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Effect of Planting dates and N levels on N concentration in the leaf, grain yield and N uptake by hybrid rice

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ABSTRACT

An experiment was conducted to find out grain yield, nitrogen concentration in the third leaf and nitrogen uptake by hybrid rice under different planting dates and nitrogen levels during 1999 and 2000. The hybrid rice planted on July 5 or 20 produced significantly higher nitrogen concentration in the third leaf, grain yield and nitrogen uptake by both grain and straw. The delayed planting between August 5 or 20 significantly reduced these crop parameters. The reduction in grain yield was to the extent of 14.06 and 28.23 %, respectively compared with planting of July 5. Number of effective tillers, grains panicle^{-1}, test weight, grain yield, N concentration in third leaf at different stages, nitrogen concentration and uptake by grain and straw increased significantly with increasing levels of nitrogen from 50 to 150 kg N ha^{-1}. Highest R^2 value has been observed for regression equation between N concentration in third leaf at 60 DAT and grain yield.

Key words: *Planting date, N level, N concentration in third leaves, Grain yield and N uptake, hybrid rice*

The yield improvement associated with hybrid rice necessitates for development of appropriate cultural management practices to achieve the potential yield. The Chinese hybrid rice experience has shown that the yield potential of hybrid rice can only be achieved, if each eco region develops its own hybrids or screens hybrids developed in other regions to meet specific local conditions (Justin *et al*, 1994). However, climatic factors i.e. temperature and solar radiation influences grain yield of rice hybrids. The amount of stem reserves allocated to the grain, the rate of dry matter production in the grain filling period, and the length of the grain filling period mainly determines the potential of a rice hybrids (Kropff *et al*, 1994). But it can only be attained if favourable temperature, solar radiation and N supply is maintained by planting the crop in appropriate time and maintaining favorable N supply environments in soil system. Although variation in climatic parameters makes it difficult to decide optimum planting times for hybrid rice, but attempt is needed to find most appropriate time of growing hybrid rice in order to avoid the risk in hybrid rice cultivation. The leaf N status is a pivotal parameter, because the rate of photosynthesis production in leaf under light saturated condition is a linear function of leaf N concentration (Cook and Evans, 1983). The minimum leaf N concentration at each point of crop growth, supports sufficient leaf area development, photosynthesis and grain yield. Moreover, efficiency of N in hybrid rice is greater than conventional rice, but to make soil environment favourable for N absorption by plant, sufficient amount has to be supplied in soil system. Therefore, experiment was undertaken to study the effect of planting date and N levels on N concentration in third leaf, yield and N uptake of hybrid rice.

MATERIALS AND METHODS

The field experiment was conducted during wet season of 1999 and 2000 at Indira Gandhi Agriculture University, Raipur, Chhattisgarh. The soil of the experimental field was neutral in reaction (pH 6.9) having organic carbon content of 0.52%. Available N, P and K content of the soil was 218, 37 and 317 kg ha^{-1}, respectively. In all, 12 treatment combinations consisted of 4 planting date and 3 nitrogen levels were laid out in split plot design with 3 replications having planting dates as main and N levels as sub plot treatments. The 4 planting dates were July 5, July 20, August 5 and August 20 and 3 N levels were 50, 100

and 150 kg N ha^{-1}. An uniform dose of 75 kg P_2O_5 and 60 kg K_2O ha^{-1} was supplied to the crop. The whole amount of P and K was given as basal while, N was supplied 40% as basal, 25% at active tillering, 25% at panicle initiation stage and 10% at flowering. Twenty-one days old seedlings of rice hybrid ProAgro 6201 were planted at the spacing of 20x15 cm in the experiment. The saturation to continuous submergence of 5±2 cm water was maintained throughout the crop period and plots were kept weed free. Nitrogen concentration in leaf, grain straw and soil was analysed. Third leaf from the top was randomly selected from each plot for analysis of N concentration. The heat unit (^oC) at different crop growth stages was calculated as described by Nagai (1962).

RESULTS AND DISCUSSION

Planting of hybrid rice on July 5 and July 20 being at par produced significantly higher grain yield than that of delayed planting on August 5 and 20 (Table 1). Hybrid rice planted on August 20 reduced the grain yield by 23.23% (based on pooled mean) compared with that planted on July 5. The reduction in grain yield due to planting on August 5 was to the extent of 14.06%. The delayed planted hybrid rice was affected by decreased temperature throughout growth period (Table 2). The total heat unit (^0C) availed by hybrid rice were 3989 and 3931 by planting on July 5; 3506 and 3570 by planting on July 20; 2920 and 3286 by planting on August 5 and 2738 and 3023 ^0C by August planting on 20 during first and second year, respectively (Table 2). The reduced yield at planting on August 5 and 20 was mainly associated with the significant reduction in effective tillers, number of filled grain and test weight. The sterility percentage also increased under planting of hybrid rice on August 5 and August 20 as compared to earlier plantings. The results are in agreement with the findings of Lakpale *et al*. (1995). The harvest index of hybrid rice significantly reduced at planting on August 5 as compared to planting on July 5 or 20.

Table 1. Effect of planting dates and nitrogen levels on yield components and grain yield of hybrid rice (Pooled data of 1999 and 2000)

Treatments	Effective tillers m^{-2} (No)	Filled grains $earhead^{-1}$ (No)	1000 grain weight (g)	Sterility (%)	Grain yield (q ha^{-1})	Harvest Index
Planting dates						
5 July	255	146	23.75	25.68	63.97	0.45
20 July	252	143	23.61	27.21	61.94	0.44
5 August	240	129	23.08	32.59	55.91	0.44
20 August	223	123	22.55	34.35	49.73	0.42
CD (P=0.05)	6.50	4.95	0.30	4.50	2.70	0.01
Nitrogen levels (kg ha^{-1})						
50	218	123	22.91	27.48	42.71	0.43
100	249	134	23.44	29.40	62.33	0.44
150	266	148	23.79	33.92	68.71	0.44
CD (P=0.05)	3.15	3.80	0.28	3.98	2.40	NS

Table 2. Effect of planting dates on heat unit (^0C) at different growth stages of hybrid rice

Planting dates	Crop Stages									
	S-T		T-MT		MT-F		F-M		Total	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
5 July	1071	905	1209	1238	617	654	1082	1133	3989	3931
20 July	882	872	1137	1188	585	608	902	902	3506	3570
5 August	868	881	966	1241	413	453	673	711	2920	3286
20 August	846	881	905	1136	306	369	681	637	2738	3023

S - seeding ; T - transplanting ; MT - maximum tillering ; F - 50% flowering; M – maturity

In general, the N concentration in third leaf from top was the maximum at 30 DAT and decreased successively upto 90 DAT (Table 3). The decline in N concentration could be due to translocation of N to plant parts including grains especially at later stage (Watselava and Farquhar, 1980). Significant difference in N concentration in third leaf from top was observed due to varied planting times. Planting of hybrid rice on July 5 or 20 produced significantly higher N concentration than that of later plantings (August 5 or 20) at all stages. The drastic reduction in N content in third leaf of hybrid rice was observed, when planted on August 20, which was significantly lower than earlier planting times. The findings are in agreement with the results of Verma *et al*. (2004). The photosynthesis in plant is linearly related with N concentration in leaf because N is an essential constituent of chlorophyll (Black, 1992). Moreover, radiation use efficiency for Co_2 assimilation depends upon the N concentration in leaf and new leaf area developed only when there is enough N (Sinclair, 1990). This fact led to increase leaf area index of hybrid rice at planting on July 5 or 20 as compared to delayed planting.

Delayed plantings between August 5 to 20 significantly reduced N concentration and uptake by grain and straw (Table 4). The planting of hybrid rice on July 5 or 20 found to be equally effective for N concentration and uptake in grain and straw due to increased concentration and dry matter production as also reported by various workers. The N status in soil at harvest significantly increased while planting of hybrid rice on August 20 as compared to earlier planting due to reduced uptake of N from the soil.

Number of effective tillers, number of filled grains and test weight were significantly increased with increase in levels of N from 50 to 150 kg N ha^{-1} (Table 1). The increase in above yield components due to application of 150 kg N ha^{-1} significantly increased the grain yield of hybrid rice. The intensity and capacity of the soil to supply nitrogen to hybrid rice was met by application of 150 kg N ha^{-1} thus increased yield components and grain yield. The leaf area index also increased with increasing levels of N from 50 to 150 kg N ha^{-1} at 30 and 60 days after planting. The application 50 kg N ha^{-1} produced the lowest sterility percentage, which was significantly lower than that of highest level of N application. The increase in yield attributes and grain yield due to N fertilization has also reported by Pandey *et al*. (1992).

Nitrogen concentration in third leaf from the top of hybrid rice was significantly increased with increase in levels of N from 50 to 150 kg ha^{-1} (Table 3). Application of 150 kg N ha^{-1} maintained N concentration to the extent of 3.18% and 3.36% at 30 DAT; 2.62% and 2.58% at 60 DAT and 1.25% and 1.22% at 90 DAT, respectively in 1999 and 2000. The reduction in N concentration in leaf indicated that application of lower N levels (50 or 100 kg N ha^{-1}) was insufficient to meet N requirement for absorption and metabolism by hybrid rice thus resulted in lower

Table 3. Effect of planting dates and nitrogen levels on leaf area index (LAI) and N concentration in third leaf form the top of hybrid rice

Treatments	LAI				N concentration in third leaf (%)					
	30 DAT		60 DAT		30 DAT		60 DAT		90 DAT	
	1999	2000	1999	2000	1999	2000	1999	2000	1999	2000
Planting dates										
5 July	1.90	1.80	5.40	5.45	3.28	3.21	2.55	2.48	1.20	1.17
20 July	1.84	1.73	5.38	5.47	3.23	3.18	2.50	2.46	1.18	1.15
5 August	2.16	2.22	5.24	5.28	2.73	2.98	2.35	2.29	1.11	1.09
20 August	1.98	2.00	5.65	5.63	2.59	2.82	2.25	2.18	1.08	1.03
CD (P=0.05)	0.17	0.05	0.12	0.12	0.05	0.04	0.06	0.05	0.03	0.007
Nitrogen levels (kg ha^{-1})										
50	1.78	1.86	4.32	4.99	2.63	2.60	2.12	2.09	1.01	1.00
100	2.01	2.21	5.61	5.17	3.05	3.18	2.51	2.39	1.16	1.12
150	2.40	2.45	6.34	5.69	3.18	3.36	2.62	2.58	1.25	1.22
CD (P=0.05)	0.34	0.04	0.62	0.08	0.03	0.04	0.05	0.05	0.04	0.05

Table 4. Effect of planting dates and nitrogen levels on N concentration and uptake by grain and straw of hybrid rice

Treatments	Grain N Concentration (%)	Grain N Uptake (kg ha^{-1})	Straw N Concentration (%)	Straw N Uptake (kg ha^{-1})	Soil available N at harvest(kg ha^{-1})
Planting dates					
5 July	1.44	93.26	0.36	29.27	224.00
20 July	1.43	89.16	0.35	27.24	227
5 August	1.36	76.52	0.30	21.34	232
20 August	1.31	66.05	0.25	17.10	288
CD (P=0.05)	0.06	8.92	0.04	3.53	5.45
Nitrogen levels (kg ha^{-1})					
50	1.31	55.85	0.23	13.11	218
100	1.40	87.41	0.33	25.31	230
150	1.45	100.47	0.38	32.78	242
CD (P=0.05)	0.04	4.88	0.04	2.89	4.94

concentration in leaves. The regression equation between grain yield and N concentration in third leaf at 30, 60 and 90 DAT has been given in Fig. 1,2 and 3. The close relationship between N concentration at all the stages and grain yield has been depicted. However, among them the highest R^2 value was observed between N concentration at 60 DAT and grain yield followed by 90 DAT and 30 DAT, respectively. The N concentration and uptake by both grain and straw increased significantly with increase levels of N from 50 to 150 kg ha^{-1} (Table 4). The N status in soil also increased significantly due to application of nitrogen up to 150 kg N ha^{-1} as also reported by Pandey *et al.* (1992).

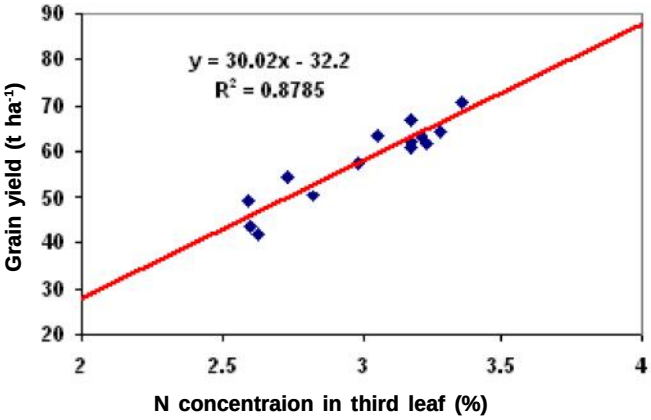

Fig. 1. Relationship between N concentration in third leaf at 30 DAT and grain yield of hybrid rice wet season

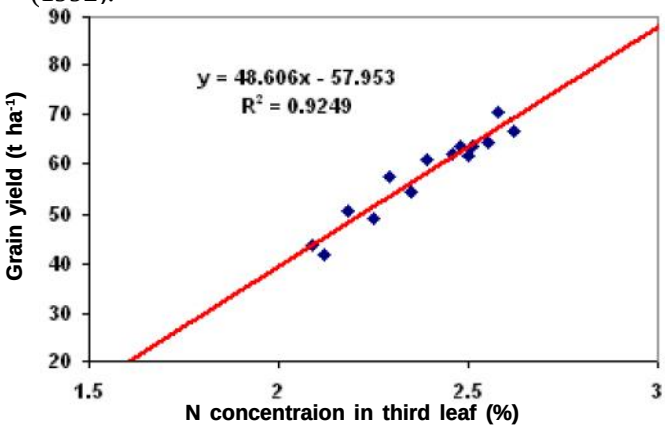

Fig. 2. Relationship between N concentration in third leaf at 60 DAT and grain yield of hybrid rice wet season

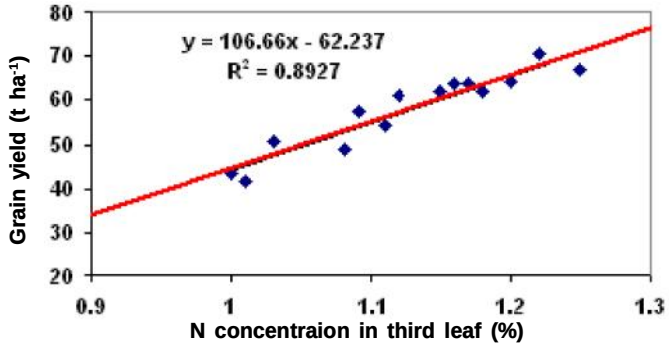

Fig. 3. Relationship between N concentration in third leaf at 90 DAT and grain yield of hybrid rice wet season

Thus planting of hybrid rice between July 5 and 20 along with 150 kg N maintained sufficient N concentration in third leaf of hybrid rice and increased grain yield during wet season.

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