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Direct Seeded Rice (Dsr) Genotypes for Drought Prone Upland Area

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Abstract: Fifty-six genotypes composed of BR, IR and rice-wheat back cross (RWBC) derivatives were evaluated at the DSR drought prone area of Chuadanga. Five genotypes viz. BR5543-5-1-2-4, BR5742-B-15-3-7-2, BR5943-B-10-1-1, BR6058-6-3-3 and IR56463-184-2-1-2 had drought recovering ability. In addition, these lines were grown 6-13 days earlier than the local variety with resistance to lodging. Although, Fulbadami (Local) had significantly longer root length potential than the above genotypes but BR21 showed significantly shorter root system than BR6058-6-3-3 and BR5543-5-1-2-4. Furthermore, BR6058-6-3-3 required significantly longer time for complete leaf rolling than Fulbadami and BR5543-5-1-2-4 was similar to the checks. Again, BR6058-6-3-3 and BR5543-5-1-2-4 showed significantly higher yields (4.0-4.1 t/ha) than Fulbadami (3.2 t/ha) and BR21 (3.1 t/ha). The yield contributing characters of these lines increased significantly over the checks. BR5543-5-1-2-4 and BR6058-6-3-3 therefore, were identified to be the promising genotypes for drought-prone DSR area.

Key words: Upland, drought, direct seeding, rice

Introduction

Drought is one of the major constraints in low rainfall DSR growing areas of Bangladesh. Traditional rice varieties have been grown in these areas due to their adaptability to prevailing drought spell but low grain yield associated with lodging susceptibility. High Yielding Varieties released (BR20, BR21 and BR24) for DSR eco-system, recommended for high rainfall areas (BRRI, 1999). There have been long felt demands of improved genotypes for drought-prone areas.

Relationship with drought resistance to root length was reported by several authors (Armenta-Soto *et al.*, 1983; Kramer, 1983; Ekanayake *et al.*, 1985; Ludlow and Muchow, 1990). Fukai and Cooper (1995) observed the leaf-rolling behaviour as an important trait for drought resistance. This study was conducted to sort out high yielding genotypes with long root system, long period of leaf rolling ability and short growth duration, for drought prone DSR condition.

Materials and methods

Screening trial: Fifty-six advanced breeding lines were screened for drought recover ability at the hot spot drought prone DSR area, Rice-Wheat Site, Chuadanga in 1998. The genotypes were comprised of 21 materials developed at Bangladesh Rice Research Institute (BRRI), 3 by International Rice Research Institute (IRI) and 32 rice-wheat back cross derivatives (RWBC). Local DSR varieties, Fulbadami and BR21 were used as local and standard checks, respectively. The crop seeded on 3 April 1998 and received a prolonged drought stress for 20 days at maximum tillering stage. Observation on the drought recovery score was recorded after 15 days of rainfall, following Standard Evaluation System of Rice (IRRI, 1988). Data on growth duration, plant height and lodging tolerance were taken at maturity.

Yield trial: Seven selected lines from 1998 trial were evaluated for yield potential and component characters at the rice-wheat site, Chuadanga in 1999. BR21 and Fulbadami were used respectively as standard variety and a local check. Direct seeding was done in dry bed condition on 24 April 1999. The unit plot size was 5.0mx2.0m. Line sowing was done at a standard seed rate of 60 kg/ha. A continous seeding was done in lines and the lines were 20 cm apart. The thinning operation was done at 10 days after seedling emergence maintaining 5-10 cm. Fertilizers at the rates of 60:40:40 kg NPK/ha were applied with all amounts of P, K and decomposed cowdung at the rate of 3.0 t/ha. The N fertilizer was applied in two equal splits. The first time of N application was done at weeding and thinning operations (10 days after seedling emergence). The second half of N was applied at the 2nd weeding (40 days after the 1st application). Spraying of insecticide was done to control the infestation of stem borer at the tillering stage. The crop received water stress for a period of six days at the maximum tillering stage. Data on plant height, panicles/m^2, spikelets/panicle, sterility %, 1000-grain weight, and grain yield per plot were recorded at maturity.

Root length potential: This study was done in the screen house of plant physiology division at BRRI Gazipur. The same set of materials for yield trial, mentioned above was studied. Polythene tubes of 15-cm diameter were filled to 75 cm with a mixture of sand and soil in a ratio of 3:1 and were placed on steel frame stand. Six-seven sprouted seeds were sown in each tube on 18 May 1999. Thinning was done at seven days after seedling emergence to keep 3 seedlings in each tube. Fifty ml of standard culture solutions (containing N, P, K, Ca, Mg, Mn, Mo, B, Zn, Cu, Fe and citric acid) were used to irrigate each tube twice a day at 8:00 AM and 3:00 PM for a period of five weeks. The tubes were cut at one side and washed in tap water carefully to get the whole root system intact with the plants. Measurement of root length was taken from the base of the plant up to the tip of the longest root.

Leaf rolling: Same set of materials mentioned above were grown in the upland field of Plant Breeding Division at BRRI Gazipur. The crop was direct seeded on 10th May 1999. Crop management was done, as mentioned above. Flag leaves were collected at 10-11 AM and immediately placed in water bath to keep the leaves in full turgid condition. The excised leaves were placed in incubator in darkness, maintaining 75% RH and 32°C. The time required for complete rolling of leaves was recorded. Five flag leaves of each entry in a set were used

Table 1: Morphological characters and drought recovery score of the selected DSR advanced lines, Rice-Wheat system research, Chuadanga, 1998.

Sr. #	Genotypes	Plant ht. (cm)	Growth duration (days)	Drought recovery score	Lodging resistance score
1	BR5543-5-1-2-4	104	100	3	R
2	BR5943-B-10-1-1	89	99	3	R
3	BR5742-B-15-3-7-2	82	103	3	R
4	IR56463-184-2-1-2	104	105	3	R
5	BR6058-6-3-3	105	99	3	R
6	IR53970-21-2-3-2	123	106	3	MS
7	BR6158-RWBC2-7-9-5-1	125	120	5	S
8	BR21 (Std. variety)	108	104	7	R
9	Fulbadami (L.ck.)	143	107	3	S

Note: R = resistant MS = moderately susceptible S = susceptible

Table 2 Leaf rolling time, root length potentials, and grain yield of DSR genotypes, Rice-Wheat system research, Chuadanga and Gazipur, 1999.

Sl #	Genotypes	Leaf rolling time (min.)	Root length (cm)	Yield (t/ha)
1	BR5543-5-1-2-4	14.5 b	61.5 b	4.0 a
2	BR5943-B-10-1-1	8.2 d	57.5 cd	3.0 c
3	BR5742-B-15-3-7-2	14.5 b	60.5 bc	3.0 c
4	IR56463-184-2-1-2	12.8 c	54.2 de	3.8 ab
5	BR6058-6-3-3	19.5 a	63.1 b	4.1 a
6	IR53970-21-2-3-2	9.2 d	71.7 a	3.5 abc
7	BR6158-RWBC2-7-9-5-1	12.6 c	55.8 de	3.0c
8	BR21 (Std. variety)	14.3 b	52.6 e	3.1 bc
9	Fulbadami (L.ck.)	14.6 b	72.2 a	3.2 bc
LSD (0.05)		1.25	3.07	0.68

Means with similar letter donot differ at 5% level

for each time.

Results and discussions

Screening trial: Table 1 showed the drought recovery, growth duration and lodging tolerance of the seven best lines among 56 test materials. It is important to note that the crop received a prolonged drought spell of twenty days. After the rainfall, only few entries could survive and start growing. BR21, the standard variety poorly recovered its growth. This poor drought recovery of BR21 would be the limitation of its adaptability to drought-prone environment. This result supported the recommendation of growing BR21 in high rainfall area (BRRI, 1999). Seven advanced lines showed drought recovery score similar to the local check Fulbadami except RWBC line that was inferior to the local check but superior to BR21 (Table1). In addition, these lines were 6-13 days earlier than Fulbadami except RWBC line that was 8 days later than the local variety. Appropriate growth duration of a new genotype is considered as important trait to suit the growing condition of a locality. The growth duration of local varieties would be the indicator of the requirement for adaptability. The identification of genotypes earlier in growth duration than Fulbadami would be added advantages of releasing the field in early date for timely transplanting of T. aman rice followed by DSR crop. All the breeding lines had lodging resistantce similar to BR21 at maturity except RWBC line and IR53970-21-2-3-2 which showed lodging susceptibility similar to Fulbadami (Table1). These two lines had the tallest stature among the breeding lines and thus were prone to lodging which was the major weakness of local varieties. The above results indicated that BR5543-5-1-2-4, BR5742-B-15-3-7-2, BR5943-B-10-1-1, BR6058-6-3-3 and IR56463-184-2-1-2 were superior to Fulbadami in respect of short growth duration and resistance to lodging in addition to similar drought recovery ability.

Yield Trial: Significant yield differences were obtained among the genotypes (Table 2). BR6058-6-3-3 and BR5543-5-1-2-4 had similar yield potential and showed significantly higher yield than all the test entries including the checks. Figure 1 showed the component characters contributed to the increase in yield of these lines. BR6058-6-3-3 and BR5543-5-1-2-4 produced significantly higher number of panicles per unit area and spikelets/panicle than all the genotypes and the checks. Although, sterility % was significantly higher in these two lines than Fulbadami but 1000 grain weight plays a positive role to sustain high yield. BR6058-6-3-3 and BR5543-5-1-2-4 thus identified as the promising genotypes for drought prone area.

Root length potential: A significant variation in root length was observed among the rice genotypes (Table 2). Fulbadami produced significantly longer roots than all the genotypes except IR53970-21-2-3-2, similar length. On the other hand, BR6058-6-3-3 and BR5543-5-1-2-4 possessed significantly longer root system than BR21, which had the least potential in this trait. Potentiality to long rooting is a tool of exploring water from deeper soil layers during water stress. Possibly, inefficient rooting habit of BR21 limited its cultivation in drought prone DSR zones and released for high rainfall areas of Bangladesh (BRRI, 1999). Adaptability of Fulbadami in drought-prone area, at Chuadanga was due to its long root system for exploring water from deeper soil layers. Moreover,

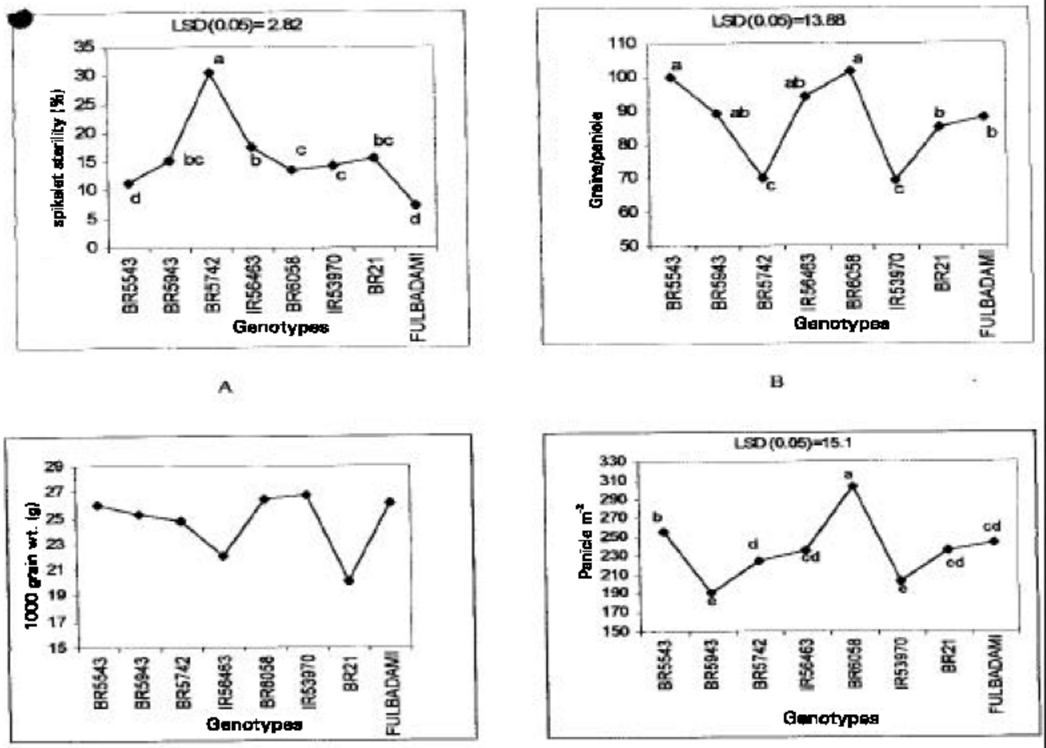

Fig 1: Percent sterility (A), No. of grains/panicle (B), 1000-grain wt. (C), and Panicle/m^2 (D) of DSR Genotypes, Rice-Wheat System Research, Chuadanga, 1999. Squares with the same letter do not differ significantly at 5%.

increase of root length potentials in IR53970-21-2-3-2, BR6058-6-3-3 and BR5543-5-1-2-4 would be an important improvement over the DSR standard variety (BR21).

Leaf rolling: The test materials showed the significant variations for leaf rolling times (Table 2). BR6058-6-3-3 took the longest time to roll the leaves completely. BR5543-5-1-2-4 and BR5742-B-15-3-7-2 showed leaf-rolling times similar to the check varieties (Table 2). One of the simple ways of measuring cuticular resistance is the estimation of time required for complete leaf rolling in darkness at a constant temperature and relative humidity. Longer the period required for rolling, the higher is the cuticular resistance since stomata's are closed and water is lost through cuticle only when turgid leaves are placed in the incubator. Contribution of high cuticular resistance in BR6058-6-3-3 would be a genetic advance over the standard DSR varieties of Bangladesh. Blum (1988) described a similar method for screening drought resistance. He reported that the stomata of the excise leaves closed upon dehydration and cuticular transpiration proceeded as a function of cuticular resistance. Cuticular resistance is thus important to minimize water loss from the plant system.

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