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RESPONSE OF DIFFERENT GENOTYPES OF SORGHUM TO *EXSEROHILUM TURCICUM* (PASS.)

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ABSTRACT

The basic components of the disease are overall disease damage (score), length, width and area of the lesion, number of lesions, number of flecks and lodging. Overall disease damage (score) is considered to embrace or integrate all the components of the plant response. Damaged leaf area, reflects the spread of the disease, while the fleck number the hypersensitive reaction. Consequently the genotypes with low fleck number and less leaf area damage are most desirable. The hybrids of SPLB 94012A, SPLB 94015A and SPLB 94006A crossed with ICSR 119; SPLB 94004A, SPLB 94012A, SPLB 94015A, SPLB 94017A, SPLB 94021A and 296A crossed with ICSR 26; and SPLB 94004A, SPLB 94006A, SPLB 94003A, SPLB 94015A, SPLB 94013A, SPLB 94021A and SPLB 94017A crossed with ICSR 90030 were resistant, and found to be stable in disease expression over two years.

Key words : Disease related parameters, leaf blight, sorghum.

INTRODUCTION

Sorghum is potentially a high yielding crop. Its productivity continued to be

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low in India as compared to world's average, owing to the hindrance due to biotic and abiotic stresses. Diseases are very important among biotic constraints and several destructive diseases affect sorghum grain and fodder yield and their quality. Among them grain mold, charcoal rot, fusarium rot, stalk rot, ergot, downy mildew, leaf blight and rust are the most predominant. Of these, leaf blight caused by *Exserohilum turcicum* (Pass.) Leonard and Suggs. (1974) is one of the extensively distributed, and at times one of the most damaging foliar pathogens of the sorghum (Sharma, 1980).

Leaf blight disease in India was first reported by Butler (1918) on the leaves of cultivated sorghum and later by Mitra (1923) in Punjab. The disease is prevalent and actively widespread particularly in the states of Andhra Pradesh, Haryana, Maharashtra, Madhya Pradesh, Karnataka, Tamilnadu and Rajasthan (Sundaram *et al.*, 1972). A disease intensity of 32 to 69% (ICRISAT, 1979) has been reported with a loss of 45% in grain yield (Sharma, 1978). The disease may be observed as foliar damage, and length, width and area of the lesion, and number of lesions and flecks, and lodging. Overall foliar disease damage (score) is considered to embrace or integrate all the components of the plant response. However, the grouping of genotypes based on the disease damage score could be different from those formed on the basis of the components. Hence, an attempt has been made, here in this paper, to describe the differential reaction of male-sterile lines, restorers and their hybrids to leaf blight on the basis of total leaf area damage (which encompasses length, width and number of lesions and flecks) for two subsequent years.

MATERIALS AND METHODS

Materials and field evaluation:

In the present study 20 CMS (cytoplasmic male-sterile i.e., A-) lines were crossed with six restorer (testers i.e., R-) lines in a line x tester fashion during rainy season in 1996 and 1997 and the resultant 120 cross combinations (A x R hybrids) along with their respective parents and checks were evaluated in a randomised complete block design replicated thrice during post rainy seasons in 1996 and 1997 for leaf blight resistance under artificial disease epphytotic conditions for various disease related parameters.

The recommended package of practices were followed to raise a healthy crop. Plot size in both the experiments consists of 2 rows of 4 m length each (75 cm between rows and 12 cm within the row). Spraying with fungicides was avoided immediately after the inoculation to prevent its adverse effect on the spread of the inoculum. However, need based plant protection measures were taken up at the

initial stages of the crop to safeguard the crop from the incidence of shoot fly. Highly leaf blight susceptible entries such as *Kundi Jowar* and H 112 were planted in two rows each as infestor rows all round the field and after every 10 rows and 12 rows of the test material during first and second seasons, respectively.

Inoculum preparation:

The leaves affected with leaf blight [*Exserohilum turcicum* (Pass.)] were collected from the field and cut into small pieces and surface sterilized with 0.1% mercuric chloride for one minute followed by washing with sterile distilled water. Leaf pieces were aseptically transferred to sterilized petri plates containing 20 ml of sterilized Potato Dextrose Agar media (PDA) and incubated at 20°C for encouraging the fungal growth. The fungal growth was aseptically transferred to flasks containing sterilized sorghum grains and incubated at 20°C for 15 days so that the sorghum grains were covered with mycelia and the conidia. The colonized fungus grains were removed from the flasks, allowed to air dry and separated as far as possible.

Inoculation:

Sorghum plants were artificially inoculated following whorl-drop method of inoculation (Frederiksen and Franklin, 1978) with the inoculum prepared as above. The inoculation was carried out 21 and 30 days after emergence of coleoptile during post rainy seasons 1996 and 1997, respectively. The second inoculation was given one week after the first inoculation. All the plants in each entry were inoculated by placing two or three grains of seed inoculum in the whorl. The high humid conditions were created by providing overhead sprinklers on the same day after inoculation until the disease has spread. It took 40 days for the disease to spread.

Observations:

The observations were recorded for disease damage (scored on a 1-9 scale on plot basis where 1= highly resistant and 9= highly susceptible), length of the lesion (cm), width of the lesion (cm), area of the lesion (cm^2), and number of lesions and flecks.

RESULTS AND DISCUSSION

Leaf area damage, reflects the spread of the disease, while the fleck number, the hypersensitive reaction. The damaged leaf area due to disease was considered low when it is 0 to 8.42 cm^2 in 1996 and 0 to 12.65 cm^2 in 1997. The fleck

number was classified as low (12.20 to 145.20), medium (145.21 to 278.20), and high (278.21 to 411.20) in 1996 and low (39.30 to 353.13), medium (353.14 to 666.96) and high (666.97 to 980.80) in 1997. Accordingly the genotypes were grouped as given below into five disease severity groups on the basis of fleck number and leaf area damage.

S.No.	Combination	Disease Severity	Group
1.	Low fleck number and less leaf area damage	1	Resistant
2.	Medium fleck number and less leaf area damage	2	Moderately resistant
3.	High fleck number and less leaf area damage	3	Less susceptible
4.	Low fleck number and high leaf area damage	3	Less susceptible
5.	Medium fleck number and high leaf area damage	4	Susceptible
6.	High fleck number and high leaf area damage	5	Highly susceptible

The set of genotypes included in the study and classified into six groups on the above criterion are presented in two-way tables for postrainy seasons 1996 (Table 1) and 1997 (Table 2).

The data given in Table 1 shows that in the first year, 18 male-sterile lines, six restores lines and 65 hybrids fall in severity group 1 i.e., resistant group, while two male-sterile lines and 43 hybrids in moderately resistant group, four hybrids in less susceptible group, five hybrids in susceptible group and three hybrids in highly susceptible group.

During the second year, 17 male-sterile lines, three restorer lines and 87 hybrids fall in disease severity group 1 i.e., resistant group, while two male-sterile lines (SPLB 94007A and SPLB 94019A), one restorer line (A 2267-2) and 26 hybrids in moderately resistant group, and one male-sterile line (SPLB 94011A), two restorer lines and four hybrids in less susceptible group, two hybrids in susceptible group and one hybrid in highly susceptible group.

The parental lines and the hybrids falling in disease severity group 1 i.e., resistant group were considered desirable for future breeding works and are very useful as seed parents for controlling leaf blight disease (Tarumoto *et al.*, 1977). A perusal between of the results showed that in the first year, of the crosses 18 male-sterile lines (falling in resistant group) and six restorer lines (falling in resistant group), only 50 F_1s fall in disease severity group 1 i.e., resistant group, and were considered desirable for future breeding programmes. Next group of hybrids from the point of desirability in future breeding programme were the hybrids (38) falling

Table 1. Two-way table showing the response of genotypes based on total leaf area damage and fleck number, post rainy season 1996, ICRISAT, Patancheru, India.

		Fleck Number			
		Low (12.20-145.20)		Medium (145.21-278.20)	High (278.21-411.20)
Total leaf area damage	Low (0-8.42 cm^2)	**A-lines**		**A-lines**	**Hybrids**
		SPLB 94003A	SPLB 94001A x ICSR 97	SPLB 94001A	SPLB 94010A x A 2267-2
		SPLB 94004A	SPLB 94003A x ICSR 97	SPLB 94019A	SPLB 94010A x ICSR 97
		SPLB 94006A	SPLB 94004A x ICSR 97	**Hybrids**	SPLB 94010A x ICSR 119
		SPLB 94007A	SPLB 94006A x ICSR 97	SPLB 94014A x A 2267-2	SPLB 94011A x ICSR 119
		SPLB 94009A	SPLB 94007A x ICSR 97	SPLB 94019A x A 2267-2	
		SPLB 94010A	SPLB 94009A x ICSR 97	SPLB 94021A x A 2267-2	
		SPLB 94011A	SPLB 94011A x ICSR 97	SPLB 94024A x A 2267-2	
		SPLB 94012A	SPLB 94012A x ICSR 97	SPLB 94025A x A 2267-2	
		SPLB 94013A	SPLB 94013A x ICSR 97	296A x A2267-2	
		SPLB 94014A	SPLB 94014A x ICSR 97	SPLB 94016A x ICSR 97	
		SPLB 94015A	SPLB 94015A x ICSR 97	SPLB 94021A x ICSR 97	
		SPLB 94016A	SPLB 94017A x ICSR 97	SPLB 94025A x ICSR 97	
		SPLB 94017A	SPLB 94019A x ICSR 97	SPLB 94003A x ICSR 26	
		SPLB 94021A	SPLB 94022A x ICSR 97	SPLB 94006A x ICSR 26	
		SPLB 94022A	SPLB 94024A x ICSR 97	SPLB 94009A x ICSR 26	
		SPLB 94024A	296A x ICSR 97	SPLB 94010A x ICSR 26	
		SPLB 94025A	SPLB 94003A x ICSR 90030	SPLB 94013A x ICSR 26	
		296A	SPLB 94004A x ICSR 90030	SPLB 94014A x ICSR 26	
		R-lines	SPLB 94006A x ICSR 90030	SPLB 94016A x ICSR 26	
		A 2267-2	SPLB 94007A x ICSR 90030	SPLB 94019A x ICSR 26	
		ICSR 26	SPLB 94009A x ICSR 90030	SPLB 94022A x ICSR 26	
		ICSR 97	SPLB 94013A x ICSR 90030	SPLB 94024A x ICSR 26	

		Fleck Number			
		Low (12.20-145.20)		Medium (145.21-278.20)	High (278.21-411.20)
Total leaf area damage	Low (0-8.42 cm^2)	ICSR 119	SPLB 94015A x ICSR 90030	SPLB 94001A x ICSR 119	
		ICSR 91025	SPLB 94017A x ICSR 90030	SPLB 94003A x ICSR 119	
		ICSR 90030	SPLB 94021A x ICSR 90030	SPLB 94009A x ICSR 119	
		Hybrids	SPLB 94001A x ICSR 26	SPLB 94014A x ICSR 119	
		SPLB 94001A x A 2267-2	SPLB 94004A x ICSR 26	SPLB 94017A x ICSR 119	
		SPLB 94004A x A 2267-2	SPLB 94007A x ICSR 26	SPLB 94019A x ICSR 119	
		SPLB 94006A x A 2267-2	SPLB 94011A x ICSR 26	SPLB 94021A x ICSR 119	
		SPLB 94007A x A 2267-2	SPLB 94012A x ICSR 26	SPLB 94024A x ICSR 119	
		SPLB 94009A x A 2267-2	SPLB 94015A x ICSR 26	SPLB 94025A x ICSR 119	
		SPLB 94011A x A 2267-2	SPLB 94017A x ICSR 26	296A x ICSR 119	
		SPLB 94012A x A 2267-2	SPLB 94021A x ICSR 26	SPLB 94003A x ICSR 91025	
		SPLB 94013A x A 2267-2	296A x ICSR 26	SPLB 94011A x ICSR 91025	
		SPLB 94015A x A 2267-2	SPLB 94001A x ICSR 91025	SPLB 94016A x ICSR 91025	
		SPLB 94016A x A 2267-2	SPLB 94006A x ICSR 91025	SPLB 94022A x ICSR 91025	
		SPLB 94017A x A 2267-2	SPLB 94007A x ICSR 91025	SPLB 94024A x ICSR 91025	
		SPLB 94022A x A 2267-2	SPLB 94009A x ICSR 91025	SPLB 94025A x ICSR 91025	
		SPLB 94004A x ICSR 119	SPLB 94010A x ICSR 91025	296A x ICSR 91025	
		SPLB 94006A x ICSR 119	SPLB 94012A x ICSR 91025	SPLB 94011A x ICSR 90030	
		SPLB 94007A x ICSR 119	SPLB 94013A x ICSR 91025	SPLB 94012A x ICSR 90030	
		SPLB 94012A x ICSR 119	SPLB 94014A x ICSR 91025	SPLB 94014A x ICSR 90030	
		SPLB 94015A x ICSR 119	SPLB 94015A x ICSR 91025	SPLB 94016A x ICSR 90030	
		SPLB 94022A x ICSR 119	SPLB 94017A x ICSR 91025	SPLB 94019A x ICSR 90030	
		SPLB 94013A x ICSR 119	SPLB 94019A x ICSR 91025	SPLB 94024A x ICSR 90030	
			SPLB 94021A x ICSR 91025	296A x ICSR 90030	

Table 1 contd..

		Low (12.20-145.20)	Medium (145.21-278.20)	High (278.21-411.20)
	High ($8.42-16.6405\ cm^2$)		**Hybrids**	**Hybrids**
			SPLB 94016A x ICSR 119	SPLB 94003A x A 2267-2
			SPLB 94025A x ICSR 26	SPLB 94025A x ICSR 90030
			SPLB 94010A x ICSR 90030	SPLB 94001A x ICSR 90030
			SPLB 94022A x ICSR 90030	
			SPLB 94004A x ICSR 91025	

Table 2. Two-way table showing the response of genotypes based on total leaf area damage and fleck number, postrainy season 1997, ICRISAT, Patancheru.

		Fleck Number			
		Low (39.30-353.13)		Medium (353.14-666.96)	High (666.97-980.80)
Total Leaf area damage	Low (0-12.648 cm^2)	**A-lines**		**A-lines**	**A-lines**
		SPLB 94001A	SPLB 94004A x ICSR 97	SPLB 94007A	SPLB 94011A
		SPLB 94003A	SPLB 94015A x ICSR 97	SPLB 94019A	**R-lines**
		SPLB 94004A	SPLB 94007A x ICSR 97	**R-lines**	ICSR 97
		SPLB 94006A	SPLB 94006A x ICSR 97	A 2267-2	**Hybrids**
		SPLB 94009A	SPLB 94009A x ICSR 97	**Hybrids**	SPLB 94007A x A 2267-2
		SPLB 94010A	SPLB 94013A x ICSR 97	SPLB 94004A x A 2267-2	SPLB 94011A x ICSR 26
		SPLB 94012A	SPLB 94014A x ICSR 97	SPLB 94010A x A 2267-2	SPLB 94019A x ICSR 97
		SPLB 94013A	SPLB 94016A x ICSR 97	SPLB 94015A x A 2267-2	
		SPLB 94014A	SPLB 94017A x ICSR 97	SPLB 94001A x A 2267-2	
		SPLB 94015A	SPLB 94021A x ICSR 97	SPLB 94003A x A 2267-2	
		SPLB 94016A	SPLB 94022A x ICSR 97	SPLB 94012A x A 2267-2	
		SPLB 94017A	SPLB 94025A x ICSR 97	SPLB 94014A x A 2267-2	
		SPLB 94021A	296A x ICSR 97	SPLB 94019A x A 2267-2	
		SPLB 94022A	SPLB 94001A x ICSR 90030	SPLB 94022A x A 2267-2	
		SPLB 94024A	SPLB 94003A x ICSR 90030	SPLB 94024A x A 2267-2	
		SPLB 94025A	SPLB 94004A x ICSR 90030	SPLB 94011A x A 2267-2	
		296A	SPLB 94006A x ICSR 90030	SPLB 94019A x ICSR 26	
		R-lines	SPLB 94007A x ICSR 90030	SPLB 94003A x ICSR 26	
		ICSR 119	SPLB 94009A x ICSR 90030	SPLB 94011A x ICSR 97	
		ICSR 26	SPLB 94013A x ICSR 26		
		ICSR 90030	SPLB 94010A x ICSR 90030	SPLB 94010A x ICSR 97	
			SPLB 94011A x ICSR 90030	SPLB 94001A x ICSR 97	
		Hybrids	SPLB 94012A x ICSR 90030	SPLB 94003A x ICSR 97	
		SPLB 94009A x A 2267-2	SPLB 94013A x ICSR 90030	SPLB 94012A x ICSR 97	

		Fleck Number			
		Low (39.30-353.13)		Medium (353.14-666.96)	HIGH (666.97-98080)
		SPLB 94006A x A 2267-2	SPLB 94014A x ICSR 90030	SPLB 94024A x ICSR 97	
		SPLB 94013A x A 2267-2	SPLB 94015A x ICSR 90030	SPLB 94011A x ICSR 119	
		SPLB 94016A x A 2267-2	SPLB 94016A x ICSR 90030	SPLB 94010A x ICSR 119	
		SPLB 94017A x A 2267-2	SPLB 94017A x ICSR 90030	SPLB 94007A x ICSR 119	
		SPLB 94021A x A 2267-2	SPLB 94019A x ICSR 90030	SPLB 94013A x ICSR 119	
		SPLB 94025A x A 2267-2	SPLB 94021A x ICSR 90030	SPLB 94011A x ICSR 91025	
		296A x A 2267-2	SPLB 94022A x ICSR 90030	SPLB 94019A x ICSR 91025	
		SPLB 94003A x ICSR 119	SPLB 94024A x ICSR 90030	SPLB 94009A x ICSR 26	
		SPLB 94015A x ICSR 119	SPLB 94025A x ICSR 90030		
		SPLB 94001A x ICSR 119	296A x ICSR 90030		
		SPLB 94006A x ICSR 119			
		SPLB 94012A x ICSR 119	SPLB 94009A x ICSR 91025		
		SPLB 94014A x ICSR 119	SPLB 94017A x ICSR 91025		
		SPLB 94016A x ICSR 119	SPLB 94021A x ICSR 91025		
		SPLB 94021A x ICSR 119	SPLB 94022A x ICSR 91025		
		SPLB 94024A x ICSR 119	SPLB 94024A x ICSR 91025		
		SPLB 94025A x ICSR119	SPLB 94025A x ICSR 91025		
	Low	296A x ICSR 119	296A x ICSR 91025		
	(0-12.648 cm^2)	SPLB 94009A x ICSR 119	SPLB 94001A x ICSR 26		
		SPLB 94017A x ICSR 119	SPLB 94004A x ICSR 26		
		SPLB 94004A x ICSR 91025	SPLB 94006A x ICSR 26		
Total		SPLB 94010A x ICSR 91025	SPLB 94007A x ICSR 26		
leaf		SPLB 94015A x ICSR 91025	SPLB 94010A x ICSR 26		
area		SPLB 94001A x ICSR 91025	SPLB 94015A x ICSR 26		
damage		SPLB 94007A x ICSR 91025	SPLB 94012A x ICSR 26		

		Fleck Number			
		Low (39.30-353.13)		**Medium (353.14-666.96)**	**HIGH (666.97-98080)**
		SPLB 94006A x ICSR 91025	SPLB 94013A x ICSR 26		
		SPLB 94012A x ICSR 91025 SPLB 94013A x ICSR 91025 SPLB 94014A x ICSR 91025 SPLB 94016A x ICSR 91025	SPLB 94014A x ICSR 26 SPLB 94016A x ICSR 26 SPLB 94017A x ICSR 26 SPLB 94021A x ICSR 26 SPLB 94022A x ICSR 26 SPLB 94024A x ICSR 26 SPLB 94025A x ICSR 26 296A x ICSR 26		
	High (12.649-25.296 cm^2)	**R-line** ICSR 91025 **Hybrids** SPLB 94003A x ICSR 91025		**Hybrids** SPLB 94004A x ICSR 119 SPLB 94022A x ICSR 119	**Hybrids** SPLB 94019A x ICSR 119

in moderately resistant group. However, the crosses falling in disease severity group three, four and five may not be useful in future breeding works.

In the second year (Table 2), all the cross combinations (except six cross combinations) involving resistant parental lines falling in disease severity group 1 i.e., resistant group were desirable with less leaf area damage and less number of flecks. However, SPLB 94010A x ICSR 119, and SPLB 94003A and SPLB 94009A x ICSR 26 fall in moderately resistant group as they exhibited medium fleck number with less leaf area damage. On the other hand, SPLB 94004A and SPLB 94022A with ICSR 119 were undesirable as they fall in disease severity group 4 i.e, susceptible group and SPLB 94019A x ICSR 119 falls in highly susceptible group. Thus the genotypes i.e. male-sterile lines, restorer lines and their cross combinations falling in resistant group could be used in future breeding programmes.

Irrespective of the differential reaction to the disease, a perusal of the data over two consecutive years revealed that the hybrids of SPLB 94012A, SPLB 94015A and SPLB 94006A crossed with ICSR 119; SPLB 94004A, SPLB 94012, SPLB 94015A, SPLB 94017A, SPLB 94021A and 296A crossed with ICSR 26; and SPLB 94004A, SPLB 94006A, SPLB 94003A, SPLB 94015A, SPLB 94013A, SPLB 94021A and SPLB 94017A crossed with ICSR 90030 were resistant, while SPLB 94003A x ICSR 26 was moderately resistant and all were found to be stable in disease expression over two years.

Thus a large number of parental lines and hybrids showed considerable promise when analyzed for disease severity and hypersensitive reactions. This could be atrributed to ICRISAT's specific leaf blight resistant male-steriles breeding programme which provided base material for this work. Finding of a large number of favourable male-sterile lines and the hybrids resistant to leaf blight showed that the ICRISAT male-sterile breeding programme has been quite successful.

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