Effect on Grain Yield in Pigeonpea Genotypes with Different Levels of Resistance to the Pod Borer, *Helicoverpa armigera*

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Abstract

Pigeonpea genotypes(12) with different levels of resistance to Helicoverpa armigera *were evaluated for their ability to withstand pod borer damage or recover from damage based on loss in grain yield under field conditions. Under unprotected conditions, ICPL 332, ICPL 84060, and ICPL 98001 suffered low pod damage compared to the susceptible check, ICPL 87, and there were >40 pods per plant in ICP 7203-1, ICPL 98001, ICPL 98008, ICPL 84060, and ICPL 332 compared to <25 pods in case of ICPL 87. Loss in grain yield was <29% in ICPL 332, ICPL 84060, and ICPL 187-1 as compared to 87.2% in ICPL 87. Genotypes such as ICPL 332, ICPL 187-1, and ICPL 84060, which suffered low pod damage and/or low reduction in grain yield can be used for the management of* H. armigera, *or as sources of resistance in the pigeonpea improvement program.*

Keywords: Pigeonpea, resistance, pod borer, *Helicoverpa armigera,* grian yield

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.], is one of the major pulses grown in the Semi-arid Tropics (SAT) between 30°N and 30°S covering about 50 countries of Asia, Africa and Americas (Nene *et al.*, 1990). More than 200 species of insects feed on pigeonpea, of which *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) is the most important pest that causes an estimated loss of US$317 million annually in pigeonpea (ICRISAT, 1992), and possibly over US$2 billion on other crops worldwide (Sharma, 2001). It has developed considerable levels of resistance to conventional insecticides, including synthetic pyrethroids (Armes *et al.*, 1992; Shanower *et al.*, 1994).

Development of improved crop varieties with resistance or tolerance to *Helicoverpa* is valuable for subsistence farming in developing countries (Sharma *et al.*, 2005). Several pigeonpea genotypes with resistance to *H. armigera* have been identified (Patnaik *et al.*, 1989; Lateef and Pimbert, 1990; Borad *et al.*, 1991; Kalariya *et al.*, 1998). However, with the introduction of high yielding varieties that are grown with insecticide protection, there has been an erosion of genotypes with better ability to tolerate damage by *H. armigera*. Therefore, there is a need to identify genotypes with better capability to withstand *H. armigera* damage, and reduce over dependence on insecticides to minimize the extent of losses due to this pest.

Materials and methods

Tolerance component of resistance was studied in 12 pigeonpea genotypes by comparing the genotypic performance under insecticide protected and unprotected conditions at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Andhra Pradesh, India during the rainy seasons of 2001 and 2002. The studies were carried out on a diverse array of *H. armigera* – resistant and susceptible genotypes (ICP 7035, ICP 7203-1, and T 21 – sources of resistance to pod borer; ICPL 98001, ICPL 98008, and ICPL 88039 – early-maturity indeterminate type genotypes with less susceptibility to pod borers; ICPL 187-1, ICPL 332, and ICPL 84060 – medium-maturity improved pod-borer resistant genotypes; and ICPL 87, ICPL 87119, and ICPL 87091 – susceptible commercial checks). The seeds were sown on ridges 75 cm apart. Each genotype was planted in 4 row plots, 4 m long, and there were three replications under each protection regime. The plants were thinned to a spacing of 15 cm between the plants 15 days after seedling emergence. Normal agronomic practices were followed for raising the crop. The trial was laid out in a split plot design, with treatments (insecticide protected and unprotected) as the main plots, and the genotypes as the sub-plots. No insecticide was applied in the unprotected plots while the crop was sprayed five times using knapsack sprayer at 10 to 15 day intervals, with methomyl (2 sprays @ 500 g *ai* ha^{-1}), cypermethrin (2 sprays @ 40 g *ai* ha^{-1}) and monocrotophos (one spray @ 1000 g *ai* ha^{-1}) in the protected plots.

At the pod maturity stage, the plots were evaluated for *H. armigera* visual damage on a 1 to 9 damage rating scale (1 = <10% pods damaged, and pods uniformly spread all over the plant, and 9 = >80% pods damaged, and pods distributed un-uniformly in the plant canopy). The numbers of damaged and total pods were also counted in three plants harvested at random from each plot at maturity. The loss of grain yield due to *H. armigera* damage was assessed using the following formula.

Avoidable losses = [(Grain yield in sprayed plots – Grain yield in unsprayed plots)/Grain yield in sprayed plots] x 100

Statistical analysis

The data were subjected to analysis of variance using factorial analysis. The significance of differences between the genotypes were tested using F-test, while the treatment means were compared using the least significant difference at P 0.05.

Results and discussion

Pod borer damage

Under protected conditions, there were significant differences in pod borer damage (DR 1.0 to 2.3) among the genotypes tested, although the damage levels were quite low, indicating that spray schedules have different levels of efficacy for minimizing pod damage on pigeonpea genotypes with varying levels of resistance/susceptibility to *H. armigera* (Table 1). Under unprotected condition, there were significant differences in pod borer damage among the genotypes tested. Lowest pod damage rating was observed in ICPL 332 (DR 3.3), followed by ICPL 84060 (5.0), and ICPL 98001 (6.0) compared to the susceptible check, ICPL 87 (8.3). Pod damage under protected conditions was <10% in case of ICPL 187-1, ICP 7203-1, ICPL 87091, ICPL 84060, and ICPL 332 compared to 13.9% damage in ICPL 87 and 18.5% in ICP 7035. Under unprotected conditions,

Table 1. Damage caused by *H. armigera* in 12 pigeonpea genotypes under protected and unprotected conditions (ICRISAT, Patancheru, 2001-2002)*

	Damage rating** (DR)		Pods damaged (%)		Total pods per plant	
Genotype	Protected	Unprotected	Protected	Unprotected	Protected	Unprotected
ICPL 187-1	1.0	8.0	8.5	79.6	29	21
ICP7203-1	1.7	6.7	9.3	64.9	58	46
ICPL88039	1.3	8.0	10.5	78.0	28	33
ICPL 98001	2.0	6.0	12.4	57.9	20	48
ICPL 98008	1.3	8.7	11.6	82.5	14	48
ICPL87091	1.0	7.3	9.4	71.6	21	14
T 21	1.3	7.7	11.3	78.9	37	38
ICPL 84060	1.3	5.0	9.8	39.9	30	54
ICPL87119	2.3	7.3	14.8	67.0	35	48
ICP 7035	2.3	3.7	18.5	24.4	42	34
Controls						
ICPL 332 (R)	1.0	3.3	9.8	22.9	41	49
ICPL 87 (S)	2.3	8.3	13.9	83.2	25	17
	Fp	LSD at P 0.05	Fp	LSD at P 0.05	Fp	LSD at P 0.05
Treatments	<0.001	0.41	0.001	4.59	0.046	5.33
Genotypes	0.001	1.40	<0.001	8.69	<0.001	13.66
Genotypes x treatments	<0.001	1.91	<0.001	11.95	0.017	18.67

* Means across two seasons; R = Resistant check; S = Susceptible check; ** Damage rating (1 = <10% pods damaged, and pods uniformly spread all over the plant, and 9 = >80% pods damaged, and pods distributed un-uniformly in the plant canopy)

the pod damage was lowest in ICPL 332 (22.9%), followed by ICP 7035 (24.4%), ICPL 84060 (39.9%), and ICPL 98001 (57.9%) compared to 83.2% pod damage in ICPL 87. The levels of resistance to *H. armigera* in the germplasm accessions are low to moderate, and this has necessitated the need for selecting genotypes with greater ability to tolerate or recover from the pod borer damage (Lateef and Pimbert, 1990; Sharma *et al.*, 2005).

Pod setting and grain yield

There were >40 pods per plant in ICP 7203-1, ICP 7035, and ICPL 332 compared to <25 pods in ICPL 98001, ICPL 98008, ICPL 87091, and ICPL 87 under protected conditions (Table 2). There were >40 pods in ICP 7203-1, ICPL 98001, ICPL 98008, ICPL 84060, and ICPL 332 under unprotected conditions compared to <25 pods in case of ICPL 87, suggesting that these genotypes are either less susceptible to damage by *H. armigera*, and/or have a good recovery resistance following *H. armigera* damage.

Grain yield was significantly higher under protected conditions compared to that under unprotected conditions (Table 2). Highest grain yield was recorded in ICP 7203-1 (7408 kg ha^{-1}), followed by ICPL 332 (5551 kg ha^{-1}), ICPL 87119 (5257 kg ha^{-1}), and ICPL 187-1 (4495 kg ha^{-1}) compared to 3257 kg ha^{-1} in ICPL 87. Under unprotected conditions, highest grain yield was obtained in ICPL 332 (4361 kg ha^{-1}), followed by ICPL 187-1 (3188 kg), ICPL 84060 (3126 kg ha^{-1}), ICPL 87119 (2600 kg ha^{-1}), and ICPL 98008 (1008 kg ha^{-1}). Avoidable losses in grain yield were lowest in ICPL 332 (21.4%), followed by ICPL 84060 (23.6%), and ICPL 187-1 (29.0%) compared to 87.2% in ICPL 87.

Grain yield was quite high in case of ICPL 332, ICPL 187-1, ICPL 84060, ICPL 87119, and ICPL 98001 under protected and/or unprotected conditions. Loss in grain yield was <29% in ICPL 332, ICPL 84060, and ICPL 187-1. Genotypes such as ICPL 332, ICPL 187-1, ICPL 84060 and ICPL 98008, which suffered low pod damage and/or low reduction in grain yield under unprotected conditions, can be used as a component in the management of *H. armigera* or as sources of recovery resistance in the pigeonpea improvement program. Tolerant cultivars do not suppress the pest population, and thus do not exert a selection pressure on the pest populations and they have a great value in pest management as such plants prevent the evolution of new insect biotypes.

Table 2. Loss in grain yield due to *H. armigera* damage in pigeonpea genotypes under protected and unprotected conditions (ICRISAT, Patancheru, 2001-2002)*

Genotype	Grain yield (kg ha^{-1}) Protected	Unprotected	Avoidable losses (%)
ICPL 187-1	4495	3188	29.0
ICP 7203-1	7408	4301	41.9
ICPL 88039	1745	536	63.9
ICPL 98001	2168	378	82.6
ICPL 98008	1908	1008	47.2
ICPL 87091	394	418	+6.9
T 21	4958	1804	63.6
ICPL 84060	4089	3126	23.6
ICPL 87119	5257	2600	50.5
ICP 7035	2637	158	94.0
Controls			
ICPL 332 (R)	5551	4361	21.4
ICPL 87 (S)	3257	418	87.2
	Fp	LSD at P 0.05	
Treatments	0.012	946.7	-
Genotypes	<0.001	1122.8	-
Genotypes x treatments		<0.001	1582.9

* Means across two seasons; R = Resistant check; S = Susceptible check

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