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Research Article

Standardization of release rate of *Trichogramma chilonis* (Ishii) in bio-intensive management of *Chilo partellus* (Swinhoe) in fodder maize

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ABSTRACT: The early season attack of *Chilo partellus*, in kharif sown fodder maize inflicts appreciable losses, if unchecked. Biointensive management with the use of egg parasitoid *Trichogramma chilonis* Ishii in fodder maize through different doses and release rate was standardized. The results of the trials from two years showed that damage parameters like Leaf Injury (LI), recorded three weeks after parasitoid release from 0.25-6.00 per cent across different treatments whereas in untreated control it was 6.50-13.25 %, respectively. Similarly the observations on percent DH patterns in different treatments varied from 0.62-3.75 % as compared to control (5.50-9.0 %). Furthermore, the per cent reduction in damage was substantially low with the second inundative release of the parasitoid than plots receiving a single release of bio-agent at a given dose. The proportion of DH recorded at three weeks after release was significantly lower (1.0 and 0.62%) in plots with t-cards @ 125,000 parasitized eggs in two releases as compared with other treatments. Additionally the green fodder yield obtained in promising treatment was statistically superior (445 q ha^{-1}) to 392 q ha^{-1} GFY as recorded in the untreated control and other lower dose treatments except the plots receiving the highest dose of parasitoid release (450q ha^{-1}). Thus the results suggested that field release of *T. chilonis* @ 125,000 parasitoids per hectare in two releases helps in substantial reduction of *C. partellus* inflicted damage with high economic returns.

KEY WORDS: *Chilo partellus,* deadhearts, fodder maize, Leaf injury, *Trichogramma chilonis*

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INTRODUCTION

Among the cereal crops, *Zea mays* L. is an ideal forage crop with numerous benefits of quality, biomass production and maturity in short period. In spite of diverse cultivation areas and growing seasons of fodder maize in northern Indian plains, the green fodder productivity is constrained by both biotic and abiotic factors. Attack of *Chilo partellus* (Swinhoe) is the chief limiting factor for realizing higher maize production ((Pingali, 2001; James, 2003; Siddiqui and Marwaha, 1993; Arabjafari and Jalali, 2007). The incidence of spotted stem borer commences from 2 weeks after germination until crop harvest and affects all plant parts except the roots. In sorghum, feeding and stem tunneling by *C. partellus* larvae cause reduction in foliage, destruction of the growing point, early leaf senescence, interference with translocation of metabolites and nutrients, thus leading to underdevelopment of the grain, stem breakage, poor juice quality, reduced plant vigor, lodging, direct damage to panicles and loss in grain yield (Prasad *et al.,* 2015). The internal feeding nature of pest makes it less vulnerable to pesticides attack when the chemicals are applied at a later stage. Broad range of insecticides belonging to old and new generations has been recommended for control of maize stem borer, but in forage maize, residues in crop and animal health are paramount and biological control in such crops allays safety concern about insecticides. The egg parasitoid, *Trichogramma chilonis* Ishii has been found to be effective and economical against *C. partellus* at the early whorl stage and most economical as it can eliminate the pest in the egg stage. (Jalali and Singh, 2003; Somchoudhary and Dutt, 1988) and it is advocated in package of technology for stem borer management in maize crop for Punjab State. The world over, this parasitoid has been used in different doses against varieties of stem borers in different crops. But in forage maize, use of this technology needs to be standard-

ized in terms of its application/release rate and subsequent containment of borer damage and comparative green fodder yield.

MATERIALS AND METHODS

The present study for parasitoid based management of stem borer in fodder maize was conducted at Forage Research Farm, Punjab Agricultural University, Ludhiana, during *kharif* season 2015 and 2016. The fodder maize, var. J1006, was sown in the first week of May in plot size of 10x5 m and crop was raised as per standard package of technology prescribed for cultivation except chemical control. For the standardization of dosages (rate of release and singly or two releases) for egg parasitoid *T. chilonis*, the treatments were imposed on 10 days old crop in RBD. The t-cards consisting of *Trichogramma* parasitized eggs of *Corcyra cephalonica,* were released @ 100,000, 125,000 and 150,000 eggs ha^{-1} in single release with buffer isolation of 5m within each treatment and subsequently in another set, inundative second release of parasitoid was given in separate plots after 7 days from first release. *T. chilonis* was released as parasitized cards just before their emergence, *i.e*., on 6-8 day after parasitization Each card was cut into small bits and inserted carefully in central whorl of maize plants (without disturbing parasitized eggs) at uniform distance in each replication at 5 places.

The observations on fresh damage caused by maize borer for Leaf Injury (LI) and Deadhearts (DH) were recorded one, two and three weeks after the release of the parasitoid from 100 fresh plants selected at random in each block. At harvest the data on stem tunneling was recorded from five randomly selected plants which were cut opened and tunneled portion (cm) was measured in each set of treatment followed by recording green fodder yield and converted to quintal per hectare. The data on green fodder yield was further utilized to work out comparative economic return of each treatment by taking into account the gross returns, net returns and cost of treatment.

The experimental data was subjected to statistical procedure using analysis of variance for randomized block design and treatments means were separated by least Significant Difference Test (Gomez and Gomez, 1984). The analysis of data was done using computer software CPCS-I (Cheema and Singh, 1991) where per cent leaf injury and deadheart values were arc sine transformed before one way Analysis of Variance (ANOVA).

RESULTS AND DISCUSSION

The data of two year experimentation showed significant reduction in leaf injury and deadheart incidence in plots with release of *T. chilonis* at varying dose in two releases in comparison to single release and untreated control.

Leaf Injury Incidence (LI): In 2015 and 2016, the leaf injury recoded three weeks after release varied from 0.25-3.25 and 1.5-6.0 per cent respectively as compared to 6.5 and 13.25 per cent in untreated control. Further it was found to be statistically superior (0.5 and 2.0 %) in plots receiving second inundative release of *T. chilonis* @ 125,000 parasitized eggs ha^{-1} in comparison to other plots receiving varying dose of bio-agent. However LI was recorded to be at par with plots receiving maximum dose of the parasitoid in two releases (Table 1). Similar results were depicted in pooled data of two years period, where number of freshly infested plants (LI) after three weeks of release was recorded to be in range of 0.87-4.75 per cent across different treatment plots in comparison to control (9.87%).

Deadheart Incidence (DH): The deadhearts incidence was low in treatments receiving parasitoid release with second inundative release in comparison to plots receiving single release or control. The DH incidence as shown in table 1 indicated that during 2015 and 2016, at an interval three weeks of parasitoid release, it was reduced to 0.75-3.0 and 0.62-3.75 per cent respectively, indicating treatment effect whereas in untreated control it was recorded to be 5.5 and 9.0 per cent. Aggarwal and Jindal (2012) also reported that incidence of deadhearts was significantly low 3.85 per cent with single release of *T.chilonis* at 100,000 ha^{-1} on 12 days old crop as compared to control in maize fields. Rawat *et al*. (1994) also reported that inundative releases of *T. chilonis* were effective against *C. partellus* in maize crop in Himachal Pradesh.

The pooled mean of two year data also indicated that treatment effect after three weeks of release was clear (0.62-3.75 %) in compassion to control (9.0 %) and per cent reduction of deadheart appearance over untreated control was recorded to be 39, 55, 48, 66, 51 and 67 per cent across different biocontrol treatments (Fig. 1). The present finding are in conformity with Farid *el al.* (2007), stating *T. chilonis* release in maize ecosystem helps to reduce 68 per cent pest damage over control. Jalali and Singh (2006), reported 90.4 and 86.6 per cent larvae of *C. partellus* in fodder maize with 5 and 3 releases of parasitoid on 1st and 2nd generation, signifying the importance of multiple release of *T. chilonis* over single release. Furthermore the DH incidence recorded three weeks after spray was significantly superior (0.62%) in augmented plots receiving the parasitoid release @ 125,000 eggs per hectare in two releases as compared to

Table 1. Effect of different rates of release of *Trichogramma chilonis* on reducing the stem border infestation during 2015 and 2016

Treatments (parasitized eggs/ha)	Borer infestation in 2015				Borer infestation in 2016					
	Leaf injury		Deadhearts		Leaf injury		Deadhearts		GFY(q/ha)	
	Before release	After three week	Before release	After three weeks	Before release	After three week	Before release	After three weeks	2015	2016
T_1: Release @ 100,000 parasitized eggs at 10 DAG	3.25 (10.36)	2.5 (10.75)	0	3.0 (10.12)	10.25 (19.05)	6.0 (14.14)	7.25 (15.55)	3.75 (10.66)	407	405
T_2: Release @ 100,000 parasitized eggs at 10 and 17 DAG	3.75 (11.14)	1.75 (07.52)	0.25 (01.43)	2.0 (08.15)	12.5 (20.67)	3.25 (10.24)	7.0 (15.24)	1.62 (06.67)	422	420
T_3 :Release @ 125,000 eggs at 10 DAG	2.25 (08.58)	3.25 (10.29)	0	2.75 (09.50)	11.5 (19.73)	4.75 (12.49)	7.0 (15.31)	2.5 (08.73)	430	435
T_4 :Release @ 125,000 parasitized eggs at 10 and 17 DAG	3.5 (10.75)	0.5 (02.86)	0.5 (02.86)	1.0 (04.10)	11.25 (19.50)	2.0 (07.99)	6.75 (14.98)	0.62 (03.16)	440	450
T_5 : Release @ 150,000 eggs at 10DAG	3.0 (09.83)	2.25 (07.20)	0.25 (02.86)	1.14 (03.98)	13.75 (21.67)	3.25 (10.29)	8.0 (16.37)	1.87 (07.20)	443	442
T_6 :Release @150,000 parasitized at 10 and 17 DAG	3.5 (10.75)	0.25 (1.43)	0.25 (01.43)	0.75 (03.46)	14.5 (22.29)	1.5 (06.93)	7.25 (15.57)	0.62 (03.16)	447	452
T_7 :Control plot	2.75 (09.43)	6.5 (14.58)	0.5 (01.43)	5.5 (13.54)	10.75 (19.11)	13.25 (21.30)	7.25 (15.57)	9.0 (16.37)	387	397
CD (p=0.05)	NS	(4.74)	**NS**	**(3.06)**	NS	(2.51)	NS	(4.10)	(13.01)	(10.89)

Figures in parenthesis are arc sine transformed values; DAG: Days after germination

Table 2. Yield advantage and economics returns from various treatments in bio-intensive management of *Chilo partellus*

Treatments (parasitized egg/ha)	Mean GFY Yield(q/ha)	Yield Advantage over control (q/ha)	Gross returns (Rs.)	Cost of Treatment (Rs/ha)	Net returns over control (Rs/ha)
T_1	406	14	1890	250	1640
T_2	421	29	3915	500	3415
T_3	432	40	5400	312	5088
T_4	445	53	7155	625	6530
T_5	442	50	6750	375	6375
T_6	450	58	7830	750	7080
T_7	392	-	-	-	-

GFY: green fodder yield; Cost of Tricho card @ 50 per card (20,000 parasitized eggs); Rate of green fodder: Rs.135/q

the plots receiving varying dose (single or double) and also it was recorded to be at par (0.62%) in the treatment plots with highest dose of parasitoid release (150,000/ha).

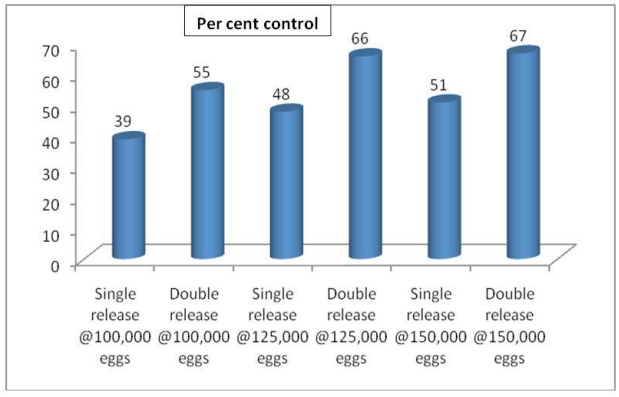

Fig. 1. Percent control of *Chilo partellus* infestation with *Trichogramma chilonis* releases.

Green Fodder Yield and Economic Returns: The fodder yield obtained in both the years (pooled mean) indicated superiority (GFY 406-450 q ha^{-1}) of bio-control plots than to 392 q ha^{-1} as obtained in untreated plots. The bio-agent release @ 125,000 parasitized eggs (two releases) yielded 445 q ha^{-1} GFY and it was recorded to be at par (450 q ha^{-1}) with treatment plots receiving maximum dose of parasitoid. Similarly, net returns obtained in mentioned treatment was Rs. 6530 per hectare. However maximum return of Rs.7080 per hectare was obtained in plots receiving t-cards @ 150,000 eggs per hectare indicating the numerical edge. But considering the control efficacy in terms of per cent deadheart reduction due to promising treatment at lower dose and green fodder yield, being at par, the bio-intensive management of *Chilo partellus* with *Trichogramma chilonis* @ 125,000 parasitized eggs in two releases emerged as best treatment. Pal *et al*. (2009) reported increase in maize grain yield of 8.83 q ha^{-1} over untreated control and net returns. The present findings are supported by finding of Jalai and Singh (2006) supporting 5 releases of *T. chilonis* for effective suppression of maize stem borer in fodder.

Therefore based on present findings and yield benefits it can concluded that augmented second release of *T. chilonis* @ 125,000 eggs at 10 and 17 days after the crop germination is recommended as safer alternative for stem borer. Since this non-chemical approach for stem borer is good option against chemical control and can be employed as an important component of IPM for sustainable crop production.

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