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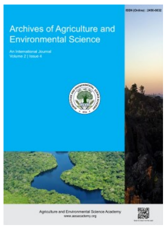

ORIGINAL RESEARCH ARTICLE

CrossMark

Interaction of nitrogen doses and establishment methods in lowland rice at Parwanipur, Bara, Nepal

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ABSTRACT

The experiment was laid out in split plot design: three establishment methods were designed (Puddled transplanted rice, Non- puddled transplanted rice, Conventional dry tillage +DSR) as a main plot and four levels of nitrogen rate (0, 60, 120, 180) as sub plot and replicated three times during summer season of 2015 and 2016 at RARS, Parwanipur. Grain yield and other yield attributes like plant height, penicle length and number of tiller per m^2 of rice was observed significantly differed ($p<0.05$) between different establishment methods and nitrogen levels. In 2015 there was not significant effect of establishment practices on grain yield but significntly highest grain yield (4603 kg/ha) was obtained from application of nitrogen@120 kg/ha and grain yield decreased with increased of nitrogen application @ 180 kg/ha (4365 kg/ha). Results reveled that significantly higher grain yield was obtained under non puddled transplanted rice (3314 kg/ha) than puddle transplanted rice (3280 kg/ha) which were at par with conventional tillage plus DSR (2123 kg/ha) and significntly highest grain yield (3424 kg/ha) was obtained from application of nitrogen@180 kg/ha during 2016. In both years the highest grain yield was obtained from puddled transplanted rice with the nitrogen application @ 120kg/ha. Based on two years results, it can be concluded that N is limiting factor for the productivity of rice in Parwanipur. Therefore 120 kg/ha nitrogen could be optimum dose for puddled transplanting and direct seeded rice at Parwanipur condition.

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INTRODUCTION

Rice is the most important among all cereals used as a food grain in the world (Kumar and Malyan, 2016). Rice is the major cereal crop in Nepal and rank 1st in terms of production but its average yield is very low as compared to neighboring countries like India and China (FAO, 2018). With the existing semi-dwarf 1 (sd1) high yielding and input responsive varieties, there is enormous potential of obtaining higher crop productivity by adopting production technology such as appropriate seed rates, sowing date, and NPK rates (Khush, 1997). Seed rate is considered as an important management factor for improved yield of rice because it is under the farmer's control in most cropping systems. Optimum seed rate and suitable fertilizer level play an important role in achieving its potential yield. Among the fertilizer, N is most important for proper growth and development (Ranjan *et al.*, 2019). N fertilizer has economic and ecological implication by its excessive use in the form of GHG gas emission or leaching of NO_3 in ground water table (Malyan *et al.*, 2016a; Kumar *et al.*, 2016). Due to increase in price of fossil fuel, the raise in price of N fertilizer limits its application by farmers in field. Appropriate doses of N fertilizer and establishment method are the need for increase nitrogen use efficiency (NUE) in rice (Ranjan and Yadav, 2019) results lowering N fertilizer application with same level of yield.

Direct seeding method of rice cultivation has been emerged as attractive alternative to transplanting and regarded as a resource conserving technology (Malyan *et al.*, 2016b; Aslam et *al.*, 2008). The input for DSR is much lower than transplanted rice (Bhullar *et al.*, 2018). This technology has been advanced with seed drill planting under zero tillage condition for more précised planting and residue retention in rice wheat system. However, instability in yields of direct-seeding compared with those of transplanting rice hindering its widespread use. Nutrient and weed management are identified as major problems need to be optimized to capture the benefit of this technology at the farm level Rao *et al.* (2007). Nutrient management is highly location specific varies with different methods of crop establishment techniques; no general recommendation is possible for all the situations. Direct seeded rice encounter diverse and heterogeneous soil environment as opposed to the more uniform conditions in transplanted rice (Kumar and Harikesh, 2018). In such cases N is subject to more losses if not applied with appropriate amount and timing. Thus N management options developed for transplanted rice are unlikely suitable for direct seeded rice. Similarly, weeds are another major constraint and are often 2-3 times higher in DSR than in transplanted rice. The establishment of DSR in zero till condition is subject to change in weed flora and fauna than in transplanted rice because flooding and puddling provides control over weeds. Earlier research in this regards also suggested that the weed dynamics is changed with the change in N dynamics (Parameswari *et al.*, 2014). Also, NUE for rice grown under different N doses and establishment methods is little understood, based on this, experiment was design to know the response of different nitrogen levels and establishment practices of rainfed lowland rice at RARS, Parwanipur, Bara.

MATERIALS AND METHODS

Climate of experimental site

Parwanipur is located northern of Nepal at altitude of 215 MSL, longitude 70.2°E with latitude 25.5°NE. The region falls under tropical condition with extreme summer and winter. However, the weather condition was quite favorable to the development of crop.

Experimental site and treatment details

The experiment was laid out in split plot design with crop establishment as main plot (Puddled transplanted rice (PTR), Non-puddled transplanted rice (NPTR), Conventional dry tillage (CDT) and direct seeded rice (DSR) and nitrogen rate as sub plot (N1: 0 kg, N2: 60 kg ha-1: 30 kg ha^{-1} at planting and 30 kg ha^{-1} at panicle initiation, N3: 120 kg ha-1': 60 kg ha^{-1} at planting, 60 kg ha^{-1} at panicle initiation and N4: 180 kg ha-1: 90 kg ha^{-1} at planting, 90 kg ha^{-1} at panicle initiation) at RARS, Parwanipur. All plots receive same rate of P and K (60 kg/ha P, 40 kg/ha K) and seeding was done on 5th July, 2015 and transplanted on 2nd August, 2015. The same treatment was applied during summer i.e on 10th July 2016 and transplanted on 12th August, 2016.

Observations of plant growth

Five plants of each plot was randomly selected and tagged in the begining of study. Thses tagged plants were used to note the morphological observations of rice crop. The observation observed at 30, 60, 90 days after transplanting (DAS) and also at harvesting stage. The different parameters of crops was observedin present investigation.

Plant hight (cm)

After the emergnce of the penicals, the hight of previously tagged plant (cm) was measured from the base of tiller to leaf tip.

Numbers of tiller (m^{-2})

The number of tiller fron each tagged plant was countedand the average of all tiller was presented in results.

Penical length (cm)

Five plant in each plot were selected for penical length measurement. The length of selected penicals was measured from base to tip with the help of scale (meter). the average of all penicals were presented in results.

Numbers of gain filled/unfilled $penical^{-1}$

Five plant tagged at the begining of experiment was used for counting the numbers of grain filled or unfilled. The grain from these tagged plants were taken and healthy grain was substracted from total grain by manually. The nuber of filled and unfilled grain was noted and their means were presented in results.

Grain yield (kg^{-1})

The crop yield obtained from each plot was weight with the help of appropiate blance.

Straw yield (kg^{-1})

The straw yield from each plot collected and their weight was calculated by substrating grain yield from biological yield.

Harvest index (HI)

It is the ratio of economic yield and biological yield.

$$\text{Harvest index} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

RESULTS AND DISCUSSION

The effect of different establishment methods was significant for HI, panicle length and Number of tiller per m^2 and non significant for rest for year 2015 and was significant for Grain yield, HI and was non-significant for rest i.e., Plant height, panicle length, Number of tiller per m^2, Filled grains $panicle^{-1}$, sterility % and TGW for year 2016. The result also showed puddled transplanted method yield (grain) more than other 2 methods in both years. But HI was more in non-puddled transplanted in both years as Table 1. Even the yield was more in puddled transplanted but HI was low because of excessive biological yield (straw yield + grain yield) in puddled transplanted method result low HI. Other yield contributing factors like panicle length, Number of tiller per m^2, Filled grains panicle^{-1} and sterility % was non significant to all the establishment method as in Table 2, table 3. There might be other traits above these that contribute significant grain yield in year 2015. Thousand grain weights were taken year 2015 and data showed that it's more in conventional tillage + DSR but there is not much variation for all the three established method as in Table 2.

The analysis at different level of N was significant for grain yield, straw yield, HI, panicle length, number of tiller per m2 and TGW and non significant for rest for the year 2015 whereas significant for grain yield, straw yield, plant height, panicle length, Number of tiller per m^2 and TGW and non significant for rest for the year 2016 as in Tables. Grain yield was recorded highest for N@120 kg/ha for both the year. Straw yield data was highest for N@180 kg/ha in year 2015 revealed that adding of more N fertilizer above 120 kg/ha result increased only in vegetative growth without translocation its component to grain yield. HI was more in N@0 kg/ha in year 2015 revealed that low biological yield result high HI as in Table 1. Data for year 2015 for Number of tiller per m^2 and TGW was high for N@120 kg/ha. These two component was contributing for higher yield. By these data we can reveal 120 kg/ha nitrogen could be optimum dose for puddled transplanting and direct seeded rice at Parwanipur condition as Figure 1 (a-b) Individual trait wise is described below.

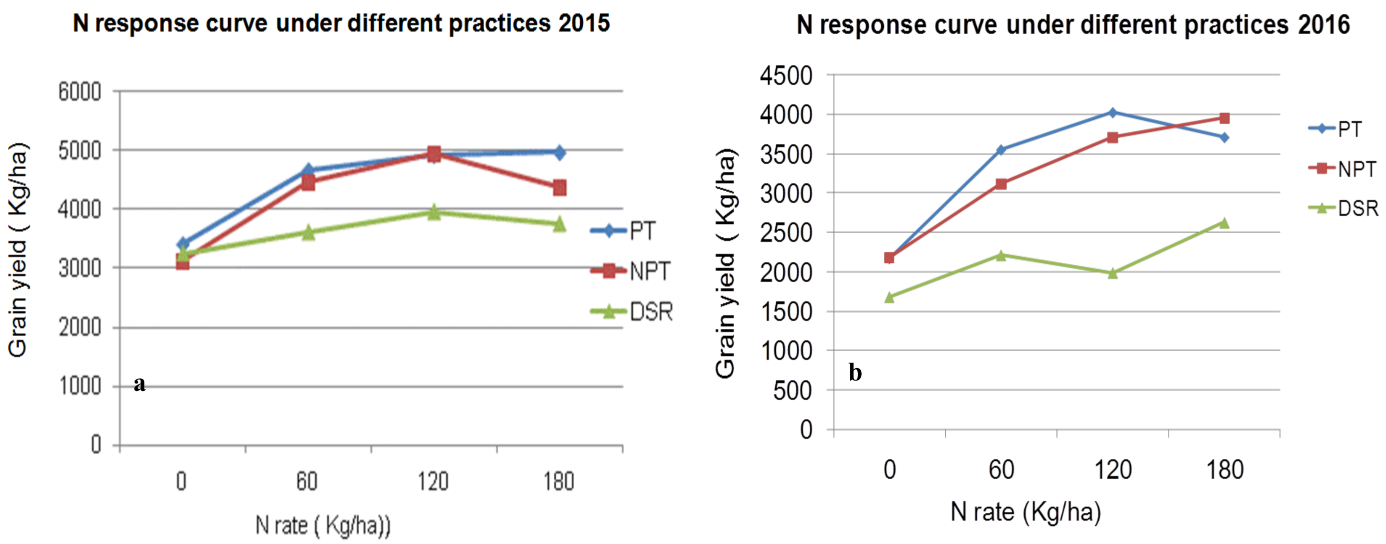

Figure 1 (a-b). Relationship between nitrogen level and grain yield.

Table 1. Yield and its related characters of rice at different establishment methods and nitrogen levels RARS, Parwanipur during 2015 and 2016.

Treatments	Grain yield		Straw yield		HI	
Years	2015	2016	2015	2016	2015	2016
Establishment method						
PTR	4488	3280	8085	6808	36	33
NPTR	4220	3314	6203	6203	41	35
DSR	3643	2123	10477	6433	27	25
F test	ns	*	ns	ns	*	*
LSD	-	850.9	-	-	5.599	6.9
Nitrogen levels						
0	3257	2008	4879	3927	41	35
60	4242	2956	8209	6778	35	30
120	4603	3236	9924	7297	33	30
180	4365	3424	10007	7924	31	30
F test	**	**	**	**	**	ns
LSD	442.1	421.5	1444.5	985.3	4.74	-
CV %	10.8	14.6	17.7	15.3	13.7	15.3

** and * denotes significant at 1 and 5 % level of significance respectively and ns stands for non significant.

Grain Yield

Grain yield is most important trait and is depend on other component traits. Grain yield was found higher in puddled followed by non-puddled transplanted rice where different level of nitrogen doses were showed significant affected yield of rice in both the year. Grain yield of rice increasd with increasing Ndose upto 120 $kgha^{-1}$ and get reduced when N@ 180 $kgha^{-1}$ in all three establishment methods in both the year.

Plant height (cm)

Introduction of dwarfing gene (sd1) reduced the plant height of most of the introduced varieties in Nepal. Plant with higher height tends to lodge most and result heavy reduction in yield and quality character of rice. The mean plant height (cm) of direct seeded rice (CDT-TPR) was higher than Puddled transplanted rice (TPR) and Non- puddled transplanted rice (NP-TPR) observed in both year. The height of plant was found to increase from 60 kg $N^{-1}$to 120 kg N^{-1} in all practices. Maximum height (113 cm) was noticed in DSR with optimum height at 120 kg (114 cm) (Table 1).

No. of tillers m^{-2}

This trait is most important component for yield. The maximum tillering (no. of tillers) of plant was obtained with 120 kg N in DSR. The mean number of tiller was 221 and 284 for 2015 and in DSR at 120 kg/ha for respective years.

Panicle length (cm)

Panicle length too decides the yield with its significant contribution. We got different results with panicle length where 180 kg N was found most effective for panicle length (Table 1). However, significant variation was observed in panicle length with increased dose of N (Tukey's test, $p < 0.05$) in both year 2015 and 2016. The mean length of panicle was more in DSR practices as compared to other two practices but was not significant.

Filled grain $panicle^{-1}$

Plant with fertile grain decides the total yield. This trait is non significant for different N doses and establishment methods.

Unfilled grain $panicle^{-1}$

Sterile or unfilled grain is due to high temperature stress during flowering and most yield reducing factor. The higher unfilled grains were noticed at 120 kg N in both PTR and CDT-TPR practices. The numbers of unfilled grains found in CDT-PTR were less than other practices but was NS with practices and N doses.

Straw yield ($kgha^{-1}$)

Similar to other parameters of growth, maximum straw yield was obtained with 180 kg N^{-1} during 2015 but non significant during 2016. The mean grain yield of NPTR practice was higher than other practices while the mean yield of straw was more in DSR practice during 2015 and NS during 2016.

Harvest Index

HI is most important factor to show the relative contribution of economic yield in relation to total biomass yield. It shows the ability of total photosynthate to convert to economic or grain yield. HI is more for 60Kg N and NPTR practices during 2015 and 2016.

Table 2. Yield attributing traits of rice at different establishment methods and nitrogen levels RARS, Parwanipur during 2015 and 2016.

Treatments	Plant height (cm)		Panicle length (cm)		Number of tiller per m^2	
Years	2015	2016	2015	2016	2015	2016
Establishment method						
PTR	108.92	94.6	27.17	22.5	247.9	303
NPTR	105.42	93	27.33	23.0	246.3	311
DSR	113.42	98	27.33	24.2	275.6	328
F test	ns	ns	ns	ns	ns	ns
LSD	-	-	-	-	-	-
Nitrogen levels						
0	96.56	87.2	25.44	20.8	221.4	231
60	108.33	98	27.11	23.6	243.8	304
120	114.33	100.3	28.11	24.3	284.7	350
180	117.78	95.3	28.44	24.2	276.6	370
F test	ns	**	**	**	**	**
LSD	-	4.4	1.338	1.4	36.35	31.3
CV %	5.3	4.7	5.0	6.2	14.3	10.1

** and * denotes significant at 1 and 5 % level of significance respectively and ns stands for non significant.

Table 3. Yield attributing traits of rice at different establishment methods and nitrogen levels RARS, Parwanipur during 2015 and 2016.

Treatments	Filled grains panicle^{-1}		Unfilled grains panicle^{-1}		TGW (gm)	
Years	2015	2016	2015	2016	2015	2016
Establishment method						
PTR	98.3	76	29	38	21.667	20.8
NPTR	99.4	77	24	32	21.583	20.7
DSR	113.8	61	25	39	22.083	20.1
F-test	ns	ns	ns	ns	*	ns
LSD	-	-	-	-	0.2987	-
Nitrogen levels						
0	99.4	69	24	34	22.111	20.8
60	106.2	64	22	40	22.000	20.6
120	107.6	73	30	43	21.667	20.7
180	102.2	80	30	28	21.333	20.0
F-test	ns	ns	*	ns	**	*
LSD	-	-	5.8	-	0.2859	0.6
CV %	16.9	15.8	22.2	32.4	1.3	3.1

** and * denotes significant at 1 and 5 % level of significance respectively and ns stands for non significant.

Direct seeding, which does not require seedlings to be raised or transplanted, is regarded as the most effective method of reducing costs, labor, drudgery and resource competitions. Direct seeding offers substantial saving in water, labor and enable early establishment of rice crop with noticeable reduction in drudgery involved in transplanting (Tripathi *et al.*, 2002; 2004; Gupta *et al.*, 2000). It increases cropping intensity and provides options to diversify rice based cropping systems particularly due to early harvesting and time saving. Direct seeding avoids puddling and its negative effect on soil physical and chemical properties which also benefit the following crop in rice based cropping system (Hobbs and Morris, 1996). The development of suitable varieties, improvement in management practices and increased availability of appropriate herbicides have increased the adoption of direct seeded rice in many Asian countries (Pandey and Velasco, 2002). However, development of a package of practices for direct seeding is underway; many things are yet to be understood correctly and materialized them accordingly as Khan, 1996 reported that 125 kg ha^{-1} is the ideal seed rate to obtain higher grain yield.

Conclusion

Based on two years results, it can be concluded that N was a limiting factor for the productivityof rice in Parwanipur areas. Yield increased with increasing level of nitrogen but there was not significant response beyond 120 kg/ha nitrogen application. Therefore 120 kg/ha nitrogen could be optimum dose with puddle transplanting at Parwanipur condition.

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