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Efficacy and economics of some newer insecticides against mustard aphid, *Lipaphis erysimi* (Kalt)

Vishal, Hem Singh and Ajay Kumar

Abstract
The field trail was conducted at CRC on Sardar vallabhbhai Patel University of Agriculture & Technology Meerut, during *Rabi* 2015-16 on Indian mustard (*Brassica* juncea) variety Urvashi. Among the seven treatments including control plot. The aphid population were found on 10 apical twigs/plot each of 10 cm length ranges from 8.33 to 38.33 aphids/plant. The minimum population (8.33 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha compared to control and also the maximum yield was obtained with treatment acephate 75 SP @ 350g a.i./ha giving 16.35 q/ha and was found superior over rest of all other treatments whereas the maximum gain in net income of Rs. 22560/ha was found from acephate 75 SP @ 350g a.i./ha. Cost benefit ratio of the treatments showed that imidachloprid 17.8 SL @ 20g a.i./ha ranked first indicating the maximum B:C Ratio (1: 10.36).

Keywords: mustard aphid, chemical insecticides bio-pesticides and management

Introduction
Mustard crops are the major *rabi* oilseed crops grown in India, which are collectively referred to as rapeseed-mustard. They occupy a prominent place being next in importance to groundnut both in area and production, meeting the fat requirement of about 50 per cent population in the states of Uttar Pradesh, Punjab, Rajasthan, Madhya Pradesh, Bihar, Orissa, West Bengal and Assam (Singh, 1999) [5]. Mustard aphid, *Lipaphis erysimi* (Kalt) belongs to sub - order Homoptera and family Aphididae. This pest is widely distributed throughout the world on all *Brassica* crops and responsible to cause from 9 to 96 percent yield loss ranging and 15 percent oil reduction in India. Aphids attack on vegetative buds and later spread on whole plant. In case of heavy infestation, plant becomes stunted and dries up resulting in no pod formation. Insect secretes honeydew, which is responsible for the growth of black fungus called 'Sooty mould' which crate the problem in photosynthesis activity of the plant. Several approaches have been adopted to management insect-pests on *Brassica* crop, among these methods of pest control, chemical control have largely been used for the control of insect-pests. Many unwanted side effects of older insecticides such as residue problem, environmental hazards, destruction of non-targeted insects such as parasites and predators as bio-control agents and honeybees as pollinators and development of resistance in insect to insecticides etc. have put a great limitation so there is a need to use the chemicals and bio-insecticides for control the mustard aphid.

Materials and Methods
The field trail was conducted at CRC on Sardar vallabhbhai Patel University of Agriculture & Technology Meerut, during *Rabi* 2015-16 on Indian mustard (*Brassica* juncea) variety Urvashi. Seven treatments including untreated control plot were evaluated in randomized block design with three replications. Two sprays were given at fifteen days interval first spray was given forty days after sowing of crop and second spray was given fifteen days after first spray. Application of insecticides and boi-pesticides namely, thiamethoxam 25 WG @ 25g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha, neem oil 1 ltr/ ha, acephate 75 SP @ 350g a.i./ha, *Beauveria bassiana* 1×10^8 CFU @ 2 ka/ha and diamethate 30 EC @ 300g a.i./ha were done using manully oprated knapsack sprayer having duromist nozzle. Aphid population was counted from 10 apical twigs/plot each of 10 cm length at 1 day prior to spraying and 3, 7 & 10 days after spraying. The yield of seed from each plot was weighed separately. Data were complied and analyzed statistically. Incremental cost benefit ratio (ICBR) for each treatment was calculated by dividing net gain over control by total cost of plant protection. Finally, net ICBR for each treatment was evaluated by dividing net profit by total cost of plant protection measure.

Results and Discussion

Observation of aphids/plant were recorded after first and second spray of different treatments. The mean number of aphids/plant has showed in Table 1. All the treatments had significant effect on the population of aphids as compared to untreated control plots. The aphid population ranges were found from 18 to 56.33 aphids/plant. The minimum population (18 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (20.33 aphids/plant) and dimethoate 30 EC @ 300g a.i./ha (21 aphids/plant) less effective in comparison acephate 75 SP @ 350g a.i./ha and in comparison thiamethoxam 25 WG @ 25g a.i./ha (30.33 aphids/plant), *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha (33.67 aphids/plant) and last treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective with aphid population (56.33 aphids/plant) recorded 18 to 56.33 aphids/plants respectively. Maximum population (114.67 aphids/plant) was recorded in untreated control plot. At seventh days, the aphid populations were decreased slightly with 14.33 to 48.0 aphids/plant. The minimum population (14.33 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (18.67 aphids/plant) and dimethoate 30 EC @ 300g a.i./ha (21.00 aphids/plant) less effective in comparison acephate 75 SP @ 350g a.i./ha and all other treatments *i.e.* thiamethoxam 25 WG @ 25g a.i./ha (28.67 aphids/plant), *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha (32.33 aphids/plant) and treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective with aphid population (48.00 aphids/plant) where the population were recorded 14.33 to 48.00 aphids/plant respectively. Maximum population (124.67 aphids/plant) was recorded in untreated control plot. Observation on 10^{th}days, the minimum population (11.67 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (15.33 aphids/plant) and dimethoate 30 EC @ 300g a.i./ha (20 aphids/plant) less effective in comparison acephate 75 SP @ 350g a.i./ha and all other treatments *i.e.* thiamethoxam 25 WG @ 25g a.i./ha (24.33 aphids/plant), *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha (26.67 aphids/plant) and treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective with aphid population (45 aphids/plant) where the population were recorded 11.67 to 45 aphids/plant respectively. Maximum population (143.67 aphids/plant) was recorded in untreated control plot.

Table 1: Effectiveness of insecticides against mustard aphid (Spray 1st).

S. No.	Treatments	Conc. %	Number of aphids/shoot			
			1 Day Before Spray	Days After Spray		
				3 DAS*	7 DAS*	10 DAS*
T_1	Thiamethoxam	25WG	104(10.24)	30.33(5.48)	28.67(5.38)	24.33(5.03)
T_2	Imidacloprid	17.8 SL	101.6(10.13)	20.33(4.55)	18.67(4.43)	15.33(4.04)
T_3	Neem oil	2.0%	105(10.29)	56.33(7.53)	48.00(6.91)	45(6.68)
T_4	Acephate	75 SP	104(10.24)	18(4.27)	14.33(3.91)	11.67(3.55)
T_5	*Beauveria bassiana*	CFU 1×10^8	103.33(10.21)	33.67(5.71)	32.33(5.72)	26.67(5.25)
T_6	Dimethoate	30 EC	103(10.19)	21(4.67)	21.00(4.62)	20(4.58)
T_7	Control		101.33(10.11)	114.67(10.73)	124.67(11.16)	143.67(12.01)
	C.D. at 5%		N.S.	0.87	0.978	1.032
	Se(m)		0.042	0.28	0.314	0.331

The mean number of aphids/plant after three days of second spray has showed in Table 2. All the treatments had significant effect on the population of aphid as compared to untreated plots. The aphid population ranges were found from 8.33 to 38.33 aphids/plant. The minimum population (8.33 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (10.67 aphids/plant) and dimethoate 30 EC @ 300g a.i./ha (13.67 aphids/plant) less effective in comparison of acephate 75 SP @ 350g a.i./ha, thiamethoxam 25 WG @ 25g a.i./ha (17.33 aphids/plant), *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha (22.33 aphids/plant) and treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective with aphid population (38.33 aphids/plant). Maximum population (150.67 aphids/plant) was recorded in untreated control plot. At seventh days the aphid populations were decreased slightly were found 2.33 to 28.33 aphids/plant. The minimum population (2.33 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (4.67 aphids/plant), dimethoate 30 EC @ 300g a.i./ha (7.67 aphids/plant), thiamethoxam 25 WG @ 25g a.i./ha (11.33 aphids/plant), *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha (16.67 aphids/plant) and treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective with aphid population (28.33 aphids/plant) where the population were recorded 2.33 to 28.33 aphids/plant in all the experimental plots respectively. Maximum population (174.33 aphids/plant) were recorded in untreated control plots. Observation on 10^{th} days the minimum population (0 aphids/plant) was recorded from acephate 75 SP @ 350g a.i./ha. It was followed by imidacloprid 17.8 SL @ 20g a.i./ha (0.67 aphids/plant), dimethoate 30 EC @ 300g a.i./ha (3.67 aphids/plant), thiamethoxam 25 WG @ 25g a.i./ha (8.33 aphids/plant), *Beauveria bassiana* 1×10^8 CFU @ 2 kg/ha (11 aphids/plant) and treatment neem oil 2 per cent @ 1 ltr/ha is the very less effective on aphid population (21.67 aphids/plant) where the population were recorded 0 to 21.67 aphids/plant in all the experimental plots respectively. Maximum population (212.33 aphids/plant) were recorded in untreated control plot.

The evident from above findings that all the treatments were effective in reducing population at different intervals after each spray in comparison to untreated control. The treatments acephate 75 SP @ 350g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha, were proved most effective treatment for the control of mustard aphid in present investigation. The effectiveness of acephate 75 SP @ 350g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha for the control of *L. erysimi* has also been reported by Dhaka *et al.*, 2009 [2] also reported that acephate 75 SP @ 350g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha, diamethate 30 EC @ 300g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha were effective against *L. erysimi*. Bhati and Sharma, 2014 also recorded that acephate 75 SP @ 350g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha,

diamethate 30 EC @ 300g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha proved best against mustard aphid. Meena *et al.*, 2013 [6] used eight microbial and boi-products against mustard aphid in which they have proved that *Beauveria bassiana* 1×10^8 CFU @ 2 ka/ha and neem seed kernel extracts were significantly best to the control plot.

Table 2: Effectiveness of insecticides against mustard aphid (Spray 2nd)

S. No.	Treatments	Conc. %	Number of aphids/shoot		
			Days After Spray		
			3 DAS	7 DAS	10 DAS
T_1	Thiamethoxam	25 WG	17.33(4.23)	11.33(3.45)	8.33(2.92)
T_2	Imidacloprid	17.8 SL	10.67(3.40)	4.67(2.38)	0.67(1.24)
T_3	Neem oil	2.0%	38.33(6.15)	28.33(5.41)	21.67(4.66)
T_4	Acephate	75 SP	8.33(3.04)	2.33(1.82)	0(1.00)
T_5	*Beauveria bassiana*	CFU 1×10^8	22.33(4.79)	16.67(4.17)	11(3.43)
T_6	Dimethoate	30 EC	13.67(3.73)	7.00(2.76)	3.67(2.09)
T_7	Control		150.67(12.28)	174.33(13.17)	212.33(14.56)
	C.D. at 5%		1.003	1.347	1.475
	Se(m)		0.322	0.432	0.473

Table 3: Yield and Economics of different treatments against mustard aphid

Treatment	Doses/ha	Yield (q/ha)	Yield saved over control (q/ha)	Value of production	Value of saved yield (Rs./ha)	Total cost of treatment application (Rs./ha)	Net income (Rs./ha)	Cost : benefit ratio
Thiamethoxam	25 g a.i./ha	11.45	3.70	3000.00	11100	1190	9910	8.33
Imidacloprid	20 g a.i./ha	14.15	6.40	3000.00	19200	1690	17510	10.36
Neem oil	1.0 ltr/ha	9.33	1.58	3000.00	4740	990	3750	3.79
Acephate 75 SP	350 g a.i./ha	16.35	8.60	3000.00	25800	3240	22560	6.96
Beauveria bassiana	2.0 kg/ha	10.40	2.65	3000.00	7950	1040	6910	6.64
Dimethoate	300 g a.i./ha	13.05	5.30	3000.00	15900	3190	12710	3.98
Control	------	7.75						

Labour charge = 140/day, Rental value of sprayer = 50/day, Self price of product= 3000/quintal

The data recorded on yield of different treatments was presented in table 3. All the treated plots resulted significantly higher yield in comparison to untreated control plot (7.75 q/ha), ranging between 9.33 to 16.35 q/ha. The maximum yield was obtained with treatment acephate 75 SP @ 350g a.i./ha giving 16.35 q/ha and was found superior over rest of all other treatments. The imidacloprid 17.8 SL @ 20g a.i./ha was second most effective treatment with yield of 14.15 q/ha followed by dimethoate 30 EC @ 300g a.i./ha, thiamethoxam 25 WG @ 25g a.i./ha, *Beauveria bassiana* 1×10^8 CFU @ 2 kg/ha and neem oil 2 per cent @ 1 ltr/ha with the yield of 13.05, 11.45, 10.40 and 9.33 q/ha, respectively. Among the different treatments lowest yield (9.33 q/ha) was found in case of neem oil 2 per cent @ 1 ltr/ha. Increase in yield over control varied from 1.58 to 8.60 q/ha in different treatments. Maximum increase in yield (8.60 q/ha) was recorded in acephate 75 SP @ 350g a.i./ha followed by imidacloprid 17.8 SL @ 20g a.i./ha, dimethoate 30 EC @ 300g a.i./ha, Thiamethoxam 25 WG @ 25g a.i./ha and *Beauveria bassiana* 1×10^8 CFU @ 2 kg/ha in which increase in yield were 6.40, 5.30, 3.70 and 2.65 q/ha respectively. However, lowest increase of untreated control plot yield 1.58 q/ha was recorded in plot treated with neem oil 2 per cent @ 1 ltr/ha.

Perusal of table 6 indicates that maximum gain in net income of Rs. 22560/ha was found from acephate 75 SP @ 350g a.i./ha treated plot followed by imidachloprid 17.8 SL @ 20g a.i./ha, dimethoate 30 EC @ 300g a.i./ha, thiamethoxam 25 WG @ 25g a.i./ha *Beauveria bassiana* 1×10^8 CFU @ 2 kg/ha with net profit of Rs. 17510, 12710, 9910 and 6910/ha, respectively. The minimum net profit (Rs. 3750/ha) was obtained from neem oil 2 per cent @ 1 ltr/ha.

Cost benefit ratio of the treatments showed that imidachloprid 17.8 SL @ 20g a.i./ha ranked first indicating the maximum B:C Ratio (1: 10.36) followed by thiamethoxam 25 WG @ 25g a.i./ha, acephate 75 SP @ 350g a.i./ha, *Beauveria bassiana* CFU 1×10^8 @ 2 kg/ha and dimethoate 30 EC 300g a.i./ha with 1: 8.33, 1: 6.96, 1: 6.64 and 1: 3.98 benefit cost ratio, respectively. The lowest benefit cost ratio (1: 3.79) was obtained in neem oil 2 per cent @ 1 ltr/ha. Mandal *et al.*, 2012 [3] also proved that imidacloprid 17.8 SL @ 20g a.i./ha dimethoate 30 EC 300g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha were effective against mustard aphid and getting maximum yield from imidacloprid 17.8 SL @ 20g a.i./ha and also highest B: C ratio. Meena *et al.*, 2013 [6] also get the maximum yield and benefit cost ratio from *Beauveria bassiana* (1×10^8 CFU) @ 2 kg/ha and neem seed kernel extracts. Similarly, Shaoo 2012 also observed that acephate 75 SP @ 350g a.i./ha, imidacloprid 17.8 SL @ 20g a.i./ha, dimethoate 30 EC 300g a.i./ha and thiamethoxam 25 WG @ 25g a.i./ha were useful to reduce the population of *Liphaphis erysimi* and getting maximum yield and benefit cost ratio from dimethoate 30 EC 300g a.i./ha which is followed by imidacloprid 17.8 SL @ 20g a.i./ha.

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