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Studies on Different Crop Establishment Techniques and Nitrogen Management on Basmati Rice Variety (*Pusa basmati* 1509)

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A B S T R A C T

A field experiment was conducted during *Kharif*2018 at Research Farm, College of Agriculture, Central Agricultural University, Imphal, Manipur. The treatment consist of two methods of crop establishment viz. broadcasting and transplanting with five integrated nitrogen management viz. 100% RDN through urea, 75% RDN through urea + 25% RDN through FYM, 50% RDN through urea + 50% RDN through FYM and 100% RDN through FYM and control. The results revealed that application of integrated nitrogen management at the rate of 75% RDN through urea + 25% RDN through FYM significantly influenced growth, yield attributes and yield over control. The highest grain yield (2638 kg ha^{-1}), straw yield (6092 kg ha^{-1}) and harvest index (30.04%) were recorded from 75% RDN through urea + 25% RDN through FYM. The highest gross return (Rs.240267 ha^{-1}), net return (Rs.188997ha^{-1}) and benefit cost ratio (3.69) were also obtained from the application of 75% RDN through urea + 25% RDN through FYM.

Introduction

Rice is a staple food for more than 50% of the world population. The leading aromatic fine quality rice in the world trade, popularly known as *basmati*, is traditionally grown in the north and north western part of Indian sub-continent (DRR, 1992). Nitrogen is one of the most important and effective elements required for obtaining high rice yields and stimulating a lot of vital processes in plants in agriculture (Niang *et al.*, 2009). Excessive use of fertilizers will cause environmental pollution and will destroy the balance of the ecosystem that is one of the major problems (Zaller, 2007).

However, long term use of inorganic fertilizers deterioration of soil structure, soil health and environmental pollution (Singh,

2000). Integration of organic manures with inorganic fertilizer is essential to maintain soil fertility and to balance nutrient supply in order to boost up the crop yield per unit area (Arif *et al.,* 2014). Organic manures provide regulated supply of plant nutrients by slowly released resulted in increasing yield of rice and nitrogen use efficiency (Sharma *et al.,* 2002). However, the use of organic manures alone might not meet the plant requirement due to presence of relatively low levels of nutrients. In order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in conjunction with inorganic fertilizers (Fageria *et al.,* 2001).

Farmyard manure (FYM) is being used as organic manure in field crops as it supplies all essential plant nutrients and increases activities of microbes in soil (Sutaliya and Singh, 2005). The conjunctive application of organics with inorganic sources of nutrients reduces the dependence on chemical inputs and it not only acts as a source of nutrients but also provides micro nutrients as well as modifies the soil physical behaviour and increases the efficiency of applied nutrients (Parihar *et al.,* 2010).

Farm yard manure (FYM) is the most effective measure for the improving soil fertility and thereby crop productivity (Hossaen *et al.,* 2011). The integrated nitrogen management helps to maintain soil health and enhanced rice productivity. Application of urea in combination with organic material (FYM) minimizes N loss and increasing N-use efficiency.

Materials and Methods

A field experiment was conducted during *kharif* 2018 to study the effect of different establishment techniques and integrated nitrogen management on basmati variety "Pusa Basmati 1509". The experimental soil was clay with pH 5.42. The soil was high in organic carbon (1.09%) and medium in available nitrogen (301 kg ha^{-1}), and available potash (225 kg ha^{-1}) but low available phosphorous (16 kg ha^{-1}). The total rainfall received during the cropping season was 789 mm.

The treatment consist of two crop establishment techniques viz., broadcasting and transplanting with five integrated nitrogen management viz. 100% RDN through urea, 75% RDN through urea + 25% RDN through FYM, 50% RDN through urea + 50% RDN through FYM and 100% RDN through FYM and control.

The experiment was replicated thrice in factorial randomised block design. Biometric observations on plant height, number of effective tillers m^{-2}, panicle length, number of filled grains $panicle^{-1}$, grain yield, straw yield and harvest index were recorded. The data were subjected to analysis of variance (ANOVA) with three replication in factorial randomised block design by using excel. The least significant difference (LSD) was calculated in comparing the treatment means at 5% level of probability.

Results and Discussion

Effect of seedling establishment techniques

Growth and yield attributes

Data in Table 1 shows that the highest plant height (123.72 cm) was recorded from transplanting which was significantly higher than broadcasting (116.88 cm). It might be due to more space, sunlight and nutrients available to wider spaced plants of transplanting than close spaced plants which facilitated the plants to attained more height.

(Shriame *et al.,* 2000) reported that the number of functional leaves and leaf area were higher under wider spacing, which increased the photosynthetic rate leading to taller plant. The highest number of effective tiller m^{-2} obtained from transplanting (254.67) was found to be significantly higher than broadcasting (220). Better growth of plants like of plant height and number of tiller m^{-2} produced transplanting rice significantly greater number of effective tillers m^{-2} than broadcasting (Gill and Walia, 2014).

Panicle length was not significantly influenced by different crop establishment techniques. But panicle length was higher in transplanting (24.17 cm) than the broadcasting (23.68 cm) (Jain *et al.,* 2018) also reported that transplanting rice of panicle length was higher than broadcasting due to efficient nutrient uptake and good plant growth. Number of filled grains $panicle^{-1}$ had significant effect with establishment techniques. Highest number of filled grains $panicle^{-1}$ (67.36) was recorded from transplanting than broadcasting (61.55). Transplanting rice had more light interception with proper spacing that enhanced to filled grains (Maqsood *et al.,* 2013).

Yield

Seedling establishment through transplanting produced significantly higher grain yield (2246 kg ha^{-1}) as compared to broadcasting (1689 kg ha^{-1}). Highest grain yield in transplanting might be due to more number of effective tillers m^{-2}, more number of filled grain $panicle^{-1}$and was also attributed to increase cumulative mean value of temperature and sunshine hour. Transplanting rice had a uniform spacing encouraged root system resulting in better nutrient uptake and efficient nutrient availability to the plant thereby, more easier in intercultural operations like weeding and spraying (Srivastava *et al.,* 2009). (Singh *et al.,* 2001) while working at Faizabad obtained significantly higher yield of transplanted rice than direct broadcasting of pre-germinated seeds in loam soil due to significantly higher number of panicles m^{-2}, grains $panicle^{-1}$ and panicle length. (Sanjay *et al.,* 2006) enumerated that grain yield of rice was significantly influenced by planting systems. Line transplanting system recorded significantly higher grain yield (55.3 q ha^{-1}) as compared to direct seeding using drum seeder (54.3 q ha^{-1}).

Straw yield was significantly higher in transplanting (5847 kg ha^{-1}) as compared to broadcasting (5200 kg ha^{-1}). It might be due to increased number of tiller m^{-2} with moderate plant height and better performance of yield attributing ultimately led the increase the biomass in the transplanting method of rice establishment.

The lowest yield was recorded in broadcasting method might be due to lesser of effective tiller m^{-2} and increased inter and intra plant competition for available growth resources on account of weed infestation. However, (Sanjay *et al.,* 2006) reported that direct seeding using drum seeder recorded significantly higher straw yield (73.7 q ha^{-1}) compared to line transplanting (69.9 q ha^{-1}) and broadcast sowing (55.4 q ha^{-1}).

Harvest index is the function of grain yield to the total biological yield (grain + straw). Harvest index was also influenced significantly by transplanting (26.88) than broadcasting (24.09). However, Dingkuhn *et al.,* (2001) reported higher harvest index in transplanted crop over direct sown crop.

The lower harvest index in direct seeded rice indicated that the major proportion of its biomass was in terms of straw rather than the grain.

Table.1 Effect of establishment techniques and integrated nitrogen management on growth, yield attributes and yield of rice variety 'Pusa Basmati 1509'

Treatments	Plant height (cm)	No. of effective tillersm^{-2}	Panicle length (cm)	No. of filled grains $panicle^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
Establishment techniques (S)							
Broadcasting (S_1)	116.88	220.00	23.68	61.55	1689	5200	24.09
Transplanting (S_2)	123.72	254.67	24.17	67.36	2246	5847	26.88
SEm(±)	1.69	3.05	0.20	1.25	57.43	25.39	0.66
C.D.(P=0.05)	5.03	9.04	NS	3.73	170.55	75.41	1.97
Integrated nitrogen management (N)							
100% RDN through urea (N_1)	124.57	247.17	25.23	70.60	2147	5958	26.30
75% RDN through urea + 25% RDN through FYM (N_2)	125.87	258.17	25.52	83.30	2638	6092	30.04
50 % RDN through urea + 50% RDN through FYM (N_3)	121.00	245.33	24.82	65.17	2123	5611	27.23
100% RDN through FYM (N_4)	118.43	239.17	24.71	61.33	1987	5357	26.95
Control (N_5)	111.63	196.83	19.33	41.87	941	4600	16.91
SEm(±)	2.68	4.81	0.32	1.98	90.80	40.15	1.05
C.D.(P=0.05)	7.96	14.30	0.95	5.89	269.66	119.23	3.12
Interaction (N x S)							
SEm(±)	3.79	6.81	0.45	2.81	128.41	56.77	1.49
C.D.(P=0.05)	NS	20.22	NS	NS	381.36	168.61	NS

Table.2 Effect of establishment techniques and integrated nitrogen management on economics

Treatment	Gross income (Rs.ha^{-1})	Net income (Rs.ha^{-1})	B:C ratio
S_1N_1	142773	97823	2.18
S_1N_2	181867	129747	2.49
S_1N_3	138667	79367	1.34
S_1N_4	136640	62990	0.86
S_1N_5	75627	36877	0.95
S_2N_1	200800	156700	3.55
S_2N_2	240267	188997	3.69
S_2N_3	201067	142617	2.44
S_2N_4	181333	108533	1.49
S_2N_5	74933	37033	0.98

Effect of integrated nitrogen management

Growth and yield attributes

The maximum plant height (125.87 cm) was recorded with the application of 75% RDN through urea + 25% RDN through FYM and the lowest (111.63 cm) was observed from control. It was followed by 100% RDN through urea and 50% RDN through urea + 50% RDN through FYM. The increased in plant height might be due to adequate nutrient supply to the plant which resulted into rapid growth by good establishment of root and various metabolic process and ultimately performed better mobilization of synthesized carbohydrates in to amino acid and protein which stimulated the rapid cell division and cell elongation. Finally, it resulted in to growth of plant faster as compare to other treatments (Sujathamma and Reddy, 2004).

Yield attributing characters like number of effective tillers m^{-2} panicle length, number of filled grains $panicle^{-1}$, grain yield, straw yield and harvest index were also significantly influenced by integrated nitrogen management. The highest number of effective tillers m^{-2} (258.17) was obtained with application of 75% RDN through urea + 25% RDN through FYM. The lowest number of effective tillers m^{-2} (196.83) was recorded from control. The results clearly indicated that the application of organic manures with chemical fertilizers increased effective tillers m^{-2} which was comparable to the 100% chemical fertilized treatment (Rahman *et al.*, 2009). Interaction between the establishment techniques and integrated nitrogen management were significantly influenced on number of effective tillers m^{-2}. The maximum number of effective tillers m^{-2} (260) was recorded from S_2N_2 transplanting with 75% RDN through urea + 25% RDN through FYM whereas the minimum number of effective tillers m^{-2} (148.67) was observed from S_1N_5 broadcasting at control. It might be due to integrated use of urea with FYM sources of fertilizers have enhanced the nitrogen availability then resulting increased nitrogen uptake by rice which promoted the production of more number of effective tillers (Imade *et al.*, 2017). Panicle length of rice was significantly influenced by different treatments (Table 1). The highest panicle length (25.52 cm) was observed at 75% RDN through urea + 25% RDN through FYM treatment. The lowest panicle length (19.33) was observed at control. The result further showed that panicle length increase was directly influenced by the increased dose of organic manure in combination with chemical fertilizers. However, (Kumar and Singh, 2006) reported that the combined application of organic manure and chemical fertilizers increased panicle length of rice. The increase in panicle length may be due to application of organic and chemical fertilizers which resulted in more availability of macronutrients as well as micronutrients (Babu *et al.*, 2001). The number of filled grains $panicle^{-1}$ was significantly affected due to application of urea with FYM. The highest number of filled grains $panicle^{-1}$ (83.30) was found at 75% RDN through urea + 25% RDN through FYM. The lowest number of filled grains $panicle^{-1}$ (41.87) was recorded from control. The combined application nitrogen with FYM sources of fertilizers was enhanced the nitrogen availability then resulting nutrient were utilized for grain formation and grain filling (Kumar *et al.*, 2016).

The grain yield of basmati rice (cv. Pusa basmati 1509) responded significantly to integrated use of urea with FYM and results have been presented in the Table 1. All the treatments produced significantly higher grain yield over control. The highest grain yield (2638 kg ha^{-1}) was obtained with application of 75% RDN through urea + 25% RDN through FYM. The lowest grain yield (941

kg/ha) was observed from control. The study revealed that integrated use of cow dung and poultry manure with chemical fertilizers reduced fertilizer without any remarkable yield decline (Haque *et al.,* 2001 and Rajni *et al.,* 2001). However, (Mondal *et al.,* 2003) also observed that the number of panicle m^{-2} and number of filled grains $panicle^{-1}$ was highest with the application of 75% of the recommended dose of NPK (60 kg N + 30 kg P_2O_5 + 30 kg K_2O) along with FYM @ 4 t ha^{-1}. The maximum rice grain yield (6 t ha^{-1}) was also recorded at 75% of the recommended dose of NPK+FYM @ 4 t ha^{-1}. Interaction between the establishment techniques and integrated nitrogen management were significantly influenced on grain yield. Highest grain yield (3003 kg ha^{-1}) was recorded from the transplanting along with application of 75% RDN through urea + 25% RDN through FYM whereas the lowest grain yield (936.67 kg ha^{-1}) was observed from transplanting without any fertilizer (control). Application of organic manure in addition to the recommended dose of fertilizers produced significantly higher grain yield in rice (Rabeya Khanam *et al.,* 1997). The increased grain yield was due to uptake of nutrients in paddy and the application of organic manure reduced the dosage of NPK. This may indicate that organic manure reduces the loss of nutrients through leaching from the soil (Bhattacharjee *et al.,* 2001). The highest straw yield (6092 kg ha^{-1}) was recorded with application of 75% RDN through urea + 25% RDN through FYM. The lowest straw yield (4600 kg/ha) was observed from control. (Singh, 2001) also reported that the application of organic manure and chemical fertilizers increased straw yield. Interaction between the establishment techniques and integrated nitrogen management were significantly influenced on straw yield. The highest straw (6302 kg ha^{-1}) was recorded from transplanting along with application of 75% RDN through urea + 25% RDN through FYM whereas the lowest straw yield (44367 kg ha^{-1}) was observed broadcasting without any fertilizer. (Rahman *et al.,* 2009) reported that the application of organic manure and chemical fertilizers increased the grain and straw yields of rice. The highest harvest index (30.04) was recorded with application of 75% RDN through urea + 25% RDN through FYM. The lowest harvest index (16.91) was observed at control. It might be due to better partitioning of photosynthetic substance to economic yield. Appreciably high harvest index shows the efficiency of converting biological yield into economic yield (Arif *et al.,* 2014). The increase in yield was further attributed to better translocation of photosynthates from source to sink due to higher uptake of NPK which are responsible for quick and easy translocation of photosynthates (Dongarwar *et al.,* 2007).

Economics

Analysis of economics factors like gross return, net return, and benefit cost ratio are important to evaluate the effect of establishment techniques and integrated nitrogen management (Table 2). Grain yield was major factor which caused differences in net income and net return per rupees invested. Maximum Gross return (Rs.240267 ha^{-1}), net return (Rs.188997 ha^{-1}) and benefit cost ratio (3.69) were recorded from transplanting along with application of 75% RDN through urea + 25% RDN through FYM. The lowest gross return (Rs.74933 ha^{-1}) was recorded from transplanting without any fertilizer, the lowest net return (Rs.36877 ha^{-1}) from broadcasting without any fertilizer and the lowest benefit cost ratio (0.86) was obtained from broadcasting without any fertilizer. It might be due to higher production of grain and straw yield and higher increased in output in comparison to input (Tomar *et al.,* 2018). However, Sharma *et al.,* (2018), Tripathi, V.K. and Mishra, H.C. (2012) also reported

that the maximum gross income, net return and benefit cost ratio was recorded from the integrated (Fertilizer + FYM) treatment for basmati rice and the lowest from control.

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