Journal of Crop and Weed 3(1) : 37-42 (2007)

Effect of graded doses of chemical fertilizers and granulated and prilled urea in rice-rice crop sequence

S. MAITI, S. PAL, RAKHI DEBARMA, H. BANERJEE AND T. PATRA

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur-741252, Nadia – 741252, West Bengal

ABSTRACT

Field experiments were conducted during both *boro* seasons (2004-05 and 2005-06) and *kharif* season (2005 and 2006) at the Regional Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, West Bengal to study the effect of sources of urea and different doses of chemical fertilizers under rice-rice cropping sequence. Yield components and grain yield increased with the increasing doses of chemical fertilizers in both the seasons and years. In rice-rice cropping system, the application of 125 % recommended dose of chemical fertilizer along with granulated form of urea during both *boro* and *kharif* seasons produced highest grain yield (9.37 t ha^{-1} yr^{-1}), net return (Rs. 20,063 ha^{-1} $year^{-1}$) and return per rupee investment (Rs. 1.50). Total nitrogen decreased in all the treatment combinations but available phosphorus and potassium content of soil after four consecutive rice cropping increased slightly where the crop received 100 or 125 % recommended dose of nutrient in addition to granulated form of urea as compared to initial value.

Key words **:** Sources of urea, chemical fertilizer, rice-rice crop sequence.

In India, rice-rice cropping system occupies the second highest area next to rice-wheat cropping system while it is the most important system prevailing in West Bengal. High yielding rice responds to judicious application of fertilizer especially N, P and K. Integrated nutrient management attains sustainable crop production with minimum deleterious effect of chemical fertilizer on soil health and least disturbance to plant-soil environment. With this idea in view the present experiment was planned.

MATERIAL AND METHODS

The experiments were carried out during *boro* seasons of 2004-05 and 2005-06 and *kharif* season of 2005 and 2006 at the Regional Research Station (RRS), Naida, West Bengal (23 ^{0} 5.3 ' N latitude and 85^0 5.3 ' E longitude and at an elevation of 9.75 m above the mean sea level. The land topographically is referred as medium land and medium in fertility with good drainage facility. The soil was sandy clay loam in texture (Entisol). The soil had pH 7.5, organic carbon 0.68 %, available P 16.00 kg ha^{-1} and available K 126.00 kg ha^{-1}. The experiment was laid out in a Factorial Randomized Block Design with 10 treatment combinations of two factors in three replicates. Factor A (sources of urea) : S_1 = Granulated Urea, S_2 = Prilled Urea. Factor B (Manurial treatment) : F_1 = Control (No fertilizer), F_2 = 50 % recommended doses of fertilizer (RDF), F_3 = 75 % RDF, F_4 = 100 % RDF and F_5 = 125 % RDF. The rice variety was Khitish (IET 4094). The crop received 60 kg N, 30 kg P_2O_5 and 30 kg K_2O ha^{-1} during *kharif* season and 120 kg N, 60 kg P_2O_5 and 60 kg K_2O ha^{-1} during *boro* season. Half dose of N and full dose of P_2O_5 and K_2O were given before transplanting and remaining N was top dressed equally at active tillering and before panicle initiation stage. Rice crop was transplanted on 05.02.05, 17.02.06, 01.08.05 and 01.08.06 and harvested on 12.05.05, 25.05.06, 14.11.05 and 20.11.06 during *boro* season of 2004-05 and 2005-06 and *kharif* sesson of 2005 and 2006, respectively.

RESULTS AND DISCUSSION

Performance of granular and prilled urea

Performance of variety Khitish was better in *boro* season than *kharif* season in all respects. Growth attributes like dry matter accumulation, leaf area index and crop growth rate, yield components like number of panicles m^{2-1}, filled grains per panicle, 1000-grain weight and grain and straw yield of rice were recorded maximum (Table 1 – 8) when the crop fertilized with granulated urea during both *boro* and *kharif* season. The values of the corresponding characters were lower when the crop received prilled urea. Sirisena *et al.* (2003), Singh *et al.* (1999) and Husin and Khanif (1992) reported that the granular urea produced the best paddy yield as compared to prilled urea due to increased N use efficiency. The performances of all the characters were very much similar in both the years.

Effect of manuring

Growth attributes, yield components and yield of rice in both the seasons and years increased with the doses of chemical fertilizer (Table 1 – 8) from 0 to 125 %. Grain yield (5.48 t ha^{-1} in *boro* and 3.61 t ha^{-1} in *kharif* season) and growth and yield characters were recorded maximum when the crop received 125 % recommended doses of

fertilizer (Table 1 – 8)). Debaraju *et al.* (1998) and Maiti *et al.* (2003) reported that increasing levels of N, P and K brought about improvement of yield components and yield of rice. The trend of variations in all the characters was very much similar in both the years.

Interaction effect of sources of urea and doses of chemical fertilizer

Maximum grain yield (5.76 t ha^{-1} in *boro* season and 3.61 t ha^{-1} in *kharif* season) and all the growth and yield components were observed when the crop fertilized with 125 % recommended doses of chemical fertilizer along with urea in granulated form (Table 1 – 8).

Effect of sources of urea and doses of chemical fertilizer on rice-rice crop sequence

Both grain and straw yields (Table 1 – 8) increased with the increasing doses of chemical fertilizer. Maximum grain (9.37 t ha^{-1} $year^{-1}$) and straw yield (10.43 t ha^{-1} $year^{-1}$) were recorded in the system when both the crops received 125 % recommended doses of fertilizer and urea was applied in the granulated form. The grain yield under this treatment was increased by 35.60 % over control.

Nutrient status of soil under rice-rice cropping system

After two years continuous rice-rice cropping in the same piece of land it was observed that total nitrogen decreased in all the treatment combinations but available phosphorus and available potassium content of soil increased over initial values slightly where the crop received 100 or 125 % recommended doses of nutrient along with granulated form of urea. But decreasing trend of result was noticed where the crop received less than 100 % RDF (Table 9).

Table 1 : Dry matter accumulation as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Dry matter accumulation (g m^{2-1}) at harvest					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	800.00	725.00	762.50	493.00	356.00	425.50
F_2 = 50 % RDF	1015.00	825.00	920.00	508.00	411.00	459.50
F_3 = 75 % RDF	1037.00	884.00	960.50	592.00	590.00	591.00
F_4 = 100 % RDF	1055.00	1027.00	1041.00	705.00	702.00	703.50
F_5 = 125 % RDF	1127.00	1067.00	1097.00	777.00	767.00	772.00
Mean	1006.80	905.60		615.00	565.20	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.919	2.727		1.085	3.222	
Dose (F)	1.452	4.312		1.715	5.093	
S × F	2.054	6.099		2.426	7.203	

Table 2 : Leaf area index as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Leaf area index at 60 DAT					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	2.69	2.53	2.61	2.63	2.55	2.59
F_2 = 50 % RDF	4.12	3.12	3.62	3.32	3.30	3.31
F_3 = 75 % RDF	4.15	3.85	4.00	3.47	3.40	3.43
F_4 = 100 % RDF	4.20	4.10	4.15	3.61	3.47	3.54
F_5 = 125 % RDF	4.63	4.42	4.52	3.92	3.49	3.70
Mean	3.95	3.60		3.39	3.24	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.014	0.042		0.048	0.142	
Dose (F)	0.022	0.067		0.076	0.225	
S × F	0.032	0.094		0.107	NS	

Table 3 : Crop growth rate as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Crop growth rate (g m^{2-1} day^{-1}) at 60 - 90 DAT					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	4.49	4.33	4.41	10.88	6.47	8.67
F_2 = 50 % RDF	11.39	5.16	8.27	10.10	7.36	8.73
F_3 = 75 % RDF	9.23	4.62	6.92	12.82	12.99	12.90
F_4 = 100 % RDF	9.09	8.23	8.66	16.33	16.39	16.36
F_5 = 125 % RDF	7.89	8.32	8.10	18.23	18.04	18.13
Mean	8.41	6.13		13.67	12.25	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.062	0.184		0.051	0.152	
Dose (F)	0.098	0.291		0.081	0.241	
S × F	0.139	0.412		0.115	0.341	

Table 4 : Panicle m^{2-1} as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Panicle m^{2-1} (no.)					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	328	329	329	285	275	280
F_2 = 50 % RDF	390	381	386	305	300	303
F_3 = 75 % RDF	414	403	409	316	307	312
F_4 = 100 % RDF	437	425	431	325	316	321
F_5 = 125 % RDF	453	447	450	350	345	348
Mean	404	397		316	309	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	2.380	7.140		2.413	7.166	
Dose (F)	3.405	10.215		3.816	11.330	
S × F	5.212	15.636		5.396	NS	

Table 5 : Filled grains / panicle as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Filled grains / panicle (no.)					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	88.1	72.4	80.3	86.4	73.4	79.9
F_2 = 50 % RDF	97.5	97.1	97.5	92.7	75.3	84.0
F_3 = 75 % RDF	115.0	114.6	114.8	103.2	82.7	93.0
F_4 = 100 % RDF	129.4	125.5	127.5	104.2	100.3	102.3
F_5 = 125 % RDF	137.0	134.3	135.7	105.7	100.7	103.2
Mean	114.0	108.8		98.4	86.5	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	2.312	6.938		1.606	4.768	
Dose (F)	3.621	10.863		2.538	7.538	
S × F	5.333	NS		3.590	10.601	

Table 6 : 1000 – grain weight as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	1000 – grain weight (g)					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	19.18	18.98	19.08	19.35	19.25	19.30
F_2 = 50 % RDF	20.00	19.44	19.72	19.66	19.35	19.66
F_3 = 75 % RDF	20.34	20.09	20.22	20.00	20.01	20.00
F_4 = 100 % RDF	20.80	20.57	20.69	20.04	20.02	20.04
F_5 = 125 % RDF	20.94	20.78	20.88	20.08	20.03	20.08
Mean	20.25	19.97	20.12	19.83	19.73	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.059	0.177		0.033	NS	
Dose (F)	0.049	0.147		0.052	0.156	
S × F	0.069	NS		0.074	NS	

Table 7 : Grain yield as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Grain yield (t ha^{-1})					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	3.26	3.10	3.18	2.65	2.49	2.57
F_2 = 50 % RDF	4.38	4.30	4.34	3.15	2.88	3.20
F_3 = 75 % RDF	4.94	4.87	4.92	3.50	3.45	3.48
F_4 = 100 % RDF	5.25	5.17	5.21	3.54	3.53	3.54
F_5 = 125 % RDF	5.76	5.21	5.49	3.61	3.60	3.61
Mean	4.72	4.53		3.49	3.24	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.039	0.117		0.055	NS	
Dose (F)	0.056	0.168		0.087	0.258	
S × F	0.088	NS		0.113	NS	

Table 8 : Straw yield as affected by manuring (Mean of two *boro* seasons, 2004-05 and 2005-06 and two *kharif* seasons, 2005 and 2006)

Treatments	Straw yield (t ha^{-1})					
	Boro season			*Kharif* season		
	S_1 = GU	S_2 = PU	Mean	S_1 = GU	S_2 = PU	Mean
F_1 = Control	5.02	5.21	5.12	3.25	2.90	3.08
F_2 = 50 % RDF	5.76	5.48	5.62	3.37	3.21	3.25
F_3 = 75 % RDF	5.76	5.83	5.81	3.65	3.50	3.58
F_4 = 100 % RDF	6.28	6.09	6.19	3.85	3.60	3.73
F_5 = 125 % RDF	6.53	6.55	6.54	3.90	3.61	3.76
Mean	5.88	5.83		3.60	3.36	
Effect of	S. Em (±)	C.D.(P=0.05)		S. Em (±)	C.D.(P=0.05)	
Sources (S)	0.038	NS		0.031	0.091	
Dose (F)	0.060	0.180		0.048	0.143	
S × F	0.088	0.264		0.068	NS	

Table 9 : Total nitrogen, available phosphorus and potassium content of soil after harvesting of each crop during 2004-05 to 2006

Treatment	Total N (%)			Available P (kg ha^{-1})				Available K (kg ha^{-1})			
	After *Boro* 2004-05	After *Kharif* 2005	After *Boro* 2005-06	After *Kharif* 2006	After *Boro* 2004-05	After *Kharif* 2005	After *Boro* 2005-06	After *Kharif* 2006	After *Boro* 2004-05	After *Kharif* 2005	After *Boro* 2005-06	After *Kharif* 2006
S_1 = Granulated Urea												
F_1 = Control	0.040	0.036	0.032	0.030	13.69	13.67	13.65	13.63	116.25	116.00	116.00	115.90
F_2 = 50 % RDF	0.045	0.043	0.042	0.040	14.10	14.00	14.00	13.40	120.15	119.75	119.50	119.40
F_3 = 75 % RDF	0.049	0.048	0.045	0.043	15.12	15.00	15.00	14.90	124.25	124.15	124.10	124.00
F_4 = 100 % RDF	0.050	0.049	0.048	0.046	16.00	16.35	16.91	16.95	126.00	126.25	126.50	126.70
F_5 = 125 % RDF	0.050	0.049	0.049	0.047	16.00	16.50	17.00	17.10	126.90	127.00	127.15	127.27
S_2 = Prilled Urea												
F_1 = Control	0.036	0.035	0.032	0.030	13.50	13.49	13.48	13.45	116.00	116.00	115.95	115.70
F_2 = 50 % RDF	0.049	0.042	0.041	0.040	14.00	13.95	13.90	13.70	120.00	119.90	119.45	119.42
F_3 = 75 % RDF	0.048	0.048	0.044	0.042	15.00	14.95	14.90	14.70	124.20	124.00	124.00	123.90
F_4 = 100 % RDF	0.049	0.048	0.048	0.046	15.95	16.00	16.90	17.00	125.95	126.00	126.45	126.50
F_5 = 125 % RDF	0.050	0.048	0.048	0.046	15.95	16.40	16.95	17.25	126.50	126.95	127.00	127.20

Table 10 : Economic analysis of rice-rice cropping sequence during *boro* 2004-05, *kharif* 2005, *boro* 2005-06 and *kharif* 2006 (Mean of two years)

Treatments	Cost of cultivation except cost of fertilizers (Rs.)	Treatment cost (Rs.)	Total cost (Rs.)	Gross return (Rs.)	Net return (Rs.)	Return per rupee investment (Rs.)
S_1F_1 = GU + 0 % RDF	33023.78	0	33023.78	40705.00	7681.22	1.23
S_1F_2 = GU + 50 % RDF	33023.78	2726.60	35750.38	48375.00	12624.62	1.35
S_1F_3 = GU + 75 % RDF	33023.78	3965.73	36989.51	55185.00	18195.49	1.49
S_1F_4 = GU + 100 % RDF	33023.78	5204.85	38228.63	56965.00	18736.37	1.49
S_1F_5 = GU + 125 % RDF	33023.78	6443.98	39467.76	59530.00	20062.24	1.50
S_2F_1 = PU + 0 % RDF	33023.78	0	33023.78	38160.00	5136.22	1.15
S_2F_2 = PU + 50 % RDF	33023.78	2726.60	35750.38	45560.00	9809.62	1.27
S_2F_3 = PU + 75 % RDF	33023.78	3965.73	36989.51	54765.00	17775.49	1.48
S_2F_4 = PU + 100 % RDF	33023.78	5204.85	38228.63	56010.00	17781.37	1.46
S_2F_5 = PU + 125 % RDF	33023.78	6443.98	39467.76	58655.00	19187.24	1.48

Economics under rice-rice cropping system

Where both *kharif* and *boro* crops were received 125 % recommended doses of chemical fertilizer along with granulated form of urea, net return (Rs. 20.062 ha^{-1} $year^{-1}$) and return per rupee investment (Rs. 1.50) were maximum as compared to other treatments (Table 10).

Considering the productivity, economics and nutrient content of soil it may be concluded that maximum grain yield, net return and return per rupee investment were recorded where the crop received 125 % recommended doses of chemical fertilizer and urea applied in the granulated form in both the *boro* and *kharif* seasons.

REFERENCES

Devaraju, K.M., Gowda, H. and Raju, B.M. (1998). Nitrogen response of Karnataka rice hybrids. *Int. Rice Res. Notes* **23** (2) : 42

Husin, A. and Khanif, Y.M. (1992). Efficiency of granular urea, recent findings. IFA FADINAP regional fertilizer conference for Asia and Pacific, 24 November – 2 December, 1992, Bali, Indonesia, 22.

Maiti, S., Narzari, N. and Pal, S. (2003). Response of high yielding and hybrid rice to varied level of nutritions. *Environment & Ecology* **21** : 296 – 300.

Sirisena, D.N., Wickramassinghe, W.M.A.D.B. and Ranatunge, R.A.N.D. (2003). Performance of different form of urea in rice cultivation. *Annals of the Sri Lanka Department of Agriculture*, **5** : 341 – 343.

Singh, S.P., Sreedevi, B. and Pillai, K.G. (1999). Influence of seedling age, source and schedule of nitrogen application on rice. *Indian Journal of Agronomy*, **44** (3) : 530 – 533.