test crop at all the locations. Basal doses of 20 kg N ha^{-1} as urea, 50 kg P_2O_5 ha^{-1} as triple superphosphate, and 40 kg K_2O ha^{-1} as muriate of potash were applied at sowing. Three levels of boron, i.e., 0, 2, and 3 kg B ha^{-1} were applied as borax. The required quantity of borax as per treatment was mixed with dry soil, broadcasted uniformly to the respective plots, and then mixed into the plow layer soil. Sowing was done in the mid-November. Germination was satisfactory and the crop stand was good. However at this stage, the treatment difference was not apparent. One irrigation was applied at preflowering stage. The crop was harvested at full maturity and dry grain yield was recorded.

Good response in grain yield of chickpea was observed (Table 1 and Fig. 1) because of boron application. Soils with less than 0.20 ppm B produced higher grain yield response both at 3 kg B ha^{-1} and at 2 kg B ha^{-1}, compared to soils with 0.27 and 0.65 ppm available B. The optimal boron level appeared at 3 kg ha^{-1} for those soils testing below 0.35 ppm in available boron, and 2 kg ha^{-1} for the soils testing above 0.35 ppm in available boron. The yield response was negatively and significantly correlated with available boron content in soil ($r = -0.91^*$), when one site was excluded where chickpea responded extremely well to boron application. The regression equation has been given in Figure 1. From this study, it is apparent that the yield of chickpea can profitably be increased in boron-deficient calcareous soils by applying 2 to 3 kg B ha^{-1}.

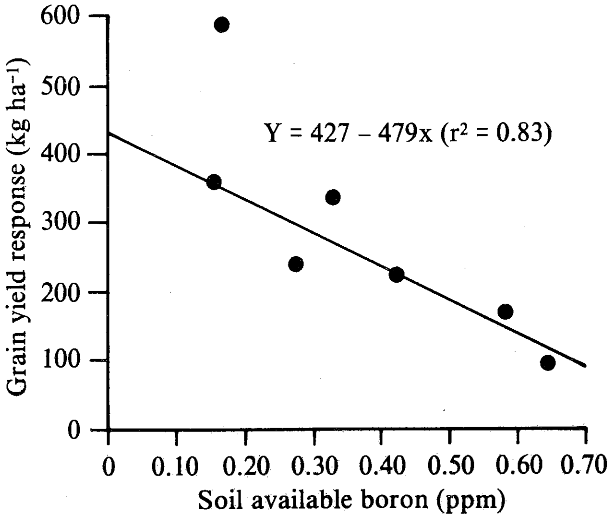

Figure 1. Grain yield response of chickpea to boron application at 2 kg B ha^{-1} level.

Entomology

Relationships between Pod-Borer Density and Yield Loss in Chickpea: One Season's Data

V.K. Sehgal, V. Rameshwar Rao, and **J.A. Wightman** (ICRISAT Center)

The pod borer [*Helicoverpa armigera* (Hübner)] is one of the few insects that can cause yield loss in chickpea crops. Contemporary approaches to pest management require a thorough knowledge of the relationships between insect density and the damage they cause. We are, therefore, carrying out a series of experiments in field conditions in which chickpea plants are exposed to a range of *H. armigera* densities at two critical crop development stages. The first season's data are reported here because they illustrate an approach apparently not applied before to this crop, at least not with any success.

Thirty 3-m x 3-m plots were sown to cv. Annigeri on 12 Oct 1988. There were 50 plants in each plot of five 2-m long rows. Caterpillars were prevented from walking in or out of the plots with a 15-cm metal barrier. The plants were sprayed with dichlorovos, 1 week before the experiment started, to kill all insects. Each plot was then covered with a 3x3x2-m fish net cage (5 mm holes) to prevent oviposition by the resident insect population.

On 2 December (flower initiation) 5, 10, 15, 25, 30, 40, 50, 65, 85, 100, 150, 300, and 500 larvae were released into 13 cages. A control cage was kept without larvae. The larvae were reared in the laboratory on a semisynthetic diet. When the larvae had completely developed the plots were sprayed regularly with dichlorovos so that no further insect damage could take place. There was surprisingly little yield difference. There was 1.9% pod damage in the control, presumably because a few larvae were not eliminated. The damage level varied between 13.3% (100 larvae $cage^{-1}$), and 26.4% (300 larvae $cage^{-1}$) in the other treatments, although two cages (65 and 85 larvae $cage^{-1}$) gave spuriously low-damage data. There was no relationship between insect density and grain mass $plant^{-1}$. It is assumed that the plants compensated for the insect damage at this stage by producing more flowers.

The second experiment was initiated on 9 December in the same way as above but with extra treatments of 120 and 200 larvae $cage^{-1}$. There was no direct relationship between initial insect density and pod damage at harvest, but there were strong relationships between the pod borer damage (%)

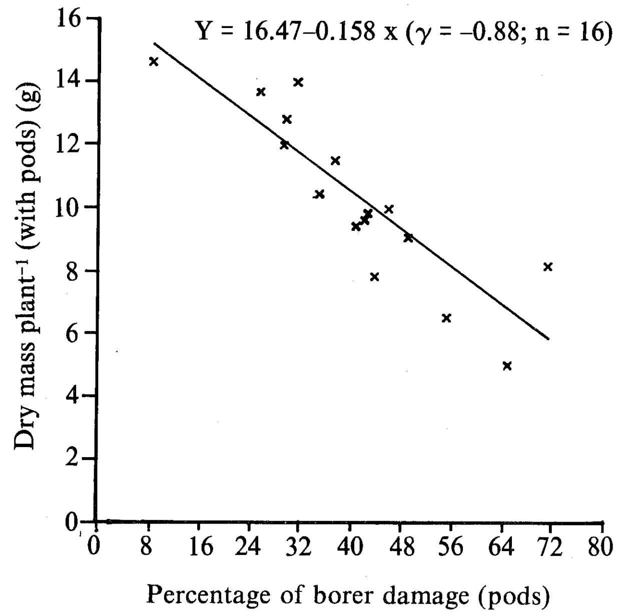

Figure 1. Relationship of pod damage (%) and dry mass plant^{-1} with pods in chickpea cv Annigeri, when different loads of *H. armigera* larvae were released at the pod-development stage.

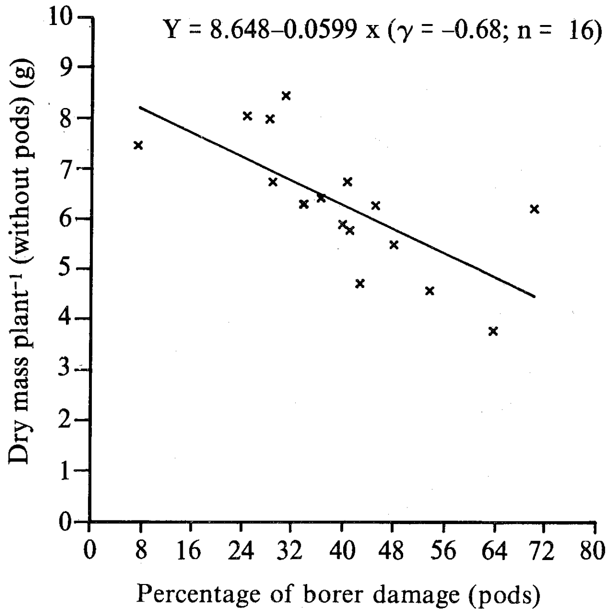

Figure 2. Relationship of pod damage (%) and dry mass plant^{-1} without pods in chickpea cv Annigeri, when different loads of *H. armigera* larvae were released at the pod-development stage.

and the mean dry mass of the plants (Figs. 1 and 2).

These data sets indicate that we are not dealing with a simple kind of insect-plant relationship. It is suspected that cannibalism, caused by food shortage or crowding, may have masked a direct density effect. However, by using pod damage percentage as an index of larval density (assuming the potential number of pods in cage was close to equal), we can demonstrate that there was a fall in grain yield plant $^{-1}$, although related to insect activity. Furthermore, this may, in part, be because of the loss of plant vigor or photosynthetic activity caused by larvae eating vegetative material in addition to the reproductive organs.

Acknowledgment: The authors are thankful to Mr M.A. Ghaffar, Research Associate, Legumes Entomology for providing the larvae required for this study.

Incidence of Chickpea Pod Borer in Syria during the 1988/89 Season

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Chickpea is an important legume in the Syrian agriculture. The crop was grown on nearly 84000 ha during 1988 with a production of 50000 t. Although it is cultivated all over the country, southern Syria comprising the provinces of Daráa, Sweida, and Damascus account for the majority of the area (64%), and production (54%) of the country. The north-western Syria (Idleb and Aleppo) with 22% of area and 22% production of the country is the second most important chickpea-production zone. The central-western region (Homs, Hama, El-Ghab, Lattakia, and Tartous) and the North-eastern region (Al Hasakeh, Al-Raqqa, and Deir-Ezzor) are relatively less important chickpea-production areas.

Although chickpea leafminer *Liriomyza cicerina* Rondani is the main insect pest of chickpea in Syria occurring in high densities every year, pod borer can also cause major damage in some areas and years. Chickpea in Syria is attacked by three species of pod borer, *Helicoverpa armigera, Heliothis viriplaca,* and *Heliothis peltigera,* of which the last occurs sporadically, in the north, and is thus of minor importance. Observations during the previous years showed that *H. armigera* and *Heliothis* spp do not cause major damage in chickpea in northern