Environment & Ecology 29 (3A) : 1296—1298, 2011
 ISSN 0970-0420

Effect of Integrated use of Non-Symbiotic Nitrogen Fixing Bacteria and Inorganic Nitrogen on Low Land Rice in an Acid Soil

H. SAHA[1] AND M. PRAMANICK[2]

[1]*Department of Agricultural Chemistry & Soil Science*
[2]*Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya*
Mohanpur 741252, India

Abstract

A field experiment was conducted during the rainy (*kharif*) season of 2002 and 2003 at Kalimpong, Darjeeling to study the effect of integrated use of non-symbiotic N_2-fixing bacteria and inorganic nitrogen on low land rice (*Oryza sativa* L.). Highest grain yield (45.71 q/ha) was recorded in the treatment receiving mixed inoculants of *Azotobacter* and *Azospirillum* along with inorganic nitrogen at 60 kg/ha. Statistically comparable yield of 45.53 q/ha was obtained in the treatment receiving mixed inoculants of *Azotobacter* and *Azospirillum* along with inorganic nitrogen at 30 kg/ha. Single inoculants either *Azotobacter* or *Azospirillum* along with any two levels of inorganic nitrogen (N_{30} or N_{60}) gave comparable yields with the treatment receiving recommended dose of N at 120 kg/ha. Statistically higher N uptakes were recorded in the treatments of mixed inoculants along with N_{30} and N_{60}. Highest agronomic efficiency and physiological efficiency (11.43 kg grain/kg N and 68.61 kg grain/kg N, respectively) were recorded in the treatment receiving mixed inoculants along with inorganic N at 30 kg/ha. The population of aerobic non-symbiotic N_2-fixing bacteria also conformed to the data of grain yield.Thus, mixed inoculants of *Azotobacter* and *Azospirillum* along with inorganic nitrogen at 30 kg/ha saved 90 kg inorganic N/ha for low land rice cultivation in the hilly soils of Kalimpong.

Key words : Non-symbiotic N_2-fixing bacteria, Inorganic nitrogen, Integrated use, Lowland rice, Hilly acid soil.

The poor efficiency of applied nitrogen due to sandy texture, slopy nature and low cation exchange capacity of soils are the major reasons behind the under-exploitation of the yield potentials of rice varieties in the soils of Darjeeling. Many workers reported the beneficial effects of integrated use of biofertilizers and fertilizer nitrogen on crop growth, yield and maintenance of soil fertility (1). Though the response of rice to inoculation with non-symbiotic N_2-fixing bacteria, viz, *Azotobacter* and *Azospirillum* has been inconsistent under field condition, yet there are some reports of improved plant growth and yield of rice (2,3). Therefore, in the present investigation a field experiment was conducted to study the effect of integrated use of inoculation with non-symbiotic N_2-fixing bacteria, viz, *Azotobacter* and *Azospirillum* along with two levels of inorganic nitrogen in different combinations on low land rice cultivation in the hilly soils of Kalimpong.

Methods

A field experiment was laid out in a randomized block design, replicated thrice with seven treatments on a clayey loam soil (Typic Haplumbrept) of Regional Research Station, Uttar Banga Krishi Viswavidyalaya, Kalimpong during *Kharif* season of 2002 and 2003. The test crop was rice (*Oryza sativa* L) cv IET 13483. The characteristics of experimental soil has been shown in Table 1. Thirty days old seedlings were used for transplanting. The cultures of *Azotobacter* and *Azospirillum* collected from Bidhan Chandra Krishi Viswavidyalaya were applied at 1 kg/ha by root dipping for 30 minutes. The plot size and plant geometry were 2m × 2 m and 15 cm ×10 cm, respectively. The treatments were as follows : T_1 : N_{120} (control) ; T_2 : *Azotobacter* + N_{30} : T_3 : *Azotobacter* + N_{60} : T_4 : *Azospirillum* + N_{30} : T_5 : *Azospirillum* + N_{60}; T_6 : Mixed Inoculant (*Azotobacter* + *Azospirillum*) + N_{30}; T_7 : Mixed Inoculant (*Azotobacter* + *Azospirillum*) + N_{60}. Farm yard manure was applied at 5 tonnes /ha in all the treatments. Analyses of soil and plant samples were done as per the standard procedures (4—6). The population of aerobic non-symbiotic N_2-fixing bacteria of the rhizosphere soil were enumerated by the

Table 1. The characteristics of experimental soil.

Parameters	Value
Soil reaction	5.8
Organic carbon	21.3 g/kg
Available NH_4^+-N	280.0 kg/ha
Bray and Kurtz No. lp	6.6 kg/ha
Ammonioum - acetate K_2O	179.0 kg/ha
Cation exchange capacity	17.1 cmol (p+)/kg
Population of aerobic non-symbiotic N_2- fixing bacteria	65.0 × 10^4 CFU/g soil

standard method (7). Agronomic and physiological response of rice to applied inorganic nitrogen were also computed (8).

Results and Discussion

Response of low land rice to different treatments has been presented in Table 2. The statistically comparable grain yields between single inoculated treatments along with two levels of inorganic nitrogen might be due to the failure of higher inorganic nitrogen (60 kg/ha) in producing extra positive effect on yield over lower level of inorganic nitrogen at 30 kg/ha. This might be attributed to the beneficial role of lower level of inorganic nitrogen on non-symbiotic nitrogen fixation (9). The higher level of N application in N_{60} might have also caused the accumulation of ammonium nitrogen to such a level that inhibited N_2-fixation as the process is inhibited by the end product itself (10).

Statistically comparable grain yields between single inoculated treatments irrespective of levels of inorganic nitrogen and treatment receiving only the recommended dose of inorganic nitrogen at 120 kg/ha were observed in the present investigation. Similar finding was also reported (11). The highest grain yields were recorded in the mixed inoculated treatments receiving inorganic nitrogen either 30 kg/ha (45.53 q/ha) or 60 kg/ha (45.71 q/ha) which were found statistically at par at 5% level of significance. The statistically greater impact of the mixed inoculants might be attributed by the synergistic effect of *Azotobacter* and *Azospirillum* throgh the greater microbial production of plant growth substances, increased rate of water and nutrient uptake from the soil and non-symbiotic N_2-fixation (1).

All the inoculated treatments showed significantly higher population of aerobic non symbiotic N_2-fixing bacteria. It might be due to the increased nitrogenase activity of the microbial population in the rhizosphere (11). The population of the same was recorded more the single inoculated treatments receiving lower level of N (30 kg/ha). The significantly highest population were recorded in the mixed inoculated treatments receiving inorganic nitrogen either at 30 kg/ha or 60 kg/ha which were found statistically at par at 5% level of significance. The lowest population was observed in the treatment receiving the recommended level of inorganic nitrogen at 120 kg/ha.

The statistically highest N uptake was recorded in the mixed inoculated treatments. The N uptake data of single inoculated treatments irrespective of levels of inorganic nitrogen and treatment receiving only the recommended dose of inorganic nitrogen at 120 kg/ha were found statistically at par at 5% level of significance. The N uptake efficiency in the mixed inoculated treatments might have increased due to

Table 2. Response of low land rice to non-symbiotic N_2-fixing bactaria and inorganic N (pooled data of two years).*Azt : Azotobacter; Azsp : Azospirillum; Azt + Azsp : Aztobacter + Azospirillum.*

Treatments	Grain yield (q/ha)	N uptake (kg/ha)	Response Kg grain/ kg N Agronomic	Physiological	Population of aerobic non-symbiotic N_2 -fixing bacteria (× 10^4 CFU/g soil)
N_{120} (control)	42.10	60.50	–	–	65
Azot + N_{30}	42.30	61.70	0.67	16.67	95
Azot + N_{60}	42.67	62.00	0.95	38.00	81
Azosp + N_{30}	43.00	62.80	3.00	39.13	99
Azosp + N_{60}	43.20	63.10	1.83	42.31	88
Azot + *Azosp* + N_{60}	45.53	65.50	11.43	68.61	114
Azot + *Azosp* + N_{60}	45.71	66.10	6.02	64.46	110
CD (P = 0.05)	1.50	1.60	2.00	12.5	10

the increased root growth.

Highest agronomic efficiency was recorded in the mixed inoculated treatment receiving lower level of N (30 kg/ha). The agronomic efficiency of inoculated treatment receiving higher level of N (60 kg/ha) was found significantly higher compared to that of any single inoculated treatments.

Highest statistically comparable physiological efficiencies were recorded in the mixed inoculated treatments (68.61 kg grain/kg N in Ml + N_{30} and 64.46 kg grain/kg N in Ml + N_{60}). The findings conformed to the data of grain yields.

The results of the present investigation show that combined inoculation of *Azotobacter* and *Azospirillum* along with 30 kg inorganic N/ha has been found the most effective integrated nutrient management with respect to nitrogen for low land rice in the hilly soils of Kalimpong.

References

1. Sardana V. 1997.Agronomic evaluation of bio-inoculants to supplement inorganic fertilizers for sustained crop production—A critical review. *Agric. Res.* 18 : 69—95.
2. Bashan Y. and H. Levanony. 1990. Current status of *Azospirillum* inoculation technology : *Azospirillum* as a challenge for agriculture. *Can. J. Microbiol*. 36 : 591—608.
3. Das A. and D. Saha. 2000. Inoculation of diazotrophs on nitrogenase activity (C_2H_2) of roots and N–transformation in the rhizosphere soils of rice. *Proc. Int. Conf. on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century.* New Delhi, India. 644—646 pp.
4. Baruah T. C. and H. P. Barthakur. 1997. *A text book* of *soil analysis.* Vikas Publ. House Pvt. Ltd., New Delhi, India.
5. Jackson M. L. 1967. *Soil chemical analysis*. Prentice Hall of India Pvt. Ltd., New Delhi, India.
6. Baldani V. L. D. and J. Debereiner. 1980. Host — Plant specificity in the infection of cereals with *Azospirillum spp. Soil Biol. Biochem*. 12 : 433—439.
7. Pramer D. and E. L. Schmidt. 1965. *Experimental soil microbiology*. Burgess Publ. Co., Minneapolis 15, Minnesota, USA.
8. Bock B. R. 1984. *Nitrogen in crop production.* R. D. Hauck (ed.) Am. Soc. Agronomy. Madison, Wisconsin, USA.
9. Kannungo P. K., B. Ramakrishnan and V. R. Rao. 1998. Nitrogenase activity of *Azospirillum* sp. isolated from rice as influenced by combination of NH_4^+-N and insecticide, carbofuran. *Chemosphere* 36: 339—349.
10. Brady N. C. and R. R. Well. 1999. The nature and properties of soils. 12th edition. Prentice Hall, New Jersy.
11. Das A. and D. Saha. 2003. Influence of diazotrophic inoculation on nitrogen nutrition of rice. *Austr. J. Soil Res.* 41 : 1543—1554.