Plant Archives Vol. 17 No. 2, 2017 pp. 1377-1380 *ISSN 0972-5210*

INFLUENCE OF PRE SOWING BIOFERTILIZER SEED TREATMENT ON GROWTH AND YIELD PARAMETERS IN RICE (*ORYZA SATIVA* L.)

S. Anand* and A. Kamaraj

Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar–608 002 (Tamil Nadu), India.

Abstract

A field experiment was conducted to study the effect of seed inoculation using biofertilizers on growth and yield parameters of rice. The seeds of rice were given inoculation treatments with 600g ha^{-1} of various biofertilizers and sown along with control. The results revealed that the seeds treated with *Azospirillum* + *Phosphobacteria* + *VAM* @ 600g ha^{-1} inoculated seeds registered higher values for growth and yield parameters *viz*., plant height, leaf length, leaf breadth, days to first flowering, days to 50 per cent flowering, panicle length, number of tillers $plant^{-1}$, number of productive tillers $plant^{-1}$, number of seeds $panicle^{-1}$, seed L/B ratio, single plant yield, dry matter production and 100 seed weight over the control.

Key words: Rice, Pre sowing biofertilizer treatment, Azospirillum, Phosphobacteria, VAM, Dual inoculation, Triple inoculation, Seed yield.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food in Asia. Globally, rice ranks second only to wheat in terms of area harvested, but in terms of importance as a food crop, rice provides more energy per hectare than any other cereal crops. For almost three decades since the green revolution, the rice yield growth rate was approximately 2.5% per year. During the 1990's however, this has decreased to only 1.1% (Riveros and Figures, 2000).

The aim of this study is to improve the growth and higher seed yield. The total world area, production and productivity under rice was 159.17 million hectares, 472.16 MMT and 4.42 metric tons per hectare in 2015-2016 (Anonymous, 2017). Major rice producing countries are China, India, Indonesia, Bangladesh, Vietnam, Thailand, Burma, Philippines, Brazil and Japan.

In India, rice cultivated in an area of 43.5 million hectares with a production of 104.41 MMT and productivity of 3.60 metric tons per hectare in 2015-2016 (Anonymous, 2017). India ranks first in area and second in production. In India, major rice producing states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab and Tamilnadu. In Tamilnadu area under rice cultivation is 21 lakh hectares with a production of 93 L.MT and productivity of 4.43 metric tons per hectare (Urban Development and Agriculture, 2015).

In India, nearly 70 per cent of cultivated land is rainfed, but accounts for about 42 per cent of the total quantity of produced food grains. Seeds are basic input for crop production. No agricultural practice can improve a crop beyond the limits set by the seed. Any achievement in the crop improvement can be propagated and established in field only through good quality seeds.

Quality seeds play a major role, along with improved package of practices leading to enhanced productivity. The low productivity under rainfed condition is due to use of poor quality seeds, soil moisture deficit, low and erratic rainfall and improper crop management. Hence, the production of high quality seed is necessary and important to the agricultural industry.

Seed treatments are followed to increase seed quality. The concept of seed treatment is use and application of biological and chemical agents that control or contain primary soil and seed borne infestation of insects and diseases which pose devastating consequences to crop

***Author for correspondence :** E-mail : svaanand45@gmail.com

production and improving crop safety leading to good establishment of healthy and vigorous plants resulting in better yields. Even with the availability of different types of seed treatments, seed hardening, seed inoculation, seed pelleting and seed priming are mostly used seed treatments.

Biofertilizers are microbial inoculants of selective microorganisms like bacteria, algae and fungi already existing in nature. They help in improving soil fertility by the way of biological nitrogen fixation from atmosphere, solubilization of insoluble nutrients already present in the soil, decomposing soil residues stimulating plant growth and production. The process is slow, consumes less energy and provides cheap nutrients to plants without polluting the nature. Biofertilizers are low cost, renewable and eco-friendly sources of plant nutrients which supplement chemical fertilizer. They can be used either in seed treatment or soil application. Biofertilizers are also ideal inputs for reducing the cost of cultivation and for practicing organic farming.

India has made spectacular breakthrough in production and consumption of fertilizers during the last four decades. But consumption of chemical fertilizers for agricultural crops will be quite a limiting factor for increasing agriculture production in future. Because of escalating energy cost, chemical fertilizers are not available at affordable prices to farmers. Moreover, the unbalanced and continuous use of chemical fertilizers is leading to reduction in crop yields and in imbalance of nutrients in the soil which has adverse effect on soil health (Bronick and Lal, 2005). The combined inoculation of seeds with biofertilizers leads to the improved growth and yield parameters in rice.

Materials and Methods

The field experiments were carried out in the Department of Genetics and Plant Breeding, Faculty of Agriculture and Experimental farm, Annamalai University, Annamalai Nagar, Tamilnadu. Required quantity of inoculant for seed treatment is mixed with rice kanji to make a slurry. Then required seeds are mixed in the slurry so as to have a uniform coating of the inoculants over the seeds. After the treatment the seeds were shade dried for 30 minutes and then sun dried to bring back into original moisture content and used for sowing. The experiment consisted of the following seed treatments.

Treatment details

$\mathbf{T_0}$ - Control
$\mathbf{T_1}$ - *Azospirillum* @ 600g ha^{-1}
$\mathbf{T_2}$ - *Phosphobacteria* @ 600g ha^{-1}
$\mathbf{T_3}$ - *VAM* @ 600g ha^{-1}
$\mathbf{T_4}$ - *Azospirillum* + *Phophobacteria* @ 600g ha^{-1}
$\mathbf{T_5}$ - *Azospirillum* + *VAM* @ 600g ha^{-1}
$\mathbf{T_6}$ - *Phosphobacteria* + *VAM* @ 600g ha^{-1}
$\mathbf{T_7}$ - *Azospirillum* + *Phosphobacteria* + *VAM* @ 600g ha^{-1}

Observations were recorded for growth and yield parameters *viz.,* plant height, days to first flowering, days to 50 per cent flowering, number of tillers $plant^{-1}$, number of productive tillers $plant^{-1}$, panicle length, leaf length, leaf breadth, number of seeds $panicle^{-1}$, seed L/B ratio, single plant yield, dry matter production and 100 seed weight. The data were statistically analysed using ANOVA.

Results and Discussion

In the present study the seeds were inoculated with various biofertilizers. Presowing inoculation treatment had significantly positive influence on the seed yield and growth parameters of rice crop. Among the treatments, seeds inoculated with *Azospirillum* + *Phosphobacteria* + *VAM* ($\mathbf{T_7}$) recorded higher values for most of the growth and yield parameters *viz*., plant height, days to first flowering, days to 50 per cent flowering, number of tillers $plant^{-1}$, number of productive tillers $plant^{-1}$, panicle length, leaf length, leaf breadth, number of seeds $panicle^{-1}$, seed L/B ratio, single plant yield, dry matter production and 100 seed weight.

Plant height (76.50 cm), leaf length (30.42 cm), leaf breadth (1.22 cm) and panicle length (23.60 cm) which are 10.91%, 11.52 %, 9.43 %, and 11.14 % increase over the control. This may be due to the Increase in growth regulating substance such as IAA, GA and/or cytokines which is produced by microorganism present in the inoculum promote better growth (Tien *et al.,* 1979; Tiwari *et al.,* 1998; Panwar and Elanchezhian, 1999 and Beatrix *et al.,* 2000).

The plant height is a genetically controlled character. In the present investigation, significant difference in the plant height was noticed among the treatments by the application of different biofertilizers individually and in combination. Among these, triple inoculation ($\mathbf{T_7}$) recorded the maximum plant height which may be due to the production of GA_3 and more availability of other nutrients by the microorganism. It was due to GA_3 effect on elongation of internodes as GA_3 has known to enhance cell elongation (Table 1).

Early days to first flowering and days to 50 per cent flowering (60.60 DAS and 81.80 DAS) may be due to the increased availability of phosphorus by the biofertilizers. It is an essential plant nutrient required for plant growth. It accelerates tillering, flower formation, good pod and seed setting besides early maturation in several economically important and cultivated crops

Table 1: Effect of biofertilizer seed treatment on plant height (cm), leaf length (cm), leaf breadth (cm), days to first flowering and days to 50 per cent flowering.

Treatment	Plant height (cm)	Leaf length (cm)	Leaf breadth (cm)	Days to first flowering	Days to 50 % flowering
T_0	68.74	26.90	1.06	67.00	86.20
T_1	74.24	27.98	1.10	64.60	84.80
T_2	72.80	27.90	1.10	65.40	85.00
T_3	70.34	27.76	1.08	65.60	85.60
T_4	75.80	29.46	1.16	63.60	82.20
T_5	74.54	29.36	1.14	64.00	82.40
T_6	76.24	30.00	1.16	61.40	82.00
T_7	76.50	30.42	1.22	60.60	81.80
Mean	73.65	28.72	1.13	64.03	83.75
SEd	0.0744	0.0233	0.0038	0.1070	0.0465
CD(P=0.05)	0.1600	0.0500	0.0081	0.2300	0.1000

Table 2: Effect of biofertilizer seed treatment on panicle length (cm), number of tillers plant^{-1}, number of productive tillers plant^{-1}, number of seeds panicle^{-1} and seed L/B ratio.

Treatment	Panicle length (cm)	No. of tillers plant^{-1}	No. of productive tillers plant^{-1}	No. of seeds panicle^{-1}	Seeds L/B ratio
T_0	20.82	18.40	10.20	137.40	2.60
T_1	22.40	20.40	12.00	143.60	2.60
T_2	22.10	19.60	11.80	142.60	2.60
T_3	22.04	19.80	11.20	142.20	2.60
T_4	23.10	21.00	13.20	151.40	2.70
T_5	22.60	20.80	12.40	144.20	2.60
T_6	23.14	22.00	14.60	154.00	2.70
T_7	23.60	23.40	15.20	155.00	2.70
Mean	22.48	20.68	12.58	146.30	2.64
SEd	0.1023	0.0465	0.0511	0.2966	0.0320
CD(P=0.05)	0.2200	0.1000	0.1100	0.6378	0.0688

(Salisbury and Ross, 1986).

Increase in growth parameters may be also due to the nitrogen fixation, production of auxins, gibberellins, cytokinins, ethylene solubilization of phosphorus, oxidation of sulfur, increase in availability of nitrate, extra cellular production of antibiotics, lytic enzyme, hydrocyanic acid, increase in root permeability, strict competition for the available and root sites, suppression of deleterious rhizobacteria and enhancement in the uptake of essential plant nutrients as reported by Enebak and Carey (2000) and Ahmed *et al.* (2004).

Growth parameter increased in the combined triple inoculation (T_7) which may be due to the increased uptake of N_2, P and other mineral nutrients and also water absorption. N_2 uptake derived from N_2 fixing *Azospirillum*, P uptake as a result of P solubulization and make available more P by *PSB* increased root surface and make macro and micro nutrients availability by *VAM* through fungal matrical hyphae (Ponmurugan and Gopi, 2006).

The number of tillers plant^{-1}, number of productive tillers plant^{-1}, number of seeds panicle^{-1}, seed L/B ratio, single plant yield, dry matter production and 100 seed weight which were 19.57%,43.14 %, 12.08%, 3.85%, 19.04%, 11 % and 8.18% increase over the control (Table 2 and Table 3). Effect of biofertilizers on number of tillers and productive tillers were positive in this experiment. This is may be due to the usage of nitrogen fertilizers at appropriate levels provide better nutrient uptake and plant photosynthesis is through improving biofertilizers activity, which results in better flowering and heading. Also, positive effect of using biofertilizer can attributed to increase water and nutrient uptake due to development and expansion of roots and also to biological nitrogen fixation by biofertilizers (Mirzaei *et al.,* 2010).

The increase in single plant yield and dry matter production in T_2 over T_0 due to biofertilizers inoculations. It may not be solely increase the yield character but because of several other factors such as release of growth promoting substances, control of plant pathogen and proliferation of beneficial organism in the *Azospirillum*, *PSB* and *VAM*. These findings are in accordance with Kundu and Gaur (1984). Solubilizations of inorganic phosphate in the soil (*PSB*) make them available to the crop and resulted in better yield. It also produced a phytohormone (IAA) which increased its nutrient absorption capacity from the soil. These findings were in accordance with Datta *et al.* (1982), Bhattacharyya and Singh (1992), Kalita and Sarmah (1992), Rekhi *et al.* (2000) and Mudenoor (2002).

Enhanced yield may be due to their better establishment in the rhizosphere, increased C_2H_2 reduction activity and available P content in soil and due to increased N and P uptake compared to single inoculation (Subba Rao *et al.,* 1979 and Pacovsky *et al.,* 1985). The increase in yield may be also due to consequent increase of root length, diameter and leaf area index as a result of the action of these microorganism (Sundravelue and Muthukrishanan, 1993). Similar increase in growth and yield was reported by Kalyani *et al.* (1996).

Increase in 100 seed weight may be due to the triple inoculation with biofertilizers. Triple inoculation might have improved photosynthesis by increasing water and nutrients absorption leading to produce more assimilate and improves translocation of metabolites from sources to sink which in turn increased 100 seed weight compared to T_0 (Mirzaei *et al.,* 2010).

Table 3: Effect of biofertilizer seed treatment on single plant yield (g), dry matter production (g) and 100 seed weight (g)

Treatment	Single plant yield (g)	Dry matter production (g)	100 seed weight (g)
T_0	21.22	60.16	2.20
T_1	24.00	62.70	2.28
T_2	23.94	61.86	2.22
T_3	23.82	60.92	2.20
T_4	24.48	66.64	2.34
T_5	24.16	65.32	2.32
T_6	25.26	66.78	2.38
T_7	26.28	68.40	2.44
Mean	24.15	64.10	2.30
SEd	0.0130	0.2514	0.0038
CD(P=0.05)	0.0281	0.5405	0.0081

Thus, from the present investigation the triple inoculation of *Azospirillum*, *PSB* and *VAM* fungus improved the seed quality, vegetative growth, nutrient uptake and yield parameters than the control.

References

Ahmed, W., B. Shahroona, Z.A. Zahir and M. Arshad (2004). Inoculation with ACC Deaminase containing *rhizobacteria* for improving growth and yield of wheat. *Pak. J. Agric. Sci.,* **41:** 119-124.

Anonymous (2017). USDA. World Agricultural Production. Foreign Agricultural Service. http : // www.pecad.fas.usda.gov/

Beatrix, R., D. Klara, K.S. Ibolya and B. Andor (2000). Characterization of hungarian rice cultivars in nitrogen fixing associations with bacteria. *Cereal Res. Commu.,* **28:** 9-16.

Bhattacharyya, P. and T. Singh (1992). Simplified methods of mass production and application of biofertilizer. *Proc. Natl. Sem. Organic farming.* Edited by Rai, M.M. and L.N. Verma, JNKVV and IGKVV, Indore, India, pp. 166-178.

Bronick, C.J. and R. Lal (2005). Soil structure and management: A review. *Geoderma,* **124:** 3-22.

Datta, M., S. Banik and R.K. Gupta (1982). Studies on efficiency of phytohormone producing phosphate solubilizing *Bacillus firmus* in augmenting paddy yield in acid soils of Nagaland. *Pl. Soil*, **69(3):** 365-373.

Enebak, S.A. and W.A. Carey (2000). Evidence for induced systemic protection to fusiform rust in loblolly pine by plant growth-promoting rhizobacteria. *Pl. Dis.,* **84:** 306-308.

Kalita, M.C. and N.N. Sarmah (1992). Effect of nitrogen level and mulch on yield and yield attribution characters of summer rice (*Oryza sativa*) under the rainfed condition. *Ind. J. Agron*., **37:** 690-693.

Kalyani, D.P., R. Shankar and P.D. Manohar (1996). Studies on the effect of nitrogen and *Azospirillum* on growth and yield of cauliflower. *South Indian Hort.,* **44:** 147-149.

Kundu, B.S. and A.C. Gaur (1984). Rice response to inoculation with N_2-fixing and P-solubilizing microorganisms. *Pl. Soil,* **79(2):** 227-234.

Mirzaei, A., S. Vazan and R. Naseri (2010). Response of yield components of safflower (*Carthamus tinctorius* L.) to seed incolution with *Azotobacter* and *Azosprilium* and different nitrogen levels under dry land condition. *World Applied Sci. J.,* **11(10):** 1287-1291.

Mudenoor, M.G. (2002). Effect of micronutrient supplemented *Azospirillum* biofertilizers on maize (*Zea mays* L.). *M.Sc. (Agri.) Thesis*, University of Agricultural Sciences, Dharwad, India.

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

Panwar, J.D. and R. Elanchezhian (1999). Effect of 2,4-D and *Azosprillum brasilense* on growth and yield in the nodule induced transplanted wheat. *Ind. J. Pl. Physiol.,* **3:** 143-146.

Ponmurugan, P. and C. Gopi (2006). In vitro production of growth regulators and phosphatase activity by *phosphate solubilizing bacteria. African J. Biotech.,* **5(4):** 348-350.

Rekhi, R.S., D.K. Benbi and B. Singh (2000). Effect of fertilizers and organic manure on crop yields and soil properties in rice-wheat cropping system. In: Abrol, I.P., K.F. Bronson, J.M. Duxbury and R.K. Gupta (Eds.), Long-term Soil Fertility Experiments in Rice-Wheat Cropping Systems. Rice-Wheat Consortium Paper Series 6. Rice-Wheat Consortium for the Indo-Gangetic Plains, New Delhi, India. 1-6.

Riveros, F. and P. Figures (2000). Keynote address of the 18th session of IRC Nanda JS. Rice breeding and genetics, Research priorities and challenges. *Science Publishers Inc.* pp. 1-8.

Salisbury, F.B. and C.W. Ross (1986). Lipids and other natural products. In: Plant Physiology. CBS Publishers & Distributors, Delhi. pp. 268-287.

Subba Rao, N.S., K.V.B.R. Tilak, C.S. Singh and M. Lakshmikumari (1979). Response of few economic species of graminae plants to inoculation with *Azospirillum brasilense*. *Current Sci.*, **52:** 133-134.

Sundravelue, S. and T. Muthukrishanan (1993). Effect of treatments with *Azospirillum* and Gibberellic acid on the growth and yield of radish. *South Ind. Hort.,* **41:** 212-213.

Tien, T.M., M.H. Gaskins and D.H. Hubell (1979). Plant growth substances produced by *Azospirillum brasilense* and their effect on the growth of pearl millet (*Pennisetum americanum* L.). *Appl. Environ. Microbiol.,* **37(5):** 1016–1024.

Tiwari, B.K., S.K. Barik and R.S. Tripathi (1998). Biodiversity value, status and strategies for conservation of sacred groves of Meghalaya, India. *Ecosystem Health,* **4(1):** 20-32.

Urban Development and Agriculture (2015). Minister for Housing, Agriculture Department Policy Note, 2015-2016.