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RESEARCH ARTICLE

Screening of morpho-physiological traits for yield enhancement in a recombinant inbred line population of rice under direct-seeded aerobic and conventional transplanted conditions.

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Abstract

Direct seeding of rice (*Oryza sativa* L.) is a resource-conservation technology as it uses water with high efficiency but at the cost of severe reduction in yield. In the present study, recombinant inbred lines (RILs) obtained from a cross between PR 120 x UPLRi 7 were sown as direct-seeded aerobic and conventional transplanted crops respectively for two seasons. Among the various morpho-physiological traits studied, plant height, MTS (Membrane thermo stability) and crop growth rate showed maximum correlation with yield. Plant height and CGR in turn correlated with RGR (relative growth rate).
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Introduction

Rice is one of the most important food crops of the world and staple food for more than half of global population. Traditionally, rice is grown by transplanting 3 to 5 weeks old seedling into puddled fields. Along with high water requirement continuous puddling in the long run causes deterioration of soil physical properties through structural breakdown of soil aggregates. Puddling also forms plough pan that restricts percolation of water causing temporary water logging and restricts root penetration and growth for succeeding crops after rice (Gill *et al* 2006). Further, rice transplanting is labour intensive operation and under changing socio-economic environment, either workers are not available or economically not viable to employ. Therefore alternative methods of establishing rice especially rice that requires less water and labour without sacrificing productivity are needed.

A fundamental approach to reduce water inputs in rice is to grow the crop like an irrigated upland crop. Direct seeding of rice refers to the process of establishing rice crop from seeds sown in the field rather than by transplanting seedlings from the nursery. Raising direct seeded rice into non-puddled soils has been found to save 35–57% water (Singh *et al* 2002). Although aerobic rice has a great potential for saving water but all this is at the cost of severe reduction in yield. A less water availability at reproductive stage is found to be a reason for low yield of aerobic rice (Bouman *et al*. 2002). In rice, the effect of drought varies with the variety, degree and duration of stress and its coincidence with different growth stages (Dwivedi *et al* 2012). Morpho-physiological basis of yield gap between aerobic and flooded rice has not been studied extensively.

Materials and Methods

Plant material: A recombinant inbred line (RIL) population obtained from a cross between PR120 x UPLRi7 was used in this study. PR 120 is a semi dwarf variety while UPLRi7 is an upland variety. F8 generation of this cross was raised at the School of Agricultural Biotechnology, Punjab Agricultural University, Ludhiana.

Crop establishment: The experiment was laid out in two sets viz.,by conventional puddled method and direct seeded aerobic method. The crop nursery was sown during May 2012 and 2013 respectively and the crop was raised as per standard procedure (Anonymous 2012)

Direct seeded aerobic method: The crop was raised in well ploughed field. Seeds were sown at the rate of 8 g per four tiers directly in four rows of 1.5m each with row to row space of 20cm. The crop was irrigated at 3 to 5 days interval. The interval was adjusted with rainfall. Irrigation was stopped10 days before harvesting.

The weeds were controlled by applying recommended herbicide under both the sowing conditions (Anonymous 2012). The crop was harvested manually during September 2012 and 2013 respectively when straw had turned yellow. The harvested crop was threshed manually. Grain samples were collected from respective RILs.

Observations were recorded on five randomly selected plants from each entry line in each. Plant height was measured by using a metre scale from soil to the tip of the topmost leaf. For Crop Growth Rate (CGR), and relative growth rate (RGR), plants were cut at ground level, separated into different parts, oven dried at 60-65^{o} C to a constant weight for ten days and then weighed. CGR and RGR were calculated by using the formula W_2-W_1/T_2-T_1 and lnW_2-lnW_1/T_2-T_1 respectively (where W_2 and W_1 are dry weights of plant material at two stages; T_2 and T_1 is time in days, ln is natural log). Leaf area was calculated with formula LxBx0.75 (where L and B are length and breadth of leaf), chlorophyll was recorded by SPAD meter, and Membrane thermo-stability was calculated from five discs of leaves dipped overnight in distilled water. After 24 hours, conductivity was measured before boiling and after boiling and MTS was calculated using the formula [(C_B-C_A)/C_A] x 100(where C_A and C_B are conductivities after and before boiling respectively).

Results and discussion

Under direct-seeded aerobic condition, the crop yield showed a significant positive correlation with plant height (r=0.251*), MTS (r=0.205*) and crop growth rate (r=0.203*). Under control (conventional transplanted) condition, crop yield showed positive correlation with plant height (r=0.189*), leaf area (r=0.209*), MTS (r=0.209*) and crop growth rate (r=0.173*). In both the sowing condition plant height negatively correlated with RGR (r= -0.100* and r=-0.500*) respectively. Crop growth rate correlated negatively with MTS (r=-0.138*) under direct seeded aerobic conditions and positively (r= 0.222*) under conventional transplanted condition (Table 1 and 2).

Plant height had significant positive correlation with grain yield (Ramanjaneyulu *et al.* 2014). Variable response to water stress was observed at different growth stages of rice cultivars (Basu *et al.* 2008). Tadesse *et al.* (2013) and Thakur *et al.* (2011) reported a higher value of CGR when the fields were aerated by draining the flood water for some time as compared to continuous flooding. This indicated that CGR was negatively affected by prolonged flooding. Leaf area is an important plant trait which is directly linked with the rate of photosynthesis and crop yield. Total leaf area present at flowering greatly affects the amount of assimilates available to the panicles (De Datta 1981). The plant size or leaf area index has a major control over water use under stress. Short stature and small leaf area are generally lead to low productivity because they limit water use. The role of chlorophyll in photosynthesis is well established. An alteration in chlorophyll contents brings changes in photosynthetic rates in the plant (Reddy *et al* 2010). Under aerobic conditions there was decrease in chlorophyll content that was due to water stress (Deka and Baruah 2000).

Conclusion:

Among various traits studied under direct-seeded aerobic and conventional transplanted conditions, plant height, MTS and crop growth rate showed maximum correlation with yield. These morpho-physiological traits can be used as selection criteria for enhancing yield under both the sowing conditions.

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Table 1. Correlation analyses between grain yield and various morphological traits in a recombinant inbred line (RIL) population of rice raised under direct-seeded aerobic conditions.

	Plant height	Leaf area	MTS	Chlorophyll	CGR	RGR	Yield
Plant height	1.000						
Leaf area	0.324*	1.000					
MTS	-0.281*	-0.009	1.000				
Chlorophyll	-0.151*	0.284*	-0.044	1.000			
CGR	0.056	0.057	-0.138*	0.336*	1.000		
RGR	-0.100*	-.0123*	-0.143*	0.427*	0.834*	1.000	
Yield	0.251*	0.074	0.205*	0.084	0.203*	0.000	1.000

*significant at 1%

Table 2. Correlation analyses between grain yield and various morphological traits in a recombinant inbred line (RIL) population of rice raised under conventional transplanted conditions.

	Plant height	**Leaf area**	**MTS**	**Chlorophyll**	**CGR**	**RGR**	**Yield**
Plant height	1.000						
Leaf area	0.097	1.000					
MTS	-0.004	0.130*	1.000				
Chlorophyll	0.031	0.006	0.065	1.000			
CGR	-0.061	0.172*	0.222*	0.080	1.000		
RGR	-0.500*	0.187*	0.095	0.060	0.675*	1.000	
Yield	0.189*	0.209*	0.209*	-0.042	0.173*	0.040	1.000

*significant at 1%