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Evaluation of biopesticides and Insectcidal spray Schedule against *Lipaphis erysimi* (Kaltenbach)

DS Patel, DM Jethva and AV Kchot

Abstract
Among the different insecticidal or biopesticidal spray schedules tested for their efficacy against *L. erysimi*, four sprays of each insecticides or biopesticides containing in schedule 5 (Flonicamid 50 WG 0.02%, *B. bassiana* 1.15 WP 0.006%,*V. lecanii* 1.15% WP 0.006%, Azadiractin 0.15 EC) or schedule 3 (Imidachloprid 17.8 SL 5%, *B. bassiana* 1.15 WP 0.006%,*V. lecanii* 1.15% WP 0.006%, Azadiractin 0.15 EC) or schedule 1 (*B. bassiana* 1.15% WP 0.006%) found to be the most effective and can be recommended for the management of *L. erysimi* in mustard at pre-flowering, 50% flowering, 100% flowering and 50% pod formation stage, respectively.

Keywords: *Beauveria bassiana* balsamo, vuillemin, schedule spraying, biopesticide, insecticides

Introduction
Aphid is major insect pests of mustard in Gujarat state (Keot *et al*., 2002) [6]. Nymphs and adults of aphid suck the cell sap from the inflorescence, terminal twig, siliqua (pod), leaves and branches. On severe infestation, plant gets poor pod formation, leaves get curled, shrivel and plants become completely dried. On the other hand, aphid secret honeydew, which facilitates the growth of black shooty mold that makes the leaves appear dirty black (Awasti, 2002) [2]. *L.erysimi* caused 20-50% yield loss, in extreme condition, yield loss about 78-80% and 11% oil loss (Dhaliwal *et al*., 2013) [3].
Beauveria bassiana (Balsamo) Vuillemin is a registered bio-pesticide with a broad host range of approximately 700 insect species used for the management of several crop insect pests. It can be developed in laboratory for use as mycoinsecticidal agent. Parameswaran and Sankaran (1977) [8] have first time recorded of this fungus occurring naturally in India. Rao (1975) reported the effectiveness of *B. bassiana* on more than 150 insect's species. Likewise, Dutky (1959) [4] stated that with its wide undefined host range, *B. bassiana* referred as "Magnificent pathogen".
Target pests must come into the contact with the fungal spores after direct application, movement on treated surface or bodily contact with other target pests already exposed. Infection by this fungus has generally been regarded to occur as a result of direct penetration into the integument by growing hyphae (Ferron, 1978) [5] and appears to be facilitated by both the mechanical and enzymatic activity and this kill the pest.

Materials and Methods
A field experiment was conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University. Gujarat Mustard -3 was used with spacing 45 cm x15 cm.
On the different bio-pesticidal and insecticidal spray schedules against *L. erysimi* on mustard crop was laid in Randomized Block Design and conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh during *rabi*, 2016-17.

Methodology
All the spray schedules were applied in the form of foliar spray with the help of knapsack sprayer (15 litre capacity). For deciding the quantity of spray fluid required per plot, the control plots were sprayed with water and determined the required spray fluid. Spray fluid was prepared by mixing measured quantity of water and pesticides; the necessary care was taken to prevent the drift of pesticides to reach the adjacent plots. The spray schedules were done at different crop stages *i.e*., pre-flowering stage, 50% flowering stage, 100% flowering stage and 50% pod formation.

Table 1: Detail of spray schedule

Treatments (Schedule)	Insecticide applied at crop growth stages			
	Pre-flowering	50% Flowering	100% Flowering	50% Pod formation
S_1	*B. bassiana* 1.15%WP 0.006%	*B. bassiana* 1.15% WP 0.006%	*B. bassiana* 1.15% WP 0.006%	*B. bassiana* 1.15%WP 0.006%
S_2	*V.lecanii*1.15%WP 0.006%	*V.lecanii*1.15%WP 0.006%	*V.lecanii*1.15%WP 0.006%	*V.lecanii*1.15%WP 0.006%
S_3	Imidachloprid 17.8 SL 0.005%	*B. bassiana* 1.15% WP 0.006%	*V.lecanii*1.15%WP 0.006%	Azadirachtin 0.15 EC 0.15%
S_4	Diafenthiuron 50 WP 0.05%	*B. bassiana* 1.15% WP 0.006%	*V.lecanii*1.15%WP 0.006%	Azadirachtin 0.15 EC 0.15%
S_5	Flonicamid 50 WG 0.02%	*B. bassiana* 1.15%WP 0.006%	*V.lecanii*1.15%WP 0.006%	Azadirachtin 0.15 EC 0.15%
S_6	Acetamiprid 20 SP 0.004%	Flonicamid 50 WG 0.02%	Diafenthiuron 50 WP 0.05%	Imidachloprid 17.8SL 0.005%
S7 (Control)	Water Spray	Water Spray	Water Spray	Water Spray

Method of recording observations

To evaluate the effectiveness of different spray schedules for the *L. erysimi*, five plants were selected randomly from each treatment plot and observations of aphid recorded 24 hour before spray, 3, 7 and 10 days after each spray schedules. The average data record on aphid index subjected to statistical analysis. Mustard aphids sit in an overlapping manner and hence, it was difficult to record aphid on numerical basis. Hence, aphid index was given for determining aphid population as described by Patel *et al.* (1995) [10]. The observations on aphid index recorded visually from five randomly plant from each plot. On the average aphid index was worked out by the following formula.

Table 2: Show the aphid index and criteria

Aphid index	Criteria
0	Plant free from aphid infestation.
1	Only few aphids with very little injury.
2	Small colonies on few twigs, no curling or yellowing of leaves.
3	Aphid colonies on almost all the twigs, stunted growth, curling and yellowing of leaves.
4	Very heavy population of aphids on inflorescence, leaves, stem and siliqua (pod).
5	Complete drying of plants due to heavy infestation of aphids.

The average aphid index was worked out by using the following formula.

$$\text{Average aphid index} = \frac{0N + 1N + 2N + 3N + 4N + 5N}{\text{Total number of plants observed}}$$

Where

0, 1, 2, 3, 4, 5 are the aphid index.
N = Number of plant showing respective aphid index.

Statistical Analysis

Statistical analysis was carried out using ANOVA technique given by Panse and Sukhatme (1985) [7].

Results and Discussion

Evaluation of bio-pesticides and insecticidal spray schedules at pre-flowering stage

Observation on aphid population were recorded from five randomly selected and tagged plants in each treatment before spray and 3, 7 and 10 days of spraying.

During present study, Schedule 5 flonicamid found to be the most effective. It recorded the highest mortality (1.00 aphid index/plant) than other treatments. While diafenthiuron found to be less effective than other treatments. Which in close agreement with the work of Roy and Debnath (2016) [11], flonicamid recorded the, highest aphid mortalities after 7 days of first spray. More or less similar tread was also notice in this study.

Table 3: Effectiveness of spray schedules against, *L. erysimi* at pre-flowering stage

Sr. No.	Treatments	Aphid index/plant at pre-flowering stage				
		Before 24 hours	3 DAS	7 DAS	10 DAS	Mean
1.	Schedule 1	1.41 (2.00)	1.14 (1.30)	1.00 (1.00)	1.00 (1.00)	1.05 (1.09)
2.	Schedule 2	1.61 (2.59)	1.52 (2.31)	1.38 (1.91)	1.14 (1.30)	1.35 (1.81)
3.	Schedule 3	1.52 (2.31)	1.28 (1.63)	1.14 (1.30)	1.28 (1.63)	1.35 (1.51)
4.	Schedule 4	1.63 (2.64)	1.52 (2.31)	1.41 (2.00)	1.52 (2.31)	1.48 (2.20)
5.	Schedule 5	1.14 (1.30)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)	1.00 (1.00)
6.	Schedule 6	1.41 (2.00)	1.14 (1.30)	1.14 (1.30)	1.28 (1.63)	1.18 (1.40)
7.	Schedule 7 (Control)	1.52 (2.31)	1.73 (3.00)	1.82 (3.32)	1.90 (3.60)	1.82 (3.30)
S.Em. ±		0.11	0.09	0.10	0.10	0.05
C.D. at 5%		NS	0.30	0.33	0.31	0.17
C.V. %		13.76	12.82	14.76	12.82	7.71

Figures in parentheses are original values while outsides are retransformed value DAS = Days after Spraying

Evaluation of bio-pesticides and insecticidal spray schedules at 50% flowering stage

Present finding showed that schedule 1 *B. bassiana* was highly effective and gave 0.63 aphid index/plant while *V. lecanii* found least effective in management of *L. erysimi*, this support the study of Araujo *et al*. (2009) [1], who stated that *B. bassiana* 10^7spore ml caused 90% mortality after 4.4 days, which corroborate with the present findings.

Table 4: Effectiveness of spray schedules against mustard, *L. erysimi* at 50% flowering stage

Sr. No.	Treatments	Aphid index/plant at 50% flowering stage				
		Before 24 hours	3 DAS	7 DAS	10 DAS	Mean
1.	Schedule 1	1.41 (2.00)	1.38 (1.91)	1.14 (1.30)	1.00 (1.00)	0.80 (0.63)
2.	Schedule 2	1.52 (2.31)	1.41 (2.00)	1.28 (1.63)	1.28 (1.63)	1.32 (1.75)
3.	Schedule 3	1.41 (2.00)	1.28 (1.63)	1.14 (1.30)	1.14 (1.30)	1.18 (1.40)
4.	Schedule 4	1.52 (2.31)	1.39 (1.93)	1.28 (1.63)	1.14 (1.30)	1.27 (1.61)
5.	Schedule 5	1.14 (1.30)	1.14 (1.30)	1.00 (1.00)	1.00 (1.00)	1.05 (1.09)
6.	Schedule 6	1.28 (1.63)	1.00 (1.00)	1.00 (1.00)	1.41 (2.00)	1.14 (1.30)
7.	Schedule 7 (Control)	1.63 (2.64)	1.73 (3.00)	1.82 (3.32)	1.90 (3.61)	1.82 (3.30)
S.Em. ±		0.10	0.11	0.10	0.11	0.08
C.D. at 5%		NS	0.35	0.31	0.36	0.25
C.V. %		12.44	14.91	14.46	15.98	11.03

Figures in parentheses are original values while outsides are retransformed value DAS = Days after Spraying

Evaluation of bio-pesticides and insecticidal spray schedules at 100% flowering stage

From all spray, Schedule 3 (*V. lecanii* 1.15 WP 0.006%) was highly effective which is in complete conformity with the results found by Parmar and Kapadia (2007) [9] who stated that the mustard leaves treated with *V. lecanii* @ 4.0 g/litre caused mortality in *L. erysimi* up to 10 days of its application and was found most effective with 17.00, 24.00, 44.33, 56.33 and 58.67% nymphal mortality, respectively.

Table 5: Effectiveness of spray schedules against mustard, *L. erysimi* at 100% flowering stage

Sr. No.	Treatments	Aphid index/plant at 100% flowering stage				
		Before 24 hours	3 DAS	7 DAS	10 DAS	Mean
1.	Schedule 1	1.79 (3.22)	1.52 (2.31)	1.41 (2.00)	1.28 (1.63)	1.40 (1.97)
2.	Schedule 2	1.73 (3.00)	1.63 (2.64)	1.52 (2.31)	1.28 (1.63)	1.47 (2.17)
3.	Schedule 3	1.38 (1.91)	1.28 (1.63)	1.14 (1.30)	1.00 (1.00)	1.14 (1.30)
4.	Schedule 4	1.63 (2.64)	1.52 (2.31)	1.41 (2.00)	1.28 (1.63)	1.40 (1.97)
5.	Schedule 5	1.52 (2.31)	1.41 (2.00)	1.14 (1.30)	1.14 (1.30)	1.23 (1.51)
6.	Schedule 6	1.63 (2.64)	1.28 (1.63)	1.41 (2.00)	1.63 (2.64)	1.44 (2.07)
7.	Schedule 7 (Control)	1.90 (3.61)	1.91 (3.65)	2.00 (4.00)	2.08 (4.32)	2.00 (3.99)
S.Em. ±		0.10	0.10	0.06	0.11	0.08
C.D. at 5%		NS	0.32	0.21	0.34	0.24
C.V. %		11.41	12.08	8.32	14.02	7.71

Figures in parentheses are original values while outsides are retransformed value DAS = Days after Spraying

Evaluation of bio-pesticides and insecticidal spray schedules at 50% pod formation stage

Mean data on incidence of aphid recorded in various insecticidal treatments during 2016-17 are presented in Table 6 indicated that all the treatments were found significantly superior over the control in reducing the aphid population. The treatment of imidacloprid 17.8 SL 0.005% (S_6) found significantly superior, as it recorded the lowest aphid index (1.19) aphid index/plant and it was at par with *B. bassiana* 1.15 WP 0.006% (S_1). Azadirachtin 0.15 EC 0.15% contained in schedule 3 and 5, as they gave 1.30, 1.51and 1.51 aphid index/plant, respectively. The remaining treatments of azadirachtin 0.15 EC 0.15% (S_4) and *V. lecanii* 1.15 WP 0.006% (S_2) were found least effective against aphid, as they registered 2.20 and 2.31 aphid index/ plant, respectively.

Table 6: Effectiveness of spray schedules against mustard, *L. erysimi* at 50% pod formation stage

Sr. No.	Treatments	Aphid index/plant at 50% Pod formation stage				
		Before 24 hours	3 DAS	7 DAS	10 DAS	Mean
1.	Schedule 1	1.72 (2.94)	1.28 (1.63)	1.14 (1.30)	1.00 (1.00)	1.14 (1.30)
2.	Schedule 2	1.73 (3.00)	1.63 (2.64)	1.52 (2.31)	1.41 (2.00)	1.52 (2.31)
3.	Schedule 3	1.38 (1.91)	1.28 (1.63)	1.14 (1.30)	1.28 (1.63)	1.23 (1.51)
4.	Schedule 4	1.63 (2.64)	1.52 (2.31)	1.41 (2.00)	1.52 (2.31)	1.48 (2.20)
5.	Schedule 5	1.52 (2.31)	1.28 (1.63)	1.14 (1.30)	1.28 (1.63)	1.23 (1.51)
6.	Schedule 6	1.63 (2.64)	1.14 (1.30)	1.00 (1.00)	1.14 (1.30)	1.09 (1.19)
7.	Schedule 7 (Control)	1.73 (3.00)	1.82 (3.32)	1.91 (3.65)	2.00 (4.00)	1.91 (3.65)
S.Em. ±		0.10	0.12	0.11	0.10	0.04
C.D. at 5%		NS	0.37	0.34	0.30	0.15
C.V. %		10.77	15.04	14.77	12.61	6.29

Figures in parentheses are original values while outsides are retransformed value DAS = Days after Spraying

Conclusion

Looking to the overall effectiveness of various insecticidal spray schedules tested against *L. erysimi*, it can be concluded that the spraying of schedule 5 (Flonicamid 50 WG 0.02%, *B. bassiana* 1.15 WP 0.006%,*V. lecanii* 1.15% WP 0.006%,Azadiractin 0.15 EC) and schedule 3 (Imidachloprid 17.8 SL 5%, *B. bassiana* 1.15 WP 0.006%,*V. lecanii* 1.15% WP 0.006%, Azadiractin 0.15 EC) at all the growth stages of mustard(Pre-flowering, 50% flowering, 100% flowering and 50% pod formation) were found significantly the most effective treatments, that recorded the lowest population of *L. erysimi*. The next effective spray schedule at various crop growth stages was schedule 1 consisted of four sprays of *B. bassiana*1.15%WP 0.006% at various crop growth stages, showed moderate population of *L. erysimi*. The rest of the spray schedules like schedule 6 (Acetamiprid 20 SP 0.004%, flonicamid 50 WG 0.02%, diafenthiuron 50 WP 0.025%, imidachlopridl 17.8 SL 0.005%), schedule 4 (Diafenthiuron 50 WP 0.025%, *B. bassiana* 1.15 WP 0.006%, *V. lecanii* 1.15% WP 0.006%, azadiractin0.15 EC) and Schedule 2 containing *V. lecanii*1.15% WP 0.006% in all growth stages were found poor in performance for the control of *L.erysimi*.

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