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Evaluation of the efficacy of relative bio-pesticide and insecticides against barley aphid

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Abstract
The bio-efficacy of the treatments evaluated against aphid on barley crop showed that lowest population of 2.20, 2.80, 5.73, 12.13, 12.20, 25.70, 30.13 / shoot. was recorded in flubendiamide 480 SC @ 250 ml ha^{-1}, imidacloprid 17.8 SL @ 100 ml ha^{-1}, acetamiprid 20 SP @ 100 $gmha^{-1}$, chlorantraniliprole 18.5 SC @ 100 $gm.ha^{-1}$, *Metarhizium anisopliae* 1×10^{8} CFU/gm.@3.0 g. lit^{-1}, *Beauveria bassiana* 1×10^{9} CFU/gm.@5.0 g. lit^{-1} and Azadirachtin 1500 ppm (0.15%EC)3.0 $ml.lit^{-1}$ respectively and were found statistically at par in their efficacy. The highest aphid population was recorded in untreated control (61.60 Aphids/shoot). The data of seed yield revealed that maximum yield of(50.38 q ha^{-1})was recorded in the plots treated with in flubendiamide @ 250 $mlha^{-1}$ followed by imidacloprid @ 100 $mlha^{-1}$, & acetamiprid @ 100 $gmha^{-1}$, which gave (50.10 q ha^{-1}& 49.21q ha^{-1}) seed yield, respectively and all these found statistically at pareach other and proved significantly superior over rest of the treatments.

Keywords: Barley aphid, insecticides, bio pesticides, *Rhopalosiphum maidis*

Introduction
Barley (*Hordeum vulgare* L.) is one of the most important cereal crops in the world**,** occupying fourth position in cultivation after wheat, rice and maize and third in total cereal production. The countries, where barley is mostly grown are Morocco, Ethiopia, Turkey, Canada, U.S.A., Spain, U. K. Australia, U.S.S.R. and France. In India barley crop is grown over an area of 6.65 lakh ha with production of 17.7 lakh tones and productivity of 26.79 qha^{-1}**.**The main barley producing states in our country are Uttar Pradesh, Rajasthan, Bihar, Madhya Pradesh, Haryana, Punjab, Himachal Pradesh, West Bengal, Maharashtra, Sikkim, Delhi and Jammu and Kashmir. The major concentration of barley starts from North-Western districts of Bihar and extends up to Mathura (Uttar Pradesh). In west, main barley areas lie in north-eastern and southern districts of Rajasthan and Haryana. In northern hills, barley is grown in Kumaon (Uttarakhand), Kangra, Kullu, Lahaul and Spiti valleys of Himachal Pradesh. Uttar Pradesh is also a most important barley growing state of the country with an area of about 1.55 lakh ha and production of 4.26 lakh tones and productivity is 27.48 qha^{-1}. In this way U.P. has great significance both in cultivated area and grain production of barley. The grains of barley contain 12.5 percent moisture, 11.5 percent albuminoids, 74.0 percent carbohydrate, 1.3 percent fat, 3.9 percent crude fiber and 1.5 percent ash.

Barley is consumed as human food, animal feed and malt formation the major portion of the grain produce is consumed by the poor classes in the form of flour for 'Roti' and `Sattu' after roasting and grinding. Barley malt is used in the preparation of syrups, extracts, beer and whisky. Degree of susceptibility of the crop 14.27 to 26.0, 2.8 to 67.5 and 2.0 to 17.1 percent damage by barley aphid was recorded by Bhatia *et al.* (1973), Bhatia and Singh (1977) and Chillar *et al.* (1981), respectively [2-4]. Singh *et al.* (1979) reported that barley crop is some time damaged severely by *Rhopalosiphum maidis* at various stages of its growth [11]. The barley aphid (*R. maidis*) may be observed in some fields, when the plants gained only of 2 or 3 cm long and sometime it is not found until about the time the plants began to head [9].

From economic cultivation point of view, it is necessary to protect the crop from the attack of *R. maidis* in early stages. The knowledge of specific appearance and its peak infestation period help the growers to control the pest well in advance. Not only has this, the factors of environment played an important role in influencing the behavior of this insect; this is the main criteria for effective and efficient pest control.

Materials and Methods

The experiment was laid out in simple randomized block design (RBD) with eight treatments (insecticides and bio pesticides) including untreated control, each replicated thrice. The plot size was 3 x 5 m ($15m^{-2}$) keeping row to row distance 23 cm. The genotype K 551 recommended for this region was used for the experiment and sown in experimental field. Seven insecticides and bio pesticides were used for testing their bio efficacy against aphid, *R. maidis* on barley crop.

The details regarding insecticides and bio pesticides and their dosages are given in table 1. Bio pesticide and Insecticidal spraying under evaluation the efficacy of insecticides and bio pesticides against barley aphids, one spray applications were done with foot sprayer @ 600 lit/ha, after appearance of aphids. The quantity of insecticides was measured by micropipette and then mixed with required water. The spray solution was prepared on the basis following formula.

$$\text{Quantity of the proprietary insecticide required} = \frac{\text{Percentage of active in gradient} \times \text{Total quantity of in sprey solution desired sprey solution required}}{\text{Percentage of active ingradient of the propietary insecticides}}$$

Observation on yield of barley

The effect of various bio pesticide and insecticidal treatments on grain yield of barley was also determined. After harvesting of each plot, grain yield was recorded.

Percentage reduction

The percentage reduction in population over untreated check was calculated with the following formula (Abbots, 1925).

$$\text{Percentage reduction} = \frac{C-T}{C} \times 100$$

Where,
C = Population in untreated check plot
T = Population in treated plot

Statistical analysis of data

The experiments were conducted in Random Block Design (RBD). Data with appropriate transformation were analyzed with the help of analysis of variance table wherever required. The critical difference was calculated at 5 percent of significance and F value was tested for comparing treatment means.

Results and Discussion

Spray of tested bio pesticides and insecticides was done to observe overall effect of four observations, it was found that the application of flubendiamide 480 SC (2.20 aphids/shoot) was found significantly superior in reducing the aphid population in comparison to other bio pesticide and insecticide except imidacloprid 17.8 SL, acetamiprid 20 SP and chlorantraniliprole 18.5 SC also gave similar effect of flubendiamide 480 SC statistically. The application of Azadirachtin was found to be least effective having (30.13aphids/shoot). All treatments were found to be statistically superior in comparison to be untreated check (61.60aphids/shoot). The percentage reduction in population over untreated check in various treatments varies from 35.66 to 83.50 percent, the lowest in Azadirachtin and highest in flubendiamide 480 SC.

Effect of insecticide or bio pesticide on population of aphid, *R. maidis*

In the present investigation, the overall bio efficacy of the treatments against aphid on barley crop showed that lowest population of flubendiamide 480 SC (2.20 aphids/shoot) was found significantly superior in reducing the aphid population in comparison to other bio-pesticide and insecticide except imidacloprid 17.8 SL, acetamiprid 20 SP and chlorantraniliprole 18.5 SC also gave similar effect of flubendiamide 480 SC statistically. The application of Azadirachtin was found to be least effective having (30.13aphids/shoot). All treatments were found to be statistically superior in comparison to be untreated check (61.60aphids/shoot). The percentage reduction in population over untreated check in various treatments varies from 35.66 to 83.50 percent, the lowest in Azadirachtin and highest in flubendiamide 480 SC.

The present findings are in conformity with that of Patel *et al.* (2015) who reported that flubendiamide 480 SC @ 250ml/ha was most effective against barley aphid on Barley crop [8]. Ahmad *et al.* (2016) Reported that Imidacloprid 200 SL (0.008%) was the most effective in reducing population of aphid on barley crop [1]. Jasrotia *et al.* (2019) who revealed that flubendamide 480 SC and acetamiprid 20 SP proved to be highly effective in suppressing the aphids on barley crop [7]. Dhawan *et al.* (2011) who reported that the azadirachtin content estimated in NSKE was 0.427 mg/ g [6]. There was 69 percent reduction in population of aphids at 6.25 percent NSKE one day after spray (DAS) which subsequently reached to 98 percent after 7 DAS. Choudhary *et al*. (2017) who reported that The *Beauveria bassiana* (1 g/l), NSKE (5.0%), imidacloprid (8 g/ kg), and acetamiprid (8 g/ kg) registered 42.57, 42.97, 48.47, and 51.60 aphids/ tiller, respectively and less effective. The highest aphid population was recorded in untreated control (81.23/ tiller). The findings are in conformity with the findings of Radha *et al*., (2006) who reported that neem insecticide, nimbicidine was least effective against R. maidis on maize crop. Similarly, Sachan *et al*., (2006) reported that NSKE and neem oil were least effective insecticides against mustard aphid *L. erysimi*, partially support the present findings. The present findings are also in agreement with those of Nirmala *et al.*, (2006) who reported that fungus isolates of *Beauveria bassiana*, *M. anisopliae* and *Verticilium lecanii* were pathogenic to *R. maidis* [12]. The order of effectiveness of all treatments was Flubendamide (250 ml/ha) = Imidacloprid (100 ml/ha) = Acetamiprid (100 gm/ha) = Chlorantaniliprole (100 ml/ha) (there are actual dose) = Azadirachtian (3 ml/l) = *Beauveria bassiana* (5 g/l) = *Metarhizium anisopliae* (3g/l).

Effect of insecticide or bio pesticide on the seed yield of barley

Significantly higher grain yield was recorded in the plots treated with flubendiamide 480 SC (100 ml), imidacloprid 17.8 SL (250 ml) and acetamiprid 20 SP (100 gm) gave significantly higher grain yield i.e. 50.38, 50.10 and 49.21 q/ha, respectively which were proved to significantly superior to chlorantranilprole 18.5 SC (100 ml), *Metarhizium anisopliae* (3.0g/l), *Beauveria bassiana* (5.0g/l) and Azadirachtin (3.0ml/l) 48.10, 47.88, 45.99 and 44.98 q/ha.

Increase yield untreated check was calculated it was highest in flubendiamide 480 SC (7.89 q/ha) treated plot which was followed imidacloprid 17.8 SL, acetamiprid 20 SP, chlorantranilprole 18.5 SC, *Metarhizium anisopliae*, *Beauveria bassiana*, Azadirachtin being 7.61, 6.72, 5.61, 5.39, 3.50 and 2.49 q/ha respectively. The performance of tested bio pesticides and insecticides, it is clear that farmer may be recommended to choose any of the bio pesticide and insecticide viz. flubendiamide 480 SC, imidacloprid 17.8 SL and acetamiprid 20 SP for spray on the barley crop to check the considerable population of aphids as well as to obtain maximum grain yield.

Table 1: Details of Insecticides & Bio pesticides used

S. No.	Common name	Trade Name	Formulation	Doses (g, ml,/ha, g/lit.)
1	Imidacloprid	Confidor	17.8% SL	100 ml/ha
2	Flubendiamide	Fame	39.35% SC	250 ml/ha
3	Acetamiprid	Ennova	20 SP	100 g/ha
4	Chlorantraniliprole	Coragen	18.5% SC	100 ml/ha
5	Azadirachtin	NeemKavach	1500 ppm (0.15% EC)	3.00 ml/lit
6	*Beauveria bassiana*	Daman	(1×10^9CFU/gm.)	5.0 g/lit
7	*Metarhizium anisopliae*	Kalichakra	(1×10^8CFU/gm.)	3.0 g/lit
8	Control untreated	-	-	-

Table 2: Evaluation of some insecticides and biopesticides against aphid, Rhopalosiphum maidis (Fitch)

S. No.	Treatment	Actual Dosages (g,ml,/ha,g/li)	Aphid population per main shoot				
			Before spray	After spray			
			1 day	1 Day	2 Days	7 Days	15 Days
1	Imidacloprid	100 ml/ha	10.40	6.77 (15.00)	5.40 (13.44)	5.13 (13.00)	2.80 (9.63)
2	Flubendiamide	250 ml/ha	9.50	5.60 (13.66)	3.73 (11.05)	5.06 (12.91)	2.20 (8.53)
3	Acetamiprid	100 g/ha	10.20	6.86 (15.18)	5.66 (13.76)	6.66 (14.89)	5.73 (3.81)
4	Chlorantraniliprole	100 ml/ha	10.26	7.13 (15.48)	6.06 (14.24)	7.00 (15.34)	12.13 (20.36)
5	Azadirachtin 1500 ppm	3.0 ml/lit	9.33	10.93 (19.30)	14.33 (26.64)	26.33 (31.73)	30.13 (33.27)
6	*Beauveria bassiana*	5.0 g/lit	11.20	9.00 (17.42)	11.40 (19.73)	14.2 (22.01)	25.7 (30.26)
7	*Metarhizium anisopliae*	3.0 g/lit	9.80	8.93 (17.38)	10.73 (19.11)	15.73 (22.83)	12.2 (20.44)
8	Control (Untreated)	3.0 g/lit	10.26	16.53 (23.99)	23.53 (29.00)	87.53 (69.66)	61.60 (51.71)
	SEm±			0.496	0.61	1.581	0.924
	C.D at 5%			1.50	1.892	3.424	3.193

Figure in parentheses are transformed value.

Table 3: Efficacy of Bio pesticide and Insecticide on the incidence of *R. maidis* after spray

S.N.	Treatment	Actual Dosages (g,ml, /ha,g/li)	No of Aphid/ shoot after spray				A.V. Percentage reduction over control
			1 Day Percentage reduction over control	2 Days Percentage reduction over control	7 Days Percentage reduction over control	15 Days Percentage reduction over control	
1	Imidacloprid	100 ml/ha	37.47	53.65	81.33	81.37	63.45
2	Flubendiamide	250 ml/ha	43.05	61.89	81.46	83.50	67.47
3	Acetamiprid	100 g/ha	36.72	52.55	78.62	73.29	60.29
4	Chlorantraniliprole	100 ml/ha	35.47	50.89	77.97	60.62	56.23
5	Azadirachtin 1500 ppm	3.0 ml/lit	19.54	8.13	54.92	35.66	29.56
6	*Beauveria bassiana*	5.0 g/lit	27.38	31.96	68.40	41.48	42.30
7	*Metarhizium anisopliae*	3.0 g/lit	27.55	34.10	67.22	60.47	47.33
8	Control (Untreated)	3.0 g/lit	16.53	23.53	87.53	61.60	-

Table 4: Efficacy of Biopesticide and Insecticide on barley grain Yield

S. No.	Treatments	Dosages (g,ml,/ha,g/lit)	Mean grain Yield (q/ha^{-1})	Increase yield over untreated check
1	Imidacloprid 17.8 SL	100 ml/ha	50.10	7.61
2	Flubendiamide 39.35% SC	250 ml/ha	50.38	7.89
3	Acetamiprid 20 SP	100 g/ha	49.21	6.72
4	Chlorantraniliprole 18.5% SC	100 ml/ha	48.10	5.61
5	Azadirachtin 1500 ppm (0.15%EC)	3.0 ml/lit	44.98	2.49
6	*Beauveria bassiana* 1×10^9 CFU/gm.	5.0 g/lit	45.99	3.50
7	*Metarhizium anisopliae* 1×10^8 CFU/gm.	3.0 g/lit	47.88	5.39
8	Control		42.49	
	SEm$\pm$		0.362	
	C.D. at 5%		1.08	

Figure in parentheses are transformed value.

Conclusion

The order of effectiveness of insecticides in descending order on the basis of seed yield of barely was found to be: flubendiamide @ (250 mlha^{-1}), Imidacloprid @ (100 mlha^{-1}), Acetamiprid @ (100g. ha^{-1}), Chlorantraniliprole @ (100ml.ha^{-1}), *Metarhizium anisopliae* @ (3.0 g/lit), *Beauveria bassiana* @ (5.0 g/lit), Azadirachtin @ (3.0 ml/lit). The present findings are in agreement with that of Patel *et al*. (2015) who reported that percent increase in yield over control in wheat & barley crop was higher in the treatment off lubendiamide @ (250 mlha^{-1}) when applied against aphids infesting barley crop. Choudhary *et al*. (2017) reported that Imidacloprid (0.005%) was most effective in protecting the grain yield [5]. The findings are in partial agreement with Radha *et al*., (2006) who reported that neem product; nimbicide was the least effective and gave lower seed yield as compared to synthetic insecticides.

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