Original Research Article

Population dynamics of spotted stem borer, *Chilo partellus* (Swinhoe) and pink stem borer, *Sesamia inferens* (Walker) on *rabi* sorghum

ABSTRACT

The maximum level of population of *C. partellus* and *S. inferens* during *rabi* season, the prevailing weather factors *viz*., rainfall, maximum temperature, minimum temperature, before noon relative humidity, afternoon relative humidity and wind speed were 0 mm, 32.8ºC, 16.7ºC, 75.83 per cent, 43.5 per cent and 20 km per h and 0.00 mm, 31.9ºC, 16.2ºC, 81.47 per cent, 48.1 per cent and 19.7 km per h, respectively. Correlation between larval population of *C. partellus* infesting *rabi* sorghum and weather parameters evidenced that before noon relative humidity and wind speed exhibited positively and negatively significant correlation with larval population of *C. partellus*, respectively. The larval population of *S. inferens* infesting *rabi* sorghum recorded positive but non-significant correlation with rainfall, before noon relative humidity and afternoon relative humidity.

Key words - Population, Significant, *C. partellus*, Correlation, *S. inferens*, Relative humidity

Introduction

Sorghum (*Sorghum bicolour* (Linnaeus) Moench) a pristine crop belonging to the grass family Poaceae is a warm-climatic crop originally domesticated and originated in African origin, which was first time cultivated in the region of Ethiopia or Chad over 5000 years ago and spread to India and other countries (Rosentrater and Evers, 2018). Sorghum is known as “the sugarcane of the desert” or “the camel among crops” because it is a C4 plant that can tolerate adverse hot and droughty climatic conditions and is effectively grown under rainfed and irrigated conditions. (Srinivas Rao *et al*., 2013)

In India, the area under sorghum crop is 4.09 million ha with the production of 3.47 million tonnes and the average yield of 849 kg per ha (FAOSTAT, 2020). Sorghum is mainly cultivated under rainfed conditions during *kharif* (rainy) as well as during *rabi* (winter) season mainly concentrated in the southern and central India. In India, the area under sorghum crop is 4.09 million ha with the production of 3.47 million tonnes and the average yield of 849 kg per ha (FAOSTAT, 2020). Sorghum is mainly cultivated under rainfed conditions during *kharif* (rainy) as well as during *rabi* (winter) season mainly concentrated in the southern and central India. Sorghum is attacked by several insect pests *viz*., shoot fly (*Atherigona soccata* Rondani), stem borers (*Chilo partellus* Swinhoe and *Sesamia* *inferens* Walker), armyworms (*Mythimna separata* Walker and *Spodoptera frugiperda* J.E. Smith), aphids (*Melanaphis sacchari* Zehntner and *Rhopalosiphum maidis* Fitch), midge (*Contarinia sorghicola* Coquillett), head caterpillars (*Helicoverpa armigera* Hubner), hairy caterpillars (*Orgyia* sp., *Olene mendosa* Hubner and *Somena scintillans* Walker), shoot bugs (*Peregrinus maidis* Ashmead) and green stink bug (*Nezara viridula* (Linnaeus) in Maharashtra. In sorghum fields, more than 35 per cent crops losses are reported due to insect pests estimated at $580 million in India (Reddy and Zehr, 2004). Amongst the most serious pests, shoot fly and stem borers, (*Chilo partellus* Swinhoe, *Sesamia inferens*Walker) occurs as serious pest in eIndia (Mti *et al*, 2014).

Material and Method

The non-replicated field experiment comprising forty-eight quadrats each of 2.70 x 3.00 sq. m size was laid to investigate the population dynamics of sorghum stem borers on *rabi* sorghum at the Research Farm of Department of Agricultural Entomology, College of Agriculture, Latur (MS) during *rabi* season, 2020-2021. The popular sorghum variety Parbhani Moti was sown at the spacing of 45 x 15 cm in 48 quadrats with all recommended package of practices recommended by VNMKV, Parbhani (Anonymous, 2018) in *rabi* season. The field experiment was conducted under pesticide free conditions. The data recorded to work out population fluctuations per quadrat. The total number of larvae collected from three quadrats separately twice in each meteorological week was divided by three to obtain total number of larvae per quadrat. The larval population was not worked out per plant due to low values which caused difficulties in its statistical analysis. The statistical analysis of the data on larval population of stem borers on *rabi* sorghum and weather parameters were carried out by simple correlation and multiple regression using WASP 2.0 software developed by ICAR Research Complex, Goa.

Results and Discussion

1. Population dynamics of *Chilo partellus* (Swinhoe)

The first incidence of *C. partellus* on sorghum was recorded in 52nd standard meteorological week (2.00 larvae per quadrat) with its peak population level (5.66 larvae per quadrat) in 4th standard meteorological week. At maximum level of population of *C. partellus*, the prevailing weather factors *viz.*, rainfall, maximum temperature, minimum temperature, before noon relative humidity, afternoon relative humidity and wind speed were 0 mm, 32.8^{o}C, 16.7^{o}C, 75.83 per cent, 43.5 per cent and 20 km per h, respectively (Table 1).

The results of present investigation are in agreement with the findings of Singh *et al.*

(2020) who revealed that maximum larval population of *C. partellus* on maize was noticed during 31^{st} SMW (3.8 larvae per plant). Patel and Purohit (2016) found that the incidence of *C. partellus* on sorghum begins from fourth week of November (0.06 larva per plant) and continued up to first week of February with a peak activity in second and fourth week of December (0.15 larva per plant). Divya *et al.* (2009) indicated that maximum number of *C. partellus* larvae were recorded during 40^{th} SMW (30 larvae per 50 plants) during *kharif* season and 3^{rd} SMW (19 larvae per 50 plants) during *rabi*-summer season. Achiri *et al.* (2020) indicated that larval population of *C. partellus* exhibited two major peaks on maize, one in the first growing season (March-June) and a second at the beginning of the second growing season (June-September). Suresh Kumar and Arivudainambi (2018) revealed that peak larval population of *C. partellus* on maize was observed during the month of July in *kharif* and it was declined during entire *rabi*. Ram Kumar *et al.* (2017) inferred that *C. partellus* on maize appeared from 2^{nd} week of August and reached its peak (2.4 larvae per plant) in 38^{th} SMW (3^{rd} week of September, 2016).

Correlation studies

The results in respect of simple correlations between larval population of *C. partellus* infesting sorghum and weather parameters during *rabi* season 2020-21 are presented in (Table.2). The data revealed that before noon relative humidity(r= 0.533*) exhibited positively significant correlation with larval population of *C. partellus* and wind speed (r= -0.549*) exhibited negatively significant correlation with larval population of *C. partellus*. However, maximum temperature (r= -0.185) and minimum temperature (r= -0.198) were negatively non-significant, while rainfall (r= 0.009) and afternoon relative humidity (r= 0.294) showed positive but non-significant correlation with larval population of *C. partellus*. (Table.1).

The results of present investigation are matching with the findings of Akshay Kumar *et al.* (2020) who revealed that maximum and minimum temperature was negatively correlated to the dead heart percentage of *C. partellus* on maize. Relative humidity was positively correlated to the dead heart percentage of stem borer. Rainfall was positively correlated to the dead heart percentage during 2015. Arshad *et al*. (2021) indicated that higher the relative humidity there was a marked fluctuation in population dynamics of *C. partellus* on maize. Achiri *et al* (2020) indicated that the relationships between temperature and humidity and the mean number of larvae of *C. partellus* were not significant for the first and second crop of maize. Suresh Kumar and Arivudainambi (2018) stated that larval population of *C. partellus* was negatively correlated with maximum temperature and insignificant with minimum temperature. Increase in relative humidity enhanced the larval population and showed positive correlation. Though the rainfall had significant positive correlation with larval population in three districts *viz.*, Karimnagar, Medak and Renga reddy it was insignificant in Warangal district. Ram Kumar *et al.* (2017) inferred that larval population of *C. partellus* on maize noticed significant negative correlation with maximum temperature and sunshine. The minimum temperature exhibited positive but non-significant effect on larval population. While, relative humidity had positive and highly significant effect on stem borer population. Lekha *et al*. (2017) revealed that *C. partellus* on sorghum exhibited significant negative correlation with mean relative humidity (r= -0.94). Patel and Purohit (2016) found that maximum, minimum and average temperature had significant negative association, while humidity, rainfall, rainy days and sunshine hours, wind velocity and evaporation had no significant association with *C. partellus* on *rabi* sorghum. Dindor *et al*. (2016) revealed that minimum temperature and wind velocity exerted negative impact on the infestation of *C. partellus* on maize i.e., damaged plants and leaf injury scale. Zulfiqar *et al.* (2010) showed that the relative humidity and temperature significantly influenced the population of *C. partellus* on maize. Ahad *et al*. (2008) found that the adult population of *C. partellus* was positively correlated with relative humidity.

Regression studies

Weather based multiple linear regression model was developed in respect of seasonal incidence of *C. partellus* (Y) as a dependent variable and weather parameters (B1 to B6) as independent variables and presented in (Table 2). The regression equation revealed that the various weather parameters had profound influence on seasonal incidence of *C. partellus* on sorghum. The coefficient of determination (R^2) was 0.671 which indicated that different weather parameters contributed 67.1 per cent variability in larval population of *C. partellus*.

2. Population dynamics of *Sesamia inferens* (Walker)

The first incidence of *S. inferens* on *rabi* sorghum was observed in 52nd standard meteorological week (1.33 larvae per quadrat) with its maximum population level (4.00 larvae per quadrat) in 3rd standard meteorological week. At maximum level of population of *S. inferens*, the prevailing weather factors *viz.*, rainfall, maximum temperature, minimum temperature, before noon relative humidity, afternoon relative humidity and wind speed were 0.00 mm, 31.9^{o}C, 16.2^{o}C, 81.47 per cent, 48.1 per cent and 19.7 km per h, respectively (Table 1.)

The results of present investigation are in accordance with the findings of Suresh Kumar and Arivudainambi (2018) who showed that *S. inferens* larval population on maize was observed to be low during *kharif* and reached its peak in January during *rabi* The larval population ranged between 0.80-4.12, 0.60-4.20 and 0.40-4.20 larvae per plant in Karimnagar, Medak and Warangal, respectively during *kharif* and *rabi* season. Sharma *et al*. (2017) illustrated that larval population of *S. inferens* on maize increased after 45th SMW and reached to maximum during the 49th SMW and then declined till 7th SMW. Reuolin and Soundararajan (2019) stated that larval population of *S. inferens* on rice was recorded during 11th SMW (first fortnight of March). Umesh Kumar *et al*. (2018) evidenced that peak larval population of *S. inferens* on maize (6.17 and 6.93 larvae per plant) was recorded at third week of August (34th SMW) during *kharif*, 2016 and 2017, respectively. Sanjay Kumar *et al*. (2017) concluded that peak period of *S. inferens* infestation on maize was observed at 70 DAS (22.38 pin holes per plant). Deole *et al.* (2017) exhibited that larval population on maize reached to a peak of 13.81 and 18.56 larvae per plant in 12th and 11th SMW in spring season during 2013-14 and 2014-15, respectively. Deole (2016) found that the maximum activity of *S. inferens* larvae and adult were observed during second week of March to third week of March (11th and 12th SMW). Singh and Kular (2015) revealed that maximum incidence of *S. inferens* in rice-wheat cropping system was observed in the months of September-October (2.76-4.17 per cent). Small peaks of *S. inferens* incidence were also observed during the months of December and February.

Correlation studies

The results in respect of simple correlations between larval population of *S. inferens* infesting sorghum and weather parameters during *rabi* season 2020-21 are presented in Table. 1. The data evidenced that the rainfall (r= 0.054), before noon relative humidity (r= 0.372) and afternoon relative humidity (r= 0.139) exhibited positive but non-significant correlation with larval population of *S. inferens*. While, maximum temperature (r= -0.107), minimum temperature (r= -0.168) and wind speed (r= -0.401) showed negative non-significant correlation with *S. inferens* larval population.

The results of present investigation are identical with the findings of Suresh Kumar and Arivudainambi (2018) who documented that *S. inferens* larval population had insignificant correlation with maximum temperature and negatively significant correlation with minimum temperature. Sharma *et al*. (2017) exhibited that larval population of *S. inferens* had a significant negative correlation with maximum temperature (T max.) and minimum temperature (T min.). Multiple regression analysis of *S. inferens* population with weather parameters evidenced that there was 80 to 82 per cent variability in larval population due to various environmental factors. Deole *et al.* (2017) illustrated that the interactions between the larval population of *S. inferens* on maize and weather parameters evidenced non-significant correlation. However, the interactions between the adult population and weather parameters during spring 2013 and 2014 exhibited negative and significant and non-significant correlation with maximum temperature, negative and significant correlation with minimum temperature while the interactions with morning and evening relative humidity was positive as well as significant with morning relative humidity but non- significant with evening relative humidity, respectively. Singh and Kular (2015) showed that the correlation between incidence of *S. inferens* and maximum, minimum, average temperature and sunshine hrs were negatively non-significant. The incidence of *S. inferens* had statistically significant and positive correlation with relative humidity. Similarly, positive and non-significant correlation of *S. inferens* incidence was recorded with rainfall.

Regression studies

Weather based multiple linear regression model was developed in respect of seasonal incidence of *S. inferens* (Y) as a dependent variable and weather parameters (B1 to B6) as independent variables and presented in Table 2. The regression equation revealed that the various weather parameters had profound influence on seasonal incidence of *S. inferens* on sorghum. The coefficient of determination (R^2) was 0.433 which indicated that different weather parameters contributed 43.3 per cent variability in larval population of *S. inferens*.

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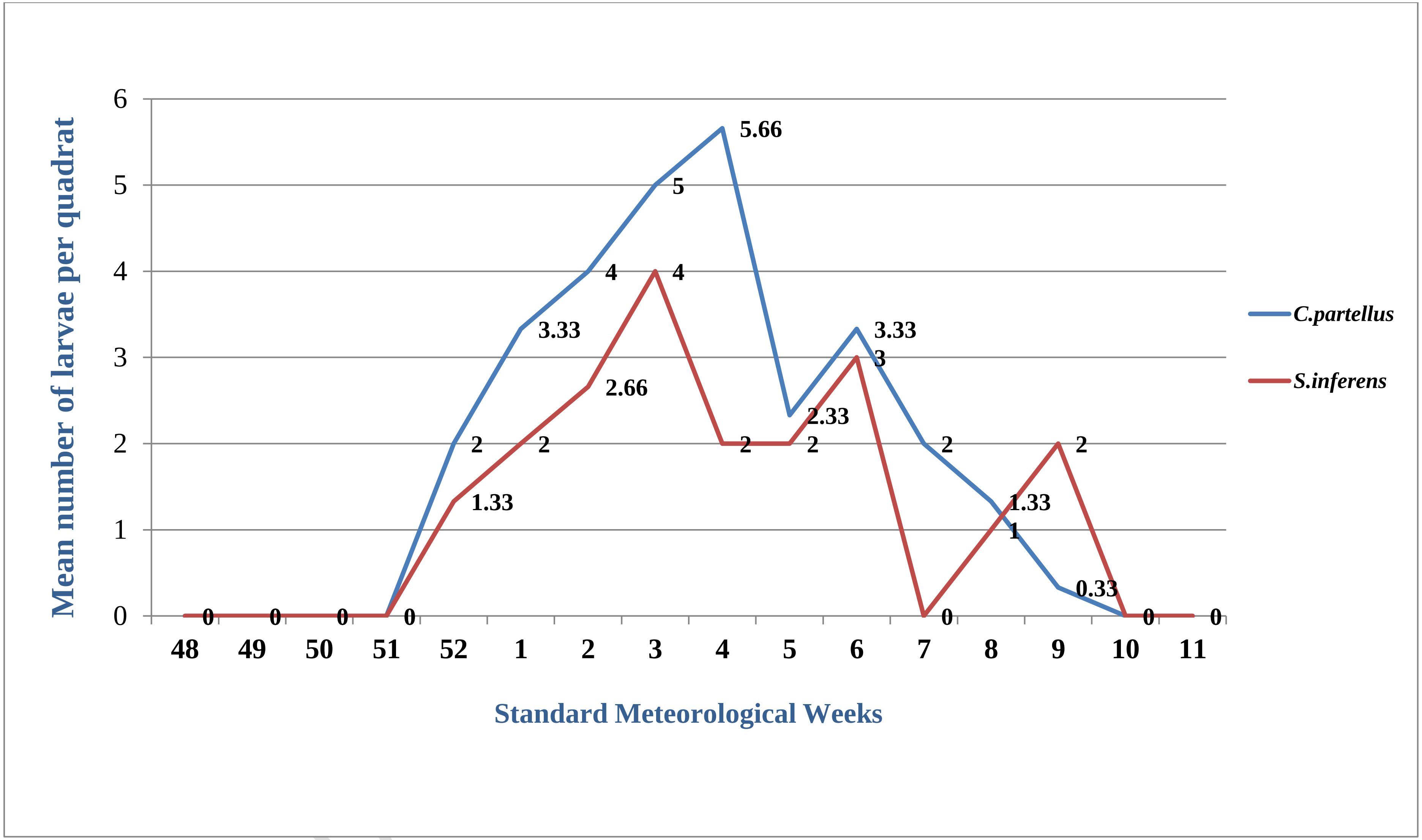

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Fig. 1: Population dynamics of *C. partellus* and *S. inferens* on sorghum in relation to weather parameters during *rabi* season 2020-21

Table 1: Population dynamics of *C. partellus* and *S. inferens* on sorghum in relation to weather parameters during *rabi* season 2020- 21

Month	Standard Meteorological Weeks	Rainfall (mm)	Temperatur e (^{o}C)		Relative Humidity (%)		Wind speed (Km per h)	Mean number of larvae per quadrat	
			Min.	Max.	Before noon	After noon		*C. partellus*	*S. inferens*
November 2020	48	-	17.5	29.4	79.4	64.5	22.3	0	0
December 2020	49	-	13.1	31.3	67.4	39.5	21.6	0	0
	50	-	15.6	31.2	67.7	45.2	21.4	0	0
	51	-	12.2	29.5	74.4	42.4	20	0	0
	52	-	12.8	30.5	75.4	43.6	18.4	2.00	1.33
January 2021	1	-	16.5	30.4	91.2	53.4	18.7	3.33	2.00
	2	1.00	16.86	31.9	82.53	51.5	19.9	4.00	2.66
	3	-	16.2	31.9	81.47	48.1	19.7	5.00	4.00
	4	-	16.7	32.8	75.83	43.5	20	5.66	2.00
	5	1.25	15.39	31.6	76.99	37.7	23.1	2.33	2.00
February 2021	6	0.5	11.99	30.9	60.24	32.5	21.7	3.33	3.00
	7	-	15.44	32.9	65.86	36.3	24	2.00	0
	8	6.25	14.6	30.8	72.9	39.6	25.7	1.33	1.00
	9	-	18.49	36	48.81	24.8	26.1	0.33	2.00
March 2021	10	-	23.4	37	42.48	25.8	26.1	0	0
	11	-	19.1	36.7	42.31	22.3	27.8	0	0
'r' values of *C. partellus*		0.009	-0.185	-0.198	0.533*	0.294	-0.549*		
'r' values of *S. inferens*		0.054	-0.107	-0.168	0.372	0.139	-0.401		

Table 2: Multiple regressions of weather parameters with *C. partellus* and *S. inferens* on *rabi* sorghum

Multiple regressions of weather parameters with *C. partellus* on *rabi* sorghum				
Weather parameters	**Reg. coefficients (b)**	**SE (b)**	**T test**	**T table(0.05)**
Rainfall (mm) (B1)	0.221	0.317	0.698	2.262
Maximum temperature (ºC) (B2)	1.315	0.707	1.860	2.262
Minimum temperature (ºC) (B3)	-0.375	0.408	-0.919	2.262
Before noon relative humidity (%) (B4)	0.127	0.083	1.529	2.262
Afternoon relative humidity (%) (B5)	0.029	0.133	0.218	2.262
Wind speed (km per h) (B6)	-0.400	0.331	-1.210	2.262

Intercept (a) = -35.694
Coefficient of determination (R Square) = 0.671
Multiple Correlation Coefficient (R) =0.819Standard Error = 1.440

The regression equation worked out is as follow.
Y= -35.694 + (0.221) x B1 + (1.315) x B2 + (-0.375) x B3 + (0.127) x B4 + (0.029) x B5 + (-0.400) x B6 + 1.440

Multiple regressions of weather parameters with *S. inferens* on *rabi* sorghum				
Weather parameters	**Reg. coefficients(b)**	**SE (b)**	**T test**	**T table(0.05)**
Rainfall (mm) (B1)	0.141	0.281	0.500	2.262
Maximum temperature (ºC) (B2)	0.593	0.627	0.946	2.262
Minimum temperature (ºC) (B3)	-0.137	0.362	-0.378	2.262
Before noon relative humidity (%) (B4)	0.075	0.073	1.019	2.262
Afternoon relative humidity (%) (B5)	-0.024	0.118	-0.206	2.262
Wind speed (km per h) (B6)	-0.252	0.293	-0.859	2.262

Intercept (a) = -14.330
Coefficient of determination (R Square) = 0.433
Multiple Correlation Coefficient (R) =0.658Standard Error = 1.277

The regression equation worked out is as follow.
Y=-14.330 + (0.141) x B1 + (0.593) x B2 + (-0.137) x B3 + (0.075) x B4 + (-0.024) x B5 + (-0.254) x B6 + 1.277