larval reduction/increase. Pod damage and seed yield were also recorded and the data were statistically analyzed.

The results in Table 1 reveal that all the treatments were significantly superior over the control (water spray) in reducing the larval incidence, pod damage, and increasing the grain yield. In the control, *H. armigera* larvae increased by 56.5%, 2 days after spraying, 93.8%, 7 days after spraying, and 150.2%, 14 days after spraying with water, resulting in higher pod damage (17.5%) and lower yield (1.07 t ha^{-1}). Among the bioagents and chemicals, NPV (@ 300 LE ha^{-1}), monocrotophos (@ 600 mL ha^{-1}), and endosulfan (@ 1200 mL ha^{-1}) produced nonsignificant effects among themselves with respect to larval reduction, pod damage, and grain yield but showed significant superiority over *T. chilonis* (@ 250 000 ha^{-1}). The poor performance of *T. chilonis* might be because of nonpreference of chickpea crop by the adult as observed by Bhatnagar and Davies (1978), who reported negligible parasitism on chickpea because of glandular hairs on the leaves which produce an acidic exudate.

Looking the overall performance of bioagents and chemicals, NPV @ 300 LE ha^{-1} was found to be most effective in reducing larval population (78.7%), pod damage (10.04%), and giving higher yield (1.86 t ha^{-1}). Narayanan (1980) also reported better results from NPV as compared to endosulfan. In view of pesticidal hazards, the problems of pollution and insecticide resistance development, a bioagent like NPV should be used in managing *H. armigera* on chickpea.

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Failure of *Trichogramma* Mass-releases in Pigeonpea and Chickpea

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Trichogramma (Hymenoptera: Trichogrammatidae) egg parasitoids are important natural enemies of *Helicoverpa armigera* on some crops such as sorghum, maize, and cotton, but rarely parasitize eggs on pigeonpea or chickpea (Romeis and Shanower 1996). However, Duffield (1994) reported high levels of egg parasitism on short-duration pigeonpea, when it was intercropped with sorghum. This was probably caused by a movement of parasitoids from sorghum into pigeonpea. Similarly, Balasubramanian et al. (1989) reported unexpectedly high egg parasitism levels from chickpea after only a single release of the exotic *T. pretiosum*. Both studies indicate that *Trichogramma* are able to attack eggs of *H. armigera* on the two pulse crops once they are attracted to or 'forced' into the field. We therefore tested the feasibility of increasing parasitism levels in both crops by mass-releasing *T. chilonis*, the most common egg-parasitoid of *H. armigera* in India (Romeis and Shanower 1996).

The trials were carried out in the 1996/97 season at ICRISAT Asia Center. *Trichogramma chilonis* were released from *Corcyra cephalonica* (Lepidoptera: Pyralidae) egg-cards produced at the Central Integrated Pest Management Centre in Hyderabad, India. Parasitoids were released equally throughout the field at weekly intervals. A minimum of 33 000 healthy females were liberated in a 0.25-ha pigeonpea (cv ICPL 87) field in each of seven releases. In a 0.2-ha chickpea (variety Annigeri) field more than 27 000 healthy female were liberated in each of five releases. *Helicoverpa armigera* eggs were collected twice a week in the release and

control fields and individually kept in the laboratory to evaluate the level of parasitism. Cylindrical sticky traps (Romeis et al. 1996) were placed in the field at crop canopy height to monitor the parasitoid population. The weather conditions during the release trials were optimal. Mass-releasing *Trichogramma* in both crops did not lead to higher *H. armigera* egg parasitism levels compared to control fields without releases. From a total of 1383 eggs collected in pigeonpea only 31 (2.2%) were parasitized. Out of a total of 1222 eggs collected in chickpea, none was found to be parasitized. The sticky trap catches showed that the *Trichogramma* population within the field remained low throughout the trial. Only two wasps were trapped in the release field and none were caught in the control fields from five sticky traps on nine sample dates. This indicates that wasps leave the field soon after emergence.

Future research should focus on the plant factors responsible for the low parasitoid efficacy on these two crops.

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Biotechnology

An Improvised Medium for In vitro Pollen Germination and Pollen Tube Growth of Chickpea

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In vitro pollen germination is a very convenient and effective technique to study many basic and applied aspects of pollen biology (Heslop-Harrison 1987, Kristen and Kappler 1990, Shivanna and Rangaswamy 1992). The composition of the medium used for pollen germination varies from species to species. The medium formulated by Brewbaker and Kwack (1963) has been used for pollen of a number of species including chickpea (Srinivasan et al. 1997). In our preliminary studies on assessing the feasibility of using pollen for screening genotypes tolerant to cold, we also used Brewbaker and Kwack (BK) medium. Although we recorded up to 80% pollen germination in some accessions, the response was inconsistent. Also, pollen tube growth was limited to < 200 µm in most of the genotypes. Polyethylene glycol (PEG) has been shown to improve markedly in vitro pollen germination and/or pollen tube growth in many species (Zhang and Croes 1982, Read et al. 1993, Shivanna and Sawhney 1995). To improve the medium for pollen germination and pollen tube growth in chickpea, we tested the effects of PEG. This communication gives details of the improvised medium for use by chickpea breeders.

Initial experiments were conducted with pollen of a cold tolerant accession ICC 8923 grown in a growth chamber (15°/5°C, day/night). The improvised medium was subsequently tested with many other cold tolerant as well as cold susceptible accessions. Pollen grains were collected from freshly opened flowers and used to raise sitting drop cultures (Shivanna and Rangaswamy 1992). In preliminary studies, various combinations of sucrose and PEG 8000 (Sigma®) concentrations were tested in the medium containing B/K salts. The best response was obtained in a medium containing 2.5% sucrose and 10% PEG. Thus the improvised medium contained sucrose 2.5 % + PEG 10% + boric acid 100 mg L^{-1} + calcium nitrate 300 mg L^{-1} + magnesium sulphate 200 mg L^{-1} + potassium nitrate 100 mg L^{-1}.