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Population dynamics and management of yellow stem borer (*Scirpophaga incertulas* Walker) with insect sex-pheromone trap

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ABSTRACT

Field experiment was conducted at the Research Farm, Rajendra Agricultural University, Pusa. Pest activity started from 30th standard week and continued upto 41st standard week, meanwhile it reached peak twice in 34th and 37th standard week. Thereafter, its population declined and finally no population was recorded. Correlation and multiple regression between weather parameters and the population of male yellow stem borer moth revealed that maximum temperature (°C), minimum temperature (°C), relative humidity (%) at 7 hr, relative humidity (%) at 14 hrs, rainfall (mm) and evaporation (mm) were positively correlated to the tune of 0.273, 0.453, 0.075, 0.478, 0.339 and 0.122, respectively with the population of male moth of yellow stem borer, whereas, sunshine (hr) was negatively correlated (-0.453) to that. Weather parameters were found to contribute about 34.60 per cent male moth population fluctuation of *Scirpophaga incertulas* when acted together. Further, the IPM package reduced the infestation (4.20, 8.82, 9.31% DH and 9.41% WEH) caused by rice yellow stem borer in respect to untreated control (4.88, 23.75, 27.68 % DH and 22.72 % WEH) at 15, 30, 50 and 90DAT. Moreover, IPM package gave higher yield (50.25 q/ha) as compared to the control (41.80 q/ha). It was also observed that net profit over the control was Rs. 11,825 with cost benefit ratio 1:2.27 with IPM package in both the years of study.

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INTRODUCTION

Rice (*Oryza sativa* L.) belonging to the family Graminae, is one of the most important food crops not only in India but the world too. Intensive use of fertilizers especially nitrogenous fertilizers, high yielding varieties, sequential cropping and indiscriminate use of insecticides have resulted in the development of pests (Gupta *et al.*, 2002). In India, approximately 100 insect pests have been reported as pests of rice and 20 of these are considered to be major pests causing 30 per cent yield loss from seedling to maturity (Cramer, 1967; Pathak and Dhaliwal, 1981 and Atwal and Dhaliwal, 2005). Among them yellow stem borer (*Scirpophaga incertulas* Walker) is the most destructive and widely occurring insect pest of rice at all stages of the crop due to its monophagy to rice. Newly emerged larva enters into the stem for feeding on inner tissues at vegetative and reproductive stage of the crop results in formation of deadheart (DH) and white earhead

(WEH).

Yield loss is found positively correlated with deadheart and white earhead infestations of the crop (Rahman *et al.*, 2004). Parwez *et al.* (2005, 2006) observed that the critical infestation of the stem borer occurred during vegetative and panicle stages of boro rice. For developing any pest management programme for a specific agro-ecosystem, information on abundance and distribution of pest in relation to weather parameters is a basic requirement (Patel and Shekh, 2006). The study of agricultural meteorology in relation to insects will be very useful to farmers in all areas where major insect pests are appearing year after year and causing serious damage to the crop (Adiroubane and Raja, 2010).

Among various Integrated Pest Management (IPM) options, pheromone technology possesses enormous potential as tools for use in IPM. Sex-pheromones help in monitoring the pest population and control of insects by either male annihilation through mass trapping or by disruption in mating. Continuous monitoring aids in timely detection and early warning of the pest, identifying the peak of occurrence and timing of insecticidal application. The technology also helps in avoiding unnecessary chemical sprays and time of application of pesticides when absolutely essential.

MATERIAL AND METHODS

In order to study the population dynamics of rice yellow stem borer (*Scirpophaga incertulas* Walker) through sex pheromone trap in North Bihar condition, a field trial was conducted at research farm, Rajendra Agricultural University, Pusa, Samastipur, Bihar during *Kharif*, 2010 and *Kharif*, 2011. For this purpose field preparation was done by ploughing once by tractor drawn disc plough and second by mould board plough. IPM package received seedling treatment and installation of sex pheromone traps. Seven days before transplanting, seedlings of well established susceptible variety Rajendra Kasturi were nursery treated with carbofuran (3G) @ 1.1kg a.i./ha while four sex pheromone traps containing rubber septa were installed at the rate of one sex pheromone trap per 500 sq.m area right from the date of transplanting to the harvesting of crop. The pheromone septa [(Z)-11 hexadecanal and (Z)-9 hexadecanal] was replaced at 25 days interval. Before transplantation, the recommended doses of fertilizers (N:P:K : 100:60:40) were applied main plots. However, the half of nitrogen was given as top dressing and remaining half of nitrogen was top dressed after 30 days after transplanting and balance half dose was applied at panicle initiation stage. All the recommended agronomic practices were observed. The observation of male moth catched per trap, deadhearts (15, 30 and 50DAT), white earheads (90DAT), yield (at harvest), meteorological parameters *viz.*, maximum temperature (°C), minimum temperature (°C), relative humidity (%) and rainfall (mm) were recorded. Simultaneously the data of the pest population obtained during the course of investigation were correlated with meteorological parameters.

Male moth catch per trap :

It attracted and catched only male moth of the insect pest. Male moth catched per trap were taken out and counted in morning (7:00 AM) at weekly intervals during the course of investigation. The mean values of male moth catched per trap at weekly intervals were worked out from the collected data and finally its correlation with meteorological parameters was documented.

Deadheart and white earhead :

Observations of insect pest infestation were recorded from randomly selected ten hills from each replication of each treatment of the investigation at 15, 30, 50 and 90 DAT. Finally data so obtained were worked out and converted into percentage of deadheart, percentage deadheart reduction over control, percentage of white earhead and percentage white earhead reduction over control with the help of followings :

$$\text{Per cent deadheart} = \frac{\text{Total number of deadhearts}}{\text{Total nuimber of tillers}} \times 100$$

$$\text{Per cent white earhead} = \frac{\text{Total number of white earherads}}{\text{Total number of tillers}} \times 100$$

$$\text{Per cent deadheart reduction over control} = \frac{\text{Per cent deadheart in control} - \text{per cent deadheart in treatment}}{\text{Per cent deadheart in control}} \times 100$$

$$\text{Per cent white earhed reduction over control} = \frac{\text{Per cent white earhead in treatment}}{\text{Per cent white earhead in control}} \times 100$$

Yield of the crop :

Recorded weight per plot was converted into quintal per hectare and percentage of yield increase over the control and documented :

$$\text{Per cent yield over control} = \frac{\text{Yield of treatment} - \text{Yield of control}}{\text{Yield of control}} \times 100$$

RESULTS AND DISCUSSION

It is evident from the pooled data presented in Table 1 and Fig. 1, that pest activity initiated from 30th standard week and continued upto 41st standard week. Pest population reached its peak twice in 34th and 37th standard week. In beginning it was low which gradually increased and reached its first peak (6.125 male moth catch/pheromone trap) in 34th standard week (4th week of August)and after a short fall again increasing and reached to second peak (10.875 male moth catch/pheromone trap) in 37th standard week(2nd to 3rd week, September). Thereafter its population declined and finally no population was recorded.

The findings of present investigation are supported by

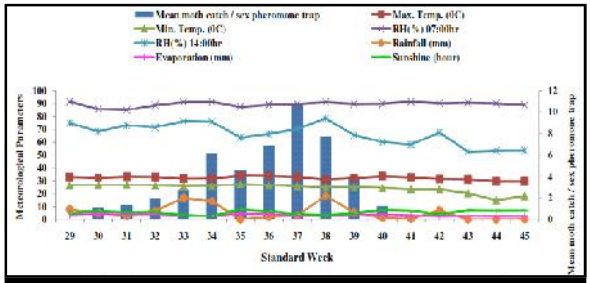

Fig. 1 : Population fluctuation of rice yellow stem borer adult (*Scirpophaga incertulas*) in relation to abiotic parameters (pooled mean of *Kharif*, 2010 and *Kharif*, 2011).

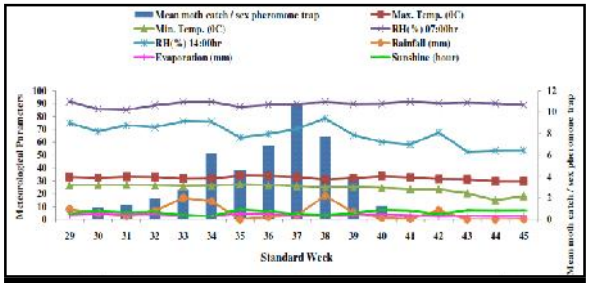

Fig. 2 : Management of rice yellow stem borer (*Scirpophaga incertulas*) in rice cv. RAJENDRA KASTURI through sex pheromone trap (pooled mean of *Kharif*, 2010 and *Kharif*, 2011).

Table 1 : Population fluctuation of rice yellow stem borer adult (*Scirpophaga incertulas*) in relation to abiotic parameters (pooled mean of *Kharif*, 2010 and *Kharif*, 2011)

Standard week	Mean moth catch / sex pheromone trap	Temperature (°C)			Relative humidity (%)		Rainfall (mm)	Evaporation (mm)	Sunshine (hour)
		Max.	Min.	Mean	07:00 hr	14:00 hr			
29	0.000	32.90	26.49	29.70	91.41	74.74	7.88	3.48	4.77
30	1.125	32.28	26.64	29.96	85.50	68.20	4.79	4.12	6.35
31	1.375	33.11	26.76	29.93	84.89	73.11	2.59	3.62	5.28
32	2.000	32.96	26.47	29.72	88.60	71.57	6.57	3.80	5.67
33	2.750	31.52	25.99	28.76	90.92	76.10	16.67	2.92	3.27
34	6.125	31.66	26.17	28.92	91.22	75.73	14.17	2.61	2.61
35	4.625	33.82	27.18	30.50	87.35	63.48	0.00	4.27	7.60
36	6.875	33.65	26.63	30.14	88.96	66.33	2.01	3.93	6.45
37	10.875	32.83	25.91	29.37	89.62	70.15	3.03	2.97	4.06
38	7.750	30.85	24.93	27.89	90.95	78.43	18.37	2.79	3.18
39	4.000	31.97	25.08	28.53	89.70	65.37	5.38	3.58	4.82
40	1.250	33.46	24.46	28.96	89.87	60.04	1.16	3.71	7.42
41	0.250	32.57	23.42	28.00	91.36	58.10	0.38	3.19	6.76
42	0.000	31.33	23.23	27.28	90.11	67.40	7.11	2.27	3.87
43	0.000	31.15	20.31	25.73	90.54	52.57	0.00	2.64	7.10
44	0.000	29.49	14.94	22.21	89.95	53.37	0.00	2.30	6.93
45	0.000	29.53	18.22	23.88	88.73	53.45	0.17	2.43	7.01

Table 2 : Correlation co-efficient and multiple regression equation between meteorological parameters and population of yellow stem borer moth per pheromone trap (pooled mean of *Kharif*, 2010 and *Kharif*, 2011)

Meteorological parameters	Correlation co-efficient(r)
Maximum temperature (°C)	0.273 (X1)
Minimum temperature (°C)	0.453 (X2)
Relative humidity (%) 7 hr.	0.075 (X3)
Relative humidity (%) 14 hr.	0.478 (X4)
Rainfall (mm)	0.339 (X5)
Evaporation (mm)	0.122 (X6)
Sunshine (hr.)	-0.453 (X7)
Co-efficient of determination (R^2) = 0.346	
Multiple regression equation: -3.322+0.625(X1)-0.122(X2)+0.059(X3)-0.164(X4)-0.084(X5) +2.462(X6) -2.344(X7)	
*correlation is significant at 0.05 level (2-tailed)	

Table 3 : Management of rice yellow stem borer (*Scirpophaga incertulas*) in rice cv. RAJENDRA KASTURI through sex pheromone trap (pooled mean of *Kharif*, 2010 and *Kharif*, 2011)

Treatments	Deadheart (%)				White earhead (%)	Grain yield
	(15DAT)	(30DAT)	(50DAT)	Mean	(90DAT)	(q/ha)
IPM Package	4.20(13.93)	8.82(62.86)	9.31(66.36)	7.44(47.71)	9.41(58.58)	50.25(20.21)
Control (C)	4.88	23.75	27.68	18.78	22.72	41.8

*Values in parenthesis are % increase/decrease over the control.

Table 4 : Economics of management of rice yellow stem borer (*Scirpophaga incertulas*) in rice cv. RAJENDRA KASTURI through sex pheromone trap (pooled mean of *Kharif*, 2010 and *Kharif*, 2011)

Treatments	Additional yield over control (Rs./ha)	Price of additional yield over control (Rs./ha)	Cost of treatment over control (Rs./ha)	Net profit/loss over control (Rs./ha)	ICBR
IPM Package	8.45	21125	9300	11825	1:2.27
Control (C)	-	-	-	-	-

Price rate: Rajendra Kasturi (@Rs.2500/q), Rubbersepta(@Rs.30/septa), Trap set (@Rs.100/set), Carbofuran 3G (@Rs.105/kg) and Man power (@Rs.150/man day)

the findings of Singh *et al.* (2006) who observed that mean yellow stem borer (*Scirpophaga incertulas* Walker) catch per sex pheromone trap per week should two peaks –first (4.78) during 3rd week of August and second (9.77) during 2nd week of September. However, Varma *et al.* (2000) reported three peak periods *viz.*, July, August and September of *Scirpophaga incertulas* moth activity during *Kharif* season. Similar observations were also reported by Mishra *et al.* (2012) as yellow stem borer moth exhibiting their peak activity in the month of September.

Correlation and multiple regression between weather parameters and the population of male yellow stem borer moth revealed that no meteorological parameters had significant role in population fluctuation of yellow stem borer. However, maximum temperature (°C), minimum temperature (°C), relative humidity (%) at 7 hr, relative humidity (%) at 14 hrs, rainfall (mm) and evaporation (mm) were positively correlated to the tune of 0.273, 0.453, 0.075, 0.478, 0.339 and 0.122, respectively with the population of male moth of yellow stem borer, whereas, sunshine (hr) was negatively correlated (-0.453) to that. Weather parameters were found to contribute about 34.60 per cent male moth population fluctuation of *Scirpophaga incertulas* when acted together (Table 2).

The findings of the present study are in close agreement with Rao (1996) as he reported that weather conditions had no significant effect on pheromone trap capture during *Kharif* season. However, Rehman *et al*. (2002) found that low temperature, high relative humidity and rainfall resulted in YSB outbreak. Rai *et al.* (2002) reported that YSB moth population had no effect of temperature while it was positively correlated to maximum relative humidity and sunshine but negatively correlated with rainfall. Padhi and Saha (2004) investigated that maximum temperature, rainfall and relative humidity were negatively correlated while minimum temperature, evaporation and sunshine were positively correlated to YSB moth population but Razvi (1991) reported that YSB moth population had positive correlation with temperature, rainfall and relative humidity.

IPM package resulted the lower infestation (4.20, 8.82, 9.31% DH and 9.41% WEH) caused by rice yellow stem borer than that of the untreated control (4.88, 23.75, 27.68% DH and 22.72% WEH) at 15, 30, 50 and 90DAT which indicate that IPM package cause 13.93, 62.86, 66.36 and 58.58 per cent reduction in infestation over the untreated control at 15, 30, 50 and 90 DAT. However, pooled of *Kharif*, 2010 and *Kharif*, 2011 is the testimony of the impact of IPM package which gave higher yield (50.25 q/ha) as compared to the untreated control (41.80 q/ha) with 20.21 mean per cent increase in yield over the untreated control (Table 3). The perusal of data in Table 4, it was observed that gross income and net profit over the control and cost benefit ratio were Rs. 21,125, Rs. 11,825 and 1:2.27, respectively in IPM package plot.

The present findings of the investigation are in close agreement with findings of Dani and Jena (2008) as they found that sex pheromone installed plot and control plot recorded 1.6 and 17 per cent YSB damage.

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