Using this method we counted 10^3 to 10^4 chickpea rhizobia/g soil in a vertisol field at ICRISAT Center, where chickpea normally nodulates well without inoculation. The number declined to fewer than 400/g below 60 cm. In a paddy field, rhizobia were fewer than 10/g soil. This method of counting will also be very useful in quality control during inoculant production, as it is the only reliable way to count the specific chickpea *Rhizobium* population in inoculants also containing other organisms. The potential usefulness of an inoculant depends primarily on the number of rhizobia it contains, and this should be at least 10^8/g of carrier.

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Research at ICARDA on Improving Nitrogen Fixation in Chickpea

The yield of chickpea in West Asia and North Africa has remained static around 750 Kg/ha for the last 10 years. This is much less as compared to the yields of *Vicia faba* (1164 Kg/ha) and soybean (1147 Kg/ha) grown in the region (FAO Production Year Book, 1977). Our surveys of farmers' fields in several countries of this region suggest that the low yields may be partly caused by the lack of effective nodulation. These surveys have helped us identify several problems associated with nitrogen fixation in chickpea, and we are now investigating these on the ICARDA farm at Tal Hadia in Syria. Some preliminary results are presented here.

Response to inoculation with *Rhizobium*

Chickpea nodulates poorly on the ICARDA farm at Tal Hadia. An experiment was conducted in the spring of 1978 to study the response of two chickpea cultivars - Syrian Local, a large seeded kabuli and NEC 2304, a small seeded desi type, to inoculation with eight strains of *Rhizobium* (CB-1189, CC-1192, Ca-7, DNRa-I, Pantnagar strain, IC-13, IC-20 and IC-26) obtained from ICRISAT but of diverse origin. The experiment was designed to identify suitable strains of *Rhizobium* for local conditions.

Three harvests at different stages of growth (early vegetative, early flowering and mid pod-fill) were made for nodulation studies before final grain yield harvest.

The uninoculated plants had, on an average, one nodule per plant. Two *Rhizobium* strains (DNRa-1 and IC-13) produced only 3 nodules per plant, but others produced 18 to 45 nodules. The two cultivars responded

Table 1. Effect of inoculation on nodulation of chickpea, Tal Hadia, Syria, 1978

Treatment	SYRIAN LOCAL			NEC 2304		
	Nodule No/plant[a]	Nodule dry wt. (mg/plant)[a]	Yield (Kg/ha)	Nodule No./ Plant[b]	Nodule dry wt. (mg/plant)[b]	Yield (Kg/ha)
Uninoculated	0.9	71	1255	0.8	83	1420
Inoculated	35.3	421	1286 to 1508[c]	28.7	-	1282 to 1798[c]
Uninoculated 120 Kg N/ha	0.4	29	-	0.2	13	-

[a] Harvested 66 days after germination
[b] Harvested 74 days after germination
[c] Range for six inoculum strains

differently in their nodule development with different *Rhizobium* strains. The Syrian Local cultivar produced most of its nodules within 28 days of germination. However, only strain IC-26 continued forming nodules until the mid pod-fill stage.

For both cultivars, nodule weight continued to increase until the mid pod-fill stage, although the rate varied considerably between strains. At this harvest, Syrian Local produced the most nodule tissue with strain CC-1192; strain IC-20 formed fewest nodules and least nodule tissue. The desi cultivar developed most nodule tissue with strain IC-20 and the least with the Pantnagar inoculum.

For both cultivars, inoculation with some *Rhizobium* strains increased grain yield in comparison with the uninoculated treatments (Table 1). Syrian Local produced most grain yield with strain IC-26 (1508 Kg/ha compared to 1255 Kg/ha for the uninoculated treatments) and the desi type produced the highest yield with Ca-7 (1798 Kg/ha compared to 1470 Kg/ha for the uninoculated control plants).

Screening Cultivars for Efficient Nodulation

The nodulation of 151 cultivars of chickpea was examined with and without inoculation. Only 40 percent of the uninoculated cultivars nodulated, averaging less than two nodules per plant.

All the inoculated cultivars formed nodules, with considerable differences in the numbers. For example, cultivar NEC-K 147 from Greece produced 19.2 nodules and 413 mg of dried nodule tissue/plant (mean for three harvests); whereas a cultivar NEC-K 126 from Spain produced only 1.7 nodules and 1.8 mg dried nodule tissue/plant when inoculated with the same *Rhizobium* strain. It was possible to identify some of the lines which had higher nodule forming ability and lines with low nodulating ability.

These results suggest that by inoculation with effective strains of *Rhizobium* the yield of chickpea can be considerably increased in dry areas. It also seems possible to select or breed cultivars for both increased nitrogen-fixation and for grain yield.

- Rafiqul Islam (ICARDA).

Grain Quality and Biochemistry

Program at ICRISAT

The Grain Quality and Biochemistry Program is concerned with all the crops of ICRISAT, and the objectives are to identify cultivars with improved nutritional quality and superior grain quality characteristics.

In the case of chickpea, about 18 000 samples have been analyzed for protein content, and the range in protein percent was from 10.6 to 31.1 with a mean of 20.5 percent. Sulphur amino acids and tryphtophan have also been analyzed in several cultivars. Chemical analyses of desi and kabuli cultivars were carried out and some notable differences were observed. Cooking quality characteristics and digestibility studies using *in vitro* techniques are being carried out in several chickpea cultivars. In a few selected samples, fractionation of proteins and chemical analysis of samples collected at different stages of maturation have been carried out.

- U. Singh and R. Jambunathan (ICRISAT).

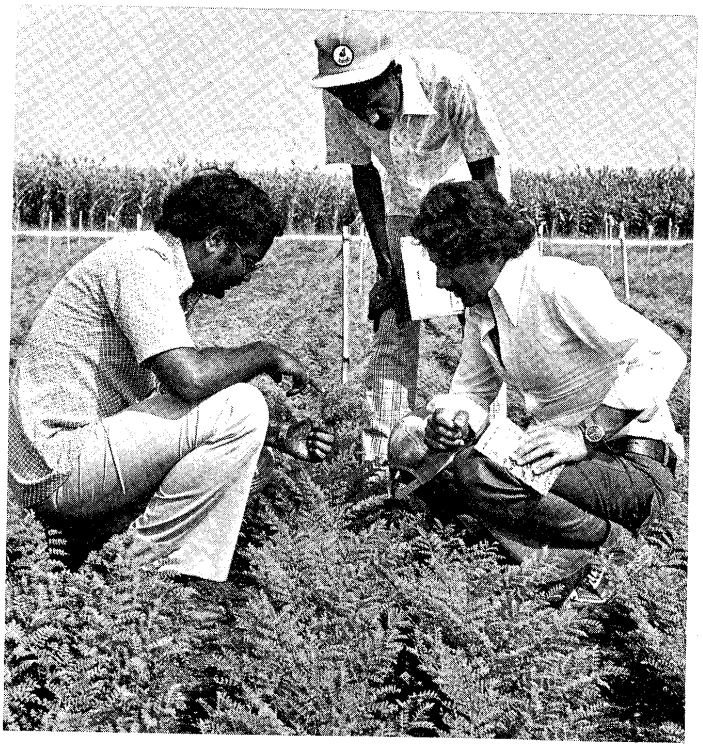

Fig. 1. Dr. C. L. L. Gowda, Chickpea Breeder, discusses chickpea material in ICRISAT fields with Mr. Assadullah Habibi from Afghanistan, and E. L. Tigani Siddig Mohamed from Sudan, who are undergoing training at ICRISAT Center. Details of training programs are obtainable from Dr. D. L. Oswalt, ICRISAT.