Evaluation of Chickpea Genotypes for Resistance to Beet Armyworm, *Spodoptera exigua*

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Abstract

Chickpea genotypes were evaluated for resistance to Spodoptera exigua *pest under field and laboratory conditions. In the detached leaf assay, the genotypes RIL 20 and ICC 12475 at the vegetative stage, and EC583264, ICC 12475 and RIL 25 at the flowering stage suffered lower leaf damage (DR 1.0 – 1.8) as compared to ICCL 86111 (DR 6.8). There were no significant differences in larval survival among the genotypes tested. However, only 22.4% larvae survived on ICC 12475 as compared to 60.0% on ICCL 86111 at the vegetative stage, and 23.3% larvae survived on KAK 2 as compared to 73.3% on ICC 10393 at the flowering stage. Larval weights were significantly lower on RIL 20, ICC 10393 and EC583264 (5.6 - 7.1 mg per larva) as compared to the larvae reared on the susceptible check, ICC 3137 (21.8 mg per larva) at the vegetative stage. There were no significant differences in larval weights at the flowering stage. Percentage pupation was significantly lower on KAK 2, RIL 20 and ICC 12475 (10.0 - 11.4%) as compared to that of ICC 10393 (35.0%) at vegetative stage, and on ICCV 10, EC583264, ICCL 86111, ICC 3137, ICC 12475 and KAK 2 (10.1 - 15.6%) at the flowering stage as compared to 34.3% pupation on ICC 10393. There were no significant differences in larval period and pupal weights of the insects reared on different chickpea genotypes. Under field conditions, there were no significant differences in* Helicoverpa armigera *and* S. exigua *eggs and larvae of* S. exigua *on different genotypes at the vegetative, flowering and maturity stages. However, significant differences were observed in* H. armigera *larvae on different genotypes at all the three stages. The lowest* H. armigera *larval density and leaf and pod damage were recorded on ICC 12475. Grain yield was significantly greater in ICCV 10 (1732.0 kg/ha), ICCL 86111 (1248.3 kg/ha), ICC 10393 (1132.1 kg/ha) and ICC 12475 (1127.8 kg/ha) than in the susceptible check, ICC 3137 (73.3 kg/ha). The genotypes suffering lower damage and with high grain yield potential can be used in chickpea improvement for resistance to* S. exigua.

Keywords: Chickpea, host plant resistance, pod borers, *Spodoptera exigua, Helicoverpa armigera*

Introduction

Chickpea (*Cicer arietinum* L.) is an important grain legume in Asia and parts of East and North Africa, Mediterranean Europe, Australia, Canada and USA (Kelly *et al*., 2000). Area under chickpea has been increasing in Andhra Pradesh since 2000, particularly in Kurnool, Prakasam, Mahabubnagar, Medak, Nizamabad and Guntur districts. The beet armyworm, *Spodoptera exigua* (Hubner) (Noctuidae: Lepidoptera) is emerging as a serious pest of chickpea, especially in southern India. The young larvae of *S. exigua* initially feed gregariously on chickpea foliage. As the larvae mature, they become solitary and continue to eat, producing large, irregular holes on the foliage (Ahmed *et al*., 1990 and Sharma *et al*., 2007). As a leaf feeder, the beet armyworm consumes much more chickpea tissues than the chickpea pod borer, *H. armigera*, but it has not been reported as a serious pest on pods. The beet armyworm is an important pest of numerous cultivated crops including cotton, tomato, celery, cabbage, onion and alfalfa in India (Singh and Bichoo, 1976) and in USA (Moulton *et al*., 2000). The pod borer, *H. armigera* is the single largest yield reducing factor in food legumes causing an estimated loss of US $328 million chickpea (ICRISAT, 1992).

The development of crop cultivars with resistance or tolerance to *H. armigera* and *S. exigua* is of prime importance for use in integrated pest management. More

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than 14,000 chickpea germplasm accessions have been screened for resistance towards *H. armigera* under field conditions (Lateef and Sachan, 1990). Several germplasm accessions with resistance to *H. armigera* have been identified, and varieties with moderate levels of resistance have been released for cultivation (Gowda *et al*., 1983; and Lateef, 1985). However, only moderate levels of resistance are available in the cultivated germplasm of chickpea, and thus, there is a need to identify wild relatives as sources of resistance to this pest to increase the levels of resistance in the cultivated chickpea. Interspecific derivatives derived from a cross between FLIP 84 – 92C (*C. arietinum*, susceptible) and PI 599072 (*C. reticulatum*, resistant) have been reported to be resistant to the beet armyworm, *S. exigua* (Clement *et al*., 2010). Development and use of chickpea cultivars with resistance to *S. exigua* and other lepidopteran pests will provide an environmentally safe option for pest management in chickpea and minimize adverse effect of insecticides in the environment. Therefore, the present studies were undertaken to evaluate a diverse array of chickpea genotypes for resistance to *S. exigua.*

Materials and methods

The experiments were conducted at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India, during the post-rainy season of 2010-11 under field conditions. The test genotypes were evaluated for resistance to *S. exigua* using detached leaf assay under laboratory conditions (Sharma *et al.,* 2005), and under natural infestation in the field.

Insects

The egg masses and larvae of *S. exigua* were collected from chickpea plants in the field from different places of Andhra Pradesh, India. They were reared on chickpea leaves for one generation before transferring them to the laboratory for rearing on chickpea flour based artificial diet used for rearing *H. armigera* (Chitti Babu *et al*., 2013). The laboratory culture was maintained under controlled conditions (27±2^{0}C; 65 to 75% RH). The *S. exigua* neonates were reared in groups of 300 - 400 in 250 ml plastic cups (having 2 to 3 mm layer of artificial diet on the bottom and sides) for 7 days or upto third instar. After seven days, the larvae were transferred individually to six cell - well plates (each cell 3.5 cm diameter, and 2 cm in depth) or small plastic cups (3.5 cm diameter and 2.5 cm in depth) to avoid cannibalism. Each cell - well had sufficient quantity of diet (7 ml) to support larval development until pupation. The pupae were removed from cell wells, sterilized with 2% sodium hypochlorite solution, and kept in groups of 50 in plastic jars containing moist Vermiculite. After adult emergence, 25 pairs were released inside an oviposition cage (30 x 30 x 30cm). Adults were provided with 10% sucrose solution in a cotton swab for feeding. Diaper liners, which have a rough surface, were hung inside the cage as an oviposition substrate. The adults laid eggs on the diaper liners. The liners were removed daily and the eggs were sterilized with 10% formalin solution to avoid virus contamination. The liners were washed with tap water, dried under a fan, and placed inside the plastic cups (250 ml). After egg hatching, the larvae were transferred to containers having artificial diet with a camel hair brush. The liners were removed after 3 days.

Evaluation of chickpea genotypes for resistance to *S. exigua* under field conditions

Nine chickpea genotypes were evaluated for resistance to *S. exigua* under natural infestation in the field. The test material was planted in January 2010 - 11. The seeds were planted on ridges 75 cm apart. The plot size was two rows, 2 m long, and planted at 60 x 10 cm, row to row and plant to plant spacing. The fertilizer (diammonium phosphate @100 kg ha^{-1}) was applied before sowing. There was no insecticide application in experimental plots. The field was irrigated immediately after planting, and at 30 day intervals thereafter. The experiment was laid out in a randomized complete block design (RCBD), and there were two replications for each genotype. Normal agronomic practices were followed for raising the crop. Data were recorded on leaf feeding damage (1 = <10%, and 9 = >80 leaf area consumed), and numbers of eggs and larvae per 5 plants at the vegetative, flowering and podding stages, pod damage and grain yield at maturity.

Evaluation of chickpea genotypes for resistance to *S. exigua* using detached leaf assay

The chickpea plants grown in the field were also bioassayed for resistance to *S. exigua* under controlled conditions in the laboratory [27 ± 2^{0}C temperature; 65 - 75% RH, and photoperiod of 12:12 h. (L: D)] using detached leaf assay (Sharma *et al*., 2005). The terminal branches of chickpea (three to four fully expanded leaves and the bud) were placed into plastic cups (4.5 x 11.5 cm diameter) in solidified agar-agar (3%). The solidified agar-agar served as a substratum for holding the chickpea branches. The terminal branches were cut with scissors and immediately placed in a slanting manner into the agar-agar medium. Care was taken so that the chickpea branches did not touch the inner walls of the cup. Ten neonates of *S. exigua* larvae were released on the chickpea leaves in each cup, and then covered with a lid to keep the chickpea terminals in a turgid condition.

The experiment was conducted in a completely randomized design, and there were three replications for each genotype.

The experiments were terminated when >80% of the leaf area was consumed in the susceptible genotype or when there were maximum differences between the resistant and susceptible genotypes (generally at 5 days after releasing the larvae on the leaves). The plants were scored for leaf feeding visually on a 1 - 9 scale (1 = <10%, and 9 = >80% leaf area consumed). Data were also recorded on larval survival, and weights of the larvae 4 h after terminating the experiment.

Statistical analysis

Data were subjected to analysis of variance by using GENSTAT 14.0. The significance of difference between the treatments was measured by F-test, whereas the treatment means were compared using the least significant difference (LSD) at P 0.05.

Results and discussion

Susceptibility of chickpea genotypes to *S. exigua* and *H. armigera* under field conditions

Vegetative stage. There were no significant differences in the number of eggs laid by *H. armigera* on different genotypes of chickpea at the vegetative stage (Table 1). However, significantly lower number (1.3 larvae per 5 plants) of *H. armigera* larvae were recorded on ICC 12475 as compared to those on EC 583264 (6.6 larvae per 5 plants) and ICC 3137 (7.3 larvae per 5 plants). The differences in the number of *S. exigua* eggs and larvae across the genotypes were not significant. Total number of pod borer larvae was lower on ICC 12475, ICC 10393, KAK 2, RIL 20 and ICCL 86111 than on EC583264 and ICC 3137. The pod borer damage was significantly lower (DR 1.0 - 1.6) on ICC 10393, ICC 12475, ICCV 10, RIL 25 and ICCL 86111 than on ICC 3137 (DR 6.6) and KAK 2 (DR 8.3). Thus it could be concluded that the total number of pod borers (*S. exigua* and *H. armigera*) and their damage was least in the genotypes ICC12475, ICC 10393 and ICCL 86111.

Flowering stage. There were no significant differences in *H. armigera* and *S. exigua* eggs and larvae of *S. exigua* between the test genotypes. Total number of pod borer larvae were lower on KAK 2 (7.3 larvae per 5 plants) as compared to that on RIL 20 and ICC 10393 (14.6 larvae per 5 plants) (Table 2).

Podding stage. Significantly lower numbers of *H. armigera* larvae were recorded on ICC 12475 and ICC 10393 (5.3 and 9.3 larvae per 5 plants, respectively) than on ICC 3137 (24.0 larvae per 5 plants) (Table 2). However, the number of *S. exigua* larvae did not differ significantly between the genotpyes tested. Total number of pod borer larvae were also significantly lower on ICC 12475 and ICC 10393 than on ICC 3137. The pod borer damage was significantly lower (DR 3.0 - 3.6) on ICC 12475, ICCL 86111, ICC 10393 and ICCV 10 than on ICC 3137 (DR 8.6).

Percentage pod damage was significantly lower (3.3- 13.2%) on ICC 12475, ICC 10393, ICCL 86111, ICCV 10 and RIL 25 than on ICC 3137 and KAK 2 (56.7%). Grain yield was significantly greater in case of ICC 12475, ICC 10393, ICCL 86111 and ICCV 10 (1127.8 - 1732.0 kg/ha) as compared to the other test genotypes (73.3 - 951.9 kg/ha). It is clearly evident that the genotypes ICC 12475 and ICC 10393 had lower total no. of pod borers, pod damage and per cent pod damage and thereby highest grain yields.

Considering all the three stages *viz.*, vegetative, flowering and podding stages, there was no single genotypes effective against the pod borers but during both vegetative and podding stages, the genotypes ICC 12475 and ICC 10393 were superior. Earlier Narayanamma *et al.,* (2007) recorded minimum oviposition, lower leaf damage and low grain yield in ICC 506EB, ICC 12476, ICC 12477, ICC 12478 and ICC 12479. According to Sharma *et al*., (2002; 2005) the chickpea accessions belonging to *Cicer bijugum*, *C. judaicum*, *C. cuneatum* and *C. microphyllum* have been identified with high levels of resistance to *H. armigera*. Bhagwat *et al*. (1995) reported minimum larvae of *H. armigera* and pod damage on ICC 506 EB. Chickpea germplasm accessions with resistance to *H. armigera* have been identified by several workers (Lateef 1985; Chhabra *et al.,* 1990; Singh and Yadav, 1999). The genotype ICC 16374 exhibited good resistance/tolerance against *H. armigera* (Patil *et al.,* 2007). The genotypic responses have been found to be quite variable across seasons and locations (Sharma *et al*., 2003). Patil *et al*., (2007) recorded highest grain yield in the genotype ICC 37.

The genotypes ICC 12475, ICC 10393, RIL 20 and EC 583264 showed resistance to pod borers, while ICCV 10 recorded highest grain yield under unsprayed conditions, and these genotypes can be used for improving chickpea to pod borer resistance for sustainable crop production. The genotypes ICC 12475, ICC 10393, ICCL 86111, ICCV 10 and RIL 25 suffering lower leaf/pod damage, and/or harboring lower pod borer population in the field, and having high grain yield under unprotected conditions in the field can be used for chickpea improvement in future.

Evaluation of chickpea genotypes for resistance to *S. exigua* using detached leaf assay

Vegetative stage. There were significant differences in between the genotypes for leaf damage by the beet

Table 1. Relative susceptibility of chickpea genotypes to pod borers, *S. exigua* and *H. armigera* at the vegetative and flowering stages under field conditions: (ICRISAT, 2011 post-rainy season)

	Vegetative stage						Flowering stage			
Genotype	*H. armigera* eggs	*H. armigera* larvae	*S. exigua* eggs	*S. exigua* larvae	Total pod borer larvae	Pod borer DR[1]	*H. armigera* eggs	*H. armigera* larvae	*S. exigua* larvae	Total pod borer larvae
EC 583264	1.0 (1.3±0.3)	6.6 (2.7±0.1)[b]	0.6 (1.2±0.2)	0.6 (1.2±0.2)	7.3 (2.8±0.2)[d]	4.3±0.6[b]	0.0 (1.0±0.0)	12.3 (3.6±0.0)	1.0 (1.3±0.3)	13. 3 (3.7±0.1)
ICC 3137	0.0 (1.0±0.0)	7.0 (2.7±0.2)[b]	0.0 (1.0±0.0)	0.3 (1.1±0.1)	7.3 (2.8±0.3)[d]	6.6±1.2[c]	0.3 (1.1±0.1)	13.6 (3.8±0.3)	0.0 (1.0±0.0)	13.6 (3.8±0.3)
ICC 10393	0.0 (1.0±0.0)	2.6 (1.5±0.1)[ab]	0.0 (1.0±0.0)	0.0 (1.0±0.0)	2.6 (1.8±0.2)[a]	1.0±0.0[a]	0.0 (1.0±0.0)	14.6 (3.9±0.1)	0.0 (1.0±0.0)	14.6 (3.9±0.1)
ICC 12475	0.6 (1.2±0.0)	1.3 (1.8±0.2)[a]	0.0 (1.0±0.0)	0.6 (1.2±0.1)	2.0 (1.7±0.1)[a]	1.0±0.0[a]	0.0 (1.0±0.0)	8.6 (2.9±0.6)	0.0 (1.0±0.0)	8.6 (2.9±0.6)
ICCL 86111	0.0 (1.0±0.0)	3.6 (2.1±0.2)[ab]	0.0 (1.0±0.0)	0.6 (1.2±0.2)	4.3 (2.2±0.2)[a]	1.6±0.6[a]	0.0 (1.0±0.0)	11.0 (3.3±0.7)	0.0 (1.0±0.0)	11.0 (3.3±0.7)
ICCV 10	0.0 (1.0±0.0)	3.3 (2.0±0.0)[ab]	0.0 (1.0±0.0)	1.6 (1.4±0.4)	5.0 (2.4±0.3)[b]	1.3±0.3[a]	0.0 (1.0±0.0)	10.0 (3.2±0.3)	0.0 (1.0±0.0)	10.0 (3.2±0.3)
KAK 2	0.3 (1.1±0.1)	3.3 [b] (1.9±0.5)[a]	0.0 (1.0±0.0)	0.3 (1.1±0.1)	3.6 (2.0±0.5)[a]	8.3±0.6[c]	0.0 (1.0±0.0)	7.3 (2.6±0.8)	0.0 (1.0±0.0)	7.3 (2.6±0.8)
RIL 20	0.0 (1.0±0.0)	2.6 (1.8±0.3)[ab]	0.0 (1.0±0.0)	1.0 (1.3±0.2)	3.6 (2.1±0.2)[a]	2.3±1.3[ab]	0.0 (1.0±0.0)	14.6 (3.9±0.4)	0.0 (1.0±0.0)	14.6 (3.9±0.4)
RIL 25	0.0 (1.0±0.0)	4.6 (2.2±0.5)[ab]	0.0 (1.0±0.0)	2.0 (1.6±0.4)	6.6 (2.7±0.1)[c]	1.3±0.3[a]	0.0 (1.0±0.0)	11.0 (3.3±0.5)	0.0 (1.0±0.0)	11.0 (3.3±0.5)
Fp	0.6	0.02	0.5	0.6	0.001	<0.001	0.5	0.6	0.5	0.01
Vr (8,16)	0.8	3.1	1.0	0.9	5.9	16.0	1.0	0.7	1.0	3.1
LSD (P 0.05)	N.S.	0.9	N.S.	N.S.	0.7	2.1	N.S.	1.5	N.S.	1.5
SE±	0.1	0.3	0.1	0.2	0.2	0.7	0.0	0.5	0.1	0.5
CV (%)	22.7	26.0	13.0	29.3	19.3	42.5	7.5	27.0	17.7	27.0

DR[1] = 1; <10 % leaf area damaged; 9 = > 80% leaf area damaged
Figures followed by the same letter within column are not significantly different at P<= 0.05
Figures in parentheses are square root transform values $\sqrt{x+1}$

armyworm, *S. exigua* (Table 3). The leaf damage rating was lower (DR 1.3 - 2.7) on RIL 20, ICC 12475, EC583264 and ICCV 10 as compared to ICCL 86111 (DR 6.8). The differences in larval survival between the genotypes were non-significant, but the larval weights were significantly lower (5.6 - 9.9 mg per larva) on RIL 20, ICC 10393, EC583264, KAK 2, ICC 12475 and ICCV 10 as compared to ICC 3137 (21.8 mg per larva). Larval period varied from 17.0 days on KAK 2 to 22.0 days on ICCV 10, but the differences between the genotypes were not significant. Pupation ranged between 10.0-35.0%, and significantly lower pupation was recorded (10.0-13.3%) on KAK 2, RIL 20, ICC 12475 and ICCL 86111 as compared to ICC 10393 (35.0%). The pupal weight varied from 49.9 - 82.6 mg per larvae, and the differences between the genotypes were not significant. Hence, it can be surmised that the genotypes RIL 20 and ICC 12475 showed lower damage rating, less larval weight and pupation exhibiting antibiosis to *S. exigua* larvae.

Flowering stage. At flowering stage, the leaf feeding damage was significantly lower (DR 1.0) in EC 583264, ICC 12475 and RIL 25 as compared to ICCV 10 (DR 2.6) (Table 3). Larval survival varied from 23.3-73.3%, and lower (23.3 - 31.3%) larval survival was recorded on KAK 2, EC 583264, RIL 25 and ICC 3137 than on ICC 10393

Table 2. Relative susceptibility of chickpea genotypes to pod borers, *S. exigua* and *H. armigera* at the maturity stage under field conditions: (ICRISAT, 2011 post-rainy season)

Genotype	Maturity stage					
	H. armigera larvae	*S. exigua* larvae	Total pod borer larvae	Pod borer DR[1]	Pod damage (%)	Grain yield (kg/ha)
EC583264	15.3 (4.0±0.1)^{c}	0.3 (1.1±0.1)	15.6 (4.0±0.1)^{cd}	6.3±0.3^{e}	24.7 (5.0±0.5)^{ab}	323.9±57.7^{a}
ICC 3137	24.0 (4.9±0.1)^{e}	1.0 (1.3±0.3)	25.0 (5.0±0.0)^{e}	8.6±0.3^{f}	56.7 (7.6±0.0)^{c}	73.3±4.5^{a}
ICC 10393	9.3 (3.2±0.1)^{ab}	0.0 (1.0±0.0)	9.3 (3.2±0.1)^{ab}	3.3±0.3^{abc}	11.5 (3.4±0.3)^{ab}	1132.1±100.8^{c}
ICC 12475	5.3 (2.5±0.0)^{a}	0.0 (1.0±0.0)	5.3 (2.5±0.0)^{a}	3.0±0.0^{a}	3.3 (2.0±0.0)^{a}	1127.8±173.3^{c}
ICCL 86111	12.0 (3.5±0.3)^{bc}	0.3 (1.1±0.1)	12.3 (3.6±0.3)^{bc}	3.0±0.0^{ab}	12.1 (3.6±0.2)^{ab}	1248.3±155.6^{c}
ICCV 10	21.3 (4.7±0.0)^{de}	0.0 (1.0±0.0)	21.3 (4.7±0.0)^{de}	4.6±1.2^{abcd}	12.1 (3.6±0.2)^{ab}	1732.0±133.3^{d}
KAK 2	17.6 (4.2±0.3)^{cd}	0.0 (1.0±0.0)	17.6 (4.2±0.3)^{cd}	6.8±2.0^{de}	56.7 (7.5±0.8)^{c}	122.8±52.5^{a}
RIL 20	16.3 (4.1±0.3)^{cd}	0.6 (1.2±0.2)	17.0 (4.2±0.3)^{cd}	6.6±0.3^{e}	30.8 (5.5±0.7)^{b}	512.8±133.9^{ab}
RIL 25	13.0 (3.7±0.3)^{bc}	0.3 (1.1±0.1)	13.3 (3.7±0.2)^{bc}	5.3±0.3^{de}	13.2 (3.5±0.8)^{ab}	951.9±263.9^{bc}
Fp	<0.001	0.8	<0.001	<0.001	<0.001	<0.001
Vr (8,16)	9.8	0.5	10.5	10.3	17.5	15.9
LSD (P 0.05)	0.7	N.S.	0.7	2.3	1.5	432.5
SE±	0.2	0.2	0.2	0.8	0.5	143.0
CV (%)	10.3	24.3	10.0	28.3	20.6	30.9

DR[1] = 1; <10 % leaf area damaged; 9 = > 80% leaf area damaged
Figures followed by the same letter within column are not significantly different at P 0.05
Figures in parentheses are square root transform values $\sqrt{x+1}$

(73.3%). The larval weights varied from 1.3-2.7 mg per larvae, but the differences between the genotypes were not significant. Larval period was prolonged (30.7 - 31.8 days) on the larvae reared on KAK 2, RIL 20, EC 583264, ICC 10393 and ICC 12475 as compared to the larvae fed on ICC 3137 and ICCV 10 (27.3 days). Percentage pupation was significantly lower on ICCV 10, EC 583264 and ICCL 86111 (10.1-14.3%) as compared to ICC 10393 (34.3%). There were no significant differences in pupal weights between the genotypes tested. It is evident that the genotype EC583264 showed lower leaf damage rating, larval survival, larval period and pupation exhibiting antibiosis effect.

It could be concluded that the genotype RIL 20 and ICC 12475 performed better while at flowering stage the genotype EC583264 was effective against *S. exigua* using detached leaf assay. Also, the performance of ICC 12475 in both field assay and laboratory assay was found to be consistent. Clement *et al*. (2010) identified nine chickpea lines as resistant and 25 lines as moderately resistant to beet armyworm, *S. exigua*.

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Table 3. Evaluation of nine chickpea genotypes for resistance to *S. exigua* using detached leaf assay at the vegetative and flowering stage of plants raised under field conditions: (ICRISAT, 2010-11 post-rainy season)

	Vegetative stage						Flowering stage					
Genotype	*Spodoptera* DR[1]	Larval survival (%)	Mean larval weight(mg)	Larval period (days)	Pupation (%)	Mean pupal weight(mg)	*Spodoptera* DR[1]	Larval survival (%)	Mean larval weight(mg)	Larval period (days)	Pupation (%)	Mean pupal weight(mg)
EC583264	2.0[a]	27.4	7.1[a]	20.1	15.7[ab]	69.4	1.0[a]	30.0	1.3	31.8[b]	14.3[a]	182.7
ICC 3137	3.3[a]	33.3	21.8[b]	17.2	18.7[ab]	49.9	1.3[ab]	31.3	1.9	27.3[a]	15.6[a]	131.4
ICC 10393	4.0[a]	46.7	5.8[a]	21.2	35.0[c]	64.1	2.1[bc]	73.3	2.3	31.8[b]	34.3[c]	145.4
ICC 12475	1.8[a]	22.4	9.0[a]	20.8	11.4[a]	82.5	1.0[a]	43.3	1.3	31.8[b]	15.6[a]	162.4
ICCL 86111	6.8[b]	60.0	11.1[a]	20.3	13.3[a]	65.5	1.6[abc]	69.9	2.1	28.8[a]	14.3[a]	133.5
ICCV 10	2.7[a]	23.3	9.9[a]	22.0	25.0[bc]	82.6	2.6[c]	36.7	2.5	27.3[a]	10.1[a]	134.2
KAK 2	3.5[a]	30.0	8.0[a]	17.0	10.0[a]	66.3	1.3[ab]	23.3	2.7	30.7[b]	15.6[a]	139.2
RIL 20	1.3[a]	23.3	5.6[a]	19.4	10.7[a]	57.3	2.0[abc]	53.3	1.7	31.3[b]	29.3[bc]	138.4
RIL 25	3.3[a]	50.0	10.1[a]	21.0	20.0[ab]	63.0	1.0[a]	30.0	2.0	28.3[a]	20.1[ab]	153.4
GM	3.2	35.2	9.9	19.9	17.8	66.7	1.6	43.5	2.0	29.9	18.8	146.7
Fp	0.01	0.3	0.02	0.5	0.01	0.5	0.01	0.1	0.7	<0.001	0.03	0.3
Vr (8,16)	3.7	1.4	3.6	1.0	7.1	1.0	3.7	2.2	0.7	18.2	4.6	1.4
SE±	0.8	11.7	2.5	1.7	3.0	10.3	0.3	12.4	0.6	0.5	3.7	14.1
LSD (P 0.05)	2.5	NS	7.7	NS	10.2	NS	0.9	NS	NS	1.5	12.4	NS
CV (%)	45.5	57.6	44.9	15.2	29.8	26.9	34.0	49.3	52.2	2.6	34.0	16.7

DR[1] = 1; <10 % leaf area damaged; 9 = > 80% leaf area damaged
Figures followed by the same letter within column are not significantly different at P 0.05

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