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Research Article

Validation of biocontrol technology for suppression of *Chilo partellus* (Swinhoe) on *kharif* maize in Punjab

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ABSTRACT: The management of maize stem borer, *Chilo partellus* (Swinhoe) with *Trichogramma chilonis* @ 100,000 ha^{-1}) at 12 days after germination (DAG) was compared with farmer's practice of two sprays of deltamethrin (Decis 2.8 EC @ 200 ml ha^{-1} at 15 and 30 DAG during *kharif* 2011 and 2012 at farmer's fields in Punjab. The mean leaf injury due to *C. partellus* at 20 DAG was 8.04 and 6.87% in biocontrol treatment and farmers practice, respectively. The dead heart incidence of 3.85 and 2.55% in these treatments was significantly lower than untreated control (12.10%). The biocontrol plots recovered 31.18% parasitism compared to farmers practice and untreated control (2.30 and 7.67%). The coccinellids and spiders counts were also higher in biocontrol plots. The grain yield was at par in biocontrol treatments (46.10 q ha^{-1}) and farmers practice (48.67 q ha^{-1}) while it was significantly lower in untreated control (37.13 q ha^{-1}). Similarly, the net returns to the farmer in biological control treatments (Rs. 10008) was comparable to the farmers practices (Rs. 12424). The release of *T. chilonis* effectively reduced the damage of *C. partellus*, increased the natural enemies in maize ecosystem and provided convincing monetary benefits to the farmer.

KEY WORDS: *Chilo partellus*, deltamethrin, maize, *Trichogramma chilonis*, validation.

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INTRODUCTION

Maize, *Zea mays* (L.) (Poaceae), ranking 3rd in area after wheat and rice, is one of the important staple crops in the world. In India, maize is cultivated over an area of 8.55 million hectares, with a production and productivity of 21.73 million tonnes and 25.40 q ha^{-1}, respectively in 2010–11 (Anonymous, 2011). In Punjab, during 2010–11 it was grown in 133 thousand hectares with a production of 491 thousand tonnes (Anonymous, 2012). With the generation of new agricultural technologies in India, during last 50 years maize production has increased more than 12 times from a mere 1.73 million tonnes in 1950–51 to 21.73 million tonnes at present. But, it lags behind in terms of productivity from leading corn producers and among the various factors affecting the realization of its full yield potential, attack of insect pests especially maize stem borer, *Chilo partellus* (Swinhoe) is the most important, causing yield losses to the tune of 26.7 – 80.4 per cent (Chatterji *et al*., 1969). In Punjab, 57.70 – 79.40 per cent losses in grain yield have been reported (Singh and Sajjan, 1982).

Various control mechanisms including chemical, cultural, host plant resistance and biological in different parts of India have been evaluated for its management. Since the pest is an internal stem feeder, it cannot be effectively controlled through chemicals. Moreover, the use of chemical pesticides resulted in environmental hazards and multiple usage of maize as raw green cobs, sweet corn, animal fodder coupled with increased consumer awareness for residue free food, biological control using predators, pathogens and parasitoids for the management of the pest has become imperative. The egg parasitoid, *Trichogramma chilonis* Ishii has been found to be effective and economical against *C. partellus* at early whorl stage of the crop growth (Jalali and Singh, 2003). This technology has been recommended by the Punjab Agricultural University (PAU), Ludhiana for the maize growers during 2006 (Anonymous, 2006) but it was adapted to a limited extent by the farmers. With the emphasis on crop diversification, maize has been given due consideration in the recent times and various production and protection technologies are being demonstrated to the farmers of Punjab. With ease in propagation, application and availability, *Trichogramma* is becoming potential choice for the management of maize borer and is gaining extensive support from the agricultural extension workers and farmers. The current studies were aimed at establishing and demonstrating the biological control of maize stem borer through the use of *T. chilonis* in farmer's field.

MATERIALS AND METHODS

The large scale field demonstrations of 10 and 20 hectares with *T. chilonis* for the management of *C. partellus* were conducted at farmers' field in village Chaggran in district Hoshiarpur (Punjab) during *kharif* 2011 and 2012, respectively. The maize hybrid PMH 2 was sown in the last week of June in both the years. All the crop raising practices as per recommendation by PAU, Ludhiana were followed. The culture of *T. chilonis* was maintained in the Biological Control Laboratory, Department of Entomology, PAU, and Ludhiana. The field was divided into three blocks representing three treatments each having three replications. A buffer zone of three meter was maintained for each treatment. The block representing the control conditions was of 500 m^2. The treatments consisted of single release of *T. chilonis* @ 1,00,000 parasitoids ha^{-1} at 12 days after germination (DAG), farmer's practice of two sprays of deltamethrin 2.8 EC @ 200 ml ha^{-1} on 15 and 30 DAG and untreated control.

The freshly laid twenty thousand eggs of *Corcyra cephalonica* Stainton glued on cards (10 x 15 cm) parasitized by *T. chilonis* were obtained from Biological Control Laboratory. The individual card was cut into 20 smaller pieces (3 x 2.5 cm) each having approximately one thousand eggs and attached to the underside of maize leaves at equal distance in the evening hours at 12 DAG in each treatment plot. For recovery studies on *T. chilonis,* cards approximately 40 eggs of *C. cephalonica* were attached to the central whorl of the maize plants randomly in the field, one day after the release of the parasitoids. These cards were recollected after 24 hour and observed for *T. chilonis* emergence. The recovery was recorded as the percentage of *Corcyra* eggs parasitized by *T. chilonis*. These studies were compared with the untreated control and farmers practice to record natural prevalence or dispersal of the of *T. chilonis.*

The observations on leaf injury and dead hearts due to *C. partellus* were recorded from 100 plants in each treatment plot at 20 and 30 DAG, respectively. The observations on natural coccinellids and spiders were also recorded from 100 plants in each treatment plot at 30, 45 and 60 DAG. The grain yield at harvest was adjusted to 15 per cent moisture and converted to hectare basis (Bhimsen, 1977). The data on per cent leaf injury and dead hearts due to *C. partellus* and parasitization were transformed arc sine prior to statistical analysis. The data of different parameters were analyzed using ANOVA. The different treatment means were separated by least significant difference test (LSD) at p=0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results of the field demonstration at farmers field during 2011 showed significantly lower leaf injury due to maize stem borer in plots with the release of *T. chilonis* @ 1,00,000 parasitoids/ha on 12 days old crop (8.50%) as compared to the untreated control (23.47%) (Table 1). The per cent leaf injury was significantly lower during 2012 with single release of *T. chilonis* @ 100,000 ha^{-1} on 12 days old crop (7.60%) than untreated control (28.37%). The pooled data revealed that the number of infested plants in biocontrol field did not exceed 8.04 percent where as in control fields it was 25.92 per cent. In

Table 1: The incidence of *Chilo partellus* and per cent parasitization in *kharif* maize during 2011 & 2012

Treatments	Per cent leaf injury due to *C. partellus* at 20 DAG			Per cent dead hearts due to *C. partellus* at 30 DAG			Per cent parasitization of *T. chilonis*		
	2011	2012	Pooled mean	2011	2012	Pooled mean	2011	2012	Pooled mean
Biocontrol Practice	8.50 (16.88)*	7.60 (15.92)	8.04 (16.40)	3.40 (10.55)	4.30 (11.92)	3.85 (11.24)	30.60 (33.56)	31.77 (34.26)	31.18 (33.91)
Farmers Practice	7.47 (15.64)	6.27 (14.38)	6.87 (15.01)	2.20 (8.46)	2.90 (9.71)	2.55 (9.10)	1.90 (7.80)	2.70 (9.41)	2.30 (8.60)
Untreated control	23.47 (28.92)	28.37 (32.15)	25.92 (30.54)	9.30 (17.74)	14.83 (22.60)	12.10 (20.16)	6.10 (14.21)	9.23 (17.59)	7.67 (15.90)
CD (p=0.05)	6.94	5.10	3.57	1.68	2.22	1.56	4.50	4.68	2.70

*Figures in parentheses are arc sine transformations farmer's practice number of infested plants was 6.87 per cent.

The incidence of dead heart was significantly low in maize plot with single release of *T. chilonis* at 100,000 ha^{-1} on 12-day-old crop (3.85%) as compared to untreated control (12.10%). However, it was at par with maize plot treated with deltamethrin 2.8 EC @ 200 ml ha^{-1} (2.55%). Similarly, Chaudhary *et al*. (2012) reported that the number of infested plants by *C. partellus* in IPM field with *T. chilonis* release did not exceed 4%, whereas in farmer's field the number of infested plants reached up to 12%. Rawat *et al*. (1994) found that inundative releases of *T. chilonis* were effective against *C. partellus* in maize crop in Himachal Pradesh also.

The recovery studies indicated that sufficient population of *T. chilonis* prevailed in the augmented plots. During 2011, significantly higher parasitism of *C. cephalonica* eggs (30.60%) as compared to untreated control (6.10%) and chemical control (1.90%) was observed in the recovery studies. Similarly, during 2012 the parasitism of *Corcyra* eggs was significantly higher in treatment with releases of egg parasitoid (31.77%) than untreated control (9.23%). The pooled data (Table 1) also revealed that the parasitism was significantly higher in *T. chilonis* released plots (31.18%) as compared to untreated control (7.67%). The parasitism (2.30%) was also significantly lower in maize plants sprayed with deltamethrin. The present findings on recovery studies are in accordance with Jalali and Singh (2003) who also reported 41.9 to 42.8 per cent egg parasitisation by *T. chilonis* in fodder maize. Similarly in Mozambique, *C. partellus* egg parasitism of 60-80% due to *Trichogramma* spp. has been reported by Gonçalves (1970) and Berger (1981).

The grain yield of biocontrol fields was 45.37 q ha^{-1} during 2011, whereas that in farmer's practices it was slightly more (47.53 q ha^{-1}) than biocontrol fields. However, in untreated control fields it was significantly lower (35.16 q ha^{-1}) (Table 2). In 2012 also, the grain yield was at par in biocontrol (46.67 q ha^{-1}) and farmer's practices (49.80 q ha^{-1}). The percent increase in yield in farmer's field practice where 2 sprays of deltamethrin were applied was only 5%, compared to 25 percent yield increase in biocontrol fields with single release of *T. chilonis* @ 100000 ha^{-1}.

The net returns of the various treatments indicated that in biological control treatments. It was of Rs. 10008/- compared to insecticidal treatments (Rs. 12424). However, the cost of treatment in plots receiving insecticide sprays was almost five times more than fields receiving biocontrol treatments thus revealing that it can be easily adopted by the resource poor farmers. Moreover, 24.15% increase in yield in biological control plots over the untreated control indicated that the releases of *T. chilonis* is the best option for eco-friendly suppression of *C. partellus* (Table 2). The reduction in *C. partellus* damage and increase in maize grain yield was also reported by Pal *et al*. (2009). According to them there was increase in grain yield of 8.83 q ha^{-1} over untreated control, net returns (Rs. 6622.50 ha^{-1}) and cost benefit ratio (6.6). Our observations are in agreement with these reports.

The widespread use of broad-spectrum insecticides in many crops has severely hampered the contribution

Table 2: Net return of different treatments used in management of maize borer (2011 & 2012)

Treatments	Yield (q ha^{-1})			Additional yield over untreated control (q ha^{-1})			Value of yield/ha (Rs)*			Cost of treatment (Rs/ha)	Net return (Rs/ha)		
	2011	2012	Pooled Mean	2011	2012	Pooled Mean	2011	2012	Pooled Mean	Pooled Mean	2011	2012	Pooled Mean
Biocontrol practice	45.37	46.67	46.10	10.21	7.57	8.89	11231	9084	10158	150	11081	8934	10008
Farmer's practice	47.53	49.80	48.67	12.37	10.70	11.54	13607	12840	13224	800	12807	12040	12424
Untreated control	35.16	39.10	37.13	–	–	–	–	–	–	–	–	–	–
CD (P = 0.05)	5.32	3.87	2.72	–	–	–	–	–	–	–	–	–	–

*Rs 11/kg of seeds (2011), *Rs 12/kg of seeds (2012) of predators and parasitoids to pest suppression (Naronjo, 2001). In the present study, the biocontrol treatment plots receiving no insecticide facilitated enhanced biocontrol agents activity in the fields. During 2011 (Fig. 1), the population of coccinellids (2.66/10 plants) was highest in biocontrol treatment plots after 30 DAG. The population increased subsequently in all the treatments at 45 DAG and again it was more in biocontrol treatment plots (4.00/10 plots). Similar observations were at 60 DAG. Similarly during 2012 the same trend was observed and the population of coccinellids at peak period i.e. at 45 DAG was more in biocontrol plots (4.00/10 plants) (Fig. 2), which was comparable to untreated plots (3.66/10 plants), but higher than that of plots receiving insecticide treatments (2.33/10 plants). The spider population also followed the same pattern with low–abundance in insecticide treated plots in both the test years (Fig. 3 & 4). Similarly, relatively higher population of natural enemies such as spiders, coccinellids, *Paederus* sp. and *Cotesia* sp. were observed in the maize ecosystem involving releases of biocontrol agents by Pal *et al*. (2009).

The biocontrol treatment was comparable to the practice of application of two sprays of deltamethrin by the farmers. Biocontrol practice not only controls the pest infestation but also helped in sustaining the natural enemy activity and yielded insecticide residue free quality produce. The reduced insect pest populations and damage; better yield than the insecticides or control treatment in bio-intensive IPM programmes was also reported in other cropping systems (Reddy, 2011). Farid *et al*. (2007) reported that four releases of *T. chilonis* during the season led to as high as 68 per cent decrease in damage over control indicating the success of sequential releases of *T. chilonis* against maize stem borer. Whereas, in present studies with single release of *T. chilonis* at 12 days old crop resulted in increase in yield of about 25 percent over control. Thus, the results suggested that if more than one inundative release of *T. chilonis* are attempted in *kharif* maize under Punjab conditions, higher grain yield can be achieved in near future. Overall it can be concluded that the population of *C. partellus* was reduced by the release of *T. chilonis* with monetary benefits to the farmers

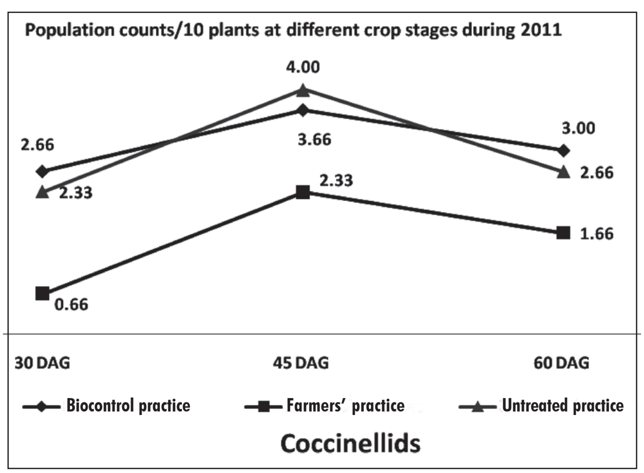

Fig. 1

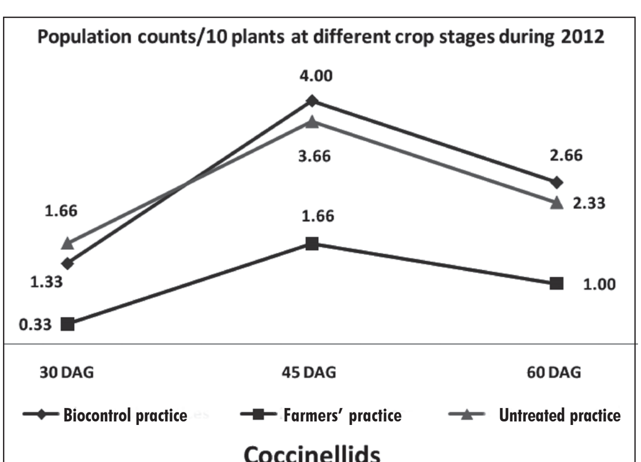

Fig. 2

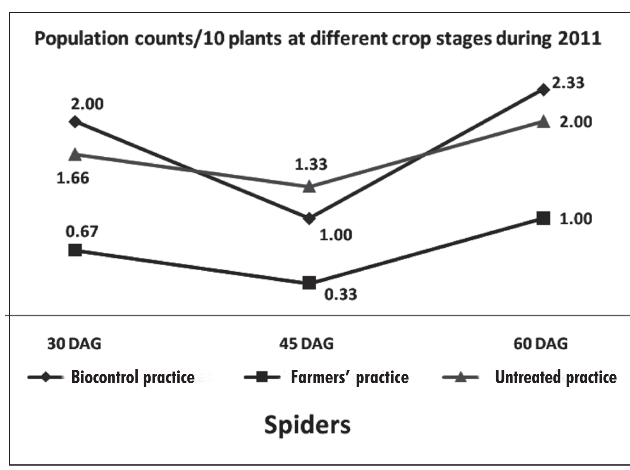

Fig. 3

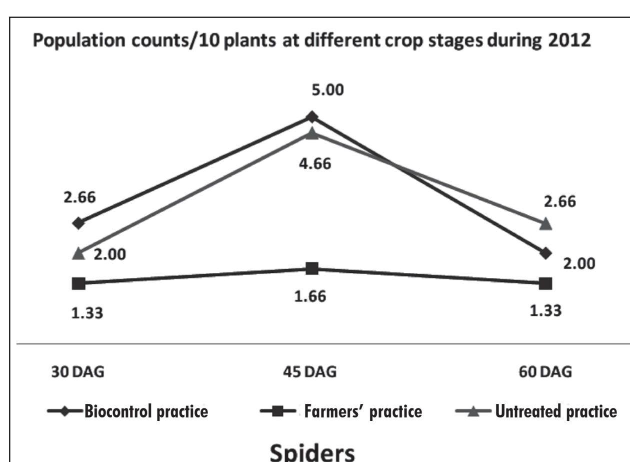

Fig. 4

and refinement will make this technology more farmers friendly.

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