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FIELD PERFORMANCE OF BARI UREA SUPER GRANULE APPLICATOR

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Abstract

Field performance of BARI Urea Super Granule (USG) applicator was evaluated on BARI research stations (Gazipur, Pabna, and Barisal) and farmer's field (Pabna, Barisal, Magura,Narshingdi,Jhenadah, Sirajgang, Rajbari and Jhalkathi) during the *boro* season of 2012-13. The applicator was tested with four treatments- application of USG by hand (165 kg/ha), application of USG by BARI USG applicator (165 kg/ha), application of prilled urea at USG rate (165 kg/ha) and application of prilled urea at farmers practice. In the farmer's field, USG applicators were evaluated with the traditional broadcasting of granular urea. Similar yield of rice was obtained from machine and hand application of USG in all locations. Higher yield of rice was obtained from USG than granular urea. During field test, average field capacity and efficiency of the applicator were 0.138 ha/h and 81%, respectively. Considering custom hiring, the net income per year was Tk. 71750 and the payback period was 3 days. The price of the applicator is Tk. 3500.

Keywords: USG applicator, Field capacity, Field efficiency, Payback period.

Introduction

Urea has emerged as an important nitrogen fertilizer for rice. Statistics indicates that about 80% of urea is used for rice production. But only 15 to 35% of the total applied nitrogen is used by the rice plant (Prasad and Datta, 1979). The low level of nitrogen recovery by rice plant is generally caused by huge losses of the soil-water-plant complex. Nitrogen loss processes are due to ammonia volatilization, de-nitrification, runoff, seepage, and leaching. Thus there is a great need to improve nitrogen use efficiency for rice production. Due to excessive loss of nitrogen, farmers in Bangladesh have not been able to make more effective use of fertilizer to boost their rice yields. In the present (granular/prilled urea) method of application, only 40% of the applied urea is used by the plant and the remaining 60% is lost by air, water or leaching under the ground (Iqbal, 2009). Another statistics showed that two out of three bags of urea go un-used in wet land rice production (Amit, 2011).With deep placement methods, fertilizers are placed in the soil irrespective of the position of seed, seedling or growing plants before sowing or after sowing the crops (Datta and Fillery, 1983). Deep placement of

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nitrogenous fertilizer (N) is an alternative for increasing the N use efficiency of wetland rice besides minimizing the adverse effects of fertilizers on the environment (Bautista *et al.* 2001). On the contrary, deep placement of urea is environment friendly having minimal loss (Ahamed, 2012). Bangladesh has substantially increased its rice production through increased use of inorganic fertilizer. The nature and degree of loss depends upon soil, climatic conditions, nitrogen fertilizer and water management practices. Much effort has been made to improve fertilizer use efficiencies in lowland rice production. Deep placement of nitrogen fertilizer into the anaerobic soil zone is an effective method to reduce volatilization loss. At present, Urea Super Granule (USG) has been started to be used in puddled rice field and found to be economic and effective method of urea fertilizer application in rice field. Hand placement of USG of 1.8-2.7 g sizes into soil of flood water has been resulted less loss of nitrogen, greater nitrogen recovery and higher yield than conventional nitrogen application method (Diamond, 1985). Instead of normal dose of 247 kg of granular urea, only 165 kg/ha of USG is required (35% less) and it increases rice yield up to 20% (Hoque, 2008). Depending on agroclimate and nitrogen use, deep-placed USG can save urea fertilizer up to 65% with an average of 33% and increase grain yields up to 50% with an average of 15% to 20% over the same amount of split-applied nitrogen as prilled urea, especially in the lower range of nitrogen rates (Savant and Stangel, 1990). But, deep placement of USG by hand requires more labour and cost. Labor shortage in rice production is one of the major constraints which cause due to migration of people to town and need mechanization for rice production (Mohammada *et al*., 2011).The hand placement of USG is labor intensive and very slow i.e. 0.07 to 0.12 ha/workday (Savant *et al.*, 1992). Also hand placement of USG is tedious work and caused back pain.

Unfortunately, farmers have not been able to be benefited from these findings, primarily because they have no suitable fertilizer placement equipment. Cost of fertilizer is increasing day by day. Efforts should be made to develop a low cost, efficient fertilizer application machine for placing the fertilizer at required depths for different crops. Thus fertilizer use efficiency will be high, resulting in higher yield and lower production cost. To minimize nitrogen loss, USG application may be a good technology to increase rice yield as well as the reduction of production cost. Minimum effort has been made in the county to develop a fertilizer applicator machine for improving fertilizer use efficiency. To solve the problem of USG placement by hand, a manually operated push type fertilizer applicator for puddled rice field has been developed in Farm Machinery and Postharvest Process (FMP) Engineering Division of Bangladesh Agricultural Research Institute (BARI) (Wohab *et al.*, 2009). DAE and IFDC in collaboration with BARI have been demonstrating this technology in 68 Upazilas (The daily Star, 27 June, 2011). This study was therefore, undertaken to evaluate the field performance of BARI USG the applicator.

Materials and Method

Operation of the USG applicator

The skids of the applicator were placed between rows of rice plants keeping two rows of rice plants between the skids. Half of the fertilizer hoppers were filled with Urea Super Granule (USG). The applicator was then pushed forward manually. This made the cage wheel and the metering devices rotated. During rotation of the metering devices, it carries USG into the pockets and delivers them to the furrow openers. During forward movement of the applicator, the skids helped float the machine. The applicator dropped the USG at 20 cm row spacing, at about 38 cm spacing along the row and at 5-6 cm depth. Furrow closers closed the furrows providing anaerobic condition for the USG. The total width of application was adjustable (70 cm-100 cm). The field operation of the machine is shown in Fig. 1.

Field performance test

The field performance test of the applicator was done in the experimental field of FMP Engineering division, Gazipur; Agricultural Research Station (ARS), Pabna and Regional Agricultural Research Station, Rahmatpur, Barisal during *boro* season of 2012-13. The USG applicator was operated at 8 days after transplanting rice seedlings. The applicator was used in 2-5 cm of standing water. The machine was operated at an average speed of 1.50 km/h. One operator could comfortably run the machine. The experiment was laid out in RCB design with the following treatments and three replications.

T_1= Application of USG (urea super granule) by hand (165 kg/ha)

T_2= Application of USG (urea super granule) by the machine (165 kg/ha)

T_3= Application of prilled urea at USG rate (165 kg/ha)

T_4= Application of prilled urea at farmers' practice (287 kg/ha)

Each plot size was 5.5 × 5 m in Gazipur; 10 × 8 m in Pabna and 17.5 m × 12.5 m in Barisal. The soil type was clay loam, loam, and sandy loam in Gazipur, Pabna, Barisal and Magura, respectively. The rice variety was BRRI dhan 28. The ages of seedlings were 35, 30 and 36 days in Gazipur, Pabna, and Barisal, respectively. The date of planting of seedlings in Gazipur was 10 March 2013, in Pabna was 14 February 2012 and in Barisal was 19 April, 2013. Row to row and hill to hill distance was 20 cm. For counting missing percentage of USG for the applicator, required numbers of USG was calculated for each plot and after application numbers of remain USG in the hopper was counted. TSP 51 kg/ha, MOP 70 kg/ha, Zinc 50 kg/ha and Boron 5 kg/ha were applied as basal dose

before final land preparation. Full dose of USG was applied at 8 DAS (days after transplanting). One third prilled urea was applied at 8 days after transplanting and second one third urea was applied 40 DAS. The rest one third urea was applied at 55-60 DAS. Weeding was done manually at 35 DAS. Irrigation was applied when the soil moisture content became below the saturation condition. The insecticides were applied as and when necessary.

To compare field performance of the USG applicator with manual broadcasted prilled urea application, total 22 crop cuts were taken from different locations of the country. Farmers were selected who has cultivated BRRI dhan 28 and applied both USG by BARI applicator and broadcasted prilled urea. Each set of data was collected from Babugang and Gouranadi upzilla of Barisal, Shibpur upzilla of Narshingdi district, Baliakandi and Pangsa upzilla of Rajbari district, Sailokopaupzilla of Jhinaidah district. Two sets of data were collected from each upzilla of Sujanagar and Sathia of Pabna, Shahajadpur and Ullapara of Sirajgang, Jhalkathisadar and Rajapur of Jhalkathi, Salikha and Sreepur of Magura. Mean values were analyzed statistically and mean separation was done at 5% level by DMRT. Incase of USG applicator and Broadcast method mean values were analysed using test. A list of farmers selected are shown in Appendix 1 and Appendix 2.

Fig. 1 BARI USG Applicator **Fig.2 Operation of USG Applicator in field**

Results and Discussion

Performance of USG applicator at different locations is shown in Table 1. Average operating time, field capacity and operator efficiency of USG applicator were 7.22 h/ha, 0.138 ha/h, 81%, respectively. Urea saved over farmers' practice of prilled urea was 122 kg/ha. In case of hand application of USG, operating time per hector was 35.97 h. USG applicator can save 80 % operation time and 78 % cost of operation than hand application of USG. During field operation missing of USG dropping was very low as 1.0%.

Table 1. Performance of BARI Urea Super Granule (USG) applicator at different locations

Parameter	Gazipur	Pabna	Barisal	Mean
USG Applicator:				
Operating time, h/ha	7.02	7.43	7.20	7.22
Field capacity, ha/h	0.143	0.135	0.138	0.138
Operator efficiency, %	83	80	81	81.33
USG used, kg/ha	165	165	165	165
Urea saved over prilled urea, kg/ha	122	122	122	122
Missing of USG dropping, %	0.98	1.2	1.0	1.06
Cost, Tk/ha	350	250	325	308.33
Hand Application:				
Operating time, h/ha	33.33	39.16	35.42	35.97
Cost, Tk/ha	1458	1224	1439	1373.66
Comparison:				
Time saved over hand application, %	80			
Cost saved over hand application, %	78			

The yield and yield contributing factors of different urea application method in *boro* rice in Gazipur is shown in Table 2. There was no significant difference in yield of treatment T_1 and T_2. The highest yield of rice was obtained from treatment T_2 followed by T_1 and T_4 and the lowest yield was found from treatment T_3. This may be due to significantly higher number of tillers per hill and number of fill grain per panicle in treatment T_2 than other treatments.

Table 2. Yield and yield contributing factors for different urea application method in *boro* rice in Gazipur

Treatment	No of hill/m^2	No. of tillers/hill	Plant height (cm)	Length of panicle (cm)	No. of fill grain / panicle	No. of unfilled grain / panicle	1000 grain (g)	Grain yield (t/ha)
T_1	19.33	16.83 a	72.40 ab	20.19 a	71.40 a	14.33 b	24.60 a	5.35 ab
T_2	19.00	16.65 a	78.40 a	20.70 a	73.15 a	15.93 b	24.86 a	5.57 a
T_3	19.00	13.23 ab	70.20 ab	17.77 b	50.40 b	31.20 a	22.16 c	4.83 c
T_4	18.66	12.13 b	68.96 b	17.38 b	62.46 ab	22.80 ab	23.06 b	5.07 bc

Similar letter(s) in same column does not differ significantly each other at 5% level by DMRT.

Yield and yield contributing factor for different urea application method in *boro* rice in Pabna is given in Table 3. It is observed from the table that there were no significant differences of number of hill per meter square, plant height, length of panicle, and numbers of unfilled grain per panicle of rice among the treatments. Number of tillers per hill, number of fill grain per panicle and 1000 grain weight were significantly lower in treatment T_3 than other treatments. It is also observed from the table that significantly highest yield was found for USG application than that of prilled urea. There was no significant difference of grain yield between machine and hand application of USG.

Table 3 Yield and yield contributing factors for different urea application methods in boro rice in Pabna

Treatment	No of hill/m^2	No. of tillers/hill	Plant height (cm)	Length of panicle (cm)	No. of fill grain / panicle	No. of unfilled grain / panicle	1000 grain (g)	Grain yield (t/ha)
T_1	25.33	11.36 a	92.46	23.64	126.60 a	13.00	27.00 a	5.21 a
T_2	15.33	11.76 a	94.33	23.430	125.43 a	14.43	26.66 a	5.10 a
T_3	26.66	9.90 b	94.41	22.90	112.56 b	14.50	23.00 b	4.45 b
T_4	123.66	11.43 ab	89.99	23.00	121.13 ab	12.23	24.67 ab	5.08 a

Similar letter(s) in same column does not differ significantly each other at 5% level by DMRT.

Table 4. Yield and yield contributing factors for different urea application method in rice in Barisal

Treatment	No of hill/m^2	No. of tillers/ hill	Plant height (cm)	Length of panicle (cm)	No. of fill grain / panicle	No. of unfilled grain / panicle	1000 grain (g)	Grain yield (t/ha)
T_1	18.66	16.65	37.66 ab	20.33	132.33 a	4.66 b	32.00 a	6.16 a
T_2	19.33	16.83	40.06 a	20.16	129.33 a	4.00 b	31.20 a	6.04 a
T_3	18.66	12.80	35.83 b	19.66	114.00 b	6.33 b	29.80 b	5.59 b
T_4	19.33	13.56	39.13 ab	20.00	109.66 a	9.66 a	30.80 b	5.70 b

Similar letter(s) in same column does not differ significantly each other at 5% level by DMRT.

Table 4 show the yield and yield contributing factors for different area application method in *boro* rice in Barisal. Significantly the highest plant height was observed for treatment T_2 than other treatments. But the plant heights of treatment T_1 and T_2 were statistically alike. Treatment T_3 and T_4 were also statistically alike. There were no significant differences of number of hills per square meter, number of tillers per hill, and length of panicle among the treatments. The highest yield of rice was obtained from treatment T_1 followed by

T_2 and T_4 and lowest yield was found from treatment T_3. But there was no significant difference between treatment T_1 and T_2. Grain yields of treatment T_3 and T_4 were also statistically alike. These results indicated that there was non-significant effect of machine and hand application of USG, but machine application method saved time about 80% and cost of application about 77.84%.

Comparative performance of yield and yield contributing characters of *boro* rice urea applied by BARI USG applicator and broadcasted is shown in Table 5. The detailed data obtained at farmer's field are presented in Appendix 1 and Appendix 2. There was no significant difference of number of hill per meter square, plant height and number of unfilled grain per panicle between the fields where urea were applied by USG applicator and broadcasted. Significantly higher yield was observed due to higher number of tiller per hill, number of effective tillers per meter square, length of panicle, number of fill grain per panicle and 1000 grain weight. Thus application of USG by BARI applicator contributed to increase the rice production.

Table 5. Comparative performance of yield and yield contributing character of *boro* rice urea applied by BARI Urea Super Granule (USG) applicator and broadcasted

Treatment	No of hill/m^2	No. of tillers/hill	Plant height (cm)	Effective tillers/m^2	Length of panicle (cm)	No. of fill grain / panicle	No. of unfilled grain / panicle	1000 grain (g)	Grain yield (t/ha)
USG applicator	29.22	422.27	93.06	409.18	25.05	146.21	17.33	21.61	7.10
Broadcast	28.95	373.27	92.70	356.27	23.65	129.08	19.79	20.56	6.15
t-test	Ns	*	ns	*	*	*	ns	*	*

Table 6. Economic performance of the Urea Super Granule (USG) applicator

Parameters	Cost
Price of the USG applicator, Tk	3500
Operating area per year, ha	
Aus	05
Aman	15
Boro	20
Total Operating time per year, day	40
Custom hire rate, Tk/ha	1875
Gross income per year, Tk	75000
Repair and maintenance cost, Tk/year	250
Net income per year, Tk	71750
Payback period, day (Rounded)	3

Economic performance and payback period of the USG applicator is given in Table 6. If one person engaged him in custom hiring of USG applicator, then the net income per year will be Tk. 71750. Considering capacity of the operator of the applicator was 1 ha/day and labour wage was 500 Tk/day, the payback period of the USG applicator in custom hiring was 3 days.

Conclusion

The field performance test of the applicator was satisfactory. Use of the applicator ensured similar yield to hand application of USG in all locations. USG applicator was easy to operate as its weight is 6 kg. It saved about 80% of USG application time and saved application cost about 78% than hand application. USG provided higher yield over the granular urea application system. Payback period was 3 days.

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Appendix 1. Data of different field where urea was applied as USG by BARI Urea Super Granule (USG) applicator

Name of the farmers and Address	District	Hill/m^2	No of Tillers/m^2	Plant height (cm)	No. of effective tillers	Panicle Length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000 grain weight	Yield (t/ha)
Md. AlomTalukder, Sadar	Jhalkathi	32	448	94.45	445	23.00	113.90	12.40	23.00	8.40
Md. Khokon Sharif, Sadar	Jhalkathi	27	382	106.25	372	25.40	124.30	18.20	22.50	8.00
Abul Bashar, Rajapur	Jhalkathi	22	353	118.80	348	25.95	134.70	11.50	20.40	6.80
Abu SobhanSikder, Rajapur	Jhalkathi	26	394	113.20	382	26.90	133.60	19.40	22.60	8.00
Md. Rabiul Islam, Rajbari	Rajbari	25	355	104.46	347	26.63	116.00	30.44	21.20	7.20
Md. Hanif, Rajbari	Rajbari	25	363	111.65	358	27.04	162.66	56.77	22.80	7.40
Abdul Aziz, Sujanagor	Pabna	30	580	87.11	562	27.17	168.44	15.55	20.00	5.76
Abdul GafurPramanik, Sujanagor	Pabna	26	390	90.47	373	27.33	151.33	15.11	22.20	6.00
ShahadatHossain, Ullapara	Sirajgang	25	355	83.30	335	24.03	133.00	17.70	22.60	6.36
Abu Syed, Shahjadpur	Sirajgang	25	375	9.55	366	25.14	163.70	12.70	21.00	6.40
Md. Najmul Bari, Shahjadpur	Sirajgang	25	425	86.90	408	25.79	132.70	14.50	22.30	6.60
Md. JasimUddin, Santhia	Pabna	23	378	83.32	362	24.72	134.70	14.20	21.60	5.28
Md. IsmaylHossain, Santhia	Pabna	24	456	87.57	437	25.03	155.60	16.60	22.80	7.00
Md. Abdul Matin, Ullapara	Sirajgang	25	455	98.25	432	24.38	140.00	16.10	20.70	5.77
Anwar Hossain, Narsindhi	Narshindhi	29	370	92.20	359	23.17	104.20	28.10	22.76	8.00
FaridMolla, Gouranadi	Barisal	36	410	103.00	364	27.00	140.71	8.86	22.00	8.40
KhalilurRahman, Babugang	Barisal	36	599	103.20	560	21.30	107.80	11.66	21.20	8.40

Appendix 1. Cont'd.

Name of the farmers and Address	District	Hill/m^2	No of Tillers/m^2	Plant height (cm)	No. of effective tillers	Panicle Length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000 grain weight	Yield (t/ha)
NikonjonKumer, Sreepur	Magura	39	461	99.97	460	24.13	123.40	7.00	21.10	7.60
SailenKumerMondol, Magura	Magura	48	497	90.59	495	23.95	139.10	10.40	22.20	6.80
GolamFaruk, Sodohati, Sailkopa	Jinaidah	28	434	103.14	430	24.51	126.80	26.40	21.16	5.20
AbulKashemMonshi, Shalikha	Jinaidah	37	510	67.73	507	24.28	248.00	7.40	17.07	8.40
IqbalMonshi, Satnaforia, Shalikha,	Magura	30	300	112.17	300	24.31	262.00	10.20	22.30	8.40

Appendix 2. Data of different fields where urea was applied by broadcasting.

Name of the farmers and Address	District	Hill/m^2	No of Tillers/m^2	Plant height (cm)	No. of effective tillers	Panicle Length (cm)	No. of filled grains/ panicle	No. of unfilled grains/ panicle	1000 grain weight	Yield (t/ha)
Md. AlomTalukder, Sadar	Jhalkathi	35	420	88.05	418	22.00	92.60	18.70	21.70	5.60
Md. Khokon Sharif, Sadar	Jhalkathi	25	260	95.75	251	22.30	88.70	19.10	21.10	5.20
Abul Bashar, Rajapur	Jhalkathi	22	332	107.50	325	24.00	120.50	14.90	21.50	6.00
Abu SobhanSikder, Rajapur	Jhalkathi	24	340	108.30	332	23.10	108.50	24.50	21.60	6.40
Md. Rabiul Islam, Rajbari	Rajbari	25	327	98.05	315	29.73	107.77	33.11	21.80	6.80
Md. Hanif, Rajbari	Rajbari	25	335	100.12	322	27.40	136.33	38.22	20.90	6.88
Abdul Aziz, Sujanagor	Pabna	25	400	78.34	381	24.52	172.22	16.44	20.30	5.40
Abdul GafurPramanik, Sujanagor	Pabna	25	375	95.14	354	27.71	141.77	16.00	21.20	5.68
ShahadatHossain, Ullapara	Sirajgang	24	339	110.40	322	23.80	133.90	15.80	22.28	5.68
Abu Syed, Shahjadpur	Sirajgang	23	365	91.75	353	24.23	118.80	17.90	21.90	5.80
Md. Najmul Bari, Shahjadpur	Sirajgang	25	400	84.26	385	24.47	129.90	14.50	19.20	5.80
Md. JasimUddin, Santhia	Pabna	20	364	86.40	344	23.54	135.70	15.40	21.80	4.80
Md. IsmaylHossain, Santhia	Pabna	22	396	91.05	375	23.87	144.50	15.10	20.70	6.24
Md. Abdul Matin, Ullapara	Sirajgang	22	389	97.07	377	23.49	137.30	12.40	20.70	5.24
Anwar Hossain, Narsindhi	Narshindhi	28	298	94.10	284	22.74	76.50	46.30	20.86	6.91
FaridMolla, Gouranadi	Barisal	32	409	93.25	350	22.91	96.66	19.50	19.50	7.60
KhalilurRahman, Babugang	Barisal	33	480	95.30	452	21.53	103.50	5.80	19.20	7.60
NikonjonKumer, Sreepur	Magura	48	393	76.32	390	20.24	85.80	16.20	19.70	6.20
SailenKumerMondol, Magura	Magura	53	421	83.88	417	21.84	124.60	11.50	19.80	6.00
GolamFaruk, Sodohati, Sailkopa	Jinaidah	35	497	92.69	491	22.35	108.10	33.30	19.90	4.92
AbulKashemMonshi, Shalikha	Jinaidah	33	396	63.28	390	20.17	228.00	17.50	16.07	7.00
IqbalMonshi, Satnaforia, Shalikha	Magura	33	276	108.51	276	24.26	248.30	13.10	20.80	7.60