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Bioefficacy and economics of insecticides against *Pyrilla perpusilla* walker in sugarcane

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Abstract

Field trial was conducted for three consecutive years 2015-16, 2016-17 and 2017-18 at Pusa farm, Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa for bio-efficacy of insecticides against *Pyrilla perpusilla* in sugarcane. Based on polled statistically analysis, Abamectin-1.9 EC @ 1ml/litre of water was registered significantly superior as higher (57.31) per cent mortality was recorded at 3, 7 and 15 days after spraying (DAS) and it was at par with Acetamiprid -20 SP @ 5ml/litre of water and Imidacloprid-17.8 SL @ 0.05 ml/litre of water being 55.13 and 50.63, respectively. In case of egg masses and cocoon mortality varied from 6.05 to 38.25 and 6.73 to 36.45, respectively. The highest (38.25) per cent mortality of egg masses was recorded with Abamectin and it was at par with Imidacloprid (34.57), whereas, cocoon per cent mortality was also recorded highest (36.45) with Abamectin and minimum was with control (6.73) at 10 DAS. The yield of millable canes was also highest (84.76 t/ha) and it was at par with Acetamiprid (83.93 t/ha). The net profit with the treatments, Abamectin, Acetamiprid and Imidacloprid resulted higher returns of Rs./ha being 1.38, 1.29 and 1.26 lakh, respectively as compared to the rest of treatments. The order of insecticidal merit were Abamectin>Acetamiprid>Imidacloprid>Chloropyrifos > Fipronil and >Profenofos. However, all the treatments were superior over control.

Keywords: Sugarcane, bioefficacy, economics, insecticides and *Pyrilla perpusilla*

Introduction

This crop is of great importance in the agricultural sector and in general economy of many of the tropical developing countries. Due to its wide range of adaptability, it supplies more than 60 per cent of the world sugar. In India, it was cultivated an about 4.95 million hectares of land with an annual production of 303.60 million tonnes and productivity 61.3 tonnes per hectare during 2016-17 ^[1]. In Bihar sugarcane was cultivated in an area of 0.29 million hectares with production of about 14.7 million tonnes and its productivity was about 50 tonnes per hectare which is comparatively low as compared with the national average^[1]. It is grown under varied soil and climatic conditions, but its productivity is generally limited by abiotic and biotic stresses as it has to face vagaries of nature all the year around in the field. India has significant potential to expand sugarcane production by increasing both planted area and yield. The poor yield of sugarcane is attributed to the attack of pests and diseases, inadequate irrigation.

The various factors responsible for low yield of sugarcane, insect pests are the major cause. Insect pests like termite, borers, pyrilla, whitefly, black bug, mites, etc. attack this crop and cause heavy losses in terms of yield and sugar recovery. Among insect pests, *Pyrilla perpusilla* is a serious pest of the sugarcane and both nymphs and adults feed on it by sucking the cell-sap, which extensively affects its production ^[2]. Temperature above 40°C and a relative humidity less than 50 per cent, along with westerly wind will drastically reduce the population of pyrilla. Outbreak of pyrilla was noticed during March-June, 2007 on sugarcane as well as wheat, jowar, maize, and berseem. About 40,000 ha area of sugarcane was infested by pyrilla in three sugarcane mill zones ^[3]. The nymphs and adults, sucking the sap from under surface of leaves near midrib, result in formation of yellowish white spots. The leaves were found pale which later on withered away. *Pyrilla perpusilla* causes enormous losses to the sugarcane farms and sugar industry. It reduces the sugar recovery as well as cane yield to a great extent and its management is of prime importance ^[4]. The damage caused by *P. perpusilla* has been reported upto 28% in the potential cane yield and 2-3 per cent in sucrose content of sugarcane. *P. perpusilla* feeding also result in poor growth of sets formation which

also causes difficulty in milling of affected canes [5]. The first epidemic appearance of pyrilla was recorded during 1930-31 in Uttar Pradesh. Since then, it has been appearing in epidemic form year after year in one or the other region of the country, with the recent one in 1999 [6].

Pyrilla abundance is negatively correlated with rainfall and humidity but positively with minimum temperature and concluded that egg parasitoids, predators and rainfall are the main factors responsible for fluctuation of *P. perpusilla* population [7]. Further they reported that dense crop, high nitrogen levels and water-logged conditions, varieties with broad leaves favours population build-up of pyrilla. The leaf-width and cane length showed a positive and significant correlation whereas the leaf-spine density had a significant negative effect with pest-population [8]. Keeping in view, the present study was under taken to find out the efficacy and economics of six insecticides against pyrilla on sugarcane under field condition for three years (2015-18) as incidence of this pest is increasing day-by-day.

Materials and Methods

To determine the efficacy of six insecticides against Pyrilla, field experiments were conducted for three consecutive years (2015-16, 2016-17 and 2017-18) during autumn season at Pusa farm, Sugarcane Research Institute, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, India with BO-153 variety of sugarcane. The trial was laid out in randomized block design with recommended agronomical practices of the university for the sugarcane were followed in time in all the experiments. There were seven treatments including control (untreated) with three replication as follows;

- T₁- Chlorpyrifos-20 EC @ 5 ml/litre of water
- T₂- Acetamiprid-20SP @ 5 g/litre of water
- T₃- Imidacloprid-17.8 SL @ 0.05 ml/litre of water
- T₄- Abamectin-1.9 EC @ 1 ml/litre of water
- T₅- Profenfos-50 EC @ 2ml/litre of water
- T₆- Fipronil-5 SC @ 2ml/litre of water
- T₇- Control (Untreated)

The plot size was 10.0 x 5.4 m² and calculate amount of insecticides were applied at the time of pest appeared on the crop. The observations were recorded at 3, 7 and 15 days after spraying of the insecticides on per cent mortality of the pyrilla and per cent mortality of egg masses and cocoon in each treatment were also recorded at 10 days after spraying. Besides the cane yield (t/ha) was recorded at the time of harvesting. The data obtained were subjected to statistically analysis. In order to find out the cost/benefit ratio analysis of the treatments versus control, total yield was converted into yield/ha and were then multiplied with unit price of the cane to get gross income from check plot income. The cost of treatment was calculated on hectare basis, cost benefit ratio was calculated through gross income divided by total cost. Greater C: B ratio indicated the efficacy of the treatment ratio.

Results and Discussion

The results showed significant differences among the treatments due to application of various insecticides in respect to per cent mortality of pyrilla, egg masses as well as cocoon and yield (t/ha) per hectare (Table 1 to 3). During first year of experimentation (2015-16) the data revealed that highest (58.15) per cent mortality of pyrilla was recorded with Abamectin – 1.9 EC @ 1ml/litre of water followed by Acetamiprid-20 SP @ 5 g/litre of water and Imidacloprid-17.8 SL @ 1 ml/litre of water followed by Acetamiprid 20SP @

5g/litre of water and Imidacloprid 17.8 SL @ 0.05 ml/litre of water being 57.00 and 50.25, respectively, at 3 days after spraying. At 7 days after spraying the per cent mortality of pyrilla was recorded highest (61.20) with Abamectin followed by 59.30 and 56.33 with Acetamiprid and Imidacloprid, respectively. Whereas, at 15 days after spraying of insecticides, highest (55.5) with Abamectine followed by Acetamiprid (52.5) and Imidacloprid (48.35). It is clearly indicated from the results (Table 1) that per cent mortality of pyrilla was highest (61.20) at 7 days after spraying than 3 and 15 DAS. In case of egg masses and cocoon per cent mortality, Abamectin-1.9 EC @ 1ml/litre of water was also recorded superior as highest (39.20) percent mortality of egg masses at 10 DAS followed by 37.30 and 35.83 with Acetamiprid-20SP @ 5 g/litre of water and Imidacloprid-17.8 SL @ 0.05 ml/litre of water, respectively. Whereas, cocoon percent mortality was recorded maximum (37.25) with Abamectine and 35.15 and 32.95 being with Acetamiprid and Imidacloprid, respectively. It is inferred from the results that Abamectin was found to be superior for reducing Pyrilla population as well as its egg masses and cocoon. However, remaining treatments were statistically at par over control.

During 2nd year of experimentation (2016-17), the data revealed that the percent mortality of pyrilla was highest (60.30) with Abamectin followed by Acetamiprid (58.35) and with Imidacloprid (55.30) at 7 DAS the insecticides. At 3 DAS, the per cent mortality of the pest was also highest (57.10) with Abamectin followed by Acetamiprid and Imidacloprid being 56.10 and 49.35, respectively but these per cent mortalities were lower than 7 DAS, although these were higher than 15 DAS. Remaining treatments, chlorpyrifos-20 EC @ 5 ml/litre of water, Profenfos-50 EC @ 2ml/litre of water and Fipronil-5 SC @ 2ml/litre of water were statistically at par over control. Whereas in case of egg masses and cocoon per cent mortality, Abamectin was also gave superior result at 10 DAS and showed significant difference among the treatments. The data revealed that highest (38.35; 36.20) per cent mortality of egg masses and cocoon with Abamectin followed by Acetamiprid (36.20; 34.15) and Imidacloprid (34.10; 31.80) at 10 DAS of the insecticides. It was also indicated from the data that per cent mortality of pyrilla, egg masses and cocoon were lower as compared to previous year (2015-16) this might be due to incidence percentage was low of the pest. The results of 3rd year experimentation (2017-18) showed similar pattern of per cent mortality of pyrilla, egg masses and cocoon as under 1st and 2nd year of experimentation. Abamectin-1.9 EC was recorded statistically significant superior over other treatments. But this year mortality was lower as compared to previous year's experimentation (2015-16 and 2016-17). It might be due to incidence was low.

Pooled data (Table 2) revealed that Abamectine-1.9 EC @ 1ml/litre of water was registered significantly superior as higher (57.13) mean per cent mortality were recorded at 3, 7 and 15 DAS and it was at par with Acetamiprid-20 SP @ 5 g/litre of water and Imidacloprid-17.8 SL @ 0.05 ml/litre of water being 55.13 and 50.63, respectively. In case of egg masses and cocoon mean per cent mortality varied from 6.05 to 38.25 and 6.73 to 36.45, respectively at 10 DAS. The highest (38.25%) mortality of egg masses and cocoon was recorded with Abamectin being 38.25 and 36.45, respectively. The yield of cane was also higher (84.76 t/ha) with Abamectin and it was at par with Acetamiprid (83.93 t/ha). However, all the treatments were statistically superior over

control. The remaining insecticides were found to be in order of their merit chlorpyrifos-20 EC (36.96) > Profenofos -50 EC (46.74) > Fipronil-5 SC (47.96) under mean per cent mortality of the pest. The order of their merit in yield (t/ha) were Profenofos (79.08) < Fipronil (79.35) < Chlorpyrifos (81.16) < Imidacloprid (83.85) < Acetamiprid (83.93) < Abamectin (84.76). The lowest yield was recorded in control (Untreated).

The increased benefit cost ratio (IBCR) of various treatments over control as calculated based on the cost incurred on the different treatments including operational charges which were deducted from the price of the additional yield of cane after that it was divided by the extra cost of treatments (Table 3). The net profit over control (Rs. /ha) showed considerable difference within the various treatments. Among treatments, Abamectin, Acetamiprid and Imidacloprid resulted higher returns of Rs./ha being 1.38, 1.29 and 1.26 lakh, respectively,

as compared to rest of the treatments. The lowest and same net profit of Rs. 1.22 lakh/ha was obtained from Chlorpyrifos and Profenofos treated plots however net profit was higher than control with 0.65 lakh/ha. The IBCR showed effectiveness for controlling the pyrilla as well as egg masses and cocoon mortality as indicated fairly high IBCR 1:2.93, 1:2.73 and 1:2.71 with Abamectin, Acetamiprid and Imidacloprid, respectively. The similar (1:2.6) was obtained in case of Profenofos and Fipronil. However, all the insecticides had proved their better effectiveness for controlling the pyrilla as well as net returns over the control. The present findings are close conformity the findings of the effectiveness of Imidacloprid in reducing *Pyrilla perpusilla* population was reported^[9, 10]. The sequence of effectiveness in descending order of various treatments were Imidacloprid > Deltamethrin > Acephate > Malathion > Endosulfan > NSKE > Nimbicidin > Actiook > M. Anisapliae > B. bassiana^[4].

Table 1: Efficacy of insecticides against sugarcane Pyrilla during 2015-16, 2016-17 and 2017-18 at Pusa farm

Treatments	Mean % Mortality of Pyrilla									Mean % Mortality of egg masses and cocoon at 10 DAS						Yield (t/ha)		
	2015-16			2016-17			2017-18			2015-16		2016-17		2017-18		2015-16	2016-17	2017-18
	3 Das	7 Das	15 Das	3 Das	7 Das	15 Das	3 Das	7 Das	15 Das	EGG Masses	Cocoon	EGG Masses	Cocoon	EGG Masses	Cocoon			
T ₁ -Chlorpyrifos-20 EC @ 5ml/lit of water	39.50	36.55	37.20	38.45	35.50	36.10	37.50	36.20	35.80	23.60	22.15	23.00	21.10	23.10	20.80	81.38	80.20	81.90
T ₂ -Acetamiprid-20 SP @ 5g/lit. of water	57.00	59.33	52.15	56.10	58.35	51.10	55.00	57.20	50.00	37.30	35.15	36.20	34.15	35.10	33.10	86.30	85.25	84.30
T ₃ -Imidacloprid- 17.8 SL @ 0.05 ml/lit of water	50.25	56.33	48.35	49.35	55.30	47.20	48.20	54.70	46.30	35.83	32.95	34.10	31.80	33.80	30.70	84.95	83.70	82.90
T ₄ -Abamectin- 1.9 EC @ 1 ml/lit of water	58.15	61.20	55.15	57.10	60.30	54.10	56.80	59.30	53.80	39.20	37.25	38.35	36.20	37.20	35.90	85.20	84.10	85.00
T ₅ -Profenofos-50 EC @ 2ml/lit. of water	47.20	50.30	45.00	46.20	49.89	44.00	45.10	48.90	44.10	30.10	31.05	29.10	30.00	28.30	29.70	79.95	78.30	79.00
T ₆ -Fipronil-5 SC @ 2ml/lit. of water	49.20	52.65	45.30	48.15	51.60	44.25	47.25	50.10	43.20	25.30	24.38	24.20	23.25	23.10	22.00	80.30	79.25	78.50
T ₇ -Control (Untreated)	12.85	25.30	17.85	12.10	24.20	16.75	13.10	23.00	16.10	6.20	7.35	5.95	6.95	6.00	5.90	59.90	51.80	57.00
SEm±	2.52	3.08	2.94	2.50	3.01	2.80	2.23	2.08	2.20	1.30	1.40	1.25	1.35	1.37	1.46	4.67	3.95	3.94
CD at 5%	7.77	9.50	9.08	7.67	9.30	9.00	6.88	6.43	6.79	4.01	4.33	4.00	4.32	4.22	4.49	14.38	13.30	12.13
CV%	9.74	10.94	11.88	9.54	10.80	10.75	8.94	7.67	9.24	8.00	8.94	8.10	8.75	9.15	9.91	10.28	9.95	8.70

DAS – Days after spraying

Table 2: Bioefficacy (Pooled) of insecticides against Pyrilla at Pusa Farm during 2015-16 to 2017-18.

Treatments	Mean % Mortality of Pyrilla at 3, 7 and 15 DAS	Mean % of mortality at 10 DAS		Yield (t/ha)
		EGG Means	Cocoon	
T ₁ -Chlorpyrifos-20 EC @ 5ml/lit of water	36.96	23.23	21.35	81.16
T ₂ -Acetamiprid-20 SP @ 5g/lit. of water	55.13	32.86	34.25	83.93
T ₃ -Imidacloprid- 17.8 SL @ 0.05 ml/lit of water	50.63	34.57	31.81	83.85
T ₄ -Abamectin- 1.9 EC @ 1 ml/lit of water	57.31	38.25	36.45	84.76
T ₅ -Profenofos-50 EC @ 2ml/lit. of water	46.74	29.13	30.25	79.08
T ₆ -Fipronil-5 SC @ 2ml/lit. of water	47.96	24.20	23.24	79.35
T ₇ -Control (Untreated)	17.91	6.05	6.73	53.90
SEm±	2.28	1.32	1.22	3.66
CD at 5%	6.51	3.77	3.48	10.45
CV%	0.67	8.79	1.15	1.61

DAS – Days after spraying

Table 3: Economics analysis (Pooled data of 3 years; 2015-16, 2016-17 and 2017-18)

Treatments	Yield (t/ha)	Total income (Rs. In lakh)	Yield increased over control	Cost treatment (Rs./ha)	Cost of cultivation (Rs. In lakh/ha)	Not profit (Rs. In lakh)	C:B ratio	IBCR
T ₁ -Chlorpyrifos-20 EC @ 5ml/lit of water	81.16	2.35	27.26	2000	1.13	1.22	1:2.08	1:2.71
T ₂ -Acetamiprid-20 SP @ 5g/lit. of water	83.93	2.44	30.03	9150	1.18	1.29	1:2.03	1:2.71
T ₃ -Imidacloprid- 17.8 SL @ 0.05 ml/lit of water	83.85	2.43	29.95	2375	1.11	1.26	1:2.19	1:2.93
T ₄ -Abamectin- 1.9 EC @ 1 ml/lit of water	84.76	2.46	30.86	1875	1.12	1.38	1:2.18	1:2.93
T ₅ -Profenofos-50 EC @ 2ml/lit. of water	79.08	2.29	25.18	800	1.14	1.22	1:1.96	1:2.6
T ₆ -Fipronil-5 SC @ 2ml/lit. of water	79.35	2.30	24.45	1400	1.10	1.18	1:1.94	1:2.6
T ₇ -Control (Untreated)	53.90	1.56	-	-	1.11	0.65	1:1.40	-

Conclusion

Based on pooled statistically analysis, Abamectin-1.9 EC @ 1ml/litre of water was registered significantly superior as higher (57.31) per cent mortality was recorded at 3, 7 and 15 days after spraying (DAS) and it was at par with Acetamiprid-20 SP @ 5ml/litre of water and Imidacloprid-17.8 SL @ 0.05 ml/litre of water being 55.13 and 50.63, respectively. The net profit with the treatments, Abamectin, Acetamiprid and Imidacloprid resulted higher returns of Rs./ha being 1.38, 1.29 and 1.26 lakh, respectively as compared to the rest of treatments. The order of insecticidal merit were Abamectin>Acetamiprid>Imidacloprid>Chloropyrifos > Fipronil and >Profenofos.

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