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Response of Crop Establishment Methods and Split Application of Nitrogen on Productivity of Rice under Irrigated Ecosystem

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Abstract A field experiment was carried out during the *kharif* season to compare the effect of crop establishment methods and split application of nitrogen on production potential of rice under trigated ecosystem. The treatment was comprised methods of crop establishment i.e. transplanting of seedlings, drum seedling of sprouted seed and direct seeding (broadcast) of sprouted seed in main plot and four split application of nitrogen i.e. $^1/_2$ basal + $^1/_2$ PI stage, $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ Pl stage, $^1/_3$ basal + $^1/_3$ maximum tillering + $^1/_3$ PI stage and $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering stage in sub-plot and replicated in thrice. Results revealed that all the growth parameter viz. plant height, dry weight, crop growth rate and relative growth rate was found to significantly superior with transplanting of seedlings as compared to others methods of crop establishment. Further, the grain yield (6.10 t ha^{-1}) was also found to be significantly higher with transplanting of seedlings as compare to drum seedling of sprouted seed (5.87 t ha^{-1}) and direct seeding (broadcast) of sprouted seed (5.40 t ha^{-1}). With respect to split application of nitrogen, it was noted that the significantly higher growth and yield attributes was recorded with application of $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering.Therefore, it may be concluded that rice grown with transplanting the seedlings alone with split application of N i.e. $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering was found to be the best alternatives to the rice growing.

Keywords Rice, Crop establishment methods, N scheduling, Grain yield.

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Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop as it is a staple food for more than 70% of the world's population. That is why the rice production always holds a key role in overall food situation of the whole world. Rice occupies an area of about 155.13 m ha at global level with production of 596.4 mt and 3.84 t/ha, respectively [1]. Fortunately, India ranks first in acreage and second in rice production only after china. During the year 2003-2004, India produce

87.12 mt rice from 44.8 m ha. About 63% of total rice growing area of the country is located in eastern part of country covering UP, Bihar, West Bengal, Assam, Orissa and Madhya Pradesh. Among the other agronomic management practices, crop establishment methods significantly increased the productivity of rice. The ideal planting methods is important for better and efficient utilization of available resources in order to get optimum productivity of rice. It has been observed that uneven plant stand due to faulty method of crop establishment favor low fertilizer use efficiency resulted in poor rice yield. Although transplanting method has been found to be the best for higher productivity of rice [2], but it is not available preposition due to higher labor charge and availability problem for short span. Therefore, alternative must be explored. Alternatively, direct seeding in rows or broadcasting of sprouted seeds under puddled condition have been reported ideal planting method to ensure optimum population at the lowest cost [3]. The positive response to nitrogen application in rice has been reported but its time of application contributes significantly towards nitrogen use efficiency and rice productivity. Application of adequate quantity of nitrogen at right stage of crop synchronizing well with most efficient utilization that influence yield of rice. Nitrogen moves very rapidly in the soil and subjected to various losses mainly due to leaching, denitrification, volatilization and surface runoff resulting into reduced nitrogen use efficiency. To overcome this problem, split application of nitrogen is recommend and response per unit of nitrogen in rice was reported to be more when applied in split doses [4].

Materials and Methods

The experiment was carried out at central research farm, Department of agronomy, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Naini, Allahabad, Uttar Pradesh (25.28^0 N latitude, 81.54^0 E longitude and 98 m altitude above msl).The experimental soil was having pH neutral (7.8), low in organic carbon (0.36%) and available nitrogen (202 kg ha^{-1} potassium (160 kg ha^{-1}) medium in phosphorus (18 kg ha^{-1}). The experiment was laid out in factorial randomized block design with twelve treatments and replicated thrice. Treatment consisting of three crop establishment methods viz. transplanting of seedling (CE_1), drum seedling of sprouted seed (CF_2) and direct seeding (broadcast) of sprouted seed (CE_3) and four application of nitrogen, viz. $^1/_2$ basal + $^1/_2$ PI stage (SN_1), $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage (SN_2), $^1/_3$ basal + $^1/_3$ maximum tillering + $^1/_3$ P1 stage (SN_3) and $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering (SN_4) with rice cv NDR-359. Tillage operation in direct seeding in dry field was done directly without any primary field preparation and for direct seeding of sprouted seed through drum-seeder in puddle soil and hand transplanting consists of one cultivator, 2 puddling and 1 planking. Butachlor @ 1.5 kg ha^{-1} was applied as pre-emergence for weed control and manual weeding was done three times, first weeding at 52 DAT/DAS and second at 71DAT/DAS, third DAT/DAS. Recommended dose of fertilizers i.e. 120 kg N: 80 kg P : 60 kg K : 25 kg Zn ha^{-1} was applied uniformly in experimental plot. The nutrient requirement of NPK and Zn was supplied with urea (46% N), single super phosphate (16% P_2O_5), muriate of potash (60%K) and zinc oxide. The full dose of phosphorus, potassium and zinc were applied at time of transplanting and direct seeding (broadcast) of sprouted seed. The data on growth and yield attributes tillers/m^2, dry weight, crop growth rate, relative growth rate, grains/panicle, 1000-seed weight, grain yield was recorded as per standard procedure. The experimental data pertaining to the each parameter of study was subjected to statistical analysis by using technique of analysis of variance (ANOVA) and their significance was tested by F test. The standard error of means (SEm ±) and least significant difference (LSD) at 5% probability ($p = 0.05$) was work out to evaluate differences between treatment mean.

Results and Discussion

Effect of crop establishment methods

Method of rice planting was found to be significant with respect to growth attributes of rice (Table 1). Transplanting of rice seedling was produced significantly higher plant stand (%) and plant height compared to other methods of crop establishment. Favorable effect of rice transplanted with seedlings was due to better initial establishment and efficient cell-division and cell elongation in meristematic tissue [5], Plant dry weight, crop growth rate and relative growth

Table 1. Effect of crop establishment methods and split application of nitrogen on growth, yield attributes and yield of rice.

Treat-ments	Crop. establishment (%)	Plant height (cm)	Tillers/ m^2 (No.)	Dry weight/ plant (g)	CGR	RGR	Grains/ panicle (No.)	1000-grain weight	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Crop establishment method											
CE_1	94.50	126.17	298	292.50	9.15	0.113	239.00	20.75	6.10	9.40	39.19
CE_2	88.50	114.92	174	241.25	6.67	0.107	209.42	19.75	5.87	9.15	39.09
CE_3	87.17	117.33	453	130.33	2.79	0.090	151.67	19.92	5.40	8.51	38.77
SEd ±	1.24	1.29	9.13	8.86	0.004	0.001	9.42	0.37	0.11	0.17	0.14
CD (p=0.05)	2.58	2.68	18.93	18.37	0.007	0.002	19.55	0.77	0.23	0.35	0.28
Split application of nitrogen											
SN_1	89.44	120.33	334	208.89	4.78	0.103	201.11	19.78	5.72	8.76	39.26
SN_2	90.56	118.22	304	238.89	7.61	0.104	199.22	20.44	5.77	9.10	38.83
SN_3	88.78	120.11	310	211.56	5.48	0.103	190.00	20.39	5.72	8.97	38.89
SN_4	91.44	119.22	282	226.11	6.94	0.103	209.78	19.94	5.94	9.24	39.09
SEd ±	1.44	1.49	10.54	10.23	0.004	0.001	10.88	0.43	0.13	0.09	0.16
CD (p=0.05)	NS	NS	21.86	21.21	0.008	NS	NS	NS	NS	NS	0.32

rate were recorded the maximum with transplanting of seedlings closely followed by drum seeding of sprouted seed and direct seeding (broadcast) of sprouted seed. Similarly, higher leaf area index may be associated with increase in assimilation of food material through photosynthesis on account of vigorus root/shoot growth, which ultimately lead to the higher dry matter production [6]. But maximum tillers/plant was found higher with direct seeding of sprouted seed all over planting methods.

The yield attributes and rice yield differed significantly with different establishment methods (Table 1). The transplanting of rice seedlings was found the highest grain yield (6.10 t ha^{-1}) than other crop establishment methods. However, drum seeding of sprouted seed was noted statistically at par with transplanting of seedlings. Similarly, grains/panicle and 1000-seed weight was recorded the maximum in transplanting of seedlings closely followed by drum seeding of sprouted seed. However, the similar trend was found in case of rice straw yield and harvest index. Higher rice yield was associated with hand transplanted rice, mainly due to higher yield attributes and better crop management [7].

Effect of split application of nitrogen

Different nitrogen scheduling of rice had significant variation in growth attributes viz. tillers, dry weight and CGR during the experimentation (Table 1). Irrespective of the split application of nitrogen, significantly highest tillers/plant was recorded with application of N as $^1/_2$ basal + $^1/_2$ PI stage of rice. The split application of nitrogen $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage was produced the highest dry weight. However, the split application of N i.e. $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering was found to be statistically at par. The maximum crop growth rate (CGR) was recorded with split application of nitrogen as $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage. However, the split application of nitrogen maintained the continuous supply of nutrients, which might have favored the crop growth [8].

Application of split levels nitrogen in rice differed significantly with respect to yield attributes and yield (Table 1). However, split application of nitrogen i.e. $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering recorded the highest grain yield (5.94 t ha^{-1}). However, the similar trend was found other yield attributes of rice viz. grains/panicle. The split application of nitrogen i.e. $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage was recorded the significantly highest 1000-grain weight. However, split application of N as $^1/_2$ basal + $^1/_2$ PI stage was found significantly higher harvest index (39.26%). This phenomenon may be due to the positive interaction effect of crop establish-

Table 2. Interaction effect of crop establishment method and split application of nitrogen on rice yield.

Crop estabilishment method	Split application of nitrogen (SN)			
	SN_1 $^1/_2$ basal + $^1/_2$ PI stage	SN_2 $^1/_2$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage	SN_3 $^1/_3$ basal + $^1/_3$ maximum tillering + $^1/_3$ PI	SN_4 $^1/_2$ basal +$^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering stage
Transplanting of seedlings	5.80	6.00	6.10	6.50
Drum seeding of sprouted seed	5.83	5.53	6.00	6.13
Direct seeding (broadcast) of sprouted seed	5.53	5.80	5.06	5.20
CD (p = 0.05)		0.47		

ment method and split application of nitrogen for higher uptake of nutrients through better established roots, which increased the utilization of moisture and nutrients and resulting in better plant growth [3].

Interaction effect

Interaction effect was found to be significant with respect to crop establishment methods and split application of nitrogen on rice yield (Table 2). The crop establishment methods i.e. transplanting of rice seedlings and split application of nitrogen i.e. $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering was found to be significantly superior (6.5 t $ha^{-1)}$ over rest of the treatment combinations but statistically at par with split application of N i.e. $^1/_3$ basal + $^1/_3$ maximum tillering + $^1/_3$ PI stage. This interaction may be due to the 'precision effect' of transplanting coupled with split application of N, which prevented the loss of nutrient and favorable condition for better growth and development of the crop [9].

Thus, it was concluded that crop establishment methods of transplanted rice through manually along with split application of nitrogen as $^1/_4$ basal + $^1/_4$ maximum tillering + $^1/_4$ PI stage + $^1/_4$ flowering stage are the best management practices for higher productivity of under irrigated condition of Eastern Uttar Pradesh on a long-term basis.

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