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Drymatter production and nutrient uptake in rice (*Oryza sativa* L.) hybrids

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Abstract: An experiment was conducted to study the drymatter production and nutrient uptake of rice hybrids at S.V.Agricultural College, Tripathi during *Rabi* season 2000. Among the cultivars, TNRH 16 recorded maximum dry matter (1164 gm^{-2}), grain yields (6470 kg ha^{-1}) and heterosis (28%) followed by DRRH 1 (1089 gm^{-2}, 5750 kg ha^{-1} and 19.5%). Although cultivars MGR 1 and KHR 1 produced lowest amount of dry matter, the proportion of drymatter gone into reproductive structure was high (52%) compared to other two high yielding hybrids (TNRH 16 and DRRH 1) with below 40%. The dry matter accumulated in different plant parts at maturity was 14.35% in root, 9.34% in leaf, 31.2% in stem and 45% in reproductive structures. Maximum uptake of nitrogen, phosphorus and potassium (144,21,126 NPK kg ha^{-1}) was recorded in TNRH 16 followed by DRRH 1 (134, 20, 97 NPK kg ha^{-1}). The amount of drymatter needed to produce 100 kg of seed contained 1.7 to 2.4 kg N, 0.27 to 0.34 kg P and 1.0 to 2.1 kg K.

Keywords : Drymatter production, Nutrient uptake and Rice hybrids.

Introduction

The yield obtained for any crop is the net result of photosynthetic productivity and the nutrient uptake. The efficient genotypes will have an efficient photosynthetic productivity and also an efficient nutrient uptake for which genetic variation may exist. In a given environment the physiological performance like partitioning of drymatter and mineral nutrients to the economic product of different genotypes will indicate some of the characters, which are essentially involved in contributing to higher yield. Further nutrient uptake of a variety is a useful guide for its fertilizer management. The heterosis was greatest for nitrate N uptake in F1 compared with conventional cultivars (Cheng and Cheng, 1989). Hence, the present investigation was planned to study the drymatter accumulation and nutrient uptake in rice hybrids.

Materials and Methods

A field experiment was conducted at Wetland farm of S.V.Agricultural College, Tirupati Andhra Pradesh (13°N, 79°E) during *Rabi*, 2000. The soil was sandy loam containing 211, 31.8, and 178 kg ha^{-1} of available N, P_2O_5 and K_2O, respectively. The rice hybrids MGR 1, APHR 2, KHR 1 NLR 33358 (Check), TNRH 16 and DRRH 1 were sown in a randomized block design with four replications. The experimental plots were (4m x 5m) fertilized with 120, 60, 45 NPK kg ha^{-1}. The seedlings were transplanted on 25th December 2000 at a spacing of 20 cm x 10 cm. Plants samples from an area of 0.5 m^2 were dug along with roots at 30 days interval from 30 DAT. The plants were separated into root, leaf, stem and panicles and were dried in a hot air oven at 100°C for 5 minutes and then at 80°C for 48 hours. The nitrogen present in different plant parts was analyzed by microkjeldhal method (AOAC, 1970) and phosphorus and potassium by standard procedures (Piper, 1950).

Results and Discussion

There was a gradual increase in dry matter from 30 DAT to maturity in all the hybrids (Table 1). At 30 DAT, KHR1 recorded maximum total dry matter (198 gm^{-2}) while NLR 33358 and TNRH 16 recorded maximum TDM (659 and 1164 gm^{-2}) at 60 and 90 DAT, respectively. The partitioning of dry matter towards stem was more (41-49%) compared to leaf (37-42%) in all the hybrids at 30 DAT. The drymatter

accumulation in stem increased upto 60 DAT and then showed a decrease in all the cultivars indicating retranslocation of photosynthates even from the stem to the developing grains. At low nitrogen levels large amount of carbohydrate accumulates in the vegetative parts before heading and contribute substantially to the grain carbohydrate (Yoshida and Ahn, 1968). TNRH 16 recorded highest drymatter accumulation in stem compared to other cultivars. The leaf drymatter accumulation was decreased from 60 DAT. The fall in leaf phytomass during subsequent stages of growth may be due to senescence and translocation of photosynthates to the developing grains. In rice, all the leaves from the flag leaf down to the third leaf from the top export assimilates to the panicles (Tanaka, 1958). It is desirable to have higher drymatter content in leaves at the time of grain filling stage to obtain maximum yields. Among the hybrids, TNRH 16 maintained high leaf dry weight (10.4%) at grain filling stage and hence it produced maximum grain yield.

Total drymatter that can be produced and its further trans location to sink are the major factors that govern the economic performance of a crop/

Table 1. Drymatter accumulation and partitioning during plant growth (g/m²) in rice hybrids

Cultivars	30 DAT				60 DAT					90 DAT				
	TDM (g/m²)	Dry matter partition (%)			TDM (g/m²)	Dry matter partition (%)				TDM (g/m²)	Dry matter partition (%)			
		R	L	S		R	L	S	G		R	L	S	G
MGR 1	137	13.8	42.2	44.0	477	22.1	16.9	46.0	15.0	755	14.2	9.6	24.4	51.8
		21.8*	40.5*	41.5*		28.0*	24.3*	42.7	22.9*		22.1*	18.0*	30.0**	46.0*
APHR 2	130	16.9	41.9	41.2	542	32.6	16.8	38.0	12.6	859	12.6	9.0	30.7	47.7
		24.3*	40.3*	39.9*		34.8*	24.2*	38.1*	21.0*		21.1*	17.5*	33.6*	43.7*
KHR 1	198	18.7	31.8	49.5	559	29.9	16.7	41.2	12.2	774	14.4	9.2	25.3	51.1
		25.6*	34.3*	44.7*		33.2*	24.1*	39.9*	20.4*		22.3*	17.7*	30.2*	45.6*
NLR 33358	121	21.2	37.8	41.0	659	24.3	15.6	53.0	7.1	968	16.0	7.9	33.1	43.0
		27.4*	37.9*	39.9*		29.5*	23.3*	46.7*	15.5*		23.6*	16.3*	35.1*	41.0*
TNRH 16	112	16.2	37.2	46.6	636	27.6	21.5	48.5	2.4	1164	12.7	10.4	39.3	37.6
		23.7*	37.6*	43.1*		31.7*	27.6*	44.1*	8.9*		20.9*	18.8*	38.8*	38.0*
DRRH 1	113	18.7	48.0	33.3	582	28.5	15.9	52.8	2.8	1089	16.2	9.9	34.4	39.5
		25.7*	43.9*	35.2*		32.3*	23.5*	46.6*	9.6*		23.7*	18.3*	36.0*	38.9*
CD 5%	6.66	NS	3.2	3.00	97.3	3.50	NS	5.56	3.60	50.84	NS	NS	3.01	3.09

TDM : Total Dry Matter. * : Denote arcsine percentage transformed values R : Root S : Stem L : Leaf G : Grain DAT : Days After Transplanting

Table 2. Nitrogen, phosphorus and potassium uptake (kg ha^{-1}) in rice hybrids

Cultivars		30 DAT				60 DAT					90 DAT				
		R	L	S	T	R	L	S	G	T	R	L	S	G	T
MGR 1	N	2.6	17.1	11.8	31.5	5.7	15.4	21.5	9.4	52.0	4.0	13.8	11.3	62.9	91.2
	P	0.2	1.4	1.0	2.6	1.5	2.3	4.6	1.5	9.9	0.9	1.1	2.2	9.4	13.6
	K	2.3	9.4	10.8	22.5	13.8	13.8	39.7	4.5	71.8	6.5	9.5	24.4	12.1	52.5
APHR 2	N	3.2	16.9	10.6	30.7	11.5	24.2	20.4	10.5	66.6	4.5	16.3	18.6	69.6	109.0
	P	0.3	1.5	0.8	2.6	2.8	2.7	4.5	1.5	11.6	1.1	1.2	2.9	10.6	15.8
	K	2.5	10.1	9.2	21.8	22.1	16.6	39.3	5.6	83.6	7.8	10.7	37.4	13.5	69.4
KHR 1	N	4.3	18.0	17.9	40.2	12.0	24.8	19.4	9.8	66.0	5.0	15.7	12.5	64.9	98.1
	P	0.5	1.7	1.5	3.8	2.8	2.7	4.1	1.4	11.0	1.2	1.0	1.8	9.9	13.9
	K	3.8	10.2	15.8	29.9	21.0	16.4	42.0	4.9	84.3	6.5	9.7	26.4	11.5	54.0
NLR 33358	N	3.8	13.4	8.5	25.7	9.9	25.1	34.3	5.7	75.0	5.0	13.9	25.6	68.1	112.7
	P	0.4	1.1	0.7	2.2	2.7	2.8	6.6	0.9	13.0	1.4	0.9	3.2	9.1	14.6
	K	2.6	6.9	7.2	16.7	20.0	16.6	61.0	3.0	100.6	9.1	10.2	40.1	11.2	70.6
TNRH 16	N	2.8	13.3	10.9	27.0	16.0	37.7	32.3	4.2	90.2	7.7	29.1	31.1	76.6	144.5
	P	0.3	1.1	1.0	2.4	4.2	4.8	9.5	0.5	19.0	1.8	2.2	5.0	12.3	21.3
	K	2.2	7.1	10.0	19.3	25.4	26.3	76.4	1.6	129.7	8.9	23.6	77.8	15.8	126.1
DRRH 1	N	3.2	17.0	7.5	27.7	14.4	25.0	30.4	4.2	73.7	9.0	27.8	24.4	73.6	134.0
	P	0.3	1.4	0.7	2.4	3.5	2.9	8.3	0.4	15.1	1.9	2.0	4.5	11.6	20.0
	K	2.4	9.1	6.7	18.2	21.4	17.7	61.5	1.5	102.1	1.0	17.8	54.1	14.6	97.1
CD 5%	N	NS	2.13	3.43	1.59	1.85	3.12	1.89	1.73	0.64	1.0	2.11	2.85	1.13	0.99
	P	0.12	0.30	0.34	0.14	1.01	0.35	1.24	0.32	0.74	0.4	0.23	1.01	1.20	1.04
	K	0.20	0.90	1.80	0.61	0.90	1.20	2.10	0.22	1.00	0.7	1.11	1.54	0.40	0.90

N : Nitrogen; P : Phosphorus; K : Potassium; DAT : Days After Transplanting

variety. Higher drymatter production in TNRH 16 than other hybrids can be attributed to more leaf area index and leaf area duration and better growth rates recorded with this hybrid. Similar increment in drymatter in case of rice hybrids over check varieties was reported by IRRI (1989). Although cultivars MGR 1 and KHR 1 produced the lowest amount of drymatter the proportion of drymatter gone into reproductive structures was 52%, whereas in other two high yielding hybrids (TNRH 16 and DRRH 1) the proportion was below 40%. This suggests that hybrid MGR 1 and KHR 1 had a good partitioning ability towards the repro-ductive structures. The present study confirms views of Fisher and Turner (1978) that the genotypes exerts major control over partitioning. The drymatter accumulated in different plant parts at maturity was 14.35% in root, 9.34% in leaf, 31.21% in stem and 45.09% in reproductive structures.

The uptake of nitrogen phosphorus and potassium by root, leaf and stem gradually increased from 30 to 60 DAT and thereafter decreased towards maturity in all the cultivars (Table 2). But the uptake of N, P and K by grain increased gradually upto 90 DAT in all the cultivars. The total N,P,K uptake was maximum at 90 DAT in all the cultivars. Among the cultivars, TNRH 16 recorded maximum uptake of N in leaf (37.7 kg ha^{-1}) root (16.0 kg ha^{-1}) at 60 DAT compared to other cultivars but NLR 33358 recorded maximum N in stem (34 kg ha^{-1}) at 60 DAT. The decreased N, P, K uptake in root, leaf and stem after 60 DAT might be due to retranslocation of nutrient (NPK) from vegetative to reproductive sink. Similarly decrease in nitrogen content in shoo during reproductive stage was also observe by Samantaray *et al.* (1990) in rice. Subbia and Prasada Rao (1983) reported that the uptak of K by high yielding variety upto flowerin and thereafter decreased continuously.

There was a significant difference betwee the rice hybrids for grain yield (Table 3). Among the hybrids, TNRH 16 recorded maximum grain yield of 6470 kg ha^{-1} followed by DRRH1 (5750 kg ha^{-1}). TNRH16 also showed higher standard heterosis of 28% over the check NLR 33358. Similar results were reported by Cheng and Cheng (1989) in rice. The TNRH-16 which produced maximum drymatter was found to contain 144.5 N, 21.3 P and 126.0 K kg ha^{-1} (Table 3). In a similar study by Agrawal (1980) also found 80 kg N, 18 kg P_2O_5 100 kg K_2O in a crop of rice yielding 5000 kg of grain ha^{-1}. Even though the total uptake of N, P and K is more by a rice crop, the amount of drymatter needed to produce 100 kg of seed contained only 1.7 to 2.4 kg N, 0.27 to 0.34 kg P and 1.0 to 2.1 kg K (Table 3). While this requirement was more in other crops like horsegram with 8 to 13 kg N, 0.6 to 1.0 kg P and 3 to 4 kg K (Annapurnamma *et al.* 1989). In all the cultivars, the partitioning of N and P was more towards reproductive structures while the partitioning of K was more towards stem. This finding indicates that among the rice hybrids

Table 3. Yield and heterosis in rice hybrids

Cultivars	Grain yield (kg ha^{-1})	Heterosis (%)	Requirement of NPK to produce 100 kg of grain (kg)		
			N	P	K
MGR 1	4775	3.0	1.9	0.28	1.0
APHR 1	5362	13.0	1.7	0.29	1.2
KHR 1	5062	8.5	1.9	0.27	1.0
NLR-33358	4627	-	2.4	0.31	1.5
TNRH 16	6470	28.0	2.2	0.32	1.9
DRRH 1	5750	19.5	2.3	0.34	2.1
CD 5%	946	-	-	-	-

studied, TNRH 16 produced higher drymatter and maximum uptake of N, P and K.

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