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Registration of Sorghum Varieties ICSV 735, ICSV 758, and ICSV 808 Resistant to Sorghum Midge, *Stenodiplosis sorghicola*

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Sorghum [*Sorghum bicolor* (L.) Moench] is one of the most important cereals in the semi arid tropics (SAT). It provides food, feed and forage, but grain yields on peasant farms are generally low, partly due to insect pest damage. Nearly 150 species of insects have been recorded as pests of sorghum, of which sorghum midge [*Stenodiplosis sorghicola* (Coquillett)] is the most important worldwide (Harris 1976). As a result of feeding by the sorghum midge larvae on the developing ovary, the damaged spikelets become chaffy. Midge damage is sometimes confused with poor seed setting due to unfavorable weather, genetic sterility, and damage by head bugs and other insects (Sharma 2001). The midge-damaged panicles have pupal cases attached to the tip of the damaged spikelets, and often have a pinhole in the glumes, through which midge parasites have emerged. Sorghum midge is widely distributed in Asia, Australia, Americas, Mediterranean Europe, and Africa (CIE 1990). It has spread as diapausing larvae in chaffy spikelets in sorghum seed to most of the countries where sorghum is grown. Annual losses due to sorghum midge have been estimated to be $ 292 million in the SAT (ICRISAT 1992).

Early planting, cultural practices, natural enemies, resistant varieties, and insecticides have been recommended for pest management in sorghum. However, it is difficult to plant at times when insect damage can be avoided. Insecticides are costly, and beyond the reach of resource-poor farmers in the SAT. Therefore, it is important to develop cultivars with resistance to sorghum midge which maintains high grain yield. Nearly 15,000 sorghum germplasm accessions have been screened for resistance to sorghum midge at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, India, and 25 lines have been identified as resistant to sorghum midge across seasons and locations in India. The germplasm accessions IS 2579C, TAM 2566, AF 28, DJ 6514, IS 3461, IS 8918, IS 8891, IS 7005, IS 10712, IS 22881, and IS 27103 are stable and diverse sources of resist-ance to sorghum midge (Sharma et al. 1993, Henzell et al. 1997). Efforts to develop sorghum cultivars with resistance to sorghum midge were initiated in the USA under the sorghum conversion program (Johnson et al. 1973), at ICRISAT (Sharma et al. 1993), and in Australia (Henzell et al. 1997), and several lines with high levels of resistance to sorghum midge have been developed. The midge-resistant varieties ICSV 735, ICSV 758, and ICSV 804 developed at ICRISAT have been found to perform well across locations in Myanmar, and have been released.

The sorghum midge-resistant varieties ICSV 735, ICSV 758, and ICSV 804 have been released as Yezin 6, Yezin 7, and Yezin 5, respectively in Myanmar. These varieties combine resistance to sorghum midge with yield potential close to the commercial cultivars Yezin 1 and Yezin 3. ICSV 735 (PM 14355-2-6) is derived from (ICSV 197 x ICSV 1)-9-1-1-2-6, ICSV 758 (PM 14403-1-1)

Table 1. Grain and fodder yield of midge-resistant sorghum genotypes fertilized with farmyard manure across three locations (Yezin Elite Sorghum Variety Trial 1993-94, Myanmar).

	Grain yield (t ha^{-1})				Fodder yield (t ha^{-1})			
Variety	Myingyan	Mahlaing	Zaloke	Mean	Myingyan	Mahlaing	Zaloke	Mean
ICSV 735	1.417	2.421	0.628	1.489	8.7	8.4	0.4	5.8
ICSV 758	1.309	3.533	1.004	1.947	3.4	6.9	0.3	3.6
ICSV 804	1.130	3.371	0.663	1.721	4.5	8.3	0.4	4.4
Control								
Local variety	0.502	1.094	2.659	0.622	6.2	12.3	1.5	6.7
SE	±0.1797	±0.3293	±0.1612	±0.1726	±0.60	±0.60	±0.10	±0.40

Table 2. Morphological characteristics of sorghum midge-resistant genotypes ICSV 735, ICSV 758, and ICSV 804.

Plant character	ICSV 735	ICSV 758	ICSV 804
Plant color	Tan	Tan	Tan
Leaf mid-rib color	White	White	White
Inflorescence compactness	Compact and elliptical	Semi-compact and broad at the tip	Semi-compact and broad at the tip
Glume color	Straw	Straw	Straw
Glume covering	1/3rd	1/3rd	1/3rd
Awns	Awnless	Awnless	Awnless
Grain color	Pearly white	Pearly white	Pearly white
Grain shape	Globular	Flat	Round
Endosperm	White and corneous	White and corneous	White and corneous
Threshability	Easy	Easy	Easy
Boot leaf	Small and erect	Long and erect	Small and erect
Leaves	Broad and erect	Broad and semi-drooping	Narrow and erect
Leaf sheath	Covering half of the next node	Covering the internode	Covering the internode
1000 grain mass (g)	19.17	28.04	25.30

from (ICSV 197 x A 13108)-1-2-1-1-1, and ICSV 804 (PM 14350) from (ICSV 197 x ICSV 1)-3-1-1-1-1. These varieties have been developed through pedigree breeding, and the segregating material has been selected for resistance to sorghum midge under field and no-choice headcage screening (Sharma et al. 1992). The grain yield of ICSV 735, ICSV 758, and ICSV 804 was 1.489, 1.949, and 1.721 t ha^{-1}, respectively compared to 0.622 t ha^{-1} for the local check in 1993/94 rainy season (Table 1). Under fertilizer application, grain yields of ICSV 735, ICSV 758, and ICSV 804 was 2.878, 3.389, and 3.416 t ha^{-1} compared to 1.910 t ha^{-1} for the local check. At ICRISAT Center, these varieties yielded 4.65 to 7.65 t per ha during the 1997 rainy season. The plant height of ICSV 735, ICSV 758, and ICSV 804 is 196, 236, 271 cm, respectively (Table 2). Days to 50% flowering ranged from 79–84 days for ICSV 735, 79–82 days for ICSV 758, and 78–84 days for ICSV 804 (Table 3). These lines are relatively less susceptible to leaf diseases than ICSV 1.

These lines are comparable to the resistant checks, DJ 6514 and ICSV 197 in midge resistance (Table 4). These are also less susceptible to the aphids, but as susceptible to shoot fly, head bugs, and stem borer as the commercial cultivars, ICSV 1 or CSH 9. Grains of ICSV 735, ICSV 758, and ICSV 804 are creamy white, shining, and with corneous endosperm. Grain mass per 1000 grain is 19.2 g for ICSV 735, 28.0 for ICSV 758, and 25.3 g for ICSV 804. Grain and food quality of these lines is comparable to commercial cultivars (CSH 9 and ICSV 1). These lines can be grown in midge-endemic areas as dual-purpose varieties, and have been released in Myanmar for this purpose. They can also be used as a base material for sorghum midge and leaf disease resistance in sorghum improvement. These lines have been used in the breeding program in Myanmar. ICSV 735 has also been distributed widely to farmers in Andhra Pradesh as a dual-purpose variety through the Indo-Swiss livestock project.

Significant progress has been made in developing sorghum cultivars with resistance to sorghum midge. There is a need to transfer midge resistance into cultivars with adaptation to different agro-ecosystems. Sorghum midge-resistant varieties exercise a constant and cumulative effect on insect populations over time and space. Sorghum midge-resistance will form the backbone of pest management in sorghum for sustainable crop production and environment conservation.

These varieties have been released as ICSV 735, ICSV 758, and ICSV 804 by the Plant Material Release Committee of ICRISAT, and their seed is available in the Genebank at ICRISAT.

Acknowledgments. We thank the staff of breeding and entomology for their help in developing these lines.

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Table 3. Sorghum midge and stem borer damage, grain yield, and days to 50% flowering in six sorghum genotypes across locations in India (1995-97).

	Midge damage (%)			Peduncle damage by stem borer (%)	Grain yield per plant (g)	Days to 50% flowering		
Genotype	Rahuri 1997	Dharwad 1995	Mean	Akola 1995	Dharwad 1995	Parbhani 1996	Parbhani 1997	Mean
ICSV 735	13.0	20.4	17.0	69.8	37.3	79.0	84.0	84.0
ICSV 758	13.7	36.3	25.0	55.4	22.7	79.0	82.0	82.0
ICSV 804	13.8	17.5	15.6	53.1	18.3	78.0	84.0	84.0
Controls								
DJ 6514(R)	4.1	10.3	7.2	61.3	35.7	74.0	83.0	83.0
CSH 9 (S)	–	–	–	58.1	61.3	–	–	–
ICSV 112 (S)	26.6	53.0	39.8	–	61.7	78.0	80.0	80.0
LSD at 5%	4.1	5.5		16.8	7.4	3.0	4.0	–

R = Resistant. S = Susceptible.

Table 4. Sorghum midge damage and agronomic expression of six sorghum lines (ICRISAT Center, 1995 rainy season).

	Midge damage rating[1]			Agronomic score[2]		
Genotype	S 1	S 2	Mean	S 1	S 2	Mean
ICSV 758	2.5	4.0	3.3	2.0	2.5	2.3
ICSV 804	3.0	3.5	3.3	2.5	2.5	2.5
ICSV 735	2.5	2.5	2.5	2.5	2.5	2.5
Controls						
DJ 6514 (R)	3.5	2.5	3.0	4.0	4.0	4.0
ICSV 197 (R)	3.5	2.5	3.0	2.5	1.5	2.0
Swarna (S)	8.5	9.0	8.8	1.0	1.5	1.3
SE±	0.7	0.7	0.5	0.4	0.3	0.3
CV%	28.7	34.1	22.3	23.2	23.3	17.0

1. Damage rating (1= <10% midge damage, and 9 = >80% midge damage).
2. Agronomic score (1 = Good, and 5 = Poor).

S 1 and S 2 = First and second sowing, respectively.
R = Resistant. S = Susceptible.

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Plant Defense Responses to Sorghum Spotted Stem Borer, *Chilo partellus* under Irrigated and Drought Conditions

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Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is one of the most important cereal crops in the semi-arid tropics (SAT), and insect pests are a major yield-reducing factor. Sorghum is attacked by nearly 150 insect species, causing an annual loss of over $1 billion in the SAT (ICRISAT 1992). A number of stem borer species have been reported as serious pests of sorghum, of which spotted stem borer, *Chilo partellus* Swinhoe (Lepidoptera: Pyralidae) is an important pest in India (Jotwani and Young 1972) and South and eastern Africa (Ingram 1958). Responses to stem borer infestation are influenced by environmental factors apart from genetic factors and their interactions. Moisture and nutrient availability influence plant growth, which in turn will influence the extent of losses due to stem borer damage. Therefore, we studied the reaction of a diverse array of sorghum genotypes to stem borer damage under irrigated and drought conditions.