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Comparison of Leaf Growth in Different Crop Establishment Methods with Nitrogen Management Practices

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ABSTRACT

Studies carried out to assess the Leaf growth parameters as influenced by system of rice intensification and normal transplantation methods with different nitrogen management practices. Leaf growth parameters like leaf area, leaf area index and leaf area duration was high under system of rice intensification compared to normal transplantation. Among the nitrogen treatments 75% inorganic+ 25% organic (N_5) treatment showed better performance compared to 100% inorganic (N_6), 100 % organic (N_2), 50% organic + 50% inorganic (N_4), 75% organic +25% inorganic (N_3) and control (N_1). SRI registered significantly higher leaf area as 965.0, 2082.3 and 1874.9 cm^2 $hill^{-1}$ at 30, 60 and 90 DAT respectively.

Key words: *SRI, NTP, Leaf area, Leaf area index, Leaf area duration.*

INTRODUCTION

Rice production governs the world food security as rice constitutes principal food commodity for more than 50% of the world's population[5]. Rice is a heavy water consumer but water for rice production is becoming scarce and expensive due to the increased demand for water from the ever growing population[4]. The per capita availability of water resources declined by 40 – 60 % in many Asian countries between 1955 to 1990 and expected to decline by 15 to 54 % by 2025 compared to 1990[3]. Therefore, rice could face a threat due to water shortages and hence, there is a need to develop and adopt water saving methods. There is ample scope to increase productivity of rice by altering the environmental conditions that modify microclimate and soil conditions, which ultimately reflect on phenotypic expression with the genotype and environment interactions[15]. The system of rice intensification (SRI) could potentially become an approach for increasing rice production with reduced water demand, thus improving both water use efficiency and water productivity. SRI was developed in Madagascar during early 1980s [17].

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SRI plants found to respond the shallow transplanting of small/young seedlings and their wider spacing, so that new tillers initially emerge more horizontally from the hills[19]. Leaf area growth determines light interception and is an important parameter in determining plant productivity[13]. SRI plants with their more open canopy structure, erect leaves, and higher LAI led to greater light interception. SRI plants achieved 89% light interception at panicle initiation stage compared with 78% interception by plants grown under conventional method. Erect leaves arrangement were mostly useful for the equal distribution of irradiation of light from top to the base part of the plant. The total leaf area of rice was closely related to grain production as the total leaf area at flowering greatly influence the photosynthetic rate activity and enhances the amount of photosynthates available to the panicle[6]. Leaf growth parameters like leaf area, leaf area index and leaf area duration was important parameters, which may directly reflect on increased dry matter production and grain yield. Total leaf area per unit ground area is an important indicator of total source available to the plant for the production of photosynthates, which accumulate in the developing sink. Development of sink was majorly depend on the leaf parameters, low performance of leaf parameters during grain filling stages automatically affect the grain yield[7]. Keeping the above things, the experiment as effect of planting methods and N management practices on leaf area, leaf area index and leaf area duration.

MATERIALS AND METHODS

The present investigation entitled **"**Leaf growth parameters influenced by SRI and NTP methods with different nitrogen management" was conducted during the *rabi* for two annual season of 2015 and 2016 at Indian Institute of Rice Research (IIRR) formerly Directorate of Rice Research (DRR) farm, ICRISAT, Patancheru, Hyderabad. The experiment was laid out in a split plot design with main plots consisting of two methods of cultivation i.e., System of rice intensification (SRI) and normal traditional cultivation (NTP) and sub plots comprising of six nitrogen management practices like without N application (N_1 - control), 100% organic (N_2), 75 % organic + 25% inorganic (N_3), 50 % organic + 50% inorganic (N_4), 25 % organic + 75% inorganic (N_5), 100 % inorganic (N_6). The treatments were replicated three times. Leaf area (cm^2) of three randomly selected hills from each plot was estimated at 30, 60 DAT and at 90 DAT by using LICOR -3100 automatic leaf area meter. The leaf area index (LAI) is the ratio of leaf area per plant to the ground occupied by each plant (spacing) [20].

$$LAI = \frac{\text{Leaf area}}{\text{Ground area}}$$

Leaf area duration (LAD) indicates the magnitude and persistence of leaf area during crop growth period. LAD based on leaf area of individual plants from successive harvest[11].

$$LAD = \frac{(LA_2 + LA_1)(t_2 - t_1)}{2} \quad (dm^2 \text{ days})$$

RESULTS AND DISCUSSION

Leaf area of the rice crop was increased up to panicle initiation stage (60 DAT), thereafter it decreased towards harvest, which could be attributed to senescence of the older leaves[12]. In the present investigation system of rice intensification registered significantly higher leaf area as 941.3, 2101.3 and 1893.2 cm^2 $hill^{-1}$ at 30, 60 and 90 DAT respectively, compared to NTP during 2015. Similar results were also obtained at 2016 as well as in pooled means. Among nitrogen treatments, application of

nitrogen as N_5 produced maximum leaf area as 744.2 and 754.2 cm^2 $hill^{-1}$ (30 DAT); 1686.4 and 1655.0 cm^2 $hill^{-1}$ (60 DAT) and 1506.4 and 1443.4 cm^2 $hill^{-1}$ (90 DAT) during 2015 and 2016, respectively. It was statistically at par with N_6 and significantly superior over N_4, N_3 and N_1 at all the growth stages. However the lowest leaf area was observed in N_1 treatment during both the years. In SRI, transplantation of younger seedlings with wider spacing generates usually offers less competition between plants thereby improving the growth of roots in addition to their activity, favouring better water and nutrient uptake. These characteristics of SRI would have contributed for higher leaf area with more erect leaves and enhanced photosynthetic rates[1].

The average leaf area index (LAI) of the rice increased at a slower rate up to 30 DAT and thereafter it increased steadily with the ontogeny of the plant reaching a peak value at 60 DAT, but there after it decreased gradually towards maturity due to senescence of leaves. The LAI of rice increases as crop growth advanced and reached a maximum at about heading or flowering [21]. The development of leaf area index reflected a sigmoid pattern of the growth. Leaf area index was not significantly different at 60 DAT in 2015 and 30 and 60 DAT in 2016. SRI registered significantly maximum leaf area index over NTP at 30 and 90 DAT of 2015, 90 DAT in 2016 and at all the growth stages of pooled means. The mean percentage increase of LAI in SRI was 15.38, 6.45 and 20.00 % at 30, 60 and 90 DAT in both the years of pooled means, respectively over NTP. Planting in square geometry with wider spacing and single seedling under SRI facilitates better utilization of the resources by the plant, leading to improved tillering ultimately enhancing the leaf area index[2, 18]. Nitrogen treatment N_5 recorded significantly higher LAI which was on par with N_6 nitrogen application but significantly superior over N_4, N_3 and N_1. The mean percentage increase of LAI under N_5 was 44.45, 33.33and 40.90 % over N_1 at 30, 60 and 90 DAT during both the years of pooled means, respectively. This might be due to the favourable effect of nitrogen on cell division and tissue organization that ultimately improved tiller formation leading to higher LAI. Several researchers have also observed similar results in rice crop [8, 9]. The most important role of N in the plant is its presence as a structural protein. It is the most important building substance from which the living material or protoplasm of every cell is made. In addition, nitrogen is also found in chlorophyll of leaves. Chlorophyll enables the plant to transfer energy from sunlight by photosynthesis. Therefore, nitrogen supply to the plant will influence the amount of protein, protoplasm and chlorophyll formed. In turn, this influences cell size and leaf area and photosynthetic activity. Thus rice plant on adequate supply of nitrogen in N_5 made a rapid growth due to stimulation of leaf and stem growth enhanced tiller production contributed to higher leaf area index.

System of rice intensification (SRI) gave significantly superior functional leaf area duration of 141.2 dm^2 days at 0-30 DAT, 456.4 dm^2 days at 30-60 DAT and 599.2 dm^2 days at 60-90 DAT compared to normal transplantation (NTP) during 2015. Similar results were also observed during 2016 as well as in pooled means. Among nitrogen treatments, N_5 treatment produced higher functional leaf area duration between 0-30 DAT (111.6 and 113.1 dm^2 days), 30-60 DAT (364.6 and 361.4 dm^2 days) and 60-90 DAT (479.0 and 464.8 dm^2 days) during 2015 and 2016, respectively, which was on par with N_2 treatment. The lowest functional leaf area duration was observed in N_1 i.e., 0-30 DAT (83.0 and 79.2 dm^2 days), 30-60 DAT (364.6 and 361.4 dm^2 days) and 60-90 DAT (479.0 and 464.8 dm^2 days) during 2015 and 2016, respectively. Higher functional leaf area duration in this treatment may be due to more number of tillers m^{-2} that resulted in higher leaf area maintenance per unit ground area[14]. Application of nitrogen as inorganic and organic (vermicompost) source which would have promoted positive soil biological processes that enhanced the availability of nutrients over a longer period lead to better growth and maintenance of higher leaf area duration[10,16].

Table 1: Leaf area (cm^2 $hill^{-1}$) influenced by planting methods and nitrogen treatments in Rice

Treatments	Leaf area								
	2015			2016			Pooled		
	DAT			DAT			DAT		
	30	60	90	30	60	90	30	60	90
Mean values of main treatments (M)									
M_1	941.3	2101.3	1893.2	988.8	2063.3	1856.7	965	2082.3	1874.9
M_2	397.7	966.9	775.8	401	899	704.6	399.3	933	740.2
S.Em±	8.3	19.3	24.3	14.9	22.7	29.1	10.9	16	11.8
C.D.at5%	50.7	117.3	147.8	90.7	138.1	177.2	66.3	97.5	71.8
Mean values of sub treatments (N)									
N_1	553.4	1252.2	1043.9	528.2	1252.3	1042.3	540.8	1252.2	1043.1
N_2	697.6	1612.7	1412.7	727.5	1523.1	1321.4	712.5	1567.9	1367
N_3	656.5	1485.9	1256.6	694.8	1394	1220.7	675.6	1440	1238.6
N_4	649.2	1523.6	1315.3	717.4	1479	1277.3	683.3	1501.3	1296.3
N_5	744.2	1686.5	1506.5	754.2	1655	1443.4	749.2	1670.8	1474.9
N_6	716	1643.7	1472	747.2	1583.7	1378.7	731.6	1613.7	1425.4
S.Em±	14.9	34	30.1	10.8	34.8	31.2	9.6	27.2	23.4
C.D.at5%	44	100.2	88.8	31.8	102.6	91.9	28.3	80.2	69.1

Table 2: Leaf area duration (dm^2 days) influenced by planting methods and nitrogen treatments in Rice

Treatments	Leaf area								
	2015			2016			Pooled		
	DAT			DAT			DAT		
	30	60	90	30	60	90	30	60	90
Mean values of main treatments (M)									
M_1	141.2	456.4	599.2	148.3	457.8	588.0	144.8	457.1	593.6
M_2	59.7	204.7	261.4	60.2	195.0	240.5	59.9	199.8	251.0
S.Em±	8.3	19.3	24.3	14.9	22.7	29.1	10.9	16	11.8
C.D.at5%	50.7	117.3	147.8	90.7	138.1	177.2	66.3	97.5	71.8
Mean values of sub treatments (N)									
N_1	83.0	270.8	344.4	79.2	267.1	344.2	81.1	269.0	344.3
N_2	104.6	346.5	453.8	109.1	337.6	426.7	106.9	342.1	440.2
N_3	98.5	321.4	411.4	104.2	313.3	392.2	101.3	317.3	401.8
N_4	97.4	325.9	425.8	107.6	329.5	413.4	102.5	327.7	419.6
N_5	111.6	364.6	479.0	113.1	361.4	464.8	112.4	363.0	471.9
N_6	107.4	354.0	467.4	112.1	349.6	444.4	109.7	351.8	455.9
S.Em±	14.9	34	30.1	10.8	34.8	31.2	9.6	27.2	23.4
C.D.at5%	44	100.2	88.8	31.8	102.6	91.9	28.3	80.2	69.1

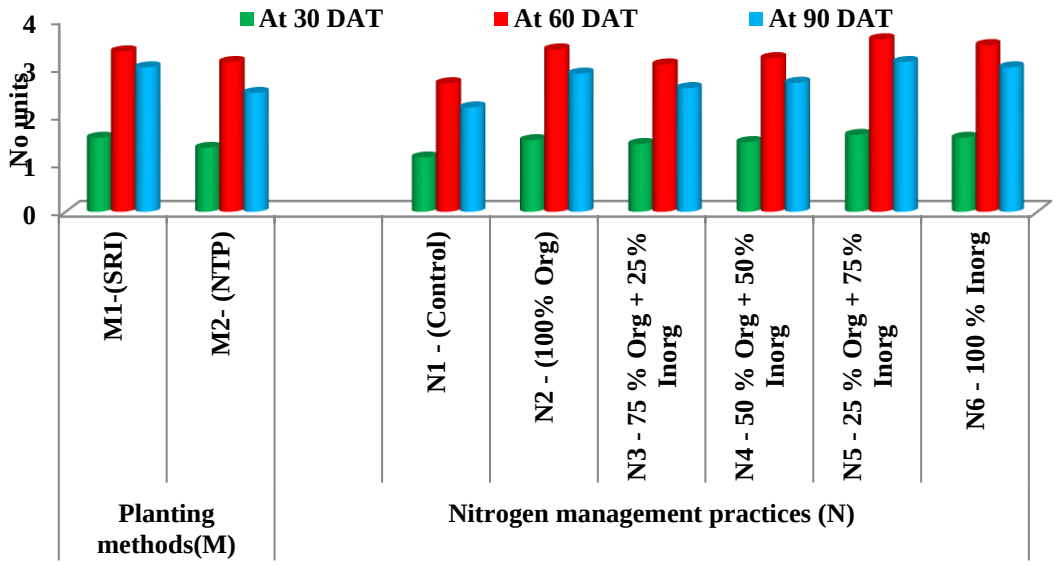

Fig. 1: Leaf area index influenced by planting methods and nitrogen treatments

CONCLUSION

Leaf area, leaf area index and leaf area duration maximum was observed in SRI compared to NTP at all the growth stages of plant. Among the nitrogen treatments leaf growth parameters showed maximum values in N_5 treatment compared to other nitrogen treatments.

REFERENCES

1. Anas, I., Rupela, O.P., Thiyagarajan, T.M and Uphoff, N., A review of studies on SRI effects on beneficial organisms in rice soil rhizospheres. *Paddy Water Environment.* **9:** 53–64 (2011).
2. Borkar, L.S., Khawale, V.S., Raut, B., Patil, T.S and Kolte Harsha, S., Studies on spacing and nitrogen management under System of Rice Intensification (SRI). *Journal of Soils and Crops*. **18(2):** 438-411 (2008).
3. Bouman, B.A.M., Hengsdjik, H., Hardy, B., Bindraban, P.S., Toung, T.P and Ladha, J.K., Water wise rice production. *Proceedings of the international workshop on water wise rice production*, 8-11 April, 2002, Los Banos Philippines. International Rice Research Institute. 9 - 38 (2002).
4. Choudhary, R.L., Dinesh, K., Shivay, Y.S., Anand, A. and Lata, N., Yield and quality of rice (*Oryza sativa*) hybrids grown by SRI method with and without plant growth promoting rhizobacteria. *Indian Journal of Agronomy*. **58 (3):** 430-433 (2013).
5. Dass, A., Shekhawat, K., Choudhary, A.K., Sepat, S., Rathore, S.S., Mahajan, G., Chauhan, B.S. 2017. Weed management in rice using crop competition-a review. Crop Protection. **95:** 45-52.
6. Datta, S.K.D., Principles and practices of rice production. IRRI. Las Banos, Philippines. 618. (1981).
7. Fageria, N.K., Baligar, V.C and Clark, R.B., Photosynthesis and crop yield. *In Physiology of Crop Production*. 95-116, Food Products Press, New York (2007).
8. Ghosh, M., Swain, D.K., Jha, M.K and Tewari, V.K., Precision nitrogen management using chlorophyll meter for improving growth, productivity and N use efficiency of rice in subtropical climate. *Journal of Agricultural Sciences.* **5(2):** 253-266 (2013).
9. Huang, D.F., Xi, L.L., Wang, Z.Q., Liu, L.J and Yang, J.C., Effects of irrigation regimes during grain filling on grain quality and the concentration and distribution of cadmium in different

organs of rice. *Acta Agronomy Science*. **34:** 456-464 (2008).

10. Hugh, M., Steenhuts, O.T and Uphaff, N. 2002. *Farmer implementation of alternate wet-dry and non-flooded irrigation practice in the system of rice intensification.* Carnel University.
11. Hunt, R., Plant growth analysis studies on biology. *96 Edward Arnold Publishers Ltd*., London. 8-38 (1978).
12. Jayanthi, T., Gali, S.K., Chimmad, V.P and Angadi, V.V., Leaf colour chart based N management on yield, harvest index and partial factor productivity of rainfed rice. *Karnataka Journal of Agricultural Sciences.* **20(2):** 405-406 (2007).
13. Koester, R. P., Skoneczka, J. A., Cary, T. R., Diers, B. W., and Ainsworth, E. A., Historical gains in soybean (Glycine max Merr.) seed yield are driven by linear increases in light interception, energy conversion, and partitioning efficiencies. *Journal of experimental botany*.**65:** 3311-3321 (2014).
14. Krishna, A., Biradarpatil, N.K., Manjappa, K and Channappagoudar, B.B., Evaluation of System of Rice Intensification (SRI) Cultivation, Seedling age and Spacing on Seed Yield and Quality in Samba Mashuri (BPT-5204) Rice. *Karnataka Journal of Agricultural Sciences*. **21(1):** 20-25 (2008).
15. Kumar, D and Shivay, Y.S. 2004. System of rice intensification. *Indian Farming*. November.18-21.
16. Kumar, S., Singh, R.S., Yadav, L and Kumar, K., Effect of moisture regime and integrated nutrient supply on growth, yield and economics of transplanted rice. *Oryza.* **50(2):** 189-191 (2013).
17. Laulanié, H., Le système de riziculture intensive malgache. Tropicultura (Brussels) **11:** 110-114 (1993).
18. Pradeep Nayak, Studies on improvement of water productivity for rice (*Oryza sativa* L.) production through different methods of establishment, *M. Sc. (Agri.) Thesis*, UAS, Bangalore, India (2009).
19. Thakur, A.K., Sreelatha, R., Patil, D.U and Ashwani, K., Effects on rice plant morphology and physiology of water and associated management practices of the system of rice intensification and their implications for crop performance. *Paddy Water Enviornment.* **9:** 13-24 (2011).
20. Watson, D. J., The physiological basis of variation in yield. *Advances in Agronomy.* **4:** 101-145 (1952).
21. Yoshida, S., Rice plant charcters in relation to yielding ability. In: Fundamentals of rice crop science (IRRI: Los Banos, Philippines). (1981).