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Research Paper

Growth and yield response of rice (*Oryza sativa*) to graded doses of nutrients and foliar spray of cow urine

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ABSTRACT

A field experiment was conducted in a split-plot design during the rainy (*kharif*) seasons of 2015 and 2016 at Varanasi, Uttar Pradesh, to evaluate the relative performance of different fertility levels (60%, 80% and 100% of recommended dose of fertilizer) and foliar spray of cow urine (control, 50%, 75% and 100% concentration) on growth, yield and economics of 'BPT 5204' rice (*Oryza sativa* L.). The recommended dose of fertilizer (RDF) for rice was 120, 60, 60 and 25 kg/ha of N, P_2O_5, K_2O and $ZnSO_4$ respectively. Various growth parameters and yield levels of rice showed significant variation during the experimental years under different levels of fertility and cow urine foliar spray. Among the fertility levels, 80% and 100% RDF significantly improved grain yields of rice over 60% RDF by 6.8% and 14.8% respectively. Applications of cow urine (4 foliar sprays) were positively correlated with various growth parameters, yield attributes and yield levels of rice. Increments in grain yields of rice were to the tune of 4.4%, 4.4% and 10% over control for 50%, 75% and 100% cow urine concentration respectively. In terms of economics, the highest net returns and benefit: cost ratios were obtained from 100% RDF and 100% cow urine spray during both the years. Among the fertilizer treatments, 100% RDF recorded up to 18.2% higher net returns over 60% RDF, which was 16.4% over the control in case of 100% cow urine spray.

Key words: Cow urine spray, Economics, Fertility levels, Growth, Yield

Rice is the principal food crop in India and also the staple food of majority of people in many parts of the world. Over the last 5 decades, there has been a 3-fold increase in rice production primarily owing to intensive cropping systems, genetically improved crop and increased use of inputs (irrigation water, fertilizers, pesticides, etc.), thereby making India the world's second largest producer of rice (ASG, 2016). However, imbalanced and indiscriminate use of agro-inputs (mainly chemical fertilizers) has led to severe deterioration of soil health. Under these circumstances, therefore, adoption of integrated nutrient management (INM) is the most appropriate one that can increase crop production without compromising with soil health (Mishra *et al*., 2017). Integrated use of inorganic fertilizers along with the organic manures can help minimizing chemical fertilizer use and sustaining crop yield by maintaining optimum soil-fertility status. Cow urine is a rich source of nutrients (especially nitrogen and potassium), but usually drains out as a waste material. Being organic in nature, it can be used in crops without any adverse effect on environment and human health (Singh *et al*., 2012). On an average, cow urine contains 95% water, 2.5% urea, minerals, 24 types of salts, hormones and 2.5% enzymes. It also contains several essential minerals like phosphorus, calcium, sulphur, iron and manganese, alongwith several other organic compounds like amino acids, carbonic acid, uric acid, cytokinin, lactose etc. (Bhadauria, 2002). Research shows that only one-fifth of nitrogenous materials consumed by cattle is absorbed in the body and remaining is excreted through urine and dung (Bhadauria, 2002). The beneficial effects of cow urine application have been reported on several crops such as mustard (Pradhan *et al*., 2016), maize (Devakumar *et al*., 2014), sweet corn (Pande *et al.*, 2015) and other vegetable crops such as watermelon (Burubai and Eribo, 2012) and lablab bean (Maheswari *et al.*, 2017). Since such studies are lacking in rice crop, an investigation was carried out with the objective of evaluating the growth and yield response of rice to graded doses

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of nutrients and foliar spray of cow urine.

MATERIALS AND METHODS

The field experiment was conducted during rainy seasons of 2015 and 2016 at the Agricultural Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (25°18' N, 83°03' E and 128.9 m above mean sea-level), situated in the centre of north Gangetic alluvial plains. The experimental site has semi-arid to hub-humid type of climate with moisture deficit index between 20 and 40%. The average annual rainfall at Varanasi is 1,100 mm and about 88% of it is received during June–September. The soil was low (0.47%) in organic carbon (wet-digestion method) with slightly alkaline in reaction (*p*H 8.1). The available N (alkaline permanganate-oxidizable), P (0.5 M $NaHCO_3$-extractable), K (1 M ammonium acetate-exchangeable K) and Zn (DTPA-extractable) were 137 (low), 20.6 (medium), 136.8 (medium) and 1.17 (low) kg/ha respectively.

The experiment was laid out in a split-plot design, keeping fertility levels in main plots and cow urine spray in subplots, with 3 replications. Three main plots treatment were: 60% recommended dose of fertilizer (RDF) where, RDF is 120: 60: 60: 25 kg N: P_2O_5: K_2O: $ZnSO_4$/ha respectively; 80% RDF and 100% RDF. The subplot treatments were: control (urine : water 0 : 600 litre/ha); 50% cow urine spray (urine: water 300 : 300 litres/ha); 75% cow urine spray (urine : water 450 : 150 litres/ha) and 100% cow urine spray (urine : water 600 : 0 litres/ha). Rice cultivar 'BPT 5204' was chosen for the experiment and was grown as conventional puddled transplanted rice. Thirty days old seedlings from nursery were transplanted onto the main field with a spacing of 20 cm × 10 cm. The crop was managed uniformly for all inputs except for nutrient management. For nutrient management, half dose of N (urea) and full doses of P (diammonium phosphate), K (muriate of potash) and $ZnSO_4$ were applied during puddling and remaining half dose of N was applied in 2 equal splits–top-dressings at 30 and 70 days after transplanting (DAT). Cow urine was collected from the cross-breed of Holstein-Friesian and indigenous cow and kept for 1 week for fermentation. Cow urine was applied as foliar spray at 30, 50, 70 and 90 DAT. The cow urine used for foliar spray containing 0.978% N (Kjeldahls, method), 0.093% P (vanadomolybdophosphoric acid yellow colour method) and 1.15% K (flame photometer method). Observations on growth parameters, yield attributes and yield of rice were recorded and their significance was tested by the variance ratio (~F-value) at 5% level (Gomez and Gomez, 1984). Treatment means were compared using critical differences (CD) at the 5% level of significance. Relative economics was calculated as per the prevailing market prices of the inputs and produce during the years of experimentation.

RESULTS AND DISCUSSION

Growth parameters

Growth parameters of rice, viz. plant height, tillers/m^2 and dry-matter accumulation varied markedly due to different levels of soil fertility and cow urine as foliar spray (Table 1). Significantly higher mean plant height was observed with 100% recommended dose of fertilizer (RDF) than the rest treatments (Table 1). However, significantly higher mean number of tillers and plant dry-matter accumulation were found with 100% RDF but remained at par with 80% RDF (Table 1). Foliar spraying of cow urine also showed significant variation in growth parameters at

Table 1. Effect of fertility levels and cow urine spray on growth and yield attributes of rice (mean of 2 years)

Treatment	Plant height (cm) at harvest	Tillers/m^2	DMA (kg/m^2)	Panicles/m^2	Grains/ panicle	1,000-grain weight (g)	Panicle length (cm)
Fertility levels							
60% RDF	85.8	551.0	2.20	285.9	131.9	13.60	19.05
80% RDF	87.0	591.7	2.40	298.4	158.7	13.90	19.95
100% RDF	89.7	627.7	2.50	312.7	162.0	14.45	20.75
SEm±	0.6	15.7	0.06	3.8	1.4	0.09	0.35
CD (P=0.05)	2.6	61.8	0.24	14.9	4.3	0.35	1.38
Cow urine spray							
Control	86.0	537.5	2.25	290.2	146.8	13.85	19.40
50% CU	86.8	562.5	2.30	296.1	149.5	13.95	19.95
75% CU	87.7	602.5	2.40	302.0	152.2	14.05	20.05
100% CU	89.4	655.0	2.55	307.5	155.1	14.20	20.30
SEm±	0.6	26.2	0.04	3.3	1.6	0.06	0.23
CD (P=0.05)	1.9	78.0	0.11	9.8	4.8	0.18	0.68

RDF, Recommended dose of fertilizer; CU, cow urine as foliar spray; DMA, dry-matter accumulation

maturity stage and 100% cow urine being at par with 75% cow urine recorded significantly higher plant growth parameters, viz. mean plant height and tiller numbers. Moreover, 100% cow urine as foliar spray recorded significantly higher mean biomass than rest of the cow urine treatments (Table 1). It was evident that rice crop supplied with adequate amount of major nutrients (100% RDF) produced more green leaves and prolific roots for supplying nutrients and water, and hence brought about greater accumulation of photosynthates, producing more taller plants and greater number of tillers that resulted in higher production of dry matter. The growth-attributing characters progressed presumably because of better supply of nitrogen and other major, secondary and micro-nutrients at higher rate of urine application. The different enzymes and hormones present in cow urine also led to better growth of plant (Vahanka *et al*., 2010). Similar findings were also reported by Mandal and Pramanick (2015), who observed that aromatic rice varieties performed better with application of liquid manure containing 1 kg fresh cow dung, 1 litre cow urine and 20 litres water.

Yield-attributing characters

Yield attributes such as panicles/m^2, grains/panicle and 1,000-grain weight exhibited marked variations during the experimental period due to differential fertility levels and cow urine as foliar spray (Table 1). The yield-attributing characters varied significantly due to different fertility levels and 100% RDF being at par with 80% RDF recorded significantly higher mean values of panicles/m^2 and grains/panicle than 60% RDF (Table 1). Similar trend was also recorded for panicle length. However, in terms of 1,000-grain weight, 100% RDF showed significantly higher value than rest of the treatments. In case of cow urine treatments, foliar spray of 100% cow urine was statistically at par with 75% cow urine and showed significantly higher mean values of panicles/m^2, grains/panicle and 1,000-grain weight than 50% cow urine and the control. Moreover, different concentrations of cow urine spraying also brought significant variation in panicle length of rice (Table 1). Singh *et al.* (2014) also reported similar effects of fertilizer and cow urine spraying on rice.

Grain and straw yields

Grain and straw yields varied considerably due to various nutrient-management practices and application of 80% and 100% RDF recorded up to 6.8% and 14.8% higher grain yields and 10.9% and 15.2% higher straw yields, respectively, than that of 60% RDF (Table 2). Increasing concentration of cow urine sprayings from control to 100% brought significant variation in grain and straw yields and application of 50, 75 and 100% cow urine marked up to 4.4, 4.4 and 10% increment in grain yields, respectively, over the control. Similarly, improvement in straw yields due to application of 50, 75 and 100% cow urine were to the extent of 3.7, 9.4 and 12.2% respectively over the control (Table 2). Thus, supplementation of 100% RDF with cow urine as foliar spray exhibited the highest grain and straw yields of rice. It is also apparent from the data that the fertility levels and foliar spraying of cow urine failed to influence the harvest index of rice to the level of significance. Our findings confirm the results of Singh *et al*. (2014). Supplementing inorganic fertilizers with organic sources of nutrients might have improved the

Table 2. Effect of fertility levels and cow urine spray on yields and economics of rice (mean of 2 years)

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)	Cost of cultivation (×10^3₹/ha)[§]	Gross returns (×10^3₹/ha)[§]	Net returns (×10^3₹/ha)	Benefit: cost ratio
Fertility levels							
60% RDF	4.40	6.90	38.9	45.10	102.60	57.50	1.27
80% RDF	4.70	7.65	38.1	45.80	112.30	66.50	1.45
100% RDF	5.05	7.95	38.9	47.10	117.30	70.20	1.49
SEm±	0.13	0.12	0.20	-	2.23	2.25	0.05
CD (P=0.05)	0.49	0.44	NS	-	8.75	8.83	0.18
Cow urine spray							
Control	4.50	7.05	38.9	44.60	104.10	59.50	1.33
50% CU	4.70	7.31	39.1	45.70	108.10	62.40	1.36
75% CU	4.70	7.71	37.9	46.10	110.20	64.10	1.39
100% CU	4.95	7.91	38.5	46.40	115.10	68.70	1.48
SEm±	0.09	0.18	0.25	-	1.86	1.86	0.05
CD (P=0.05)	0.26	0.53	NS	-	5.64	5.64	0.14

RDF, Recommended dose of fertilizer; CU, cow urine

[§]Calculated based on the prevailing market prices of inputs and produce during the years of experimentation

soil health and the availability of micro- and macro- nutrients to rice plants during the growth period, thus improving the synthesis and translocation of metabolites to the sinks, resulting in better yield attributes and yield of rice (Kumari *et al*., 2010; Patra *et al*., 2017).

Economics

Cost of cultivation varied considerably across the treatments primarily due to differential costs incurred in different treatments (fertility levels and cow urine spray). Economics of the rice cultivation revealed that, gross and net returns of rice significantly varied under different treatments. The highest gross and net returns were recorded with 100% RDF, being at par with 80% RDF. The gross and net returns under 100% RDF were 13.6% and 18.2% higher over 60% RDF respectively. Similarly, 100% cow urine being at par with 75% cow urine recorded significantly higher gross and net returns over the control. The gross and net returns under 100% cow urine were 10.6% and 16.4% higher over the control, respectively (Table 2). The highest gross and net returns in these treatments were primarily owing to higher grain and straw yields obtained from rice. In terms of benefit: cost ratio (B: C ratio), 100% RDF appeared to be superior with mean B : C ratio of 1.49. With respect to foliar application of cow urine, increasing concentration improved the B : C ratio continuously up to the highest level of application (100% cow urine).

Based on the results obtained from the experiment, it may be inferred that integration of inorganic fertilizers with 4 sprayings of 100% concentration of cow urine as organic source of nutrients can be an effective integrated nutrient-management strategy in increasing growth and yield response of rice with higher income.

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