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EFFECT OF INTEGRATED USE *Azotobacter*, *Azolla* AND UREA ON FERTILITY STATUS OF SOIL AND PRODUCTION OF RICE (*Oryza sativa* L.)

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ABSTRACT

Field experiment was conducted at research farm of Udai Pratap (Autonomous) College, Varanasi, (U. P.) to evaluate the effect of integrated use of chemical fertilizer (urea), *Azotobacter* and *Azolla* on growth, grain yield, nutrient uptake by rice and soil fertility status in a sandy loam soil. The treatments consisting of T_1 = control, T_2 = 50% RD of N through urea, T_3 = 100% RD of N through urea, T_4 = *Azotobacter* + *Azolla* and T_5 = 50% RD of N through urea + *Azotobacter* + *Azolla*. The treatments were replicated thrice in randomized block design. Rice variety Mansoory was taken as a test crop. The soil fertility status (Organic carbon, available N, P and K) was found to be significantly improved due to application of 50% RD of N through urea + *Azotobacter* + *Azolla* as compared to other treatments. The highest N, P and K uptake was also recorded with application of 50% RD of N through urea + *Azotobacter* + *Azolla* as compared with other treatments. It was found that 50% RD N could be saved by application of *Azotobacter* + *Azolla*. Thus, substitution of chemical nitrogen with biofertilizer, *Azotobacter* and *Azolla* sustained the productivity even at lower rate of nitrogen application as urea.

KEYWORDS : Rice, Available N, P, K, *Azotobacter*, *Azolla*

Rice the prime among cereals is the staple food crop which feeds more than 2/3rd of Indian population and accounts for about 52 per cent of the total food grain production and 55 per cent of the total cereal production in India. Rice is being more exhaustive in nature. The unbalanced use of nitrogenous fertilizers have led to environmental contaminations, disturbance in soil nutrient balance and depletion of soil fertility. Even the introduction of high yielding varieties and intensive cultivation with excess and imbalanced use of chemical fertilizers and irrigation showed reduction in the fertility status and yield by 38 per cent of rice crop. Thus causes have led to renewed interest in the use of renewable sources (organic manure/wastes) and prompted the scientist to find out an alternative agricultural system which involves the farming in a way that harmonize rather than conflict with natural processes operating in natural ecosystem (Roy and Singh, 2014). As no single source is capable of supplying the required amount of plant nutrients, integrated use of all sources of plant nutrients is a must to supply balanced nutrition to the crop (Das et al., 2010). Thus, application of organic sources of nutrients on agricultural land has received considerable attention in recent years, not only because of increased energy requirement for synthetic fertilizer production, but also because of costs and environmental problems associated with their disposal. Many organic could be recycled through application to agricultural land as a source of plant nutrients especially nitrogen, as well as soil amendment to enhance future crop production by improving soil quality. Keeping these facts in consideration the present investigation entitled, integrated use of chemical fertilizer and bio-inoculants on performance of rice and soil properties was planned.

MATERIALS AND METHODS

A field experiment was conducted using rice crop at the Research Farm of Udai Pratap (Autonomous) College, Varanasi (latitude 25^0 18' N, longitude 83^0 30'E and an altitude 125.93 meters), (U. P.). The important initial soil characteristics of the experimental field were sandy loam (45.17 % sand, 29.73 % silt and 25.10 % clay) in texture with pH 7.56, E.C. 0.32 dS m^{-1}, organic carbon 0.42%. Available N, P and K were 184.00, 19.35 and 130.56 kg ha^{-1}, respectively. The treatments consisting of T_1 = control, T_2 = 50% RD of N through urea, T_3 = 100% RD of N through urea, T_4 = *Azotobacter* + *Azolla* and T_5 = 50% RD of N through urea + *Azotobacter* + *Azolla*. The treatments were replicated thrice in randomized block design. Recommended dose of N, P and K (120: 60:60 kg ha^{-1}) were applied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively. 25 days old rice seedling cv Mansoory were transplanted in 20x10 cm. plot. Half of nitrogen was top-dressed in two equal splits i.e. at

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active tillering stage and panicle initiation stage of rice crop in two equal doses. Carrere based inoculants of *Azotobacter* was applied to raise their number to $100x10^6$ / 100 kg of organic materials. *Azolla* was broadcasted at 7 days after transplanting @ 500 kg ha^{-1} (fresh weight). The fresh *Azolla* was contained 3% N on dry weight basis. The crop management practices were practiced as per standard recommendation.

Soil samples were collected from effective root zone depth at the end of experiment from each plot. Organic carbon, available nitrogen, phosphorus and potassium in soil were determined by wet chromic acid digestion method (Walkley and Black, 1934), alkaline potassium permanganate method (Subbiah and Asija, 1956), sodium bicarbonate method (Olsen's et al., 1954), ammonium acetate extract with the help of flame photometer method (Jackson, 1967) respectively. Yield and yield attributes were recorded from all plots. Plot wise Plant samples were collected at the time of harvesting were chopped, dried and ground digested in concentrated H_2SO_4 for determination of total nitrogen content (Kjeldhal's method), tri-acid mixture for determination of total phosphorus determined by vanadomolybdophosphoric acid yellow colour method (Tondon, 1993) potassium by flame-photometrical (Jackson, 1973). Uptake of nutrient was calculated by multiplying nutrient contents in plants with their dry matter yield.

RESULTS AND DISCUSSION

Grain and Straw Yield

Grain and straw yield of rice was significantly influenced by the different treatment combination over the control (Table 1). The highest grain and straw yield was obtained with the application of 50% N through urea with *Azotobacter* and *Azolla* which was at par with that of 100% N through urea. This could be attributed to higher and continuous supply of N, which increased significantly the yield characteristics of the rice. This is in agreement with the findings of Mohammad (2000) who found the highest yield of rice when urea was applied in combination with Azotobacter plus *Azolla*. The beneficial effect of nitrogen fixing bacteria *Azotobacter* to increase the yield is related not only to their nitrogen fixing proficiency but also with their ability to produce antibacterial and antifungal compounds, growth regulators and siderophores (Majumdar et al., 2007). The application of N through urea produced higher grain and straw yields than biofertilizers sources alone.

In general, higher number of tillers, total plants, higher dry matter production and grain yield were obtained in plots which received 50% urea N, *Azotobacter* and *Azolla*. This might be due to greater availability of nutrients in soil, improved physical condition and higher total uptake of nutrients because of better root penetration leading to better absorption of nutrient and moisture which ultimately resulted in higher yields (Meena et al., 2010).

Plant Growth Attributes

The mean plant height under 50% urea N + biofertilizers applied plots significantly higher as compared to other combinations. The average plant height under T_1, T_2, T_3, T_4 and T_5 treatments at harvesting were 89.13, 90.60, 94.26, 91.20, and 101.33 cm respectively. This beneficial effect of *Azotobacter* and *Azolla* on plant height was also observed by Singh et al. 2005.

Application of nitrogen through biofertilizer and urea significantly increased the number of tillers as compared to control plots. The number of tillers were however significantly higher in T_5 treatments (390 m^{-2}) and lower in T_1 treatment (313 m^{-2}) at harvesting. The values of tiller number obtained under T_1, T_2, T_3, T_4 and T_5 treatments at harvesting were 313, 341, 368, 350 and 390 per meter square area, respectively. Similar findings have also been reported by Ram et al. (1985). Application of 50% N through urea and biofertilizers (T_5) recorded significantly higher dry matter as compared to 100% N through urea (T_3), *Azotobacter* + *Azolla* (T_4), 50% N through urea (T_2) and control (T_1) treatments. It might be attributed to higher number of tillers and plant height under 50% urea N plus biofertilizer.

Nutrient uptake

The total uptake of N, P, and K (Table 3) at varying treatment combination varied between 9.576 to 23.969, 7.288 to 15.834 and 51.87 to100.234 kg ha-1, respectively. The highest N uptake was recorded with the treatment of

Table 1 : Effect of Integrated Use *Azotobacter*, *Azolla* and Urea on Growth and Yield of Rice

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Plant height (cm)	No. of tiller (m^{-2})
T_1	26.6	60	89.13	313
T_2	31.7	71.44	90.6	341
T_3	39	78.14	94.26	368
T_4	34.5	74.16	91.2	350
T_5	43.58	83.21	101.33	390
S E m±	1.674	3.074	0.846	8.961
CD (0.05%)	3.86	7.089	1.951	20.664

Table 2 : Effect of Integrated Use of *Azotobacter*, *Azolla* and Urea on Fertility Status

Treatment	Organic Carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
T_1	0.37	177	12	117
T_2	0.42	182	13	120
T_3	0.47	190	14.66	126
T_4	0.44	186	13.5	122
T_5	0.49	195	16.2	133
S E m ±	0.017	2.145	0.649	1.673
CD (0.05%)	0.039	4.946	1.497	3.859

Table: 3 Nutrient Uptake in Rice Plant as Influenced by Integrated Use of *Azotobacter*, *Azlolla* and Urea

Treatment	Nutrient uptake		
	Total N Uptake (kg ha^{-1})	Total P Uptake (kg ha^{-1})	Total K Uptake (kg ha^{-1})
T_1	9.576	7.2884	51.87
T_2	13.314	8.8443	66.57
T_3	19.5	12.948	88.92
T_4	15.18	10.488	77.625
T_5	23.969	15.834	100.234
S E m±	0.0318	0.015	0.077
CD (0.05%)	0.1737	0.0826	0.409

50% N through urea + biofertilizer. This treatment produced the highest grain and straw yield, so it could bring about the highest total N uptake. This might be due to the improved physical condition of soil with better N availability to the rice crop. This result is in conformity with the findings of Singh and Mandal (1997). The highest total P and K uptake by rice crop was also observed with the application of 50% N through urea + *Azotobacter* + *Azolla* which was significantly superior to the control. It may be attributed to regulated availability of nutrients in soil and positive interaction effect of organic and inorganic sources (Gogoi et al., 2010). It may also be due to *Azotobacter* and *Azolla* inoculants which not only influence the nitrogen uptake but improved the phosphorus and potassium uptake also (Tripathi et al., 2009). Similar results were also reported by Talashilkar et al. (1999) and Dixit and Gupta (2000).

Organic Carbon

The various treatment combinations had significant effect on changes in soil organic carbon content (Table 2). Application of inorganic fertilizer N alone or in combination with *Azotobacter* and *Azolla* had increased the soil organic carbon content due to addition of organic matter through *Azotobacter* and *Azolla*. This could be attributed to higher plant exudates owing to higher biomass production in 50% urea N + biofertilizer treated plots. This result is in accordance with those of (Singh et al., 2005) who reported the increase in the organic carbon was due to higher microbial population in biofertilizers treated plots. The increase in organic carbon content due to use of fertilizers can be attributed to higher contribution of biomass to the soil in the form of greater root biomass through crop stubble and residues (Sarkar and Singh, 1997). However, in control plot there was a significant reduction in organic carbon content than the other treatments. The highest organic carbon accumulation was observed in the plot where 50% urea N + biofertilizer were applied.

Available Nitrogen

The available N status of soil after two consecutive years of rice cropping was 177 kg ha^{-1} in control where as the maximum available N was found in T_5 (Table 2). This result clearly indicates that higher dose of inorganic N plus Azotobacter and Azolla had increased the nitrogen content of soil. Increase in available N with biofertilizer plus inorganic N application to the available pool of the soil through nitrogen fixation biofertilizer as well. Similar results were also reported by Acharya et al. (1988) and Bhandari et al. (1992). Application of inorganic N or biofertilizer N source proved superior to control. The favourable soil conditions under these treatments might have helped in the mineralization of soil N leading to build up to higher available N. This might be due to *Azotobacter* and *Azolla* integrated with chemical fertilizers (NPK) suggesting the fact that helped in biological nitrogen fixation *Azotobacter* and *Azolla* by adding the various plant growth promoting substances in soil (Tripathi et al.,2009).

Available Phosphorus and Potassium

Application of biofertilizer with or without inorganic N significantly increased the available P content or compared to control. The higher availability of soil P observed in plots receiving biofertilizers might be due to mineralization of added P. Higher available phosphorus and potassium content of soil under 50% N through urea + *Azotobacter* + *Azolla* treated plots may be due to higher biomass added by plant roots leaf litter and biofertilizer. Available phosphorus content in soil increased with combined application of inorganic (Urea) and bio-inoculants (*Azotobacter* and *Azolla*) which might be due to solubilisation of native phosphorus in the soil through release of the various organic acids which helps in solubilizing the native soil phosphorus as well as reduce the fixation of phosphate by providing protective cover on sesqueoxides and chelating cations (when applied along with inorganic fertilizer) which in turn enhanced the availability of phosphorus ((Tripathi et al., 2009, Roy and Singh, 2014).

The available K status in soil increased significantly due to combined application of biofertilizer and inorganic fertilizer (50% N through urea with Azotobacter and Azolla) compared to inorganic fertilizer alone (Table 2). This may be due to reduction of potassium fixation, solubilisation and release of potassium due to the interaction of bio-inoculants with clay, besides the direct potassium addition to the potassium pool of the soil.

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