Response of Hybrid Rice (*Oryza sativa* L.) to Varying Levels of Nitrogen and Homo-Brassinosteroids in Lateritic Zone of West Bengal

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Abstract

A field experiment on hybrid rice (PHB-71) was conducted during *kharif* season of 2009 and 2010 in agriculture farm, Institute of Agriculture, Sriniketan, Visva-Bharati, West Bengal to study the effect of nitrogen and homo-brassinosteroids on growth, yield parameters and yield of hybrid rice (*Oryza sativa* L.) in lateritic zone of West Bengal in India. The experiment was conducted with five nitrogen levels, viz. 0, 50, 100, 150 and 200 kg ha^{-1} and three levels of homo-brassinosteroids (no spray, spary at panicle initiation stage and spray at panicle initiation+flowering stage). Application of nitrogen @ 150 kg ha^{-1} recorded significantly more panicle weight, grain yield (54.11 q ha^{-1}) and harvest index (43.58%) whereas 200 kg ha^{-1} showed maximum plant height, number of tillers $hill^{-1}$, number of effective tillers $hill^{-1}$ and straw yield. In case of homo-brassinosteroids, spraying at PI+flowering stage resulted in significantly taller plants with more number of effective tillers $hill^{-1}$, panicle weight, grain yield (47.29 q ha^{-1}), straw yield (63.17 q ha^{-1}) and harvest index (42.38%).

1. Introduction

Rice plays a key role in sustaining food sufficiency. It occupies a pivotal position in the food security system of India, contributing about 43% of total food grain production and 46% of total cereal production in the country (Directorate of Rice Development, 2011). The future increase in food production of the country will depend on the ability to achieve a continuous improvement in productivity and profitability of rice cultivation. Hybrid rice with suitable production techniques is suggested as viable and appropriate strategies. Hybrid rice has potential of yielding 20-25% more than the best variety grown under similar conditions (Meena et al., 2002). For exploiting the full heterotic potential of hybrids, development of matching agronomic production technology including nitrogen response is essential. Nitrogen is an important component of rice production technology with high yielding cultivars and has immense role in increasing rice productivity (Kumar and Prasad, 2004). Nitrogen is an important constituent of many organic compounds and is known to improve the various morphological attributes in rice because of higher synthesis of protoplasmic proteins and nucleic acids. It is an integral part of chlorophyll which is the primary absorber of light. It is also responsible for more leaf area and dry matter production due to higher rate of photosynthesis (Murata, 1959; Baba, 1961). It promotes rapid growth (increased plant height and tiller number) and increased leaf size, spikelet number per panicle, percent filled spikelets in each panicle, and grain protein content. Thus, N affects all parameters contributing to yield. Its deficiency or excess may adversely affect these processes and reduce crop yield while excess nitrogen may lead to relatively higher crop growth, creating favorable condition for pest and disease (Om et al., 1996). Brassinosteroid plays pivotal roles in the hormonal regulation of plant growth and development was also found to induce disease resistance in plants. The potentialities of brassinolide activity on stress responding systems and its ability to induce disease resistance in rice plants was analyzed by Nakashita et al. (2003). Wu et al. (2008) reported that brassinosteroid hormone levels are active in only the stems, leaves and roots.

2. Materials and Methods

A field experiment on hybrid rice (PHB-71) was conducted during *kharif* season of 2009-2010 and 2010-2011. The experiment was laid out in agriculture farm, Institute of Agriculture, Sriniketan, Visva-Bharati, Birbhum, West Bengal. The experiment 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^{o}39' N latitude and 87^{o}42' E longitude with an average altitude of 58.9 m msl. 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 design with three replications. Five levels of nitrogen (N_0, N_{50}, N_{100}, N_{150} and N_{200}) and three levels of brassinosteroids (no spray, spray at panicle initiation stage and spray at panicle initiation+flowering stage). The crop was transplanted on 13th and 18th July during 2009 and 2010, respectively. The nitrogen fertilizer was applied as per need of the treatment for individual plots. 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. Temperature ranging from 16.60 to 34.09°C and 19.12 to 34.70°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 and 113.74 h prevailed during the crop periods of 2009 and 2010, respectively.

3. Results and Discussion

3.1. Plant height

Nitrogen played an important role on increasing plant height of hybrid rice. The pooled analysis over two years' data showed that plant height increased gradually due to increasing nitrogen levels (Table 1).

Application of 200 kg N ha^{-1} significantly increased plant height as compared to other levels of nitrogen. The results are in conformity with those of Tripathi and Jaishwal (2006). Homo-brassinosteroids also significantly affected on plant height of hybrid rice. Plant height significantly increased with two sprays of homo-brassinosteroids at panicle initiation and flowering stage. The results are in conformity with those of Wu et al. (2008).

3.2. Number of panicles m^{-2}

The pooled analysis over two years' data showed that nitrogen had a significant influenced on number of panicles m^{-2} (Table 1). The result showed that the number of panicles m^{-2} increased gradually due to increasing levels of nitrogen application. The maximum number of panicles m^{-2} (380) was recorded in crop receiving 200 kg N ha^{-1} as compared to control (141). The result highlighted the importance of nitrogen on plant nutrition for increasing the tiller bearing capacity of hybrid rice. The beneficial effect of nitrogen fertilizer application on increasing effective tillers production was also noticed by Pandey et al. (1997) and Buresh et al. (2005). Spraying of homo-brassinosteroids at panicle initiation and panicle initiation+flowering stage produced significantly higher number of panicles m^{-2} (269) and (275), respectively as compared to no spray (232). The results are in conformity with those of Sakamoto et al. (2006) and Bera and Pramanik (2010).

3.3. Number of grains panicle^{-1}

The effect of nitrogen on number of grains panicle^{-1} was influenced significantly (Table 1). The number of grains panicle^{-1} ranged from 108 to 150. The result of pooled analysis over two years' data showed that the number of grains panicle^{-1} increased gradually due to increasing levels of nitrogen application. The maximum number of grains panicle^{-1} was recorded in crop receiving 150 kg N ha^{-1} during both the years. The similar

Table 1: Plant height (cm), number of tiller hill-1, and number of effective tiller hill-1 of rice hybrid as influenced by nitrogen levels and homo-brassinosteroids

Treatments	Plant height (cm) at harvest			Number of panicle m^{-2}			Number of grains panicle^{-1}		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Nitrogen levels (kg ha^{-1})									
N_0	89.93	91.56	90.75	132	149	141	103	108	106
N_{50}	95.85	99.15	97.50	179	188	184	115	121	118
N_{100}	102.08	105.40	103.74	246	281	264	131	137	134
N_{150}	108.74	111.50	110.12	305	346	326	160	167	163
N_{200}	111.72	114.38	113.05	361	398	380	148	153	150
SEm±	0.76	0.71	0.52	5.0	7.0	5.0	1.1	1.3	0.9
CD (p=0.05)	2.20	2.06	1.04	14.0	20.0	10.0	3.2	3.8	1.8
Homo-brassinosteroids									
No spray	100.16	103.26	101.71	224	240	232	120	125	122
PI stage	101.85	104.04	102.94	253	284	269	130	138	134
PI+flowering stage	103.00	105.89	104.44	257	293	275	144	150	147
SEm±	0.59	0.55	0.40	4.0	6.0	4.0	0.8	1.0	0.7
CD (p=0.05)	1.71	1.59	0.80	11.0	17.0	8.0	2.5	3.0	1.4

PI=Panicle initiation

results were noticed by Wang et al. (2001) and Huang et al. (2008). Homo-brassinosteroids also showed significant effect on the number of grains panicle^{-1} production in hybrid rice. Spraying of homo-brassinosteroids at panicle initiation stage and panicle initiation + flowering stages produced significantly higher number of grains panicle^{-1} as compared to no spray. The results are in conformity with those of Wu et al. (2008).

3.4. *Panicle weight*

The panicle weight was significantly influenced by different levels of nitrogen (Table 2).

The result recorded that pooled analysis over two years' data of the panicle weight with application of 150 kg N ha^{-1} was significantly higher as compared to 0, 50 and 100 kg N ha^{-1}. Further increase in nitrogen level did not increase the panicle weight. The results are in conformity with those of Balasubramaniyan (1984), Thakur (1989) and Subbaiah et al. (2001). The panicle weight in hybrid rice was significantly influenced by homo-brassinosteroids application. Spraying of homo-brassinosteroids at panicle initiation+flowering stage resulted in higher panicle weight as compared to no spray and one spray at panicle initiation stage. The results are in conformity with those of Sakamoto et al. (2006); Bera and Pramanik (2010).

3.5. *Grain yield*

Nitrogen application increased the grain yield significantly at each increased levels up to 150 kg N ha^{-1} (Table 2). The pooled analysis over two years' data showed that grain yield significantly increased up to 150 kg N ha^{-1} as over other nitrogen levels. Further increase in nitrogen did not increase the grain yield. The percentage increase in pooled grain yield with 150 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) and Bera and Pramanik (2011). Homo-brassinosteroids had significant effect on grain and biological yield of hybrid rice. Grain and biological yield increased steadily with the increase in homo-brassinosteroids spraying at panicle initiation and flowering stage. The percentage increase of pooled grain yield with two sprays at panicle initiation and 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 Nakashita et al. (2003) and Bera and Pramanik (2010).

3.6. *Straw yield*

Nitrogen played an important role on increasing straw yield of hybrid rice. The result of pooled analysis over two years' data showed that straw yield increased gradually due to increasing nitrogen levels (Table 2). 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). Homo-brassinosteroids not only significantly affected the plant height but also straw yield of hybrid rice. Plant height significantly increased with two sprays of homo-brassinosteroids at panicle initiation and flowering stage. The results are in conformity with those of Wu et al. (2008).

3.7. *Harvest index*

The pooled analysis over two years' data revealed that nitrogen

Table 2: Panicle weight, grain yield, straw yield and harvest index of rice hybrids as influenced by nitrogen levels and homo-brassinosteroids

Treatments	Panicle weight (g)			Grain yield (q ha^{-1})			Straw yield (q ha^{-1})			Harvest index (%)		
	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled	2009	2010	Pooled
Nitrogen levels (kg ha^{-1})												
N_0	2.59	2.70	2.65	31.22	32.82	32.02	44.44	47.18	45.81	41.25	41.00	41.13
N_{50}	2.76	2.91	2.83	37.85	39.82	38.84	52.13	55.68	53.91	42.06	41.70	41.88
N_{100}	3.30	3.38	3.34	45.43	47.86	46.65	60.91	64.04	62.47	42.72	42.77	42.74
N_{150}	4.02	4.02	4.02	53.42	54.81	54.11	68.18	70.11	69.14	43.62	43.54	43.58
N_{200}	3.73	3.81	3.77	50.93	52.32	51.63	69.74	71.38	70.56	42.19	42.27	42.23
SEm±	0.02	0.03	0.02	0.25	0.33	0.21	0.47	0.42	0.33	0.12	0.18	0.11
CD (p=0.05)	0.06	0.09	0.04	0.72	0.96	0.42	1.36	1.22	0.66	0.35	0.52	0.22
Homo-brassinosteroids												
No spray	3.12	3.17	3.14	41.18	42.92	42.05	56.42	59.02	57.72	42.16	42.14	42.15
PI stage	3.26	3.33	3.29	43.65	45.55	44.61	58.85	61.64	60.24	42.46	42.35	42.41
PI+flowering stage	3.46	3.61	3.54	46.48	48.18	47.29	61.97	64.38	63.17	42.48	42.28	42.38
SEm±	0.01	0.02	0.01	0.19	0.26	0.16	0.37	0.38	0.26	0.10	0.14	0.09
CD (p=0.05)	0.03	0.06	0.02	0.55	0.75	0.32	1.07	1.10	0.52	0.29	0.41	0.18

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

4. Conclusion

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

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