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Short Note

Identification of Rice Hybrids for Aerobic Condition Based on Yield and Yield Associated Traits

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An experiment was conducted to identify rice hybrids for aerobic condition based on yield and yield associated traits. None of the hybrids showed desirable performance for all the traits studied. Water deficit under aerobic condition decreased the pollen fertility and increased spikelet sterility under aerobic conditions. However, five hybrids *viz.,* IR 68885A / IR 73718-3-1-3-3, IR 67684A / CT-6510-24-1-2, IR 70372A / PSBRC 80, IR 70372A / IR 73718-3-1-3-3 and IR 70369A / IR 73718-3-1-3-3 maintained high pollen /spikelet fertility and recorded higher yield under aerobic conditions. Expression of desirable genes for pollen/spikelet fertility under stress is a desirable trait and these genotypes can be better utilized under aerobic conditions.

Key words: Rice hybrids, Aerobic condition, Pollen fertility, Spikelet fertility.

Rice plays an important role in providing food to two third of the world population particularly in Asian countries. Hence, rice is known as Asia's lifeline. Increasing the current annual rice production of 545 million tonnes to about 700 million tonnes for feeding an additional 650 million people by 2025 is indeed the great challenge for Asia (Cantrell, and Hettel, 2004). Asia's food security depends largely on irrigated rice, which produces three quarters of all rice harvested. However, the increasing scarcity of fresh water threatens the sustainability of the irrigated rice ecosystem (Zhao *et al*., 2009). Hence, shifting gradually from traditional rice production system to growing rice aerobically like an irrigated upland crop, especially in water scarce irrigated lowlands can mitigate the water related problems and help in achieving the challenge. For rice to succeed as an aerobic crop, it should tolerate intermittent water deficits created due to aerobic conditions. Hybrid rice with its vigorous and more active root system tolerates moderate stresses caused due to limited irrigation water and therefore can be exploited under aerobic conditions. So far, there has been no major efforts on this front. Keeping this in view the present investigation was carried out to identify suitable rice hybrids for aerobic condition based on yield and yield associated traits.

Materials and Methods

An experiment was carried with thirty rice hybrids under aerobic conditions at Tamil Nadu Agricultural University, Coimbatore during *rabi,2005*. The experimental material comprising of thirty rice hybrids were obtained by crossing six drought tolerant CGMS lines with five male parents (Testers) in Line x Tester design. Well preserved seeds from the thirty cross combinations were sown in raised nursery beds. Twenty Five days old seedlings were transplanted in the main field in a randomized block design (RBD) replicated twice adopting a spacing of 20 cm between rows and 10 cm between plants. Single seedling was transplanted per hill in single row of two metre length (20 plants per row) in each replication. The transplanted crop was maintained under flooded condition (2-3 cm water layer) for 15 days to ease the establishment of the crop. Thereafter, aerobic condition was imposed *i.e.* irrigation was applied to bring the soil water content in the root zone up to field capacity after it has reached a certain lower threshold (*eg.,* half way between field capacity and wilting point) (Bouman, 2005). A total of 12 irrigations were given during the crop growth period .The soil moisture content was estimated using gravimetric method. All the yield attributes and yield were recorded Panicle harvest index as the ratio of grain weight to the total weight of a single panicle was calculated and expressed as percentage.

Results and Discussion

The mean of various traits studied are given in (Table.1) . Early maturing hybrids are desirable as they are more efficient in partitioning carbohydrate to the panicle (Lafitte and Courtois, 2002) and producing more yield per day under stress. Russo (2004) found that early maturing cultivars were more adapted to aerobic conditions than late maturing ones and suggested earliness as a suitable criterion for selection of improved varieties. In the present study, the hybrids IR 68887A / PSBRC 80, IR 68885A /CT-6510-24-1-2, IR 68885A / IR 73718-3-1-3-3, IR

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Table 1. Mean values of yield and yield components of rice hybrids studied under aerobic condition

Hybrids	Days to 50 % flowering	Plant height at maturity (cm)	No. of tillers per plant	No. of productive tillers per plant	Panicle length (cm)	Pollen fertility (%)	Spikelet fertility (%)	Grain yield (g)	Panicle harvest index(%)	Harvest index
IR 67684A / PSBRC 80	90.50	76.00	10.50	9.95	23.90	90.00**	85.00**	89.22**	12.27	0.55
IR 67684A / PSBRC 82	104.50	69.00**	7.50	6.90	21.00	81.00	79.33**	80.43	9.94	0.53
IR 67684A / CT-6510-24-1-2	87.50	77.25	17.50**	14.20**	24.25	95.50**	90.95**	90.63**	19.78**	0.57**
IR 67684A / IR 73005-23-1-3-3	91.00	72.50**	8.40	5.95	20.90	83.00	78.50**	77.50	8.88	0.52
IR 67684A / IR 73718-3-1-3-3	104.50	70.65**	3.30	2.00	18.88	56.75	41.25	39.36	1.93	0.29
IR 68281A / PSBRC 80	91.50	78.00	9.40	6.25	21.10	83.30	76.01	78.89	11.43	0.39
IR 68281A / PSBRC 82	89.00	83.70	8.90	8.50	22.10	86.25**	79.50**	83.50**	11.01	0.53
IR 68281A / CT-6510-24-1-2	87.50	88.80	10.10	10.10	22.50	81.50	82.50**	84.50**	14.63	0.52
IR 68281A / IR 73005-23-1-3-3	92.00	78.20	10.95	9.80	22.50	89.00**	80.00**	84.10**	8.05	0.55
IR 68281A / IR 73718-3-1-3-3	95.50	78.50	12.85**	10.85**	22.20	94.50**	90.78**	90.83**	15.45	0.53
IR 68885A / PSBRC-80	91.00	79.50	8.00	7.90	20.50	9.00	8.85	24.44	2.23	0.14
IR 68885A / PSBRC-82	92.00	72.25**	9.50	9.25	24.18	90.88**	84.10**	88.93**	9.76	0.54
IR 68885A / CT-6510-24-1-2	83.00**	70.50**	10.10	6.25	21.90	85.00**	82.93**	85.69**	10.91	0.48
IR 68885A / IR 73005-23-1-3-3	98.50	82.90	8.35	8.10	24.50**	91.90**	85.66**	87.15**	13.41	0.53
IR 68885A / IR 73718-3-1-3-3	81.50**	76.00	13.20**	11.50**	24.75**	95.90**	91.10**	91.85**	18.56**	0.57**
IR 68887A / PSBRC 80	82.00**	87.00	8.80	8.16	22.97	76.90	78.75**	79.25	9.69	0.39
IR 68887A / PSBRC 82	85.00**	86.90	9.70	9.00	23.50	85.00**	80.92**	84.44**	12.05	0.54
IR 68887A / CT-6510-24-1-2	98.00	79.70	8.25	7.30	19.80	8.00	7.30	19.00	2.28	0.21
IR 68887A / IR 73005-23-1-3-3	88.50	80.50	9.75	8.25	23.95	92.00**	89.37**	87.22**	15.74**	0.46
IR 68887A / IR 73718-3-1-3-3	90.50	79.17	8.60	8.23	22.20	84.50**	84.25**	84.97**	9.59	0.51
IR 70369A / PSBRC 80	89.50	79.50	7.30	7.00	22.50	91.50**	87.76**	88.46**	16.09**	0.54
IR 70369A / PSBRC 82	93.00	80.50	8.20	7.60	22.10	86.50**	75.50	77.50	13.32	0.55
IR 70369A / CT-6510-24-1-2	88.00	91.80	7.30	7.30	21.50	71.00	70.50	68.56	5.34	0.26
IR 70369A / IR 73005-23-1-3-3	92.50	81.00	9.70	6.25	21.20	92.75**	87.00**	88.56**	13.95	0.52
IR 70369A / IR 73718-3-1-3-3	86.00**	76.50	11.25	10.50	23.90	94.00**	85.00**	90.89**	19.45**	0.56
IR 70372A / PSBRC 80	89.50	78.50	12.50**	11.65**	25.88**	94.80**	87.50**	90.01**	17.39**	0.56
IR 70372A / PSBRC 82	95.50	84.70	9.80	9.05	24.00	83.10	85.25**	84.25**	12.95	0.53
IR 70372A / CT-6510-24-1-2	93.00	91.20	9.80	8.60	25.00**	31.00	22.82	36.50	2.97	0.14
IR 70372A / IR 73005-23-1-3-3	108.50	85.35	9.55	8.70	22.70	89.00**	85.10**	87.83**	12.84	0.51
IR 70372A / IR 73718-3-1-3-3	91.50	89.00	10.20	9.60	24.80**	93.00**	91.17**	85.32**	16.46**	0.55
Mean (Hybrids)	91.68	79.86	9.64	8.48	22.71	79.55	75.15	77.65	11.61	0.46
SEd	1.54	1.63	0.84	0.81	0.66	1.38	0.84	1.16	0.92	0.04
CD at 5 %	4.20	3.23	1.66	1.61	1.31	2.73	1.66	2.30	1.81	0.08
CD at 1 %	5.02	4.29	2.20	2.14	1.74	3.63	2.21	3.06	2.41	0.11

** Significant at 1% level * significant at 5% level

68887A / PSBRC 82 and IR 70369A/ IR 73718-3-1-3-3 exhibited early flowering and were found suitable for aerobic condition.

Hybrids with semi dwarf plant type are preferable and highly productive. In the present investigation, the hybrids IR 67684A / PSBRC 82, IR 68885A / CT-6510-24-1-2, IR 67684A / IR 73718-3-1-3-3, IR 68885A / PSBRC 82 and IR 67684A / IR 73005-23-1-3-3 were found to be highly significant for semi dwarf plant stature and can be utilized under aerobic conditions to overcome lodging.

Atlin *et al.* (2004) stated that selection based on increased panicle number may be a promising avenue for increasing grain yield under aerobic conditions. In the present study, cross combinations IR 67684A / CT-6510-24-1-2, IR 70372A / PSBRC 80, IR 68885A / IR 73718-3-1-3-3 and IR 68281A / IR 73718- 3-1- 3-3 were observed to have profuse tillering and more number of productive tillers per plant. Raju *et al.(* 2005) reported that proliferic tillering would aid in the production of higher leaf areas, higher crop growth rate, and thus, increased yield under water stress.

Hybrids with lengthy panicles are desirable, since the number of spikelets would increase proportionally with the enhancement of panicle length (Krishnaveni *et al.,* 2005). Hybrids with lengthy panicles observed in this study were IR 68885 A/ IR 73005 -23-1-3-3 , IR 68885 A/ IR 73718 -3-1-3-3, IR 70372 A/ PSBRC 80, , IR 70372 A/ CT-6510-24-1-2 and IR 70372 A/ IR 73718-31-3-3.Hybrid combinations involving IR 70372 A as female parent were found to possess higher panicle length.

Niewenhuis *et al.* (2002) and Shashidhar (2007) emphasized that breeding efforts have to be concentrated on the development of aerobic rice cultivars that maintain a high spikelet fertility under aerobic conditions. In the present study, IR 68885A / IR 73718-3-1-3-3, IR 67684A / CT-6510-24-1-2 IR 68281A / IR 73718-3-1-3-3 and IR 70372 A/ IR 73718-3-1-3-3 exhibited high *per se* performance for pollen fertility and spikelet fertility. In general, a reduction in spikelet fertility was observed in the hybrids studied. The reduction in spikelet fertility may be due to poor fertility restoration under aerobic conditions. When the water potential of the panicle decreases during stress, the spikelets dessicate

completely resulting in high spikelet sterility. Reduction in leaf water potential at anthesis may cause poor exertion of the panicle and increase the percentage of sterile spikelets because of pollination abnormalities. (Ekanayake *et al.,* 1989).

Panicle harvest index is used as a secondary trait in the selection of drought tolerant genotypes (Lafitte *et al.* 2003). It was observed that the hybrids which recorded high spikelet fertility were found to possess high panicle harvest index.

Grain yield, an economic output of the plant was found to be highly significant in nine hybrids under aerobic conditions. The hybrid IR 67684A / CT-6510-24-1-2 out yielded the other hybrid combinations by recording 19.78 g/plant, followed by the hybrids,IR 70369A/IR73718-3-1-3-3, IR 68885A / IR 73718-3-1-3-3, IR 70372A / PSBRC 80 and IR 70372A / IR 73718-3-1-3-3. The best hybrid IR 67684A / CT-6510-24-1-2 for grain yield also recorded high *per se* performance for pollen fertility as well as spikelet fertility. Maintenance of high pollen fertility and spikelet fertility even under water stress may be the reasons for higher grain yield in this hybrid.

Zhao *et al*. (2009) stated that aerobic system, requires cultivars that combine moisture stress tolerance with high harvest index. Based on *per se* performance, two hybrids *viz.,* IR 67684A / CT-6510-24-1-2 and IR 68885A/ IR 73718-3-1-3-3 exhibited higher harvest index and these hybrids can be utilized under aerobic condition.

In the present study, none of the hybrids showed desirable performance for all the traits studied. However, five hybrids *viz.,* IR 68885A / IR 73718-3-1-3-3, IR 67684A / CT-6510-24-1-2, IR 70372A / PSBRC 80, IR 70372A / IR 73718-3- 1-3-3 and IR 70369A/IR 73718-3-1-3-3 recorded desirable mean values for maximum characters and exhibited better adaptability to aerobic conditions.

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