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Effect of Nitrogen Rates on Dry Matter Remobilization of Three Rice Cultivars

[1]S. Shokri, [1]S.A. Siadat, [1]Gh. Fathi, [1]B. Maadi, [2]A. Gilani and [1]A.R. Abdali Mashhadi
[1]Department of Agronomy and Plant Breeding,
Ramin Agricultural and Natural Resources University, Ahwaz, Iran
[2]Agricultural Research Center, Ahwaz, Iran

Abstract: The aim of this study was to evaluate the effects of nitrogen fertilizer rates on dry matter remobilization among three rice cultivars. A field study was carried out at Ramin Agricultural and Natural Resources University. In 2007, a split plot experiment in the basis of randomized complete block design with three replications was used. Four nitrogen fertilizer rates (0, 100, 135 and 170 kg ha^{-1} from urea source) as the main plots and three rice cultivars (Champa, Anburi and LD183) as the sub plots were used. Results showed that nitrogen fertilizer rates had significant effect on dry matter remobilization amount in total shoot, stem and leaves in which among cultivars, LD183 had the highest amounts in terms of stem and total shoot dry matter remobilization. This amount was obtained at 0 kg ha^{-1} nitrogen fertilizer treatment. The highest rate of dry matter remobilization in leaves (except flag leaf) related to LD183 that obtained in 170 kg ha^{-1} nitrogen fertilizer level. Also, flag leaf of LD183 had the highest dry matter remobilization amount, although was not affected by nitrogen fertilizer rate. Thus, it seems that this part has important role in current photosynthesis at post anthesis stage compared with dry matter remobilization. According to our findings, flag leaf in Champa not only has no significant role in dry matter remobilization, but also act as a powerful sink for photosynthetic assimilates.

Key words: Dry matter remobilization, nitrogen fertilizer, rice cultivars

INTRODUCTION

Rice (*Oryza sativa* L.) is an important primary crop in the world. It is a staple food for more than two third of the world's population (Singh, 1993). Nitrogen is an important component of rice production technology with high yielding cultivars and it's immense role in increasing rice productivity is well documented (Kumar and Prasad, 2004). Rate and timing of nitrogen are critical in terms of their effects on yield. Nitrogen increases plant height, panicle number, leaf size, spiklet number and number of filled spikelets (Doberman and Fairhurst, 2000). Two physiological processes are involved in grain growth: utilization of photosynthesis through current photosynthesis and remobilization and translocation of substance accumulated before anthesis (Sarvestani and Pirdashti, 2001). In rice, available carbon assimilates for grain growth is determined by carbon assimilation during filling period plus assimilates reserve stored in the straw (Ntanos and Koutroubus, 2002). Sarvestani and Pirdashti (2001) reported that dry matter and nitrogen remobilization of shoot (stem + leaf + flag + flag leaf) had an important effect on grain dry matter and nitrogen accumulation. Ntanos and Koutroubus (2002) reported that contribution of pre-anthesis accumulated

Corresponding Author: Sajjad Shokri, Ramin Agricultural and Natural Resources University, Ahwaz, Iran Tel: +98-916-9962400 Fax: +98-612-3222425

reserves to grain weight ranged from 9.1 to 42.2% indicating the importance of pre-anthesis storage of assimilated for attaining high grain yield of rice and grain filling was positively and significantly correlated with dry matter and nitrogen translocation efficiency. Also, cultural practices have a strong influence on translocation of assimilate during the grain filling period. Results of studies showed that remobilization of reserves to grain is critical for grain yield, if the plants are subjected to different treatments for example water stress during grain filling (Kumar *et al*., 2006). Recently, it has been proposed that grain filling is closely linked to the whole plant senescence process (Yang *et al*., 2000; Mi *et al*., 2002). Unfavorably delayed senescence, which in practice can be induced by either heavy use of nitrogen (N) fertilizer or adoption of lodging-resistant cultivars that stay green for too long (i.e., plants remain green when grains are due to ripen), results in a low grain-filling rate, leading too many poorly filled grains (Plaut *et al*., 2004; Cock and Yoshida, 1972; Ehdaie and Waines, 1996). The objective of present study was to determine the effects of nitrogen fertilizer rates on dry matter remobilization among different rice cultivars in South of Iran conditions.

MATERIALS AND METHODS

This study was conducted at Ramin Agricultural and Natural Resources University, Ahwaz, Iran (31° 36' N, 48° 53' E) in 2006-2007. the experiment arranged in split plot in the basis of randomized complete block design with three replications. Four nitrogen fertilizer levels (including 0, 100, 135 and 170 kg ha^{-1} from urea source) as the main plots and rice cultivars (including Anburi (traditional), LD183 (improved) and Champa) as sub plots were used. Phosphate and potassium fertilizers were applied at the rate 100 kg ha^{-1} before sowing. At the anthesis and the maturity, plants were collected and separated to different parts (including stem, flag leaf and other leaves) and then dried in 75°C for 72 h and weighed. Amount of dry matter remobilization accounted as followed:

$$\text{Amount of dry matter remobilization (g m}^{-2}\text{)} = \text{Amount of dry matter at anthesis-Amount of dry matter at maturity grain}$$

All data were analyzed with SAS Institute Inc. 6.12. All data were first analyzed by ANOVA to determine significant ($p \leq 0.05$) treatment effects. Significant differences between individual means were determined using grouped in Duncan multiple comparison test.

RESULTS

Results of analysis variance (Table 1) showed that nitrogen fertilizer management had significant effects on dry matter remobilization amount in total shoot, stem, flag leaf and

Table 1: Analysis of variance of effects nitrogen rates and variety on dry matter remobilization

SOV	df	Total shoot	Stem	Flag leaf	Other leave	Grain yield
Replication	2	4.00	2.28	2.25	28.38	266.19
Nitrogen rates	3	2435.35**	1414.10**	595.95**	3322.66**	590780.96**
Error (a)	6	5.97	16.69	2.21	5.64	336.49
Cultivar	2	1196754.52**	103225.23**	765.77**	11522.33**	861830.02**
Cultivar×Nitrogen rates	6	3026.47**	4415.57**	114.58**	341.15**	537252.76**
Error (b)	16	21.40	19.79	8.59	45.72	1328.20
CV		1.00	1.27	21.14	7.03	3.76

**,*Significant at the 5 and 1% levels of probability, respectively. ns: Non-significant

Table 2: Results of mean comparison of studied traits in Nitrogen fertilizer rates and cultivar

Treatments	Total shoot	Stem	Flag leaf (mg plant^{-1})	Other leave	Grain yield
Nitrogen fertilizer rates (kg ha^{-1})					
0	425.28ab	357.45a	9.73d	56.21d	1039.57d
100	421.31b	346.68b	12.83c	64.67c	1113.25c
135	423.64b	336.92c	17.12b	68.53b	1128.83b
170	430.62a	332.73d	20.83a	73.48a	1145.64d
Cultivar					
Champa	273.15b	198.63b	10.24c	63.78b	857.21b
Anburi	231.77c	161.15c	14.53b	56.91c	764.35c
LD183	769.22a	673.64a	20.63a	76.87a	1691.15a

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$), N_1, N_2, N_3 and N_4: Nitrogen fertilizer rates in levels 0, 100, 135 and 170 kg ha^{-1}

Table 3: Interaction effects of nitrogen fertilizer rates in cultivar

Treatments	Total shoot	Stem	Flag leaf (mg plant^{-1})	Other leave	Grain yield
N_1C_1	236.93i	177.81h	5.32h	51.46gh	836.72h
N_1C_2	194.42k	136.25j	9.12g	48.25h	745.13g
N_1C_3	844.95a	758.25a	15.32de	69.31d	1536.41d
N_2C_1	269.83g	195.42g	9.63g	65.50e	900.75e
N_2C_2	230.15j	165.13i	12.96fg	53.72g	820.24i
N_2C_3	764.41b	679.21b	17.50cd	75.56c	1620.35c
N_3C_1	282.63f	203.68f	12.25ef	68.69de	850.92f
N_3C_2	251.52h	175.54h	17.58cd	58.17f	755.19j
N_3C_3	731.75d	631.75c	21.60b	79.92b	1750.82b
N_4C_1	302.84e	217.48e	14.70de	70.31d	843.63g
N_4C_2	252.18h	167.71i	19.68bc	65.63e	736.52k
N_4C_3	737.41c	625.42d	28.25a	84.35a	1856.31a

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$), N_1, N_2, N_3 and N_4: Nitrogen fertilizer rates in levels 0, 100, 135 and 170 kg ha^{-1}, C_1, C_2 and C_3: Cultivar levels of Champa, Anburi and LD183

other leaves. Among cultivars and nitrogen fertilizer levels, LD183 (improved cultivar) and 170 kg ha^{-1} fertilizer level had the highest amount in terms of total shoot (430.62 and 769.22 mg per plant) dry matter remobilization, respectively (Table 2). Anburi (traditional cultivar) had least amount of dry matter remobilization from total shoot (Table 2). In this experiment interaction effect o f nitrogen fertilizer with cultivar was significant at 1% probability level (Table 1). The highest amount of dry matter remobilization obtained in LD183 with 0 kg ha^{-1} fertilizer level treatment (Table 3). Nitrogen fertilizer rate and cultivars had significant effect on dry matter amount dry matter amount from remobilized stem (Table 1). Among cultivars, LD183 had the highest amount of dry matter remobilization from stem (Table 2). This amount was obtained in 0 kg ha^{-1} nitrogen fertilizer (Table 3). Results also showed that stem part has an important role in remobilization than other parts (other leaves and flag leaf).

Flag leaf of LD183 had the highest dry matter remobilization among cultivars (Table 2). On the other hands, interaction effect of cultivar with nitrogen fertilizer was significant at 1% probability level (Table 1). Table 3 showed that LD183 with 170 kg ha^{-1} nitrogen fertilizer treatment has the highest amount of remobilization from flag leaf. Also, other leaves (all leaves except flag leaf) remobilization was affected by nitrogen fertilizer rate and cultivars (Table 1). The highest amount of remobilization from other leaves (84.35 mg per plant) was obtained for LD183 and 170 kg ha^{-1} nitrogen fertilizer rate treatment (Table 3). In this experiment, dry matter remobilization of stem, total shoot and other leaves had a significant and positive correlation with yield ($r = 0.84^{**}$, $r = 0.78^{**}$ and $r = 0.50^{**}$, respectively) (Table 4).

Table 4: Correlation between studied traits

Traits	Grain yield	Total shoot	Stem	Flag leaf	Other leaves
Grain yield	1				
Total shoot	0.78**	1			
Stem	0.84**	0.75**	1		
Flag leaf	0.065^{ns}	0.43**	0.063^{ns}	1	
Other leaves	0.50**	0.65**	0.31*	0.36**	1

**,*Significant at the 5 and 1% levels of probability, respectively. ns: Non-significant

DISCUSSION

Results showed that dry matter remobilization in rice is affected by genotype and cultural practices. Palta and Fillery (1995) reported that with application of nitrogen fertilizer, role of dry matter at pre-anthesis will increase in the yield of rice cultivars. In this experiment stem had higher amount of dry matter remobilization than other parts. Poshtmasari *et al.* (2007) also, reported that Shafagh cultivar (improved cultivar) had the highest amount of remobilization of stem among the cultivars. Also, this result is consistent with the findings of Sarvastani (1995), Ntanos and Koutrobus (2002), Yang *et al.* (2003) and Kumar *et al.* (2006). Flag leaf of Champa cultivar (traditional cultivar) was not important in dry matter remobilization. Thus, it seems that flag leaf had important role in current photosynthesis at post anthesis stage compared with dry matter remobilization. Present findings showed that flag leaf in Champa cultivar not only has not an important role in dry matter remobilization but also acted as a strong sink for photosynthetic assimilates. Cultivar and nitrogen fertilizer management affect other leaves dry matter remobilization. This result is consistent with the result of Sarvestani and Pirdashti (2001) and Poshtmasari *et al.* (2007). They reported that different rate of remobilization among the cultivars was related to their agronomic characteristics.

CONCLUSION

Results of the present study indicate that there is a difference in dry matter remobilization in different cultivars and nitrogen fertilizer levels under Ahwaz weather conditions. Differential responses to the treatment and also in different parts of the shoot suggest that the remobilization of dry matter be controlled through different mechanisms. This result can help physiologists and breeders to determine physiological and morphological features of varieties that contribute most to increasing yield production.

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