Journal of Pharmacognosy and Phytochemistry 2017; 6(4): 1860-1864

Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(4): 1860-1864
Received: 27-05-2017
Accepted: 28-06-2017

Anjali Dahiya
Department of Chemistry and Biochemistry, CCS Haryana Agricultural University, Hisar, Haryana, India

Ritu Saini
Department of Chemistry and Biochemistry, CCS Haryana Agricultural University, Hisar, Haryana, India

Correspondence
Ritu Saini
Department of Chemistry and Biochemistry, CCS Haryana Agricultural University, Hisar, Haryana, India

Variation in morphological traits of aerobic and lowland *indica* rice genotypes at different stages

Anjali Dahiya and Ritu Saini

Abstract
Rice (*Oryza sativa* L.) is cultivated under flooded lowland conditions and is a single biggest user of fresh water. Overexploitation of groundwater has caused serious problems in many parts of India including Haryana and Punjab. A new development in water saving technologies is the concept of aerobic rice. Rice is considered a drought sensitive crop species, however, aerobic rice withstand water stress. In the present investigation, different morphological traits were studied in aerobic (MAS25, MAS26) and lowland (HKR47, PAU201, HBC 19 and PUSA1121) *indica* rice genotypes, grown under well watered conditions in pots. Root length, fresh root weight and dry root weight declined in all aerobic rice genotypes while, conversely, lowland rice genotypes showed enhancement under well watered environment at late vegetative and reproductive stages.

Keywords: Aerobic, rice, morphology, root biomass

Introduction
Water scarcity is one of the most pressing issues facing agriculture today. Increasing scarcity of water has threatened the traditional rice cultivation practices all over the world. The situation is further provoked by drought, global warming, methane emission, unfavorable climatic changes, over-using of ground water causing aquifer resources to decline and the high “cost” of water. Rice is a single biggest user of fresh water that consumes more than 50 per cent of the water used for irrigation in Asia because majority of the world’s rice is being produced under flooded lowland conditions. Overexploitation of groundwater has caused serious problems in many parts of India including Haryana and Punjab (Bouman and Tuong 2001) [2]. By 2025, it is expected that 2 million ha of Asia’s irrigated dry season rice and 13 million ha of its irrigated wet season rice will experience “physical water scarcity,” and most of the ~22 million ha of irrigated dry season rice in South and Southeast Asia will suffer “economic water scarcity” (Tuong and Bouman 2003) [12]. Declining water resources for rice cultivation has encouraged research on the development of water efficient “aerobic rice” varieties by combining the high-yielding traits of lowland varieties with the drought-resistant characteristics of upland varieties (Belder *et al*. 2005) [2]. Aerobic rice refers to a cultivation system in which rice is dry direct seeded in well-tilled leveled fields with uniform slope under unpuddled conditions. The crop is cultivated under aerobic conditions with no standing water throughout the season. Aerobic rice systems use less water than conventional flooded rice (Toung *et al*. 2005) through the use of rice varieties capable of responding well to reduced water inputs in non-puddled and non-saturated soils (Atlin *et al*. 2006; Peng *et al*. 2006) [1, 11]. The soil is therefore “aerobic” or with oxygen throughout the growing season, as compared to traditional flooded fields, which are “anaerobic.” Rice is characterized by a shallow root system compared with other cereal crops, having limited water extraction below 60 cm (Fukai and Inthapan 1988) [4]. The form of the rice root system also varies with the cultivation method (Yoshida and Hasegawa 1982) [15]. In upland conditions with direct sowing, the root system generally develops deeper roots than in transplanted plantings in lowland conditions (Gowda *et al*. 2011). Compared with traditional lowland rice cultivation, water inputs in aerobic rice are supposed to be less than 50 %, water productivities 64–88 % higher, and less labour. It is hard to say if aerobic rice will replace the traditional rice varieties, but there is no doubt that aerobic rice may find its place in water-short irrigated lowlands, fields on upper slopes or terraces in undulating, rain fed lowlands, favourable uplands etc. The first drought tolerant aerobic rice officially released in India was MAS946-1 in 2006–07, developed through marker assisted selection, by University of Agricultural Sciences, Bangalore, which promised 6.5–7.0 tons of grain yield and 7.0 tons of fodder yield and consume 40 per cent of water as against submerged conditions (Hemamalini *et al*. 2000) [6]. Other varieties such as PMK3 and MAS26

have also been developed for aerobic rice cultivation (Jeyaprakash *et al*. 2005; Veeresh *et al*. 2011) [8, 14]. In this paper, we report the evaluation of two water-efficient aerobic (MAS25, MAS26) and four lowland high-yielding (HKR47, PAU201, Taraori Basmati and Pusa1121) *indica* rice genotypes for morphological components under well watered conditions in pots in a net house.

Material and methods

Plant material

The crop was raised during kharif season in 2014 – 2015 in nethouse of Department of Chemistry and Biochemistry, CCS HAU, Hisar. The experimental material was comprised of Basmati (Taraori Basmati and Pusa1121), *indica* (PAU201 and HKR47) and aerobic rice genotypes (MAS25 and MAS26). MAS25 and MAS26 are the aerobic rice varieties developed by University of Agricultural Sciences, Bangalore. Seeds of various rice varieties were collected from Department of Molecular Biology, Biotechnology & Bioinformatics and Department of Genetics & Plant breeding at CCS HAU Rice Research Station, Kaul, Kaithal (Haryana).

Morphological parameters

All observations were recorded at late vegetative and reproductive stage.

Root length (cm)

The root length of rice seedlings were recorded and expressed in cm.

Fresh root weight (g)

Fresh root weight of rice seedlings were recorded and expressed in grams.

Dry root weight

The seedlings whose fresh root weight was taken, were dried at 800C in an oven till constant weight was obtained. Dry root weight were recorded and expressed in grams.

Statistically analysis

The data was statistically analyzed by using complete randomized design (CRD). The critical difference among variants were calculated at $p \leq 0.05$.

Results and Discussion

Fresh root weight (g)

Fresh root weight was more at reproductive stage as compared to late vegetative stage in lowland rice varieties as well as in aerobic rice varieties under well watered conditions but fresh root weight was more in lowland rice varieties as compared to aerobic rice varieties under well watered conditions at both the stages

Fresh root weight ranged from 4.75 (MAS25) to 7.35 g (HBC19) under well watered conditions at late vegetative stage and from 6.86 (MAS26) to 11.72 g (HBC19) (Fig.1).

Dry root weight (g)

A similar pattern of decline in dry root weight in all the aerobic rice varieties and enhancement in lowland rice varieties under well watered conditions was observed. Dry root weight was more at reproductive stage as compared to late vegetative stage in lowland rice varieties as well as in aerobic rice varieties under well watered conditions. Average dry root weight varied from 1.95 (MAS26) to 3.81 g (HKR47) at late vegetative stage and 3.86 (MAS26) to 7.85 g (HBC19) at reproductive satge in conventional flooded conditions (Fig.2). Hsu *et al*. (2003) reported increase in root dry weight in aerobic rice genotypes when irrigated with 25% less water as compared to normal flooded conditions of rice cultivation. Similarly, Matsuo *et al*. (2009) [10] reported higher fresh and dry root weight in Sensho (upland) as compared to Koshihikar (lowland) varieties in rice. Khakwani *et al*. (2005) [9] postulated that decrease in root dry weight with deep water could be due to reduction of leaf area, which in turn decreases photosynthesis causing reduced flow of carbohydrates from leaves to the roots. Increase in root dry weight in aerobic rice varieties under water limiting aerobic conditions, along with the long, intense and dense root system, indicates that these cultivars have the high potential to penetrate deep into the soil in the quest of water and can fight against drought due to increased biomass of lateral roots.

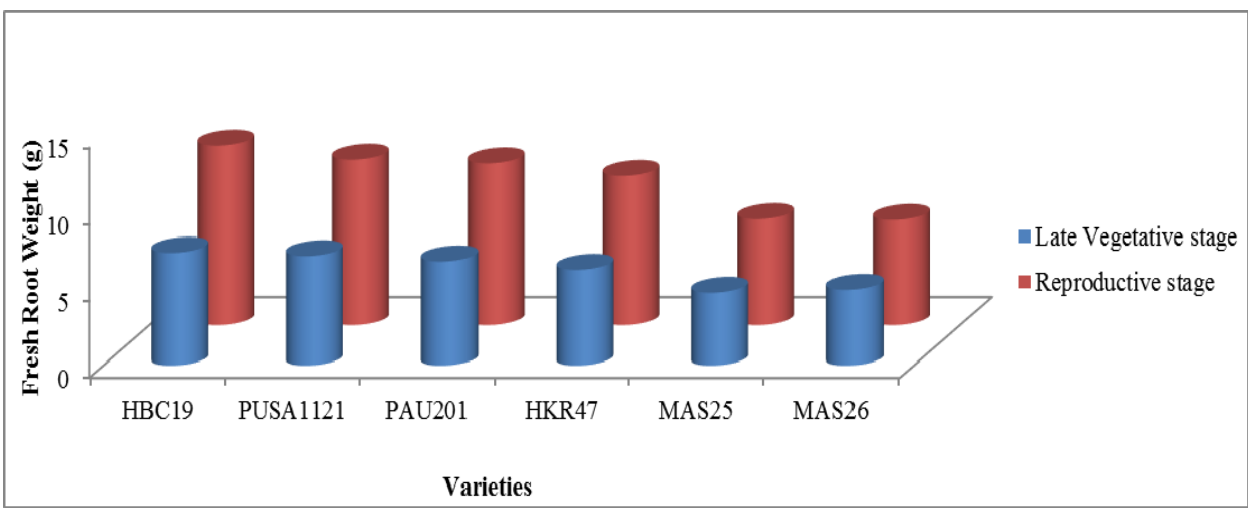

Fig 1: Effect of well watered environment on Fresh root wt. of lowland and aerobic rice varieties at late vegetative and reproductive stages.

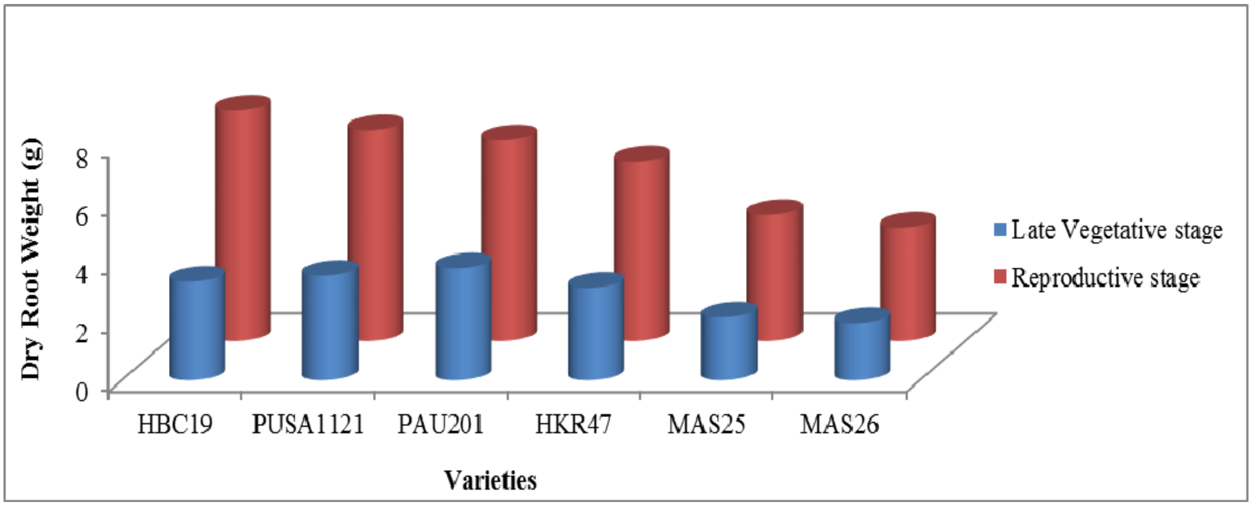

Fig 2: Effect of well watered environment on Dry root wt. of lowland and aerobic rice varieties at late vegetative and reproductive stages.

Root Length

Aerobic rice varieties (MAS25 and MAS26) showed a significant decline in root length under well watered conditions while, conversely, lowland rice varieties (HBC19, HKR47, PUSA1121 and PAU201) showed enhancement in roots length under well watered conditions at both stages but more decline was observed at late vegetative stage. Average root length at late vegetative stage varied between 26.83 (MAS26) and 39.57 cm (HBC19) (Fig. 3). The root is the main part of the plants to absorb water and considered as one of the important components to fight against water scarce conditions. Among the root morphological traits, long and profuse roots are thought to be associated with drought tolerance. In the present investigation, while root length increased in lowland rice varieties, it declined significantly in aerobic varieties under well watered conditions at all the stages of plant growth and development (Fig.3).

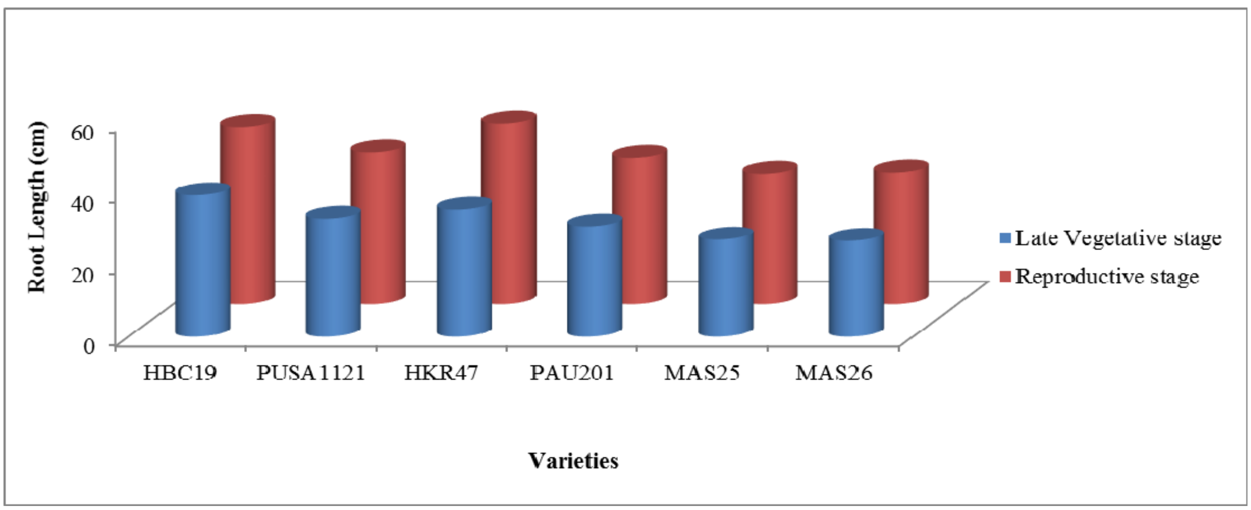

Fig 3: Effect of well watered environment on Root length of lowland and aerobic rice varieties at late vegetative and reproductive stages.

Correlation between Root length and Root Biomass

Results in Fig.4 (A & B) show the significant positive correlations (at p≤0.5) between the root length and root biomass (fresh root weight & dry root weight) under well watered conditions with respect roots at late vegetative and reproductive stages.

At late vegetative stage correlations (R^2) were found to be 0.671 and 0.834 between the root length and root biomass (fresh root weight & dry root weight), respectively (Fig.4 a). Similarly, at reproductive stage, highest correlation was between the root length and dry root weight (R^2= 0.724) (Fig.4 b). Between all the stages, highest positive correlation was observed at late vegetative stage between root length and fresh root weight (R^2= 0.834).

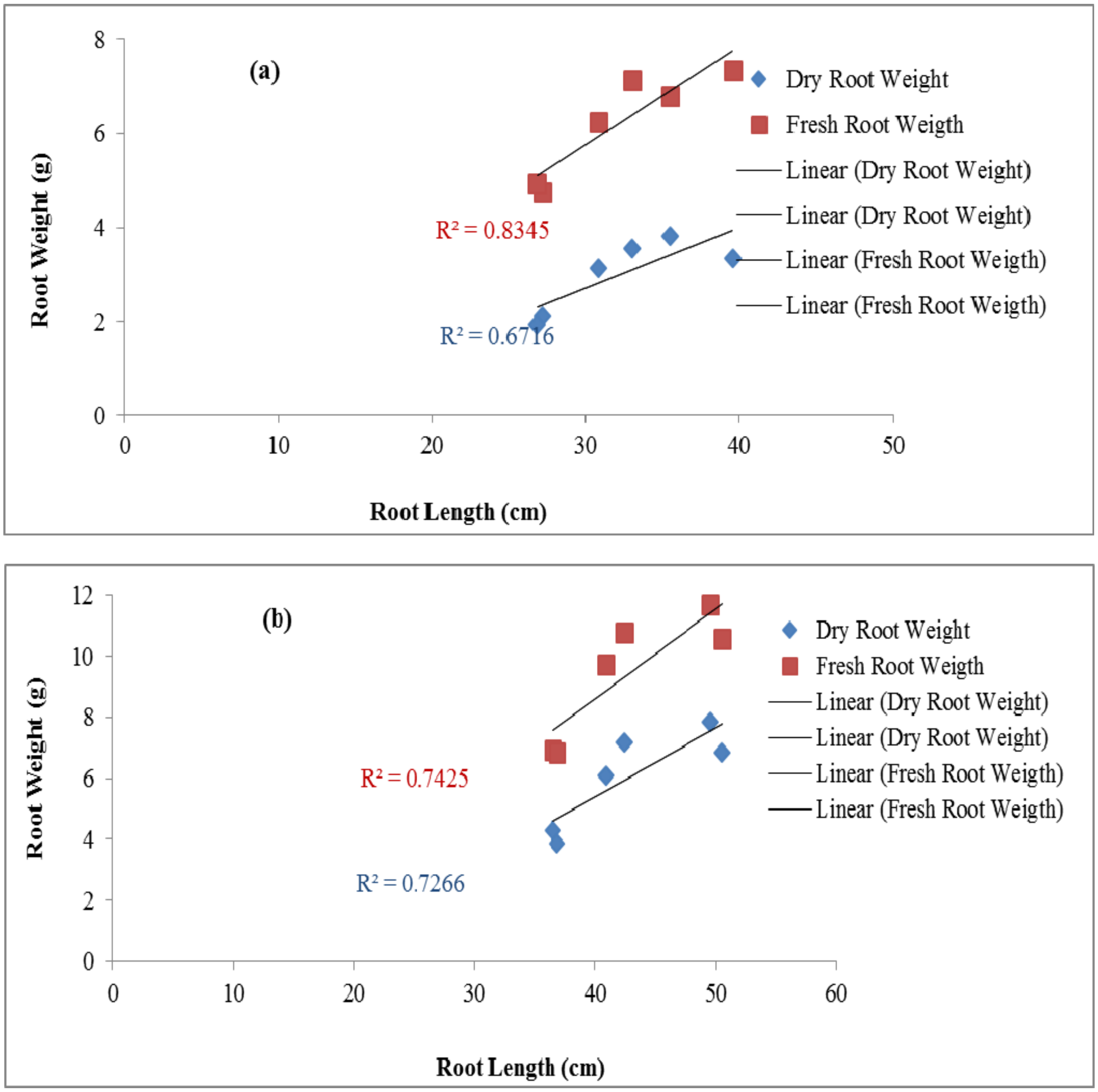

Fig 4: (a) Correlation between root length and root biomass under well watered conditions at late vegetative stage (b) Correlation between root length and root biomass under well watered condition at reproductive stage.

References

1. Atlin GN, Lafitte HR, Tao D, Laza M, Amante M, Courtois B. Developing rice cultivars for high-fertility upland systems in the Asian tropics. Field Crops Res; 2006; 97:43-52.
2. Belder P, Bouman BAM, Spiertz JHJ, Peng S, Castaneda AR, Visperas RM. Crop performance, nitrogen and water use in flooded and aerobic rice. Plant and Soil. 2005; 273:167-182.
3. Bouman BAM, Tuong TP. Field water management to save water and increase its productivity in irrigated rice. Agr Water Manag. 2001; 49(1):11-30.
4. Fukai S, Inthapan P. Growth and yield of rice cultivars under sprinkler irrigation in south-eastern Queensland. Aust J Exp Agric. 1988; 28:249-252.
5. Gowda VRP, Amelia H, Akira Y, Shashidhar HE, Rachid S. Root biology and genetic improvement for drought avoidance in rice. Field Crop Res. 2011; 122:1-13.
6. Hemamalini GS, Shashidhar HE, Hittalmani S. Molecular marker assisted tagging of root morphological traits under two contrasting moisture regimes at peak vegetative stage in rice *Oryza sativa* L. Euphytica. 2000; 112:69-78.
7. Hsu SY, Hsu YT, Kao CH. The effect of polyethylene glycol on proline accumulation in rice leaves. Biological Plantarum. 2003; 46:73-78.
8. Jeyaprakash P, Robin S, Ganesh SK, Subramanian M, Palchamy A, Balasubramaniyan P, *et al*. PMK(R) 3- an early-maturing, drought-tolerant rice variety for Tamil Nadu, India. Int Rice Res Note. 2005; 30(2):14-15.
9. Khakwani AA, Shiraishi M, Zubair M, Baloch MS, Naveed K, Awan I. Effect of seedling age and water depth on morphological and physiological aspects of transplanted rice under high temperature. Journal of Zhejiang Universal Sciences. 2005; 6(5):389-395.
10. Matsuo, Naoki, Kiyoshi O, Toshihiro, Mochizuki. Genotypic differences in root hydraulic conductance of rice (*Oryza sativa* L.) in response to water regimes. Plant Soil. 2009; 316:25-34.
11. Peng S, Bouman BAM, Visperas RM, Castaneda A, Nie L, Park HK. Comparison between aerobic and flooded rice in the tropics: agronomic performance in an eight-season experiment. Field Crops Res. 2006; 96:252-259.
12. Tuong TP, Bouman BAM. Rice production in water-scarce environments. In: Kijne JW, Barker R, Molden D (eds) Waterproductivity in agriculture: limits and

opportunities for improvement. CABI Publishing, UK. 2003, 53-67.
13. Tuong TP, Bouman BAM, Mortimer M. More rice, less water: integrated approaches for increasing water productivity in irrigated rice-based systems in Asia. Plant Prod Sci. 2005; 8:231-241.
14. Veeresh, Desai BK, Vishwanatha S, Anilkumar SN, Rao S, Halepyati AS. Growth and yield of rice Oryza sativa L. varieties as influenced by different methods of planting under aerobic method of cultivation. Res J Agr Sci. 2011; 2(2):298-300.
15. Yoshida S, Hasegawa S. The rice root system: its development and function, In: Drought Resistance in Crops with Emphasis on Rice IRRI, Manila, Philippines. 1982, 97-114.