https://doi.org/10.29321/MAJ.10.A03087

Madras agric. J. 65 (6) : 363—366, June, 1978.

Nitrogen and Phosphorus needs of Gram (*Cicer arietinum*) along with Bacterial Fertilization

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Experiment conducted at R.B.S. College Agricultural Research Farm Bichpuri, Agra to find out the response of Bacterial Fertilization to gram with N and P levels has shown that : (1) Gram responds favourably to inoculation and N and P Fertilization. Inoculation increased the grain and straw yield by 12.4 and 9.5 per cent. (2) Inoculation at 80 or 120 kg P_2O_5/ha alone or with 15 kg N/ha as starter dose was statistically equally effective to nitrogen fertilization at 15 or 30 kg with 80 or 120 kg P_2O_5 in respect of yield and N and P content of plants and (3) Inoculation alongwith 80 kg P_2O_5 proved to be the most economic combination which could increase 33 per cent grain yield over control, 18.6 per cent over inoculation alone and 11.8 per cent over inoculation with 40 kg P_2O_5.

Biological nitrogen fixation has been the mainstay for the nitrogen nutrition of crops at least in developing countries like India where the cost of fertilizers has gone up steeply. Atmospheric nitrogen can be fixed by *Rhizobium* the legume bacteriax in the nodules. The *Rhizobium* legume symbiosis is estimated to add nearly 14 million tons of nitrogen per annum all over the world which is almost half of the industrially fixed nitrogen (Subba Rao, 1974). Among several environmental and biochemical factors affecting nitrogen fixation, phosphate manuring of legumes is well understood by different workers (Katti, 1968, Singh, 1971; Tikka, 1972). Starter dose of N application through fertilizer along with inoculation may help raising the nitrogen fixing capacity. An experiment was conducted to assess the capacity of *Rhizobium* to fix atmospheric nitrogen by gram crop in the soil-climate-complex of Agra and to find out suitable combination of inoculation and / or nitrogen and phosphorus for the practical use.

MATERIALS AND METHODS

An experiment was conducted at the R.B.S. College Research Farm, Bichpuri, Agra on sandy loam soil, low in available nitrogen, medium in available phosphorus and high in available potassium (available N = 233.2 kg/ha, available P_2O_5 = 28.7 kg/ha

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and available K_2O = 342.0 kg/ha). The experiment was laid out in a randomized block design with three replications with gross plot size of 9 x 5 m. The total amount of nitrogen and phosphorus was placed 5 cm below the seed at sowing through urea and superphosphate, respectively (Table I). *Rhizobium* culture was applied by coating arround the seeds.

TABLE I. Effect of inoculation and N and P fertilizer application on yield and N and P nutrition of gram

Treatments	Yield (q/ha) (%)		N content (%)		P content (%)		N uptake (kg/ha)		P uptake (kg/ha)		Total uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	N	P
N_0P_0	21.0	22.5	2.52	0.72	0.42	0.06	52.90	16.20	8.81	1.35	69.10	10.16
N_1P_0	23.7	24.7	2.81	0.80	0.45	0.05	69.02	19.77	10.67	1.24	88.79	11.91
N_1P_1	25.3	25.0	2.92	0.79	0.76	0.09	73.92	19.80	19.24	2.25	93.72	21.49
N_1P_2	28.2	27.9	2.91	0.78	0.88	0.12	81.50	21.72	24.25	3.34	103.22	27.59
N_1P_3	28.2	27.8	2.92	0.78	0.86	0.13	82.43	21.72	24.27	3.62	104.15	27.89
N_2P_0	23.6	24.6	2.89	0.79	0.46	0.05	68.35	19.43	10.90	1.23	87.78	12.13
N_2P_1	25.1	25.0	2.91	0.79	0.75	0.10	73.04	19.73	18.83	2.49	92.77	21.32
N_2P_2	28.0	27.0	2.91	0.78	0.85	0.13	81.50	21.04	23.80	3.51	102.54	27.31
N_2P_3	28.1	27.8	2.92	0.79	0.88	0.12	82.11	22.01	24.70	3.39	104.12	28.09
N_3P_0	23.9	25.9	2.90	0.82	0.40	0.06	69.25	21.19	9.55	1.55	90.44	11.10
N_3P_1	25.0	26.1	2.90	0.80	0.70	0.09	67.45	20.90	17.41	2.35	88.35	19.76
N_3P_2	28.1	27.6	2.92	0.79	0.83	0.12	81.90	21.84	23.31	3.32	103.74	26.63
N_3P_3	28.0	28.3	2.90	0.80	0.83	0.14	75.60	28.70	23.94	3.27	98.30	27.21
N_4P_0	23.4	26.5	2.92	0.82	0.45	0.04	68.27	21.70	10.52	1.06	89.97	11.58
N_4P_1	25.0	26.5	2.90	0.82	0.73	0.80	72.65	21.70	18.30	2.12	94.35	20.42
N_4P_2	28.0	27.8	2.90	0.81	0.81	0.11	82.04	22.52	22.66	3.06	104.56	25.72
N_4P_3	28.1	27.8	2.92	0.82	0.85	0.12	82.05	22.84	23.90	3.34	104.89	27.24
C.D. 5%	2.1	1.8	0.22	0.06	0.08	0.03	7.94	1.92	2.03	0.44	12.50	3.12

N_0 = No inoculation and no fertilization
N_1 = Fertilizer N @ 15 kg/ha
N_2 = Inoculation only
N_3 = Inoculation with fertlizer N @ 15 kg/ha
N_4 = Fertilizer N @ 30 kg/ha

P_0 = No application of phosphorus
P_1 = Phosphorus @ 40 kg P_2O_5/ha
P_2 = Phosphorus @ 80 kg P_2O_5/ha
P_3 = Phosphorus @ 120 kg P_2O_5/ha

C-24 variety of gram (*Cicer arietinum*) at 50 kg/ha was sown at a row distance of 30 cm. At harvest grain and straw yields were recorded and the samples were analysed for nitrogen and phosphorus contents in the wet digest (Snell and Snell, 1955), and vanadate phosphomologybate yellow method (Chapman and Pratt, 1961), respectively. The uptake of these nutrients was also calculated. The statistical analyses were done as per the methods described by Snedecor and Cochran (1967). Profit index of different treatments was calculated over the net return under control. The net return value under control was considered equivalent to 100. Net return as given in Table II refers to the gross return minus total cost of cultivation.

RESULTS AND DISCUSSION

From the perusal of the data in Table I, it is evident that application of N and P fertilizers and inoculation with *Rhizobium* culture had a significant effect on grain yield. Highest yield i.e. 28.0 to 28.2 q/ha was obtained where phosphorus at the rate of 80 kg or 120 kg P_2O_5 was applied with either of nitrogen level. The effect of each nitrogen treatment in respect to yield was almost the same at both the P levels. Irrespective of nitrogen levels, 80 kg P_2O_5 produced the same amount of grain as produced by the application of phosphorus @ 120 kg P_2O_5/ha. The addition of nitrogen with inoculation did not significantly increase the grain yield over inoculation alone or with the levels of phosphorus. At 80 kg P_2O_5/ha inoculation increased the grain yield by 33.0, 18.6 and 11.6 percent over control, inoculation alone and inoculation with 40 kg P_2O_5, respectively. Thus, bacterial inoculation in gram proved to be more advantageous if it is advocated with phosphorus application @ 80 kg P_2O_5. Inoculation replaced the use of 15 kg/ha nitrogen and thus, could save 33.3 kg urea per hectare. Inoculation alone can fulfil the nitrogen requirement of gram crop but sufficient amount of phosphorus. Tikka (1972) also reported that application of P_2O_5 is a must for gram. According to Katti (1968) yield characters of gram were influenced by inoculation + P_2O_5 treatment in alluvial clay loam soil. The data in Table II clearly reveal that inoculation of gram with

TABLE II. Economics of different treatments of *Rhizobium* inoculation and N and P Fertilizer application in gram

Treatments	Net return Rs./ha	Profit index
Control (N_0P_0)	2253.50	100.0
N_1P_0	2623.35	116.4
N_1P_1	2591.55	115.1
N_1P_2	2776.65	123.2
N_1P_3	2526.15	112.0
N_2P_0	2666.00	118.3
N_2P_1	2612.30	115.9
N_2P_2	2792.30	123.6
N_2P_3	2517.00	111.6
N_3P_0	2651.15	117.6
N_3P_1	2543.65	113.3
N_3P_2	2748.15	121.7
N_3P_3	2469.15	109.5
N_4P_0	2527.80	112.1
N_4P_1	2503.30	111.0
N_4P_2	2661.30	118.0
N_4P_3	2424.80	107.6

Rhizobium has increased the yield. Further, *Rhizobium* inoculation along with 60 kg P_2O_5/ha has been found economical.

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