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Response of Hybrid and Inbred Rice Varieties to the Application Methods of Urea Supergranules and Prilled Urea

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Abstract: The response of hybrid (Sonar Bangla-1 and Alok 6201) and inbred (BRRI Dhan 34) rice varieties was determined to the application methods of urea supergranules (USG) and prilled urea(PU). Grain and straw yields were highest (4.87 and 7.72t ha^{-1}, respectively) in BRRI Dhan 34. The highest grain yield of BRRI Dhan 34 was mostly the outcome of highest number of grains $panicle^{-1}$. Sonar Bangla-1 produced the second highest (4.28t ha^{-1}) grain yield while the lowest one (3.86t ha^{-1}) was produced by Alok 6201 which was the consequence of lowest number of grains $panicle^{-1}$ and highest number of sterile spikelets $panicle^{-1}$. BRRI Dhan 34 showed the best performance among the varieties studied for almost all the growth and yield characters. Grain yield was recorded the highest (4.5t ha^{-1}) in the method of half USG + half PU at 10 and 30 DAT which maintained similarity with recommended method of USG and furrow placement of USG. BRRI Dhan 34 interacted favourably with furrow placement of USG to produce the highest grain yield.

Key words: Hybrid rice, inbred rice, urea supergranules, prilled urea, hybrid response

Introduction

It is a fact that rice plants require more nutrients especially nitrogen, to produce more yield. The efficiency of nitrogen fertilizer especially urea is very low in rice but urea is the principal source of nitrogen for rice in Bangladesh. This important element has been found to be deficit in most of the soils of Bangladesh. However, the nature and magnitude of N loss largely depend on the sources and methods of N fertilizer application. Prilled urea (PU) is a fast releasing nitrogen fertilizer which is usually broadcasted in splits, that causes considerable loss as ammonia volatilization, immobilization, denitrification and surface run off. Fertilizer N loss as ammonia volatilization from the flooded rice field could be as high as 40-60% (Sreenivasan and Subrahmanyan, 1995). On the other hand, deep placement of slow releasing nitrogenous fertilizer such as urea supergranule (USG) reduces the N loss as well as increases N use efficiency in wetland rice. According to Crasswell and De Datta (1980), broadcast application of urea on the surface soil causes losses up to 50% but point placement of USG in 10cm depth results in negligible loss and also provides a bonus of nitrogen to the soil. Modified urea fertilizers are designed to control one or more types of N loss to which ordinary urea is commonly susceptible. To minimize the losses of nitrogen, slow releasing of nitrogenous fertilizer has been advocated with deep placement. Slow release nitrogenous fertilizer dissolves slowly in the soil providing a steady supply of available nitrogen throughout the growing period of the crop. Placement of urea supergranules in the root zone is the most effective method for increasing the nitrogen use efficiency and rice yield (Sharma, 1985). It is known that the response of crops to nitrogen varies due to variety. So, it becomes essential to investigate the response of newly developed hybrid rice varieties to different forms of urea fertilizer and mode of its application under rainfed conditions. The superiority of USG, a slow releasing nitrogenous fertilizer, over PU is not yet well established especially under irrigated or rainfed conditions in Bangladesh. Therefore, a study was undertaken with a view to study the response of some hybrid and inbred rice varieties to the application methods of urea supergranules and prilled urea in transplant aman season.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University (BAU), Mymensingh in the aman season during June to December 2000. Soil of the experimental field was more or less neutral in reaction (pH=6.45), low in organic matter content (1.37%) and its general fertility level was also low. The experimental area was under the sub-tropical climate. Two factors were included in the experiment: (a) variety BRRI Dhan 34 , Sonar Bangla-1 and Alok 6201; (b) method of application of urea supergranule (USG) and prilled urea(PU)-recommended method of USG, recommended method of PU, furrow placement of USG, side placement of USG, two third USG+ one third PU at 10 days after transplanting (DAT)and half USG + half PU at 10 and 30 DAT. The experiment was laid out in randomized complete block design with three replications. Each replication (block) was divided into 18 unit plots where treatment combinations were allocated at random. Unit plot size was 4.0x2.5m^2 with 1.0m distance between two replications. A piece of high land was selected for raising seedlings. Sprouted seeds were sown in nurseries on 20th June 2000. The experimental land was first opened with a tractor drawn disc plough and then puddled thoroughly by ploughing and cross ploughing with a country plough and subsequently leveled by laddering. The field layout was made on 13th July 2000 according to experimental specification immediately after final land preparation. Individual plots were cleaned off weeds and stubbles and finally leveled by wooden plank.

BRRI Dhan 34 was fertilized with 130kg ha^{-1} PU/USG, 100kg ha^{-1} triple super phosphate (TSP), 70kg ha^{-1} muriate of potash (MP), 60kg ha^{-1} gypsum and 10kg ha^{-1} $ZnSO_4$. Sonar Banlga-1 was fertilized with 260kg ha^{-1} PU/USG, 90kg ha^{-1} TSP, 67kg ha^{-1} MP, 112kg ha^{-1} gypsum and 15kg $ha^{-1}$$ZnSO_4$. Alok 6201 was fertilized with 260kg ha^{-1} PU/USG, 130kg ha^{-1} TSP, 120kg ha^{-1} MP, 70kg ha^{-1} gypsum and 10kg ha^{-1} $ZnSO_4$.

TSP, MP, gypsum and $ZnSO_4$ were applied as basal during final land preparation in all the plots. But PU or USG were applied as per experimental specifications. USG was applied at 10 DAT and recommended method of PU was applied at 10, 30 and 45 DAT. One seedling $hill^{-1}$ was transplanted on 15th July 2000 maintaining hill spacing of 15cm and row spacing of 25cm. All intercultural operations like gap filling, weeding and irrigation were performed as and when necessary. No remarkable pest infestation was noticed. Ten hills (excluding border hills) from each plot were randomly selected, uprooted and properly tagged before harvesting for recording the necessary data. The crop was harvested at full maturity when 90% of the grains turned golden yellow in colour. Sonar Bangla-1 was harvested on 19th October, Alok 6201 was harvested on 24th October and BRRI Dhan 34 was harvested on 23rd November 2000. Alok 6201 took 5 days more to mature in comparison with Sonar Bangla-1 and BRRI Dhan 34 took 30 days more to mature compared with Alok 6201. Pedal thresher was used to thresh the crop of individual plots. Grains were sun dried to a moisture content of some 14% and then weighed. Straw was sun dried and weighed. Yields of both grain and straw were converted to t ha^{-1}. The collected data was analyzed following the ANOVA technique and the mean differences were adjudged by the Duncan's Multiple Range test (Gomez and Gomez, 1984) by using a statistical computer package MSTAT.

Results and Discussion

Effect of variety: Variety exhibited significant influence on all the plant characters including grain and straw yields of rice (Table 1). BRRI Dhan 34 produced the tallest plant (163.74cm), highest number of grains panicle^{-1} (177.43), and lowest number of sterile spikelets panicle^{-1}. As a result, BRRI Dhan 34 became the highest grain yielding variety (4.87t ha^{-1}). Sonar Bangla-1 ranked second regarding grain yield but produced highest number of total tillers hill^{-1} (12.45) and highest 1000-grain weight (24.11g). Although in respect of productive tillers hill^{-1} Alok 6201 produced the highest value (8.48) but this variety failed to give the highest grain yield due to lowest number of grains panicle^{-1} (91.87) and highest number of sterile spikelets panicle^{-1} (51.87). As a result, Alok 6201 produced lowest grain yield (3.86t ha^{-1}). Grain yield differences due to variety were also reported by Anwar *et al.* (1999). The highest straw yield (7.72t ha^{-1}) was observed in BRRI Dhan 34. While the lowest one (5.58t ha^{-1}) was observed in Sonar Bangla-1. Variation in straw yield was also reported by Anwar *et al.* (1999). The highest harvest index (43.46%) was observed in Sonar Bangla-1 while BRRI Dhan 34 (38.69%) and Alok 6201 (37.98%) were statistically similar in terms of straw yield.

Effect of application method of USG and PU: The effect of application method of USG and PU was not significant in respect of number of total tillers hill^{-1}, panicle length, number of sterile spikelets panicle^{-1} and 1000-grains weight (Table 2). The tallest plant (134.42cm) at harvest was recorded with half USG and half PU at 10 and 30 DAT. The highest number of productive tillers hill^{-1} (8.53) was recorded with two third USG and one third PU at 10 DAT which was statistically similar to side placement of USG (8.24), recommended method of USG (8.2), and half USG + half PU at 10 and 30 DAT (7.93).

These results are not in agreement with those obtained by Jee and Mahapatra (1989). Number of grains panicle^{-1} was found highest (124.96) with recommended method of USG which was at par with side placement of USG. Sarder *et al.* (1988) also agreed to this view. Grain yield (4.21t ha^{-1}) and straw yield (6.38t ha^{-1}) were recorded lowest with recommended method of PU. Number of total tillers hill^{-1} (11.01) and number of productive tillers hill^{-1} (7.31) were found to be lowest but straw yield (6.78t ha^{-1}) was recorded the highest with furrow placement of USG. Side placement of USG produced the shortest plant (126.20cm). Plant height (134.42cm), grain yield (4.5t ha^{-1}) and harvest index (41.45%) were found to be highest with half USG + half PU at 10 and 30 DAT. Bhale and Salunke (1993) also recorded highest grain yield with half USG + half PU. But Mishra *et al.* (1994) reported highest grain yield with prilled urea applied in three splits.

Effect of interaction: Variety coupled with USG and PU application method significantly influenced the plant height, number of productive tillers hill^{-1}, number of grains panicle^{-1}, grain yield, straw yield and harvest index (Table 3). The tallest plant was produced in BRRI Dhan 34 grown with half PU + half USG at 10 and 30 DAT. The highest number of grains panicle^{-1} (188.4) was given by BRRI Dhan 34 grown with recommended method of USG. The results clearly indicate that BRRI Dhan 34 produced the lowest number of sterile spikelets panicle^{-1} regardless the method of USG and PU application. BRRI Dhan 34 produced the highest grain yield when grown with furrow placement of USG with half USG and half PU at 10 and 30 DAT BRRI Dhan 34 produced the highest straw yield (8.33t ha^{-1}) when grown with recommended method of USG or side placement of USG. Sonar Bangla-1 grown

Table 1: Effect of variety on different plant characters of hybrid and inbred rice varieties

Varieties	Plant height (cm)	No. of total tillers hill^{-1}	No. of productive tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000-grains wt.(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
BRRI Dhan 34(V_1)	163.74a	10.37b	7.91b	25.27	177.43a	22.61c	11.40c	4.87a	7.72a	38.69b
Sonar Bangla-1(V_2)	106.34c	12.45a	7.64b	24.52	94.19b	37.71b	24.11a	4.27b	5.58c	43.46a
Alok 6201(V_3)	115.38b	12.42a	8.48a	24.94	91.87c	51.87a	20.42b	3.86c	6.30b	37.98b
CV	4.34	13.18	5.78	3.80	7.75	28.47	11.24	3.15	3.87	2.61
Level of significance	0.01	0.01	0.01	NS	0.01	0.01	0.01	0.01	0.01	0.01

Table 2: Effect of application method of USG and PU on different plant characters of hybrid and inbred rice varieties

Fertilizers	Plant height (cm)	No. of total tillers hill^{-1}	No. of productive tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelets Panicle^{-1}	1000-grains wt.(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
F_1	126.31b	11.71	8.20ab	25.15	124.96a	42.14	18.23	4.34abc	6.77a	39.04b
F_2	128.29b	11.15	7.83bc	25.12	119.47b	32.40	17.31	4.21c	6.38b	39.78b
F_3	127.13b	11.01	7.31c	24.61	121.09b	34.78	19.47	4.41ab	6.78a	39.36b
F_4	126.20b	12.24	8.24ab	24.63	124.48a	40.29	19.07	4.28bc	6.39b	40.48ab
F_5	128.56b	12.74	8.53a	24.77	118.77b	33.26	18.72	4.27bc	6.50b	39.69b
F_6	134.42a	11.62	7.93ab	25.19	118.19b	41.51	19.08	4.5a	6.38b	41.45a
CV	4.34	13.18	5.78	3.80	1.75	28.47	11.24	3.15	3.87	2.61
Level of significance	0.05	NS	0.01	NS	0.01	NS	NS	0.1	0.01	0.01

NS =Not significant; In a column, figures with the same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT).

F_1 = Recommended method of USG F_2 = Recommended method of PU F_3 = Furrow placement of USG

F_4 = Side placement of USG F_5 = Two third USG + one third PU at 10 DAT F_6 = Half USG + half PU at 10 and 30 DAT

Table 3: Effect of interaction of variety and method of application of USG and PU on different crop characters of hybrid and inbred rice varieties

Interaction (variety × method)	Plant height (cm)	No. of total tillers hill^{-1}	No. of productive tillers hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of sterile spikelets panicle^{-1}	1000-grains wt.(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1F_1	160.28b	10.26	8.12abcd	25.25	188.40a	23.84	11.14	4.83cd	8.33a	36.70gh
V_1F_2	156.84b	9.60	6.94ef	25.56	182.02b	18.43	11.43	4.16gh	7.33b	36.23h
V_1F_3	162.15b	10.03	6.87ef	25.54	181.82b	22.53	11.88	5.40a	8.16a	39.79cdef
V_1F_4	157.44b	10.13	8.13abcd	25.03	177.03c	23.74	10.98	5.01bc	8.33a	37.54efgh
V_1F_5	165.28b	11.36	8.72abc	25.04	171.72d	19.03	12.42	4.66de	7.00bc	40.00cdf
V_1F_6	180.44a	10.80	8.66abc	25.27	163.62c	28.10	10.54	5.16ab	7.16b	41.89c
V_2F_1	102.82d	11.93	7.60cdef	24.98	97.05fg	49.27	23.82	4.50def	6.16de	42.09c
V_2F_2	111.96cd	12.46	8.16abcd	24.71	91.41hi	33.63	19.92	4.48efg	5.00g	47.26a
V_2F_3	106.67cd	11.00	7.13def	24.11	91.44hi	32.81	25.60	4.16gh	6.00de	41.64cd
V_2F_4	104.36cd	15.26	8.66abc	23.67	99.36f	36.36	25.77	4.16gh	5.16fg	40.00cde
V_2F_5	102.75d	13.46	7.73bcde	24.31	88.81ij	30.70	23.52	4.00hi	6.00de	45.61ab
V_2F_6	109.47cd	10.60	6.54f	25.32	97.08fg	43.45	26.01	4.33fgh	5.16fg	38.60defgh
V_3F_1	115.83cd	12.93	8.90ab	25.24	89.45ij	53.30	19.72	3.66i	5.83bc	36.89gh
V_3F_2	116.09cd	11.40	8.40abc	25.09	85.00j	45.14	20.58	4.00hi	6.83bc	36.92gh
V_3F_3	112.58cd	12.00	7.92bcde	24.18	90.00ij	49.00	20.93	3.66i	6.16de	37.31fgh
V_3F_4	116.78cd	11.33	9.92bcde	25.18	97.07jg	60.78	20.44	3.66i	5.66ef	39.29defg
V_3F_5	117.65c	13.40	9.13a	24.91	95.83fgh	50.06	20.19	4.16gh	6.50cd	39.06defg
V_3F_6	113.37cd	13.46	8.60abc	25.05	93.89ghi	52.98	20.68	4.00hi	6.83bc	36.92gh
CV	4.34	13.18	5.78	3.80	1.75	28.47	11.24	3.15	3.87	2.61
Level of significance	0.01	NS	0.01	NS	0.01	NS	NS	0.01	0.01	0.01

NS = Not significant; In a column, figures with the same letter or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT). See Table 2 for F_1-F_6

with recommended method of PU produced highest harvest index (47.26%).

From the above discussion it is clearly found that different varieties responded differently to different methods of application of USG and PU. BRRI Dhan 34 gave highest grain yield in furrow placement of USG which was identical with half USG and half PU at 10 and 30 DAT. Sonar Bangla-1 produced highest grain yield in recommended method of USG which was similar to recommended method of PU i.e. USG had no advantage over PU in this variety. In case of Alok 6201, two third USG and one third PU at 10 DAT produced highest grain yield which was statistically similar to recommended method of PU. Half USG + half PU at 10 and 30 DAT also gave similar results.Considering the price of USG and its laborious method of application half USG and half PU may be recommended for BRRI Dhan 34 and Alok 6201. Sonar Bangla-1 responded similarly to recommended method of USG and recommended method of PU. On the same ground the use of prilled urea in Sonar Bangla-1 may be suggested.

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