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Efficacy of different insecticides and biopesticide against wheat aphid

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Abstract
Wheat, *Triticum aestivum* L. is an important winter cereal crop in India. Punjab is one of the major wheat producing state. Like other states of India, every year wheat crop in the state of Punjab is also infected by complex species of aphid, which consist of *Rhopalosiphum maidis* (Fitch), *R. padi* (L.), *Sitobion avenae* (F.) and *S. miscanthi* (Takahashi). Therefore, an on farm trial was carried out to evaluate the efficacy of different insecticides (Confidor 17.8 SL @ 100 ml ha^{-1}, Monocil 36 SL @ 1000 ml ha^{-1}) and biopesticide (Indoneem 1500 ppm @ 1200 ml ha^{-1}) against wheat aphid during Rabi season 2018. All the insecticides and biopesticide significantly reduced the aphid infestation; however, on numerical basis Confidor 17.8 SL appeared as most effective with minimum infestation (0.67 aphid/ear) assessed fifteen days after application. Grain yield of treatment with Confidor 17.8 SL @ 100 ml/ha was found with highest yield (51.55 q/ha) and superior than other treatments including control. Benefit-cost ratio (BCR) calculated for different insecticidal treatments also revealed that Confidor 17.8 SL @ 100 ml/ha was found most cost effective (1:6.65) as compared to other insecticides.

Keywords: *Triticum aestivum*, *Rhopalosiphum maidis*, *Sitobion avenae*, insecticides, biopesticide

Introduction
India is the second producer of wheat after China and shares 12.4 per cent of the total production in the world (Hazra, 2000) [12]. In India wheat is the second important cereal crop after rice and contributes as a staple food for the majority of the North Indians. It shares about 35 per cent of the total food grain production in India (Nagarajan, 2000) [18]. In Punjab wheat is grown in area of 34.95 lakh hectares with a production of 176.36 lakh tonnes (Anonymous, 2018) [2]. Despite the large cultivation area of wheat in the country, still the productivity of wheat per hectare is low as compared to other countries. This is due to several abiotic and biotic factors, such as cultivation of non-recommended varieties, imprudent use of nitrogenous fertilizers, infestation of weeds particularly *Phalaris minor* Retz., deficiency of Manganese and Zinc in soil, attack of insect-pests and diseases. Wheat crop is attacked by several insect-pests from sowing to harvesting *viz*. complex species of aphids (*Rhopalosiphum maidis*, *R. padi*, *Sitobion avenae*, *S. miscanthi*) (Srivastava *et al*., 2016; Shah *et al*., 2007) [27, 22], pink stem borer (*Sesamia inferens*) (Walker), army worm, (*Mythimna unipuncta*) (Haworth), termites (*Microtermes obesi*) (Holmgren), (*Odontotermis obesus* Rambur) and gram pod borer (*Helicoverpa armigera*) (H**ü**bner), Brown mite (*Petrobia latens* Mull.) (Singh, 1988 [25]). Wheat aphid complex causes 3.53 – 21.05 per cent yield losses in wheat varieties in Punjab (Singh and Deol, 2003) [23]. Wheat aphid causes direct damage by sucking the cell sap, especially during the milky grain stage and also due to the development of sooty mould on plant leaves (Kannan, 1999; Aziz *et al*., 2013) [13, 3]. Population of aphid varies every year with prevailing climatic conditions and wheat cultivars, therefore the monitoring is necessary throughout the year (Shafique and Ahmed, 2016) [21]. For the management of aphid population many control measures have been adopted to manage the aphid population below economic threshold level (ETL) like host plant resistance, conservation of bio-control agent, cultural, mechanical, physical and chemical control. Insecticides belong to the group of neonicotenoids have been recommended for the control of aphid which possess systemic and translaminar activity. These insecticides have quick knock down effect on target pest by interfering with transmission of impulse in the nerve system. Application of neonicotinoid group of insecticides on wheat reduces aphid infestation and also checks the spread of many crop viruses. (Dewar, 1992; Knaust and Poehling, 1992; Mullins, 1993; Westwood *et al.*, 1998; Elbert *et al.*, 1998; Bethke *et al.*, 2001; Elzen, 2001) [8, 14, 17, 28, 9, 5].

An earlier insecticide used by farmer belongs to the class of carbamate group for the management of aphid which was more toxic than neonicotenoids. (Boyd and Boethel, 1998; Brunner *et al.*, 2001) [6, 7]. Among the major insect-pests of wheat in Barnala district, aphid has gained economic importance of regular pest and reported from all wheat growing blocks. The present study was carried out to evaluate the efficacy of different insecticides and neem seed kernel extract (NSKE) based biopesticide for the eco-friendly management of aphid under farmer's field conditions.

Materials and Methods

An on farm trial was conducted to study the efficacy of different insecticides and biopesticide against wheat aphid during Rabi season 2018 at four different locations in Barnala district of Punjab. The efficacy of different insecticides and biopesticide *viz*., Confidor 17.8 SL @ 100 ml/ha, Indoneem 1500 ppm @ 1200 ml/ha, Monocil 36 SL @ 1000 ml/ha (Farmer's practices) per 250 liter of water were evaluated and an untreated control was also kept where no insecticide was applied. The insecticides were sprayed with the help of knapsack sprayer at ear head stage when the incidence of aphid crossed economic threshold level (ETL) of 5 aphid per ear (Singh *et al*., 2003) [24]. For counting of wheat aphid population, ten plants were randomly selected per replication in the treatment. Aphid count was taken one day before the application of insecticide and after spraying of insecticides, population counts of aphids were recorded at one, three, seven, and fifteen days of interval. The data were analyzed by applying Two-way ANOVA. The grain yield per treatment was recorded and converted into quintal per hectare. The economics of different treatments was worked out on the basis of prevailing market price of crop, cost of insecticides and application cost. Net profit and benefit-cost ratio (BCR) were also worked out.

Results and Discussion

Insecticidal efficacy

The data on efficacy of insecticides and biopesticide on foliage feeding wheat aphids at 1, 3, 7 and 15 days after spray are presented in Table 1. The pretreatment count for aphid population was recorded 24 hrs before insecticide application varied from 7.33 to 8.33 per ear/plant. The data indicated that statistically non-significant differences among the Confidor 17.8 SL and Untreated treatment as well as there is non-significant difference between Indoneem 1500 ppm and Monocil 36 SL treatments before the application of insecticides. After the foliar application of Confidor 17.8 SL @ 100 ml/ha to wheat, recorded a minimum mean number of aphids (3.07/ear/plant) followed by Indoneem 1500 ppm @ 1200 ml/ha (3.40/ear/plant) and Monocil 36 SL @ 1000 ml/ha (4.67/ear/plant). The insecticide efficacy data indicated that all the insecticides and biopesticide treatments were significantly superior over untreated control at 1, 3, 7 and 15 days after spray (DAS). The minimum population of aphid per ear/plant was recorded i.e. 3.33, 1.67, 1.33 and 0.67 at 1, 3, 7 and 15 days after spray, respectively with the treatment of Confidor 17.8 SL @ 100 ml/ha and there is non-significant difference between Indoneem 1500 ppm @ 1200 ml /ha, at 1 days after spray (3.67/ear/plant). While, treatment with Monocil 36 SL @ 1000 ml/ha recorded the number of aphids/ ear/plant (7.33, 5.33, 2.33 and 1.00) at 1, 3, 7 and 15 days after spray, respectively and there is non-significant difference between Indoneem 1500 ppm treatment at 7 and 15 days after treatment (2.00 and 1.33/ear/plant), respectively. The treatment with no spray (untreated) recorded significantly maximum number of 8.67, 9.33, 10.67 and 13.00 aphids/ear/plant at 1, 3, 7 and 15 days. Our results corroborate with the findings of Elbert *et al.*, (1991) [10] who also reported that Confidor 17.8 SL has outstanding insecticidal activity against sucking pests with longer persistent toxicity. This neonicotenoid insecticide has a potential for the management of aphid by treating the seed with this insecticide (Mckirdy and Jones, 1996; Mahmoud *et al.*, 2017) [16, 15]. The bioefficacy of Confidor 17.8 SL was evaluated at 20 g.a./ha against wheat aphid and author reported that highest yield, net return and benefit-cost ratio was observed with this insecticide treatment (Patil *et al*., 2009) [19]. Rajendra and Dikshit (2001) [20] also reported that imidacloprid is a new generation effective and prospective insecticide. It is highly effective against major insects including sucking pests due to its high intrinsic acute and residual activity. Further, (Srinivasa and Sharma, 2003) [26] also confirmed that imidacloprid was highly effective in controlling of wheat aphid.

Grain yield and benefit-cost ratio: The differences in yield of wheat was observed (Table 2) due to different insecticide treatments. The highest yield of wheat was observed with the treatment Confidor 17.8 SL (51.55 q/ha). It was followed by the treatment with Indoneem 1500 ppm (51.26 q/ha), and Monocil 36 SL (51.17 q/ha). Additional income of all the treatments revealed that highest income was found with Confidor 17.8 SL (₹ 9837) followed by Indoneem 1500 ppm (₹ 9334) and Monocil 36 SL (₹ 9178). Benefit-cost ratio calculated for different insecticidal treatments revealed that application of Confidor 17.8 SL followed by Monocil 36 SL and Indoneem 1500 ppm were 6.65, 5.92 and 5.56, respectively (Table 2). Different researchers (Akbar *et al*., 2010 [1]; Babu and Sharma, 2003 [4] and Patil *et al*., 2009 [19] also reported similar observations on the efficacy of various insecticides on grain yield of wheat.

Table 1: Efficacy of different insecticides and biopesticide against wheat aphid population

Treatments	Number of aphids/ear					
	DBS	1 DAS	3 DAS	7 DAS	15 DAS	Mean
Confidor 17.8 SL	8.33 (3. 04)^{a}	3.33 (2. 08)^{c}	1.67 (1. 63)^{d}	1.33 (1. 52)^{c}	0.67 (1. 28)^{c}	3.07 (1.91)
Indoneem 1500 ppm	7.33 (2. 88)^{b}	3.67 (2.16)^{c}	2.67 (1. 91)^{c}	2.00 (1. 72)^{b}	1.33 (1. 52)^{b}	3.40 (2.04)
Monocil 36 SL	7.33 (2. 88)^{b}	7.33 (2. 88)^{b}	5.33 (2. 52)^{b}	2.33 (1. 82)^{b}	1.00 (1. 41)^{bc}	4.67 (2.30)
Untreated	7.67 (2. 94)^{ab}	8.67 (3. 11)^{a}	9.33 (3. 21)^{a}	10.67(3. 42)^{a}	13.00 (3. 74)^{a}	9.87 (3.28)
Mean	7.67 (2.94)	5.75 (2.56)	4.75 (2.32)	4.08 (2.12)	4.00 (1.99)	

Mean of three replications (30 ears/ treatment); figures in parenthesis are square root transformation; DBS-day before spray; DAS-day after spray CD (P=0.05)
Treatment= 0.14
Days= 0.15
Treatment X Days= 0.31

Table 2. Effect of different insecticides and biopesticide on grain yield and benefit-cost ratio

Tre Tre Treatments	Dose	Yield (q/ha)	Additional Production (q/ha)	Additional Income (Rs./ha)	Cost of spray including spraying charges (Rs./ha)	BCR
Confidor 17.8 SL	Imidacloprid @ 100 ml/ha	51.55	5.67	9837	1480	6.65
Indoneem 1500 ppm	Neem seed kernel extract @ 1200 ml/ha	51.26	5.38	9334	1680	5.56
Monocil 36 SL	Monocrotophos @ 1000 ml/ha	51.17	5.29	9178	1550	5.92
Untreated		45.88		-	-	-

Cost of Confidor 17.8 SL is Rs. 112 per 40 ml
Cost of Indoneem 1500 ppm is Rs. 200 per 500 ml
Cost of Monocil 36 SL is Rs. 175 per 500 ml
Labour charges for spray is Rs. 1200 per ha
Wheat sale @ Rs. 1735 per q

Conclusion

The perusal of data revealed that minimum mean aphid population 3.07 per ear was found with treatment Confidor 17.8 SL @100 ml/ha and found significantly better than other treatments. The results of this field study clearly indicated that Confidor 17.8 SL @100 ml/ha was the most effective against wheat aphid and gave extra income of ₹ 9837 as well as the highest benefit- cost ratio (6.65). However neem seed kernel extracts (NSKE) based biopesticide Indoneem 1500 ppm @ 1200 ml/ha gave additional income of ₹ 9334. Therefore, the application of neem seed kernel extracts (NSKE) based biopesticide can be incorporated for the management of this pest under Integrated Pest Management (IPM) strategies.

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