

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 <i>Rhizobium</i> strains			Nodule dry wt (mg/plant) <i>Rhizobium</i> strains			Yield (g/plant) <i>Rhizobium</i> 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	3.7	42.4	38.2	23.1	38.2	6.4	5.8	5.8	5.8
LSD at 5% for methods of inoculation												24.3
												NS

NS = Not significant

inoculation. This was followed by the direct peat placement method. Fresh broth + sand mixture was the poorest. The three strains showed little difference in nodulation. Also, the methods of inoculation x strains of *Rhizobium* interaction was not significant. The yield per plant was not affected significantly by the different inoculation methods, although there was a trend for the liquid method to be slightly superior to others.

These results indicate that the liquid method of inoculation was more effective in terms of nodulation than the others. The water added along with the culture may have ensured a better distribution of *Rhizobium* in the rhizosphere and thus more nodule production occurred. This method is simple, less time-consuming and, therefore, best suited for nurseries and trials where a large number of germplasm lines are required to be planted.

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### Interaction of Chickpea Cultivars with *Rhizobium* Strains at Dohad in Gujarat State

An experiment was conducted at Dohad, Gujarat State, India during the post-rainy season of 1978-79 to study the response of four chickpea cultivars, BG-208, H-203, Chaffa (local), and Dohad Yellow (local) to inoculation with three strains of *Rhizobium*: F 75 (Indian Agricultural Research Institute, New Delhi), H 45 (JNKVV University, Jabalpur), and Paushak (local). The experiment was of a split plot design, with four replications. Fertilizer was applied at sowing at the rate of 50 kg P<sub>2</sub>O<sub>5</sub> + 10 kg N/ha. Nodulation was recorded at 45 days after sowing, while the plant heights, numbers of pods, and yields per plant and per hectare were recorded at harvest.

Table 1 shows that at 45 days after sowing the noninoculated plants averaged 5.0 nodules per plant but those inoculated with the *Rhizobium* strain F 75 had significantly more nodules (11.9) per plant. There were no significant differences between varieties. Inoculation with *Rhizobium* strains increased grain yield in comparison with the noninoculated control. *Rhizobium* strain F 75 produced significantly greater yields from Dohad Yellow and Chaffa than did the other *Rhizobium* strains. The variety Dohad Yellow and

Table 1. Effect of inoculation with *Rhizobium* on nodule number and grain yields of chickpea at Muvalia Farm, Dohad, Gujarat in 1978-79.

Variety <i>Rhizobium</i> strains	BG-203		H-208		Chaffa		Dohad yellow	
	Nodule No./plant	Yield (kg/ha)	Nodule No./plant	Yield (kg/ha)	Nodule No./plant	Yield (kg/ha)	Nodule No./plant	Yield (kg/ha)
Noninoculated	6.5	1506	4.6	1274	4.0	1125	5.2	1518
F 75	11.7	2435	10.7	2202	10.0	2345	15.4	2988
H 45	7.5	2381	8.2	2226	9.3	2274	10.2	2631
Paushak	9.7	2306	6.2	2113	5.1	1952	8.8	2089
<b>Nodulation</b>	SE (Means)	LSD at 5%	CV (%)					
Varieties (V)	+ 0.72	NS	34.8					
<i>Rhizobium</i> strains (S)	+ 0.64	1.99	30.7					
V x S	+ 1.28	NS						
<b>Grain yield</b>								
Varieties (V)	+ 117	NS	22.4					
<i>Rhizobium</i> strains (S)	+ 89	234	19.0					
V x S	+ 198	NS						