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Response of different nitrogen levels and homo-brassinolide on yield and economics of hybrid rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment on hybrid rice (PHB-71) was conducted during kharif seasons of 2009 and 2010 in Agriculture farm, Institute of Agriculture, Sriniketan, Visva-Bharati, Birbhum, West Bengal. To study the agronomic evaluation of nitrogen and homo-brassinolide on productivity, correlation and economics of hybrid rice (Oryza sativa L.). Hybrid rice PHB-71 was tested with five nitrogen levels viz. N_0, N_{50}, N_{100}, N_{150} and N_{200} kg ha^{-1} and three levels of homo-brassinolide [no spray (BR_0), PI stage (BR_1) and flowering stage (BR_2)]. The individual effect of nitrogen and homo-brassinolide on yield was found significant. Nitrogen 150 kg ha^{-1} gave the highest grain yield and harvest index but maximum straw yield were found under nitrogen 200 kg ha^{-1}. In case of homo-brassinolide, spraying at PI +flowering gave the highest grain yield, straw yield and harvest index. Application of nitrogen 150 kg ha^{-1} with two foliar spray of homo-brassinolide was recorded higher net Return (Rs.37200 and Rs.39101), net returns per rupee invested (Rs.2.17 and 2.33) and benefit: cost ratios (1.17 and 1.33) during 1st year and 2nd year 2009 and 2010, respectively.

***Key words*:** Hybrid rice, nitrogen, homo-brassinolide, grain yield, economics

Rice is a semi-aquatic annual grass plant and is the most important cereal crop in the developing world. Ninety percent of all rice is grown and consumed in Asia (Anon., 1997; Luh, 1991). Rice feeds more than half the people in the world (David, 1989). Therefore, to increase production of rice plays a very important role in food security and poverty alleviation. Theoretically, rice still has great yield potential to be tapped and there are many ways to raise rice yield, such as building of irrigation works, improvement of soil conditions, cultural techniques and breeding of high yielding varieties. Among them, it seems at present that the most effective and economic way available is to develop hybrids based on the successful experience in China. Hybrid rice has potential of yielding 20-25% more than the best inbred varieties grown under similar conditions (Meena *et al.*, 2002). Like many hormones, BRs affect many plant processes, including those that control tiller number, leaf size, and leaf angle (Fujii *et al*., 1991 and Morinaka *et al*., 2006). This suggests that manipulation of BR levels in specific parts of crop plants could be one way to further increase grain yields.

MATERIALS AND METHODS

A field experiment on hybrid rice (PHB-71) was conducted during *kharif* seasons of 2009 and 2010. The experiment was laid out in Agriculture farm. Institute of Agriculture, Sriniketan, Visva-Bharati, Birbhum,West Bengal. The experimental site is located in the western part of West Bengal under sub-humid red and lateritic agro-ecological zone. The geographical location of Sriniketan is about $20^0 39^/N$ latitude and $87^0 42^/E$ longitude with an average altitude of 58.9 meters above mean sea level. The soil was slightly acidic (pH 6.1), low in soil organic carbon (0.49%), available nitrogen (193.40 kg ha^{-1}), phosphorus (15.40 kg ha^{-1}) and medium in potassium (171.90 kg ha^{-1}). The field experiment was carried out in Factorial RBD with three replications. Five levels of nitrogen (N_0, N_{50}, $N_{100,}$ N_{150} and N_{200}) and three numbers spraying of homo-brassinolide at No spray (HB_0), spray at panicle initiation stage (HB_1) and spray at panicle initiation +flowering stage(HB_2). The spraying of homo-brassinolide was 0.2 ppm (Double @0.5 ml $litre^{-1}$, Godrej Agrovet). The crop was transplanted on 13th July and 18th July during 2009 and 2010, respectively. The nitrogen fertilizer was weighted separately as per need of the treatment for individual plots. Required quantity of fertilizer as per treatment was applied uniformly in the plots through broadcast method of application. A uniform dose of 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} were applied in the form of Single Super Phosphate (16% P_2O_5**)** and Murate of Potash (60% K_2O), respectively before the last puddling of the field. Temperature ranging from 16.60 to 34.09 and 19.12 to 34.70 ^{0}C, relative humidity ranging from 66.43 to 91.71% and 75.00 to 89.63 %, total rainfall of 897.37 and 672.49 mm and total bright sunshine of 111.02 hours and 113.74 hours prevailed during the crop periods of 2009 and 2010, respectively

RESULTS AND DISCUSSION

Grain yield

Nitrogen application increased the grain yield significantly at each increased levels of nitrogen up to 150 kg ha^{-1} (Table 1). The pooled grain yield significantly increased up to 150 Kg N ha^{-1}. Further addition of nitrogen did not increase the grain yield. The per cent increase in pooled grain yield with 150

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kg N ha^{-1} over 0, 50, 100 and 200 kg N ha^{-1} were 66.74, 37.51, 14.49 and 3.52 respectively. The results are in conformity with those of Mahajan and Tripathi (1992), Dehal and Mishra (1994), Bera and Pramanik (2011). Homo-brassinolide had significant effect on grain and biological yield of hybrid rice. Grain and biological yield increased steadily with homo-brassinolide spraying at panicle initiation and flowering stage. The percentage increase of pooled grain yield with two sprays at panicle initiation + flowering stage over no spray and one spray at panicle initiation stage was 10.28 and 4.62, respectively. The results are in conformity with those of Bera and Pramanik (2010) and Nakashita *et al,* (2003).The interaction effect of application of nitrogen and spraying of homo-brassinolide on grain yield was found significant (Table2). The highest grain yield (58.42 q ha^{-1}) was recorded in crop receiving 150 kg N ha^{-1} and two sprayings of homo-brassinolide at panicle initiation +flowering stage.

Straw yield

Nitrogen played an important role on increasing straw yield of hybrid rice. The result showed that straw yield increased gradually due to increasing nitrogen levels (Table 1). Application of 200 kg N ha^{-1} significantly increased straw yield as compared to other levels of nitrogen. The results are in conformity with those of Tripathi and Jaishwal (2006). Application of homo-brassinolide also significantly improved the plant height of hybrid rice. Plant height significantly increased with two sprays of homo-brassinolide at panicle initiation and flowering stage. The results are in conformity with those of Wu *et al,* (2008).

Harvest index

Nitrogen influenced the harvest index of hybrid rice (Table 1). Application nitrogen at150 kg ha^{-1} significantly higher harvest index as compared to other nitrogen levels. The result showed that the nitrogen 150 kg ha^{-1} increased the grain yield of hybrid rice. The result also showed that the harvest index decreased at 200 kg N ha^{-1}. The result is in conformity with those of Subbaiah *et al,* (2001). Homo-brassinolide also played an important role on influencing the harvest index. Spraying of homo-brassinolide at panicle initiation and flowering stage produced significantly higher harvest index as compared to no spray of homo-brassinolide. The results are in conformity with those of Nakashita *et al,* (2003) and Bera and Pramanik (2010).

Correlation studies

To find out the relationship between grain yield (kg ha^{-1}) and various yield attributes, correlation were worked out the correlation coefficients (r) are given (Table 3 and 4). Correlation coefficient among grains yield (Y) and yield attributes viz., number of tiller $hill^{-1}$ (X_1), effective tiller $hill^{-1}$ (X_2), panicle length (X_3), test weight (X_4), straw yield (X_6), biological yield (X_7) and harvest index (X_8) were positively and significantly different from zero. Positive and significant correlation was observed between number of tiller $hill^{-1}$ (X_1), effective tiller $hill^{-1}$ (X_2), panicle length (X_3), test weight (X_4), straw yield (X_6), biological yield (X_7) and harvest index (X_8) during the both years.

Response curve

The relationship between grain yield and rate of nitrogen was studies in pooled data as well as in the both years separately, with the help of second degree polynomial.

It indicates that the linear and quadratic components of nitrogen response were significant, thus a quadratic equation was fitted for nitrogen levels and grain yield using the equation $Y= a + bx + cx^2$, where Y represents the grain yield in q ha^{-1}, corresponding to X q ha^{-1} of nitrogen The response curve equation for 1st year, 2nd year and pooled and in Fig. 1, 2 and 3.

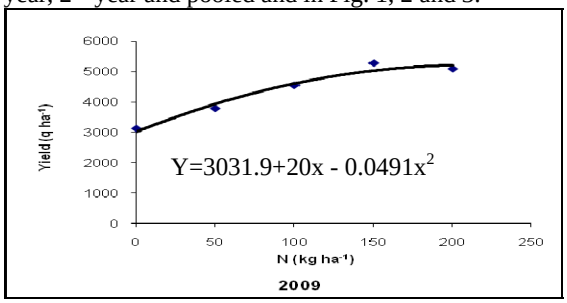

Fig.1. Response curve sowing estimated grain yield at various nitrogen levels

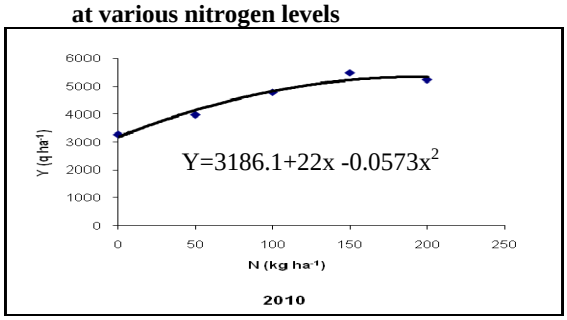

Fig.2. Response curve sowing estimated grain yield at various nitrogen levels

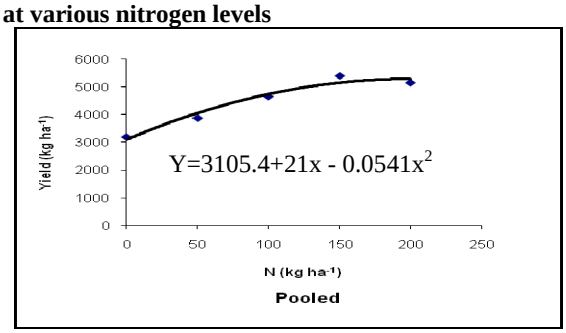

Fig.3. Response curve sowing estimated grain yield at various nitrogen levels

Table 1: Grain yield, straw yield and harvest index of hybrid rice as influenced by nitrogen levels and homo-brassinolide

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Nitrogen levels (Kg ha^{-1})									
N_0	31.22	32.82	32.02	44.44	47.18	45.81	41.25	41.00	41.13
N_{50}	37.85	39.82	38.84	52.13	55.68	53.91	42.06	41.70	41.88
N_{100}	45.43	47.86	46.65	60.91	64.04	62.48	42.72	42.77	42.75
N_{150}	53.42	54.81	54.12	68.18	70.11	69.15	43.62	43.54	43.58
N_{200}	50.93	52.32	51.63	69.74	71.38	70.57	42.19	42.27	42.23
SEm(±)	**0.25**	**0.33**	**0.21**	**0.47**	**0.42**	**0.33**	**0.12**	**0.18**	**0.11**
LSD (0.05)	**0.72**	**0.96**	**0.59**	**1.36**	**1.22**	**0.93**	**0.35**	**0.52**	**0.31**
Homo-brassinolide									
HB_0	41.18	42.92	42.05	56.42	59.02	57.73	42.16	42.14	42.15
HB_1	43.65	45.55	44.61	58.85	61.64	60.25	42.46	42.35	42.41
HB_2	46.48	48.18	47.29	61.97	64.38	63.18	42.48	42.28	42.38
SEm(±)	**0.19**	**0.26**	**0.16**	**0.37**	**0.38**	**0.26**	**0.10**	**0.14**	**0.09**
LSD (0.05)	**0.55**	**0.75**	**0.45**	**1.07**	**1.10**	**0.74**	**0.29**	**0.41**	**0.25**

Note: HB0= No spray, HB_1= spray at panicle initiation stage, HB2 = spray at panicle initiation +flowering stage

Table 2: Interaction effect of nitrogen and homo-brassinolide on grain yield (q ha^{-1}) of hybrid rice

Nitrogen levels (Kg ha^{-1})	2009			2010			Pooled		
	Homo-brassinolide			Homo-brassinolide			Homo-brassinolide		
	HB_0	HB_1	HB_2	HB_0	HB_1	HB_2	HB_0	HB_1	HB_2
N_0	29.25	31.14	33.28	30.41	33.04	35.02	29.83	32.09	34.15
N_{50}	35.58	37.79	40.19	37.75	39.63	42.08	36.67	38.71	41.14
N_{100}	42.79	45.36	48.15	45.21	48.04	50.33	44.00	46.70	49.24
N_{150}	49.82	52.83	57.59	51.06	54.14	59.24	50.44	53.49	58.42
N_{200}	48.44	51.16	53.20	50.20	52.93	53.85	49.32	52.04	53.53
SEm(±)		**0.44**			**0.26**			**0.36**	
LSD(P=0.05)		**1.27**			**0.75**			**1.02**	

Table 3: Simple correlation coefficient for grain yield and yield attributes of hybrid rice as influenced by nitrogen levels and homo-brassinolide (2009)

Character	Grain yield (Y)	Number of tiller hill^{-1} (X_1)	Effective tiller hill^{-1} (X_2)	Panicle length (X_3)	Panicle weight (X_4)	Test weight (X_5)	Straw yield (X_6)	Biological yield (X_7)	Harvest index (X_8)
Y	1.000	0.956	0.930	0.942	0.945	0.954	0.988	0.997	0.817
X_1		1.000	0.966	0.926	0.951	0.949	0.967	0.965	0.700
X_2			1.000	0.940	0.966	0.945	0.946	0.941	0.657
X_3				1.000	0.967	0.962	0.961	0.955	0.659
X_4					1.000	0.966	0.969	0.961	0.636
X_5						1.000	0.965	0.963	0.700
X_6							1.000	0.998	0.722
X_7								1.000	0.768
X_8									1.000

Table 4: Simple correlation coefficient for grain yield and yield attributes of hybrid rice as influenced by nitrogen levels and homo-brassinolide (2010)

Character	Grain yield (Y)	Number of tiller hill^{-1}	Effective tiller hill^{-1} (X_2)	Panicle length (X_3)	Panicle weight (X_4)	Test weight (X_5)	Straw yield (X_6)	Biological yield (X_7)	Harvest index (X_8)
Y	1.000	0.956	0.924	0.926	0.942	0.934	0.951	0.985	0.800
X_1		1.000	0.947	0.948	0.942	0.938	0.974	0.965	0.689
X_2			1.000	0.994	0.930	0.947	0.935	0.928	0.670
X_3				1.000	0.924	0.942	0.933	0.925	0.689
X_4					1.000	0.969	0.961	0.957	0.644
X_5						1.000	0.959	0.954	0.617
X_6							1.000	0.960	0.660
X_7								1.000	0.687
X_8									1.000

Table 5: Observed and expected yield (q ha^{-1}) with nitrogen application of hybrid rice

Treatment	2009		2010		Pooled	
	Observed	Expected	Observed	Expected	Observed	Expected
Nitrogen (Kg ha^{-1})						
0	31.22	30.32	32.82	31.86	32.03	31.05
50	37.85	39.43	39.82	41.56	38.84	40.59
100	45.43	46.09	47.86	48.40	46.65	47.41
150	53.42	50.30	54.81	52.37	54.11	51.04
200	50.93	52.05	52.32	53.47	51.63	52.95

Table 6: Optimum nitrogen dose and yield of hybrid rice

Years	Nitrogen optimum (kg ha^{-1})	Yield optimum (kg ha^{-1})
2009	198.42	5203
2010	183.83	5343
Pooled	189.56	5288

Table 7: Gross return, net returns Rs ha^{-1}, net return ($) rupee^{-1}, B:C ratio of hybrid rice as influenced by nitrogen levels and homo- brassinolide

Treatments	Gross return		Net returns		Net return$		B:C ratio	
	2009	2010	2009	2010	2009	2010	2009	2010
N_0BR_0	35569.9	37019.6	8655.9	10105.6	1.32	1.38	0.32	0.38
N_0BR_1	37806.8	40113.2	9452.8	11759.2	1.33	1.41	0.33	0.41
N_0BR_2	40329.6	42509.6	10535.6	12715.6	1.35	1.43	0.35	0.43
$N_{50}BR_0$	43112.3	45715.2	15554.3	18157.2	1.56	1.66	0.56	0.66
$N_{50}BR_1$	45688.4	48084.8	16659.4	19055.8	1.57	1.66	0.57	0.66
$N_{50}BR_2$	48639.1	50978.8	18170.1	20509.8	1.60	1.67	0.60	0.67
$N_{100}BR_0$	51679.3	54577.0	23415.3	26313.0	1.83	1.93	0.83	0.93
$N_{100}BR_1$	54732.0	57933.7	25028.0	28229.7	1.84	1.95	0.84	0.95
$N_{100}BR_2$	58144.9	60799.3	27000.9	29655.3	1.87	1.95	0.87	0.95
$N_{150}BR_0$	60035.5	61640.1	31096.5	32701.1	2.07	2.13	1.07	1.13
$N_{150}BR_1$	63585.0	65154.4	33248.0	34817.4	2.10	2.15	1.10	1.15
$N_{150}BR_2$	69019.6	70920.3	37200.6	39101.3	2.17	2.33	1.17	1.33
$N_{200}BR_0$	58660.5	60754.7	29046.5	31140.7	1.98	2.05	0.98	1.05
$N_{200}BR_1$	61843.9	63926.6	30789.9	32872.6	1.99	2.06	0.99	1.06
$N_{200}BR_2$	64322	65118	31802	32624	1.98	2.00	0.98	1.00

The expected yields were worked out at various levels of nitrogen by using these equations and presented in table 5. Under the assumption that the response curve was a second degree parabola ($Y= a + bx + cx^2$), the optimum dose of nitrogen application was calculated by ½ c (q/p-b), where p and q represents the price of one quintal of hybrid rice and one kilogram of nitrogen, respectively. The average price of hybrid rice was taken Rs 1100 quintal^{-1} and the cost of nitrogen was Rs. 13.5 kg^{-1}. Substituting these values for p and q, the optimum dose of nitrogen was found to be 189.42 kg ha^{-1} in the first year, 183.83 kg ha^{-1} in the second year and 189.56 kg ha^{-1} in the pooled (Table 6) respectively.

Optimum yield was calculated by substituting the values of x in the equations. The optimum yields were found 52.03 q ha^{-1} in the first year, 53.43 q ha^{-1} in the second year and 52.88 q ha^{-1} in the pooled, respectively.

Economics

The economics of application of nitrogen and homo-brassinolide was calculated for gross return ha^{-1}, net return ha^{-1}, net return rupee^{-1} and B: C ratio invested for hybrid rice are presented in Table 7. In hybrid rice higher gross return (Rs. 69019 and Rs. 70920) and net return ha^{-1} (Rs..37200 and Rs.. 39101) was with application of nitrogen 150 kg ha^{-1} with two sprayings of homo-brassinolide at PI + flowering stage respectively. Application of nitrogen fertilizer with two spraying of homo-brassinolide recorded higher net return rupee^{-1} (Rs..2.17 and Rs. 2.33) and B:C ratio (1.17 and 1.33) invested in the hybrid rice.

From the present study, it is clear that both nitrogen and homo-brassinolide had significant effect on the growth and yield of hybrid rice. Application of 150 Kg N ha^{-1} and homo-brassinolide at panicle initiation + flowering stage resulted in significantly higher grain yield and harvest index.

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