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Seasonal incidence of sorghum shootfly and correlations with weather parameters

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ABSTRACT
Studies were undertaken on the seasonal occurrence of sorghum shootfly during the *kharif* 2002 at the Main Agricultural Research Station, Dharwad form July to October. Results revealed that, the pest was active through out the study period of four months starting form July first week (27th Standard week) to October last week (44th standard week). The oviposition by shoot fly on 27th standard week was 0.90 eggs per plant, which reached a peak on 33rd standard week (3.2 eggs/plant) and declined gradually up to 0.70 eggs per plant on 44th standard week. Similar trend was observed with respect to dead hearts. During 27th standard week it was 43.1 per cent and reached a peak with 93.4 per cent on crop sown during 33rd standard week and gradually declined to 35 per cent during 44th standard week. Attempts to determine the relationship between egg load and dead heart with weather parameters of 1, 2, 3 and 4 weeks lead time (prior) and same week of the observations revealed the following results. In all the aforesaid correlated weeks, the combined weather parameters of maximum temperature with afternoon and morning relative humidity were highly significant and negatively correlated with egg load and dead heart formation. Whereas, the morning and afternoon relative humidity, minimum temperature and after noon relative humidity together exerted highly significant positive relationship with egg load and dead hearts due to shoot fly. However, the same week weather parameters influenced more on egg load (54 %) and dead heart formation (44.7 %) due to shootfly.

Key words: Sorghum shootfly, Prediction models, Lead time, Weather factors, Correlations

INTRODUCTION
Sorghum shootfly, *Atherigona soccata* Rondani (Muscidae : Diptera) is a major pest during seedling stage and its infestation causes dead heart formation leading to killing of the plants. Nearly 32 per cent of the sorghum crop is lost due to insect pests in India (Borad and Mittal. 1983), of which 5 per cent of the loss has been attributed to sorghum shoot fly (Jotwani, 1983). The incidence of shootfly is known to vary from region to region and season to season. Singh and Verma (1988) reported peak activity of shootfly during August in Hariyana. The activity of shootfly was adversely affected by the atmospheric temperature (> 40°C). However, high relative humidity (>60 %) increased its population. In this study, the relationship of weather parameters of different lead weeks on shootfly incidence and also regression models were developed for early prediction of damage. This may be fruitfully utilized for forewarning farmers and screening of genotypes.

MATERIALS AND METHODS
Studies were undertaken on the seasonal occurrence of sorghum shootfly during the *kharif* 2002 at the Main Agricultural Research Station, Dharwad form July to October. Sowing of hybrid sorghum, CSH-16 was taken up at weekly intervals commencing from 27th standard week (first week of July) to 44th standard week (last week of October) covering 18 sowings. The sowing was carried out on a plot size measuring 3 x 1.35 m with spacing of 45 x15 cm and replicated twice.

Observation on egg load per plant was recorded on twenty randomly selected plants in each plot on 14th day after emergence (DAE) of the crop. Observation on dead heart was recorded on 28th DAE. The per cent dead hearts due to shootfly was worked out based on the number of plants per plot and the number of plants showing dead heart symptoms.

$$\text{Deadhearts \% due to shootfly} = \frac{\text{Number of plants with deadhearts per plot}}{\text{Total number of plants per plot}} \times 100$$

Weather parameters that prevailed during 4th, 3rd, 2nd and 1st week prior (lead weeks) and same week of observation were correlated with biological observations (Number of eggs per plant and per cent deadhearts). Multiple regression equation models were developed for the relationship.

RESULTS AND DISCUSSION
Observations recorded on egg load and per cent deadhearts on weekly sown crop are presented in table 1. In the present study all the correlated lead weeks with egg load, the combination of weather parameters *viz.*, maximum temperature with afternoon and

Table 1 : Seasonal incidence of shootfly, *Atherigona soccata* on sorghum

Sowing week (Std. Weeks)	Mean eggs per plant (14 DAE)	Per cent dead heart (28 DAE)
27 (Jul 02-08)	0.90 (1.37)*	43.1 (41.00)**
28 (Jul 09-15)	1.20 (1.49)	69.0 (56.17)
29 (Jul 16-22)	1.50 (1.59)	68.6(55.93)
30 (Jul 23-29)	2.10 (1.76)	79.9(63.36)
31 (Jul 30-05)	2.60 (1.91)	84.4(66.75)
32 (Aug 06-12)	2.80 (1.96)	91.5(73.06)
33 (Aug 13-19)	3.20 (2.04)	93.4(75.12)
34 (Aug 20-26)	3.00 (2.00)	92.0(73.58)
35 (Aug 27-02)	2.80 (1.96)	89.8(75.36)
36 (Sept 03-09)	2.70 (1.92)	86.2(68.19)
37 (Sept 10-16)	2.60 (1.90)	83.3(65.87)
38 (Sept 17-23)	2.30 (1.81)	80.70(63.94)
39 (Sept 24-30)	2.10 (1.76)	73.00(58.68)
40 (Oct 01-07)	1.90 (1.70)	68.80(56.04)
41 (Oct 08-14)	2.10 (1.76)	71.0(57.43)
42 (Oct 15-21)	2.00 (1.73)	68.2(55.68)
43 (Oct 22-28)	1.50 (1.58)	63.5(52.84)
44 (Oct 29-04)	0.70 (1.30)	35.0(36.25)

* Figures in parentheses indicate $\sqrt{x+1}$ transformations
** Figures in parentheses indicate arc sin transformations
DAE = Day after emergence

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Table 2 : Correlation matrix between egg load and weather parameters at different lead-times

	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	Egg load per plant at 14 DAE
	Maximum	Minimum	Morning	Afternoon		
	MaxT	MinT	RH-I	RH-II	RF	Y
			Weather parameters at 4 weeks lead time (4 weeks prior)			
MaxT	1.00	-0.195	-0.823**	-0.938**	-0.102	-0.247
MinT		1.000	0.468*	0.437	0.102	0.229
RH-I			1.000	0.910**	0.209	0.098
RH-II				1.000	0.037	0.124
RF					1.000	-0.327
Y						1.000
			Weather parameters at 3 weeks lead time (3 weeks prior)			
MaxT	1.00	-0.239	-0.704**	-0.865**	-0.141	-0.361
MinT		1.000	0.693**	0.625**	0.216	-0.115
RH-I			1.000	0.919**	0.286	0.244
RH-II				1.000	0.551	0.283
RF					1.000	0.005
Y						1.000
			Weather parameters at 2 weeks lead time (2 weeks prior)			
MaxT	1.00	-0.293	-0.710**	-0.882**	-0.163	-0.291
MinT		1.000	0.745**	0.599**	0.290	0.070
RH-I			1.000	0.923**	0.317	0.269
RH-II				1.000	0.196	0.259
RF					1.000	-0.004
Y						1.000
			Weather parameters at 1 week lead time (1 week prior)			
MaxT	1.000	-0.329	-0.719**	-0.883**	-0.173	0.024
MinT		1.000	0.774**	0.579**	0.339	0.047
RH-I			1.000	0.900**	0.338	0.007
RH-II				1.000	0.205	-0.036
RF					1.000	0.118
Y						1.000
			Weather parameters during same week of observation			
MaxT	1.000	-0.267	-0.715**	-0.889**	-0.139	-0.514*
MinT		1.000	0.698**	0.619**	0.165	-0.043
RH-I			1.000	0.920**	0.260	0.467*
RH-II				1.000	0.116	0.420
RF					1.000	0.126
Y						1.000

N = 17, r value 0.575 at 0.01, r value 0.456 at 0.05
**r values significant at 0.05 and 0.01 levels * r values significant at 0.05 level
DAE = Days after emergence

morning relative humidity had highly significant negative correlation with egg load. Where as the morning and morning and afternoon relative humidity, minimum temperature and afternoon relative humidity have together exerted highly significant positive correlation with egg load, except at four weeks lead time. Except these none of weather parameters showed any significant correlation with egg load (Table 2). Multiple regression equations for different weeks correlated are presented in table 4. Total weather parameters of different correlated weeks influenced the egg load to the extent of 42.00 per cent (four week prior), 23.50 per cent (three week prior), 23.5 per cent (two week prior), 15.2 per cent (one week prior) and 54 per cent in the same week of observation. Similarly, in all the correlated lead weeks with percent dead heart, the combination of weather parameters *viz.*, maximum temperature with afternoon and morning relative humidity had highly significant negative correlations with dead heart formation. Where as the morning and morning and afternoon relative humidity, minimum temperature and afternoon relative humidity have together exerted highly significant positive correlation with deadheart formation. Except these none of weather parameters showed any significant correlations with deadheart

Table 3 : Correlation matrix between per cent deadhearts and weather parameters

	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)	% DH at 28 DAE
	Maximum	Minimum	Morning	After noon		
	MaxT	MinT	RH-I	RH-II	RF	Y
			Weather parameters at 4 weeks lead time (4 weeks prior)			
MaxT	1.00	-0.239	-0.704**	-0.865**	-0.141	-0.346
MinT		1.000	0.693**	0.625**	0.216	0.060
RH-I			1.000	0.919**	0.286	0.369
RH-II				1.000	0.151	0.388
RF					1.000	0.004
Y						1.000
			Weather parameters at 3 weeks lead time (3 weeks prior)			
MaxT	1.000	-0.293	-0.710**	-0.882**	-0.163	-0.333
MinT		1.000	0.745**	0.599**	0.290	0.283
RH-I			1.000	0.923**	0.317	0.403
RH-II				1.000	0.196	0.378
RF					1.000	-0.00
Y						1.000
			Weather parameters at 2 weeks lead time (2 weeks prior)			
MaxT	1.000	-0.329	-0.714**	-0.883**	-0.173	-0.100
MinT		1.000	0.774**	0.589**	0.339	0.353
RH-I			1.000	0.900**	0.338	0.230
RH-II				1.000	0.205	0.101
RF					1.000	-0.056
Y						1.000
			Weather parameters at 1 week lead time (1 week prior)			
MaxT	1.000	-0.308	-0.689**	-0.878**	-0.199	0.033
MinT		1.000	0.789**	0.578**	0.335	0.073
RH-I			1.000	0.885**	0.368	0.286
RH-II				1.000	0.240	0.092
RF					1.000	-0.020
Y						1.000
			Weather parameters during same week of observation			
MaxT	1.000	-0.358	-0.694**	-0.841**	-0.223	0.048
MinT		1.000	0.825**	0.679**	0.334	0.535*
RH-I			1.000	0.908**	0.383	0.265
RH-II				1.000	0.266	0.236
RF					1.000	0.106
Y						1.000

N = 17, r value 0.575 at 0.01 r value 0.456 at 0.05

**r values significant at 0.05 and 0.01 levels * r values significant at 0.05 level

DAE = Days after emergence, DH = Deadhearts

formation (Table 3). Multiple regression equations for different weeks correlated are presented in table 4.

Total weather parameters of different correlated weeks influenced the per cent dead hearts to the extent of 27.2 per cent (four week prior), 20 per cent (three week prior), 24 per cent (two week prior), 30 per cent (one week prior) and 44.7 per cent in the same week of observation. The above findings are in agreement with the reports of Somasekhar (1985), Singh and Verma (1988), Katole and Mundiwale (1992), Shekar (1995) Balikai and Venkatesh (2001) and Venkatesh and Balikai (2002), who also observed negative significant correlation with maximum temperature and positive significant correlation with relative humidity. The present results are contradictory to the findings of Dubey and Yadav (1980), Khan and Singh (1980) and Nair *et al.* (1995) who reported a positive correlation with maximum temperature. Similarly, the present results are also contradictory to results of Dubey and Yadav (1980) who noticed that the relative humidity of 86 to 88 per cent resulted in the reduction of shootfly. This might be due to differences in the climatic conditions and rainfall pattern prevailed and cultivars used. During the study, rainfall had no effect on shootfly oviposition and deadheart formation. However, according to Nair *et al.* (1995), rainfall intensity had detrimental effect on egg laying and adult population. This might be due to washing effect of eggs with high intensity.

Table 4 : Multiple linear regression models for estimation of shootfly egg load and deadhearts

Correlated weeks	Multiple regression equation for shootfly egg load	R^2 value
4 week lead time	Y = 18.948-5.983 MaxT+1.755 MinT +1.320RHI-1.826 RHII-2.395RF	0.421
3 week lead time	Y = 6.203+5.560MaxT-5.021 MinT+2.659 RHI + 3.651RHII + 5.513 RF	0.235
2 week lead time	Y = 5.820-1.578 MaxT-1.297 MinT+9.013 RHI-5.880RHII-5.787 RF	0.152
1 week lead time	Y = 2.689-6.346 MaxT+4.800 MinT+3.250 RHI-3.405RHII-7.006 RF	0.043
Same week of observation	Y = 10.029-2.812MaxT-3.113MinT+1.627RHI.025RHII-6.532RF	0.540
Correlated weeks	**Multiple regression equation for shootfly dead hearts**	**R^2 value**
4 week lead time	Y = 36.452+5.010MaxT-1.268MinT + 3.762RHI + 1.825RHII + 1.252RF	0.272
3 week lead time	Y =64.006-2.752 MaxT +1.113MinT+1.576RHI-9.356RHII-1.608 RF	0.200
2 week lead time	Y =61.393-3.783 MaxT +6.273MinT+1.230RHI-1.566RHII-2.267RF	0.240
1 week lead time	Y =-60.66+2.603 MaxT +5.342MinT+7.494RHI-5.849RHII-1.788RF	0.300
Same week of observation	Y =-89.353+2.817 MaxT+7.814MinT-1.700RHI + 1.0040 RHII + 4.009RF	0.447

R^{2} = Coefficient of determination

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