Oryza Vol. 50 No.1, 2013 (76-80)

Screening physiology of rice drought stress protein

R Shukla[1], Aparna Dube[2] and DK Dwivedi[2]
[1] Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh
[2] College of Agriculture, N.D. University of Agriculture and Technology, Kumarganj, Faizabad
Email : rahulbio07@hotmail.com

ABSTRACT

Achieving drought tolerance in rice requires a deeper understanding of the relationship between possible physiological mechanisms available for water stress tolerance and the identification of expressed proteins under adverse conditions. An investigation was carried out at N.D.U.A.T., Kumarganj, Faizabad. The introgression lines and checks were sown under drought stress and control (irrigated) condition. Drought stress situation was applied 60 days after sowing, while in case of control condition optimum moisture was maintained by frequent irrigations. The rice leaves were selected from drought and control conditions, four introgression lines were selected for 12% acryl amide gel electrophoresis, along with two checks IR 64 and NDR 97. Out of four introgression lines two lines IR 82870-26 and IR 82870-29 were susceptible and other two lines IR 82870-2 and IR 82870-11 were drought tolerant. The leaf protein produced novel bandings patterns in two lines IR 82870-2 and IR 82870-11 rice genotypes which also exhibited good response under drought environment.

Key words: *drought protein, rice leaf protein, SDS PAGE, leaf rolling scale*

The knowledge about the extent and nature of association of rice plant characters among themselves and with yield and yield contributing traits would provide a better understanding in improving yield through selection in field as well as in lab conditions. Drought stress is a major constraint to rice production and yield stability in rained ecosystems (Dey and Upadhyaya, 1996). Rice must be made more drought tolerant, but this is a somewhat contradictory objective considering that rice is most commonly grown under flooded conditions. Achieving drought tolerance in rice will require a deeper understanding of the possible physiological mechanisms available for water stress tolerance and the identification of favourable alleles for introgression into rice varieties that otherwise suit specific environments. Drought stress most severely impacts yield when applied during the reproductive stage of the rice plant. By reducing risk and encouraging farmers to invest in yield-increasing inputs, upland rice cultivars with improved drought resistance could result in greater productivity both in drought years and years with adequate rainfall. Progress in breeding for drought resistance has been slow (Fukai and Cooper, 1995). When the traits that need to be improved are low in heritability, MAS may be more efficient than phenotypic selection (Asíns, 2002). Drought tolerant near isogenic introgression lines in the genetic background of IR64, developed at the International Rice Research Institute, Philippines (Dwivedi *et. al.,* 2004), varieties from geographically diverse localities used in hybridization programme of introgression lines, are available for wide testing and several QTLs for drought tolerance have been identified. In the present study, given introgression lines was evaluated in the stress and control conditions at the Student Instructional Farm of NDUAT, Faizabad.

MATERIALS AND METHODS

The material for this study consisted of 18 introgression lines developed in the genetic background of IR-64 and three check varieties namely *IR 64, Nagina-22* and *NDR-97*. The introgression lines and checks were sown in same nursery bed. After 25 days single seedling hill^{-1} were transplanted with three replications under drought stress and control (irrigated) condition. The crop was

Table 1. Mean Performance of Genotypes under Drought Condition

Entries	Leaf rolling	Seedling height (cm)	Leaf seedling^{-1}	Days to 50% flowering	Plant height (cm)	Panicle bearing tillers plant^{-1}	Spikelet panicle^{-1}	Grains spikelet^{-1}	Spikelet fertility (%)	Test weight (g)	Biological yield (g)	Harvest index (%)	Grain yield (g)
IR-82870-2	0.000	23.500	4.400	81.333	88.133	9.400	111.267	80.000	71.933	17.433	35.333	43.467	15.333
IR-82870-4	0.000	22.500	4.467	74.333	82.500	9.000	90.333	71.400	79.167	24.733	26.000	30.500	8.000
IR-82870-6	0.333	25.033	4.533	80.333	84.400	7.600	114.400	82.867	72.367	17.533	28.000	32.267	9.000
IR-82870-8	0.000	19.033	3.600	71.000	82.433	7.400	114.800	93.733	81.633	19.833	33.000	33.433	11.000
IR-82870-10	0.333	26.833	4.000	78.333	90.267	8.067	108.067	84.267	77.967	19.567	31.333	29.933	9.333
IR-82870-11	0.000	23.000	3.733	80.333	89.733	9.667	126.267	101.667	80.600	22.400	37.333	33.800	12.667
IR-82870-12	0.333	27.067	3.867	75.000	79.367	8.200	86.600	66.267	76.467	25.067	26.000	28.133	7.333
IR-82870-13	0.333	26.333	3.200	77.333	96.700	6.533	125.733	106.133	84.433	20.533	27.667	37.467	10.333
IR 82870-14	0.333	25.800	3.467	76.667	81.567	8.467	142.667	117.000	82.000	23.467	34.333	32.833	11.333
IR-82870-17	0.333	24.100	3.867	78.667	75.800	7.800	94.600	75.800	80.133	19.967	27.333	28.000	7.667
IR-82870-19	0.333	23.800	3.600	78.667	81.200	6.000	102.733	83.200	80.967	20.700	24.000	33.733	8.000
IR-82870-21	0.000	21.933	3.267	77.667	88.633	7.500	114.667	91.733	80.000	19.100	31.667	27.333	8.667
IR-82870-22	1.000	26.000	3.867	81.333	84.633	6.800	109.667	87.667	79.967	17.767	25.333	31.467	8.000
IR-82870-26	2.000	24.300	3.400	81.000	82.833	5.867	117.933	88.200	74.833	16.933	28.000	21.500	6.000
IR-82870-29	1.000	24.633	3.200	81.667	84.133	5.600	113.667	91.567	80.567	18.567	26.000	26.967	7.000
IR-82870-31	1.000	24.400	3.000	78.667	82.933	6.400	107.800	84.933	78.933	17.400	24.667	35.267	8.667
IR-82870-34	1.000	25.533	3.000	78.333	84.500	8.067	107.267	90.333	84.167	18.367	32.000	27.033	8.667
IR-82870-35	0.333	27.367	3.000	76.667	82.033	7.800	104.733	78.133	74.633	19.500	35.667	22.533	8.000
IR 64	0.667	18.933	4.433	86.000	82.033	11.600	114.133	96.867	84.833	19.767	41.333	38.700	16.000
Nageena 22	0.333	25.167	3.000	72.667	99.333	8.733	115.533	107.667	93.167	20.267	28.667	35.067	10.000
Narendra 97	0.333	25.833	3.000	71.333	76.967	10.267	70.400	59.600	84.667	17.700	30.000	27.667	8.333

Table 1. Mean Performance of Genotypes under Drought Condition

Entries	Seedling height (cm)	Leaf seedling^{-1}	Days to 50% flowering	Plant height (cm)	Panicle bearing tillers plant^{-1}	Spikelet panicle^{-1}	Grains panicle^{-1}	Spikelet fertility (%)	Test weight (g)	Biological yield (g)	Harvest index (%)	Grain yield (g)
IR-82870-2	23.500	4.400	81.667	87.233	8.533	131.767	110.667	84.133	18.400	37.667	23.067	9.000
IR-82870-4	22.500	4.467	77.667	86.533	9.800	104.467	88.367	84.533	19.367	36.000	33.167	12.000
IR-82870-6	25.033	4.533	82.333	91.667	8.000	144.067	125.333	87.033	24.033	38.000	29.600	13.667
IR-82870-8	19.033	3.600	72.667	89.333	8.733	125.600	115.133	91.767	21.733	36.000	36.967	10.667
IR-82870-10	26.833	4.200	80.667	91. 333	8.733	133.733	111.267	83.233	22.300	40.000	34.967	13.000
IR-82870-11	23.000	3.733	79.000	91.767	8.133	149.600	126.067	84.267	24.767	28.000	40.300	12.000
IR-82870-12	27.067	3.867	77.000	89.933	8.400	103.267	84.533	81.900	29.233	38.667	32.767	12.667
IR-82870-13	26.333	3.200	77.000	96.267	12.000	111.333	94.333	84.800	23.033	45.000	31.167	13.000
IR-82870-14	25.800	3.467	76.667	109.60	9.000	159.800	140.067	87.633	29.067	48.333	31.467	16.333
IR-82870-17	24.100	3.867	80.000	86.333	9.200	130.000	109.500	84.433	19.567	34.667	33.433	11.333
IR-82870-19	3.800	3.600	79.667	92.867	7.800	123.200	107.200	87.067	22.400	32.000	37.400	12.000
IR-82870-21	21.933	3.267	75.667	96.567	9.267	117.000	90.733	77.533	22.933	31.667	33.700	10.667
IR-82870-22	26.000	4.000	83.333	82.867	7.633	126.000	106.067	84.133	23.467	41.667	42.400	17.667
IR-82870-26	24.300	3.400	81.667	96.667	9.867	157.400	131.800	83.733	20.200	29.333	41.600	12.000
IR-82870-29	24.967	3.200	84.333	85.600	10.133	124.800	99.333	79.667	17.300	28.667	49.400	14.000
IR-82870-31	24.400	3.000	81.667	86.533	8.400	119.867	100.200	83.733	21.000	30.667	39.167	12.000
IR-82870-34	25.533	3.000	79.333	84.000	10.000	125.933	106.033	84.200	24.567	36.000	38.833	14.000
IR-82870-35	7.367	3.000	83.667	86.633	8.733	125.733	94.467	75.100	21.100	32.667	34.700	11.333
IR 64	18.933	4.433	80.000	89.167	9.067	111.667	92.400	82.767	22.233	23.333	37.567	16.667
Nageena 22	25.167	3.000	72.000	105.00	13.067	96.067	87.000	90.633	20.200	40.000	36.700	14.667
Narendra 97	25.833	3.000	71.000	78.767	12.267	82.733	71.933	86.967	27.600	24.000	41.433	10.000

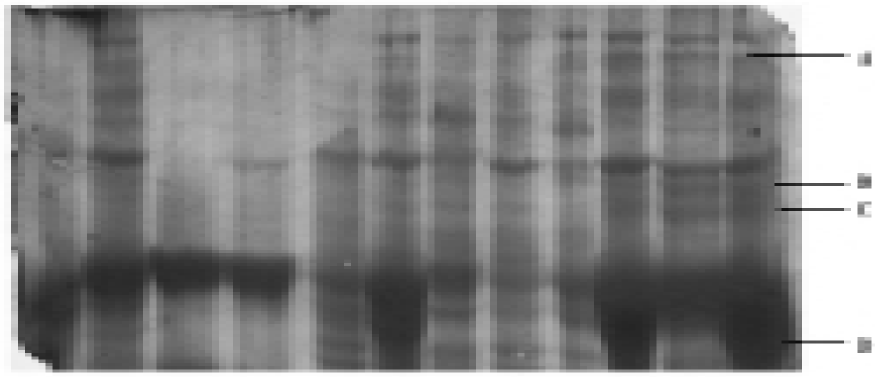

Fig. 2. **SDS PAGE gel of all six rice genotypes under drought and control both conditions**

C	Dt	C	Dt	C	Dt	C	Dt	C	Dt	C	Dt
NDR 97		IR 64		IR 82870-29		IR 82870-26		IR 82870-11		IR 82870-2	
Control				Drought susceptible				Drought Tolerant			

maintained properly at 120:60:60 kg ha^{-1} NPK level. The experiment was initially grown under irrigated condition. Rainfed situation was applied after 60 days of sowing in stress conditions, while in case of control condition optimum moisture was maintained by frequent irrigations. Five plants randomly selected from each accession in each replication for recording the observations on seedling vigour, plant height, leaf rolling, days to 50% flowering, panicle bearing tillers plant^{-1}, spikelet panicle^{-1}, grains panicle^{-1}, spikelet fertility, test weight, biological yield, harvest index and grain yield plant^{-1}. Crude rice leaf protein isolated by the fresh 5*g* rice leafwere cut into small pieces and crushed in sodium phosphate buffer (0.25M, pH 7.0) containing 0.15 NaCl. It was homogenized mechanically and centrifuged at 10,000 *rpm* at 4^{0}C for 20 minutes. This process was done twice. After centrifugation the supernatant was collected. This supernatant was crude rice leaf protein. Protein gel electrophoresis done following the method of Laemmli *et. at,* (1970).

RESULT AND DISCUSSION

Among the high yielding genotypes five most promising genotypes in order of merit were IR 64, IR 82870-2, IR 82870-11, IR 82870-14 and IR 82870-8. IR 64 exhibited good performance for number of leaf, panicle bearing tillers plant^{-1}, number of spikelet panicle^{-1}, number of grain spikelet^{-1}, spikelet fertility, biological yield and harvest index. IR 82870-2 also exhibited good performance for leaf rolling, seedling height, number of leaf, panicle bearing tillers plant^{-1}, spikelet panicle^{-1}, number of grains spikelet^{-1}, biological yield and harvest index under drought conditions. IR 82870-11 exhibited good performance for leaf rolling, seedling height, panicle bearing tillers plant^{-1}, number of spikelet panicle^{-1}, number of grains spikelet^{-1}, spikelet fertility, test weight and biological yield. Swarna showed better performance for leaf rolling, plant height, panicle bearing tillers plant^{-1}, number of spikelet panicle^{-1}, number of grains spikelet^{-1} and biological yield. Under control condition IR 82870-22 showed highest grain yield among the eighteen introgression lines followed by IR 82870-14, Nagina 22, IR 82870-29 and IR 82870-34. IR 82870-22 exhibited good performance for seedling height, number of leaf seedling^{-1}, spikelet panicle^{-1}, grains panicle^{-1}, spikelet fertility, test weight, biological yield and harvest index.

Out of twenty one lines, rice leaves were selected from both the environments *viz.,* drought and control conditions; four introgression lines (ILs) IR 82870-2, IR 82870-11, IR 82870-26 and IR 82870-29 were selected for protein electrophoresis, along with two checks IR 64 and NDR 97. Out of four ILs two lines IR 82870-26 and IR 82870-29 were susceptible and other two lines IR 82870-2 and IR 82870-11 were drought tolerant as evaluated on 0 to 9 leaf rolling scale adopting SES, IRRI (Courtois *et al.*2000) and mean performance of genotypes. The leaf protein of rice genotypes produced novel bandings patterns (A, B, C and D) for a specific protein in two lines IR 82870-2 and IR 82870-11 rice genotypes which also exhibited give good response under drought environment (Salekdeh *et al.,* 2002*;* Ali and Komatsu, 2006; Swain and Baig, 2008; Ke *et al.,* 2009). These genotypes identified on the basis of desirable mean performance and protein screening may be mentioned as elite lines for their probable genetic worth to be incorporate in hybridization programmesas donor parent for improvement of these characters along with drought tolerance.

REFERENCES

Ali G M and Komatsu S 2006. Proteomic analysis of rice leaf sheath during drought stress. J. Proteome Res., 5(2) 396–403.

Asins MJ 2002. Review: Present and future of quantitative trait locus analysis in plant breeding. Plant Breed.121:281–291.

Courtois B, McLaren G, Sinha P K, Prasad K, Yadav R, Shen L 2000. Mapping QTLs associated with drought avoidance in upland rice. Mol Breed6:55–66.

Dey M M and Upadhyaya H K 1996. Yield loss due to drought, cold and submergence tolerance. *In*: Evenson, R. E., Herdt, R.W., Hossain, M. (Eds.), Rice Research in Asia: Progress and Priorities. IRRI in Collaboration with CAB International, UK.

Dwivedi DK, Gao YM, Lafitte R, Vijaykumar CHM, Fu BM, Xu JL, Ali J, Doming JR, Maghirang R, Mackill D and Li ZK 2004. Marker aided breeding for development of drought tolerant IR-64 lines. International symposium on resilient crops for water limited environment, CIMMYT, Mexico (2004).

Fukai S and Cooper M 1995. Development of drought-resistant cultivars using physio-morphological traits in rice. Field Crops Res.40:67–86.

Ke Y, Hanb G, He H and Li J 2009. Differential regulation of proteins and phosphoproteins in rice under drought stress. Biochemical and Biophysical Research Communication 379 (1) 133-138.

Salekdeh G H, Siopongco J, Wade LJ, Ghareyazie B, Bennett J 2002. Proteomic analysis of rice leaves during drought stress and recovery. Proteomics2 (9), 1131 -1145.

Swain P and Baig MJ 2008. Moisture stress induced physiological and biochemical changes in rice varieties. Drought Frontier Project. http:// seeds.irri.org/drought.

Laemmli EK 1970. Cleavage of structural proteins during the assembly of the head of bacteriophage T4. Nature, 227: 680-685.