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# Evaluation of Chickpea Genotypes for Resistance to Legume Pod Borer (*Helicoverpa armigera*) and Root-knot Nematode (*Meloidogyne javanica*)

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**Abstract**

Twenty-one chickpea genotypes were screened for resistance to identify genotypes with multiple resistance in glasshouse and field. Genotypes, ICC 506, ICCV 10, ICCL 86102, and ICCV 95992 had a low pod damage rating of 3 (on a 1 = less susceptible to 9 = highly susceptible scale) to *H. armigera*. All the 21 genotypes were susceptible to nematode-caused root damage (galls on root) and nematode reproduction (egg sac production). ICCL 86102 showed tolerance to nematode damage and produced flowers and pods despite severe nematode infection. ICCL 86102, a short duration genotype, and ICCL 86106, a medium duration genotype were identified as promising sources with resistance to *H. armigera* and tolerance to *M.javanica*.

## Introduction

The legume pod borer (*Helicoverpa armigera* Hub.) is the most important pest of chickpea (*Cicer arietimum* L.). This insect is an insatiable feeder on chickpea plant. It infests at the seedling stage and continues to devour flowers, pods and seeds until crop maturity (Reed *et al.*, 1987). The larvae prefer nitrogen rich plant parts such as flowers and pods (Fitts, 1989). Chickpea genotypes with moderate to high resistance levels to the pod borer have been identified (Dias *et al.*, 1983; Lateef *et al.*, 1985).

The root-knot nematode (*Meloidogyne javanica* Treub) is another important subterranean pest of chickpea in the tropics (Sharma *et al.*, 1992). This nematode completes its life cycle in less than four weeks at 25°C and each female lays about 300-400 eggs. The nematode infected plants develop several galls (knots) on the roots. The symptoms of nemotade attack on above-ground parts of the plant are non-descript. Affected plants are stunted and bear small number of fruits. Losses can be as high as 22-84% in northern India (Ali, 1997). As both of the pests are widespread in India and in many other tropical countries in Asia and Africa, the aim of this study was to identify chickpea genotypes with resistance to both these pests.

## Material and Methods

*Screening for Helicoverpa Resistance*

An open field screening technique using natural population of *H. armigera* (Lateef and Reed, 1983) was used to screen the chickpea genotypes. Genotypes that were identified as promising in terms of reduced susceptibility to *H.armigera* were repeatedly tested at the research farm of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andhra Pradesh, India between 1985 and 1996. The experimental plots were not treated with soil insecticides or foliar sprays. Chickpea cultivars, Annigiri, K 850, and L 550 were used as susceptible checks in all the years. Data on borer damage were collected (Lateef and Reed, 1983) and resistance rating of the genotypes to the pest was calculated in comparison with the rating of

the checks to identify chickpea genotypes with resistance to the insect pest. All the genotypes were rated on 1 (less susceptible) to 9 (highly susceptible) scale (Lateef, 1985).

*Screening for Root-knot Nematode Resistance*

A population of *M. javanica* was maintained on a highly susceptible local variety of tomato (*Lycopersicon esculentum*) at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Andhra Pradesh, India.

*Greenhouse Screening*

Eggs of *M. javanica* were extracted from 8-week-old plants by treating the roots with a solution of sodium hypochlorite. Ten thousand nematode eggs in water suspension were inoculated in the same depressions in which seeds were sown in 15-cm-d pots containing riverbed sand + black cotton soil mixture (4:1, v:v). All the pots were irrigated regularly. Eight weeks after seedling emergence, roots were carefully washed with tap water and evaluated for nematode-induced root damage in terms of gall number, gall size, and area of root galled. Nematode reproduction was measured by counting the number of egg sacs of the nematode. Roots were treated with 0.25% trypan blue to stain the egg sacs dark blue (Sharma and Mohiuddin, 1993) for counting them.

The roots were rated on a 1-9 scale for Gall Index (GI): 1 = no galls; 2 = 1-5 galls; 3 = 6-10 galls; 4 = 11-20 galls; 5 = 21-30 galls; 6 = 31-50 galls; 7 = 51-70 galls; 8 = 71-100 galls; and 9 = >100 galls. Gall Size (GS) was evaluated on a 1-9 scale (1 = no galls; 3 = very small, about 10% increase in root area at the galled region over non-galled normal root area; 5 = small galls about 30% increase; 7 = medium, about 31-50% increase; and 9 = big galls, about 51-100% increase). Percent Galled Area (GA) of root was rated on a 1-9 sclae where 1 = no galls; 3 = 1-10% root area galled; 5= 11-30% root area galled; 7 = 31-50% root area galled; and 9 = >50% root area galled. GI, GS and GA are intrinsic components of damage by the root-knot nematodes and a Damage Index (DI) was calculated by dividing the sum of GI, GS, and GA by three [(GI + GS + GA)/3]. Genotypes with DI = 1 were considered as highly resistant to damage, 2-3 as resistant, 4-5 as moderately resistant, 6-7 as susceptible, and 8-9 as highly susceptible (Sharma, 1995). Numbers of egg sacs were rated using the 1-9 scale for gall number (Egg sac Index (EI) 1 = no egg sacs, 9 = >100 egg sacs). Genotypes with EI = 1 were considered highly resistant to nematode reproduction and those with EI = 9 were highly susceptible.

For determination of tolerance to nematode density, seeds of all the 21 genotypes were sown in a mixture of autoclaved sand + black soil (4:1, v:v) in 12.5-cm-diameter pots. Each genotype was grown in 10 pots. In five pots 5000 eggs of *M. javanica* were inoculated while the other five pots were maintained as nematode-free controls. The growth of test genotypes was compared in pots containing nematode-free soil as well as in nematode infested soil. Data on nematode-caused galls and egg sacs, and dry shoot mass were compared. The response of a promising genotype ICCV 95992 was tested again in soils infested with 0, 50, 500, and 5000 eggs in 12.5-cm-diameter pots. All other details were same as described above.

*Field Screening*

Twenty-one genotypes were evaluated in a farmer's field naturally infested with *M. javanica* at Aziznagar area 30 kms south of ICRISAT. All the genotypes were sown in October in 4-meter long, 2-row plots and these were in two replications. The experiment was laid out in a randomized block design. The rows were 30 cm

apart and plant-to-plant distance was 10 cm. No chemical or organic fertilizer was added to the soil. Plant growth was assessed visually after 45 and 75 days of planting. The genotypes were examined and rated for plant growth on a 1 to 5 scale : 1 = excellent uniform growth (>90% plant showing uniform good growth), 2 = very good growth (81-90% plants showing uniform good growth), 3 = good growth (71-80% plants showing uniform growth) 4 = moderate growth (51-70% plants showing good growth), 5 = poor growth (50% and less plants showing good growth). At 75 days after planting, four plants per replication were carefully dug up and their roots were evaluated for GI,GS,GA,and EI.

## Results and Discussion

*Reaction to H.armigera*

The pooled data on mean pod damage, based on 10 years of field screening, showed that ICC 506, ICCV 10, ICCL 86102, and ICCV 95992 had a low pod damage rating of 3.0 (Table 1). The pod damage percentage ranged between 2 and 19 in the short-duration chickpea. One advanced breeding line (ICCX 730266-3-4) and two cultivars (ICCC 37 and Annigiri) had consistently high pod damage ranging from 8 to 34%. Four medium duration genotypes, ICC 4935-E-2793, ICCL 86106, C 235, and H 208 suffered moderate pod damage as compared to

**Table 1. Reaction of chickpea genotypes to pod borer (*Helicoverpa armigera*) and root-knot nematode (*Meloidogyne javanica*).**

| Genotypes | *Helicoverpa* resistance rating | Gall index | Gall size | Galled area of root | Egg sac index | Growth index* |
|---|---|---|---|---|---|---|
| **Short duration (desi)** | | | | | | |
| ICC 506 | 3 (10) | 9 | 5 | 9 | 9 | 2, 3 |
| ICCV 93122 | 5 (2) | 9 | 5 | 7 | 9 | 3, 3 |
| ICCV 93118 | 4 (1) | 7 | 5 | 8 | 6 | 5, 5 |
| ICCV 95992 | 3 (1) | 9 | 5 | 7 | 8 | 4, 3 |
| ICCC 37 | 7 (5) | 9 | 7 | 9 | 9 | 3, 3 |
| ICCL 86101 | 4 (7) | 9 | 9 | 9 | 9 | 2, 3 |
| ICCL 86102 | 3 (7) | 9 | 7 | 9 | 9 | 2, 2 |
| ICCX 730266-3-4 | 8 (6) | 9 | 9 | 9 | 9 | 3, 4 |
| Annigiri (C) | 6 (10) | 9 | 7 | 9 | 9 | 2,4 |
| **Medium duration (desi)** | | | | | | |
| ICC 4935-E-2793 | 5 (8) | 9 | 7 | 9 | 9 | 3, 3 |
| ICC 4958 | 7 (2) | 9 | 5 | 9 | 9 | 4, 5 |
| ICCL 86105 | 6 (5) | 9 | 9 | 9 | 9 | 1, 3 |
| ICCL 86106 | 4 (6) | 9 | 6 | 8 | 9 | 3, 2 |
| ICC 3137 | 8 (5) | 9 | 7 | 9 | 9 | 3, 3 |
| C 235 | 5 (3) | 9 | 5 | 9 | 9 | 5, 5 |
| H 208 | 4 (7) | 9 | 7 | 9 | 9 | 3, 4 |
| K 850 (C) | 6 (7) | 9 | 7 | 7 | 9 | 2, 3 |
| **Short / medium duration (kabuli)** | | | | | | |
| ICCV 2 | 8 (2) | 9 | 5 | 7 | 9 | 3, 4 |
| ICCX 730244-17-2 | 9 (7) | 9 | 7 | 9 | 9 | 5, 5 |
| L 550 (C) | 6 (7) | 9 | 7 | 7 | 9 | 3, 4 |

*The plant growth was measured at 45 and 75 days after planting.
Figures in parentheses are number of years of testing.
1 = Highly resistant and 9 = Highly susceptible.

ICC 3137. All the kabuli genotypes tested were susceptible.

*Reaction to M. javanica*

In the greenhouse test, all the 21 genotypes showed a susceptible reaction to nematode infection. These genotypes had more than 100 galls per plant within 60 days of sowing. The gall size was bigger on ICCL 86101, ICCX 730266-3-4, and ICCL 86105 than ICC 506 and ICC 4958. The average gall size was medium on six lines. There was no line with small galls. Consequently, the nematode caused galls covered more than 30% of the root area on all the genotypes. All lines except, ICCV 93118, were highly suitable for nematode reproduction. The reactions of these lines were also confirmed in the nematode infested field. However, plant growth scores differed. ICCV 93118 was less suitable for nematode reproduction, but it was intolerant to nematode infection and showed stunted growth within six weeks of sowing. ICCL 86102 was identified as a tolerant line. It showed tolerance to nematode damage and produced flowers, and pods despite severe nematode infection. ICCX 730266-3-4 was severely affected. Other short duration (desi) lines had good plant growth and pod formation. Five short-duration genotypes showed good growth though their roots were heavily infected. In the glasshouse, growth of all the test genotypes was significantly reduced in the nematode-infested soils as compared with that in the nematode-free soil. The dry shoot mass of ICCV 95992 in the nematode-infested soil was similar to that in the nematode-free soil. Symptoms of yellowing of leaves in the nematode-infested soils were observed in all the genotypes. As the roots in the pots were confined to a small volume of soil and they were exposed to high nematode inoculum of 10 eggs per $cm^3$ of soil. In the field the nematode density was 2-3 nematodes $cm^{-3}$ soil at planting. This suggests that the field tolerance in chickpea genotypes to root-knot nematodes is not absolute and have the ability to withstand nematode-induced stress up to certain level of threshold (>3 juveniles $cm^{-3}$ soil). ICC 95992 showed the ability to recover from nematode-induced stress as its growth was initially stunted but it recovered gradually.

Three medium duration (desi) lines showed marked stunting in the nematode infested field. ICC 4958 and C 235 were highly affected; while in ICCL 86105 nearly 20% plants showed symptom of nematode-caused stress at 75 days of sowing.

These studies have shown that some chickpea genotypes have a capacity to endure pod borer and root-knot nematode damage in the field. ICCL 86102, a short duration genotype, and ICCL 86106, a medium duration genotype are promising sources with resistance to insect pest and tolerance to nematode pest. These genotypes need to be tested across many locations in farmers' fields to confirm their wide utility. It appears that the short duration desi genotypes have better capabilities to tolerate pod borer damage and nematode infection than the medium duration genotypes. The short duration of the crop itself may be a contributory factor in better performance of the genotypes. Previous studies have indicated that higher levels of maleic acid (Rembold and Winter, 1981), oxalic acid (Yoshida *et al.,* 1995), and high acidity in the leaf (Srivastava and Srivastava, 1989) are associated with resistance to the pod borer. The ability to tolerate nematode infection is related to uptake of calcium from soil (Sharma *et al.,* 1995). Factors that are responsible for less pod borer damage and tolerance to the nematode need to be studied to understand the mechanisms of insect resistance and nematode tolerance in chickpea.

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