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Intercropping with cowpea: An ecofriendly tool of managing spotted stem borer, *Chilo partellus* on maize

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Abstract
Studies on intercropping cowpea in maize (2:1) as a tool of habitat manipulation for management of *Chilo partellus* (Swinhoe) in maize was conducted during Kharif, 2010 and 2011 at the farm of Indian Agricultural Research Institute, New Delhi. Five plant protection measures viz., seed treatment with imidacloprid @ 7ml/kg seed; foliar spray with endosulfan @ 2ml/litre of water at 10 and 20 DAG; cabaryl @ 2.5g/l and NSKE @ 12.5 g/l were evaluated and compared with intercropping of cowpea. During 2010, the least plant infestation (2.08 percent) was observed in maize intercropped system. The percent plant infestation was highest (1.51) in seed treatment plot while the plants were found free of *Chilo* infestation where cowpea was intercropped alongwith the seed treatment during kharif-2011. The intercropped maize recorded less LIR (1.09) than that of maize plants protected with NSKE (1.12) during 2011. Similarly LIR (1.20) recorded in maize cowpea system was less than LIR in seed treatment (1.58) and endosulfan spray (1.36) during 2010. The severity of plant injury in terms of LIR and dead hearts was recorded least in cowpea treatments in both the years. The yield of maize was maximum (4.73t/ha) in case of seed treatment +cowpea intercropping system in 2011. More yield (1.88 t/ha) obtained with seed treatment than 1.75 t/ha obtained from intercropped maize during kharif, 2010 may be because of the phytotonic effects of imidacloprid, but the yield was adequately compensated with the yield of cowpea pods.

Keywords: Maize, cowpea, intercropping, *Chilo partellus*, control measures

Introduction
Maize (*Zea mays* L.) serves as a staple food of millions of people particularly in different parts of the tropical world. In India, maize is third most important crop after rice and wheat. Though the area under the crop and its production is increasing, the average productivity is very low due to various biotic and abiotic stresses. Among the major biotic constraints, maize stemborer, *Chilo partellus* (Swinhoe) is the most important source of crop loss. A yield loss of 24.3 to 36.3 per cent is estimated due to this pest (Chatterji *et al*., 1969) [5]. The pest problems have arisen due to large-scale cultivation of maize as a sole crop and improper use of pesticides. The ecological damage, food contamination, cost of protection are some of the important considerations because of which, it is worthwhile to strengthen other components of pest control, so that they can be adopted in integrated pest management strategy. In recent years, habitat management techniques, which aim at increasing plant biodiversity through mixed cropping, have gained increased attention in stem borer control. It is the practice of cultivating 2 or more crops in the same space at the same time the main crop being the crop of primary importance. The importance of intercropping as a method of control of stemborers in sorghum has already been reported (Ayisi *et al.* 2001; Ndemah *et al.* 2003) [4, 12]. Intercropping of compatible plants encourages biodiversity by providing habitat for a variety of insects and soil organisms; increase the abundance of natural enemies of phytophagous insects such as spiders, parasitic wasps and predators. It also limits the places where pests can find optimal foraging or reproductive conditions. Intercropping can reduce water evaporation and improve conservation of soil moisture as compared to solo maize (Ahmad *et al.*, 2010) [1]. By intercropping, farmers achieve several production and conservation objectives simultaneously, with crop mixtures, farmers can take advantage of ability of cropping system to reuse their own stored nutrients. In intercropped maize agro-ecosystem, among five crops intercropped with maize, cowpea has been observed to be the most preferred host for egg laying and reduce the egg load on maize plants (Shivananda, 2007) [15]. As cowpea has been observed to bear a heavy egg load of *Chilo partellus*, it can be included in IPM practices for maize stem borer. Before including it in IPM strategy, it is essential to ascertain the efficacy of cowpea in reducing the pest damage and its comparison to other usual control tactics need to be evaluated, hence the present investigations were undertaken to generate the data for various

combinations of control tactics with and without cowpea so as to validate the stem borer management practice.

Materials and Methods

Two field trials were carried out at the farm of Indian Agricultural Research Institute, New Delhi during Kharif 2010 and 2011. Maize variety HQPM-1 was sown following the recommended agricultural practices. Maize seeds were sown on the side of ridges and cowpea on the opposite side in between two maize seeds. Eight rows of 2.5 m length with row to row and plant to plant distance of 60x15 cm were sown. The fertilizers were applied at the recommended rate and the crop was maintained in good health by weeding and irrigating from time to time.

There were 7 treatments each replicated thrice during both the years. The treatments including intercropping with cowpea were same during both the years but treatments to manage *C. partellus* with foliar spray differ (as shown in table below).

Table 1: Detail of Different treatments used for managing *Chilo partellus* infestation in maize

Treatment no.	Treatment followed	
	Kharif, 2010	**Kharif, 2011**
T1	**Intercropping** Maize + cowpea (2:1)	**Intercropping** Maize + cowpea (2:1)
T2	**Seed treatment** Imidacloprid 600FS@7mL/kg.	**Seed treatment** Imidacloprid 600FS@7mL/kg.
T3	**T2+T1**	**T2+T1**
T4	**Seed treatment+ foliar spray** Endosulfan @2mL/1 at 10 DAG	**Two Foliar sprays** carbaryl @2.33g/l at 10 and 20 DAG
T5	**Single foliar spray** Endosulfan @2mL/l at 10DAG	**Two Foliar sprays** NSKE @12.5g/l at 7 and 14 DAG
T6	**Two foliar sprays** Endosulfan @2mL/1 at 10and 20DAG	**NSKE + cowpea** single spray @12.5g/l +cowpea
T7	**Control**	**Control**

For seed treatment, the seeds were treated with imidacloprid @7mL/kg and dried under shade before sowing. Endosulfan was sprayed @ 2mL/l at 10 DAG (days after germination) in treatment T4 and T5 with its second spray repeated at 20 DAG in treatment T6 during kharif 2010.

During Kharif 2011, the seed treatment was similarly done with imidacloprid @7ml/kg in treatment T3 and seeds were dried under shade before sowing. Spary of carbaryl @2.35g/l was done twice at 10 and 20 DAG in treatment T4 (Table 1). Neem seed kernel extract was sprayed @ 12.5 g/l at 7 and 14 days after germination in treatment T5 and T6. Observations on plant infestation and leaf injury rating (LIR) were recorded 20 DAG while dead hearts were observed 30 DAG during both the years. The field was monitored regularly to observe the cowpea pod formation and beans were harvested four times at weekly interval from the plots of treatments T1 and T3 during Kharif 2010 and T1, T3 and T6 during kharif 2011. The crop from different treatment plots was harvested, properly tagged and brought to the lab for data recording of yield.

Results

The data on different parameters of plant infestation, dead hearts, leaf injury and yield of maize in intercrop agro-ecosystem is given in Table 2.

Plant infestation

The seed treatment with imidacloprid resulted in highest (9.02 percent) plant infestation which was at par with control (8.33 percent). The plots where seed treatment was done alongwith intercropping, showed less incidence of plant infestation (3.47) during kharif 2010. The infestation was still lower in plots where maize was intercropped with cowpea only and no other pest control method was used. The infestation in intercropped maize was significantly less than maize with endosulfan single spray (6.25) and with two sprays (4.16).

During kharif 2011, the percent plant infestation was highest (1.51) in seed treatment plot while there was no infestation where intercropping was done along with the seed treatment. Spray with carbaryl showed 1.07 percent of plants infested which was more than the infestation observed in intercropping treatment. The other treatments followed a trend of plant infestation in between (Table 2)

Leaf Injury Rating

The observations during kharif 2010 indicated a higher LIR of 1.58 in seed treatment plots but the LIR dropped to 1.24 when cowpea was intercropped in maize treated with imidacloprid (Table 2). The spray of endosulfan resulted in least LIR of 1.12. Solo maize crop showed a still higher LIR of 1.36.

All the plants were healthy in plots where intercropping was done alongwith seed treatment. The average LIR in plots of seed treatment with and without cowpea was 1.00 and 1.03 respectively. Whereas spray with carbaryl resulted in LIR of 1.09 during 2011 (Table 2).

Dead Hearts

The observation of dead hearts during kharif 2010 showed no plants with LIR 9 in maize intercrop system, while the seed treatment with imidacloprid resulted in 1.38 percent dead hearts. The spray of endosulfan showed no difference in the number of dead hearts(0.69) formed as the plots recorded same number of dead hearts (0.69) in control as well (Table 2).

There were no dead hearts observed in plots of seed treatment with and without intercropping, While 1.02 percent dead hearts were observed in plots with carbaryl spray. The efficacy of intercropping was further observed from less number of dead hearts (0.51 percent) recorded in intercropped maize than solo maize (1.21) during 2011.

Yield

During kahrif 2010, the yield recorded was highest (1.88 t/ha) in plot of seed treatment with imidicloprid. The intercropped maize showed a yield of 1.75 t/ha which was at par with 1.84 t/ha in endosulfan spray+seed treatment. The plots where seed treatment along with intercropping was done, the yield was 1.635 t/ha which was at par with yield (1.63 t/ha) in case of endosufan spray. Two sprays of endosulfan resulted in yield of 1.74t/ha which was at par with maize intercropped with cowpea (1.75t/ha). The yield obtained was more in all the treatments than control.

The yield was maximum (4.73t/ha) in case of seed treatment with cowpea plots and minimum (2.33 t/ha) in plots with NSKE spray during kharif 2011. The intercropped maize showed a comparable yield of 3.99 t/ha to solo maize where the yield was 4.01t/ha. Similarly NSKE spray resulted in higher yield in cowpea intercropped maize (3.7t/ha) than solo maize (2.33t/ha). An additional yield of 0.29, 0.13 and 0.11 t/ha of beans was obtained along with maize in treatments where cowpea was intercropped. The additional yield of 3.84 and 4.0t/ha of beans was harvested along with maize.

Table 2: Damage parameters of C*hilo partellus* and yield of maize during Kharif 2010 and 2011

Treatment	LIR	Plant infestation (%)	Dead hearts (%)	Maize yield* (t/ha)	Cowpea yield** (t/ha)
Kharif, 2010					
Maize + cowpea	1.20	2.08	0.00	1.75	3.83
Seed treatment (ST)	1.58	9.02	1.38	1.88	
ST+Cowpea	1.24	3.47	2.77	1.64	4.05
ST+ Endosulfan	1.36	7.65	0.69	1.84	
Endosulfan (1 spray)	1.32	6.25	0.69	1.63	
Endosulfan (2 sprays)	1.12	4.16	0.69	1.74	
Control	1.36	8.33	0.69	1.56	
Kharif, 2011					
Maize+Cowpea	1.09	1.49	0.51	3.99	0.29
Seed treatment (ST)	1.03	1.52	0.00	4.60	
ST+Cowpea	1.00	0.00	0.00	4.72	0.13
Carbaryl @2.35g/l	1.09	1.07	1.02	3.51	
NSKE	1.04	0.50	0.00	2.33	
NSKE+Cowpea	1.12	1.50	1.51	3.70	0.11
Control	1.10	1.21	1.21	4.01	

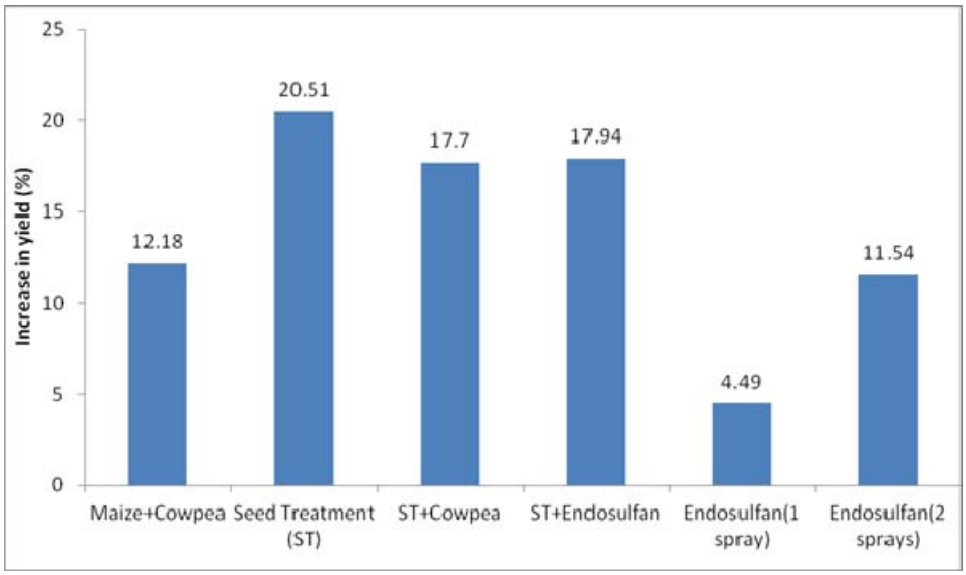

Fig 1: Percent increase in yield over control in different management practices of *Chilo partellus* on maize

Discussion

Based on percent plant of infestation, leaf injury rating and yield, maize intercropped with cowpea in the ratio of 2:1 row was found at par with seed treatment and spray of endosulfan or carbaryl in the present studies. Intercropping of compatible crops influence the oviposition of major pests in many ways; they compete for oviposition with main crops; they mask the main crop thus reducing the chance of gravid females to have access on that. Cowpea has been found to reduce the oviposition load of *C. partellus* to varying degree on maize. Egg laying on intercrop (non host plant) predisposes neonate larvae to natural enemies for larger period as they have to reach plant. Some of them may also get exhausted before reaching their destination. Their increased vulnerability to the biotic and abiotic stresses can reduce the losses caused by them. Thus, the presence of a non-host in the system reduces the chances of the dispersing larvae to land on a suitable host thereby increasing larval mortality.

The present findings on LIR and percent plant infestation during both the years clearly indicated that though the severity of infestation is less and does not vary much in all the treatments but the number of plants infested with *Chilo partellus* were less in intercropped maize than other treatments. The findings are in accordance with Maluleke *et al.* (2005) [9], who studied that *C. partellus* incidence in sole culture maize and maize in maize/lablab intercrop. Jiang *at al.* (2006) [7], while studying the effect of mixed cropping systems of maize, sorghum, millet and beans on infestation of stemborers found that systems containing the non host bean were more efficient in reducing pest densities than those with millet or sorghum only. In the present study also the intercrops reduced the percent infestation of *C. partellus* to varying degree on maize.

Seed treatment with imidacloprid has been claimed to increase seed germination and vigor in some crops (Horii *et al*., 2007; Stevens *et al*., 2008) [8]. The enhanced plant vigour makes the plant more attractive towards C. *partellus* infestation. That is why, plant infestation in this treatment was observed highest. But the vigour of the plant adequately tolerate the insect damage and surpass in the yield of other treatments. The dead hearts were also less in intercropped maize where seed treatment was done than the plots where carbaryl was sprayed during kharif 2011. In Melkassa, intercropping of maize with beans at ratios of 1:1 to 2:1 significantly decreased borer densities compared to pure maize stands (Difabachew and John, 2010). Kwesi *et al.* (1994) also recorded the reduction of *C. partellus* incidence in sorghum when intercropped with cowpea. The yield was highest in intercropped maize+seed treatment during kharif 2011. Similarly yield, though less in intercropped maize but was at par with that of endosulfan spray during Kharif 2010. Schulthess *et al.* (2004) [14] found that while yields increased

in mono-cropped insecticide-treated maize under low pest pressure, borer densities were similar in both untreated mono- and intercropped maize.

Conclusion

Cowpea can be gainfully intercropped with maize as the indicated by lower plant infestation and dead hearts and comparable yield to that of insecticide spray. The practice will help save the environment by decreasing the pesticide load in agroecosyatem. Further the intercropping with cowpea will help conserving the moisture and suppressing weeds. Cowpea being leguminous which improve the soil nutrients there by offsetting yield penalty if any.

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