

## RESEARCH / INVESTIGACIÓN

## Morphological study of different varieties of rice traits influencing nitrogen and water uptake efficiency

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**Abstract:** This research aimed at establishing the morphology of the root and sizes under various irrigation cultures. The comparison was made for root to shoot ratio under the traditional culture of flooding. We hypothesize that, due to limited root system development under aerobic conditions, rice is poorly adapted to different environments. In the meantime, there has to be an increase in demand for grain and output per area, as newly planted areas are scarce. This study discusses the latest theoretical physiological, metabolic and genetic factors affecting nitrogen intake and use in different N processes. It covers the root system's position and nitrate- ammonium assimilation and its relationship with Nitrogen Use Efficiency (NUE) and Water Use Efficiency (WUE), were discussed. Phenotyping and molecular breeding techniques concerning N and water regimes and genetic diversity were also evaluated and simulated.

**Key words:** QTLs, NUE, WUE, Morphology, Irrigation culture.

## Introduction

Rice root is a fasciculate system and sense at the herbaceous plant, chill, and water deficiencies sensitive<sup>1,2</sup>, indices, the essential role of the root is extracted and absorption of dissolved minerals and water from the flooded region<sup>3,4</sup>. Recently studies report about the characteristics of root for assessed and attributed the relationships genetic expression and root physiology and morphology<sup>5,6</sup>. The reactions of nitrogen (N) to organic growth and associated characteristics can, therefore, reflect the genetic traits inherited from ancestral to cultivated species<sup>7,8,46</sup>. The features to improve root for uptake N catch associated with profundity, density<sup>9,10</sup>. The regular plant irrigation, including alternative wetting and mild soil drying drainage, could improve root tip cell ultra-structure; enhance root thickness size and cytokinin accumulation in root<sup>11</sup>. Root architecture traits have been related to water and N uptake such as the ammonium ( $\text{NH}_4^+$ ) transport systems at physiological levels, exhibit linear kinetics<sup>12,13</sup>. Ammonium: nitrate ( $\text{NH}_4^+ : \text{NO}_3^-$ ) ratio arrived at 1:100 in agriculture land, with low focus  $\text{NH}_4^+$  uptake from plant roots highest rates<sup>14</sup>. Unusually, perhaps the root plasma film negative electrical polarization in this way its high fondness to the  $\text{NH}_4^+$  more than  $\text{NO}_3^-$ <sup>15,16</sup>. Without a doubt, rice root has  $\text{NH}_4^+$  tolerant respiratory increment, and show neither a tight electrochemical angle for  $\text{NH}_4^+$  efflux over the plasma layer<sup>17</sup>. The efflux components of transport  $\text{NH}_4^+$ , because of the intense cytosolic concentration of  $\text{NH}_4^+$  found under  $\text{NH}_4^+$  conditions, are often energy-consuming due to inward plant plasma membrane<sup>18</sup>. Because of the enormous size of  $\text{NH}_4^+$ , the energy consumption in respiratory oxygen could increase<sup>19,20</sup>. But deep root systems extract more water from deeper soil layers as a result of changes in as similar partitioning, where roots grow more (number and depth) during vegetative growth. Partitioning between different shooting components is seldom hindered<sup>21</sup>. aerobic rice farming is a disruptive technology that aims to reduce water consumption, but the vulnerability of rice to aerobic conditions has restricted its progress<sup>22</sup>. Total root biomass variability was mainly due to the individual root growth for aerobic culture. In aerobics, the stomach closing was distinct at the vegetative stage although the soil water production was close to the field power, in part due to poor rooting, vigor<sup>23</sup>. Nitrogen fertilizer as

an Ammonium or nitrate is associated with a release of Green House Gases (GHGs) arrived at 10- 20% from N fertilizer uses in the world<sup>24</sup>. Alternative agronomic approaches can be established for minimizing the use of N-fertilizers through the production and adoption of NUE varieties<sup>25</sup>, the use of molecular breeding inputs, agronomy and nutrient modeling, genetic variation<sup>26</sup>. The usability of  $\text{NO}_3\text{-N}$  seems, therefore, to be impaired in the NUE as well, representing the condition of nature, two carriers family nitrate 1/peptide carrier family (NPF) and 2 families of nitrate carriers (NRT2) were response on uptake and translocation of nitrate in rice<sup>27</sup>. It is still NUE is only about 50-fold<sup>28</sup>, which indicates that there is a big challenge to develop rice plants with a strong NUE capacity<sup>29</sup>. For understanding the pathway regular of N movement in rice root and increasing NUE results from Quality of N-use (NuTE) & quality of N-uptake (NuPE) by increase lateral roots to absorbed more surface area for N uptake<sup>30</sup>. Script enzymes lead to physiology and quantitative genetics in hereditary strategy enhanced proteins that connect N translocations of quantitative traits loci (QTLs)<sup>31</sup>. Obara *et al.*<sup>32</sup> found in the study. Several QTLs were mapped to chromosome regions containing GS2 in rice for agronomic features related to the use and yield of N.

Water management had the association between the root morphological characteristics and the productivity of water use in rained lowlands, deep water, marshland, and rain-fed uplands and irrigated grain<sup>33</sup>. They review the findings of many studies of SRI supporters. It is more important for poor and marginalized farmers because it tends to boost yields in terms of increased radically-based physiological productivity<sup>34</sup>. Nature rice plants become likely to develop a variety of climatic conditions, including sustained aerobic, drought (radical or irregular)<sup>47</sup>, poor soil quality, and floods<sup>35</sup>. Hence, the classification among root epigenetic regulation characteristics desirable for versatility to the unique number of conditions encountered by rice grains, and even the hereditary territories accountable for such plasticity characteristics, can encourage the choice for large tolerance of rice genotypes to variable conditions to maintain reliable output<sup>36</sup>.

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## Materials and methods

### Case 1#

Simulated results of the study by Matsunami *et al.*<sup>36</sup> for four Indica rice varieties (Puluik Arang, Badari Dhan, Shwe Nang Gyi, and Ratul), after transplanting varieties were identified under flooded condition (soil water potentials of -0.02 Megapascals (MPa)) 43% [w/w], and unflooded soil type (probable soil water; -0.10 MPa), 33% [w/w]. Water consumption became assessed about three times every day. Therefore, shooting and root biomass were evaluated at three weeks by extracting all the root and shoot and drying at 80 ° C for more than three days and weighing. Root statistical analysis: measurement of the firing ratio in SAS software (version 6.12, SAS Institute, Cary, NC, USA) and graphed for each case at the excel system 2010.

### Case 2#

This simulated Qun *et al.*<sup>41</sup> survey analyzing two elite check rice (CK) cultivars (SY-63 and HD-5) and super rice (IY-084 and WYJ-24) varieties and water quality. The two cultivars and varieties mature in pots with three soil moisture levels after 11 days from transplantation to maturity, three water specifications have been placed by regulating water distribution in well-watered (WW) (0 kilopascal (kPa), mild water deficit (MWD) (-15±5) kPa and severe water deficit (SWD) (-30±5) kPa. Four pots of each the root and shoot dry weight (gpot-1) measurement has been dried at 70 ° C to continue in the oven during drought. Root: shoot ratio was calculated using the formulas Root/Shoot and Painted on the adoption of the program of Excel 2010.

### Case 3#

Chu *et al.*<sup>44</sup> Two representative cultivars (Chunyou927 (CY-927) and Yongyou538 (YYY-537)) and two representative JIR cultivars (Xiushui09 (XS-09)) and Zhejiang99(ZJ-99)) have been searched for in the field of alternative wetters and severe drying experiments (AWSD), Watered up to 30 kPa of surface capacity and constant flooding with 2-3 cm of precipitation, CF. Precipitation is continually flooded. Upon physiological maturity, the dry matter of each root and shoot was estimated at a constant weight upon drying at 70 ° C and then weighed and

measured by Root: shooting ratio equations for IJHR cultivars in addition to the root of the IJHR: efficiency of shooting and specifications for water were regulated by two irrigation systems based on a mean± standard error at P = 0.05 and graphically based on excel 2010.

## Results and Discussion

### WUE's interaction with root systems

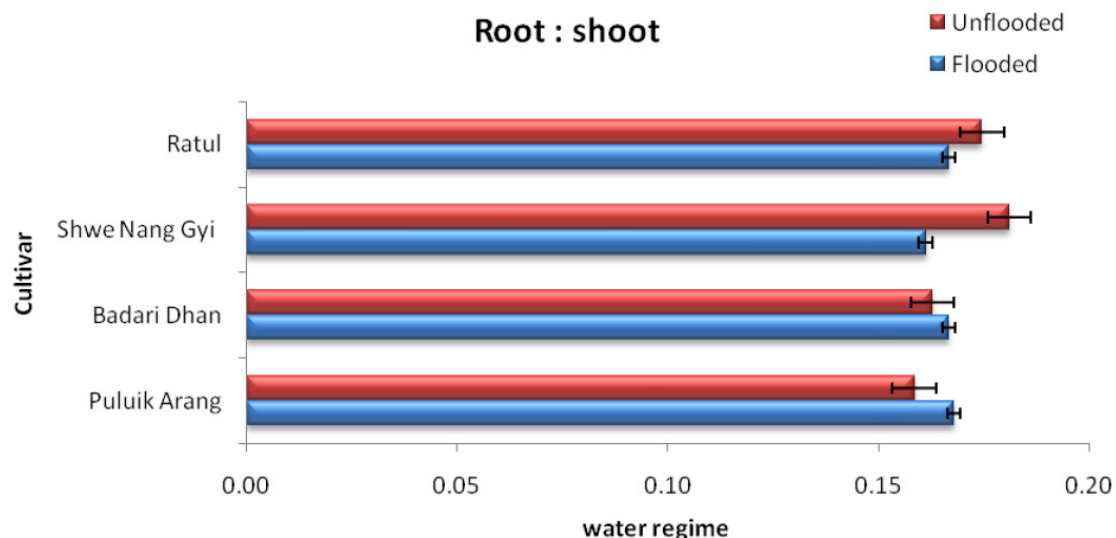
The high-water absorption potential in Figure.1 results in Puluik Arang are more excellent than Badari Dhan for the conservation of root: shoot ratio, while Badari Dhan was significant among the cultivars Ratul and Shwe Nang Gyi. In Puluik Arang, the results were outstanding. Puluik Arang showed no significant root variations under the unflooded condition: shooting between the cultivars (Badari Dhan, Shwe Nang Gyi and Ratul).

Such results confirm the physiologic and morphological characteristics of spark-and-rain cultivar Puluik Arang and Badari Dhan which are prone to unsafe conditions and are thus associated with water absorption and which therefore adds significant bio-mass renewability under a flooded environment. Research showed that genetic variation in root function was essential to better water intake under stressful conditions<sup>50</sup>.

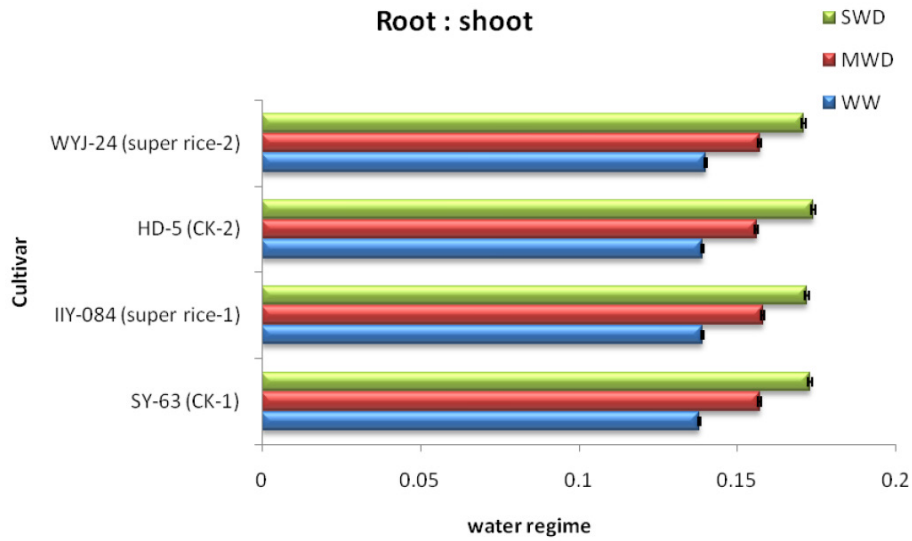
At root: the root ratio was reduced under the flood conditions compared with flooded areas, irrespective of the cultivar. Similar results have been documented in other experiments under soil moisture conditions and were generally limited even when water is mild or the soil is saturated<sup>57,58</sup>.

The findings in figure 2 indicate the same actions as root: corresponding shooting ratio for both crops. When water surpluses rose, significantly below the SWD, moderately below MWD and lowest below the WW, the cultivars decreased considerably and no noticeable difference between the four varieties under WW.

The findings indicate either MWD or SWD: the root ratio decreased as water deficit increased to deal with soil water deficits and is better at growing rice cultivars. The root ratio decreased. No significant difference in moisture treatment between four cultivars: fire ratio showing the greater photosynthetic potential of the root and the snorkel, especially in soil deficits. The expectation is that small root biomass can sustain



**Figure 1.** Mean± Standard Error of Root: Shoot ratio of four rice cultivars subjected to flooded and unflooded conditions. (Figure design depended<sup>36</sup> results at p < 0.05 according to Turkey's test).



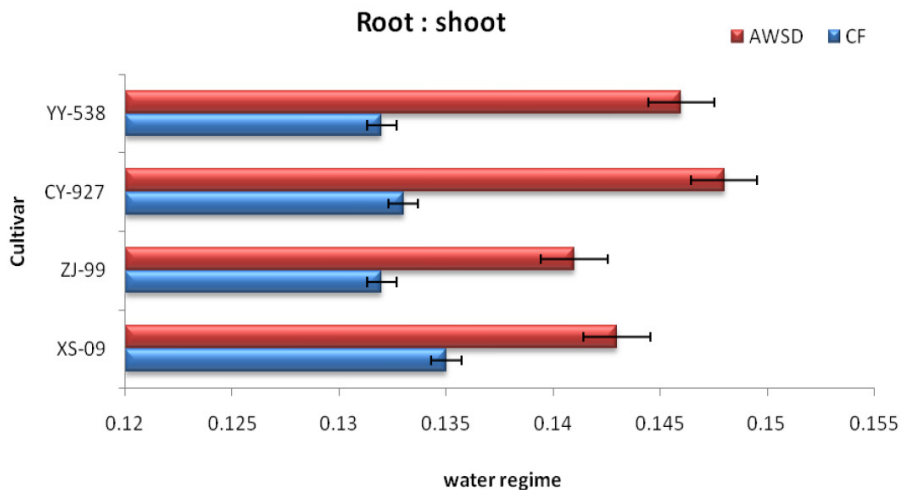
**Figure 2.** Mean  $\pm$  Standard Error of Root: Shoot ratio of four rice cultivars subjected to well-watered (WW), moderate water deficit (MWD), and severe water deficit (SWD) conditions. (Figure design depended on<sup>41</sup> results at  $p < 0.05$  according to Turkey's test)

a strong biomass production over the field, while a deep root distribution will maximize land moisture capture and thus hold plant water in the high condition under dry conditions<sup>39,40</sup>.

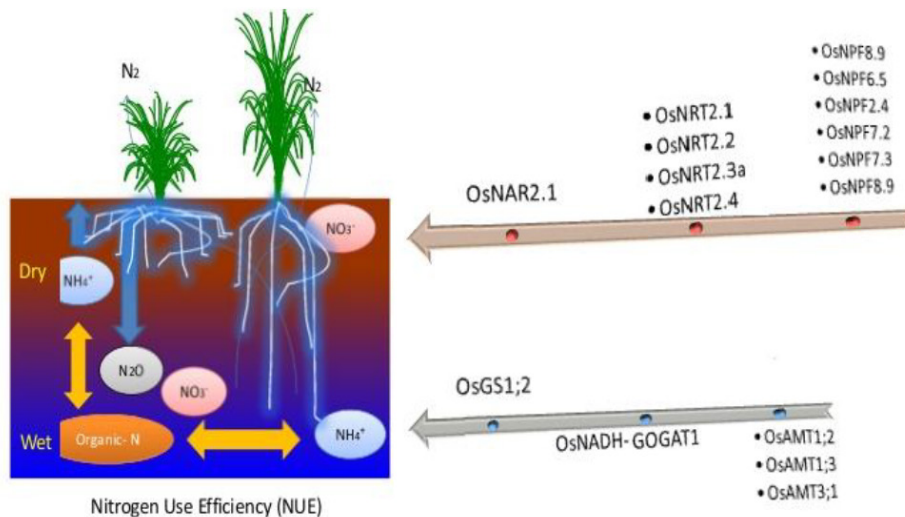
Results in figure 3 show that the AWS D irrigation system was highly significantly increased root: shoot ratio among cultivars relative to CF, with a more significant reduction in CY-927 > YY-538 > XS-09 > ZI-99 varieties consecutively, but also better root: shoot ratio performance and highly under the CF irrigation regime compared with the XS-09 cultivars compared with other cultivars. Larger root: association of shoot with the deeper distribution of root and photosynthesis of plants with IJHR cultivar AWS D irrigation system. The experimental variations were due to changes in the hydrological component of the soil and the pacing of irrigated techniques. Better grains production and WUE for AWMD is mainly due to reduced vegetative residual growth and improved stability of canopy and increased root growth in hormone levels. Increases abscisic acid concentration and cytokinin levels usually during soil drying and decreased carbon transfer from tissue to vegetative grain during rewatering<sup>37,38</sup>.

#### NUE's interaction with root systems

In figure 4 simulated, the analyze the root-shooting and root-soil relationships are the underlying role for higher seed production, the root-sourced hormonal roles in regulating crop development and growth, and the effect of soil moisture and nutrient distribution on root morphology and metabolism. The overall root productivity was significantly lower than in flooded plants due to the reduction in root abundance in the soil. Due to the significant reduction in the number of preventive plants, the role of fast root growth in soil water absorption and, hence, air perspiration survival, the weak ratio of root to shoot and disadvantaged root production in the surface layer of aerobic culture. The root morphology under upland rice included some portion of an ideotype to improve N capture for potential  $\text{NO}_3^-$  passage in the shaped profile at lower depths, but root appropriation varies unambiguously with soil conditions, supplement availability, and mechanical impedance. Upland rice's root morphology is an ideotype for optimizing N collection, extracting nitrate from lower root profiles, but its root distribution varies widely with the soil characteristics, fertilizer



**Figure 3.** Mean  $\pm$  Standard Error of Root: Shoot ratio of four rice cultivars subjected to alternate wetting and severe drying (AWS D) and constant flooding (CF) conditions. (Figure design depended on<sup>44</sup> results at  $p < 0.05$  according to Turkey's test)



**Figure 4.** Schematic description of identified and predicted roles of NRT and NPF family rice nitrate carriers, AMT family ammonium carriers, and GOGAT nitrogen assimilation proteins<sup>32,46</sup>.

efficiency and mechanical impedance. NRT, NAR (OsNAR 2.1, 2.2), OsNRT, has functions for upregulating the transcription of N-use-related genes for both NO<sub>3</sub> and NH<sub>4</sub><sup>+</sup>, and also for floral genes, for the most part of the NO<sub>3</sub>-transport families (OsNRT 2.1; 2.2, 2.3 and 2.4). NPF family members described to date were low-affinity NH<sub>4</sub> transporters, with the especially that OsNPF family (8.9; 6.5; 2.4; 7.2 and 7.3) demonstrated dual-affinity nitrate transportation behavior associated with increased NO<sub>3</sub>- absorption and root-to-shoot transportation. OsNPF6.5, called an OsNPF8.9 putative mRNA splicing drug, has a major impact on both NUE and yield OsNPF8.9, expressed predominantly in root skin and epidermis were cloned to cause N absorbance. Location of OsNPF4.1 in rice panicle elongation and OsNPF8.20 (OsPTR9) role in the absorption of NH<sub>4</sub><sup>+</sup>, lateral root development and decreased kernel yield were shown to work. The NUE-related QTLs and glutamine synthetase 1 (OsGS1;2), OsAMT(1;2, 1;3, and 3;1) and Glutamine oxoglutarate aminotransferase1 (OsNADH-GOGAT1) are affinity with NH<sub>4</sub> transporters<sup>32,43,44,45</sup>. Here we noted that OsNRT (OsNPFs), a member of the rice (*Oryza sativa*) nitrate transporter family 1/peptide transporter, is involved in regulating N intake and yield. Gene over-expression in different cultivars appeared not to affect root size or WUE, being a good candidate gene for optimizing NUE and yield has been significantly improved, these conclusions mean that under stress conditions root uptake increases area uptake<sup>48,49</sup>, root: shoot ratio has finally been correlated with grain uptake N.

## Conclusions

NH<sub>4</sub><sup>+</sup> and NO<sub>3</sub><sup>-</sup> is a major driving factor for growing crop yields, but with considerable flowering delays, prolonging the maturation and thus increasing the risk of yield losses. Therefore, characteristics that use high N levels without slowing ripening are highly desirable for plant breeding. The root morphology for upland and flood rice is part of an ideotype to optimize N aggregation, absorb nitrate at lower root profile depths, but the root distribution varies widely with soil capital, fertilizer quality, and irrigation system. Gene over-expression in different cultivars appeared not to affect yield or NUE or WUE, being a functional candidate gene for optimizing NUE and return has been significantly improved. In rice, these conclusions mean that under stress conditions root uptake increases area

uptake, root: shoot ratio has finally been correlated with grain uptake N.

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