



## 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<sup>-1</sup>, dimethoate 30 EC @ 1 litre ha<sup>-1</sup>, quinalphos 25 EC @ 1 litre ha<sup>-1</sup>, and chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> 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<sup>-1</sup> and chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup>. Maximum seed yield was obtained in treatment chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> followed by quinalphos 25 EC @ 1 litre ha<sup>-1</sup> at both the locations. Thus, spray of chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> and quinalphos 25 EC @ 1 litre ha<sup>-1</sup> 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-montaneous 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, Ballawal 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<sub>1</sub>: thiamethoxam 25 WG @ 50 g ha<sup>-1</sup>, T<sub>2</sub>: thiamethoxam 25 WG @ 100 g ha<sup>-1</sup>, T<sub>3</sub>: dimethoate 30 EC @ 500 ml ha<sup>-1</sup>, T<sub>4</sub>: dimethoate 30 EC @ 1 litre ha<sup>-1</sup>, T<sub>5</sub>: quinalphos 25 EC @ 500 ml ha<sup>-1</sup>, T<sub>6</sub>: quinalphos 25 EC @ 1 litre ha<sup>-1</sup>, T<sub>7</sub>: chlorpyrifos 20 EC @ 750 ml ha<sup>-1</sup>, T<sub>8</sub>: chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> and T<sub>9</sub>: 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<sup>-1</sup> (T<sub>2</sub>), dimethoate 30 EC @ 1 litre ha<sup>-1</sup> (T<sub>4</sub>), quinalphos 25 EC @ 1 litre ha<sup>-1</sup> (T<sub>6</sub>) and chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> (T<sub>8</sub>) 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<sub>2</sub>, T<sub>4</sub>, T<sub>6</sub> and T<sub>8</sub> were effective in controlling the aphid population under field conditions. Almost, similar trend was observed at PAU Regional Research Station, Ballawal Saunkhari (Table 2).

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

Treatment	Number of aphids 10 cm <sup>-1</sup> central twig								
	BS*	3 DAS**	PR <sup>Å</sup>	7 DAS	PR	10 DAS	PR	14 DAS	PR
T <sub>1</sub>	44.9	24.1	60.7	20.3	69.8	23.1	69.1	18.3	69.9
T <sub>2</sub>	48.8	7.1	88.4	0.8	98.8	1.1	98.5	1.9	96.9
T <sub>3</sub>	49.7	32.7	46.6	23.4	65.3	28.0	62.5	20.8	65.8
T <sub>4</sub>	52.9	10.1	83.5	2.9	95.7	5.2	93.0	3.5	94.3
T <sub>5</sub>	50.4	34.3	44.1	22.0	67.4	25.5	65.9	20.5	66.3
T <sub>6</sub>	51.5	12.7	80.2	4.5	93.3	5.6	92.5	3.8	93.8
T <sub>7</sub>	46.2	30.3	50.6	21.6	68.0	24.5	67.2	20.5	66.3
T <sub>8</sub>	48.3	10.7	82.5	2.7	96.0	3.0	96.0	1.7	97.3
T <sub>9</sub>	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; <sup>Å</sup> PR: Per cent reduction over control

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

Treatment	Number of aphids 10 cm <sup>-1</sup> central shoot								
	BS*	3 DAS**	PR <sup>Å</sup>	7 DAS	PR	10 DAS	PR	14 DAS	PR
T <sub>1</sub>	37.0	15.3	62.4	9.3	82.8	13.3	78.3	15.3	72.7
T <sub>2</sub>	38.3	8.3	79.6	2.7	95.0	3.3	94.6	4.3	92.3
T <sub>3</sub>	37.7	17.3	57.4	14.0	74.2	15.3	75.0	16.7	70.2
T <sub>4</sub>	38.7	8.3	79.6	5.3	90.2	6.3	89.7	7.3	86.9
T <sub>5</sub>	39.3	15.3	62.4	14.7	72.3	16.0	73.8	18.3	67.3
T <sub>6</sub>	40.0	12.0	70.5	5.7	89.5	6.7	89.1	7.7	86.3
T <sub>7</sub>	39.3	14.3	64.8	13.3	75.5	13.0	78.7	14.7	73.7
T <sub>8</sub>	38.0	12.3	69.8	6.0	88.9	6.7	89.1	6.3	88.7
T <sub>9</sub>	39.0	40.7	—	54.3	—	61.3	—	56.0	—
LSD ( <i>P</i> <0.05)	NS	1.8		2.5		2.0		2.3	

\* BS: Before spray, \*\*DAS: Days after spray, Variety: PBR 357; <sup>Å</sup> 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 <sup>-1</sup>									Yield (kg ha <sup>-1</sup> )	PI <sup>ÅÅ</sup>
	BS*	3 DAS**	PR <sup>Å</sup>	7 DAS	PR	10 DAS	PR	14 DAS	PR		
T <sub>1</sub>	26.1	25.7	27.9	25.3	26.0	22.1	25.9	6.5	35.1	1422.2	4.5
T <sub>2</sub>	33.3	32.8	7.9	31.8	6.8	28.8	3.6	6.3	37.7	1483.3	8.9
T <sub>3</sub>	34.3	33.4	6.2	32.5	4.9	28.9	3.3	7.4	26.5	1411.1	3.7
T <sub>4</sub>	34.3	33.7	5.4	32.3	5.5	29.4	1.6	7.3	27.2	1416.7	4.1
T <sub>5</sub>	34.8	31.6	11.2	30.4	10.9	27.5	8.0	6.7	33.8	1436.1	5.5
T <sub>6</sub>	34.5	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	2027.8	48.9
T <sub>7</sub>	30.5	27.5	22.7	26.2	23.2	22.3	25.2	6.3	37.7	1508.3	10.8
T <sub>8</sub>	33.9	0.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	2063.9	51.6
T <sub>9</sub>	36.3	35.6	-	34.1	-	29.9	-	10.1	-	1361.1	-
LSD ( <i>P</i> <0.05)	NS	8.2		8.0		7.3		3.5		82.4	

\* BS: Before spray, \*\*DAS: Days after spray, Variety: PBR 357; <sup>Å</sup> PR: Per cent reduction over control; <sup>ÅÅ</sup> PI: Per cent increase over control

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

Treatment	No of larvae plant <sup>-1</sup>									Yield (kg ha <sup>-1</sup> )	PI <sup>ÅÅ</sup>
	BS*	3 DAS**	PR <sup>Å</sup>	7 DAS	PR <sup>Å</sup>	10 DAS	PR	14 DAS	PR		
T <sub>1</sub>	24.7	23.7	25.2	20.7	36.7	18.0	47.1	16.3	48.5	1053.3	14.4
T <sub>2</sub>	29.7	19.3	39.1	17.7	45.8	14.7	56.7	14.7	53.6	1070.6	16.3
T <sub>3</sub>	28.7	25.7	18.9	25.0	23.5	22.7	33.2	21.7	31.5	1023.6	11.2
T <sub>4</sub>	26.7	24.0	24.3	21.3	34.8	19.0	44.1	18.7	41.0	1055.3	14.7
T <sub>5</sub>	29.3	15.3	51.7	13.3	59.3	11.7	65.6	12.0	62.1	1116.0	21.3
T <sub>6</sub>	28.7	1.3	95.9	1.7	94.8	2.0	94.1	2.7	91.5	1534.6	66.7
T <sub>7</sub>	28.0	14.0	55.8	13.7	58.1	11.7	65.6	11.0	65.3	1135.3	23.4
T <sub>8</sub>	27.7	1.7	94.6	2.0	93.8	2.3	93.2	3.0	90.5	1570.6	70.6
T <sub>9</sub>	29.7	31.7	—	32.7	—	34.0	—	31.7	—	920.3	—
LSD ( <i>P</i> <0.05)	NS	1.7		1.4		1.6		1.7		28.8	

\* BS: Before spray, \*\*DAS: Days after spray, Variety: PBR 357; <sup>Å</sup> PR: Per cent reduction over control; <sup>ÅÅ</sup> 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<sup>-1</sup> (T<sub>6</sub>) and chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> (T<sub>8</sub>) 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, Ballawal 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<sup>-1</sup> was recorded in T<sub>8</sub>: chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> (Table 3), followed by T<sub>6</sub>: quinalphos 25 EC @ 1 litre ha<sup>-1</sup> (2027.8 kg ha<sup>-1</sup>), T<sub>7</sub>: chlorpyrifos 20 EC @ 750 ml ha<sup>-1</sup> (1508.3 kg ha<sup>-1</sup>) and T<sub>2</sub>: thiamethoxam 25 WG @ 100 g ha<sup>-1</sup> (1483.3 kg ha<sup>-1</sup>). 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 Ballawal 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<sup>-1</sup> was obtained in T<sub>8</sub>: chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> followed by 1534.6 kg ha<sup>-1</sup> in T<sub>6</sub>: quinalphos 25 EC @ 1 litre ha<sup>-1</sup> 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 chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> resulted in maximum benefit cost ratio of 40.90: 1 followed by quinalphos 25 EC @ 1 litre ha<sup>-1</sup> (32.30: 1) (Table 5).

Patel *et al.* (2017) have also reported thiamethoxam 25 WG @ 0.25 g ha<sup>-1</sup>, dimethoate 30 EC @ 1 ml litre<sup>-1</sup>, quinalphos 25 EC @ 1 ml litre<sup>-1</sup> and chlorpyrifos 20 EC @ 0.1 ml litre<sup>-1</sup> 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<sup>-1</sup> 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<sup>-1</sup> and dimethoate 30 EC @ 1 litre ha<sup>-1</sup> provide effective control of *L. erysimi* only, application of chlorpyrifos 20 EC @ 1.5 litre ha<sup>-1</sup> and quinalphos 25 EC @ 1 litre ha<sup>-1</sup> provide effective control

of both *L. erysimi* and *P. brassicae*. Thus, in fields infested with both the insects, the application of latter two insecticides (chlorpyrifos 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.

## References

- Anonymous. 2018. *Package of practices for crops of Punjab-Rabi*. Directorate of Extension Education. Punjab Agricultural University, Ludhiana, pp. 45-57.
- Chaudhuri N, Ghosh S, Ghosh J and Senapati SK. 2001. Incidence of insect pests of cabbage in relation to prevailing climatic conditions of Terai region. *Indian J Entomol* **63**: 421-428.
- Feltwell J. 1985. Large White Butterfly: The Biology, Biochemistry and Physiology of *Pieris brassicae* (Linnaeus). W. Junk Publishers, The Hague, Boston, London, ISBN-13: 9789061931287, pp. 535.
- Gupta PR, Verma AK and Mishra RC. 1985. Field efficacy of some insecticides against caterpillars and thrips on cauliflower seed crop. *Vegetable-Science, Himachal Pradesh Krishi Vishwa Vidyalyaya, SNS Nagar, Solan* **12**: 49-54.
- Hasan F and Ansari MS. 2011. Effects of different brassicaceous host plants on the fitness of *Pieris brassicae* (L.). *Crop Prot* **30**: 854-862.
- Hasan F and Ansari MS. 2010a. Effect of different cole crops on the biological parameters of *Pieris brassicae* (L.) (Lepidoptera: Pieridae) under laboratory condition. *J Crop Sci Biotechnol* **3**: 195-202.
- Hasan F, Ansari MS. 2010b. Population growth of *Pieris brassicae* (L.) (Lepidoptera: Pieridae) on different cole crops under laboratory conditions. *J Pest Sci* doi:10.1007/s10340-010-0339-9
- Hwang SY, Liu CH and Shen TC. 2008. Effects of plant nutrient availability and host plant species on the performance of two *Pieris* butterflies (Lepidoptera: Pieridae). *Biochem Syst Ecol* **36**: 505-513.
- Jainulabdeen S and Prasad SK. 2004. Severe infection of cabbage butterfly, *Pieris brassicae* (L.) on six species of *Brassica* and effect of abiotic factors on its population dynamics. *J Entomol Res* **28**: 193-197.
- Kular JS and Kumar S. 2011. Quantification of avoidable yield losses in oilseed Brassica caused by insect pests. *J Plant Prot Res* **51**: 38-43.
- Kumar S and Sangha MK. 2013. Biochemical mechanism of resistance in some Brassica genotypes against *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae). *Vegetos* **2**: 387-395.

- Kumar S and Singh YP. 2015. Insect-pests. In: Kumar A, Banga SS, Meena PD and Kumar PR (eds.) *Brassica Oilseeds Breeding and Management*. CABI Publishing, Wallingford, UK, pp. 193-232. ISBN: 9781780644837
- Kumar S. 2011. *Cotesia glomeratus* - a potential biocontrol agent for large white butterfly, *Pieris brassicae* in Indian Punjab. In: *Proc. 13<sup>th</sup> Intl Rapeseed Congress*, Prague (June 05–09, 2011) 13: 1141–1143.
- Kumar S. 2017. Potential of Ethiopian mustard, *Brassica carinata* as a trap crop for large white butterfly, *Pieris brassicae* infesting Indian mustard, *B. juncea*. *J Pest Sci* **90**: 129-137.
- Patel S, Yadav SK and Singh CP. 2017. Bio-efficacy of insecticides against *Lipaphis erysimi* (Kalt.) in mustard ecosystem. *J Entomol Zool Studies* **5**: 1247-1250.
- Raqib A. 2004. Population dynamics of cabbage butterfly and cabbage aphid on five cultivars of cauliflower at Peshawar. *Asian J Plant Sci* **3**: 391-393.
- Reddy PP. 2016. Selective pesticides in IPM. In: *Sustainable crop protection under protected cultivation*. Springer Science and Business Media, Singapore, pp. 121-129.
- Sheoran OP, Tonk DS, Kaushik LS, Hasija RC and Pannu RS. 1998. Statistical Software Package for Agricultural Research Workers. In: DS Hooda & RC Hasija. *Recent advances in information theory, statistics and computer applications*, Department of Mathematics and Statistics, CCS HAU, Hisar, pp. 139-143.
- Singh YP and Sharma KC. 2012. Integrated approach to manage the mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae) in oilseed Brassica crops- A Review. *J Aphidol* **16**: 77-88.
- Ullah MI, Arshad M, Ali S, Iftikhar Y, Mahmood SU and Arshad M. 2016. Effect of thiamethoxam and some botanical extracts on *Cotesia glomerata* L. (Hymenoptera: Braconidae): an endoparasitoid of *Pieris brassicae* L. (Lepidoptera: Pieridae). *Egyptian J Biol Pest Contr* **26**: 545-549.
- Weinberger K and Srinivasan R. 2009. Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection. *J Asia Pac Entomol* **12**: 253-259.