Table 2. Organogenesis in the three genotypes of chickpea, C 235, Gaurav, and Gora Hisari, on modified B_5 medium supplemented with varying concentrations of growth regulators, individually or in combination.

Concentration of growth regulators (mg L^{-1})					Organogenetic effects				
BAP	NAA	2,4-D	Kin	Adenine	Callusing	Embryo-genesis	Rooting	Shooting	Plantlet
1.0			0.5		CG[1]	CG	CG	C	-
2.0			1.0		GH	G	CG	C	C
2.0	2.0				GH	G	-	-	-
0.5	1.0				GH	G	C	CG	-
	0.5	1.5			CGH	C	-	-	-
				160	CG	C	C	-	-
4.0	1.0			160	G	CG	CG	C	C
		1.5		160	G	CG	-	-	-

1. C - cv C 235
H - cv H 75-35 (Gaurav)
G - cv Gora Hisari.

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Entomology

Dusting Chickpea with Fine Rock Powder: Effects on Yield and Damage Caused by *Helicoverpa armigera*

M.P. Pimbert and **C.P. Srivastava** (ICRISAT)

A growing body of literature suggests that mineral nutrients in the soil can influence insect and host plant resistance relationships (Day 1950; Schutte and Myers 1979; Chaboussou 1985; Mattson 1980; Metcalfe 1970; Ghildiyal et al. 1977; Kemp and Moody 1984; Leuck et al. 1974). Plants provided with a balanced and complete set of minerals (major, minor, and trace elements) tend to show high rates of protein synthesis, low accumulation of intermediate metabolites (free amino acids and reducing sugars), enhanced plant vigor, and good levels of resistance against pests.

In this experiment, two chickpea genotypes were dusted with finely ground rock around flowering time. The damage caused by *Helicoverpa armigera* on dusted plants was compared with that observed on nontreated chickpea of the same genotypes.

Results and discussions. No significant differences in pod-borer damage were observed between dusted and nondusted ICCX 79012. Levels of pod-borer damage were significantly greater in the case of Annigeri plants that received one foliar application of rock powder (Table 1). Dusting chickpea with rock powder may therefore worsen the *Helicoverpa* problem in this case. However, before making any pest management recommendation we shall repeat this experiment for the following reasons:

1. The incidence of pod-borer attacks on chickpea was generally low at ICRISAT Center this year.

We need to monitor the responses of chickpeas dusted with rock powder under higher pest pressure.

2. Rock dust was applied on to the plants later than scheduled. This was particularly true for Annigeri plants, 50% of which had flowered, and on which pod-borer oviposition had begun prior to dusting.

Despite these limitations, we present our preliminary results because they do have interesting agronomic implications. Yields were significantly higher in plots where both chickpea genotypes received foliar applications of fine rock powder (Table 1). Pod production increased by 55%, and seed yield by 69% when ICCX 79012 was dusted. Higher pod yield (+58%) and seed yield (+66%) were also observed in Annigeri treated with rock dust. The mean mass of a single seed of each genotype was also greater when rock dust was applied (Table 1).

We suggest that the acid leaf exudates solubilized the rock powder minerals and facilitated their absorption into the plant via the leaves. The mineral nutrition of chickpea dusted with rock powder was improved in comparison with the control plants that took up minerals only from the soil. This would explain the large differences in yield observed here. Alternatively, the presence of dust particles on the plants may have had a cooling effect on the crop by increasing the albedo of the canopy. The lower rates of evapotranspiration that presumably ensued were reflected in higher yields.

Table 1. Effect of one foliar application of rock powder dust on pod production, percentage pod damage, number of seeds harvested, and seed mass in two chickpea cultivars, (Annigeri and ICCX 79012), at ICRISAT Center, 1988/89.

Treatment	Mean no.of pods $plant^{-1}$ (no. plants examined)	Pod damage $plant^{-1}$ (%)	Mean no. of seeds $plant^{-1}$	Mean seed mass $plant^{-1}$ (g)	Mass of a single seed (g)
		ICCX 79012			
Plants dusted with rock powder	46.9 (160)	5.26	49.6	7.20	0.1460
Control (no dusting)	30.1 (160)	4.68	30.4	4.25	0.1397
Effective SE	±2.33 (a)[1]	±0.56(b)[1]	±2.44(c)[1]	±0.36(d)[1]	±0.0014(e)[1]
		Annigeri			
Plants dusted with rock powder	56.1 (160)	10.8	57.2	11.02	0.1889
Control (no dusting)	35.4 (160)	6.4	35.0	6.63	0.1857
Effective SE	±2.64 (a)[2]	±0.64(b)[2]	±2.94(c)[2]	±0.59(d)[2]	±0.002(e)[2]

1. Differences between treatments are significant at 0.05% level for parameters a, c, d, and e.
2. Differences between treatments are significant at 0.05% level for all parameters studied.

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Performance of *Helicoverpa*-resistant Chickpea Cultivars under North Central Plateau Conditions of Orissa, India

H.P. Patnaik and **L.K. Rath** (Regional Research Station, Orissa University of Agriculture and Technology, Keonjhar, Orissa 758 002, India)

Chickpea, a major winter crop in the North Central Plateau Zone of Orissa, is predominantly infested by *Helicoverpa armigera* (Hübner) during its vegetative and podding stages. The extent of pod damage, as seen from our past trials in research stations, as well as from field surveys, ranged from 0.7% to 40.9%, with an overall average of 13.4%. However, pod damage was reported to range from 0% to 84.4% in India, with the overall average being <8% (Sithanantham et al. 1983). The use of resistant cultivars has been established as a primary method of control of the insect, and as a component of integrated pest management (Wiseman 1982). Variation in susceptibility to *H. armigera* among chickpea cultivars has been established (Singh and Sharma 1970; Srivastava et al. 1975; and Lateef 1985). The relative performance of pod-borer resistant chickpea cultivars obtained from ICRISAT under the North Central Plateau Zone conditions of Orissa is reported here.

Two early-maturing chickpea cultivars ICCX 730008-8-1-IP-BP and ICC 506, along with susceptible controls Annigeri and Keonjhar local, were grown during the 1985/86 postrainy season. Four more cultivars, ICCX 790197-25PLB-12PLB-3PLB-BPLB; ICCX 790197-3PLB-3PLB-BPLB; ICCX 780286-5PLB-2PLB-2EB; and ICCX 790197-23PLB-11PLB-2EB were added in 1986/87. A row-to-row spacing of 60 cm, and a plant-to-plant spacing of 60 cm were maintained, on 2.4 m wide plots with 4 m rows. The cultivars were grown under pesticide-free conditions in randomized-block design, with five replications during 1985/86, and three replications during 1986/87.

The cultivars flowered in 58-62 days. Despite low pod-borer incidence during 1986/87, all the test cultivars showed less susceptibility to *Helicoverpa* attack, compared with the susceptible control, Annigeri. Cultivars ICCX 730008-8-1-1P-BP and ICC 506, showed similar pod damage and yield (Table 1). Low pod damage of <10% was recorded on these cultivars as against 19.0% in Annigeri. The cultivar ICCX 780286-5PLB-2PLB-2EB had the highest yield (1.82 t ha^{-1}), and was followed by cultivar ICCX 790197-25PLB-12PLB-3PLB-BPLB (1.61 t ha^{-1}). Consistently higher yields were recorded for cultivars ICC 730008-8-1-1P-BP (1.32 t ha^{-1}) and ICC 506 (1.36 t ha^{-1}). Cultivars ICCX 790197-3PLB-3PLB-BPLB and Keonjhar local were found to be inferior to Annigeri with respect to yield.

Fusarium wilt incidence was high during 1986/87. However, low wilt incidence was observed in early-maturing cultivars ICCX 790197-3PLB-3PLB-BPLB (6.5%); ICC 506 (6.8%); and ICCX 790197-25PLB-12PLB-3PLB-BPLB (7.2%). Cultivars ICCX 790197-23PLB-11PLB-2EB, Annigeri and Keonjhar local were, on the other hand, more damaged by wilt (10.7% to 16.9%).

Although promising *Helicoverpa*-resistant chickpea cultivars have been identified in these trials, the stability of their performance (yield, wilt/pod-borer resistance) needs to be established in different agroecological zones of India.