PRODUCTIVITY AND PROFITABILITY OF RICE CULTIVATION AS AFFECTED BY DIFFERENT NITROGENOUS FERTILIZER AND WEED CONTROL METHOD

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Abstract

This experiment was conducted at the Bangladesh Rice Research Institute (BRRI) Gazipur Farm during T. aman 2007 season to determine the relative profitability of different types of N- fertilizer and weed control method. The treatments were use of three types N- fertilizer (PU= Prilled urea as per recommended rate of N and applied in 3 equal splits; USG_1= Broadcasting urea super granules as basal as per recommended rate of N; USG_2= Deep placement of USG as per recommended rate of N and applied as single dose and USG_3= Deep placement of USG as per recommended rate of N and applied in 2 equal splits) and three weed control methods (M_1= REFIT at 4 DAT + One hand weeding at 40 DAT ; M_2= Hand weeding at 20 and 40 DAT; and M_3= Weeding by weeder at 20 and 40 DAT). BRRI dhan41 was used for experimental purpose. It was observed that the interaction effect of method of weed control and application of N-fertilizer were significant on the production of tiller number, panicle number and grain yield. Two times deep placement of USG and application of refit produced the highest grain yield followed by hand weeding and weeder weeding. There was no significant difference among different weed control methods in prilled urea, broadcasting USG and deep placement of USG. Refit gave profit of Tk.6473 ha^{-1} and Tk.3148 ha^{-1} over hand weeding and weeder weeding, respectively. Weeder weeding gave a profit of Tk.3325 ha^{-1} over hand weeding. If USG was deep placed in one time and two times instead of PU, the profit was Tk.4913 ha^{-1} and Tk.3017 ha^{-1}, respectively. The loss of Tk.4162 ha^{-1} was observed when USG was broadcasted instead of prilled urea application. It was also observed that two times deep placement instead of one time deep placement of USG gave a loss of Tk.1896 ha^{-1}.

Keywords: PU, USG, weed control, yield, cost, return and partial budgeting.

Introduction

Rice (*Oryza sativa L.*) is considered the most important staple food in the world as it supplies the major food requirement for more than one half of the world's population (FAO, 2010). Rice is grown in 11.77 million hectares of land with a population of 34.518 million tons (BBS, 2014-15).The average yield of rice in Bangladesh is 4.50tha^{-1} (BRRI, 2016) and this average yield is almost less than 50% of the world average rice grain yield. Nitrogen is one of the most essential elements for the growth of rice plant. Proper management of nitrogen is obligatory to improve crop growth and grain yield. In most cases, farmers use imbalance dose of nitrogen fertilizer which causes higher insect and disease infestation resulting to lower yield. Generally farmers use N fertilizer in the form of prilled urea (PU) which is very easy to apply though rice plant can receive only 25 to 30% of applied fertilizer (BRRI, 2007). To reduce nitrogen loss, application of urea super granule (USG) is strongly considered to be an important alternative that increases the efficiency of N about 20 to 25% and also increases the yield by 15 to 20% (BRRI, 2008). Weed infestation and interference is a serious problem in rice fields that significantly decreases yield. In Bangladesh weed infestation reduce rice grain yield by 70-80% in Aus rice, 30-40% in transplanted aman rice and 22-36% for modern boro rice cultivars (BRRI, 2006; Mamun, 1990). The weed flora under transplanted condition is very much diverse and consists of grasses, sedges and broad-leaf weeds causing yield reduction of rice up to 76% (Singh *et al*., 2004). Hence proper weed management practices are essential to obtain better yields in

transplanted rice. Mechanical and cultural weed control in transplanted rice is an expensive method. Especially at the time of peak period of labor crisis sometimes weeding becomes late causing drastic losses in grain yield. Nowadays use of herbicides is gaining popularity in rice culture due to their rapid effects and less cost involvement compared to traditional methods. Mechanical weeding and herbicides are the alternative to hand weeding. Herbicides alone or in combination with hand weeding are effective in controlling weeds (Ahmed *et al*., 2005). Information regarding labor requirement, labor cost and benefits due to different weeding method and different sources of nitrogen for rice cultivation is still limited and yet to be determined.

Therefore, the present study was conducted to determine the productivity and profitability of rice cultivation as affected by application of different nitrogenous fertilizer and method of weed control.

Materials and Methods

The experiment was conducted at the West Byde of BRRI farm, Gazipur during T. aman' 2007 season. The treatments (Table 1) were different nitrogenous fertilizer and weed control method arranged in a Randomized Complete Block (Factorial) design with three replications.

Table 1. Treatments

Factor A: Nitrogenous fertilizer
PU=Application of prilled urea (PU) as per recommended rate of N and applies 3 equal splits
USG_1=Broadcasting the urea super granules (USG) as basal as per recommended rate of N
USG_2= Deep placement of USG as per recommended rate of N and applies one time
USG_3= Deep placement of USG as per recommended rate of N and applies 2 equal splits
Factor B: Weed control method
M_1= REFIT at 4 DAT + One hand weeding at 40 DAT
M_2= Hand weeding at 20 and 40 DAT
M_3= Weeding by weeder at 20 and 40 DAT

The unit plot size was 10m X 10m. BRRI dhan41 was used for experimental purpose. Fertilizer was applied at 80-60-40-20-10 kg of N, P_2O_5, K_2O, S and Zn per ha, respectively. Except urea other fertilizers were applied as basal. Urea was applied as per treatment. Thirty days old seedling @ 3 seedlings $hill^{-1}$ was transplanted. Data on labour requirement for different weeding methods, PU and USG application, yield and yield components were collected. Cost and return were worked out and partial budgeting was calculated. Yield and yield components data were analyzed by following a standard statistical procedure (Crop Stat) and the mean differences were adjusted by LSD method.

Results and Discussion

The interaction effect of method of weed control and application of N-fertilizer were significant for tillers production, panicle number and grain yield (Table 2).

Tiller number

Comparing different weed control methods under same nitrogenous fertilizer, it was observed that hand weeding (M_2) gave the highest number of tillers in PU (304 tiller m^{-2}) and USG_1 (USG broadcasted) plots (299 tiller m^{-2}). In USG_2 (one time deep placement of USG) plots, using of weeder (M_3) produced the highest number of tiller (312 tiller m^{-2}) but in USG_3 (two times deep placement of USG) plots, application of refit (M_1) gave the highest number (323 tiller m^{-2}) of tiller. Comparing different nitrogenous fertilizers under same weed control method reveled that in refit (M_1) applied plot, USG_3 performed the best (323 tiller m^{-2}) followed by USG_2 (307 tiller m^{-2}) and PU (295 tiller m^{-2}) but lowest in USG_1 (294 tiller m^{-2}). In hand weeding USG_3 also produced the highest number of tiller (319 tiller/m_2) followed by USG_2 (308 tiller m^{-2}) and PU (304 tiller m^{-2}) but no significant difference between USG_2 and PU. The lowest tiller number (299 tiller m^{-2}) was found in USG_1. In weeder used plot, USG_3 gave the highest number of tiller (317 tiller m^{-2}) followed by USG_2 (312 tiller m^{-2}), PU (299 tiller m^{-2}) and lowest in USG_1 (295 tiller m^{-2}) but no significant difference between USG_1 and PU. This result was similar with the findings of Aziz *et al*. (2014). They found that deep placement of USG increased tiller over control.

Panicle number

Comparing different weed control methods under same nitrogenous fertilizer the result showed that in PU plot, hand weeding produced

the highest number (264 panicle m^{-2}) of panicle followed by refit (262 panicle m^{-2}) and lowest in weeder (259 panicle m^{-2}). In USG_1 (USG broadcasted) and USG_3 (two times deep placement of USG) same trend also observed. In USG_1 and USG_3 under hand weeding the highest number of panicle was 264 m^{-2} and 281 m^{-2}, respectively. When USG was deep placed in one time i.e. USG_2, the weeder used plots produced the highest number of

Table 2. Tiller number, panicle number and grain yield of rice as affected by the interaction effect of weed control method and application of N-fertilizer' T. aman' 2007

Tiller m^{-2} (no.)				
Treatment	PU	USG_1	USG_2	USG_3
M_1	295	294	307	323
M_2	304	299	308	319
M_3	299	295	312	317
$LSD_{0.05}$		4.9		
Panicle m^{-2} (no.)				
M_1	262	259	270	280
M_2	264	264	271	281
M_3	259	258	273	279
$LSD_{0.05}$		0.54		
Grain yield (t ha^{-1})				
M_1	4.37	4.31	4.64	4.79
M_2	4.40	4.07	4.65	4.52
M_3	4.30	4.15	4.67	4.49
$LSD_{0.05}$		0.26		

panicle (273 panicle m^{-2}) followed by hand weeding (271 panicle m^{-2}) and lowest in refit (270 panicle m^{-2}). Regardless of different weed control methods, comparing different nitrogenous fertilizer it was observed that application of USG in two equal splits i.e. USG_3 plots produced the highest number of panicles followed by USG_2 and lowest in PU plots. This result agreed with the findings of Aziz *et al*. (2014).

Grain yield

Comparing different weed control methods it was observed that grain yield was not significantly affected by weed control methods on PU, USG_1 (broadcasting USG) and USG_2 (one time deep placement of USG) applied plots. In USG_3 plot (two times deep placement of USG) application of refit (M_1) produced the highest grain yield (4.79tha^{-1}) followed by hand weeding (4.52 tha^{-1}) and lowest (4.49 tha^{-1}) in weeder used plots. Here refit application at 4 DAT followed by one hand weeding at 40 DAT increased grain yield indicating that weed infestation was kept at minimum level in the plot to ensure higher yield. Mitra (2005) found that only refit application was not effective to keep weed infestation at a minimum level for higher yield of T. aman rice. Regardless of weed control methods USG_2 and USG_3 produced higher and statistically identical grain yield followed by PU and lowest in USG_1 plot. This result agreed with the findings of Paul (2015); Aziz *et al*. (2014) and Savant et al. (1991). They reported that deep placement of USG at 8 to 10 cm depth of soil can save about 30% of N, increases N use efficiency, improves soil health and eventually increases grain yield over control and PU.

Table 3. Effect of method of weed control and application of N-fertilizer on grains panicle^{-1}, thousand grains weight, and straw yield' T. aman' 2007

Methods of weed control			
Treatments	Grain panicle^{-1} (no.)	1000-grain wt. (g)	Straw yield (t ha^{-1})
M_1	89	20.9	6.14
M_2	88	20.6	5.94
M_3	89	20.4	5.91
$LSD_{0.05}$	ns	ns	ns
N-Fertilizer			
PU	88	20.9	6.01
USG_1	87	20.6	5.69
USG_2	90	20.9	6.17
USG_3	90	20.0	6.12
$LSD_{0.05}$	ns	ns	0.28

Grain per panicle, 1000-grain weight, and straw yield

The grain panicle^{-1}, 1000-grain weight, and straw yield were not significantly affected by the interaction of the method of weed control and application of different types of N-fertilizer. These were not also significantly affected by method of weed control (Table 3). The grain panicle^{-1} and 1000-grain weight were not significantly affected by application of different types of N-fertilizer but the straw yield was significantly affected by application of different types of N-fertilizer. Deep placement of USG in one time (USG_2) produced the highest straw yield (6.17 tha^{-1}) followed by two times deep placement

of USG and application of prilled urea (Aziz *et al.*, 2014). Broadcasting of USG as basal produced the lowest straw yield. These results corroborated with the results of Ahmed *et al* (2005) and Hasanuzzaman *et al* (2007)

Table 4. Total labor requirement (md ha^{-1}) as affected by method of weed control and application of N-fertilizer' aman' 2007

Treatment	M1	M2	M3	Mean
PU	212	254	219	228
USG_1	201	240	212	218
USG_2	219	260	226	235
USG_3	225	266	234	242
Mean	214	255	223	-

Labor requirement

Two times deep placement of USG required the highest number (242 md ha^{-1}) of labors followed by one time deep placement (235 md ha^{-1}) of USG, application of prilled urea (228 md ha^{-1}) and was lowest in USG (218 md ha^{-1}) broadcasting (Table 4). Hand weeding required the highest number (255 md ha^{-1}) of labors followed by weeder (223 md ha^{-1}) use and lowest was in refit application (214 md ha^{-1}).

Table 5. Cost and return of weed control method and N-fertilizer use for rice cultivation

Treatment combination	Total variable cost (Tk ha^{-1})	Gross Return (Tk ha^{-1})	Gross Margin (Tk ha^{-1})
PU x M_1	25294	106480	81186
PU x M_2	28794	106180	77386
PU x M_2	25216	102800	77584
USG_1 x M_1	24886	103390	78504
USG_1 x M_2	28386	98200	69814
USG_1 x M_3	24839	100190	75351
USG_2 x M_1	26804	111250	84446
USG_2 x M_2	30305	111570	81265
USG_2 x M_3	26695	111880	85185
USG_3 X M_1	27456	114790	87334
USG_3 x M_2	30956	108070	77114
USG_3 x M_3	27430	108190	80760

Note: Price of rice and straw are Tk. 20.0 Kg^{-1}, and Tk. 3.0 Kg^{-1} respectively. Labor cost Tk. 112 day^{-1}.

Partial budgeting

The cost and return have been given in Table 5 for calculating partial budgeting (Table 6. a,b,c,d,e,f). Application of refit instead of hand weeding and weeder gave a profit of Tk. 6473 ha^{-1} and Tk. 3148 ha^{-1}, respectively. When weeder was used instead of hand weeding, the profit was Tk. 3325 ha^{-1}. Deep placement of USG in one time and two times instead of PU, the profit was Tk. 4913 ha^{-1} and Tk. 3017 ha^{-1}, respectively. If USG was broadcasted instead of application of prilled urea the loss was Tk. 4162 ha^{-1}. Two times deep placement of USG instead of once the loss was 1896 Tk. ha^{-1}.

Table 6 . Partial budgeting

(a) RIFIT versus Hand weeding (M_1 versus M_2)

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using refit	26110	Return from using refit	108978
Revenue forgone for not using hand weeding	106005	Cost for using hand weeding	29610
Profit/Loss	+6473		
Total	138588	=	138588

(b) RIFIT versus Weeder (M_1 vesus M_3)

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using refit	26110	Return from using refit	108978
Revenue forgone for not using weeder	105765	Cost for weeder	26045
Profit/Loss	+3148		
Total	135023	=	135023

(c) Weeder versus Hand Weeding (M_3 vs M_2)

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using weeder	26045	Return from using weeder	105765
Revenue forgone for not using Hand weeding	106005	Cost for Hand weeding	29610
Profit/Loss	+3325		
Total	135375	=	135375

(d) USG_1 versus PU

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using USG1	26037	Return from using USG1	100593
Revenue forgone for not using PU	105153	Cost for using PU	26435
Profit/Loss	- 4162		
Total	127028	=	127028

(e) USG_2 versus PU

Debit(Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using USG_2	27935	Return from using USG_2	111567
Revenue forgone for not using PU	105153	Cost for using PU	26435
Profit/Loss	+4913		
Total	138001	=	138001

(f) USG_3 versus PU

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using USG_2	28614	Return from using USG_2	110350
Revenue forgone for not using PU	105153	Cost for using PU	26435
Profit/Loss	+3017		
Total	136785	=	136785

(g) USG_3 versus USG_2

Debit (Tk ha^{-1})		Credit (Tk ha^{-1})	
Cost for using USG_3	28614	Return from using USG_3	110350
Revenue forgone for not using USG_2	111567	Cost for using USG_2	27935
Profit/Loss	-1896		
Total	138285	=	138285

Similar results on the weed control costs as also observed by Hasanuzzaman *et al* (2009). If USG was broadcasted instead of application of prilled urea the loss was Tk. 4162 ha^{-1}. Two times deep placement of USG instead of once the loss was 1896 Tk. ha^{-1}. Similar results on the weed control costs as also observed by Hasanuzzaman *et al* (2009).

Conclusion

It may be concluded that USG deep-placement appeared to be economically most viable treatment which produced higher yield than that of USG broad cast and prilled urea application. One time deep placement of USG gave the highest profit than application of PU and two times deep placement of USG. The application of refit at 4 DAT followed by one hand weeding at 40 DAT gave the highest profit than hand weeding and use of weeder.

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