

Inheritance of Resistance to Midge, *Contarinia sorghicola* Coq. in Sorghum, *Sorghum bicolor* (L.) Moench*

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Abstract—Inheritance of resistance to sorghum midge, *Contarinia sorghicola* Coq. was studied on a set of 21 diallel crosses involving four midge-resistant and three susceptible sorghum, *Sorghum bicolor* (L.) Moench cultivars under natural midge infestation at Dharwad during the late rainy season (August to November) 1983. Both additive and nonadditive genetic variances were important for midge resistance. The parents, DJ 6514 and TAM 2566, proved as better general combiners. Mean performance of the parents and their general combining ability (GCA) effects were strongly correlated. Crosses with positive specific combining ability (SCA) effects in both F_1 and F_2 generations had at least one parent with high GCA effects and better *per se* midge resistance. Midge-resistant parents, DJ 6514 and TAM 2566, with high *per se* resistance and GCA effects should be utilized in breeding for midge resistance.

Key Words: *Sorghum bicolor* (L.) Moench, combining ability, midge, *Contarinia sorghicola* Coq., resistance, infester row, gene action, genetics

Résumé—Cet article présente l'étude de l'hérédité de la résistance à la cécidomyie du sorgho, *Contarinia sorghicola* Coq. portant sur un ensemble de 21 croisements dialèles comprenant 4 cultivars de sorgho, *Sorghum bicolor* (L.) Moench résistants et 3 sensibles à la cécidomyie. L'étude a été effectuée dans les conditions de l'infestation naturelle par cet insecte à Dharwad, vers la fin de la saison des pluies (août à novembre), 1983. Les variances génétiques additives et les variances génétiques non additives sont toutes les deux importantes pour la résistance à la cécidomyie. Les parents DJ 6514 et TAM 2566 se sont avérés de très bons combineurs généraux. Une forte corrélation a été constatée entre la performance moyenne des parents et leurs effets d'aptitude générale à la combinaison (AGC). Les croisements avec des effets d'aptitude spécifique à la combinaison (ASC) positifs au niveau des générations F_1 et F_2 avaient au moins un parent ayant d'importants effets d'aptitude générale à la combinaison (AGC) et une meilleure résistance à la cécidomyie. Des parents résistants à la cécidomyie, réunissant une forte résistance et des effets AGC importants, doivent être exploités dans la sélection pour la résistance à la cécidomyie.

INTRODUCTION

Considerable genetic variability for plant resistance to sorghum midge, *Contarinia sorghicola* Coq. is observed among cultivated lines of sorghum, *Sorghum bicolor* L. (Bowden and Neve, 1953; Wiseman *et al.*, 1974; Raodeo and Karanjkar, 1975; Syamasunder *et al.*, 1975; Venugopal *et al.*, 1977; Wuensche *et al.*, 1978; Faris *et al.*, 1979; Sharma and Davies, 1981). However, success is limited in transferring genetic resistance into commercial cultivars, partially due to inadequate information on the genetic nature of this trait. Recently, Patil and Thombre (1982), and Henzel *et al.* (1986) reported that it is a quantitatively inherited trait governed by additive and nonadditive gene effects. Boozaya-Angoon *et al.* (1984) and Widstrom *et al.* (1984) reported that complex trait is governed by recessive genes.

The present studies determined the nature of sorghum midge resistance in a seven parent diallel set

of crosses (excluding reciprocals) both in F_1 and F_2 generations.

MATERIALS AND METHODS

The midge resistance evaluation was conducted on a set of experimental material, consisting of four midge-resistant (TAM 2566, S GIRL-MR 1, AF 28, and DJ 6514) and three midge-susceptible (SPV 422, SPV 351, and SC 108-3) cultivars, and their 21 F_1 's and 21 F_2 's. The parental cultivars were chosen randomly. All test entries were evaluated for midge resistance in a randomized complete block design with three replications at the University of Agricultural Sciences Farm, Dharwad, Karnataka, India during the 1983 rainy season (July to November) under a delayed planting condition (6 weeks later than normal plantings), to enable a satisfactory natural population built up of sorghum midge. The experiment was planted twice (10-day interval) (25 July and 4 August) to expose at least one of the plantings to midge under natural conditions. The midge population was built up by planting infester rows with a bulk of mixed maturity type of sus-

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Table 1. Analysis of variance for combining ability for midge resistance (per cent seed set) in sorghum

Source	df	Mean squares	
		F ₁	F ₂
General combining ability (GCA)	6	345.89**	296.77**
Specific combining ability (SCA)	21	70.56**	34.03**
Error	54	14.95	3.50
Components: σ^2_g		30.59	29.19
σ^2_s		55.61	30.53
Predictability ratio ($2\sigma^2_g/2\sigma^2_g + \sigma^2_s$)		0.524	0.657

**Significant at $P = 0.01$.Table 2. Mean performance and general combining ability (GCA) effects of the parents over F₁ and F₂ generations for midge resistance in sorghum

Parent	Mean % seedset	GCA effects	
		F ₁	F ₂
SPV 422	15.7	-8.9**	-8.9**
TAM 2566	74.1	4.7**	2.9**
S-GIRL-MR 1	61.6	2.3*	1.5**
SPV 351	26.6	-3.6**	-2.8**
AF 28	75.8	0.6	2.4**
SC 108-3	38.9	-4.5**	-4.1**
DJ 6514	83.5	9.4**	8.8**
<i>r</i>		0.927**	0.945**
SE (\hat{g}_i)		± 1.2	± 0.6
SE ($\hat{g}_i - \hat{g}_j$)		± 1.8	± 0.9

Significant at * $P = 0.05$ and ** $P = 0.01$.*r* = Rank correlation of mean performance and GCA effects.

ceptible cultivars in 4 rows after every 24 rows of test material one month before planting of the test material (Sharma, 1984). The parents and the F₁'s were planted in single-row plots; and the F₂'s in four row plots of 4 m length. The interrow spacings were 45 cm and the intrarow spacings were 15 cm.

Sorghum midge infestations were higher in the second planting (observed 10 to 12 midges per panicle during flowering) and hence the data on midge damage were recorded in this experimental set only. Midge damage was recorded on individual panicle in terms of percentage seed set by counting the seeds in a random bulk sample of 250 florets drawn from the most-affected portion of the individual panicle. The midge incidence was recorded on five panicles of each parent, and F₁; and 50 panicles of each F₂ in each replication. The data on percentage seed set was subjected to arc sine transformation and analysed using method 2, model 2 of Griffing (1956).

RESULTS

Significant differences were observed among parents, their F₁'s, and F₂'s for midge resistance (percentage seed set). The mean squares for general combining ability (GCA) and specific combining ability (SCA) were highly significant in F₁ and F₂ generations (Table 1). Estimated variance due to GCA was less than that of SCA in the F₁ generation and almost equal in F₂ generation. Estimated variance due to GCA exhibited no change from the F₁ to F₂ generation, while there was a substantial decrease in variance due to SCA from the F₁ to F₂ generation. The predictability ratio was moderate over generations.

Results on GCA effects indicated that all the resistant parents had good combining ability over generations (Table 2). There was good correspondence between mean performance of parents and their GCA effects, except for AF 28. Among resistant parents, DJ 6514 and TAM 2566 were better general combiners and maintained their combining ability of resistance.

Table 3. Mean performance and specific combining ability (SCA) effects of the crosses over F₁ and F₂ generations for midge resistance in sorghum

Cross	F ₁ generation		F ₂ generation	
	Mean seedset (%)	SCA	Mean seedset (%)	SCA
SPV 422 × TAM 2566	62.3	4.9*	52.5	3.8**
SPV 422 × S-GIRL-MR 1	59.7	5.5*	32.8	-6.2**
SPV 422 × SPV 351	44.8	2.7	43.7	4.5**
SPV 422 × AF 28	46.5	-0.8	46.7	1.0
SPV 422 × SC 108-3	36.1	-1.5	40.5	3.9**
SPV 422 × DJ 6514	78.4	10.5**	68.8	7.7**
TAM 2566 × S-GIRL-MR 1	75.5	1.4	66.6	1.8
TAM 2566 × SPV 351	73.5	6.1*	59.6	1.8
TAM 2566 × AF 28	60.7	-5.9*	56.6	-5.1**
TAM 2566 × SC 108-3	64.0	1.8	44.6	-5.5**
TAM 2566 × DJ 6514	77.5	-4.2	64.4	-6.9**
S-GIRL-MR 1 × SPV 351	77.5	11.1**	63.6	5.7**
S-GIRL-MR 1 × AF 28	41.2	-14.9**	55.7	-4.2**
S-GIRL-MR 1 × SC 108-3	63.8	3.4	56.2	2.7*
S-GIRL-MR 1 × DJ 6514	84.3	3.0*	73.3	0.03
SPV 351 × AF 28	66.0	5.5*	53.6	-1.1
SPV 351 × SC 108-3	35.2	-7.6**	58.8	8.5**
SPV 351 × DJ 6514	84.7	9.5**	73.2	4.4**
AF 28 × SC 108-3	74.2	11.6**	47.8	-3.1*
AF 28 × DJ 6514	61.1	-10.3**	71.4	-2.1
SC 108-3 × DJ 6514	70.0	0.6	58.6	-3.2*
SE (\hat{s}_{ij})		2.95		1.43
SE ($\hat{s}_{ij} - \hat{s}_{ik}$)		5.16		2.49
SE ($\hat{s}_{ij} - \hat{s}_{kl}$)		4.82		2.34

Significant at * $P = 0.05$ and ** $P = 0.01$.

The SCA effects showed that SPV 422 \times TAM 2566, S GIRL-MR 1 \times SPV 351, SPV 422 \times DJ 6514, and SPV 351 \times DJ 6514 crosses had better SCA effects over generations. Consequently, these crosses had at least one resistant parent with high GCA effects. Crosses involving DJ 6514, in general, showed better resistance than the crosses with other resistant lines.

DISCUSSION

There existed sufficient genetic variability for midge resistance in the experimental material studied. The highly significant mean squares observed for GCA and SCA effects over generations, suggested that this trait is under the control of both additive and nonadditive gene effects. Similar observations were made earlier by Patil and Thombre (1982) and recently by Henzel *et al.* (1986). The decrease noticed in SCA variance from F_1 to F_2 generations was as per the nonadditive genetic expectations. The moderate predictability ratio over generations revealed that the better combining midge resistant parents can be partially judged based on GCA effects.

Good correspondence between resistance of parents and their GCA effects clearly indicated that *per se* resistance is indicative of good combiner for midge resistance. Parents, DJ 6514 and TAM 2566, maintained their GCA for midge resistance over generations, probably due to the presence of more additive genes. The crosses which had more SCA effects over generations, had at least one parent with better midge resistance and high GCA effects, indicated that both *per se* resistance and the GCA effects are important to realize better heterosis. This is further supported by the fact that the parent DJ 6514 with better midge resistance and high GCA effects contributed good level of resistance in its crosses. Hence, it is concluded that source(s) with better performance and high GCA effects, such as DJ 6514 and TAM 2566, should be utilized as potential midge resistant combiners in breeding for midge resistance.

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