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Management of painted bug, *Bagrada hilaris* (Burmeister) in mustard with different spray schedules

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Abstract
The bio-efficacy of five insecticidal spray schedules against painted bug, *Bagrada hilaris* Burmeister in mustard was evaluated. The field experiment was conducted at Instructional Farm, College of Agriculture, JAU, Junagadh (Gujarat) during *rabi* 2012-13 and 2013-14. The results revealed that schedule 4 consisting of flonicamid 50 WG @ 0.02 per cent at seedling stage, flubendiamide 480 SC @ 0.014 per cent at pre-flowering stage, azadirachtin 1500 ppm @ 0.15 per cent at 50% flowering stage and acephate 25 + fenvalerate 3 EC @ 0.028 per cent at 50% pod formation stage was significantly. Superior treatment which recorded highest per cent mortality (74.58) over stage of the crop and year, whereas the schedule S_1 (71.75 per cent mortality) proved next better effective schedule against mustard painted bug. The highest grain yield was found in schedule S_4 (1302 kg/ha) followed by S_3 (1218 kg/ha) and S_5 (1172 kg/ha). The lowest grain yield was recorded in untreated control schedule S_6 (500 kg/ha). The highest net realization was found in schedule S_4 (29674 Rs/ha) followed by schedule S_3 (26566 Rs/ha). The schedule S_2 generated highest ICBR ratio (1:6.7) followed by schedule S_3 (1:6.3) and schedule S_4 (1:6.3) whereas, schedule S_1 (1:3.1) gave significantly lower ICBR than other schedules. Thus, schedule S_2 (imidacloprid 17.8 SL + indoxacarb 14.5 SC + *L. lecanii* @ 2.0 kg/ha and triazophos 35 + deltamethrin 1 EC) and S_3 (thiamethoxam 25 WG + emamectin benzoate 5 WG + *N. rileyi* @ 2.5 kg/ha and chlorpyriphos 16 + alphamethrin 1 EC) can be suggested for the effective and economical management of mustard painted bug.

Keywords: Management, insecticides, spray schedules, mustard, painted bug

Introduction
Mustard, *Brassica juncea* (Linnaeus) Czern and Coss (family: cruciferae) is an important oilseed crop and a major source of edible oil [9]. It is second most important oilseed crop of the world as well as India after groundnut and in India it occupies an area of 6652 million hectare with total production of 7109 million tonnes and productivity of 1069 kg/ha during 2016-2017. It is also important *rabi* oilseed crop in Gujarat and cultivated in 200 million hectares of area with total production of 303 million tonnes with productivity of 1515 kg/ha [3].
About 50 insect species have been found infesting mustard in India among which, painted bug, *Bagrada hilaris* (Burmeister) is the most important pest of crucifer crops in India [12]. It causes damage to mustard at the seedling as well ae pod formation stage. The losses at seedling stage varied from 26.8 to 70.8 per cent whereas at the pod formation and maturity stages 30.1 per cent losses in yield and 3.4 per cent in oil content has been reported [14].
Management of insect-pest is the basic requirement for attending higher seed yield and good quality. Peak activity as well as nature of damage of these pests varies from pest to pest. Hence, a single insecticide will not provide effective control of these pests attacking at various stages of mustard crop. Secondly, at flowering stage honeybees play a vital role in pollination and ultimately help in increase in seed yield of mustard. Therefore, in mustard crop, it is prime need to develop such insecticidal module which not only effectively control the various pests attacking the crop but also provide safety to honeybee. Hence, in the present study few insecticides were selected according to activity of pests and stages of the crop.
The information regarding most effective insecticide for the control of mustard painted bug at various stages of crop the most effective schedule have been generated for control of major insect pest of mustard.

Materials and Methods
To evaluate various insecticidal spray schedules against painted bug, *Bagrada hilaris*, a field

experiment was conducted at Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh (Gujarat) during *rabi* 2012-13 and 2013-14. Gujarat Mustard-3 variety was sown at spacing of 45 x 15 cm with following recommended package of practices except plant protection. The experiment consisted of four replications and 6 insecticidal spray schedules.

During the seedling stage *i.e.* 20 to 25 days after sowing, various schedules commenced with the application of acetamiprid 20 SP (S_1), imidacloprid 17.8 SL (S_2), thiamethoxam 25 WG (S_3), flonicamid 50 WG (S_4) and monocrotophos 36 SL (S_5) as first spray, while during pre-flowering stage *i.e.*, 45 to 55 days after sowing, second application of spinosad 45 SC (S_1), indoxacarb 14.5 SC (S_2), emamectin benzoate 5 WG (S_3), flubendiamide 480 SC (S_4) and quinalphos 25 EC (S_5) insecticides in corresponding schedules were made. At the time of 50 per cent flowering stage (60 to 65 days after sowing), the insecticides were applied in schedule of *Beauveria bassiana* @ 2.5 kg/ha (S_1), *Lecanicillium lecanii* @ 2.0 kg/ha (S_2), *Nomuraea rileyi* @ 2.5 kg/ha (S_3), azadirachtin @ 1500 ppm (S_4) and NSKE 5% (S_5). Further, another spray of insecticides were applied profenophos 40 + cypermethrin 4 EC (S_1), triazophos 35 EC + deltamethrin 1 (S_2), chlorpyriphos 16 + alphamethrin 1 EC (S_3), acephate 25 + fenvalerate 3 EC (S_4) and ethion 40 + cypermethrin 5 EC (S_5) at 50 per cent pod formation *i.e.* 70 to 75 days after sowing. For deciding the quantity of spray fluid required, control plots were sprayed with water. Spray fluid was prepared by mixing measured quantity of water and insecticides. All necessary care was taken to prevent the drift of insecticides to reach the adjacent plots. When population of *B. hilaris* crossed its ETL level, the first spray schedule was given on 25th December at seedling stage in both the years. Similarly, the second, third and fourth spray schedule was given at twenty days interval, *i.e.* on 15th January at pre-flowering stage, 5th February at 50 per cent flowering stage and 26th February at 50 per cent pod formation stage during 2012-13 and 2013-14.

Generally, the observations were recorded visually during early morning from five randomly selected plants from each plot [5]. A pre-spray observation was taken and subsequently the observations on number of bugs were recorded at 1, 3 and 7 days after spray from each treatment. The population of painted bug obtained was converted to per cent mortality and the data thus obtained were subjected to appropriate transformation and analyzed statistically [7].

Yield

The grain yield obtained from each net plot of insecticidal treatments was converted on hectare basis and were subjected to statistical analysis. The percentage of yield increased and avoidable yield losses were worked out [11].

$$\text{Yield increase (\%)} = 100 \times \left[\frac{T - C}{C}\right]$$

$$\text{Avoidable yield loss (\%)} = 100 \times \left[\frac{T - C}{T}\right]$$

Where,

T= Yield of respective treatment (kg/ha)

C= Yield of control (kg/ha)

Before arriving at gross realization over control and net gain over control, increase in yield over control in each treatment was worked out by deducting the yield obtained in untreated plot from yield of each treatment. Thereafter, gross realization was assessed by multiplying the yield of each treatment [8].

Results and Discussion

Insecticidal schedules against painted bug

At seedling stage

The mean per cent mortality of painted bug (Table1) at seedling stage recorded during 2012-13 showed that the flonicamid 50 WP (S_4) was found superior than rest of insecticidal treatments as it recorded highest *i.e.* 84.25 per cent mortality and it did not differ significantly with acetamiprid 20 SP (S_1) as it registered 81.33 per cent mortality of the pest. However, treatment of imidacloprid 17.8 SL (S_2) was found next in order with 64.16 per cent mortality while, thiamethoxam 25 WG (S_3) noted 55.50 per cent mortality and found moderately effective against painted bug. Monocrotophos 36 SL (S_5) was found least effective treatment to control of mustard painted bug as it recorded 49.83 per cent mortality.

In the second year *i.e.* 2013-14, more or less the same results were obtained in which, highest (82.25 per cent) mortality of painted bug was found in schedule S_4 which was at par with schedule S_1 which registered 80.58 per cent mortality of painted bug.

Pooled data showed the same results and schedule (S_4) registered highest per cent mortality of painted bug (83.25) than all other treatments. Looking to the effectiveness of treatments the chronological order of treatments are as follows: flonicamid 50 WG (S_4) > acetamiprid 20 SP (S_1) > imidacloprid 17.8 SL (S_2) > thiamethoxam 25 WG (S_3) > monocrotophos 36 SL (S_5).

At pre-flowering stage

In the pre-flowering stage (Table 2), per cent mortality recorded during 2012-13 indicated that the treatment of flubendiamide 480 SC (S_4) registered highest mean per cent mortality (84.00) and it was statistically at par with treatment of spinosad 45 SC (S_1) gave 80.83 per cent mortality of the pest whereas, indoxacarb 14.5 SC (S_2) gave 69.25 per cent mortality while the treatment of emamectin benzoate 5 WG (S_3) found moderately effective against painted bug and registered 59.58 per cent mortality. The treatment of quinalphos 25 EC (S_5) was found least effective against mustard painted bug at pre-flowering stage (showed 48.58 per cent mortality).

In the second year *i.e.* 2013-14, more or less the same results were obtained in which, highest (80.91 per cent) mortality of painted bug was found in schedule S_4 which was at par with schedule S_1 which registered 77.41 per cent mortality of painted bug.

Pooled over year data indicated that the order of efficacy of various treatments were flubendiamide 480 SC (S_4) > spinosad 45 SC (S_1) > indoxacarb 14.5 SC (S_2) > emamectin benzoate 5 WG (S_3) and quinalphos 25 EC (S_5) with painted bug 82.45, 79.12, 69.04, 59.62 & 49.70 per cent mortality, respectively.

At 50 per cent flowering stage

The data presented in Table 3 on pooled results of effectiveness of insecticides against mustard painted bug revealed that the maximum reduction was recorded in the

treatment of azadirachtin 1500 ppm (S_4) with 63.75 per cent mortality however, it was statistically at par with treatment of *B. bassiana* @ 2.5 kg/ha (S_1) (60.25 per cent). The treatment of *L. lecanii* @ 2.0 kg/ha (S_2) was found next in order and recorded 51.16 per cent mortality while, *N. rileyi* @ 2.5 kg/ha (S_3) showed moderately effective for control of the pest and gave 44.41 per cent mortality. The NSKE 5% (S_5) was found least effective against mustard painted bug and provided 38.16 per cent mortality of pest.

In the second year *i.e.* 2013-14, more or less the same results were obtained in which, highest (57.41 per cent) mortality of painted bug was found in schedule S_4 which was at par with schedule S_1 which registered 55.33 per cent mortality of painted bug at 50 per cent flowering stage.

Thus, looking to the overall effectiveness of various insecticidal spray schedules tested against mustard painted bug (2012-13 and 2013-14). It can be concluded that the schedule (S_4) *i.e.* azadirachtin 1500 ppm was found the highest (60.58%) mortality of painted bug than all other treatments.

At 50 per cent pod formation stage

The population of mustard painted bug at 50 per cent pod formation stage (Table4) after spraying of different spray module showed that the treatment of acephate 25+ fenvalerate 3 EC (S_4) was the most effective as it recorded 76.91 per cent mortality of painted bug and it did not differ significantly from treatment of profenophos 40 + cypermethrin 4 EC (S_1) and registered 73.66 per cent mortality of the pest. The next better treatment was triazophos 35 + deltamethrin 1 EC (S_2) provided 64.16 per cent mortality of the pest, while treatment of chlorpyriphos 16 + alphamethrin 1 EC (S_3) found moderately effective (54.50 % mortality). The treatment of ethion 40 + cypermethrin 5 EC (S_5) was found least effective caused 45.25 per cent mortality of mustard painted bug.

In the second year *i.e.* 2013-14, more or less the same results were obtained in which, highest (67.16 per cent) mortality of painted bug was found in schedule S_4 which was at par with schedule S_1 which registered 64.58 per cent mortality of painted bug at 50 per cent pod formation stage.

The overall order of effectiveness of various treatments (schedules) in reducing per cent mortality of mustard painted bug, *B. hilaris* was acephate 25 + fenvalerate 3 EC (S_4)> profenophos 40 + cypermethrin 4 EC (S_1) > triazophos 35 EC + deltamethrin 1 (S_2) > chlorpyriphos 16 + alphamethrin 1 EC (S_3) > ethion 40 + cypermethrin 5 EC (S_5) during both years (2012-13 and 2013-14).

Thus, looking to the overall effectiveness of various insecticidal spray schedules tested against mustard painted bug presented in Table 5, indicate that treatment like flonicamid 50 WG at seedling stage, flubendiamide 480 SC at pre-flowering stage, azadirachtin 1500 ppm at 50 per cent flowering stage and acephate 25 + fenvalerate 3 EC at 50 per cent pod formation stage found significantly the most effective gave highest per cent mortality of mustard painted bug over stage of the crop and year. The next effective spray schedule was schedule no. 1 consisting of acetamiprid 20 SP, spinosad 45 SC, *B. bassiana*@ 2.5 kg/ha and profenophos 40 + cypermethrin 4 EC at various crop growth stages.

Very little information is available related to effective spray schedule of different treatments against painted bug infesting mustard. However, the effective management of painted bug in mustard imidacloprid @ 7 and 14 g/kg was found superior than seed treatment of imidacloprid @ 5 g/kg seed and standard check, methyl parathion @ 25 kg/ha [2]. The phosphamidon, chlorpyriphos, dimethoate and methyl parathion as effective and cypermethrin as the best treatment for the controlling of painted bug under laboratory condition [6].

Studies conducted on chemical control of revealed that, fenvalerate 0.4 D @ 8 kg per acre effectively checked painted bug, *B. hilaris* infesting turnip [4]. According to higher painted bug control and yield was obtained by imidacloprid 17.8 SL@ 40 g a.i./ha, spinosad 45 SC @ 75 g a.i./ha, indoxacarb 14.5 SC @ 75 g a.i./ha and acetamiprid 20 SP @ 40 g a.i./ha [16]. The treatment of fenvalerate 0.4 % dust was found effective for control of painted bug in mustard [13]. The treatments of spinosad 45 SC @ 75 g/ha and acetamiprid 20 SP @ 40 g/ha were found significantly superior against *B. hilaris* in mustard [15].

Grain yield

The data presented in Table 6 indicated that all insecticidal spray schedules gave significantly higher grain yield of mustard as compared to control. Among the six spray schedules, S_4 recorded the highest grain yield *i.e.* 1302 kg/ha of mustard, followed by S_3 (1218 kg/ha) and S_5 (1172 kg/ha). The lowest grain yield was recorded in schedule S_6 *i.e.* control (500 kg/ha). Data presented in Table 6 indicated that the highest (160.4) per cent increase in yield over control was recorded in schedule S_4 followed by S_3 (143.6%) and S_5 (134.4%). The overall order of effectiveness of various treatments (schedules) in term of grain yield was $S_4 > S_3 > S_5 > S_6$ (Untreated control).

Economics

It is evident from the data that highest gross realization was obtained in schedule S_4 (48174 Rs/ha), followed by schedule S_3 (45066 Rs/ha). Schedule S_1 gave lowest gross realization (33929 Rs/ha) (Table 7). Similar trend was observed while considering the net realization, wherein highest net realization was obtained again from schedule S_4 (29674 Rs/ha) followed by schedule S_3 (26566 Rs/ha). Whereas, minimum net realization was recorded from schedule S_1 (15429 Rs/ha) (Table7). [1] The result revealed that sowing of mustard seed treated with imidacloprid @ 5-7 g/kg in second fortnight of October in dry soil followed by irrigation gives higher productivity (2769-2859 kg/ha), higher economic returns (Rs. 41102-42666) and lower plant damage (4.9-5.8%) due to *B. hilaris*.

From the above results, it is evident that both gross realization and net realization were comparatively higher in schedule S_4 followed by schedule S_3.

Incremental cost benefit ratio (ICBR)

The Incremental cost benefit ratio (ICBR) for different schedules were worked out and presented in Table7. The data on ICBR *i.e.* gain in rupees per cost of rupee per treatment indicated that schedule S_2 generated highest ICBR ratio (1:6.7) followed by schedule S_3 (1:6.3) and schedule S_4 (1:6.3), whereas schedule S_1 (1:3.1) gave significantly lower ICBR ratio than other schedules (Table 7).

Though, schedule S_4 recorded highest grain yield with highest per cent mortality of painted bug population, the ICBR was 1:6.7 this was due to lowest price of chemicals.

The effectiveness of various insecticidal spray schedules against mustard painted bug, *B. hilaris* was evaluated by overall rank method. For this purpose, all

treatments/schedules were given their individual rank in descending order of their effectiveness for different characters studies.

These ranks of individuals characters under study were summed up and ranked (Table 8). The schedule S_4 was found most effective over rest of treatments/schedules and occupied first rank. The order of effectiveness of different insecticidal spray schedules against mustard painted bug, *B. hilaris* based on rank was found to be $S_4 > S_3 > S_2 > S_1 > S_5 > S_6$ (Untreated control).

Nagar *et al.* [10] observed that the highest incremental cost benefit ratio of 1:11.7 was obtained in malathion 50 EC @ 500 ml/500 litre of water. Singh *et al.*, [16] reported that the most favorable incremental cost benefit ratio was obtained by the treatments *i.e.* imidacloprid 17.8 SL@ 40 g a.i./ha (1:32) followed by acetamiprid 20 SP @ 40g a.i./ha (1:28), dimethoate 30 EC @ 300 g a.i./ha (1:27), oxy-demeton methyl 25 EC @ 250 g a.i./ha (1:19), indoxacarb 14.5 SC @ 75 g a.i./ha (1:17.0), spinosad 45 SC @ 75 g a.i./ha (1:17) and fipronil 5 SC @ 75 g a.i./ha (1:9).

Table 1: Effectiveness of spray schedules against *B. hilaris* at seedling stage

Sr. No.	Treatments	Mean per cent mortality								Pooled
		2012-13			Pooled over periods	2013-14			Pooled over periods	
		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
1	S_1 Acetamiprid 20% SP	68.34 (86.38)	70.36 (88.71)	57.17 (70.60)	65.28 (81.33)	63.64 (80.28)	66.07 (83.54)	62.22 (78.28)	63.97 (80.58)	64.63 (80.95)
2	S_2 Imidacloprid 17.8% SL	51.60 (61.41)	60.41 (75.62)	48.75 (56.52)	53.58 (64.16)	51.37 (61.02)	57.06 (70.43)	50.17 (58.98)	52.86 (63.16)	53.22 (63.66)
3	S_3 Thiamethoxam 25% WG	48.39 (55.90)	53.52 (64.66)	43.13 (46.73)	48.34 (55.50)	47.46 (54.28)	50.48 (59.51)	46.26 (52.20)	48.06 (55.08)	48.20 (55.29)
4	S_4 Flonicamid 50% WG	70.68 (89.05)	72.17 (90.63)	59.73 (74.59)	67.52 (84.25)	65.25 (82.47)	67.58 (85.46)	63.69 (80.36)	65.50 (82.25)	66.51 (83.25)
5	S_5 Monocrotophos 36% SL	46.07 (51.86)	48.79 (56.60)	39.93 (41.20)	44.93 (49.83)	44.29 (48.76)	45.87 (51.52)	43.10 (46.69)	44.42 (49.00)	44.67 (49.41)
S.Em. ±		2.87	3.00	2.59	1.63	2.33	2.81	2.31	1.50	0.92
C.D. at 5 %		8.64	9.03	7.82	4.64	7.02	8.45	6.95	4.28	2.73
C.V. %		12.07	11.78	12.52	12.11	10.28	11.73	10.43	11.28	4.92

Figures in parentheses are retransformed values, those outside were arcsine values DAS = Days after spraying

Table 2: Effectiveness of spray schedules against *B. hilaris*at pre-flowering stage

Sr. No.	Treatments	Mean per cent mortality								Pooled
		2012-13			Pooled over periods	2013-14			Pooled over periods	
		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
1	S_1 Spinosad 45% SC	66.23 (83.76)	68.66 (86.76)	59.20 (73.78)	64.69 (80.83)	61.68 (77.50)	64.33 (81.24)	60.64 (75.96)	62.21 (77.41)	63.45 (79.12)
2	S_2 Indoxacarb 14.5% SC	56.81 (70.04)	61.05 (76.57)	52.46 (62.88)	56.77 (69.25)	54.58 (66.41)	58.61 (72.87)	55.47 (67.87)	56.22 (68.83)	56.49 (69.04)
3	S_3 Emamectin benzoate 5% WG	48.67 (56.39)	55.83 (68.45)	47.47 (54.31)	50.65 (59.58)	49.56 (57.92)	54.00 (65.45)	48.69 (56.42)	50.74 (59.66)	50.70 (59.62)
4	S_4 Flubendiamide 480% SC	67.27 (85.07)	70.22 (88.55)	63.45 (80.03)	66.98 (84.00)	63.60 (80.23)	66.41 (83.99)	62.94 (79.31)	64.31 (80.91)	65.64 (82.45)
5	S_5 Quinalphos 25% EC	43.69 (47.72)	47.22 (53.88)	41.67 (44.20)	44.19 (48.58)	45.00 (50.00)	47.18 (53.81)	44.28 (48.75)	45.48 (50.83)	44.84 (49.70)
S.Em. ±		2.85	2.62	3.36	1.71	2.71	3.21	2.91	1.70	0.64
C.D. at 5 %		8.59	7.91	10.14	4.87	8.18	9.68	8.76	4.85	1.89
C.V. %		12.10	10.39	15.28	12.55	11.86	13.26	12.82	12.69	3.37

Figures in parentheses are retransformed values, those outside are arcsine values DAS = Days after spraying

Table 3: Effectiveness of spray schedules against *B. hilaris*at 50% flowering stage

Sr. No.	Treatments	Mean per cent mortality								Pooled
		2012-13			Pooled over periods	2013-14			Pooled over periods	
		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
1	S_1 *B. bassiana* 2.5 kg/ha	47.95 (55.13)	51.57 (61.37)	53.65 (64.86)	51.05 (60.25)	44.00 (48.25)	48.75 (56.52)	51.57 (61.37)	48.10 (55.33)	49.57 (57.79)
2	S_2 *L. lecanii* 2 kg/ha	42.10 (44.95)	46.30 (52.26)	48.67 (56.39)	45.69 (51.16)	39.46 (40.39)	42.26 (45.23)	47.75 (54.79)	43.15 (46.91)	44.42 (49.04)
3	S_3 *N. rileyi* 2.5 kg/ha	39.22 (39.97)	41.82 (44.47)	44.28 (48.75)	41.77 (44.41)	36.14 (34.79)	39.65 (40.71)	42.10 (44.95)	39.29 (40.25)	40.53 (42.33)
4	S_4 Azadirachtin 1500 ppm	50.07 (58.80)	53.43 (64.51)	55.91 (68.59)	53.13 (63.75)	45.72 (51.25)	49.63 (58.04)	52.71 (63.29)	49.35 (57.41)	51.24 (60.58)
5	S_5 NSKE 5%	35.17 (33.17)	37.71 (37.42)	41.33 (43.61)	38.06 (38.16)	33.82 (30.98)	36.99 (36.20)	37.71 (37.42)	36.17 (35.00)	37.12 (36.58)
S.Em. ±		1.81	2.16	2.90	1.34	2.16	1.97	2.27	1.23	0.59
C.D. at 5 %		5.46	6.52	8.73	3.84	6.50	5.95	6.85	3.51	1.75
C.V. %		10.13	11.25	14.25	12.2	13.00	10.90	11.76	11.87	3.92

Figures in parentheses are retransformed values, those outside are arcsine values DAS = Days after spraying

Table 4: Effectiveness of spray schedules against *B. hilaris*at 50% pod formation

Sr. No.	Treatments	Mean per cent mortality								Pooled
		2012-13			Pooled over periods	2013-14			Pooled over periods	
		1 DAS	3 DAS	7 DAS		1 DAS	3 DAS	7 DAS		
1	S_1 Profenophos 40 + cypermethrin 4% EC	57.13 (70.55)	62.32 (78.43)	58.94 (73.39)	59.46 (73.66)	51.78 (61.72)	57.13 (70.54)	52.25 (62.52)	53.71 (64.58)	56.59 (69.12)
2	S_2 Triazophos 35 + deltamethrin 1% EC	54.00 (65.45)	55.52 (67.95)	50.85 (60.15)	53.45 (64.16)	47.30 (54.02)	48.62 (56.31)	48.75 (56.52)	48.22 (55.58)	50.84 (59.87)
3	S_3 Chlorpyriphos 16 + alphamethrin 1% EC	45.72 (51.25)	51.45 (61.16)	45.79 (51.37)	47.65 (54.50)	43.27 (46.98)	44.28 (48.75)	41.98 (44.74)	43.17 (46.83)	45.41 (50.66)
4	S_4 Acephate 25 + fenvalerate 3% EC	60.18 (75.27)	64.75 (81.80)	60.44 (75.67)	61.78 (76.91)	54.19 (65.77)	58.26 (72.32)	53.23 (64.16)	55.22 (67.16)	58.50 (72.04)
5	S_5 Ethion 40 + cypermethrin 5% EC	40.38 (41.97)	45.01 (50.01)	41.38 (43.69)	42.25 (45.25)	39.93 (41.20)	40.97 (42.98)	39.15 (39.87)	40.01 (41.41)	41.13 (43.33)
S.Em. ±		3.04	2.52	2.72	1.59	1.96	2.30	2.23	1.25	1.23
C.D. at 5 %		9.16	7.60	8.19	4.55	5.91	6.92	6.71	3.56	4.48
C.V. %		14.18	10.85	12.67	12.56	9.94	11.06	11.35	10.81	3.25

Figures in parentheses are retransformed values, those outside are arcsine values DAS = Days after spraying

Table 5: Pooled data on effectiveness of spray schedules against *B. hilaris*at different crop growth stages

Sr. No.	Treatments	Mean per cent mortality				
		seedling stage	pre-flowering stage	50% flowering stage	50% pod formation	Overall pooled
1	Schedule 1	64.63(80.95)	63.45(79.12)	49.57(57.79)	56.59(69.12)	58.57(71.75)
2	Schedule 2	53.22(63.66)	56.49(69.04)	44.42(49.04)	50.84(59.87)	51.25(60.41)
3	Schedule 3	48.20(55.29)	50.70(59.62)	40.53(42.33)	45.41(50.66)	46.21(51.98)
4	Schedule 4	66.51(83.25)	65.64(82.45)	51.24(60.58)	58.50(72.04)	60.48(74.58)
5	Schedule 5	44.67(49.41)	44.84(49.70)	37.12(36.58)	41.13(43.33)	41.94(44.76)
S.Em. ±		0.92	0.64	0.59	1.23	1.36
C.D. at 5 %		2.73	1.89	1.75	4.48	4.11
C.V. %		4.92	3.37	3.92	3.25	2.69

Figures in parentheses are retransformed values, those outside are arcsine values DAS = Days after spraying

S_1 = Acetamiprid + Spinosad + *B. bassiana* + Profenophos+cypermethrin

S_2 = Imidacloprid + Indoxacarb + *L. lecanii* + Deltamethrin+triazophos

S_3 = Thiamethoxam + Emamectin benzoate + *N. rileyi* + Chlorpyriphos+alphamethrin

S_4 = Flonicamid + Flubendiamide + Azadirachtin + Acephate+fenvalerate

S_5 = Monocrotophos + Quinalphos + NSKE + Ethion + cypermethrin

Table 6: Effectiveness of insecticidal spray schedules on the grain yield of mustard crop (Pooled data of *rabi*2012-13 and 2013-14)

Schedules	Yield of mustard grain (kg/ha)	Increase in yield over control (%)	Avoidable yield loss	Rank
Schedule 1	917	83.4	45.5	2
Schedule 2	1011	102.2	50.5	2
Schedule 3	1218	143.6	58.9	1
Schedule 4	1302	160.4	61.6	1
Schedule 5	1172	134.4	57.3	1
Schedule 6 (Control)	500	--	--	3
S. Em ±	61.7	--	--	--
C. D. at 5 %	185.8	--	--	--
C. V. %	12.1	--	--	--

Schedule 1 = Acetamiprid 20% SP + Spinosad 45% SC + *B. bassiana* @ 2.5 kg/ha + Profenophos 40+cypermethrin 4% EC

Schedule 2 = Imidacloprid 17.8% SL + Indoxacarb 14.5% SC + *L. lecanii* @ 2.0 kg/ha + Triazophos 35+deltamethrin 1% EC

Schedule 3 = Thiamethoxam 25% WG + Emamectin benzoate 5% WG + *N. rileyi* @ 2.5 kg/ha + Chlopyriphos 16+alphamethrin 1%EC

Schedule 4 = Flonicamid 50% WG + Flubendiamide 480% SC + Azadirachtin 1500 ppm + Acephate 25+fenvalerate 3% EC

Schedule 5 = Monocrotophos 36% SL + Quinalphos 25% EC + NSKE 5% + Ethion 40 + cypermethrin 5% EC

Schedule 6 = Water spray

Table 7: Economics of different spray schedules against *B. hilaris*infesting mustard

Schedules	Cost of insecticides (Rs/ha)	Total cost of control measures (Rs/ha)*	Yield (Kg/ha)	Gross realization (Rs/ha)**	Net realization (Rs/ha)	ICBR	Rank
Schedule 1	4225.2	5025.2	917	33929	15429	1:3.1	3
Schedule 2	2035.4	2835.4	1011	37407	18907	1:6.7	1
Schedule 3	3427	4227	1218	45066	26566	1:6.3	2
Schedule 4	3926	4726	1302	48174	29674	1:6.3	2
Schedule 5	7139.7	7939.7	1172	43364	24864	1:3.1	3
Schedule 6	--	800	500	18500	--	--	4

* Labour charges @ Rs. 200/ha spray ** Market value of mustard @ Rs. 37/kg

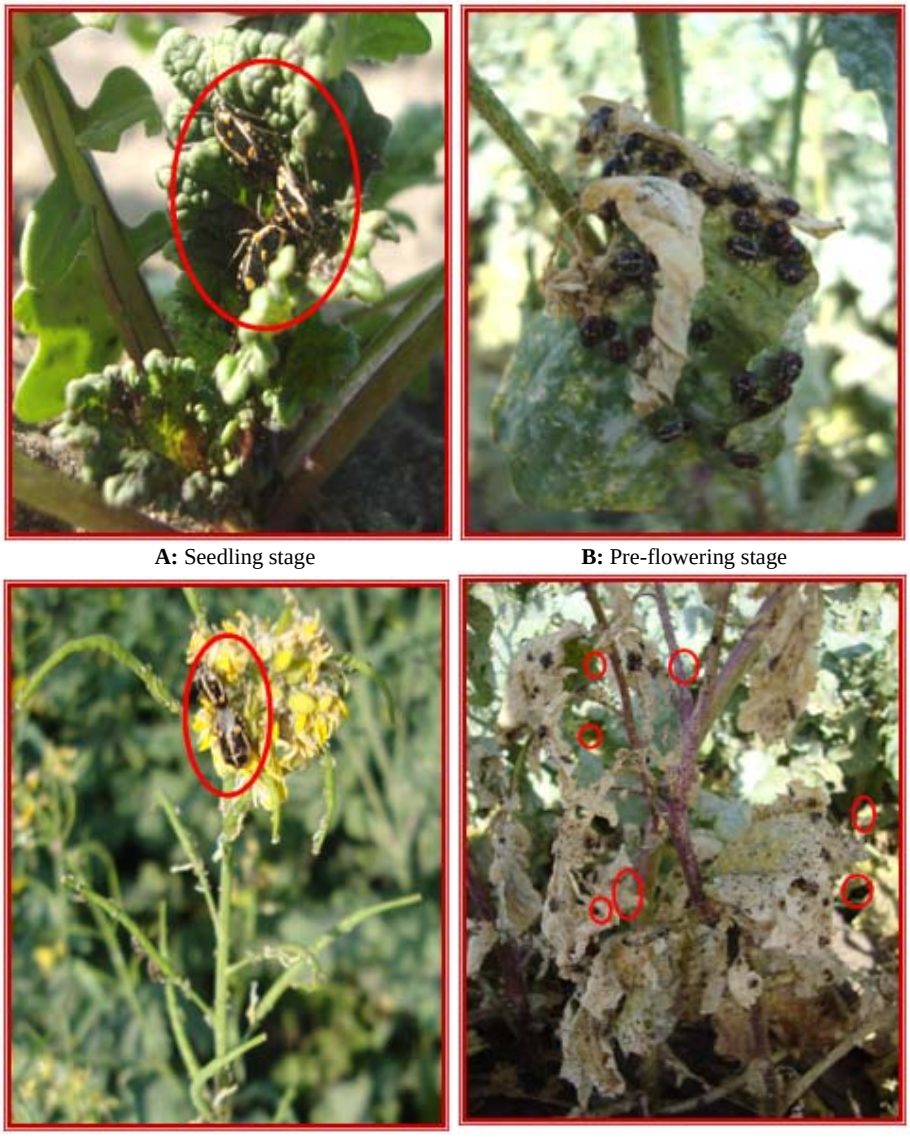
Schedule 1 = Acetamiprid 20% SP + Spinosad 45% SC + *B. bassiana* @ 2.5 kg/ha + Profenophos 40+cypermethrin 4% EC

Schedule 2 = Imidacloprid 17.8% SL + Indoxacarb 14.5% SC + *L. lecanii* @ 2.0 kg/ha + Triazophos 35+deltamethrin 1% EC
Schedule 3= Thiamethoxam 25% WG + Emamectin benzoate 5% WG + *N. rileyi* @ 2.5 kg/ha + Chlopyriphos 16+alphamethrin 1%EC
Schedule 4 = Flonicamid 50% WG + Flubendiamide 480% SC + Azadirachtin 1500 ppm + Acephate 25+fenvalerate 3% EC
Schedule 5 = Monocrotophos 36% SL + Quinalphos 25% EC + NSKE 5% + Ethion 40 + cypermethrin 5% EC
Schedule 6 = Water spray

Table 8: Overall effectiveness of different spray schedules on mustard (Based on ranking)

Schedules	Overall Rank					
	Painted bug	**Yield (Kg/ha)**	**Net realization (Rs/ha)**	**ICBR**	**Total rank**	**Ranking**
Schedule S_1	3	2	5	4	14	4
Schedule S_2	3	2	4	1	10	3
Schedule S_3	2	1	2	2	07	2
Schedule S_4	1	1	1	3	06	1
Schedule S_5	4	1	3	5	13	5
Schedule S_6	5	3	6	6	20	6

Schedule 1 = Acetamiprid 20% SP + Spinosad 45% SC + *B. bassiana* @ 2.5 kg/ha + Profenophos 40+cypermethrin 4% EC
Schedule 2 = Imidacloprid 17.8% SL + Indoxacarb 14.5% SC + *L. lecanii* @ 2.0 kg/ha + Triazophos 35+deltamethrin 1% EC
Schedule 3= Thiamethoxam 25% WG + Emamectin benzoate 5% WG + *N. rileyi* @ 2.5 kg/ha + Chlopyriphos 16+alphamethrin 1%EC
Schedule 4 = Flonicamid 50% WG + Flubendiamide 480% SC + Azadirachtin 1500 ppm + Acephate 25+fenvalerate 3% EC
Schedule 5 = Monocrotophos 36% SL + Quinalphos 25% EC + NSKE 5% + Ethion 40 + cypermethrin 5% EC
Schedule 6 = Water spray



A: Seedling stage **B:** Pre-flowering stage

C: Flowering stage **D:** Pod formation stage

Fig 1: Damage of *B. hilaris* at different stages of mustard crop

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