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PERFORMANCE OF SEPARATED TILLERS OF TRANSPLANT AMAN RICE AT DIFFERENT LEVELS OF UREA SUPER GRANULES

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Abstract

An experiment was conducted at the research field of Department of Agronomy, Bangladesh Agricultural University, Mymensingh during June to December 2012 to investigate the effect of age of tiller seedlings, number of tiller seedlings hill^{-1} and application of urea super granules (USG) on the yield and yield contributing characters of transplant *Aman* rice (cv. BRRI dhan52). The experiment consisted of two ages of tiller seedlings *viz.* 25 and 35-days old, three levels of tiller seedlings hill^{-1} *viz*. 1, 3 and 5 seedlings hill^{-1} and three levels of USG *viz*. 0, 1.8 (55 kg N ha^{-1}) and 2.7g USG (80 kg N ha^{-1}) four hill^{-1} in every alternate row. The experiment was laid out in a Randomized Complete Block Design (Factorial) with three replications. The highest plant height, number of effective tillers hill^{-1}, number of total tillers hill^{-1}, number of total spikelets panicle^{-1}, number of grains panicle^{-1}, grain yield and harvest index were found in 1.8 g USG applied @ one granule 4-hill^{-1}. The highest number of sterile spikelets panicle^{-1} was found in control treatment and the lowest in 1.8 g USG. The highest number of effective tillers hill^{-1}, number of total spikelets panicle^{-1} and grain yield ha^{-1} was found when 5 tiller seedlings were transplanted hill^{-1} combined with 1.8 g USG. Application of urea super granules 1.8 g (55 kg N ha^{-1}) at 10 days after transplanting @ one granule 4-hill^{-1} in every alternate row with 25 day old tiller seedlings using 5 tiller seedlings hill^{-1} was found beneficial for grain yield of transplant Aman rice. Tiller separation could be an alternative source of seedling during seedling scarcity.

Keywords: Age of tiller seedlings, transplant Aman rice, USG, yield.

Introduction

Aman rice is very common in Bangladesh but damage occurred due to early or late flash flood. Due to unavailability of seedlings farmers cannot re-transplant their field after the recession flood water. If available, seedlings are either too young or too old to produce a good crop. Re-transplantation of separated clonal tillers from an unaffected *Aman* crop and subsequent management practices could be a remedy to overcome this loss. This technique of transplanting of separated clonal tillers may be a promising alternative for growing a post-flood transplant *Aman* crop (Sarkar *et al*., 2011; Mridha *et al*., 1991 and Siddique *et al*., 1991). Clonal propagation was somewhat superior to nursery seedlings and yield did not decrease with the removal of clonal tillers (Sharma, 1994). In some flood-prone lowlands, where the transplanted crop is damaged by natural hazard,

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vegetative propagation using tillers separated (4 tillers hill^{-1}) from the previously established transplanted crop gave higher yield than nursery seedlings transplanted on the same date (Biswas and Salokhe, 2001).

Age of tiller seedlings is an important determinant that may influence the tiller production, growth, grain formation and other yield contributing characters of rice. The highest grain yield could be obtained by transplanting tiller seedlings which were separated from mother plants 35 days after transplanting (Biswas *et al*., 1987). Tillers could be separated at 30-40 days after transplanting (BRRI, 1988). Paul *et al.* (2002) reported that tillers can be separated at 25 or 35 days after transplanting (DAT) without hampering grain yield. Planting density, number of tillers and their growth are greatly affected by number of seedlings hill^{-1}. Optimum number of tiller seedlings may enable the rice plant to grow properly both in its aerial and underground parts which ultimately may lead to enhancement of yield. While the least number of tiller seedlings hill^{-1} may cause insufficient tiller growth. Urea super granules (USG), a slow release nitrogenous fertilizers dissolves slowly in the soil providing a steady supply of available nitrogen throughout the growing period of the crops can be applied in the root zone of the rice plants at 8-10 cm depth of soil (reduced zone of rice soil), which can save 30% nitrogen compared to prilled urea. Placement of USG in rice gave significantly higher grain and straw yields than split application of prilled urea (Mohanty *et al*., 1989, Bowen *et al*., 2005 and Hasan, 2007). It increases absorption rate, improves soil health and ultimately increases rice yield. It is therefore, necessary to find out the influence of age of tiller seedlings, number of tiller seedlings hill^{-1} and application of urea super granules on the yield performance of transplant *Aman* rice cv. BRRI dhan52.

Materials and Method

The experiment was conducted at the research field of Department of Agronomy, Bangladesh Agricultural University, Mymensingh during the period from June to December 2012. The experimental sites belongs to the Sonatola Soil Series of Old Brahmaputra Floodplain (AEZ 9) having non calcareous dark grey floodplain soil. The land was medium high with sandy loam texture having pH 6.5. Soil contained 1.67% organic matter, 0.10% total N, 26.0 ppm available P, 0.14 (me) % exchangeable K and 13.9 ppm available S. The experiment consisted of two ages of tiller seedlings *viz.* 25 and 35 days old, three levels of tiller seedling hill^{-1} *viz.* 1, 3 and 5 seedlings hill^{-1} and three levels of USG *viz.* 0, 1.8 and 2.7g USG. The experiment was laid out in a Randomized Complete Block Design (Factorial) with three replications. The size of unit plot was 4.0m × 2.5m. A high yielding variety BRRI dhan52 of transplant *Aman* rice was used as the test crop. Tillers were separated from 25 and 35 days after transplanting from previously transplanted rice field and then re-transplanted in the main field on 13

September 2012 according to treatments. Fertilizer P, K, S and Zn were applied @ 21, 35, 11 and 3.5 kgha^{-1} in the form of triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate respectively. TSP, MoP, gypsum and zinc sulphate were applied at the time of final land preparation. Nitrogen was applied according to experimental specification in the form of Urea Super Granules (USG) at 10 days after transplanting @ one granule 4-hill^{-1} in every alternate row. Irrigation, weeding and other intercultural operations were done as and when required.

The crop was harvested on 20 November 2012. Grain and straw yields were recorded from the harvest of 2.5m x 2.0m harvest area from the middle portion of each plot. The grain yield was adjusted to 14% moisture content and straws dried to record the straw yield. Grain yield and straw yield altogether were regarded as biological yield i.e. Biological yield = Grain yield + Straw yield.

Harvest index is the relationship between grain yield and biological yield. Harvest index was calculated by the following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}(t\,ha^{-1})}{\text{Biological yield}(t\,ha^{-1})} \times 100$$

The recorded data were statistically analyzed with the help of MSTAT-C software. The differences among treatment means were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Age of Tiller Seedlings

Age of tiller seedlings is an important determinant as that of nursery seedling for the production of transplant Aman rice. Plant height and yield contributing characters were significantly affected by age of tiller seedlings. The highest plant height, number of total spikelet panicle^{-1}, number of grains panicle^{-1} and number of sterile spikelets panicle^{-1} were found in 25-day old tiller seedlings where effective tillers hill^{-1}, number of total tillers hill^{-1} and panicle length were found in 35-day old tiller seedlings (Table 1). Plant height, number of grains panicle^{-1}, total number of sterile spikelets panicle^{-1}, grain yield ha^{-1}, biological yield ha^{-1} and harvest index were decreased with the increase of age of tiller seedlings. Younger tiller seedling (25 days) and long duration for vegetative growth might have influenced plant height, number of total spikelet panicle^{-1} and grains panicle^{-1} (Table 1). Similar results were reported by Sarkar *et al.* (2011). On the contrary, older tiller seedlings get less time for their proper vegetative growth and rapidly entered into the reproductive phase producing decreased number of total spikelet panicle^{-1} and grains panicle^{-1}. Transplanting 25-day old tillers produced higher

Table 1. Effect of age of tiller seedlings, no. of tiller seedlings hill^{-1} and USG application on yield and yield contributing characters of transplant *Aman* rice.

	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Total tillers hill^{-1} (no.)	Panicle length (cm)	Total spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Age of tiller seedlings (days)												
25	108.23a	6.44b	8.22b	24.65b	186.19a	155.78a	30.41a	24.66	5.17a	5.83b	11.00a	47.00a
35	107.09b	8.19a	9.56a	25.46a	142.81b	121.70b	21.11b	24.71	4.73b	6.07a	10.80b	43.79b
CV%	3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54
No. of tiller seedlings hill^{-1}												
1	107.19	6.06c	7.50c	24.89	155.83c	127.06c	28.78a	24.58	4.72b	5.77	10.49	45.11
3	108.97	7.33b	8.94b	25.72	162.39b	135.72b	26.67b	24.68	4.92b	6.11	11.03	44.98
5	106.82	8.56a	10.22a	24.56	175.28a	153.44a	21.83c	24.79	5.20a	5.97	11.17	46.77
CV%	3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54
USG application (g)												
0	104.76b	4.56c	5.83b	24.82	128.17c	94.39c	33.78a	24.42	4.24b	5.85	10.08	42.21b
1.8	109.42a	9.17a	10.72a	25.91	185.44a	167.00a	18.44c	24.67	5.40a	6.14	11.55	47.52a
2.7	108.80a	8.22b	10.11a	24.44	179.89b	154.83b	25.06b	24.96	5.20a	5.86	11.06	47.14a
CV%	3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54

Means having same or without letter do not differ significantly at 5% level of probability by DMRT.

Table 2. Interaction effect of age of tiller seedlings and no. of tiller seedlings hill^{-1} on yield and yield contributing characters of transplant *Aman* rice.

Age of tiller seedlings (days)	Tiller seedlings hill^{-1} (no.)	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Total tillers hill^{-1}(no.)	Panicle length (cm)	Total spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
25	1	106.78	5.11	6.78	25.59ab	143.44	108.56	34.89a	24.63	4.61	5.40	10.01	45.90a
	3	108.34	6.33	8.11	25.12ab	149.78	118.44	31.33b	24.47	4.59	6.69	11.28	40.84b
	5	106.16	7.89	9.78	23.25b	163.11	138.11	25.00c	24.86	4.98	6.11	11.09	45.16ab
35	1	107.61	7.00	8.22	24.19ab	168.22	145.56	22.67cd	24.52	4.83	6.14	10.97	44.33ab
	3	109.60	8.33	9.78	26.32a	175.00	153.00	22.00d	24.90	5.24	5.53	10.77	49.13a
	5	107.47	9.22	10.67	25.87a	187.44	168.78	18.67e	24.72	5.42	5.83	11.25	48.38a
CV (%)		3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54

Means having same or without letter do not differ significantly at 5% level of probability by DMRT.

Table 3. Interaction effect of age of tiller seedlings and USG application on yield and yield contributing characters of transplant *Aman* rice.

Age of tiller seedlings (days)	USG application (g)	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Total tillers hill^{-1} (no.)	Panicle length (cm)	Total spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
25	0	104.28	4.33e	5.56d	23.72	120.3f	79.44f	40.89a	24.48	3.86	5.83	9.69	40.03
	1.8	109.31	8.00c	9.78c	26.29	171.78c	149.22c	22.56c	24.42	5.24	6.45	11.69	45.16
	2.7	107.68	7.00d	9.33c	23.95	164.22d	136.44d	27.78b	25.07	5.08	5.92	10.99	46.70
35	0	105.24	4.78e	6.11d	25.91	136.00e	109.33e	26.67b	24.36	4.61	5.86	10.47	44.38
	1.8	109.52	10.33a	11.67a	25.53	199.11a	184.78a	14.33d	24.92	5.57	5.83	11.40	49.12
	2.7	109.92	9.44b	10.89b	24.93	195.56b	173.22b	22.33c	24.85	5.32	5.81	11.13	48.33
CV (%)		3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54

Means having same or without letter do not differ significantly at 5% level of probability by DMRT.

grain yield compared to older tiller seedlings but higher straw yield ha^{-1} from 35-day old tiller seedlings (Table 1). Similar results were reported by Sarkar *et al*. (2011) and Kirttania *et al*. (2013). The crop of 25-day old tiller seedlings received relatively more time for their growth, development and grain filling and resulted in the increased grain yield. In this case, the yield components were improved and sterile spikelets panicle^{-1} were decreased which were mainly responsible for the improvement of grain yield. Paul *et al*. (2002) reported that cultivar BR23 appeared to be resistant to tiller separation and tillers could be separated at 25 or 35 DAT without hampering grain yield.

Number of Tiller Seedlings Hill^{-1}

Yield attributes and grain yield were significantly influenced by number of tiller seedlings hill^{-1}. The highest number of effective tillers hill^{-1}, number of total tillers hill^{-1}, number of total spikelets panicle^{-1}, number of grains panicle^{-1}and grain yield ha^{-1} were found in the crop raised from 5 tiller seedlings transplanted hill^{-1} and the lowest from 1 tiller seedling hill^{-1} (Table 1). Sarkar *et al.* (2011) reported that in cultivar BR 23, two tiller seedlings hill^{-1} appeared to be enough for the cultivation of transplant Aman rice. Planting of one seedling hill^{-1} was at par with planting of 2 seedlings hill^{-1} in terms of grain yield (Dongarwar *et al*., 2002). Paul *et al.* (2002) reported that the highest number of effective tiller hill^{-1}, grains panicle^{-1} and grain yield ha^{-1} were obtained when 2 tillers were kept hill^{-1}. Biswas and Salokhe (2001) mentioned that higher densities of clonal tillers transplanted hill^{-1} gave lower panicle number and grain weight. Intra-tiller seedlings competition for nutrients, light, air and water in a hill resulted in the reduced grain yield when 6 tiller seedlings were transplanted hill^{-1}. There was no significant difference in biological yield due to number of tiller seedlings hill^{-1} highest grain yield was observed when 5 tiller seedlings hill^{-1} (Table 1). Therefore, increased grain yield was the main reason for increase of number of effective tillers hill^{-1} and number of grains panicle^{-1}. Transplanting 5 tiller seedlings hill^{-1} produced highest the number of tillers hill^{-1} and also highest number of grains panicle^{-1} thus produced the highest grain yield.

Urea Super Granules (USG) Application

Plant height, yield contributing characters, grain yield ha^{-1} and harvest index were significantly influenced by the application of USG (Table 1). The highest number of effective tillers hill^{-1}, number of total spikelets panicle^{-1} and number of grains panicle^{-1} were found when 1.8 g USG was applied but both 1.8 g and 2.7 g USG applied per 4 hills in every alternate row showed results identical in respect of plant height, total tillers, grain yield and harvest index. Grain yield and other plant characters were lower where USG was not applied. Grain yield was the highest in 1.8 g USG due to increasing number of grains panicle^{-1} for the

adequacy of nitrogen as USG probably favored the cellular activities during panicle formation and development which led to increased number of productive tillers hill^{-1}. These results also agreed by Singh and Singh (1997). The increased number of tillers hill^{-1} with increased nitrogen levels USG (Hasan, 2007).

Interactions

Panicle length, number of sterile spikelet's panicle^{-1} and harvest index were significantly influenced by the interaction between the age of tiller seedlings and number of tiller seedlings hill^{-1}. The longest panicle was produced when 35-day old tiller seedlings by transplanting 3 tiller seedlings hill^{-1} and the shortest panicle with 25-day old tiller seedlings with 5 tiller seedlings hill^{-1}. Similar result was reported by Kirttania *et al*. (2013). The highest number of sterile spikelets panicle^{-1} was produced in the crop raised from 25-day old tiller seedlings using 1 tiller seedlings hill^{-1} and the lowest in 35-day old tiller seedlings with 5 tiller seedlings hill^{-1}. The maximum harvest index was produced by transplanting 35-day old tiller seedlings using 5 tiller seedlings hill^{-1} followed by other treatments except lowest in 25 day old tiller seedlings with 3 tiller seedlings hill^{-1} (Table 2).

Age of tiller seedlings and USG application significantly influenced number of effective tillers hill^{-1}, number of total tillers hill^{-1}, total spikelets panicle^{-1}, number of grains panicle^{-1} and sterile spikelets panicle^{-1}. The highest number of effective tillers hill^{-1}, number of total tillers hill^{-1}, number of total spikelets panicle^{-1} and grains panicle^{-1} were produced by transplanting 35-day old tiller seedlings when 1.8 g USG was applied and the lowest one was in the crop raised from 25-day old tiller seedlings without USG (Table 3). Kirttania *et al*. (2013) reported that 35-day old tiller seedlings of BRRI dhan49 fertilized with 2.7g USG produced the higher number of effective tillers hill^{-1} and grains panicle^{-1} compared to 25-day old tiller seedlings with 1.8 g USG. The highest number of sterile spikelets panicle^{-1} was produced from 25-day old tiller seedlings without USG but lowest in 35-day old tiller seedlings when 2.7 g USG was applied (Table 3).

Number of effective tillers hill^{-1}, total tillers hill^{-1} and total spikelets panicle^{-1} were significantly influenced by the interaction between number of tiller seedlings hill^{-1} and USG application. The highest number of effective tillers hill^{-1} was produced in the crop raised from 5 tiller seedlings hill^{-1} when 1.8 g USG was applied and the lowest in 1 tiller seedling hill^{-1} when USG was not applied (Table 4). The maximum number of total tillers hill^{-1} was produced in 5 tiller seedlings hill^{-1} along with application of 1.8 g USG followed by 2.7 g USG of same no. of tiller. The lowest was produced in 1 tiller seedling hill^{-1} without application of USG. Similar trend was followed in case of total spikelets panicle^{-1}. Grain yield was significantly influenced by the interaction between number of tiller seedlings hill^{-1} and USG application. Higher grain yield ha^{-1}was produced in the crop raised from 5 tiller seedlings hill^{-1} when 1.8 g USG was applied followed by 1 and 3

Table 4. Interaction effect of no. of tiller seedlings hill^{-1} and USG application on yield and yield contributing characters of transplant *Aman* rice

No. of tiller seedlings hill^{-1}	USG application (g)	Plant height at harvest (cm)	Effective tillers hill^{-1} (no.)	Total tillers hill^{-1} (no.)	Panicle length (cm)	Total spikelets panicle^{-1} (no.)	Grains panicle^{-1} (no.)	Sterile spikelets panicle^{-1} (no.)	Weight of 1000-grains (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
	0	104.26	4.00g	5.00f	25.17	122.67f	84.33	38.33	24.28	3.92d	5.38	9.29	42.17
1	1.8	108.81	7.50de	9.17cd	26.27	175.00c	154.50	20.50	24.61	5.25abc	5.97	11.22	47.07
	2.7	108.51	6.67e	8.33d	23.23	169.83d	142.33	27.50	24.84	5.00bc	5.96	10.96	46.09
	0	104.72	5.17f	6.33e	24.27	125.67f	90.67	35.00	24.81	4.38c	6.29	10.67	41.23
3	1.8	110.61	8.83c	10.50b	26.34	184.50b	165.83	18.67	24.31	5.16abc	6.42	11.57	45.12
	2.7	111.59	8.00cd	10.00bc	26.54	177.00c	150.67	26.33	24.93	5.22abc	5.63	10.84	48.60
	0	105.32	4.50fg	6.17e	25.01	136.17e	108.17	28.00	24.17	4.42c	5.88	10.29	43.22
5	1.8	108.83	11.17a	12.50a	25.12	196.83a	180.67	16.17	25.10	5.81a	6.04	11.85	49.24
	2.7	106.30	10.00b	12.00a	23.55	192.83a	171.50	21.33	25.11	5.38ab	6.00	11.38	47.85
CV(%)		3.91	10.09	8.98	9.31	4.16	3.9	10.94	3.45	6.96	18.38	10.66	10.54

Means having same or without letter do not differ significantly at 5% level of probability by DMRT.

Table 5. Interaction effect of age of separated tiller seedlings, no. of tiller seedlings hill^{-1} and USG application on grain yield of transplant *Aman* rice

Age of tiller seedlings (days)	Tiller seedlings hill^{-1} (no.)	USG application (g)		
		0	1.8	2.7
25	1	3.33h	5.33bcd	5.17bcd
	3	3.92g	4.84def	5.00cde
	5	4.33fg	6.42a	5.07b-e
35	1	4.50efg	5.17bcd	4.83def
	3	4.83def	5.47a-d	5.43bcd
	5	4.50efg	5.55abc	5.58b
CV (%)		6.96	6.96	6.96

Means having same or without letter do not differ significantly at 5% level of probability by DMRT.

tiller seedlings hill^{-1} (Table 4). Maximum seedlings without USG showed lower grain yield. Kirttania *et al*. (2013) found that maximum number of effective tillers hill^{-1}, grains panicle^{-1} and grain yield were produced when 1.8 g USG was applied.

Only grain yield ha^{-1} was significantly influenced by the interaction of age of tiller seedlings, number of tiller seedlings hill^{-1} and USG application (Table 5). The maximum grain yield was produced in the crop raised from 25-day old tiller seedling using 5 tiller seedlings hill^{-1} with 1.8 g USG followed by 35-day old seedlings using 3 tillers hill^{-1} of same amount of USG application. The lowest grain yield was produced in 25-day old tiller seedling using 1 tiller seedlings hill^{-1} when USG was not applied.

Conclusion

It appears that 25-day old tiller seedlings @ 5 hill^{-1} fertilized with 1.8g USG @ one granule 4-hill^{-1} in every alternate row was found to be a promising practice to obtain the highest grain yield of transplant Aman rice cv. BRRI dhan52. The highest grain yield of transplant Aman rice could also be obtained by transplanting 35-day old tiller seedlings with 3 or 5 seedlings hill^{-1} and fertilized with 1.8 g USG @ one granule 4-hill^{-1} in every alternate row.

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