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# Growth, yield components and yield of hybrid rice as influenced by nitrogen levels and time of Homo-Brassinolide application

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**Abstract**

A field experiment was conducted on hybrid rice during the *kharif* season of 2011 at the farm of Palli Siksha Bhavana (Institute of Agriculture), Visva Bharati, Sriniketan, West Bengal to study the effect of nitrogen and homo-brassionlide on growth and productivity of hybrid rice. The experiment was laid out in FRBD with five levels of nitrogen viz. $N_0$, $N_{60}$, $N_{120}$, $N_{180}$ and 240 kg $ha^{-1}$ and three levels spraying of homo-brassionlide viz. active tillering (AT), active tillering +panicle initiation (PI) and active tillering +panicle initiation + flowering (FL). The results showed that hybrid rice responded well to fertilizer application. Application of 180 kg N improved all the growth attributes such as plant height, number of tillers $m^{-2}$ and dry matter accumulation and increased the yield attributes like number of panicles $m^{-2}$, panicle length, number of grains $panicle^{-1}$, percentage of filled grain and test weight that ultimately led to high crop productivity. The spray of homo-brassinolide has a significant effect on plant height, number of tillers $m^{-2}$ and dry matter accumulation and increased the yield attributes like number of panicles $m^{-2}$, panicle length, number of grains $panicle^{-1}$, percentage of filled grain and test weight that ultimately led to high crop productivity. Among the spraying, thrice spraying of homo-brassinolide i.e. at AT+PI + FL recorded significantly higher yield parameters and yield as compared to AT, MT+PI. The study advocated cultivating hybrid rice 180 kg N with for its high productivity.

**Highlights**

- Application of 180 kg $Nha^{-1}$ improved all the growth attributes, yield attributes and yield.
- The spray of homo-brassinolide at active tillering + panicle initiation + flowering recorded significantly higher growth attributes, yield attributes crop productivity.

**Keywords:** Hybrid rice, nitrogen, homo-brassinolide, yield attributes, productivity

Rice is one of the most important food grain produce and consume all over the world. More than 90% of the world rice is produced and consumed in Asia which is a home for 60% of the earth population. The world demand for rice in 2025 is estimated to be about 765 mt. Introduction of hybrid rice is an important step towards amplification of rice yield. Yield of hybrid rice is about 15-20% more than the promising high-yielding commercial varieties (Chaturvedi, 2005). Nitrogen is one of the most important nutrients for plant growth and a major factor that limits crop yields (Elena and Rodrigo, 2008; 2002; Dai *et al.*,2009). At present, both production and consumption of nitrogen fertilizer occupy the first place in the agricultural production all over the world. The deficiency of nitrogen (N) is one of the most vital nutritional disorders in lowland rice producing areas of the world. Hybrid rice production technology aims to increase the yield potential of rice beyond the level of inbred high yielding varieties (HYV) by exploiting the phenomenon of hybrid vigour. Besides other agronomical inputs optimization of nitrogen and spraying of suitable phytohormone are extremely important and maximum yields are possible when nitrogen uptake is sufficient to sustain biomass accumulation, sink formulation throughout the crop growth and development period. Proper nitrogen fertilization is an important management practice which can increase the yield of hybrid rice. Proper and optimum N applied gave maximum filled grain percentage, 1000-grain weight, grain and straw yield of hybrid rice (Peng *et al.,* 1996). Maske *et al.,* (1997) accounted that increasing nitrogen levels up to 120 kg N/ha significantly increased plant height, leaf area, yield component and grain yield of rice. Brassinosteroids are a class of plant polyhydroxysteroids that are ubiquitously distributed in the plant xysteroids that are ubiquitously distributed in the plant xysteroids that are ubiquitously distributed in the plant kingdom. These compounds, when applied to plants, improve their quality and yield Brassinolide (BL), considered to be the most important homo-brassinolide (HBR) playing a pivotal roles in the hormonal regulation of rice plant growth and development, and its ability to induce disease resistance in rice plants was analyzed by Nakashita *et al.,* (2003).

**Materials and Methods**

A field experiment was conducted during the *kharif* season of 2011 to study the effect of nitrogen levels and time of homo-brassinolide spraying on growth and productivity of hybrid rice at the farm of the Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati, Sriniketan, West Bengal. The place is situated at 23°39 N latitude, 87°42′ E longitude and an elevation of 58.9 m above mean sea level. Normally the area received about 1000 mm rainfall during the *kharif* season (July to October). But there was low rainfall during the crop season of 2011in 720 mm. The deficiency in rainfall was 27.4% in 2011. The soil of the experimental plot was sandy loam in texture (62.5% sand, 26.0% silt and 10.5% clay), neutral in reaction (pH 6.1) medium in organic carbon (0.49%) and available N (136.0 kg $ha^{-1}$), low in available P (11.5 kg $ha^{-1}$) and available K (160.5 kg $ha^{-1}$) status. The experiment was laid out in factorial Randomized Block Design with three replications in 4 m x 2.5 m plots with five nitrogen levels ($N_0$= 0 kg N/ha (control), $N_{60}$= 60 kg N/ha, $N_{120}$= 120 kg N/ha, $N_{180}$= 180 kg N/ha, $N_{240}$= 240 kg N/ha) and three spraying of homo-brassinolide (at Active tillering (AT), Active tillering + Panicle initiation (PI) and Active tillering + Panicle initiation + Flowering). The hybrid rice GAP 4011was transplanted on July July 29, 2011 taking single seedling per hill at 25 x 25cm. All plots received full dose of P and K and $1/4^{th}$ N fertilizer at basal and remaining N fertilizer in three equal splits - at mid-tillering, panicle initiation and flowering as per treatments. The crop irrigated as and when required. The weeds were removed manually at 30 and 45 days after transplanting (DAT). Harvesting was done on November 11, 2011. The observation on plant height was recorded from 10 hills randomly selected in each plot at different stages and their average was worked out. Tiller number from the same hills was also recorded at 60 DAT. Samples for biomass has been collected from 5 hills from ear-marked area and dried in an oven at 65-70°C till constant weights were obtained. The dry weight of were noted and converted into g $m^{-2}$. The dry weight of leaves was used for determining leaf area index (LAI) as suggested by Watson (1952). DMA at different stages was used for determining crop growth rate (CGR). Observation on yield parameters like number of panicles $m^{-2}$, number of spikelets and filled grains $panicle^{-1}$, test weight along with grain yield, straw yield and harvest index were recorded at maturity. The data were statistically analyzed applying the techniques of analysis of variance and the significance of different sources of variations were tested by error mean square of Fisher Snedecor's 'F' test at probability level 0.05 (Cochran and Cox, 1977).

## Results and Discussion

### *Growth attributes*

Plant height at all the growth stages and tillering increased steadily due to increasing level of nitrogen application during the study. The result showed that the height of the rice plant increased progressively up to 80 days after transplanting (DAT) when it attained about 97.3- 107.2 cm height. The tallest plants and highest number of tillers $m^{-2}$ were recorded in crop receiving 240 kg N ($N_{240}$), but was comparable to those of its immediate lower ($N_{180}$) level (180 kg N $ha^{-1}$). Both the above nitrogen levels produced significantly taller plants and greater number of tillers $m^{-2}$ than those recorded at lower nitrogen level ($N_0$). At low nitrogen ($N_0$) level produced the dwarf most plants at all the growth stages and lowest number of tillers $m^{-2}$ among all other nitrogen treatments (Table 1). It appeared that hybrid rice required high rate of nitrogen application for better growth of the crop as reflected by its tillering and plant height. An increase in plant height and tiller number in rice due to N application have also been reported by a number of workers earlier and recently by Navin kumar *et al*. (1996), Padmavathi (1997) and Peng *et al.* (2006).

Time of homo-brassinolide (HBR) spraying had significant influence on plant height and tiller production. Increasing number of homo-brassinolide spraying steadily increased plant height at all the growth stages and number of tillers $m^{-2}$ (Table 1). The tallest plants and highest number of tillers $m^{-2}$ were produced at thrice spraying of homo-brassinolide at active tillering (AT) + panicle initiation (PI) + flowering (FL) stages and were significantly greater than what obtained at only spraying at active tillering (AT) stage. The dwarf most plants at different stages

**Table 1. Plant height (cm) and tillers $m^{-2}$ of hybrid rice at different growth stages as influenced by nitrogen and time of homo-brassinolide application**

| Treatment | Plant height (cm) Tillers $m^{-2}$ | | | | |
|---|---|---|---|---|---|
| | 20DAT | 40DAT | 60DAT | 80DAT | 60 DAT |
| Nitrogen levels(kg/ha) | | | | | |
| $N_0$* | 54.58 | 73.11 | 86.66 | 97.30 | 379.4 |
| $N_{60}$ | 61.86 | 77.03 | 95.89 | 102.09 | 397.5 |
| $N_{120}$ | 63.59 | 77.54 | 96.61 | 103.32 | 412.7 |
| $N_{180}$ | 65.80 | 80.49 | 99.49 | 105.69 | 453.0 |
| $N_{240}$ | 67.40 | 82.60 | 100.72 | 107.24 | 476.6 |
| SEm(±) | 1.17 | 0.89 | 0.97 | 0.99 | 8.5 |
| CD(P=0.05) | 3.39 | 2.58 | 2.81 | 2.87 | 24.6 |
| Time of homo-brassinolide application | | | | | |
| AT | 63.41 | 78.92 | 95.36 | 102.00 | 389.1 |
| AT+PI | 60.96 | 76.21 | 94.63 | 103.19 | 424.1 |
| AT+PI+FL | 63.56 | 79.34 | 97.63 | 104.19 | 458.3 |
| SEm(±) | 0.90 | 0.69 | 0.75 | 0.77 | 6.6 |
| CD(P=0.05) | NS | 2.00 | 2.17 | NS | 19.1 |

*$N_0$ = 0 kg N/ha (control), $N_{60}$ = 60 kg N/ha, $N_{120}$ = 120 kg N/ha, $N_{180}$ = 180 kg N/ha, $N_{240}$ = 240 kg N/ha); AT = Active tillering, AT+PI= Active tillering + Panicle initiation and AT+PI+FL= Active tillering + Panicle initiation + Flowering).

**Table 2. Effect of nitrogen levels and time of homo-brassinolide application on leaf area index and crop growth rate of hybrid rice**

| Treatments | Leaf Area Index (LAI) | | | | CGR ($g/d/m^2$) | | |
|---|---|---|---|---|---|---|---|
| | 20 DAT | 40DAT | 60DAT | 80DAT | 20 -40DAT | 40-60DAT | 60-80DAT |
| Nitrogen level (kg/ha) | | | | | | | |
| N0* | 0.83 | 3.43 | 4.05 | 0.96 | 4.5 | 8.4 | 6.5 |
| N60 | 0.99 | 3.73 | 4.17 | 1.15 | 6.1 | 13.4 | 14.7 |
| N120 | 1.15 | 3.97 | 4.36 | 1.41 | 6.7 | 14.6 | 14.2 |
| N180 | 1.39 | 4.28 | 4.76 | 1.70 | 8.1 | 17.8 | 14.3 |
| N240 | 2.00 | 4.71 | 5.43 | 2.01 | 9.6 | 20.6 | 14.4 |
| SEm(±) | 0.045 | 0.075 | 0.106 | 0.050 | 0.22 | 0.32 | 0.35 |
| CD(P=0.05) | 0.130 | 0.217 | 0.307 | 0.144 | 0.63 | 0.92 | 1.01 |
| Time of homo-brassinolides application | | | | | | | |
| AT | 1.27 | 3.99 | 4.34 | 1.18 | 6.3 | 12.2 | 12.8 |
| AT+PI | 1.27 | 4.00 | 4.56 | 1.57 | 7.4 | 14.9 | 12.7 |
| AT+PI+FI | 1.28 | 4.08 | 4.75 | 1.58 | 7.3 | 17.7 | 12.9 |
| SEm(±) | 0.035 | 0.058 | 0.082 | 0.039 | 0.17 | 0.25 | 0.27 |
| CD(P=0.05) | NS | NS | 0.237 | 0.112 | 0.49 | 0.72 | NS |

and lowest number of tillers $m^{-2}$ were recorded in crop at only one spraying at active tillering (AT). Similar type of result was reported by Bera and Pramanik (2013). Nitrogen level exerted significant effect on LAI, DMA and CGR in the hybrid at all the growth stages. Maximum LAI, DMA and CGR were recorded in crop at high nitrogen level ($N_{240}$); but were comparable to those obtained at its immediate fertility level ($N_{180}$). Both the above nitrogen levels produced significantly higher values of LAI, DMA and CGR than those recorded at lower nitrogen levels ($N_0$ and $N_{60}$) at most of the stages (Tables 2 and 3). Rice hybrid at low nitrogen ($N_0$) produced the lowest values of LAI, DMA and CGR as compared to those at all other nitrogen levels at most of the growth stages. Higher nitrogen levels ($N_{240}$ and $N_{180}$) increased DMA by 41 to 110% over low nitrogen level ($N_0$) at different stages due to increased CGR. Wang *et al.* (2001) noticed that moderate LAI (5.0) functioning for longer duration was more important than maximum LAI functioning for short period on influencing the crop productivity. High LAI at higher nitrogen levels functioning during tillering to flowering resulted in high CGR that caused further increase in DMA during the reproductive period leading high crop productivity. The results corroborate the findings of Peng *et al.*, (2002) and Huang *et al.* (2008).

The highest values of LAI and DMA was recorded at the thrice spraying of homo-brassinolide (AT+PI+FL) and was significantly greater than what obtained at the one spraying of homo-brassinolide spraying (AT) at most of the growth stages. The highest CGR value was recorded at the thrice spraying of homo-brassinolide (AT+PI+FL), but were comparable to that of the twice spraying of homo-brassinolide (AT+PI) in most of the cases. The lowest values of LAI, DMA and CGR of both hybrids were produced by the crop at the only one spraying of homo-brassinolide (AT) at most of the growth stages (Tables 2 and 3). The results corroborate the findings of Rao *et al.* (2002).

### *Yield components*

Hybrid rice responded well to nitrogen level in improving the yield components. All the yield

**Table 3. Effect of nitrogen level and time of homo-brassinolide application on dry matter accumulation (DMA) at different stages of hybrid rice**

| Treatments | DMA ($gm^{-2}$) | | | |
|---|---|---|---|---|
| | 20 DAT | 40DAT | 60DAT | 80DAT |
| Nitrogen level (kg/ha) | | | | |
| N0* | 109.3 | 198.9 | 366.2 | 497.0 |
| N60 | 117.9 | 240.1 | 508.6 | 802.1 |
| N120 | 133.7 | 267.8 | 559.7 | 843.8 |
| N180 | 145.3 | 307.8 | 663.7 | 948.9 |
| N240 | 153.6 | 346.2 | 757.1 | 1044.9 |
| SEm(±) | 2.5 | 4.6 | 5.3 | 3.9 |
| CD(P=0.05) | 7.2 | 13.3 | 15.3 | 11.3 |
| Time of homo-brassinolides application | | | | |
| AT | 129.9 | 255.6 | 499.0 | 754.6 |
| AT+PI | 131.3 | 279.5 | 578.1 | 833.4 |
| AT+PI+FL | 134.8 | 281.4 | 636.0 | 894.0 |
| SEm(±) | 1.9 | 3.6 | 4.1 | 3.1 |
| CD(P=0.05) | NS | 10.4 | 11.8 | 8.9 |

components like number of panicles $m^{-2}$, panicle length, number of spikelets and filled grains $panicle^{-1}$, percentage of filled grain and test weight increased steadily up to the application $N_{180}$ and were comparable to $N_{240}$ (Table 4). Both $N_{180}$ and $N_{240}$ recorded significantly higher number of panicles $m^{-2}$, longer panicle length, greater number of spikelets and filled grains $panicle^{-1}$, higher percentage of filled grain and greater test weight than what obtained at lower nitrogen levels ($N_{120}$, $N_{60}$ and $N_0$). The crop at low nitrogen level ($N_0$) produced the lowest values of all the yield components, but was comparable to those obtained at $N_{120}$ and $N_{60}$ in most of the cases during the study. The tropical rice hybrids are panicle size and require adequate nutrition like nitrogen for producing higher number of large size panicles (Buresh *et al.*, 2005). Application of lower dose of nitrogen ($N_{60}$ and $N_0$) did not mitigate the nutrient need of the crop particularly during its reproductive period resulting in lower number of spikelets and filled grains $panicle^{-1}$ with low test weight due to its adverse affect on grain filling of hybrid rice. The results are in conformity with the findings of Hu *et al.*, (2007) and Huang *et al*. (2008). Spraying of homo-brassinolide showed significant effect on all the yield components of hybrid rice. Spraying of homo-brassinolide at AT+PI+FL and AT+PI recorded significantly higher number of panicles $m^{-2}$, longer panicle length, greater number of spikelets and filled grains $panicle^{-1}$, higher percentage of filled grain and greater test weight than what obtained at only one application of spraying of homo-brassinolide at active tillering stage. The crop at single application of homo-brassinolide produced the lowest values of all the yield components. Similar type of results were reported by Sakamoto *et al*. (2006) and Bera and Pramanik (2012).

*Crop productivity*

The nitrogen level exerted significant effect on grain yield, straw yield and harvest index (HI) of hybrid rice. The highest grain yield (6116 kg $ha^{-1}$) was produced in crop receiving $N_{180}$ nitrogen level (180 kg N $ha^{-1}$); whereas, the highest straw yield (8170kg

**Table 4. Effect of nitrogen levels and time of homo-brassinolide application on yield components of hybrid rice**

| Treatment | No. of panicles $m^{-2}$ | Panicle length (cm) | Spikelets $Panicle^{-1}$ | No. of filled grains $panicle^{-1}$ | Fertility % | Test wt (g) |
|---|---|---|---|---|---|---|
| Nitrogen levels(kg/ha) | | | | | | |
| N0 | 295.8 | 23.7 | 174.3 | 131.5 | 75.2 | 22.7 |
| N60 | 313.7 | 24.8 | 176.2 | 143.7 | 81.4 | 22.9 |
| N120 | 329.1 | 25.3 | 183.2 | 155.0 | 84.4 | 23.4 |
| N180 | 371.4 | 26.3 | 198.8 | 184.3 | 92.5 | 23.6 |
| N240 | 371.0 | 25.6 | 189.3 | 146.2 | 76.8 | 23.4 |
| SEm(±) | 7.6 | 0.3 | 3.2 | 3.3 | 0.7 | 0.1 |
| CD(P=0.05) | 22.4 | 0.8 | 9.2 | 9.5 | 2.1 | 0.3 |
| Time of homo-brassinolide application | | | | | | |
| AT | 305.46 | 24.06 | 167.92 | 133.29 | 79.01 | 22.68 |
| AT+PI | 340.40 | 25.59 | 187.35 | 154.53 | 82.35 | 23.62 |
| AT+PI+FL | 362.86 | 25.85 | 197.96 | 168.67 | 84.97 | 23.43 |
| SEm(±) | 5.89 | 0.23 | 2.48 | 2.55 | 0.58 | 0.08 |
| CD(P=0.05) | 17.36 | 0.67 | 7.18 | 7.90 | 1.68 | 0.23 |

**Table 5. Effect of nitrogen level and time of homo-brassinolide application on productivity of hybrid rice**

| Treatment | Grain yield (kg $ha^{-1}$) | Straw yield (kg $ha^{-1}$) | Harvest index (%) |
|---|---|---|---|
| Nitrogen levels (kg/ha) | | | |
| N0 | 3096 | 5018 | 38.17 |
| N60 | 4288 | 6091 | 41.39 |
| N120 | 5166 | 6702 | 43.59 |
| N180 | 6116 | 7840 | 43.85 |
| N240 | 5522 | 8170 | 40.35 |
| SEm(±) | 38 | 142 | 0.40 |
| CD(P=0.05) | 111 | 411 | 1.16 |
| Time of homo-brassinolide application | | | |
| AT | 4616 | 6428 | 41.50 |
| AT+PI | 4808 | 6822 | 41.01 |
| AT+PI+FL | 5090 | 7403 | 41.90 |
| SEm(±) | 29 | 110 | 0.31 |
| CD(P=0.05) | 85 | 318 | NS |

Homo-brassinolide spraying played an important role in regulating the grain and straw yield of hybrid rice. The highest grain yield (5090 kg $ha^{-1}$) was recorded in crop grown at thrice spraying of homo-brassinolide at AT+PI+FL. Twice spraying of homo-brassinolide at AT+PI also produced significantly higher grain yield (4806 kg $ha^{-1}$) than what obtained at only one spraying of homo-brassinolide at active tillering stage (4616 kg $ha^{-1}$). The straw yield increased steadily and significantly up to the thrice spraying of homo-brassinolide (7403 kg $ha^{-1}$) which was significantly superior to that obtained at other homo-brassinolide spraying. The lowest grain and straw yields were obtained from the crop at only one spraying of homo-brassinolide. HI did not show significant response to spraying of homo-brassinolide. The results are in conformity with those of Wu *et al.* (2008), Dey *et al.* (2012) and Bera and Pramanik (2012).

## Conclusion

From the present study, it is clear that both nitrogen and homo-brassinolide had significant effect on the growth, yield components and yield of hybrid rice. Application of 180 kg N $ha^{-1}$ and homo-brassinolide spraying at active tillering + panicle initiation + flowering stages resulted higher grain yield and straw yield.

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