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Effect of environmental factors on grain quality traits in hybrid rice

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ABSTRACT

The effect of environmental factors on certain grain quality traits of three notified rice hybrids viz., PA 6201, PA 6444 and KRH-2 and one high-yielding inbred variety IR 64 were studied during wet seasons of 2005 and 2006 at two locations i.e. Simbhaoli and Hyderabad. Milling recovery and head rice recovery increased with increase in ageing from one month to six months and with increase in number of seedlings planted hill^{-1} from 1 to 3. Further, these environmental factors like ageing and number of seedlings planted per hill had no or non-significant effect on chemical characters like amylose content, gelatinization temperature and aroma.

Key words: *hybrid rice, aroma, grain quality, environment*

Although hybrid rice gives higher grain yield than many of the inbred varieties, it is still facing a tough challenge in terms of acceptance from the farmer owing to its poor grain quality specially the head rice recovery. Although the grain quality characters are genetically controlled, they are equally affected by the environmental and agronomic factors like synchronized grain maturity at harvesting, time of harvest, moisture percent at harvesting, ageing and milling conditions (Virmani, 1994).

The current cultivation package recommended for hybrid rice production is transplanting one seedling hill^{-1} with planting density of 33 plants sq.mt.$^{-1}$, as against 3 to 5 seedlings hill^{-1} with planting density of more than 60 plants sq.mt.$^{-1}$ as for the inbred varieties. This is mainly due to the high seed cost associated with hybrids (Pillai, 1996). This different cultivation package in hybrid rice production could be a cause for the differential grain maturity and grain moisture content at harvest, leading to low head rice yield during milling (Sha and Linscombe, 2007).

Keeping all the problems and prospects of hybrid rice production in term of its acceptance as an alternative to traditional rice for increasing rice yield, the present investigation was planned to study the effect of environmental factors on certain quality traits in hybrid rice.

MATERIALS AND METHODS

Three popular hybrids viz., KRH-2, PA 6201 and PA 6444 and one popular high yielding variety IR 64 were taken as test material. The seeds of these varieties were sown in nursery during the wet seasons of 2005 and 2006. Twenty five days old seedlings were carefully transplanted in the main field at two locations i.e. Simbhaoli (Uttar Pradesh) and Hyderabad.

The experiments were laid out in a split - split plot design, with number of seedlings planted hill^{-1} (1, 2, and 3 seedlings) as main plot, plant density (33, 44 and 67 plants sq.m^{-1})as sub-plot and genotypes (4 varieties) as sub-sub plots in three replications. Standard cultural practices were adopted to raise a healthy crop. All the plots were separately harvested at 18-20% grain moisture and dried under shade till the moisture content reached 14%. Three samples of 1 kg each from each plot was taken and stored for ageing at room temperature. Data on milling yield (%), head rice recovery (%), amylose content (%), gelatinization temperature and aroma were recorded after one, three and six months of ageing.

RESULTS AND DISCUSSION

Perusal of the data revealed that with increase in number of seedling hill^{-1}, milling and head rice recovery increased. The milling and head rice recovery increased significantly from one seedling hill^{-1} to two seedlings

hill^{-1} in some cases. This increase in milling and head rice recovery may be due to the higher number of effective tillers in three seedlings hill^{-1} than two seedlings hill^{-1} and one seedling hill^{-1} (Table 1 and 2). The mean values indicated that head rice recovery increased due to ageing of grains from one month to six month. A similar increase in head rice recovery was observed due to increase in number of seedlings planted per hill from one seedling hill^{-1} to three seedlings hill^{-1}, suggesting that the number of seedling planted/ hill had superior positive effect on head rice recovery. Milling recovery after six months (M6) recorded the highest mean values followed by M3 (milling recovery after three months of ageing) experiments indicating the positive effect of ageing on milling recovery. Sulochana and Dakshinamurthy (2002) also reported that milling after six months of storage reduced milling breakage. The mean values for head rice recovery recorded at Hyderabad in 2005 and 2006 were relatively higher at all ageing durations than at Simbhaoli 2005 and 2006. This could be due to less humid environment at Hyderabad that was conducive for reducing breakage. Khush *et al*.(1979) had also reported that humidity at ripening and post-harvest handling operations influenced the grain breakage during milling. Further, the number of seedlings planted hill^{-1} did not show any significant differences on amylose content, gelatinization temperature and aroma at all duration of ageing (Table 3, 4 and 5) which suggest that milling and head rice recovery could be increased by increasing the number of seedlings planted hill^{-1} without compromising on cooking and eating qualities of rice. Further, it was also observed that PA 6444 was aromatic in all durations of ageing at Simbhaoli but it lost its aroma in some cases after three and six months of ageing at Hyderabad location (Table 5). It indicates that aroma could be lost in some genotypes under warmer temperatures prevailing during maturity and storage. Rao *et al*. (2000) and Xu *et al*. (2006) had also reported that at low day mean temperatures aroma was superior than at higher day mean temperatures.

Table 1. Effect of number of seedlings planted hill^{-1} on milling recovery in the four experiments

Planting density	Hyderabd WS 2005			Hyderabd WS 2006			Simbhaoli 2005			Simbhaoli 2006		
	M1	M3	M6	M1	M3	M6	M1	M3	M6	M1	M3	M6
S1 (1 seedling hill^{-1})	62.91	67.56	68.94	62.35	66.97	68.24	59.97	64.61	67.56	64.72	67.54	68.74
S2 (2 seedlings hill^{-1})	67.38^{a}	69.85	71.68^{a}	66.43^{a}	69.00^{a}	70.66^{a}	64.14^{a}	66.73	69.84	68.83^{a}	69.57	71.12^{a}
S3 (3 seedlings hill^{-1})	68.80^{b}	71.74^{b}	73.12^{b}	67.98^{b}	71.17^{b}	72.31^{b}	65.45^{b}	68.40^{b}	71.74^{b}	70.15^{b}	71.30^{b}	72.71^{b}
Mean	66.36	69.72	71.25	65.59	69.05	70.40	63.19	66.58	69.72	67.90	69.47	70.86
SE	1.18	0.98	0.92	1.08	0.90	0.83	1.09	0.92	0.98	1.14	0.91	0.84
CD (P=0.05)	3.32	2.75	2.58	3.03	2.53	2.32	3.06	2.58	2.75	3.21	2.54	2.35

a=S1 vs. S2; b=S1 vs. S3; means differ significantly at P= 0.05. WS - wet season
M1, M3 and M6 = Milling recovery at 1, 3 and 6 months of ageing, respectively.

Table 2. Effect of number of seedlings planted hill^{-1} on head rice recovery in the four experiments

Planting density	Hyderabd WS 2005			Hyderabd WS 2006			Simbhaoli 2005			Simbhaoli 2006		
	H1	H3	H6	H1	H3	H6	H1	H3	H6	H1	H3	H6
S1 (1 seedlinghill^{-1})	54.50	59.16	60.55	54.15	57.75	59.95	52.76	57.16	57.54	53.24	57.04	59.20
S2 (2 seedlingshill^{-1})	59.23^{a}	61.69	63.54^{a}	58.24^{a}	60.20	62.70^{a}	57.20^{a}	59.51	60.01	58.00^{a}	59.32	61.83
S3 (3 seedlingshill^{-1})	60.88^{b}	63.82^{b}	65.21^{b}	60.82^{b}	62.27^{b}	64.15^{b}	58.57^{b}	61.53^{b}	61.53^{b}	59.51^{b}	61.27^{b}	63.64^{b}
Mean	58.20	61.55	63.10	57.74	60.06	62.27	56.17	59.40	59.69	56.92	59.21	61.56
SE	1.25	1.09	1.01	1.23	1.01	0.96	1.15	1.03	0.89	1.21	1.04	0.96
CD (P=0.05)	3.50	3.07	2.84	3.45	2.83	2.70	3.22	2.90	2.50	3.40	2.91	2.70

a=S1 vs. S2; b=S1 vs. S3; means differ significantly at P= 0.05. WS - wet season
H1, H3 and H6 = Head rice recovery at 1, 3 and 6 months of ageing, respectively.

Table 3. Effect of number of seedlings planted hill^{-1} on amylase content in the four experiments

Planting density	Hyderabd WS 2005			Hyderabd WS 2006			Simbhaoli 2005			Simbhaoli 2006		
	A1	A3	A6	A1	A3	A6	A1	A3	A6	A1	A3	A6
S1 (1 seedling hill^{-1})	22.19	22.01	22.90	21.86	21.66	22.28	22.64	22.15	22.53	21.84	22.61	22.54
S2 (2 seedlings hill^{-1})	22.06	21.99	23.22	21.86	21.66	22.44	22.50	22.17	22.70	21.65	21.91	22.39
S3 (3 seedlings hill^{-1})	22.13	21.89	22.81	21.99	21.54	22.18	22.63	22.06	22.44	21.71	22.18	22.34
Mean	22.13	21.97	22.98	21.90	21.62	22.30	22.59	22.13	22.55	21.73	22.23	22.42
SE	1.01	0.38	0.41	0.34	0.35	0.37	0.35	0.35	0.37	0.36	0.37	0.38
CD (P=0.05)	2.84	1.06	1.16	0.96	0.97	1.04	0.97	0.97	1.04	1.04	1.04	1.05

A1, A3 and A6 = Amylose content at 1, 3 and 6 months of ageing, respectively.

Table 4. Effect of number of seedlings planted hill^{-1} on gelatinization temperature in the four experiments

Planting density	Hyderabd WS 2005			Hyderabd WS 2006			Simbhaoli 2005			Simbhaoli 2006		
	G1	G3	G6	G1	G3	G6	G1	G3	G6	G1	G3	G6
S1 (1 seedling hill^{-1})	4.70	4.66	4.72	4.62	4.37	4.56	4.63	4.74	4.77	4.53	4.59	4.70
S2 (2 seedlings hill^{-1})	4.75	4.72	4.79	4.66	4.39	4.59	4.68	4.79	4.83	4.59	4.63	4.75
S3 (3 seedling hill^{-1})	4.71	4.68	4.75	4.65	4.37	4.56	4.66	4.76	4.81	4.54	4.60	4.71
Mean	4.72	4.69	4.75	4.64	4.37	4.56	4.66	4.76	4.80	4.55	4.61	4.72
SE	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
CD (P=0.05)	0.26	0.26	0.26	0.25	0.24	0.24	0.24	0.25	0.24	0.25	0.26	0.26

G1, G3 and G6 = Gelatinization temperature at 1, 3 and 6 months of ageing, respectively.

Table 5. Effect of number of seedlings planted hill^{-1} on aroma in the four experiments

Planting density	Hyderabd WS 2005			Hyderabd WS 2006			Simbhaoli 2005			Simbhaoli 2006		
	AR1	AR3	AR6	AR1	AR3	AR6	AR1	AR3	AR6	AR1	AR3	AR6
S1 (1 seedling hill^{-1})	0.75	0.75	0.64	0.75	0.67	0.61	0.75	0.75	0.75	0.75	0.75	0.75
S2 (2 seedlings hill^{-1})	0.75	0.75	0.69	0.75	0.69	0.64	0.75	0.75	0.75	0.75	0.75	0.75
S3 (3 seedlings hill^{-1})	0.75	0.75	0.72	0.75	0.72	0.67	0.75	0.75	0.75	0.75	0.75	0.75
Mean	0.75	0.75	0.69	0.75	0.69	0.63	0.75	0.75	0.75	0.75	0.75	0.75
SE	0.07	0.07	0.08	0.07	0.08	0.08	0.07	0.07	0.07	0.07	0.07	0.07
CD (P=0.05)	0.21	0.21	0.22	0.21	0.22	0.23	0.21	0.21	0.21	0.21	0.21	0.21

AR1, AR3 and AR6 = Aroma at 1, 3 and 6 months of ageing, respectively.

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