ISSN: 2348-1927

RESEARCH ARTICLE

Annals of Biological Sciences
2015, 3 (3):8-11

Screening for nitrogen use efficiency with their root characteristics in rice (Oryza spp.) genotypes

Swamy K N, Kondamudi R, Kiran T V, Vijayalakshmi P, Rao Y V, Rao P R, Subrahmanyam D and Voleti S R*

Department of Plant Physiology, Indian Institute of Rice Research, Rajendranagar, Hyderabad. India.
**Corresponding author: drvoletisr@gmail.com*

ABSTRACT

Root system plays vital role in absorption of water and mineral nutrients for plants' need. Nitrogen is very important macronutrient for plant's growth and yield. The selected 10 genotypes were screened for nitrogen use efficiency based on Root Dry Weight Efficiency Index (RDWEI), yield and their nitrogen content. The results of this study proved that, the root growth was increased (root length by 14% and root dry weight by 60%) in the plants grown in recommended doses of nitrogen over plants grown in stress condition. This method serves to identify the efficient nitrogen utilizing varieties which will directly result in the efficient nitrogen management. The knowledge on these aspects brings awareness on economic usage of the fertilizers which in turn results in the soil health.

Keywords: Nitrogen use efficiency, Root Dry Weight Efficiency Index, *Oryza* spp. Filled grain weight.

INTRODUCTION

Root system is considered a key issue for a successful exploitation of soil resources. It is of great interest to develop accurate indices to explore the best rooting configuration to optimize the competition for water and nutrients. A vigorous root system is responsible for growth and development of healthy plant and consequently causes higher yields [1], but root growth is generally influenced by environmental and soil conditions [2].

Nitrogen fertilizer is important for higher yields in rice cultivation and also efficient use of nitrogen promotes root development and extends space for root to extract water and other nutrients from the soil [3], but haphazard use of nitrogen to rice crops creates environment related problems, leaching, emission leads to global warming and eutrophication [4-5] brings many undesirable changes in ecological pyramid. Oxides of nitrogen demolish stratospheric ozone with the emission of toxic ammonia into the atmosphere [6-7].

To reduce the hazardous effects, it is essential to identify the varieties which can absorb efficiently and accumulate the externally applied nitrogen [8]. This is the reason why society and policy makers ask for efficient nitrogen using varieties in agriculture. The objective of the study was to identify the genotypes which can efficiently utilize the nitrogen.

MATERIALS AND METHODS

The experiment was conducted in the field of plant physiology section, Indian Institute of Rice Research, Hyderabad. Ten heat tolerant rice lines from Panjab Agricultural University were selected [TAMCAU9A, YANGKUM (RED), Dular, ARC14088, NANGUANGZHAN, DJOGOLON-DJOGOLON, IR 88634:3-B-1, IR 88634:11-B-1, IR88633:5-54-B-1 and IR88633:12-126-B-1] and screened for nitrogen use efficiency in two nitrogen levels *i.e.* recommended dose (100 kg N/ha) as control and stress treatment (no external nitrogen was supplied, *i. e* N-0).

From both the plots, the plants were uprooted at physiological maturity stage along with its rhizosphere (30 cm depth of the soil) properly without damaging to the root system. Root length was measured. After drying the plant material at 70˚C the roots and shoots were weighed. The genotypes were estimated for nitrogen content [9] in both the treatments and relationship between root dry weight efficiency index (RDWEI) and yield was established.

RDWEI was calculated by using the formula of Fageria [10]:

$$\text{RDWEI} = \frac{\text{Root dry wt. at low N rate}}{\text{Ave. root dry wt. of 10 genotypes at low N rate.}} \times \frac{\text{Root dry wt. at high N rate}}{\text{Ave. root dry wt. of 10 genotypes at high N rate.}}$$

Genotypes having RDWEI values >1.0 were considered as efficient, the values, between 0.5 and 1.0 were classified as moderately efficient and those with RDWEI values < 0.5 were considered as inefficient in using nitrogen. The data represents the mean values of 3 replicates. The data was analyzed by two-way ANOVA. The differences were considered significant if P was at least ≤ 0.05.

RESULTS AND DISCUSSION

Root length: The mean root length in recommended nitrogen was observed as 19.1 cm. It ranged from 15.7 cm to 24.7cm in YANGKUM (RED) and IR88634:11-B-1 respectively (Fig-1). Similarly under stressed condition, shorter roots (12.6 cm) were observed in NAN-GUANG-ZHAN and longer (20.4 cm) in IR88633:12-126-B-1 with a mean of 16.4 cm. Nitrogen deficiency had reduced the root length by 14%. Root growth plays an important role in controlling senescence, prolong the grain-filling stage and finally enrich the grain [11]. Similar results were reported by Lotfollahi [12] in wheat. High nitrogen treatment increased the root length**,** total lateral root length and relative growth rates in Chinese maize hybrids released between 1973 and 2009 [13].

Root dry weight: The root dry weight under recommended dose was as minimum as 3.41g/plant to as maximum as 9.7 g/plant (Fig-2). Similarly, under stress the root dry weight ranges between 1.35 g/plant to 4.1g/plant. The mean root dry weight values for N recommended and N stressed were observed to be 5.47 and 2.15 respectively. Nitrogen deficiency had reduced the root dry weight by 60%. Razzaque et al. [14] reported optimum level of nitrogen produced higher root dry weight over control root dry weight in rice. Our results are concurrent with Drew et al. [15] in barley.

RDWEI: It was found that, 50% of the genotypes were found to be efficient, on the other hand 30% were observed as moderately efficient and 20% inefficient (Fig-3). The efficient genotypes in nitrogen use were ARC14088, IR88633:12-126-B-1, IR88634:3-B-1, and YANGKUM (RED). Moderately efficient genotypes were Dular, NANGUANGZHAN and DJOGOLON-DJOGOLON. Inefficient genotype was IR88633:5-54-B-1 and TAMCAU9A. The trends of RDWEI and total grain weight were in same fashion. It was observed that the difference in nitrogen content between both the treatments is also following more or less same trend (Fig-4).

Acknowledgement
This work was supported by National Initiative on Climate Resilient Agriculture (NICRA), Indian Council of Agricultural Research (ICAR), Ministry of Agriculture, Govt. of India [F. No. Phy/NICRA/2011-2012].

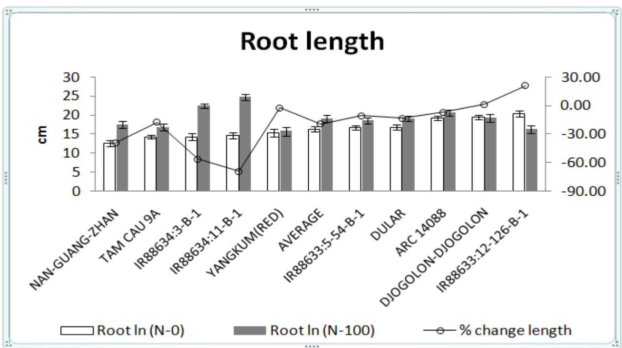

Fig-1. Influence of nitrogen on root lengths and percent change in stressed and control plants.

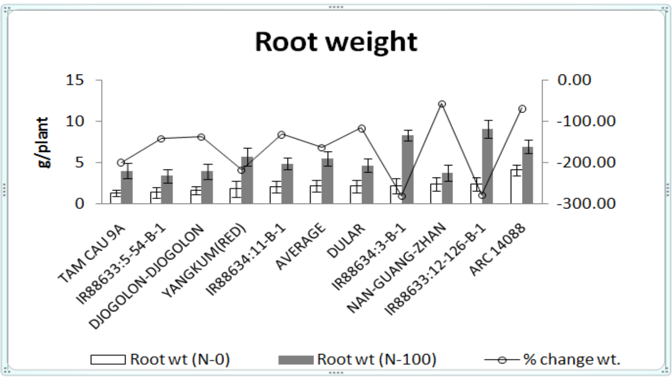

Fig-2. Influence of nitrogen on root dry weights and percent change in stressed and control plants.

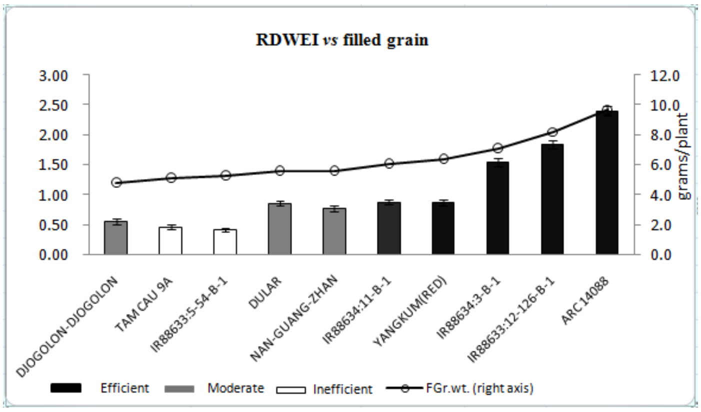

Fig-3. Relationship between Root Dry Weight Efficiency Index and filled grain weight of stressed plants.

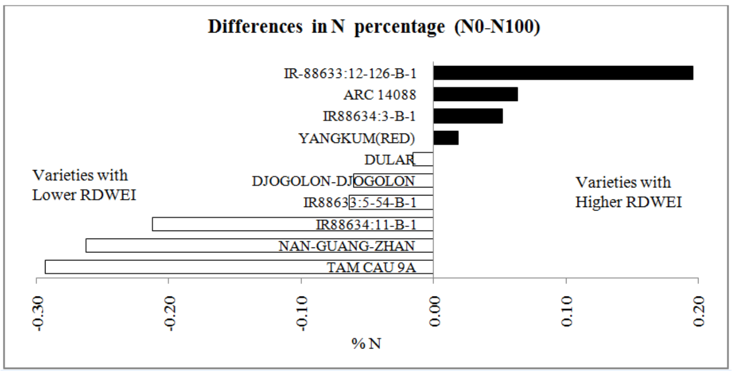

Fig-4. Differences in total nitrogen percentage in plants grown under stress and recommended doses of nitrogen.

REFERENCES

[1]S. Dorlodot, B, Forster, L. Pages, A. Price, R. Tuberosa, X. Draye, *Trends in Plant Sciences*, **2007,** 12: 474–481.
[2]B.G. Zhang, Q.X. Chen, Q. Yang, K.D. Liu, *International Journal of Agricultural and Biology*, **2012,** 14, 145–148.
[3]Y.Z.Li, F.X. Wang, L.H. Liu, *Plant Nutrition and Fertilizer Science*, **1999**, 5, 206-313.
[4]D.R. Keeney, Stevenson, F.J., *American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America:Madison Wisconsin*, **1982**, 605– 649.
[5] J.G.London, *Nature,* **2005**, 433, 791.
[6]C.Ramos, C. Rodriguez-Barrueco, Dordrecht, The Netherlands: *Kluwer Academic Publishers*, **1996**, 355–361.
[7] I. Stulen, M. Perez-Soba, L.J. De Kok, L. Van Der Eerden, *New Phytologist.* **1998,** 61-70.
[8]B. Hirel, J.L. Gouis, B. Neyand, A. Gallais, *Journal of Experimental Botany*,**2007**,58, 2369–2387.
[9] J.Z. Kjeldahl, *Analytacal Chemistry*, **1883**, 22, 366.
[10] N.K. Fageria, *New York: CRC Press*, **2009.**
[11] X.D. Shi, Y.F. Liu, Z.Q. Wen, W.W. Wang, *Journal of Anhui Agricultural Science,* **2006**, 34, 2043–2045.

[12] M.A. Lotfollahi, Brisbane Australia. Published on DVD, **2010**.
[13] Q. Wu, F. Chen, Y. Chen, L. Yuan, F. Zhang, G. Mi, *Science China Life Science*, **2011**, 54, 642-650.
[14]M.A. Razzaque, M.M. Haque, M.A. Hamid, Q.A. Khaliq, *Bangladesh journal of Agricultural Research*, **2009,** 34, 313-322.
[15] M.C. Drew, L.R. Saker, T.W. Ashley, *Journal of Experimental Botany*, **1993,** 24, 1189-1202.