Oryza Vol. 51 No.4, 2014 (285-288)

Response of *boro* rice to *Azospirillum* inoculation with fertilizer nitrogen in coastal Sagar Island of West Bengal

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ABSTRACT

A field experiment was conducted during the dry season of 2007-2008 and 2008-2009 at Rudranagar village in Sagar Island of South 24 Parganas, West Bengal, India to find out the response of Azospirillum inoculation at varying levels of fertilizer nitrogen on growth, yield components, yield and economics of boro rice. The results of the study showed that Azospirillum inoculation progressively increased the growth, yield contributing parameters, grain and straw yield of boro rice with the incremental application of fertilizer N up to 100 kg ha^{-1}. Azospirillum inoculation along with 100 kg N ha^{-1} registered the higher grain and straw yield, economic returns and benefit-cost ratio to rice and could save at least 30 kg N ha^{-1} which could be benevolent to the resource poor boro rice growers of coastal Sagar Island in West Bengal.

Key words: *Azospirillum inoculation, fertilizer N, response, boro rice, West Bengal*

Soil salinity is one of the potential environmental hazards associated with the physical, chemical and biological degradation leading to the unsustainability for cultivation. High concentration of soluble salts in coastal rice soil adversely affects the seed germination, survival, growth and nutrient imbalance in the plant due to high osmotic pressure and prevention of soil moisture and nutrients absorption in adequate amounts (Jena and Rao, 1988). It also depresses the nitrogen uptake by plants due to low urease activity with poor nitrogen transformation in soil (Kannan and Ponmurugan, 2010). In the coastal agro-ecosystem of West Bengal, about 0.72 million ha of land is seriously affected by variable salt toxicity resulting in declined crop productivity (Agarwal *et al*., 1982; Patra and Ray, 2002). The situation is aggravated during the lean dry season due to the combined effect of salt injury and scarcity of adequate good quality irrigation water (Mandal and Sarangi, 2011). The farmers generally apply a higher dose of fertilizers including nitrogen in soil to mitigate the salt toxicity. However, the escalating cost of nitrogenous fertilizers coupled with poor use efficiency by crop limits the rice production on a sustainable way. In this perspective, the relevance of biofertilizers as an alternative source of nitrogen is increasing rapidly because of its inherent capability to fix atmospheric N to the rhizosphere soil (Saikia *et. al.*, 2012). These non-conventional nitrogen sources are cost effective, ecofriendly and simultaneously boost up the productivity of crop (Patra *et al*., 1989). The objective of the present investigation was to assess the effect of *Azospirillum* inculation with graded doses of nitrogen on growth, yield and economics of *boro* (dry season) rice in a coastal soil of Sagar Island in West Bengal, India.

MATERIALS AND METHODS

A field experiment was conducted during the dry season of 2007-2008 and 2008-2009 at Rudranagar village in Sagar Island of South 24-Parganas, West Bengal, India. Climate of the area is hot subtropical humid. Mean maximum and minimum temperature is 36 ^{0}C and 13.5 ^{0}C, respectively. The average annual rainfall is about 1853 mm of which 75 to 80% is received during June through September. Soil was silty clay loam in texture (sand 12.2%, silt 46.5%, clay 41.3%) with pH 7.6, electrical conductivity 2.57 dS m^{-1}, organic carbon 5.4 g kg^{-1}, CEC 14.9 cmol (p^+) kg^{-1}, available N 195.6 kg ha^{-1}, available P 16.8 kg ha^{-1} and available K 235.5 kg ha^{-1}. There were ten treatments consisted of five levels of N @ 0, 40, 70, 100 and 130 kg ha^{-1} with and without biofertilizer inoculation. Nitrogen as urea was applied as per treatment schedules in three splits viz. 1/4th as basal, 1/2th at 20 days after transplanting (DAT) and the remaining 1/4th at 45 DAT. Full P_2O_5 and half of K_2O @ 65 kg ha^{-1} each through single superphosphate and muriate of potash, respectively were applied as basal and rest 1/2 th K_2O was top dressed at 45 DAT in panicle initiation stage. The carrier-based inoculants of A*zospirillium* @ 1 kg ha^{-1} was applied through dipping the seedling roots in suspension. Farmyard manure @ 10 t ha^{-1} was uniformly applied to all plots during final land preparation. The experiment was arranged in a randomized block design with three replications (Table 1). Thirty days-old seedlings of rice cv. Annada (IET 6223) was transplanted in the second week of December at a spacing of 20 cm x 10 cm and harvested in April in each cropping season. The net plot size was 4 m x 2 m. Standard agronomic and plant protection measures were followed. Harvested rainwater stored in field adjacent pond during wet season was used for crop irrigation and was applied at 3±1 day after disappearance of ponded water. The data was analyzed for statistical significance of the treatment effects following the least significance difference (P = 0.05) test outlined by Gomez and Gomez (1984). Net economic return was calculated after subtracting the cost of cultivation from the gross economic return. Benefit: cost ratio was expressed as the ratio of gross economic return to cost of cultivation. The physical and chemical properties of soil were determined by the methods as outlined by Jackson (1973).

RESULTS AND DISCUSSION

Application of biofertilizer increased the grain and straw yield of *boro* rice over control (no-nitrogen) in both the years, but the difference was significant only for grain yield during 2008-09 (Table 1). Incorporation of *Azospirillium* inoculants at variable level of nitrogen fertilization also augmented the grain and straw yields significantly over the corresponding N levels in each year excepting 40 and 130 kg ha^{-1} in 2007-'08 and 130 kg ha^{-1} in 2008-'09 for grain and 40, 100 and 130 kg ha^{-1} in 2007-'08 and 40 kg ha^{-1} in 2008-'09 for straw. On an average, the increase in yield with the inoculation of *Azospirillium* at 0, 40, 70, 100 and 130 kg ha^{-1} of nitrogen was 12.9, 14.4, 19.7, 14.6 and 4.7 per cent for grain and 10.9, 3.2, 12.7, 11.9 and 6.2 per cent for straw over the respective nitrogen level. However, maximum grain (6.40 t ha^{-1}) and straw (7.83 t ha^{-1}) yield of rice was obtained with *Azospirillium* inoculation along with 130 kg N ha^{-1} and was at par with the incorporation of *Azospirillium* with 100 kg N ha^{-1}. This implies that not only increase the yield significantly, but application of biofertiliser (*Azospirillium*) along with fertilizer N @ 100 kg ha^{-1} created an ambient plant-microbe

Table 1. Effect of *Azospirillum* inoculation with fertilizer N on grain and straw yield of *boro* rice

Treatments	Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
	2007-08	2008-09	Mean	2007-08	2008-09	Mean
Control (no- nitrogen)	2.57	2.53	2.55	3.46	3.30	3.38
Nitrogen @ 40 kg ha^{-1}	3.73	3.60	3.67	4.58	4.86	4.72
Nitrogen @ 70 kg ha^{-1}	4.58	4.76	4.67	5.90	5.75	5.82
Nitrogen @ 100 kg ha^{-1}	5.35	5.45	5.40	6.73	6.50	6.61
Nitrogen @ 130 kg ha^{-1}	5.93	6.29	6.11	7.40	7.34	7.37
Azospirillum	2.86	2.90	2.88	3.92	3.58	3.75
Nitrogen @ 40 kg ha^{-1} + *Azospirillum*	3.97	4.44	4.20	4.80	4.94	4.87
Nitrogen @ 70 kg ha^{-1} + *Azospirillum*	5.47	5.71	5.59	6.62	6.51	6.56
Nitrogen @ 100 kg ha^{-1} + *Azospirillum*	6.02	6.36	6.19	7.50	7.30	7.40
Nitrogen @ 130 kg ha^{-1} + *Azospirillum*	6.30	6.51	6.40	7.71	7.95	7.83
SEm(±)	0.15	0.12	0.13	0.22	0.18	0.21
CD (P<0.05)	0.43	0.35	0.37	0.65	0.52	0.62

Azospirillum added @ 1.0 kg ha^{-1}

association which is helpful for obtaining higher yield of rice there by saving, 30 kg N ha^{-1}. The control plot receiving neither fertilizer N nor *Azospirillium* inoculation registered the minimum grain yield (2.55 t ha^{-1}). The influence of *Azospirillum* inculation with graded doses of nitrogen on growth and yield contributing parameters such as plant height, number of tiller hill^{-1}, panicle length, filled-grain panicle^{-1} and 1000-grain weight followed almost the same trend as in grain and straw yield of rice (Table 2). The increase in grain yield caused by *Azospirillium* inoculation irrespective of fertilizer N doses could be attributed to the improving atmospheric N fixing activity of the bacteria in rhizosphere of plants and secretion of growth hormones which in effect are partly responsible for promotion of plant growth (Kannan and Ponmurugan, 2010).

The economics of *boro* rice cultivation showed that incorporation of *Azospirillium* supplemented with increasing doses of fertilizer N consistently increased the monetary returns and benefit-cost ratio (Table 3). Maximum gross return (` 71047 ha$^{-1}$), net return (Rs. 52137 ha$^{-1}$) and benefit-cost (3.76) ratio was obtained with *Azospirillium* inoculation with 130 kg ha$^{-1}$ of nitrogen. The corresponding values were Rs. 68560 ha$^{-1}$, ` 50110 ha^{-1} and 3.71 for *Azospirillium* inoculated with 100 kg N ha^{-1}. The control plot without receiving nitrogen and biofertilizer application recorded the minimum gross (` 28542 ha$^{-1}$) and net (`15042 ha^{-1}) economic returns and lowest benefit-cost ratio (2.11). However, in terms of additional investment and the magnitude of monetary returns from the crop,

Table 2. Effects of *Azospirillum* inoculation with N on yield contributing parameters of *boro* rice cv Annada(pooled data of 2008-2009 years)

Treatments	Plant height (cm)	No. of tiller hill^{-1}	Panicle length (cm)	Filled grain panicle^{-1}(%)	1000-grain weight(g)
Control (no- nitrogen)	94.78	9.33	6.19	84.30	18.90
Nitrogen @ 40 kg ha^{-1}	98.37	10.10	6.70	85.10	19.14
Nitrogen @ 70 kg ha^{-1}	105.14	10.81	7.21	86.62	19.37
Nitrogen @ 100 kg ha^{-1}	109.42	11.20	7.58	87.14	19.70
Nitrogen @ 130 kg ha^{-1}	115.15	11.65	7.85	87.50	19.86
Azospirillum	96.67	9.95	6.54	84.73	19.12
Nitrogen @ 40 kg ha^{-1} + *Azospirillum*	103.60	10.77	7.05	86.40	19.58
Nitrogen @ 70 kg ha^{-1} + *Azospirillum*	110.09	11.51	7.67	87.33	19.83
Nitrogen @ 100 kg ha^{-1} + *Azospirillum*	113.12	12.06	7.86	88.21	20.15
Nitrogen @ 130 kg ha^{-1} + *Azospirillum*	118.83	12.19	8.10	88.16	20.20
CD (P<0.05)	4.05	0.65	0.32	0.71	0.37

Azospirillum added @ 1.0 kg ha^{-1}

Table 3. Economics of *Azospirillum* inoculation with fertilizer N on *boro* rice cultivation

Treatments	Cost of cultivation (` ha^{-1})	Gross return (` ha^{-1})	Net return (` ha^{-1})	Benefit: cost ratio
Control (no- nitrogen)	13500	28542	15042	2.11
Nitrogen @ 40 kg ha^{-1}	17175	40948	23773	2.38
Nitrogen @ 70 kg ha^{-1}	17637	51938	34301	2.94
Nitrogen @ 100 kg ha^{-1}	18100	59949	41849	3.31
Nitrogen @ 130 kg ha^{-1}	18560	67733	49173	3.65
Azospirillum	13850	32175	18325	2.32
Nitrogen @ 40 kg ha^{-1} + *Azospirillum*	17525	46383	28858	2.65
Nitrogen @ 70 kg ha^{-1} + *Azospirillum*	17987	61804	43817	3.43
Nitrogen @ 100 kg ha^{-1} + *Azospirillum*	18450	68560	50110	3.71
Nitrogen @ 130 kg ha^{-1} + *Azospirillum*	18910	71047	52137	3.76

Grain price – Rs. 1000 q^{-1}, straw price – Rs. 90 q^{-1}, *Azospirillum* added @ 1.0 kg ha^{-1}

application of 100 kg ha^{-1} of nitrogen conjugated with *Azospirillium* inoculants was observed to be optimum plant nutrition for producing higher economic benefits.

From the above results, it may be concluded that application of fertilizer nitrogen @ 100 kg ha^{-1} with integration of *Azospirillium* inoculants could be benevolent to the resource poor *boro* rice growers of coastal agro-ecosystem in Sagar Islands of West Bengal with higher grain yield and economic returns.

REFERENCES

Agarwal RR, Yadav JSP and Gupta RN 1982. Saline and Alkali Soils of India, Indian Council of Agricultural Research, New Delhi.

Gomez KA and Gomez AA 1984. Statistical procedures for agricultural research. John Wiley and Sons, Newyork.

Jackson ML 1973. Soil chemical analysis. Prentice Hall of India Private Ltd., New Delhi.

Jena PK and Rao VR 1988. Influence of salinity, rice straw and water regime on nitrogen fixation in paddy soils. Journal of Agricultural Science 111: 121-125

Kannan T and Ponmurugan P 2010. Response of paddy (*Oryza sativa* L.) varieties to *Azospirillium brasilense* inoculation. Journal of Phytology 2(6): 8-13.

Mandal AB and Sarangi SK 2011. Promising varieties of rice for rabi and kharif season in the coastal areas of India. Journal of the Indian Society of Coastal Agricultural Research 29 (2): 29-34.

Patra SK and Ray R 2002. Two decades (1982-2002) of research in agricultural drainage in coastal saline and inland low-lying land in West Bengal. BCKV-ICAR publication. pp 14-38.

Patra SK, Padhi AK and Mishra SN 1989. Effect of biofertilizers at graded levels of nitrogen on the yield of wheat and toria in the north-eastern ghat region of Orissa. Environment and Ecology 7 (3): 533-536.

Saikia SP, Bora D, Goswami A, Mudoi KD and Gogoi A 2012. A review on the role of *Azospirillum* in the yield improvement of non-leguminous crops. African Journal of Microbiology Research 6 (6): 1085-1102.