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Chlorophyll Content and Biological Yield of Modern and Old Rice Cultivars in Different Urea Fertilizer Rates and Applications

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Abstract: In order to investigating the effects of different urea fertilizer applications and split application on leaves chlorophyll content (flag leaf and other leaves) and biological yield of modern and old rice cultivars, an experiment was conducted at Rice Research Institute of Iran (Deputy of Mazandaran, Amol) during, 2005. Experiment was arranged in split-split plots based on completely randomized block design with 3 replications in which nitrogen fertilizer as urea (including 100, 150 and 200 kg ha^{-1}), split application of urea (including pre-transplanting, tillering and heading stage with different rates) and cultivars (Tarom (old cultivar), Shafagh and GRH1 Hybrid (modern cultivar) were the treatments. Results showed that all mentioned factors had significant effects on chlorophyll content of flag leaf in which the greatest amount of chlorophyll content was belonged to GRH1 hybrid, also increasing of fertilizer rates caused a significant increase in flag leaf chlorophyll content and the among split application levels, the third type of split application had the highest chlorophyll amount of flag leaf. Chlorophyll content of the other leaves also was affected by cultivar and split application in which the highest amount of this trait was observed in GRH1 hybrid and the third type of split application. Biological yield of different cultivars in response to fertilizer amount and split application were significant in which among cultivars Tarom had the highest biological yield. Summary, 200 kg nitrogen fertilizer per hectare and the third type of split application caused a significant increasing of flag leaf chlorophyll content probably related to photosynthesis rate.

Key words: Chlorophyll, urea fertilizer, split application, biological yield, rice

INTRODUCTION

Nitrogen is a key element found in chlorophyll molecules that captures the sunlight that is used in photosynthesis. Nitrogen fertilizer, more than any other nutrient amendment has increased commercial rice (*Oryza sativa* L.) yield (Stevens *et al*., 1999). Split application of nitrogen is very often used in rice cultivation to increase its availability in critical growth stages (Saha *et al*., 1998).

Chlorophyll meter or SPAD is a simple and nondestructive approach for estimating of chlorophyll leaf content and can apply to estimate leaf nitrogen status of rice (*Oryza sativa* L.) (Markwell *et al*., 1995; Peng *et al*., 1999). Prediction ability of chlorophyll content on base leaf area by SPAD explained in some crops such as rice, wheat (*Triticum aestivum* L.) and corn (*Zea mays* L.) (Takebe and Yoneyama, 1989; Singh *et al*., 2002). Singh *et al*. (2002) used SPAD to test need-based nitrogen management approaches for rice and wheat. They reported that plant need-based nitrogen management through chlorophyll meter reduce nitrogen previously requirement of rice from 15.5 to 25% with no less in yield. Also, Garcia *et al*. (1996) previously reported that use of SPAD in determination the time of nitrogen fertilizer applies caused increase of yield and leaves with high SPAD value have the high chlorophyll content. Studies showed that nitrogen leaf statue has a closely relationship with photosynthesis rate and biomass production and it can control the photosynthesis and Crop Growth Rate (CGR). Some factors are affected on chlorophyll contents, for example fertilizer management and its application time, variety type, plant density and light intensity in growth season, also diseases and

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environmental stresses (Hussain *et al*, 2000; Stevens *et al*., 1999; Turner and Jund, 1994). Critical values of SPAD are different in rice groups. These values are about 30-32 for traditional, improved cultivars and aromatic cultivars, also varied about 35-37 for dwarf India varieties (Balasabramain *et al*., 1999). In this case, Hussein *et al*. (2000) reported that new variety of IRRI (IR72) has 35 values in critical value of SPAD reading. Agronomists in Texas suggested that critical value for Lemont variety is about 40 values in heading stage. Yang *et al*. (2003) carried out a field experiment in Philippine and applied nitrogen levels in the three growth stages and used SPAD and Leaf Color Chart (LCC) for estimating of chlorophyll content. Results showed that there is a liner relation between LCC value and SPAD value. Aim of this paper is determination the effect of urea fertilizer management on chlorophyll leaf value by SPAD and biological yield of old and modern rice cultivars.

MATERIALS AND METHODS

This study was conducted at the Rice Research Institute of Iran, deputy of Mazandran-(Amol) located in north of Iran (52°22′ E, 36°28′ N). The experiment arranged in split plot based on randomized complete block design with three replications. Three urea fertilizer levels (including 100, 150 and 200 kg ha^{-1}) three split application levels of urea (including before transplanting time as the based dressing, tillering time and before heading) (Table 1) and rice cultivars (including Tarom (old cultivar), Shafagh and GRH1 hybrid (modern cultivar)) considered as the main plot, sub plot and the sub-sub plots, respectively. P and K fertilizers were applied at rate of 100 kg ha^{-1} at before transplanting time.

In this experiment, SPAD meter (Minolta company in Japan) was used for determination of chlorophyll content. Were selected samples from flag leaf and other leaves by 10 times at heading stage and their average was applied for data analysis. For determination of biological yield and grain yield, 16 hills (1 m^2) were selected from each plot and then dried to 14% moisture. Analysis of variance was preformed by SAS and Duncan's Multiple Ranges test was used at 0.05 level of probability to test difference between treatment means.

Table 1: Urea split application types

Split application	Basal fertilizer (%)	Tillering (%)	Heading (%)
S_1	50	25	25
S_2	25	50	25
S_3	25	25	50

RESULTS

Variance analysis (Table 2) showed that all factors urea fertilizer rate, split application and cultivars had signification effects on chlorophyll amount of flag leaf. The highest value of flag leaf chlorophyll content was obtained in the 150 and 200 kg ha^{-1} urea fertilizer and the among of split application levels, the three split application (50, 25 and 25%) treatment had the highest chlorophyll content of flag leaf (Table 3). Among cultivars the Tarom and GRH1 Hybrid cultivars had the highest and Shafagh cultivar contained the lowest value of SPAD reading in flag leaf.

Table 2: The analysis of variance for effects of urea fertilizer rates, split application and variety on studied traits

SOV	df	Grain yield (t ha^{-1})	Biological yield and	Other leaves SPAD	Flag leaf Reading
Replication	2	0.13	0.016	14.85	0.95
Urea fertilizer and rates	2	0.43**	13.05*	11.09	3.58*
Error (a)	4	0.0055	0.11	7.63	0.40
Split application	2	0.46	6.01*	27.75**	21.31*
Split application *urea fertilizer rates	4	0.135	6.5*	2.68	6.35**
Error (b)	4	0.192	0.83	1.48	1.66
Variety	2	44.30**	6.58**	44.75**	17.07**
Variety * split application	4	0.27**	4.60**	6.74	5.95*
Variety * urea Fertilizer rates	4	0.089	3.29	4.91	4.73*
Variety * split application * urea fertilizer rates	8	0.38**	3.26**	11.20*	4.86**
Total error	44	0.05	1.10	4.45	1.63
C.V (%)	-	3.91	7.65	5.80	3.52

* and ** significant at the 5 and 1% levels of probability, respectively

Table 3: Results of mean comparison of studied traits in urea fertilizer rates, split application and variety

Treatments	Kernel yield (t ha^{-1})	Biological yield	Other leaves SPAD	Flag leaf Reading
Urea fertilizer rates				
N_1	5.92c	13.11c	35.77b	35.92b
N_2	6.00b	13.58b	36.31a	36.37ab
N_3	6.17a	14.48a	37.01a	37.64a
Split application				
S_1	6.17a	14.03a	36.52b	35.92b
S_2	6.01a	13.96a	35.58b	35.69b
S_3	5.91a	13.18b	37.52a	37.33a
Variety				
V_1	4.56c	14.29a	35.55b	37.70a
V_2	6.88a	13.47b	35.71b	35.40b
V_3	6.66b	13.40b	37.86a	36.82a

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$) N_1, N_2 and N_3: Respectively, urea fertilizer rates in levels of 100, 150 and 200 kg ha^{-1}-S_1, S_2 and S_3: Respectively, urea fertilizer split application levels (Table 1)-V_1, V_2 and V_3, Respectively, Variety levels, Tarom, Shafagh and GRH1 hybrid

Interaction effects between urea fertilizer rate split application, cultivar urea fertilizer rates and cultivar split application were significant at 0.01, 0.05 and 0.01 levels of probability, respectively (Table 2). The highest of chlorophyll content in flag leaf was observed in the 200 kg ha^{-1} urea fertilizer level and third split application (Table 5). Also, Tarom cultivar had the highest chlorophyll value in third split application of fertilizer (Table 6). Interaction effect between urea fertilizer rate and cultivar showed that the highest chlorophyll value was observed in 200 kg ha^{-1} and GRH1 hybrid rice (Table 4). Also, chlorophyll value in other leaves (all leaves except flag leaf) was affected by cultivar and split application but urea fertilizer rate had not significant effect (Table 2). The highest of chlorophyll value of other leaves (37.86) belong to GRH1 hybrid rice third split application interaction (Table 3). Interaction effects between cultivar urea fertilizer rate, cultivar split application were affected in 5% level of probability in chlorophyll content of other leaves (Table 2).

Result showed that biological yield of rice was affected by nitrogen fertilizer, cultivar and split application in 1, 1 and 5% levels of probability (Table 3). The highest biological yield was obtained in 200 kg ha^{-1} nitrogen fertilizer and the first and two split application treatments. Also the results showed that among cultivars Tarom had the highest biological yield (Table 3).

Table 4: Interaction effects of urea fertilizer rates in variety

Treatments	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Other leaves SPAD	Flag leaf Reading
N_1V_1	4.54e	13.34a	34.57a	34.62b
N_1V_2	6.82a	12.67a	34.70a	35.24b
N_1V_3	6.42bc	13.32a	38.03a	35.91b
N_2V_1	4.72cd	14.37a	35.38a	36.80b
N_2V_2	6.82a	13.84a	36.37a	35.84b
N_2V_3	6.70ab	12.51a	37.18a	36.47b
N_3V_1	4.66de	15.16a	36.71a	36.73b
N_3V_2	7.00a	13.90a	36.06a	35.11b
N_3V_3	6.85a	14.38a	38.36a	38.10a

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$) N_1, N_2 and N_3: Respectively, urea fertilizer rates in levels 100, 150 and 200 kg ha^{-1}-V_1, V_2 and V_3: Respectively, Variety levels Tarom, Shafagh and GRH1 hybrid

Table 5: Interaction effect of urea fertilizer rates in split application

Treatments	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Other leaves SPAD	Flag leaf Reading
N_1S_1	5.95b	13.75a	35.76a	36.06b
N_1S_2	6.03b	13.88a	34.43a	35.64b
N_1S_3	5.00b	11.70b	37.11a	36.06b
N_2S_1	6.14b	13.28ab	36.18a	35.65b
N_2S_2	5.91b	13.27a	35.52a	36.12b
N_2S_3	5.94b	14.08a	37.24a	37.34b
N_3S_1	6.43a	15.05a	36.12a	36.04b
N_3S_2	6.10a	14.63a	36.81a	35.31b
N_3S_3	5.99b	13.57a	38.21a	38.58a

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$) N_1, N_2 and N_3: Respectively, urea fertilizer rates in levels of 100, 150 and 200 kg ha^{-1}-S_1, S_2 and S_3: Respectively, urea fertilizer split application levels (Table 1)

Table 6: Interaction effect split application in variety

Treatments	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Other leaves SPAD	Flag leaf Reading
S_1V1	4.62d	15.04a	35.96a	35.87c
S_1V_2	7.09a	14.06a	35.43a	34.88c
S_1V_3	6.80b	12.92a	36.67a	37.00b
S_2V_1	4.51d	14.06a	34.86a	35.55bc
S_2V_2	6.70bc	13.32a	34.33a	35.05c
S_2V_3	6.82b	14.49a	37.56a	36.46b
S_3V_1	4.54d	13.77a	35.84a	38.72a
S_3V_2	6.84b	12.96a	37.37a	36.25c
S_3V_3	6.35cd	12.97a	39.34a	37.02b

Means within the same column followed by the same letter not significantly different according to DMRT ($p<0.05$) S_1, S_2 and S_3: Respectively, nitrogen fertilizer split application levels (Table 1)-V_1, V_2 and V_3: Respectively, variety levels Tarom, Shafagh GRH1 hybrid

DISCUSSION

Findings of this research showed that GRH1 hybrid and Tarom cultivars had the highest amount of chlorophyll content in flag leaf but Tarom cultivar had the least of chlorophyll content in other leaves and the highest biological yield. In general, India traditional cultivars have the least chlorophyll content and nitrogen density. Findings by Balasubramaian *et al.* (1999) are in agreement to these results. GRH1 hybrid rice had the highest chlorophyll content in 200 kg ha^{-1} urea fertilizer. Turner and Jund (1999) showed a relationship between SPAD value and nitrogen density based on dry weight of leaves. This relationship depends on plant growth stage and cultivar type. In this experiment, Tarom cultivar received more rates of urea fertilizer and it had highest vegetative growth than GRH1 hybrid rice and Shafagh cultivars, that caused flag leaf of Tarom showed the highest chlorophyll content.

Also, among cultivars, Tarom had maximum biological yield because of its high photosynthesis rate but improved cultivars had the least biological yield because of their high sink potential and fertilizer demand. Therefore, modern cultivars can transport high nitrogen rates to grain due to low biological yield. Also, the greater plant height and Leaf Area Index (LAI) are some reasons for increasing the biological yield in Tarom cultivar (Mahdavi *et al.*, 2004). Peng *et al.* (1995) reported that chlorophyll content of leaf has a near relationship to photosynthesis rate and biological yield. Therefore photosynthesis rate controls CGR and nitrogen of leaf. (Table 7) showed that biological yield had significant

Table 7: Correlation coefficients between studied traits

Traits	Flag leaf SPAD	Other leaves SPAD	Biological yield
Flag leaf SPAD	1		
Other leaves SPAD	0.008^{ns}	1	
Biological yield	-0.57*	0.53*	1

* Significant at the 5% levels of probability ns: non-significant

correlation to chlorophyll of other leaves and not significant to chlorophyll of flag leaf. When chlorophyll of leaves increase, the amount of photosynthesis assimilates increase too and also, these products stay in total shoot of plant. But, when chlorophyll content of flag leaf is high, the photosynthesis assimilates transported to kernel and flag leaf role in production of biological yield is low than other leaves. In general, 200 kg nitrogen fertilizer per hectare and the third type of split application caused an increasing of chlorophyll content that related to photosynthesis rate and biomass.

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REFERENCES

Balasabramain, V., R.T. Morales Cruzand and S. Abdulrachman, 1999. On-farm adaptation of knowledge intensive nitrogen management technologies for rice systems. Nutr. Cycl. Agroecosyst., 53: 93-101.

Garcia, F.V., S. Peng, H.C. Gianes, R.S. Laza, A.L. Sanico, R.M. Visperas and K.G. Cassman, 1996. Chlorophyll meter-based nitrogen rice in farmres fields. IRRI., pp: 187-190.

Hussain, F., K.F. Bronson, Y. Singh, B. Singh and S. Peng, 2000. Use of chlorophyll meter sufficiency indices for nitrogen management of irrigated rice in Asia. Agron. J., 92: 875-879.

IRRI., 1999. Use of Leaf Color Chart (LCC) for N Management in Rice. Crop Resour. Mauge. Network Technol. Brief. IRRI. Manila, Philippenes.

Mahdavi, F., M.A. Esmaili, H. Pirdashtiand and A. Fallah, 2004. Study on the physiological and morphological indices among the modern and old rice (*Oryza sativa* L.) genotypes. In: Proceedings of the 4th International Crop Science Congress. Brisbane, Australia.

Markwell, J., J.C. Ostermanand and J.L. Mitchell, 1995. Calibration of the Minolta SPAD -502 leaf chlorophyll meter. Photosynthesis Res., 46: 467-472.

Peng, S., K.G. Cassmanand and M.J. Kropff, 1995. Relationship between leaf photosynthesis and nitrogen content of fields grown rice in the tropics. Crop Sci., 35: 1627-1630.

Peng, S., K.G. Cassman, S. Virmani, J. Sheehy and G.S. Khush, 1999. Yield potential trends of tropical rice since the release of IR8 and the challenge of increasing rice yield potential. Crop Sci., 39: 1552-1559.

Saha, A., R.K. Sarkarand and Y. Yamagishi, 1998. Effect of time of nitrogen application on spikelet differentiation and degeneration of rice. Bot. Bull. Acad. Sin., 39: 119-123.

Singh, B., Y. Singh, J.K. Ladha, K.F. Bronson, V. Balasubramanian, J. Singhand and Ch. S. Khind, 2002. Chlorophyll meter and leaf color chart based nitrogen management for rice and wheat in northwestern India. Agron. J., 94: 821-829.

Stevens, G., S. Hefner and E. Tunner, 1999. Monitoring crop nitrogen in rice using portable chlorophyll meters. Information from Missouri Rice Res. Update, pp: 1-3.

Takebe, M. and T. Yoneyama, 1989. Measurement of leaf color scores and its implication to nitrogen nutrition of rice plants. Jpn. Agric. Res., 23: 89-93.

Turner, F.T. and M.F. Jund, 1994. Assessing the nitrogen requirements of rice crops with a chlorophyll meter method. Aust. J. Exp. Agric., 34: 1001-1005.

Yang, W.H., Sh. Peng, J. Huang, A.L. Sanico, R.J. Bureshand and Ch. Witt, 2003. Using leaf color charts to estimate leaf nitrogen status of rice. Agron. J., 95: 212-217.