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Field efficacy of insecticides against two different feeding guilds: the sap sucking *Lipaphis erysimi* (Kaltenbach) and foliage feeder *Pieris brassicae* (L.) infesting Indian mustard

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Abstract

Turnip aphid, *Lipaphis erysimi* (Kaltenbach) and the large white butterfly, *Pieris brassicae* (L.) are important pests of rapeseed-mustard in Punjab, India. In this study, we have attempted to evaluate four insecticides against both the pests for their field efficacy at two locations. Among them thiamethoxam 25 WG @ 100 g ha^{-1}, dimethoate 30 EC @ 1 litre ha^{-1}, quinalphos 25 EC @ 1 litre ha^{-1}, and chlorpyriphos 20 EC @ 1.5 litre ha^{-1} successfully controlled turnip aphid at both the locations. While, successful control of the large white butterfly was obtained only with treatments quinalphos 25 EC @ 1 litre ha^{-1} and chlorpyriphos 20 EC @ 1.5 litre ha^{-1}. Maximum seed yield was obtained in treatment chlorpyriphos 20 EC @ 1.5 litre ha^{-1} followed by quinalphos 25 EC @ 1 litre ha^{-1}at both the locations. Thus, spray of chlorpyriphos 20 EC @ 1.5 litre ha^{-1} and quinalphos 25 EC @ 1 litre ha^{-1} could be the best option for control of both turnip aphid and the large white butterfly.

***Key words**: Brassica juncea,* foliage feeder, insecticides, mustard aphid, sucking pests

Introduction

Among the many herbivores that feed on members of family Brassicaceae, turnip aphid, *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae) is a serious pest of oilseed *Brassica* in Indian subcontinent and many other countries. It is the most serious pest of oilseed *Brassica* and the damage in field conditions by this pest can range from as low as 9% to as high as 96% under different agroclimatic conditions, intensity of population and crop growth stage (Kumar and Sangha, 2013, Kumar and Singh, 2015, Kumar et al., 2015). Both adults and nymphs cause damage by sucking large quantities of sap from flower buds, flowers, pods and tender leaves leading to their yellowing, curling and crinkling. In addition to this, the large white butterfly, *Pieris brassicae* (L.) (Lepidoptera: Pieridae) is also a serious pest of rapeseed-mustard next only to mustard aphid in north-western sub-mountaneous regions of the country. It is basically a pest of vegetable Brassicas, which also infests rapeseed-mustard crops. It is an oligophagous pest with wide host range and is known to infest 83 species of food plants belonging to Cruciferae, Tropaeolaceae, Capparaceae, Resedaceae and Papilionaceae (Feltwell, 1985). The pest has Palearctic distribution from North Africa across Europe and Asia to the Himalayan Mountains (Raqib, 2004; Jainulabdeen and Prasad, 2004). It is reported to cause severe damage to 15 plant species including cabbage, cauliflower, mustard, radish, rape and turnip (Hwang *et al.*, 2008) and damages crop all the growth stages i.e. seedling, vegetative and flowering stages (Ullah *et al.*, 2016). Young larvae feed voraciously on the leaves (Hasan and Ansari, 2011), while the grown up caterpillars feed on almost all the above ground plant parts. In India, it is reported to cause about 40 per cent damage to different cruciferous crops (Hasan and Ansari, 2010 a, b). Intensive cultivation of vegetable Brassicas over the years has resulted in high pest infestations (Chaudhuri *et al.*, 2001; Weinberger and Srinivasan, 2009). In Punjab, this pest was earlier restricted to vegetable Brassicas only, however, it is emerging as an important pest of oilseed Brassicas as well, particularly on *B. juncea, B. carinata, B. rapa* and *B. napus* (Kumar 2011, 2017). *P. brassicae* larvae are voracious feeders and cause heavy damage to the leaves and inflorescence. In the event of heavy pest infestation, all the plant parts including pods are eaten up leaving only the twigs. If the timely pest management interventions are not taken up, the pest has potential to cause 100 per cent yield loss. Thus, it becomes imperative to evaluate insecticides so that timely pest management interventions can be applied in the event of pest attack. In the present study, we have attempted to evaluate some insecticides for their field efficacy against both *L. erysimi* and *P. brassicae*.

Materials and Methods

The present study was carried out at Oilseeds Research Farm, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India and PAU Regional Research Station for *Kandi* Area, Ballowal Saunkhari, Balachaur, Shaheed Bhagat Singh Nagar, India during *Rabi* 2018-19 crop season. *Brassica juncea* (L.) Czern & Coss. variety PRB 357 was grown in randomized block design in plots of size 4.2 x 3.0 m in rows 30 cm apart. Sowing was deliberately delayed from the normal sowing in October and was done in second week of November as late sown crop is attacked more by the pest (Kular and Kumar, 2011, Kumar, 2011, 2017). At the time of sowing a uniform dose of nitrogen and phosphorous was applied. After 3 weeks of sowing, thinning was done in each plot and a plant to plant distance of 15 cm was maintained followed by manual weed removal. All the recommended package of practices for raising a good crop was followed except for the insecticide treatments (Anonymous, 2018).

Field infestation of *L. erysimi* starts from second week of January in this part of the country which increases with the warming up of the season and the pest continues to damage the crop till crop maturity. Cold and cloudy weather generally favours population development. On the other hand, *Pieris brassicae* infestation generally starts from second fortnight of February and continues till maturity of the crop. Two sprays were applied during the crop season i.e. one when the aphid population reached economic threshold level of 50-60 aphids/ top 10 cm central twig of the plant and the second spray was applied at appearance of *P. brassicae* larvae on the crop at the end of February. The different insecticides were applied as per the following treatments: T_1. thiamethoxam 25 WG @ 50 g ha^{-1}, T_2: thiamethoxam 25 WG @ 100 g ha^{-1}, T_3: dimethoate 30 EC @ 500 ml ha^{-1}, T_4: dimethoate 30 EC @ 1 litre ha^{-1}, T_5: quinalphos 25 EC @ 500 ml ha^{-1}, T_6: quinalphos 25 EC @ 1 litre ha^{-1}, T_7: chlorpyriphos 20 EC @ 750 ml ha^{-1}, T_8: chlorpyriphos 20 EC @ 1.5 litre ha^{-1} and T_9: control. Data on the aphid population were recorded from top 10 cm central twig of the plant while that on *P. brassicae* larval population were recorded by visual observations for number of larvae per plant before spray, 3, 7, 10 and 14 days after spray from 5 plants selected at random from each plot. Yield data were recorded at harvest of the crop.

Statistical Analysis

Data on the aphid population, larval population at different time intervals and yield data at harvest were subjected to Analysis of Variance (ANOVA) using statistical software OPSTAT (Sheoran *et al.*, 1998). When differences among means were significant ($P<0.05$), means were separated by LSD.

Results and Discussion

At Ludhiana, aphid population in all the treatments was significantly lower than control after 3, 7, 10 and 14 days of spray (Table 1). However, critical analysis of the data revealed that thiamethoxam 25 WG @ 100 g ha^{-1} (T_2), dimethoate 30 EC @ 1 litre ha^{-1} (T_4), quinalphos 25 EC @ 1 litre ha^{-1} (T_6) and chlorpyriphos 20 EC @ 1.5 litre ha^{-1} (T_8) resulted in more than 80 per cent reduction in aphid population after 3 days of spray which further increased to more than 90 per cent after 7, 10 and 14 days of spray. Thus, treatments T_2, T_4, T_6 and T_8 were effective in controlling the aphid population under field conditions. Almost, similar trend was observed at PAU Regional Research Station, Ballowal Saunkhari (Table 2).

Table 1: Efficacy of different insecticides against *L. erysimi* at Ludhiana during *Rabi* 2018-19

Treatment	Number of aphids 10 cm^{-1} central twig								
	BS*	3 DAS**	PR^{Â}	7 DAS	PR	10 DAS	PR	14 DAS	PR
T_1	44.9	24.1	60.7	20.3	69.8	23.1	69.1	18.3	69.9
T_2	48.8	7.1	88.4	0.8	98.8	1.1	98.5	1.9	96.9
T_3	49.7	32.7	46.6	23.4	65.3	28.0	62.5	20.8	65.8
T_4	52.9	10.1	83.5	2.9	95.7	5.2	93.0	3.5	94.3
T_5	50.4	34.3	44.1	22.0	67.4	25.5	65.9	20.5	66.3
T_6	51.5	12.7	80.2	4.5	93.3	5.6	92.5	3.8	93.8
T_7	46.2	30.3	50.6	21.6	68.0	24.5	67.2	20.5	66.3
T_8	48.3	10.7	82.5	2.7	96.0	3.0	96.0	1.7	97.3
T_9	51.1	61.3	-	67.4	-	74.7	-	60.9	-
LSD (P<0.05)	NS	7.9		5.3		5.1		3.7	

* BS: Before spray, **DAS: Days after spray, Variety: PBR 357; ^{Â} PR: Per cent reduction over control

Table 2: Efficacy of insecticides against *Lipaphis erysimi* at Ballowal Saunkhri during *Rabi* 2018-19

Treatment	Number of aphids 10 cm^{-1} central shoot								
	BS*	3 DAS**	PR^	7 DAS	PR	10 DAS	PR	14 DAS	PR
T_1	37.0	15.3	62.4	9.3	82.8	13.3	78.3	15.3	72.7
T_2	38.3	8.3	79.6	2.7	95.0	3.3	94.6	4.3	92.3
T_3	37.7	17.3	57.4	14.0	74.2	15.3	75.0	16.7	70.2
T_4	38.7	8.3	79.6	5.3	90.2	6.3	89.7	7.3	86.9
T_5	39.3	15.3	62.4	14.7	72.3	16.0	73.8	18.3	67.3
T_6	40.0	12.0	70.5	5.7	89.5	6.7	89.1	7.7	86.3
T_7	39.3	14.3	64.8	13.3	75.5	13.0	78.7	14.7	73.7
T_8	38.0	12.3	69.8	6.0	88.9	6.7	89.1	6.3	88.7
T_9	39.0	40.7	—	54.3	—	61.3	—	56.0	—
LSD (P<0.05)	NS	1.8		2.5		2.0		2.3	

* BS: Before spray, **DAS: Days after spray, Variety: PBR 357; ^ PR: Per cent reduction over control

Table 3: Efficacy of different insecticides against *Pieris brassicae* at Ludhiana during *Rabi* 2018-19

Treatment	No of larvae plant^{-1}									Yield (kg ha^{-1})	PI^^
	BS*	3 DAS**	PR^	7 DAS	PR	10 DAS	PR	14 DAS	PR		
T_1	26.1	25.7	27.9	25.3	26.0	22.1	25.9	6.5	35.1	1422.2	4.5
T_2	33.3	32.8	7.9	31.8	6.8	28.8	3.6	6.3	37.7	1483.3	8.9
T_3	34.3	33.4	6.2	32.5	4.9	28.9	3.3	7.4	26.5	1411.1	3.7
T_4	34.3	33.7	5.4	32.3	5.5	29.4	1.6	7.3	27.2	1416.7	4.1
T_5	34.8	31.6	11.2	30.4	10.9	27.5	8.0	6.7	33.8	1436.1	5.5
T_6	34.5	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	2027.8	48.9
T_7	30.5	27.5	22.7	26.2	23.2	22.3	25.2	6.3	37.7	1508.3	10.8
T_8	33.9	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	2063.9	51.6
T_9	36.3	35.6	-	34.1	-	29.9	-	10.1	-	1361.1	-
LSD (P<0.05)	NS	8.2		8.0		7.3		3.5		82.4	

* BS: Before spray, **DAS: Days after spray, Variety: PBR 357; ^ PR: Per cent reduction over control; ^^ PI: Per cent increase over control

Table 4: Effiacy of insecticides against *Pieris brassicae* at Ballowal Saunkhri during *Rabi* 2018-19

Treatment	No of larvae plant^{-1}									Yield (kg ha^{-1})	PI^^
	BS*	3 DAS**	PR^	7 DAS	PR^	10 DAS	PR	14 DAS	PR		
T_1	24.7	23.7	25.2	20.7	36.7	18.0	47.1	16.3	48.5	1053.3	14.4
T_2	29.7	19.3	39.1	17.7	45.8	14.7	56.7	14.7	53.6	1070.6	16.3
T_3	28.7	25.7	18.9	25.0	23.5	22.7	33.2	21.7	31.5	1023.6	11.2
T_4	26.7	24.0	24.3	21.3	34.8	19.0	44.1	18.7	41.0	1055.3	14.7
T_5	29.3	15.3	51.7	13.3	59.3	11.7	65.6	12.0	62.1	1116.0	21.3
T_6	28.7	1.3	95.9	1.7	94.8	2.0	94.1	2.7	91.5	1534.6	66.7
T_7	28.0	14.0	55.8	13.7	58.1	11.7	65.6	11.0	65.3	1135.3	23.4
T_8	27.7	1.7	94.6	2.0	93.8	2.3	93.2	3.0	90.5	1570.6	70.6
T_9	29.7	31.7	—	32.7	—	34.0	—	31.7	—	920.3	—
LSD (P<0.05)	NS	1.7		1.4		1.6		1.7		28.8	

* BS: Before spray, **DAS: Days after spray, Variety: PBR 357; ^ PR: Per cent reduction over control; ^^ PI: Per cent increase over control

However, field efficacy of the different treatments against *P. brassicae* differed from that against *L. erysimi*. At Ludhiana, only two treatments i.e. quinalphos 25 EC @ 1 litre ha^{-1} (T_6) and chlorpyriphos 20 EC @ 1.5 litre ha^{-1} (T_8) resulted in 100 per cent reduction in larval population after 3, 7, 10 and 14 days of spray which was significantly lower than control (Table 3). Almost similar trend was observed at PAU Regional Research Station, Ballowal Saunkhari with more than 90 per cent reduction in larval population after 3, 7, 10 and 14 days of insecticide application (Table 4).

From the yield data, it is evident that maximum and significantly high seed yield of 2063.9 kg ha^{-1} was recorded in T_8: chlorpyriphos 20 EC @ 1.5 litre ha^{-1} (Table 3), followed by T_6: quinalphos 25 EC @ 1 litre ha^{-1} (2027.8 kg ha^{-1}), T_7: chlorpyriphos 20 EC @ 750 ml ha^{-1} (1508.3 kg ha^{-1}) and T_2: thiamethoxam 25 WG @ 100 g ha^{-1} (1483.3 kg ha^{-1}). The respective increase in seed yield in these four treatments was 51.6, 48.9, 10.8 and 8.9 per cent over control. The seed yield in rest of the treatments did not differ significantly from that in the control.

At Ballowal Saunkhari, seed yield in all the treatments was significantly higher than that in control (Table 4). However, here again, the maximum seed yield of 1570.6 kg ha^{-1} was obtained in T_8: chlorpyriphos 20 EC @ 1.5 litre ha^{-1} followed by 1534.6 kg ha^{-1} in T_6: quinalphos 25 EC @ 1 litre ha^{-1} with 70.6 and 66.7 per cent respective increase in seed yield over control. Due to rainfed ecology yield levels in general were lower than those recorded at Ludhiana.

Among the different treatments, application of chlorpyriphos 20 EC @ 1.5 litre ha^{-1} resulted in maximum benefit cost ratio of 40.90: 1 followed by quinalphos 25 EC @ 1 litre ha^{-1} (32.30: 1) (Table 5).

Patel *et al.* (2017) have also reported thiamethoxam 25 WG @ 0.25 g ha^{-1}, dimethoate 30 EC @ 1 ml $litre^{-1}$, quinalphos 25 EC @ 1 ml $litre^{-1}$ and chlorpyriphos 20 EC @ 0.1 ml $litre^{-1}$ to be effective against *L. erysimi.* Gupta *et al.* (1985) reported chlorpyrifos 0.05% to be effective against *P. brassicae*, *P. xylostella* and *H. armigera* on cauliflower seed crop. Reddy (2016) reported quinalphos 25 EC to be effective at 2 ml $litre^{-1}$ to be effective in controlling *P. brassicae* under protected conditions.

Conclusion

Thus, it can be concluded from this study that although thiamethoxam 25 WG @ 100 g ha^{-1} and dimethoate 30 EC @ 1 litre ha^{-1} provide effective control of *L. erysimi* only, application of chlorpyriphos 20 EC @ 1.5 litre ha^{-1} and quinalphos 25 EC @ 1 litre ha^{-1} provide effective control of both *L. erysimi* and *P. brassicae*. Thus, in fields infested with both the insects, the application of latter two insecticides (chlorpyriphos 20 EC and quinalphos 25 EC) should be preferred over the former ones (thiamethoxam 25 EC and dimethoate 30 EC) to control both the pests with a single spray.

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