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Population Dynamics of Spotted Stem Borer, *Chilo partellus* (Swinhoe) and Pink Stem Borer, *Sesamia inferens* (Walker) on Rabi Sorghum

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

During the rabi season, the peak populations of *Chilo partellus* and *Sesamia inferens* were observed under specific weather conditions: no rainfall, maximum temperatures of 32.8°C and 31.9°C, minimum temperatures of 16.7°C and 16.2°C, morning relative humidity of 75.83% and 81.47%, afternoon relative humidity of 43.5% and 48.1%, and wind speeds of 20 km/h and 19.7 km/h, respectively. Correlation analysis revealed that the larval population of *C. partellus* infesting *rabi* sorghum had a significantly positive correlation with morning relative humidity and a significantly negative correlation with wind speed. In contrast, the larval population of *S. inferens* showed a positive but non-significant correlation with rainfall, morning relative humidity, and afternoon relative humidity. By monitoring specific weather conditions, such as humidity and wind speed, and understanding their impact on pest populations, effective interventions can be designed to mitigate the damage caused by *C. partellus* and *S. inferens*. This knowledge is crucial for improving crop yields and ensuring sustainable agricultural practices.

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Keywords: Population; significant; C. partellus; correlation; S. inferens; relative humidity.

1. INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moen.), a crop from the grass family Poaceae, is a warm-climate species originally domesticated in Africa. It was first cultivated in regions of Ethiopia or Chad over 5,000 years ago and later spread to India and other countries [1]. Known as "the sugarcane of the desert" or "the camel among crops," sorghum is a C_4 plant capable of withstanding hot and drought-prone conditions, thriving under both rainfed and irrigated environments [2]. In India, sorghum is cultivated over an area of 4.09 million hectares, yielding 3.47 million tonnes with an average productivity of 849 kg per hectare [3]. Primarily grown under rainfed conditions, sorghum is cultivated during the kharif (rainy) and rabi (winter) seasons, predominantly in southern and central India [4-6]. Sorghum is susceptible to several insect pests, including the 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 the green stink bug (*Nezara viridula* Linnaeus) in Maharashtra. In sorghum fields, insect pests account for over 35% of crop losses, estimated at $580 million annually in India [7]. Among the most severe pests are the shoot fly and stem borers (*Chilo partellus* Swinhoe and *Sesamia inferens* Walker), which pose significant threats in India [8].

2. MATERIALS AND METHODS

A field experiment, consisting of forty-eight quadrats each measuring 2.70 x 3.00 m^2, was conducted to investigate the population dynamics of sorghum stem borers on *rabi* sorghum. The study took place at the Research Farm of the Department of Agricultural Entomology, College of Agriculture, Latur (MS) during the rabi season of 2020-2021. The popular sorghum variety ParbhaniMoti was sown with a 45 x 15 cm spacing across 48 quadrats, following the recommended agronomic practices outlined by VNMKV, Parbhani [9]. The experiment was conducted under pesticide-free conditions. Data on larval population fluctuations were recorded per quadrat. Larvae were collected from three quadrats separately twice during each meteorological week, and the average number of larvae per quadrat was calculated by dividing the total number of larvae by three. Due to low larval counts, estimating the population per plant was impractical for statistical analysis. Statistical analysis of the data, including simple correlation and multiple regression, was performed using WASP 2.0 software developed by ICAR Research Complex, Goa, to examine the relationship between the larval population of stem borers and weather parameters.

3. RESULTS AND DISCUSSION

3.1 Seasonal Occurrence of *Chilo partellus* (Swinhoe)

The first incidence of *Chilo partellus* on sorghum was recorded in the 52^{nd} standard meteorological week (SMW) with an average of 2.00 larvae per quadrat. The population peaked at 5.66 larvae per quadrat during the 4th SMW. At this peak population level, the prevailing weather conditions were as follows: no rainfall, a maximum temperature of 32.8°C, a minimum temperature of 16.7°C, a morning relative humidity of 75.83%, an afternoon relative humidity of 43.5%, and a wind speed of 20 km/h (Table 1). The results of this investigation align with previous studies. Singh et al. [10] reported a maximum larval population of *C. partellus* on maize during the 31st SMW, with an average of 3.8 larvae per plant. Patel and Purohit [11] observed that the incidence of *C. partellus* on sorghum began in the fourth week of November (0.06 larvae per plant) and continued until the first week of February, peaking in the second and fourth weeks of December (0.15 larvae per plant). Divya et al. [12] found that the highest number of *C. partellus* larvae were recorded during the 40th SMW (30 larvae per 50 plants) in the kharif season and the 3rd SMW (19 larvae per 50 plants) in the rabi-summer season. Achiri et al. [13] noted two major peaks in the larval population of *C. partellus* on maize: one during the first growing season (March-June) and another at the beginning of the second growing season (June-September). Suresh Kumar and Arivudainambi [14] reported that the peak larval population of *C. partellus* on maize occurred in July during the kharif season, with a decline throughout the rabi season. Ram Kumar et al. [15] found that *C. partellus* on maize appeared in the 2nd week of August and peaked at 2.4 larvae per plant in the 38th SMW (3rd week of September, 2016).

3.2 Correlation between Weather Parameters and *C. partellus* Infestation

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. partellu s*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 findings of the present investigation are consistent with those of Akshay Kumar et al. [10], who reported that maximum and minimum temperatures were negatively correlated with the dead heart percentage of *Chilo partellus* on maize, while relative humidity showed a positive correlation. Additionally, rainfall was positively correlated with dead heart percentage during 2015. Arshadet al. [16] noted that higher relative humidity caused marked fluctuations in the population dynamics of *C. partellus* on maize. Achiri et al. [13] found that temperature and humidity did not significantly affect the mean number of *C. partellus* larvae on maize during the first and second cropping seasons. Suresh Kumar and Arivudainambi [14] observed that the larval population of *C. partellus* was negatively correlated with maximum temperature and had an insignificant relationship with minimum temperature. They also found that increased relative humidity positively correlated with the larval population. Rainfall showed a significant positive correlation with larval population in Karimnagar, Medak, and Renga Reddy districts but was insignificant in Warangal district.

Ram Kumar et al. [15] reported a significant negative correlation between *C. partellus* larval population on maize and maximum temperature and sunshine. Minimum temperature had a positive but non-significant effect, while relative humidity had a positive and highly significant effect on the stem borer population. Lekha et al. [17] demonstrated a significant negative correlation between *C. partellus* on sorghum and mean relative humidity (r= -0.94). Patel and Purohit [11] found that maximum, minimum, and average temperatures had a significant negative association with *C. partellus* on rabi sorghum, while humidity, rainfall, rainy days, sunshine hours, wind velocity, and evaporation showed no significant association. Dindor et al. [18] revealed that minimum temperature and wind velocity negatively impacted *C. partellus* infestation on maize, affecting damaged plants and the leaf injury scale. Zulfiqar et al. [19] indicated that relative humidity and temperature significantly influenced the population of *C. partellus* on maize. Ahad et al. [20] found a positive correlation between the adult population of *C. partellus* and relative humidity.

3.3 Regression Studies of *C. partellus* infestation on *Rabi* Sorghum

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 parameter shadpro found influence on seasonal incidence of *C. partellu s*on sorghum. The coefficient of determination (R^2) was 0.671 which indicated that different weather parameters contributed 67.1per centvariabilityin larvalpopulation of *C. partellus*.

3.4 Population Dynamics of *Sesamia inferens* (Walker)

The first incidence of *Sesamia inferens* on *rabi* sorghum was recorded in the 52nd standard meteorological week (SMW), with an average of 1.33 larvae per quadrat. The population reached its peak at 4.00 larvae per quadrat in the 3rd SMW. At this peak population level, the prevailing weather conditions were: no rainfall, a maximum temperature of 31.9°C, a minimum temperature of 16.2°C, a morning relative humidity of 81.47%, an afternoon relative humidity of 48.1%, and a wind speed of 19.7 km/h (Table 1).

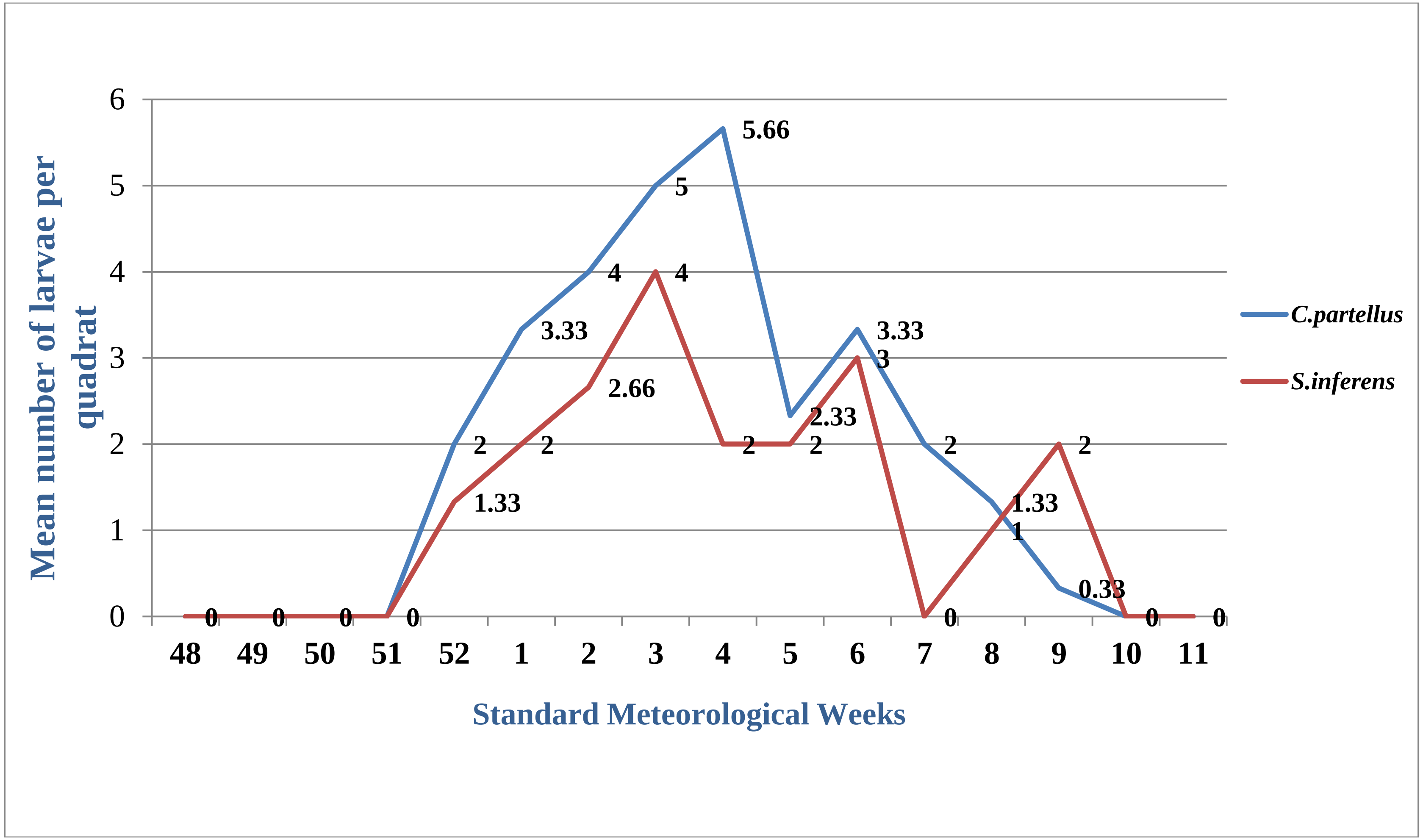

Fig. 1. Population dynamics of *C. partellus* and *S. inferens*on sorghum in relation to weather parameters during *rabi* season 2020-21

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

Month	Standard Meteorologial Weeks	Rainfall(mm)	Temperatue (ºC)		Relative Humidity(%)		Windspeed (Km perh)	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
December2020	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
January2021	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
February2021	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
March2021	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’ valuesof *C.partellus*		0.009	-0.185	-0.198	0.533*	0.294	-0.549*		
‘r’ valuesof*S. inferens*		0.054	-0.107	-0.168	0.372	0.139	-0.401		

Table 2. Multiple regression sofweather 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)**	**Ttest**	**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
Windspeed (kmper h) (B6)	-0.400	0.331	-1.210	2.262

Intercept(a) =-35.694
Coefficient of determination (RSquare) =0.671
Multiple Correlation Coefficient (R) =0.819StandardError = 1.440
Theregressionequationworked outisasfollow.
Y= -35.694 + (0.221) x B1 + (1.315) x B2 + (-0.375) x B3 + (0.127) x B4 + (0.029) xB5 +(-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
Maximumtemperature(ºC)(B2)	0.593	0.627	0.946	2.262
Minimumtemperature(ºC)(B3)	-0.137	0.362	-0.378	2.262
Beforenoonrelative humidity(%)(B4)	0.075	0.073	1.019	2.262
Afternoonrelativehumidity(%)(B5)	-0.024	0.118	-0.206	2.262
Windspeed (kmper h) (B6)	-0.252	0.293	-0.859	2.262

Intercept(a) =-14.330
Coefficient of determination (RSquare) =0.433
Multiple Correlation Coefficient (R) =0.658StandardError = 1.277
The regression equation worked outisas follow.
Y=-14.330 + (0.141) x B1 + (0.593) x B2 + (-0.137) x B3 + (0.075) x B4 + (-0.024) xB5 +(-0.254) x B6 +1.277

The findings of the present investigation align with those of Suresh Kumar and Arivudainambi [14], who reported that the larval population of *Sesamiainferens* on maize was low during the kharif season and peaked in January during the rabi season, with larval populations ranging from 0.80-4.12, 0.60-4.20, and 0.40-4.20 larvae per plant in Karimnagar, Medak, and Warangal, respectively. Sharma et al. [21] observed that the larval population of *S. inferens* on maize increased after the 45th SMW, reached its maximum during the 49th SMW, and then declined until the 7th SMW. Reuolin and Soundararajan [22] recorded the larval population of *S. inferens* on rice during the 11th SMW (first fortnight of March). Umesh Kumar et al. [23] noted peak larval populations of *S. inferens* on maize (6.17 and 6.93 larvae per plant) in the third week of August (34th SMW) during the *kharif* seasons of 2016 and 2017, respectively. Sanjay Kumar et al. [24] found that the peak infestation period of *S. inferens* on maize was observed at 70 days after sowing (DAS), with an average of 22.38 pinholes per plant. Deole et al. [25] reported that the larval population on maize peaked at 13.81 and 18.56 larvae per plant in the 12th and 11th SMW during the spring seasons of 2013-14 and 2014-15, respectively. Deole [26] observed maximum activity of *S. inferens* larvae and adults during the second and third weeks of March (11th and 12th SMW). Singh and Kular [27] revealed that the maximum incidence of *S. inferens* in a rice-wheat cropping system occurred in September-October (2.76-4.17 per cent), with smaller peaks observed in December and February.

3.5 Correlation between Weather Parameters and *S. inferens* Infestation

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 relativehumidity (r= 0.372) and afternoon relative humidity (r= 0.139) exhibited positive butnon-significant correlation with larval population of *S. inferens*. While, maximumtemperature (r= -0.107), minimum temperature (r= -0.168) and wind speed (r= -0.401) showed negative non-significant correlation with *S.inferens* larval population.

3.6 Regression Studies of *S. inferens* Infestation on Rabi Sorghum

Weather based multiple line regression model was developed in respect of seasonal incidence of *S. inferens*(Y) as a dependent variable and weather parameters(B1to B6)as independentvariables and presented in Table 2.The regression equation revealed that the various weather parameter shad 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 percent variability inlarval population of *S.inferens*.

4. CONCLUSION

The study investigated the relationship between weather conditions and the populations of *Chilopartellus* and *Sesamiainferens* on *rabi* sorghum. *C. partellus* was significantly affected by morning humidity (positively) and wind speed (negatively). *S. inferens* showed a positive but non-significant correlation with rainfall and humidity. Understanding these correlations helps predict pest outbreaks and plan effective interventions, improving crop yields and promoting sustainable agriculture. This information is valuable for farmers, agricultural services, researchers, and policymakers in developing precise pest management strategies.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as ChatGPT have been only used for writing (only manuscript language) and no any artificial data produced during manuscript preparation by using AI tool explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

Details of the AI usage are given below:

1. ChatGPT based on the GPT-4 architecture.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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