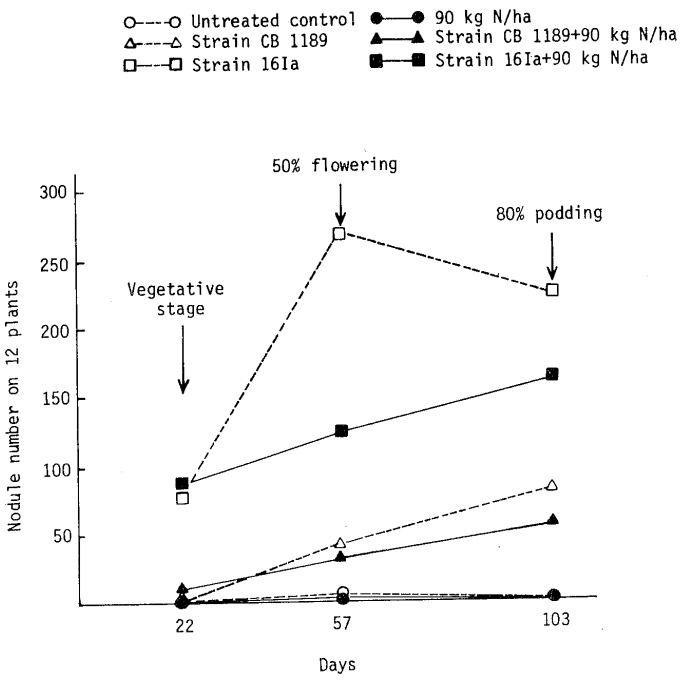

Figure 1. Effect of inoculation and nitrogen on nodule number.

Effect of Single, Double, and Multiple Strains of *Rhizobium* on Nodulation of a Kabuli-Type Chickpea

Most commercial inoculants are made from a number of different strains of *Rhizobium*. It is thought that such multiple-strain inoculants might be more stable across a range of different host cultivars and environments. There are indications in some legume species that such inoculants may be substantially less effective than single-strain inoculants in certain situations. Very little work, however, has been reported on the relative performance of single-and multiple-strain inoculants in chickpeas.

An experiment was therefore conducted on the ICARDA farm at Tel Hadia during the 1978-79 growing season with a large-seeded kabuli type chickpea (cv. Syrian Local Large, ILC-1929). Three strains of *Rhizobium* (3827, Ca-7, and IC-26) were chosen on the basis of their nodule-production ability in a strain trial experiment conducted in the previous year (1977-78). Each strain was grown separately in Yeast Mannitol Broth (YMB) and mixed with irradiated peat. Equal proportions of the strains were used when preparing multiple-strain inocula. Each of the eight treatments (Table 1) had four replications. Approximately 240 mm rainfall was received during the growing period and no supplementary irrigation was provided.

Table 1: Nodule number, nodule dry weight, and grain yield of chickpea as affected by single-, double-, and multiple-strain inoculants of *Rhizobium*.

Treatment	Nodule No./plant	Nodule dry wt (mg/plant)	Yield (kg/ha)
Noninoculated	6.4	27.7	1801
3827	26.0	65.8	1966
Ca7	41.4	50.4	1855
IC 26	40.5	62.1	2335
3827 + Ca 7	24.4	65.8	1990
Ca 7 + IC 26	31.2	60.5	2330
3827 + IC 26	12.8	65.9	1860
3827 + IC 26 + Ca 7	51.1	68.5	2284
LSD 5%	8.4	10.5	266

The noninoculated plants produced only a few nodules (Table 1). Inoculation greatly increased the nodule production. Inoculation with a single strain (Ca 7 and IC 26)produced more nodules than the combination of strains. Though the number of nodules differed considerably in the different inoculation treatments, the total nodule weight per plant remained more or less similar whether inoculated with single, or multiple strains. It appears that plants with fewer nodules compensated by producing larger nodules. The plants inoculated with IC 26 alone or in combination with Ca 7 or with Ca 7 + 3827 produced higher yields. The other two strains alone or in combination did not affect grain yield when compared with the control, and combination of IC 26 with 3827 resulted in a similar yield level. These results indicate that the presence of one effective strain in an inoculant is sufficient to produce adequate nodulation and to increase the yield of chickpea and that the efficiency of such a strain could be lost by

combining it with a less effective strain. Therefore, it is essential that an effective strain is identified by proper screening of a large number of strains for each location.

-- *Rafiqul Islam (ICARDA).*

Effect of Methods of Inoculation on Nodulation and Yield of Chickpea

Separate inoculations of a large number of seed lots for breeding and germplasm nurseries is a very time-consuming and costly process. Further, it was found that seed inoculation of spring-planted chickpeas on the ICARDA farm at Tel Hadia resulted in much poorer nodulation than in the winter-planted chickpea. The nodules of the spring-planted crop were located near the crown region only, possibly because of inadequate movement of the bacteria into the soil profile due to lack of sufficient moisture. It was, thus considered necessary to develop a simpler and more efficient method of inoculation. The present experiment was conducted to evaluate various methods of inoculation.

The experiment was planted on 17 February 1979 on the ICARDA farm at Tel Hadia, Syria. Four methods of inoculation included (1) conventional method (peat-based inoculum suspended in cellulose gum was mixed thoroughly with the seeds, dried and planted), (2) liquid method (peat-based inoculum suspended in water directly poured into the furrows), (3) direct peat placement method (peat-based inoculum was mixed with some field soil and placed directly into the planting furrows), and (4) fresh broth was mixed with sterilized sand and placed directly into the furrows. For each method of inoculation, three strains of *Rhizobium* were used. The peat inoculum contained approximately 10^9 to 10^{11} bacteria/g peat at the time of inoculation and the same quantity of peat inoculum was used for the different methods of inoculation. When adding fresh broth, adjustments were made to ensure an equivalent number of bacteria per plot. Each treatment was replicated four times.

Harvests were made at several stages of growth for nodulation assessment. Nodulation data of only one harvest, i.e., at the early-flowering stage, are given in Table 1. Nodulation was best with the liquid method of

Table 1. Effect of inoculation method and strain of *Rhizobium* on nodulation and grain yield of chickpeas at Tel Hadia, 1979.

Treatment	Nodule No./plant *Rhizobium* strains				Nodule dry wt (mg/plant) *Rhizobium* strains				Yield (g/plant) *Rhizobium* strains			
	3827	3889	IC-26	Mean	3827	3889	IC-26	Mean	3827	3889	IC-26	Mean
METHOD												
Seed inoculation	8.1	7.0	9.3	8.1	22.1	23.3	40.1	28.5	5.2	5.4	5.9	5.5
Liquid method	21.3	21.5	21.8	21.5	63.0	58.5	32.9	51.5	7.4	5.8	7.0	6.7
Fresh broth inoculum sand mixture method	3.2	3.4	3.6	3.4	17.3	1.4	9.4	9.4	6.4	5.5	5.2	5.7
Direct peat placement	20.0	17.2	14.9	17.4	67.3	69.7	10.0	49.0	6.5	6.6	4.9	6.0
Mean	13.2	12.3	12.4		42.4	38.2	23.1		6.4	5.8	5.8	
LSD at 5% for methods of inoculation				3.7				24.3				NS

NS = Not significant