.93] and acetamiprid 20 SP @ 0.02% [2.02] were found to be least effective against *L. erisimi* and were at par with each other.

Effect of different insecticides on coccinellids population

Different synthetic insecticides were also evaluated for their adverse effect on coccinellids. The periodical population of coccinellids recorded before each spray as well as 3, 7, 10 and 14 days after first and second sprays.

First spray

The pooled data on population of coccinellids (Table 1) revealed that some of the treatments are found less toxic as the coccinellids population was high in treated

Table 3 : Effect of different treatments on mustard fruit yield.

S. no.	Treatments	Seed yield (kg/ha)	Yield increase over control (kg/ha)	Percentage yield increase over control
1	Dimethoate 30 EC	1705	201	13.38
2	Acetamiprid 20 sp	1612	108	7.22
3	Flonacamid 50 WG	1998	494	32.87
4	Afidopyropen 5 DC	2260	756	50.31
5	Spinetoram 11.7 SC	2006	502	33.38
6	Cyantraniliprole 10.26 OD	2283	779	51.85
7	Sulfloxaflor 21.8 EC	1682	178	11.84
8	Beta cyfluthrin 8.49 +Imidacloprid 19.81 OD	1975	471	31.33
9	Spiroteramate11.01+Imidacloprid 11.01 SC	1959	455	30.31
10	Control (No Spray)	1504	-	-
Mean		1856	-	-
ANOVA				
S. Em. ±		79.86	-	-
C. D. @ 5%		237.26	-	-
C. V. %		7.28	-	-

Notes: Treatment mean are not significant at 5% level of significant within a column.
Yield increase over control = Yield of treatment – Yield of control.

plots. The population of coccinellids remained higher in the control plot than the treated plots. All synthetic insecticides recorded significantly lower population of coccinellids (1.20 to 5.21 per plant) as compared to control (6.49). Out of nine insecticidal treatments, the plot treated with afidopyropen 5 DC, 0.007% have recorded highest number of coccinellids (5.21 coccinellids /plant) and found least toxic insecticide. Somehow, afidopyropen 5 DC, 0.007% was found at par with flonicamid 50 WG @ 0.015% (5.02), cyantraniliprole 0.018% 10.26 OD @ (4.89) and spinetoram11.7 SC @ 0.011% (4.63) and found less toxic to coccinellids. The next treatments *i.e.*, sulfoxaflor 21.8 SC @ 0.0087% (3.53) and spirotetramate + imidacloprid 11.01 + 11.01 SC @ 0.022% (3.24) were found medium toxic to coccinellids and found at par with each other. The rest of the insecticides *i.e.*, beta-cyfluthrin + imidacloprid 8.49 + 19.81 OD @ 0.011% (1.92), acetamiprid 20 SP @ 0.02% (1.48) and dimethoate 30 EC @ 0.03% (1.20) were found highly toxic in respect to the safeness towards the coccinellids.

Second spray

The data on population of coccinellids (Table 2) revealed that there was a significant difference among the treatments after second spray. All synthetic insecticides recorded significantly lower population of coccinellids (2.81 to 6.62 coccinellids per plant) as compared to control (8.54). More or less, the same result was obtained as of first spray. Afidopyropen 5 DC, 0.007% was found the best treatment as highest number of coccinellids (6.62) was recorded in this treatment. Afidopyropen was found at par with flonicamid 50 WG @ 0.015% (6.47), cyantraniliprole 10.26 OD, 0.018% (6.33) and spinetoram 11.7 SC @ 0.011% (6.15) found less toxic to coccinellids. The next treatments *i.e.*, sulfoxaflor 21.8 SC @ 0.0087% (5.10) and spirotetramate + imidacloprid 11.01 + 11.01 SC @ 0.022% (4.55) were found medium toxic to coccinellids and found at par with each other. While, the rest of the insecticides *i.e.*, beta-cyfluthrin + imidacloprid 8.49 + 19.81 OD @ 0.011% (3.39), acetamiprid 20 SP @ 0.02% (3.13) and dimethoate 30 EC @ 0.03% (2.81) were found highly toxic in respect to the safeness towards the coccinellids.

The obtained results were compared with the results of different workers across the globe as afidopyropen was found not toxic to adult or third instar larvae of *Hippodamia convergens* (Koch *et al.*, 2019); cyantraniliprole 10% OD was found quite safer to coccinellids beetles, *Menochilus sexmaculatus* and *Coccinella septempunctata* (Shalu and Math, 2017). According to Patel *et al.* (2015), the higher population of natural enemies like coccinellids, green lacewings and spiders was observed in plots treated with cyantraniliprole 10 OD @ 45 g a.i./ha. Spinetoram 12% SC @ 300 and 375 g.a.i/ ha was found with a least adverse effect on natural enemies build up like coccinellids (Guruprasad *et al.*, 2019); Flonicamid allows for the possibility of longerterm lady beetle survivorship (Robideau, 2015). According to Visnupriya and Muthukrishnan (2019), there was negligible reduction on coccinellid population due to spinetoram 12 SC 36 g a.i./ha. In the present investigation, more or less same trend was also observed. However, no information is available on rest of the insecticides evaluated in the present investigation and hence, results could not be compared with the work done in past.

Yield increase Over Control

The seed yield increased over control was also worked out (Table 3). Maximum yield increased over control and percent yield increase over control was recorded in the plots treated cyantraniliprole 10.26 OD, 0.014% and afidopyropen 5 DC, 0.007% followed by spinetoram 11.7 SC @ 0.011%, flonicamid 50WG @ 0.015%, beta-cyfluthrin + imidacloprid 8.49 +19.81 OD @ 0.011% and spirotetramate + imidacloprid 11.01 +11.01 SC @ 0.022% was found mediocre in their effectiveness. While, very less yield increase over control was recorded in the treatments of dimethoate 30 EC @ 0.03%, sulfoxaflor 0.0087% and acetamiprid 0.02% when, it was compared with the best treatments. According to Bavisa *et al.* (2018), flonicamid 0.02%, have recorded highest yield as well as the yield increase over control of mustard crop. Except these, no information is available on rest of insecticides under present investigation for their yield and per cent increase over control and hence, results could not be supported with work done in past.

Conclusion

The present investigation concluded that damage due to *L. erisimi* in mustard is effectively managed by spray application of cyantraniliprole 10.26 OD, 0.018% and afidopyropen 5 DC, 0.007% and restrict the aphid population below ETL. While, spray application of afidopyropen 5 DC, 0.007%, flonicamid 50 WG @ 0.015%, cyantraniliprole 10.26 OD, 0.018% and spinetoram 11.7 SC @ 0.011% are found safer against coccinellids as very less mortality was found and the population were maintained throughout the crop period.

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