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Yam Bean Seed Extract: An Alternative to Chemical Insecticide in Managing Cereal Aphid in Barley

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Abstract

Barley is an important cereal grown in Northern India, particularly during the rabi season. Nowadays, the aphid (*Sitobium avenae*) has emerged as a major key pest because of anthropogenic climate change and natural variability, which was considered as a minor pest during the past decade. An experiment was conducted at Research farm, Tirhut College of Agriculture,Dholi to evaluate the efficacy of tuber crop based bio-pesticide against aphid in barley. Bio-pesticides based on yam bean and cassava such as yam bean seed extract and powder, cassava leaf extract, and tuber rind extract along with chemical insecticide (dimethoate) were evaluated. Among them, two sprays of yam bean seed extract @ 5% at an interval of 15 days was found to be the most effective in managing the aphid population, which was at par with that of chemical insecticide dimethoate @ 0.05% and found to be safe for natural enemies particularly ladybird beetle and spider which are considered as a major predator of aphid in this ecosystems.

Key words: Yam bean seed extract, Aphid, Barley, Chemical insecticide

Introduction

Barley, *Hordeum vulgare*, the oldest domesticated food grain source, is an important winter cereal and grown particularly northern parts of India. It is known for it's relatively tolerance to salinity and drought. It is a rich source of vitamin B and help in reducing the risk of obesity, diabetes, heart diseases and certain types of cancer (Ware and RDN, 2019). It is grown in an area of 48 million hectares throughout the world and mainly used for animal feeding, for the production of beer and spirits and directly in human diet (Verstegen et al., 2014). In India, it is grown in an area of 6.6 lakh hectares with a production of 1.77 million tonnes and productivity of 26.79 q ha^{-1}. The major barley growing states are Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab and West Bengal. It is also grown in a few pockets of Bihar, Uttarakhand and Himachal Pradesh. Infestation of cereal aphid is considered as one of the major factors responsible for decreasing production and productivity (Gill and Metcalfe, 1977; Malik et al., 2013). Several tools of pest management were already developed for management of aphids in various crops. Because these aphids reproduce asexually, population may grow quickly under optimal environmental conditions. Severity of the pest incidence and consequent yield losses pose threat to the barley cultivation. Under this situation, use of chemical is the one and only options for suppressing the aphid population. A lot of generic insecticide has been evaluated against aphid and aphid show resistance to many of them. Hence, there is always a need for evaluating the newer insecticide molecules and plant products.

Yam bean and cassava are the two important tuber crops grown in eastern and southern parts of the country, respectively. The mature seeds of yam bean are known to contain rotenone, which was used as a popular insecticide during the past decades. On the other hand, being a plant

origin, there is no problem of residue, resistant and secondary pest outbreak. Keeping this in view, the study was conducted to evaluate the efficacy of some tuber crop based bio-pesticide against aphid in barley.

Materials and Methods

The experiment was carried out at the Research Farm, Tirhut College of Agriculture, Dholi, Bihar, India for the period of one year i.e., during 2019-20. The experimental site was located at latitude of 25.98^{0}N, longitude of 85.61^{0}E and an altitude of 52.12m above mean sea level.

The experiment was conducted in randomised block design with ten treatments and each treatment was replicated thrice. Barley (Variety-RD-2967) was raised in plot of size 5m × 4 m with a row spacing of 22.5 cm following the recommended standard agronomical practices to raise healthy crops except chemical pest management. The insecticidal treatments for the management of aphid consists of two doses of yam bean seed extract (YBSE) @ 2% and 5%, two doses of yam bean seed powder (YBSP) @ 2% and 5%, two doses of cassava leaf powder (CLP) @ 2% and 5%, two doses of cassava tuber rind extract (CTRE) @ 2 and 5% and Dimethoate 30 EC @ 0.05%. An untreated control was simultaneously maintained during the study. The spraying of chemicals was done during warm and sunny conditions with little or no wind with the help of a high volume knapsack sprayer fitted with hollow cone nozzole and using 500 L of spray fluid per hectare. The application was done when the pest population reaches the economic threshold level (ETL). The first and second spraying was done on 15th of February and 2nd of March 2020.

Determination of aphid population reduction

Five plants were randomly selected from each plot and the aphid population was counted one day prior to treatment and 3, 5, 7 and 10 days after treatment (DAT). After ten days of second spraying, the per cent reduction of pest over control was calculated as PR=[(control count-treatment count/control count) × 100]. Treatment wise grain yields were recorded after harvest and expressed in quintal per ha.

Determination of natural enemies population

To evaluate the effect of bio-pesticides on population of natural enemies, 5 plants from each plot were randomly examined for natural enemies like the ladybird beetle and spider. The population of natural enemies at their adult stages was counted one day prior to treatment and ten days after each treatment. According to IOBC classes of toxicity, the bio-pesticide tested under the field conditions were classified as N, harmless or slightly harmful (0-50% reduction); M, moderately harmful (51-75% reduction) and T, harmful (> 75% reduction) respectively (Boller et al., 2005).

Statistical analysis

The computation of analysis of variance of data collected from field experiment was done by Randomized Block Design (RBD). Statistical analysis of data was carried out using SPSS version16.0.

Results and Discussion

The efficacy of different bio-pesticides on aphids in barley is presented in Table 1. Prior to spraying, mean aphid population per plant varied non-significantly from 70 to 92 in different plots. Maximum reduction of aphid population was observed on 10 DAT, in plot treated with chemical insecticides i.e., Dimethoate @ 0.05% (from 77.00 to 19.67). However, among bio-pesticides, maximum reduction of aphid population per plant was observed in plot treated with YBSE @ 5% where the population of aphid declined from 86.33 to 31.67, which was statistically at par with plot treated with YBSE @ 2% (from 92.67 to 34.00) followed by YBSP @ 5% (from 83.33 to 37.33) and YBSP @ 2% (from 80.33 to 40.00). However, bio-pesticide based on cassava was found to be less effective in managing the aphid population than bio- pesticide based on yam bean. Plot treated with CTRE @ 5% recorded 43.00 number of aphids per plant followed by plot treated with CTRE @ 2% (47.33 number of aphids per plant) and CLP @ 5% (55.67 number of aphids per plant) and CLP @ 2% (58.00 number of aphids per plant). In contrast, there was a continuous rise of the aphid population in control plot.

Before the second spray, mean number of aphid population per plant varied significantly from 27.00 in the Dimethoate treated plot to 79.67 in the control plot. After ten days of second spraying, the lowest aphid population per plant was observed in plot treated with Dimethoate @ 0.05% (3.67 number of aphids per plant), which was statistically at par with plot treated with YBSE @ 5% (7.33 number of aphids per plant). This was followed by plot treated

Table 1. Effect of bio-pesticides on cereal aphid in barley

Treatment	1st Spray					2nd Spray					Yield ($kg plot^{-1}$)	Yield ($q ha^{-1}$)
	1 DBT	3 DAT	7 DAT	10 DAT	PR	1 DBT	3 DAT	7 DAT	10 DAT	PR		
T1-YBSE (2%)	92.67	39.67	26.33	34.00	56.59	44.33	20.67	7.33	10.67	85.18	2.22	29.86
T2-YBSE (5%)	86.33	32.67	23.67	31.67	59.57	38.00	18.67	6.67	7.33	89.82	2.27	30.31
T3-YBSP (2%)	80.33	40.00	32.33	40.00	48.93	51.67	21.33	14.33	22.33	68.99	2.16	28.75
T4-YBSP (5%)	83.33	36.67	31.33	37.33	52.34	47.33	19.67	13.00	17.33	75.93	2.24	29.61
T5-CLP (2%)	70.00	55.67	48.67	58.00	25.95	65.67	47.33	33.67	38.67	46.29	2.09	27.86
T6-CLP (5%)	84.00	54.67	44.67	55.67	28.93	63.67	42.00	29.33	35.67	50.46	2.12	28.25
T7-CTRE (2%)	81.33	46.33	39.00	47.33	39.58	58.00	27.67	21.00	30.33	57.88	2.13	28.37
T8-CTRE (5%)	80.33	43.33	34.33	43.00	45.10	57.67	24.33	18.33	26.33	63.43	2.15	28.71
T9-Dimethoate (0.05%)	77.00	25.00	17.67	19.67	74.89	27.00	11.67	3.33	3.67	94.90	2.38	31.71
T10-Control	73.67	76.00	75.67	78.33	-	79.67	81.33	80.67	72.00	-	1.91	25.48
C.D (5%)	NS	14.71	9.20	6.56		9.10	8.69	8.31	5.60		0.07	0.94
SE(m)	10.74	4.91	3.07	2.19		3.04	2.90	2.77	1.87		0.03	0.44
C.V	23.18	18.91	14.25	8.53		9.88	15.97	21.13	12.26		1.91	1.89

DBT- Day before treatment, DAT- Day after treatment, PR- Percentage Reduction, YBSE:- Yam Bean Seed Extract YBSP: Yam Bean Seedpowderr CLP: Cassava Leaf Powder, CTRE: Cassava Tuber Rind Extract

with YBSE @ 2% (10.67 number of aphids per plant), YBSP @ 5% (17.33 number of aphids per plant) and YBSP @ 2% (22.33 number of aphids per plant). Plot treated with CTRE @ 5 and 2% recorded aphid population of 26.33 and 30.33 per plant respectively. Similarly plot treated with CLP @ 5% and 2% recorded aphid populations of 35.67 and 38.67 per plant. Though, all the treatments were found to be superior to control plot, it was only dimethoate @ 0.05% and YBSE @ 5%, found to be suppressed aphid population below the ETL. The highest grain yield was recorded in plot treated with Dimethoate @ 0.05% (31.71 q ha^{-1}) followed by YBSE @ 5% (30.31 q ha^{-1}). These findings are in accordance with the finding of Singh *et al* (2019) who reported that yam bean seed extract was equally effective with the chemical insecticides i.e., Dimethoate in managing the population of aphid in mustard. Basukiradi et al. (2014) also observed that yam bean seed extract act as an ovipositional deterrent to Diamond back moth, thereby helps in regulating the pest population in the field.

During the cropping period, natural enemies such as ladybird beetle and spider were commonly observed in the barley ecosystem. Among bio-pesticide, none of the treatments has any significant effect on the population of natural enemies. However, the plot treated with Dimethoate @ 0.05 % recorded a declining trend of natural enemies population (Fig. 1). The population of natural enemies was highest in control plot as compared to other treatments therefore, all the bio-pesticide was classified as N (*harmless or slightly harmful*).

As per grain yield is concerned, plot treated with chemical insecticides i.e., Dimethoate @ 0.05% recorded highest grain yield (31.71 q ha^{-1}) which was found to be statistically at par with plot treated with Yam bean seed extract @ 5% (30.31 q ha^{-1}) followed by Yam bean seed extract 2 % (29.86 q ha^{-1}) (Table 1). However, all the treatments were superior over control with respect to pest population suppression, thus increasing the yield.

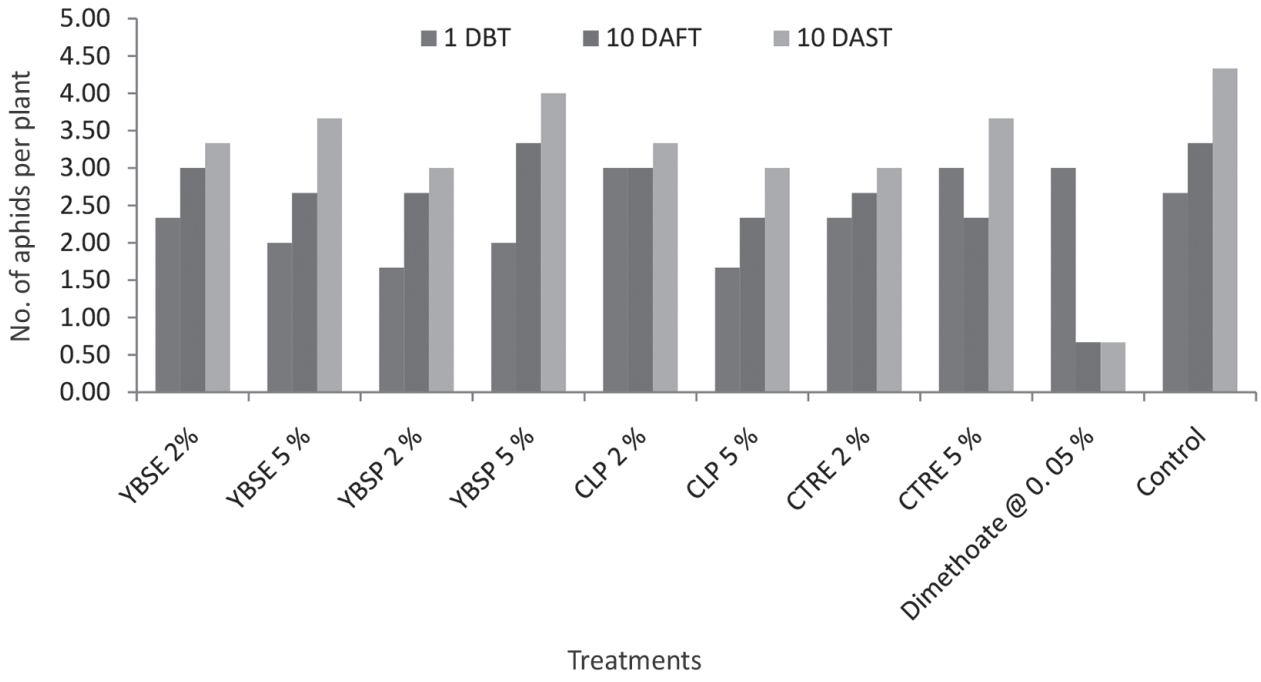

Fig. 1. Effect of different treatments on aphid population

Conclusion

It was found that, two consecutive sprays of YBSE @ 5% at an interval of 15 days are equally effective with that of chemical insecticides for suppression of aphid population below the ETL. It also provides seed yield equal to that of chemical treatment and safer to the natural enemies which are essential components of the agro-ecosystems. In the present situation, it is important to go for an alternative to chemical insecticides particularly for the management of sucking insect pests like aphids and whiteflies. Even a slight deviation either in the method of application or in the dosages of chemical insecticides, may lead to the development of resistance problem. Therefore, we conclude that, two sprays of YBSE @ 5% at a fortnight interval is effective for managing aphid in barley.

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