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Short Communication

Response of Isabgol to *Azotobacter* Inoculation under Field Conditions in Arid Zone

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Isabgol (*Plantago ovata* Forsk.), an annual stemless herb, is grown as a cash crop in parts of Rajasthan and Gujarat. Export of seed and husk earns good amount of foreign exchange for the country. The husk is used as a medicine for correcting the intestinal disorders, particularly in habitual constipation, chronic diarrhoea and dysentery. This crop is grown on marginal lands with irrigation in *rabi* season and it matures in about 4 months. The areas where the crop is grown receive very low rainfall with erratic distribution. The yield of this crop is low because it is grown on nutritionally deficient soils with no or small quantity of N fertilizers (Godawat, 1999). Ramesh *et al.* (1989) reported that fertilizers had little effect on vegetative growth, yield attributes and yield of isabgol. On the contrary Singh *et al.* (1994) recorded enhanced seed yield with increasing nitrogen and phosphorus fertilizers. Under such conditions, the use of various nitrogen-fixing bacteria to enrich the soil environment offers considerable scope to supplement the N requirements of this crop. Among these bacteria, *Azotobacter,* a free-living nitrogen fixing bacterium was found to fix atmospheric nitrogen and enhance the yields of many crop plants (Wani 1997; Lakshminarayan and Narula, 1995). Therefore, an attempt has been made to quantify the response of isabgol to inoculation with *Azotobacter* in combination with organic and inorganic sources of nitrogen under field conditions.

The experiment was conducted at the C.R. Farm, Central Arid Zone Research Institute, Jodhpur, during *rabi* season of 1997. The soil is hyperthermic, Typic Haplocambids with pH 8.1, EC 0.18 dS m^{-1}, organic carbon 0.22%, total nitrogen 0.03%, available phosphorus 16 kg ha^{-1} and available potassium 225 kg ha^{-1}. The soil contains 85% sand, 8.1% silt and 5.5% clay. Seven treatments viz., control, inoculation with *Azotobacter* (*A. chroococcum* from Microbiology section), 5 t FYM ha^{-1}, 40 kg N ha^{-1}, *Azotobacter* + 2.5 t FYM ha^{-1}, 2.5 t FYM ha^{-1} + 20 kg N ha^{-1}, and a combination of *Azotobacter* + 2.5 t FYM + 20 kg N ha^{-1} were replicated thrice in randomized block design. Isabgol (cv. GI-2) was sown in rows 20 cm apart with plant to plant spacing of 5 cm with a seed rate of 6 kg ha^{-1} in November, 1997. After sowing seeds were covered thinly by raking the soil and a light irrigation was given immediately. Second irrigation was given one week after sowing and third at 3 weeks after sowing. After that, irrigations were given at an interval of 3 weeks. The crop was harvested close to the ground in 2nd week of March, 1998. At 50 days of crop growth,

Table 1. Effect of different nitrogen sources on seed yield, nitrogen content of isabgol and nitrogen fixing potential of rhizosphere soil

Treatment	N_2-fixing potential of rhizosphere soil (n mole C_2H_4 h^{-1} 50 mg^{-1} soil)	Seed yield (kg ha^{-1})	Nitrogen (%)
Control	77.4	646	2.37
Azotobacter	121.0	850	2.59
5 t FYM	82.2	807	2.59
40 kg N	74.2	985	2.86
Azotobacter + 2.5 t FYM	136.5	885	2.76
2.5 t FYM + 20 kg N	91.5	903	2.69
Azotobacter + 2.5 t FYM + 20 kg N	146.2	920	2.72
LSD (p = 0.05)	NS	99	0.08

rhizosphere soil samples in all the treatments were collected after uprooting the plants carefully and were analyzed for N_2-fixing potential measured as N_2-ase activity by incubating 50 mg soil in 7 ml test tubes containing 3 ml of nitrogen free semi-solid medium (K_2HPO_4 0.8 g, KH_2PO_4 0.2 g, NaCl 0.19 g, $Na_2MoO_4.2H_2O$ 0.025 g, $MnSO_4.2H_2O$ 0.01 g, Fe-EDTA 4 ml of 1.64% aq. sol., $MgSO_4.7H_20$ 0.5 g, malic acid 5.0 g, sucrose 5.0 g, mannitol 5.0 g, yeast extract 0.1 g, glutamic acid 0.37 g, BTB 3 ml of 0.5% EtOH, water 1000 ml, pH 6.8, agar 1.75 g) at 30±1°C for 48 h. Then the cotton plugs were replaced with subaseals. About 10% of the air in the test tubes was replaced by acetylene. These tubes were incubated at 30±1°C for 24 h. The gas mixture was analyzed for the production of ethylene in an AIMIL Nucon gas chromatograph employing Poropak-T column (2 x 0.03 mm) at 110°C oven temperature with hydrogen as fuel and nitrogen as carrier (Rao and Venkateswarlu, 1982). Nitrogen content of plant samples was analyzed by modified Kjeldahl method. All the data were statistically analyzed in a randomized block design as per standard procedure.

Nitrogen fixing potential, measured as N_2-ase activity of the rhizosphere soils in different treatments, varied from each other indicating the presence of nitrogen fixing bacteria in the isabgol rhizosphere as has been reported in the rhizosphere of many other crop plants (Mulder, 1975); but it was not significant. Nitrogenase activity in all the treatments was enhanced over the control with maximum enhancement with *Azotobacter* inoculation. The nitrogen fixing potential was further improved with the application of FYM, indicating thereby the supply of nutrients for the growth and multiplication of the bacterium. The soils in the tropics are generally poor in organic matter that serve as energy source for such N_2-fixing bacteria. Addition of organic matter/substances such as FYM into the soil not only provides nutrients for N_2-fixing bacteria but also helps these bacteria to overcome the antagonistic effects of soil fungi and bacteria (Vancura and Macura, 1961). The reduction in soil N_2-ase activity with 40 kg N ha^{-1} might be due to the end product inhibition caused by high dose of nitrogen fertilizer (Rao and Venkateswarlu, 1982).

There was significant variation in the seed yield of isabgol in different treatments with the maximum increase with 40 kg N ha^{-1}. The increase in seed yield was also observed by Singh *et al.* (1994). A significant enhancement in the seed yield upon inoculation with *Azotobacter* was observed and this increase was further enhanced with the application of FYM and/or N fertilizer at 20 kg ha^{-1} as has been reported by Wani (1997), Mulder (1975) and Lakshminarayan and Narula (1995) in many crops upon inoculation with *Azotobacter*. Though the seed yield of isabgol was maximum with 40 kg N ha^{-1} it was at par with that of other treatments where 10 kg N ha^{-1} was given along with FYM or *Azotobacter* inoculation. Similar trend was observed with respect to the nitrogen concentration in isabgol. Increased N concentration, along with enhanced grain yields upon inoculation, is indicative of nitrogen fixation or increased nitrogen assimilation by the plants (Pacovsky *et al.*, 1985). Wani (1997) and Lakshminarayan and Narula (1995) reported significant increase in nitrogen uptake in many crops upon inoculation with *Azotobacter*. It is suggested that the yield of isabgol can be improved and made sustainable by adopting integrated nutrient management practices using *Azotobacter* as seed inoculant, coupled with FYM application with the judicious use of N fertilizer.

References

Godawat, S.L. 1999. Prospects of *isabgol (Plantago ovata* Forsk.) cultivation in Rajasthan. In: *Management of Arid Ecosystems* (Eds. A.S. Faroda, N.L. Joshi, S. Kathju and Amal Kar), pp. 229-234. Arid Zone Research Association of India, Scientific Publishers, Jodhpur.

Lakshminarayan, K. and Narula, N. 1995. Development of *Azotobacter chroococcum* as biofertilizer for cereals and oilseed crops. In *Plant Microbe Interaction in Sustainable Agriculture* (Eds. R.K. Behl, A. Khurana and R.L. Dogra), pp. 115-120. Bioscience Publication, Hisar.

Mulder, E.G. 1975. Physiology and ecology of free living nitrogen fixing bacteria. In *Nitrogen Fixation by Free Living Micro-organisms* (Ed. D.P. Stewart), pp. 3-28. Cambridge University Press, Cambridge, UK.

Narula, N., Nijhawan, D.C., Lakshminarayan, K., Kapoor, R.L. and Verma, O.P.S. 1991. Response of pearl millet *(Pennisetum glaucum)* to soil isolates and analogue nutrient mutant of *Azotobacter chroococcum. Indian Journal of Agricultural Sciences* 61: 484-487.

Pacovsky, R.S., Paul, E.A. and Bethlenfalvay, G.J. 1985. Nutrition of sorghum plants fertilised with nitrogen and inoculated with *Azospirillum brasilense. Plant and Soil* 85: 145-148.

Ramesh, M.N., Farooqi, A.A., Subbaiah, T. and Subaiah, T. 1989. Influence of sowing date and nutrients on growth and yield of Isabgol *(Plantago ovata Forsk.). Crop Research* 2: 169-174.

Rao, A.V. and Venkateswarlu, B. 1982. Nitrogen fixation by *Azospirillum* isolated from tropical grasses native to Indian desert. *Indian Journal of Experimental Biology* 20: 316-318.

Singh, I. and Chouhan, G.S. 1994. Effect of mixtalol and different combinations of nitrogen and phosphorus fertiliser on growth and yield of blond psyllium (*Plantago ovata*). *Indian Journal of Agronomy* 39: 711-712.

Vancura, J. and Macura, J. 1961. The effect of root excretion on *Azotobacter. Folia Microbiologica* 61: 250-259.

Wani, S.P. 1997. Role of free living and associative diazotrophs in non-legumes. In: *Biotechnological Approaches in Soil Microorganisms for Sustainable Crop Production* (Ed. K.R. Dadarwal), pp. 109-127. Scientific Publishers, Jodhpur.