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Popular Article

Aerobic Rice: Implications and Prospects

Eashan Mukherjee
[1] Ph.D. Research Scholar, Department of Genetics and Plant Breeding, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar-125004, Haryana, India
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Introduction

Rice botanically known as *Oryza sativa* L. belongs to the family poaceae. It is the staple food of a large number of Asian countries and occupies 1/5th of total cultivable land area in the world. It is one of the most important food crops in the world and attributes to a significant proportion of contribution to the world food basket. However, the crop being input-intensive requires huge amounts of water which has become a problem in today's world of decreasing water and land availability. Hence adoption and utilization of newer cultivation systems so as to increase yield, maintain crop productivity and sustainability has become the prime requirement in today's agricultural scenario. In this context, the present article focuses on package and practices involved in adopting aerobic rice cultivation systems to ameliorate crop productions, its advantages, cultivar development specifications, constraints encountered and strategies employed to improve rice production under aerobic system for crop improvement.

Advantages of aerobic rice

Reclamation of water scarce areas experiencing low rainfall and low ground water status was significantly achieved through aerobic rice cultivation. Improvements in overall soil texture and structure were also acquired. Sustainability towards food supply, improving farmers' income, overall crop and water productivity with increased economic gains were achieved. Absence of transplanting and puddling activities in case of aerobic cultivation of rice have also contributed towards improved

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labor management, less labor involvement and less water expenses. Hence overall reduction in cost of cultivation is achieved.

Important cultivars of aerobic rice

Prime consideration to cultivar development for aerobic rice is that the cultivars should be highly responsive to fertilizers and water inputs so as to obtain increase yields. Aerobic rice cultivations have been testified from Brazil wherein increased yields of up to 6t/ha were obtained in comparison to existing cultivars. Characteristically moderate tillering, medium plant height, lodging resistance and erect leaves were prominently exhibited. In China, with additional supplementation from agronomic practices like seed coating, improved herbicide sprays and water managements aerobic rice cultivars have successfully out-yielded the existing cultivars. For example, varieties like HD 297, HD 502 released from China Agricultural University yielded 2 times and 2.3 times more than the existing cultivar JD 305. Prominent institution associated with aerobic rice development and improvement is the International Rice Research Institute (IRRI), Manila, Philippines, wherein effective outcomes have been obtained by bringing a number of cultivars under aerobic cultivation. Significantly, less water expenditures sustained by stable yields were realized. IR 64616H, a semi dwarf hybrid variety of rice when brought under aerobic managements produced a greater number of tillers, increased panicle sizes, short plant stature and henceforth increased yields (~5.3t/ha). In another instance, the variety IR 55423-01 also exhibited similar ideal plant characteristics as mentioned above along with high harvest index. Under aerobic rice cultivation systems, it has also been found that seedlings exhibit a competitive outgrowth over the existing weeds. A positive association has been observed between early seedling vigor and yield. In India, significant investigations towards aerobic rice have been the testing of existing lowland rice accessions and identifying and screening out of potentially high yielding lines. To this effect the variety PMK 3 has been reported to produce economically high yields (~3684 kg/ha) under low input aerobic systems (Amudha et al. 2009).

Constraints to aerobic rice cultivation

A number of factors are responsible for decline in aerobic rice cultivation. Broadly they could be categorized into

1. Biotic,
2. Abiotic and
3. Interaction effect of biotic and abiotic factors

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Among the biotic factors plant parasitic nematodes have caused significant yield losses to aerobic rice cultivation. Among the nematodes Root Knot Nematodes are the primary cause of concern. Among the pathogenic fungi *Pyrenochaeta* sp. were found to significantly affect aerobic rice by production of growth inhibiting substances which delimit seedling growth and plant stand. Nematode infestations further pre-disposed the crops to attack from other micro-organisms. Injury marks on roots paved way for different bacterial and fungal pathogens into the plant systems causing crop losses. Abiotic reasons to aerobic rice yield decline could be attributed to excessive rice monocultures which have led to the accumulation of several toxic soil exudates from crops of the previous season. Auto toxic and allelopathic effects in the soil rhizosphere affecting beneficial micro-flora were observed due to the above-mentioned reasons. Such micronutrient deficiencies are further amplified by soil pH changes such as soil alkalization. Kreye et al. (2009) had mentioned about the soil pH increments from 6.5 to 8 over a continuous 2-year cultivation of aerobic rice at the Dapdap experimental station at Philippines. Interactive effects of biotic and abiotic factors aggravate the yield decline of aerobic rice. Investigations have found cumulative decline in productivity of rice in nematode infested fields with excess soil alkalinity. Ammonia toxicity was also seen to be triggered among the rice fields with stringent monocultures. Thus, all three factors are the major constraints to aerobic rice cultivations. Significant interventions to improve the productivity mitigating the constraints have been discussed below.

Strategies to ameliorate aerobic rice cultivation

Firstly, avoiding crop monocultures in cropping systems have significantly reduced the yield losses in aerobic rice. Practicing crop rotation along with fallow rotations in the field have further improved the status of aerobic rice. Alternate conversion to flooded rice improved soil organic matter content, soil micro-organism status and overall soil health. Crop rotations with legumes like cowpea, faba bean, soya bean have contributed to soil fertility improvement, broken the pathogen and weed cycles and hence reduced the incidence of soil-borne diseases. Across the different forms of fertilizers application of nitrogen in ammonium sulphate form improved the abiotic stress tolerance in aerobic rice. Soil treatment with biocidal chemicals have controlled the pathogens. Heat treatment, fungicidal treatment, pre-sowing herbicide treatment have abated the biotic factors for yield decline. Crop losses due to unwanted alkalization have been reduced through soil acidification with sulphuric acid or gypsum. Besides lowering the soil pH to optimum levels Sulphur application further improved nitrogen availability and uptake (Nie et al. 2012).

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Molecular interventions in aerobic rice

Identification and utilization of major QTLs associated with yield and stress tolerances through marker-assisted selection could work towards aerobic rice crop improvement. Despite elucidation of a large number of major QTLs in rice, most of the QTLs are related stress tolerance rather than yield enhancement. Significantly *qtl12.1* was identified as a major QTL affecting yield, flanked by two simple sequence repeat markers (SSR) namely, RM28048 and RM511 (Bernier et al. 2007). Similarly, another effective QTL qDTY6.1 was identified by Venuprasad et al. (2012) which attributed to stable yields under multiple environments.

Conclusion

The concept of aerobic rice decreases the need of excess irrigations in rice as well as offers a sustainable and comprehensive way out for economic rice cultivation in today's world. Investigations at International Rice Research Institute (IRRI) have elucidated lower water requirements under aerobic systems in addition to improvised yields. Of late the area of research has been expanded over multiple environments and newer varieties well adapted over wide agro-ecological regimes with stable productivities are expected to come forth.

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