Callosobruchus maculatus Resistance in Some Wild Relatives and Interspecific Derivatives of Pigeonpea

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Abstract

The present study of Screening of some wild relatives of pigeonpea against bruchid revealed that amongst the 4 Cajanus species, comprising of seven accessions, bruchid damage ranged between 14 and 30 %, compared to 78% in the commercially cultivated pigeonpea variety ICPL 85010. Wild species Cajanus scarabaeoides *accession ICPW 130 and* C. platycarpus *accession ICPW 66 had lowest damage (14% and 16% respectively). The larval/pupal period was prolonged in wild accessions (42 – 55days) compared to 33 days on the susceptible control ICPL 85010 indicating the antibiosis mechanism of resistance in the wild species. Though there was high oviposition on the seeds of interspecific derivative of* C. platycarpus *A 4-10-7-19, it had the least damage (10 %). In the rest of the derivatives the damage rating ranged between 10 and 55 % compared to 80% damage in the susceptible control, reflecting the potential of utilizing these wild species derivatives in pigeonpea crop improvement to overcome the Bruchid damage*.

Keywords: Bruchid, *Callosbruchus maculatus*, *Cajanus* species, interspecific derivatives, antibiosis**,** pigeonpea.

Introduction

Pigeonpea (*Cajanus cajan* (L.) Millspaugh) is one of the major grain legume (pulse) crops of the tropics and subtropics of Asia.

More than 200 species of insects have been recorded as pests on pigeonpea in India, but only a few cause economic losses and are common over large areas. Most of the economic damage is caused by pests that feed on flowers and pods, however, in store, bruchid *Callosobruchus maculatus* F. is common on pigeonpea and can cause economic damage within few months of storage (Lateef and Reed, 1989). In East Africa both *C. maculatus* and *C. chinensis* infest and damage pigeonpea (Davies, 1960; Mphuru, 1978; Khamala *et al.*, 1978).

The mottled dull brown bruchid beetle (3mm) lays its eggs on pods or seeds, the white larva burrows into the pod and later attacks the seed through it's base. Pupation takes place inside the seed from which the adult emerges through a neat cylindrical hole. A generation takes 4 -6 weeks, depending on the temperature (Schotman, 1986).

Though no serious infestations have been reported from the fields on ICRISAT farm, however when late maturing varieties are grown close to other maturity groups followed by delayed harvest, results in considerable bruchid damage (ICRISAT, 1977).

Considering the economic importance of this pest and the disadvantages of chemical control option available to farmers in managing it, it is worth developing eco-friendly management options involving host plant resistance. The research with cultivated pigeonpea so far has not revealed any encouraging results. Hence the present study was undertaken to see the possibility of finding resistance sources in the wild relatives of pigeonpea.

Material and methods

Rearing of Bruchids

Bruchids were collected with a 'pooter' from the damaged seeds in the pigeonpea field on ICRISAT farm and were allowed to multiply on a popular local variety (ICPL 87119) in the laboratory. After rearing them for two generations, the adults were used for screening wild *Cajanus* species. Laboratory culture of the beetles was carried out in a cylindrical transparent plastic box (13 x 11 cm diameter) with a well ventilated lid.

Seed material

Seeds of wild species *C. platycarpus* (ICPW 64, 66 and 68), *C. scarabaeoides* (ICPW 94 and 130), *C. sericeus* (ICP 15671), *C. acutifolius* (ICPW 15613) were selected for the study. Interspecific derivative lines 237-1 and 238-1 were derived from *C. scarabaeoides*. Lines A4-10-7-1, A4-10-7-2, A4-10-7-4, A4-10-7-7, A4-10-7-19 and A4-10-7-20 were derived from *C. platycarpus*. 7018-40-26-7-1 is an advance generation line derived from *C. acutifolius*. Screening for bruchids was carried out along with cultivated pigeonpea which was used as susceptible control (ICPL-85010).

Test procedure

Twenty fresh seeds of each accession were placed in glass petri-dish and placed inside a plastic box with 12 cm width and a transparent mesh covering the lid. To facilitate observations and to prevent the movement of seeds when beetles move on them a circular 'Whatman' filter paper was placed in the petri-dish. Four freshly emerged bruchids of both sexes were placed in individual boxes for 5 days. Each box was checked at 48 hour interval for egg-laying. After 5 days of egg-laying, individual seeds with eggs on them were counted and recorded. At the time of removal of bruchids after 5 days, it was ensured that all the seeds had eggs on them. Most seeds had 2-3 and sometimes more eggs on them. The whole experiment was kept inside a 'Percival' Incubator with 24º ± 2º C with 70% RH and 14:10 hrs (L:D).

Observations on the number of eggs laid on 20 seeds was converted to mean % oviposition against control, number of eggs failed to hatch, number of adults emerged and average number of days taken for adult emergence were recorded. The experiment was replicated twice. The data were subjected to analysis of variance (ANOVA) to separate the resistance factor of the accessions.

Results and discussion

In all the experiments, *C. maculatus* laid eggs on all the seeds of each accession tested. Invariably, the egg load was high on the susceptible line and the difference between the resistant and the susceptible lines was easily observable. Oviposition by female bruchids was moderate (30-40 %) on *C. scarabaeoides* accession ICPW 130 and *C. acutifolius* ICPW 15613 lines except on *C. scarabaeoides* accession ICPW-94 which had 84% oviposition. *C. platycarpus* lines had moderate oviposition whereas the susceptible line ICP-85010 showed 100 % oviposition. Oviposition on interspecific lines ranged from 40 to 60% (Fig 1).

Observations on seed damage on *C. platycarpus* accessions revealed that 50-60% of the eggs did not hatch (Fig. 2), whereas the unhatched percentage was around 25-70% in *C. platycarpus* derived lines on the lines A4-10-7-1, A4-10-7-2, A4-10-7-4, A4-10-7-7, A4-10-7-19 and A4-10-7-20 (Fig. 4). Line A4-10-7-19 had a maximum of 70% unhatched eggs. Seed damage on *C. platycarpus* accessions ranged between 16-38% (Fig. 2) and between 4-60% on their derivatives (Fig. 4). Seed damage was between 18-22% in *C. scarabaeoides* accessions ICPW 94 and ICPW 130 (Fig. 2) and between 35-39% in their derivatives (237-1 and 238-1; Fig. 4). Seed damage of 26% was observed on *C. acutifolius* accession ICPW 15613 while its interspecific derivative line 7018-40-26-7-1 showed 25% damage (Fig. 4). Compared to the wild relatives and their interspecific derivative lines, bruchid damage in susceptible control ICPL 85010 was above 65.5% (Fig. 2 and 4).

In the control line ICPL 85010, the percentage of un-hatched eggs was as low as 20%, it ranged from 50-70% in *C. platycarpus* accessions. On *C. scarabaeoides* accessions, *C. acutifolius* and *C. sericeus* too percent unhatched eggs ranged from 58-69% (Fig 2). On interspecific derivative lines percent un-hatched eggs ranged from 10-75% (Fig. 4)

The average days taken for adult bruchid emergence on *C. scarabaeoides*, *C. acutifolius* and *C. platycarpus* accessions ranged between 42-54 days, where as in the control line the development took 33 days (Fig. 6). On *C. scarabaeoides* accession ICPW 94 and on *C. platycarpus* accession ICPW 64, maximum days for emergence was observed (Fig 3). Observations on *C. platycarpus*, *C. acutifolius* and *C.*

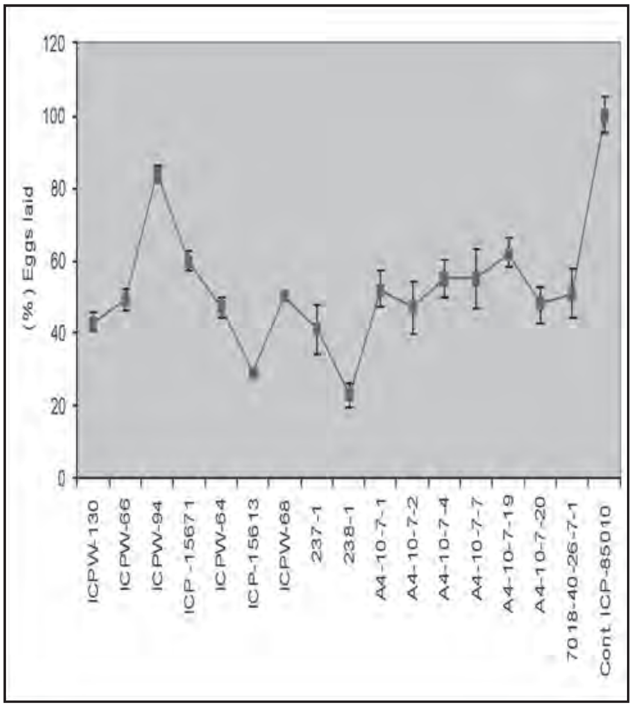

Figure 1. Oviposition by female bruchid on seeds of *Cajanus* species and their interspecific derivatives

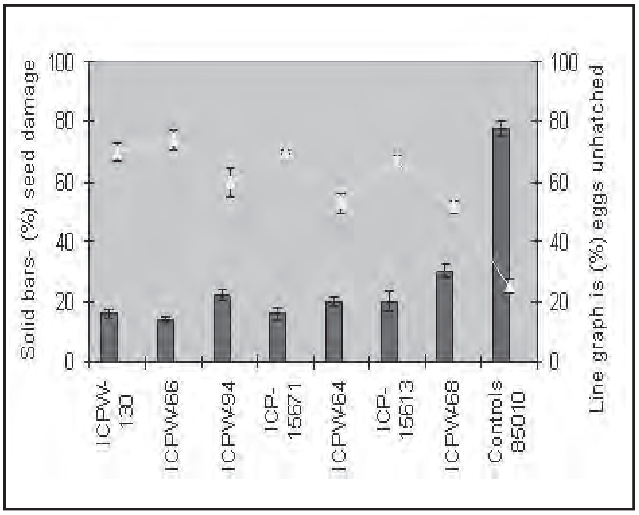

Figure 2. Bruchid damage in wild relatives of pigeonpea

scarabaeoides derived lines showed longer grub development, which ranged from 42 to 48 days, while the development period in the control line ICP 85010 was 32 days (Fig 5).

The wild relatives of pigeonpea namely *C. scarabaeoides*, *C. acutifolius*, *C. sericeus* and *C. platycarpus* used in this experiment had low oviposition in most of the lines. It was interesting to note high rate of unhatched eggs which translated into low to moderate levels of seed damage suggesting occurrence of antibiosis mechanism of resistance. Similar trend was also noticed in *C. platycarpus* line with delayed adult emergence. The adults that developed from these wild species were small in size compared to those emerged from the cultivated species, again suggesting the role of physical and chemical factors**.** Prolonged life cycle (88 days) in different urdbean varieties was also reported indicating the role of antibiosis in urdbean varieties affecting the developmental biology of the bruchid. (Souframanien *et al.*, 2010). Similar results were recorded in Mexican bean beetle, *Zabrotes subfasciatus* (Boheman) causing antibiosis in beans (*Phaselous vulgaris* L.) in Latin America (Schoonhoven, 1976 and Cardona, *et al.*, 1989).

Large seed size in some Interspecific derivatives has shown to influence infestation by bruchids as these seeds possibly provide more surface area for oviposition and larval development than small-size grains. A similar observation was made for urdbean (*Vigna mungo* L.) by (Dharmasena and Subasinghe, 1986 and Tomooka *et al.*, 2000).

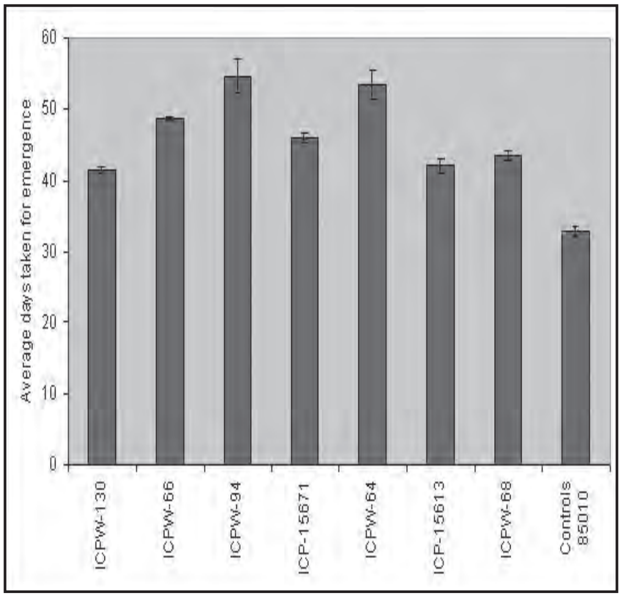

Figure 3. Bruchid *C. maculatus* larval/pupal developmental period in *Cajanus* spp.

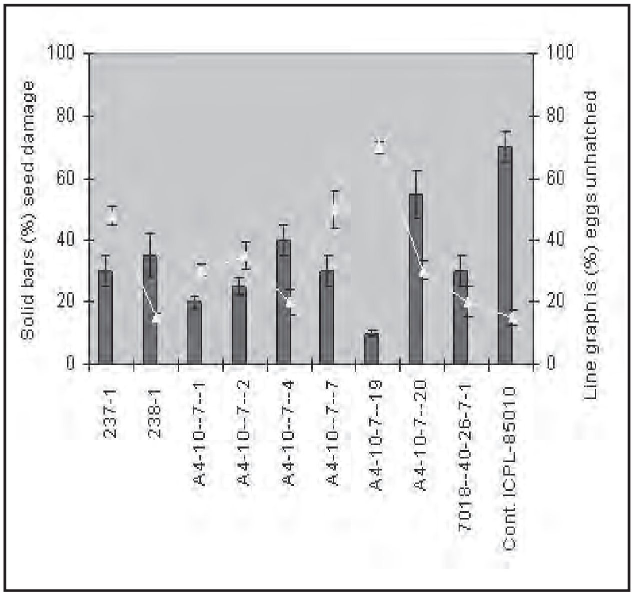

Figure 4. Bruchid damage in interspecific derivative lines of pigeonpea

The present investigation showed that wild relatives of pigeonpea used in this experiment are good sources of resistance to bruchids as percent damage was low on these plants, with low adult emergence in most lines, with more than 40 days for adult emergence and high percent of unhatched eggs. One *C. platycarpus* derived line A4-10-7-19

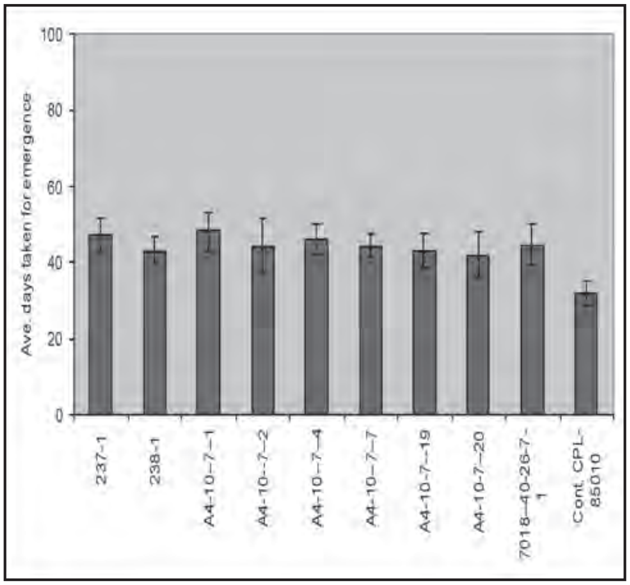

Figure 5. Bruchid larval/pupal developmental period

had more than 70% unhatched eggs. It is important to identify such lines in early generation derivatives and use them to breed for bruchid resistance.

Wild relatives of pigeonpea both from secondary (*C. scarabaeoides* and *C. acutifolius*) as well as tertiary gene pool (*C. platycarpus*) are good sources of resistance to bruchids as seen in the present experiment. ICRISAT has utilized many of these resources to introgress useful traits such as resistance to pod borers and have succeeded in this endeavour (Mallikarjuna *et al.*, 2011 a & b). Hence, lines derived from the above mentioned wild relatives can be used to introgress multiple disease resistance.

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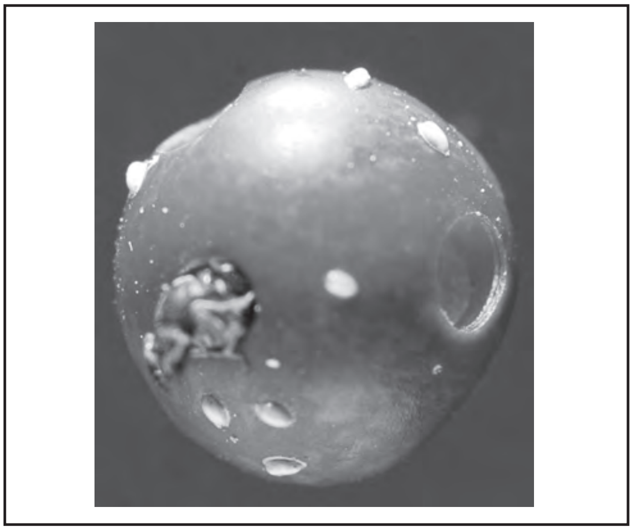

Figure 6. Bruchid damage on pigeanpie sedd. The arrows point at the insect exit holes

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