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Influence of weather variables on the incidence of sorghum shootfly in *rabi* season

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ABSTRACT

Field trials were conducted for three consecutive years from 1990 to 1992 at the Regional Research Station, Bijapur (Karnataka) to find out correlation between the deadhearts caused by shootfly and the prevailing weekly meteorological parameters during 1, 2, 3 and 4 weeks prior to the date of observation of shootfly (lead time) under early (September) and late (October) sown conditions. The analysis was performed individually as well as in combination for the various periods of lead time. Results indicated that rainfall received at one week after emergence (four weeks lead time) and higher day temperature at two weeks after emergence (three weeks lead time) reduced shootfly infestation, whereas lower afternoon relative humidity at four weeks after emergence (one week lead time) increased it. Further, the crop sown during 39th MSW was least affected by shootfly in all the three years of experimentation, and hence it is recommended as the optimum time for sowing to reduce the impact of shootfly on sorghum in *rabi* season in the Northern Dry Zone of Karnataka.

Key words : Sorghum, Shootfly, Weather factors, Forecast

The shootfly (*Atherigona soccata* Rondani) is one of the major pests of sorghum in India. The problem has become more acute with the introduction of exotic dwarf hybrids, which are highly susceptible to shootfly. Rai and Jotwani (1977) estimated the losses in grain yield of sorghum due to this pest to be 13 to 20% at 20% infestation level, and about 60-90% at 90% infestation level. Many workers have established influence of weather parameters on the incidence of this pest (Taneja *et al.*, 1986; Mote and Kadam, 1986). However, attempts to ascertain its forecastability have been limited. This paper describes the results of an experiment conducted to choose the appropriate time of sowing for least shootfly incidence and to identify weather parameters influencing its incidence in *rabi* season.

MATERIALS AND METHODS

Field trials were conducted for three consecutive years from 1990 to 1992, at Regional Research Station, Bijapur (16^0 50' N; 75^0 43' E; 594 m amsl), Karnataka. The sorghum hybrid CSH-5 was sown from August to October at the beginning of each meteorological standard week (MSW) in paired rows of 3m length which were replicated thrice. However, for the purpose of analysis in this paper, the period from second week of September to end of October (MSW 37 to 43) was considered, since this is the normal period of sowing of *rabi* sorghum in this region. The weekly weather data were computed from daily weather data collected at the agrometeorological observatory situated on the farms of the research station. The observations on deadhearts caused by shootfly were recorded on 28th day after emergence of the crop. Correlation analysis between the deadhearts and the weekly meteorological parameters of 1, 2, 3 and 4 weeks prior to the date of observation (lead time) was performed, together as well as separately, for early (September) and late (October) sown crop. The analysis was performed individually as well as in combination for the various periods of lead time. For this purpose, the observations of deadheart caused by shootfly on the crop sown in each MSW of each year along with the corresponding meteorological variables was considered as an individual data point.

RESULTS AND DISCUSSION

The shootfly incidence on the sorghum crop shown from MSW 37 to 43 is shown in Fig.1. It is noticed that the crop sown in MSW 39 was the least affected by shootfly in all the three years of the experimentation, and hence it is identified as the optimum time for sowing in order to reduce the impact of shootfly. These results are in line with the findings of Taneja *et al.* (1986).

The normal weekly meteorological variables at Bijapur (Fig.2) indicate that rainfall increases abruptly from MSW 37 to MSW 39 and decreases rapidly from MSW 40. Thus, the crop sown in September experiences wet weather, whereas the crop sown in October experiences dry weather during the corresponding period leading to incidence of shootfly. This was also true during the years of experimentation (Fig. 3). Hence, the analysis has been performed not only for the *rabi* sorghum sowing period as a whole (September to October) but also separately for the crop sown in September (early *rabi*) and October (late *rabi*). The normal maximum temperature varied little, whereas the minimum temperature and relative humidity experienced a drop after MSW 40 (Fig. 2). Similar variations were observed in the years of experimentation also, excepting that the drop was noticed form MSW 41 (Fig. 3).

Rainfall

From Table 1 it is noticed that the influence of rainfall did not show any gradual change, when the data sets of both September and October were considered together. However, when the two sets of data of September and October were analysed separately, the associations were generally positive for September-sown crop, but negative for October-sown crop. This supports the assumption of the authors that the analysis has to be performed separately for early and late sown conditions, to understand the weather - shootfly relations. The only uniformity noticed was at four weeks lead time, i.e. one week after emergence when rainfall was negatively associated with shootfly incidence. In case of October the correlation was significant. This suggests that the rainfall situation at one week after emergence suppresses the shootfly and thereby the deadheart count.

The deadheart count on September-sown crop was associated positively with the rainfall in the lead time of 1, 2 and 3 weeks individually as well as in combinations. However, the correlation coefficients were not significant. In complete contrast, the shootfly dead heart count on October sown sorghum indicated negative association throughout the antecedent period. The correlations were significant for the lead times of 4, 2-4 and 3-4 weeks,

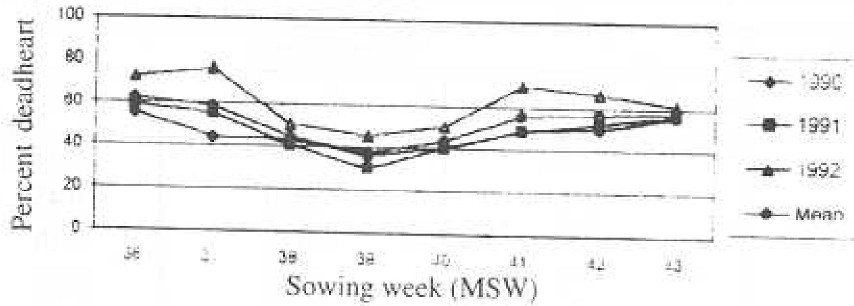

Fig. 1 : Incidence of sorghum shootfly on crop sown in different weeks

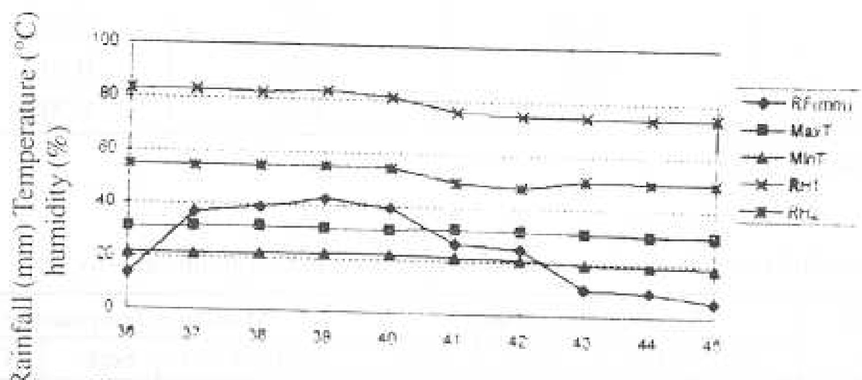

Fig. 2 : Normal weekly meteorological variables at Bijapur

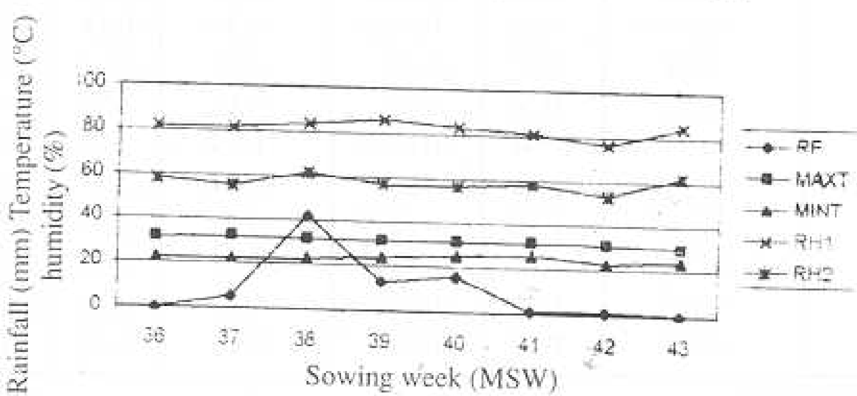

Fig. 3 : Meteorological variables during years of experimentation.

Table 1 : Influence of rainfall on sorghum shootfly in terms of correlation coefficient.

Lead Time (Weeks)	Sowing month		
	Sept. + Oct.	Sept.	Oct.
4	-0.36	-0.22	-0.58 *
3	-0.02	0.20	-0.45
2	-0.08	0.12	-0.10
1	0.22	0.18	-0.27
1-4	-0.10	0.05	0.02
2-4	-0.20	0.05	0.61 *
3-4	-0.30	-0.02	-0.63 *
1-3	0.10	0.24	0.25
2-3	-0.05	0.25	-0.29
1-2	0.18	0.22	0.30

* Significant at 5% level

Table 2 : Correlation coefficient between air temperature and sorghum shootfly.

Lead Time (Weeks)	Maximum Temperature			Minimum Temperature		
	Sept. + Oct.	Sept.	Oct.	Sept. + Oct.	Sept.	Oct.
4	-0.14	0.51	-0.63 *	-0.21	-0.21	-0.22
3	-0.48 *	-0.04	-0.84 **	-0.40	-0.18	-0.42
2	-0.14	0.37	-0.42	-0.28	-0.11	0.10
1	-0.24	-0.20	0.00	-0.05	0.38	0.34
1-4	-0.38	0.44	-0.82 **	-0.28	0.03	0.34
2-4	-0.34	0.52	-0.86 **	-0.34	-0.16	-0.25
3-4	-0.36	0.38	-0.82 **	-0.35	-0.20	-0.37
1-3	-0.41	0.07	-0.71 *	-0.28	0.09	-0.28
2-3	-0.38	0.22	-0.75 *	-0.37	-0.14	-0.24
1-2	-0.23	0.10	-0.34	-0.18	0.18	-0.13

* Significant at 5% level
** Significant at 1% level

Table 3 : Correlation coefficient between relative humidity and sorghum shootfly

Lead Time (Weeks)	Morning relative humidity			Afternoon relative humidity		
	Sept. + Oct.	Sept.	Oct.	Sept. + Oct.	Sept.	Oct.
4	-0.16	0.14	-0.28	0.09	0.24	-0.17
3	-0.13	0.26	-0.48	0.11	0.64	-0.39
2	-0.50 *	-0.50	-0.54	-0.34	-0.52	-0.32
1	-0.30	-0.50	-0.10	-0.37	0.18	-0.81 **
1-4	-0.40	-0.20	-0.60 *	-0.20	0.45	-0.63 *
2-4	-0.38	-0.08	-0.60 *	-0.00	0.41	-0.42
3-4	-0.17	0.26	-0.43	-0.13	0.52	-0.41
1-3	-0.44 *	-0.32	-0.53	-0.30	0.45	-0.67 *
2-3	-0.39	-0.16	-0.46	-0.10	0.43	-0.44
1-2	-0.49 *	-0.54	-0.41	-0.50 *	-0.30	-0.69 *

* Significant at 5% level
** Significant at 1% level

indicating the importance of rainfall particularly at 4 weeks lead time in reducing the shootfly deadhearts.

Temperature

The association of maximum temperature with shootfly incidence was negative at 3 weeks lead time (Tabe 2). It was significant for the combined data of September and October (-0.48) and highly significant (r = -0.84) for the crop sown in October. The shootfly incidence on October-sown crop was particularly sensitive to maximum temperature, as indicated by the significant negative correlation coefficients during the lead periods of 4, 1-3 and 2-3 weeks, and highly significant negative correlation at 3, 1-4, 2-4 and 3-4 weeks. This suggests that the thermal stress at 2 to 4 weeks lead time has adverse effect on shootfly deadhearts for the crop sown in October. On the other hand, the sorghum shootfly incidence had poor association with minimum temperature.

Relative humidity

The shootfly incidence was negatively associated with relative humidity at one and two weeks lead time. However, at 3 and 4 weeks lead time it was positively associated for September sown crop, and negatively associated for the crop sown in October with non-significant coefficients. It is of particular importance that the combinations of the various lead times indicated a general non-significant positive association between sorghum shootfly and afternoon relative humidity in case of crop sown in September and good negative association in case of the crop sown in October. The association was highly significant (r = -0.81) at 1 week lead time and significant at 1-4, 1-3 and 1-2 lead weeks for October-sown crop. Taneja *et al.* (1986) reported that the abundance of deadhearts caused by shootfly was highly dependent on temperature and minimum humidity.

Forecasting of shootfly

The above correlation analysis was utilised to develop regression equations for forecasting the shootfly incidence on *rabi* sorghum sown in October. Regression analysis was performed by considering the parameters having highly significant correlation coefficient, and the models developed are given below.

$$Y = 240.94 - 6.10\ MaxT\ (3) \qquad R^2 = 0.70$$

$$Y = 111.08 - 1.01\ RH2\ (1) \qquad R^2 = 0.69$$

$$Y = 221.13 - 4.24\ MaxT\ (3) - 0.65\ RH2(1) \qquad R^2 = 0.89$$

where, Y is percent deadhearts caused by shootfly, MaxT is maximum temperature (°C), RH2 is afternoon relative humidity(%). Numbers in parentheses indicate lead time in weeks.

Among the above models, the first equation can forecast shootfly deadhearts three weeks ahead up to 70% accuracy, and hence can be used in agroadvisories. However, by supplementing the afternoon relative humidity the third equation can increase the accuracy by 19%, but at only one week lead time, which is not sufficient for using in agroadvisories.

The results thus revealed that none of the five meteorological variables, namely, rainfall, maximum temperature, minimum temperature, morning and afternoon relative humidity was associated significantly with the deadheart of shootfly on *rabi* sorghum crop sown during September. On the other hand rainfall, maximum temperature and morning and afternoon relative humidity were negatively and significantly correlated at different lead times. The results further revealed that, due to their highly significant nature of association with deadhearts, maximum temperature at 3 weeks lead time and afternoon relative humidity at one week lead time were capable to forecast the attack of shootfly on sorghum crop sown during October.

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