

Original Research Article

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

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.

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

Introduction

Sorghum (*Sorghum bicolor* (Linnaeus) Moench), 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 (Rosentrater and Evers, 2018). Known as “the sugarcane of the desert” or “the camel among crops,” sorghum is a C4 plant capable of withstanding hot and drought-prone conditions, thriving under both rainfed and irrigated environments (Srinivas Rao *et al.*, 2013). 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 (FAOSTAT, 2020). Primarily grown under rainfed conditions, sorghum is cultivated during the kharif (rainy) and rabi (winter) seasons, predominantly in southern and central India [26-28]. 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*

34 *maidis* Fitch), midge (*Contarinia sorghicola* Coquillett), head caterpillars (*Helicoverpa*
35 *armigera* Hubner), hairy caterpillars (*Orgyia* sp., *Olene mendosa* Hubner, and *Somema*
36 *scintillans* Walker), shoot bugs (*Peregrinus maidis* Ashmead), and the green stink bug (*Nezara*
37 *viridula* Linnaeus) in Maharashtra. In sorghum fields, insect pests account for over 35% of
38 crop losses, estimated at \$580 million annually in India (Reddy and Zehr, 2004). Among the
39 most severe pests are the shoot fly and stem borers (*Chilo partellus* Swinhoe and *Sesamia*
40 *inferens* Walker), which pose significant threats in India (Mti *et al.*, 2014).

41 **Material and Method**

42 A field experiment, consisting of forty-eight quadrats each measuring 2.70 x 3.00 m²,
43 was conducted to investigate the population dynamics of sorghum stem borers on *rabi*
44 sorghum. The study took place at the Research Farm of the Department of Agricultural
45 Entomology, College of Agriculture, Latur (MS) during the rabi season of 2020-2021. The
46 popular sorghum variety Parbhani Moti was sown with a 45 x 15 cm spacing across 48
47 quadrats, following the recommended agronomic practices outlined by VNMKV, Parbhani
48 (Anonymous, 2018). The experiment was conducted under pesticide-free conditions. Data on
49 larval population fluctuations were recorded per quadrat. Larvae were collected from three
50 quadrats separately twice during each meteorological week, and the average number of larvae
51 per quadrat was calculated by dividing the total number of larvae by three. Due to low larval
52 counts, estimating the population per plant was impractical for statistical analysis. Statistical
53 analysis of the data, including simple correlation and multiple regression, was performed using
54 WASP 2.0 software developed by ICAR Research Complex, Goa, to examine the relationship
55 between the larval population of stem borers and weather parameters.

56 **Results and Discussion**

57 **1. Seasonal occurrence of *Chilo partellus* (Swinhoe)**

58 The first incidence of *Chilo partellus* on sorghum was recorded in the 52nd **standard**
59 **meteorological week (SMW)** with an average of 2.00 larvae per quadrat. The population
60 peaked at 5.66 larvae per quadrat during the 4th SMW. At this peak population level, the
61 prevailing weather conditions were as follows: no rainfall, a maximum temperature of 32.8°C,
62 a minimum temperature of 16.7°C, a morning relative humidity of 75.83%, an afternoon
63 relative humidity of 43.5%, and a wind speed of 20 km/h (Table 1). The results of this
64 investigation align with previous studies. Singh *et al.* (2020) reported a maximum larval
65 population of *C. partellus* on maize during the 31st SMW, with an average of 3.8 larvae per
66 plant. Patel and Purohit (2016) observed that the incidence of *C. partellus* on sorghum began

67 in the fourth week of November (0.06 larvae per plant) and continued until the first week of
68 February, peaking in the second and fourth weeks of December (0.15 larvae per plant). Divya
69 *et al.* (2009) found that the highest number of *C. partellus* larvae were recorded during the 40th
70 SMW (30 larvae per 50 plants) in the kharif season and the 3rd SMW (19 larvae per 50 plants)
71 in the rabi-summer season. Achiri *et al.* (2020) noted two major peaks in the larval population
72 of *C. partellus* on maize: one during the first growing season (March-June) and another at the
73 beginning of the second growing season (June-September). Suresh Kumar and Arivudainambi
74 (2018) reported that the peak larval population of *C. partellus* on maize occurred in July during
75 the kharif season, with a decline throughout the rabi season. Ram Kumar *et al.* (2017) found
76 that *C. partellus* on maize appeared in the 2nd week of August and peaked at 2.4 larvae per
77 plant in the 38th SMW (3rd week of September, 2016).

78 **Correlation between weather parameters and *C. partellus* infestation**

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

87 The findings of the present investigation are consistent with those of Akshay Kumar *et*
88 *al.* (2020), who reported that maximum and minimum temperatures were negatively correlated
89 with the dead heart percentage of *Chilo partellus* on maize, while relative humidity showed a
90 positive correlation. Additionally, rainfall was positively correlated with dead heart percentage
91 during 2015. Arshad *et al.* (2021) noted that higher relative humidity caused marked
92 fluctuations in the population dynamics of *C. partellus* on maize. Achiri *et al.* (2020) found
93 that temperature and humidity did not significantly affect the mean number of *C. partellus*
94 larvae on maize during the first and second cropping seasons. Suresh Kumar and
95 Arivudainambi (2018) observed that the larval population of *C. partellus* was negatively
96 correlated with maximum temperature and had an insignificant relationship with minimum
97 temperature. They also found that increased relative humidity positively correlated with the
98 larval population. Rainfall showed a significant positive correlation with larval population in
99 Karimnagar, Medak, and Renga Reddy districts but was insignificant in Warangal district.

100 Ram Kumar *et al.* (2017) reported a significant negative correlation between *C. partellus* larval
101 population on maize and maximum temperature and sunshine. Minimum temperature had a
102 positive but non-significant effect, while relative humidity had a positive and highly significant
103 effect on the stem borer population. Lekha *et al.* (2017) demonstrated a significant negative
104 correlation between *C. partellus* on sorghum and mean relative humidity ($r = -0.94$). Patel and
105 Purohit (2016) found that maximum, minimum, and average temperatures had a significant
106 negative association with *C. partellus* on rabi sorghum, while humidity, rainfall, rainy days,
107 sunshine hours, wind velocity, and evaporation showed no significant association. Dindor *et*
108 *al.* (2016) revealed that minimum temperature and wind velocity negatively impacted *C.*
109 *partellus* infestation on maize, affecting damaged plants and the leaf injury scale. Zulfiqar *et*
110 *al.* (2010) indicated that relative humidity and temperature significantly influenced the
111 population of *C. partellus* on maize. Ahad *et al.* (2008) found a positive correlation between
112 the adult population of *C. partellus* and relative humidity.

113 **Regression studies of *C. partellus* infestation on rabi sorghum**

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

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

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

127 The findings of the present investigation align with those of Suresh Kumar and
128 Arivudainambi (2018), who reported that the larval population of *Sesamia inferens* on maize
129 was low during the kharif season and peaked in January during the rabi season, with larval
130 populations ranging from 0.80-4.12, 0.60-4.20, and 0.40-4.20 larvae per plant in Karimnagar,
131 Medak, and Warangal, respectively. Sharma *et al.* (2017) observed that the larval population
132 of *S. inferens* on maize increased after the 45th SMW, reached its maximum during the 49th
133 SMW, and then declined until the 7th SMW. Reuolin and Soundararajan (2019) recorded the

134 larval population of *S. inferens* on rice during the 11th SMW (first fortnight of March). Umesh
135 Kumar *et al.* (2018) noted peak larval populations of *S. inferens* on maize (6.17 and 6.93 larvae
136 per plant) in the third week of August (34th SMW) during the *kharif* seasons of 2016 and 2017,
137 respectively. Sanjay Kumar *et al.* (2017) found that the peak infestation period of *S. inferens*
138 on maize was observed at 70 days after sowing (DAS), with an average of 22.38 pinholes per
139 plant. Deole *et al.* (2017) reported that the larval population on maize peaked at 13.81 and
140 18.56 larvae per plant in the 12th and 11th SMW during the spring seasons of 2013-14 and
141 2014-15, respectively. Deole (2016) observed maximum activity of *S. inferens* larvae and
142 adults during the second and third weeks of March (11th and 12th SMW). Singh and Kular
143 (2015) revealed that the maximum incidence of *S. inferens* in a rice-wheat cropping system
144 occurred in September-October (2.76-4.17 per cent), with smaller peaks observed in December
145 and February.

146 **Correlation between weather parameters and *S. inferens* infestation**

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

154 **Regression studies of *S. inferens* infestation on *rabi* sorghum**

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

161 **Conclusion**

162 The study investigated the relationship between weather conditions and the populations of
163 *Chilo partellus* and *Sesamia inferens* on *rabi* sorghum. *C. partellus* was significantly affected
164 by morning humidity (positively) and wind speed (negatively). *S. inferens* showed a positive
165 but non-significant correlation with rainfall and humidity. Understanding these correlations
166 helps predict pest outbreaks and plan effective interventions, improving crop yields and
167 promoting sustainable agriculture. This information is valuable for farmers, agricultural

168 services, researchers, and policymakers in developing precise pest management strategies.

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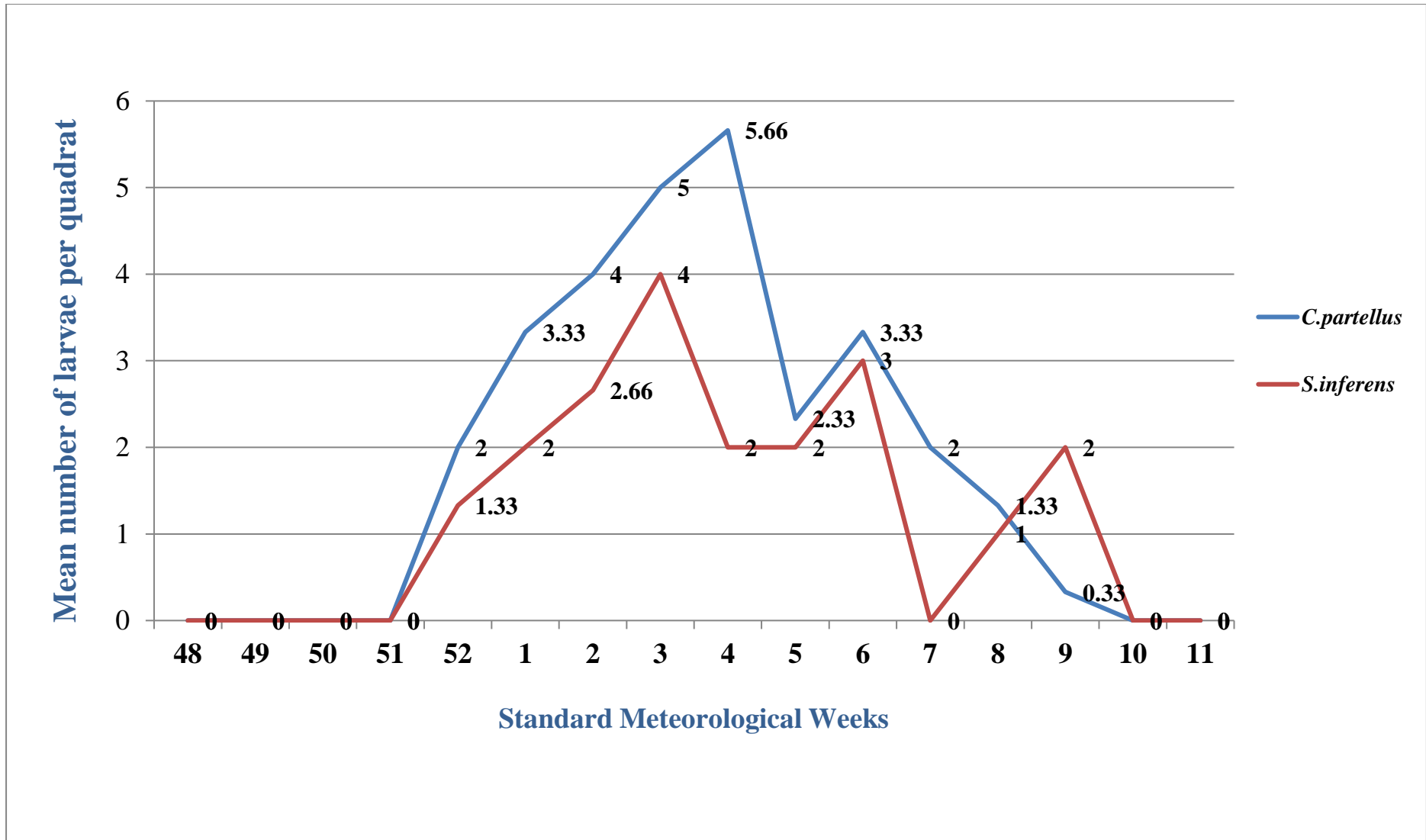
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260 insect sex-pheromone trap.



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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) | Temperature (°C) | | Relative Humidity (%) | | Wind speed (Km per h) | Mean number of larvae per quadrat | |
|-----------------------------------|-------------------------------|---------------|------------------|--------|-----------------------|------------|-----------------------|-----------------------------------|--------------------|
| | | | Min. | Max. | Before noon | After noon | | <i>C. partellus</i> | <i>S. inferens</i> |
| 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 <i>C. partellus</i> | | 0.009 | -0.185 | -0.198 | 0.533* | 0.294 | -0.549* | | |
| 'r' values of <i>S. inferens</i> | | 0.054 | -0.107 | -0.168 | 0.372 | 0.139 | -0.401 | | |

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

| Multiple regressions of weather parameters with <i>C. partellus</i> on rabi sorghum | | | | |
|--|-------------------------------|---------------|---------------|----------------------|
| Weather parameters | Reg. coefficient s (b) | SE (b) | T test | T table(0.05) |
| Rainfall (mm) (B1) | 0.221 | 0.317 | 0.698 | 2.262 |
| Maximum temperature (°C) (B2) | 1.315 | 0.707 | 1.860 | 2.262 |
| Minimum temperature (°C) (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. $Y = -35.694 + (0.221) \times B1 + (1.315) \times B2 + (-0.375) \times B3 + (0.127) \times B4 + (0.029) \times B5 + (-0.400) \times B6 + 1.440$ | | | | |
| Multiple regressions of weather parameters with <i>S. inferens</i> on rabi sorghum | | | | |
| Weather parameters | Reg. coefficient s(b) | SE (b) | T test | T table(0.05) |
| Rainfall (mm) (B1) | 0.141 | 0.281 | 0.500 | 2.262 |
| Maximum temperature (°C) (B2) | 0.593 | 0.627 | 0.946 | 2.262 |
| Minimum temperature (°C) (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. $Y = -14.330 + (0.141) \times B1 + (0.593) \times B2 + (-0.137) \times B3 + (0.075) \times B4 + (-0.024) \times B5 + (-0.254) \times B6 + 1.277$ | | | | |

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