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# Effects of Host Resistance, Temperature, and Duration of Wetness of Leaf Blight Development of Grain Sorghum

**R.I. Karunakar, S. Pande, and R.P. Thakur**
*Crop Protection Division ICRISAT Asia Center, Patancheru 502 324, A.P.*

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**Abstract**

The effects of post-inoculation temperatures and periods of leaf wetness of leaf blight (*Exserohilum turcicum* (Pass.) Leonard and Suggs) development were studied in three sorghum genotypes (IS 3443C-40, ICSV 1, and 296B or Local FSRP) having varying levels of blight resistance. In two different experiments, pot-grown plants of these genotypes were spray-inoculated and subjected separately to i) six temperature regimes (10,15,20,25,30 and 35°C) for 24h with a 12h photoperiod and high relative humidity (100% RH) and ii) six periods of leaf wetness (RH-100%) of 2,4,6,8,24, and 48 h at 25°C Leaf blight severity (percentage leaf area damaged) was maximum (55%) at 25°C at 24 h of leaf wetness period in the susceptible genotypes Local FSRP and 296B. There was no leaf blight development at 10°C and 35°C and, significnatly, only low blight development (%) up to 8 h of leaf wetness. Implication of these findings in refining leaf blight screening technique is discussed.

## Introduction

Leaf blight of sorghum (*Sorghum bicolor* (L.) Moench) caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs, is a disease of economic significance in the sorghum-growing regions of relatively cool and humid climate (Bergquist, 1986; Tirr, 1362). The pathogen infects the plant at all stages of growth and causes long, elliptical, reddish purple or yellowish tan lesions, upto 12 mm wide and 25-150 nun long, first on lower leaves and later on upper leaves. Under humid conditions, abundant sporulation occurs on the lesions, which contributes to the secondary spread of the disease (Bergquist, 1986).

Among the weather factors influencing plant disease development, moisture is often the most critical, followed by temperature (Jones, 1986). Information on weather factors that influence blight development, which is vital to the development of an effective field screening technique in a resistance breeding program, is limited. Our objectives in this study were to determine the critical temperature and leaf wetness duration required for leaf blight development in sorghum genotypes with varying resistance levels.

## Materials and Methods

### *Isolation and inoculum production*

Leaf bright lesions from naturally infected sorghum leaves, collected from ICRISAT Asia Center fields during the post-rainy season of 1991, were cut into 3-4 cm long pieces. These were surface sterilized with mercuric chloride (0.1%) for 30 seconds, washed thrice in sterile distilled water, placed on lactose casein hyrolysate agar medium (LCHA) in glass petridishes, and incubated at 25°C with a 12 h photoperiod. Conidia were removed 7 days later from a sporulating colony and a suspension was made in 10 ml sterile water. After progressive dilutions, the suspension (10 conidia ml" ) was streaked on to the surface of water agar (4%) in plastic petridishes and incubated overnight for the conidial germination. Single germinated conidia were isolated, under an Olyumpus stereo microscope, and transferred on to the LCHA medium in glass

petridishes and incubated at 25°C under 12 h photoperiod for 14 days.

***Inoculation and disease assessment***

Inoculum was prepared by flooding 14-day-old cultures on LCHA medium and sterilized distilled water and loosening the conidia with a spatula, and straining through a double-layered *cheesecloth.* One drop of Tween 20 (polyoxyetheylene sorbitan monolaurale) was added to 100 ml conidial suspension as a wetting agent. The suspension was diluated to 5 x $10^4$ condial $ml^{-1}$ with the help of a haemocytometer.

Three sorghum genotypes (resistant, IS 3443C-40; moderately resistant, ICSV 1; and susceptible, Local FSRP to leaf blight) were grown in 12-cm square plastic plot filled with vertisol-mix (23 vertisol; 2 sand; 1 farmyard manure by volume) in the greenhouse. Plants at the 4-5 leaf stage were spray inoculated, using at atomizer, with the conidial suspension until runoff, and placed in incubators (Pervical Mfg. Co. Boone, Iowa Model 1-35LL) at the required temperatues in different experiments.

Leaf blight severity was scored 14 days after inoculation as percentage leaf area covered by lesions on the 4th and 5th leaves of each plant, and the mean blight severity was determined for each replication.

***Temperature* and *disease development***

The experiment was planned as a split-plot experiment in randomized block design (RBD) with six temperature regimes (10,15,20, 25, 30, and 35°C) as main plots and the three sorghum genotypes as subplots in three replications. Each pot with four plants was maintained as a replication.

Prior to inoculation, the plants were acclimatized at the respective temperature regimes for 24 h and were returned to the same temperature regimes (Percival Incubators) immediately after inoculation. High relative humidity (RH = 100%) was maintained for 24 h at each temperature regime by covering the pots with polyethyelene bags pre-wetted with water.The polyethylene bags were removed24 h later, and the plants were left at the same temperatures for next 14 days with a 12 h photoperiod. Plants were removed from the incubators and leaf blight severity was scored as described earlier. The experiment was repeated twice.

***Leaf wetness duration and disease development***

In another experiment, the inoculated plants of the three genotypes (expect that the Local FSRP was replaced by 296B) were exposed to the six periods of leaf wetness (2,4,6,8,24, and 48h). The experiment was conducted as a split-plot, with periods of leaf wetness as the main plots and the genotypes as the subjects in two replications, with four plants per replication, inoculated plants were covered with pre-wetted polyethylene bags to ensure the required duration of leaf wetness at 25°C. The plants were then shifted to the greenhouse benches (25 ± 2°C and 60-70% RH), Blight severity was scored 14 days after inoculation as described before. The experiment was repeated thrice.

***Data analysis***

Disease severity scores were subjected to analysis of variance (ANOVA) to determine treatment difference. Since ANOVA of the arcsin transformed data was comparable to that of the percentage data we report only percentage data in this paper. ANOVA for temperature and periods of leaf wetness was done ou pooled data over experimental runs, after testing the homogeneity of error among the runs ($x^2$ values non-significant). The relationships between disease *severity,*

temperature, and leaf wetness duration were quantified using regression techniques.

## Results and Discussion

*Effects of host resistance and temperature on leaf blight infection*

The ANOVA showed highly significant (P = ) effects of temperatures, host genotypes, and temperature x genotype infection (Table 1). Maximum variability was found among the genotypes, followed by temperature. The high variation due to temperature x genotype inter action indicates that blight development is highly temperature dependent.

Blight severity increased with increasing temperature upto 25°C and decreased rapidly with further increase in temperature. The optimal temperature for disease development among the cultivars varied between 22 and 23°C (Fig.1). The susceptible Local FSRP showed maximum severity (55% of the leaf area was damaged) whereas in moderately resistant ICSV1 it was 18% and in the resistant IS 3443C-40 it was 11%.

The relationship between temperatures and severity of blight in each genotype was explained by quadratic regression curve (Fig.1). The temperature of 10° C and 35°C were not included in fitting the response curve, as there was no disease development at these temperatures.

Hennessery *et al.,* (1990) also observed that high incidence of sorghum leaf blight was associated with minimum and mean temperatures of 14-16°C and 20.8-22.2°C, respectively. The blight incidence was significantly lower when the minimum temperature remained below 16°C between 2 wk before sowing and 3 wk after sowing. Similarly, Levy and Cohen (1983) found that corn leaf blight (*E. turcicum)* occurred at temperatures between 20 and 25°C, with maximum infection at 20°C, but traces of disease were also observed at 30°C. Our results are in agreement with these findings.

*Effects of host resistance and periods of leaf wetness on leaf blight*

ANOVA showed highly significant (P = ) effects of leaf wetness duration, host genotypes and leaf wetness duration x host genotype interaction' on blight development (Table 1). Maximum variability was observed among the genotypes, followed by that under varying periods of leaf wetness.

The relationship between periods of leaf wetness and disease severity in each

**Table.** Analysis of variance for leaf blight severity in three sorghum genotypes at four temperature regimes and six periods of leaf wetness in the greenhouse

| Source of variation | Temperature | | Leaf wetness duration | |
|---|---|---|---|---|
| | df | Ms | df | Ms |
| Experiments (E) | 1 | 272.22*** | 2 | 45.62 |
| Replication/E | 4 | 14.93 | 3 | 12.76 |
| Treatment (T) | 3 | 2512.50*** | 5 | 2222.26*** |
| Genotype (G) | 2 | 3371.18*** | 2 | 5071.95*** |
| T x G | *6* | 587.85*** | 10 | 731.57*** |
| Error | 44 | 14.55 | 51 | 7.86 |

*** = Significant at P = 0.001

* = Significant at *P =0.05*

a Zero values at temperatures 10 and 35°C were not used in the analysis

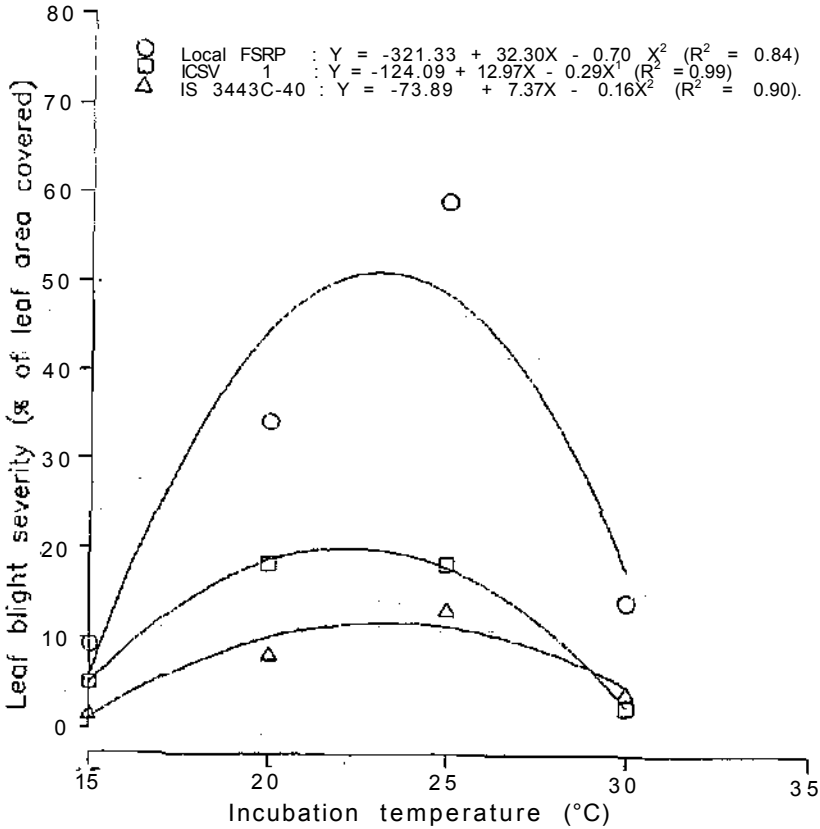


**Fig. 1.** Effect of temperature on the severity of leaf blight (percentage of leaf area covered by leaf blight lesions) in three sorghum genotypes (Local FSRP = highly susceptible, ICSV1 = *moderately resistant, and IS 3443C-40 = resistant to leaf blight*). *Regression* equations for leaf blight development for Local FSRP = Y = -321.22 +.333X-0.70$X^2$ ($R^2$ = 0.84);for ICSVI = Y = -124.09 + 12.97X-*029*$X^2$($R^2$ = 0.99);for IS 3443C-40 = Y = -73.89 + 737X-0.16$X^2$($R^2$ = 0.90), where Y = percentage leaf area infected and X = incubation temperature

genotypes was quantified through a linear regression (Fig. 2). With the longer periods of leaf wetness, blight severity increased in each sorghum genotypes. The regression of blight severity on the periods of leaf wetness was significant (P=0.05) for all the three genotypes. Again, the disease developed faster in the susceptible genotypes 296B (8% severity after 2h of leaf wetness) than in the moderately resistant and resistant genotypes that did not show blight symptoms after the same period of leaf wetness. The symptoms appeared in moderately resistant ISCV 1 and after 6 h of leaf wetness, and in resistant IS 3443C-40 after 24 h of leaf wetness. In the susceptible genotype, disease severity increased significantly as the periods of leaf wetness became longer, reaching almost 60% at 48b, of leaf wetness. The rate of blight development is negatively correlated with the levels of resistance in each genotype, irrespective of the leaf wetness duration.

Leaf blight infection in corn after 6h of dew period was quite low, but heavy infection occurred after 29h of leaf wetness (Misra and Singh, 1963) in corn leaf blight. Exposure of inoculated plants to high humidity for a longer period (40h and beyond) resulted in chlorotic symptoms; subsequently, the plants died. This could be due to the toxins produced by *E. turcicum* (Wolf and Earle, 1990).

These results clearly demonstrate the influence of temperature, period of leaf wetness, and level of resistance on development of leaf blight in sorghum. Germplasm and breeding lines can be screened effectively by providing optimum temperature and period of leaf wetness both in field and greenhouse; Maximum-blight development at temperatures between 20 and 25°C under high relative humidity for 24h or more explains why blight is a problem of high altitude sorghum. Blight epidemics have also been observed in plains when nights are cooler and weather is rainy.

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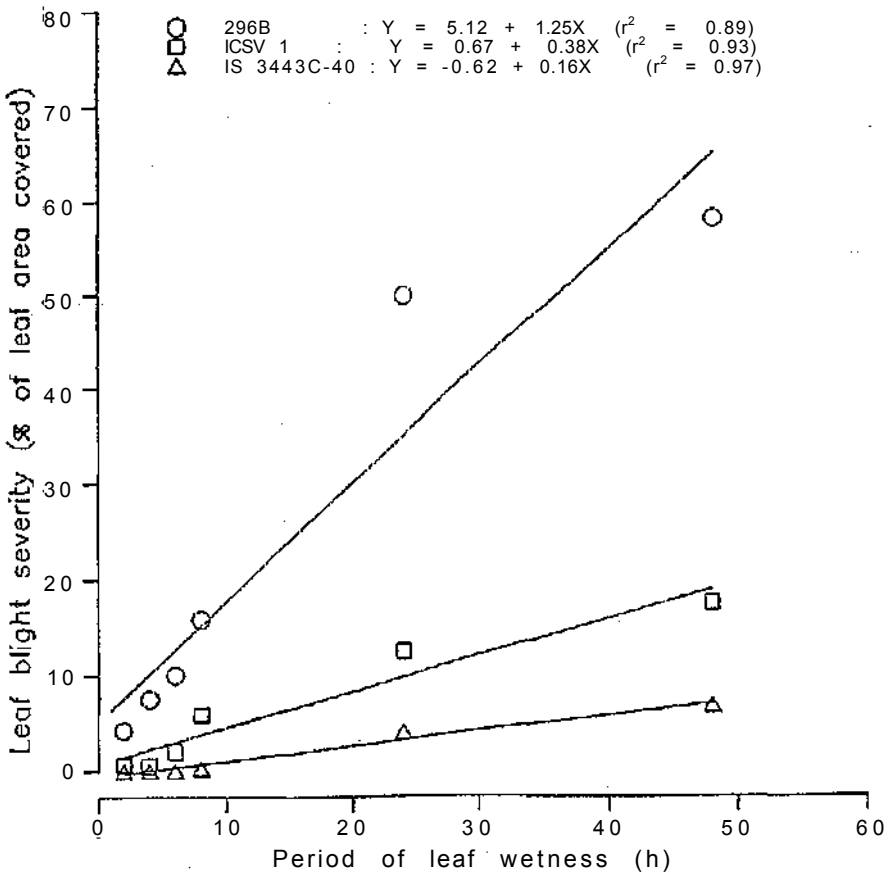


**Fig. 2.** Effect of period of leaf wetness on the severity of leaf blight (percentage of leaf area covered by leaf blight lesions) in three sorghum genotypes (296B = highly susceptible, ICSV1 = moderately resistant, and IS 3443C-40 = resistant to leaf blight). Regression equations for leaf blight development for 296B = Y =5.12 + 1.25X($r^2$ = 0.89); for ICSV1 = Y = 0.67 + 0.38X ($r^2$ = 0.93); for IS 3443C-40 = Y = -0.62 + 0.12X ($r^2$ = 0.97), where Y = percentage leaf area infected and X = (leaf wetness duration