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RESEARCH ARTICLE

Evaluation of morphological parameters in relation to seed yield in aromatic rice during *Kharif*

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SUMMARY

A study was undertaken to evaluate the morphological parameters, dry matter production and yield in eight aromatic rice genotypes during *Kharif* 2010-2011. The aromatic rice genotypes differed significantly with respect to plant height, number of tillers, number of leaves, root parameter (root length, root volume and root weight), area of top three leaves including flag leaf, yield and harvest index. Results on morphological characteristics measurement showed that highest plant height and lowest plant heights were recorded in genotype Chittimuthyalu and RNR 2378, respectively. Maximum number of tillers and number of leaves were recorded in genotype RNR 2354. Root parameters like root length, root volume and root weight were highest in genotype RNR 2354 and lowest in Pusa1121. Maximum combined leaf area of first three leaves from the top including flag leaf were found in genotype RNR 2354 and minimum was recorded with genotype Pusa1121. Highest dry matter and grain yield were recorded in genotype RNR 2354 and the lowest grain yield was recorded by Pusa 1121. Root volume, root weight, root length, number of leaves, number of effective tillers and flag leaf area were found positively associated with dry matter production and grain yield in aromatic rice.

Key Words : Number of tillers, Leaf number, Flag leaf area, Root parameters, Dry matter production, Yield

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Aromatic rice is known for its characteristic fragrance when cooked.This constitutes a small but special group of rice, which is considered best in quality. Aromatic varieties fetch higher price in rice market than the non-aromatic ones.Cultivation of aromatic rice has been gaining popularity over the recent years, because of its huge demand for both internal consumption and export. Identifying promising morphological traits associated with quality and yield plays an important role in varietal development programs. Development of rice cultivars with a high yielding ability is one of the most fundamental approaches for dealing with the expected increase in the world demand. Morphological parameters *viz.*, leaf number, root length, root weight and root volume, number of effective tillers and area of top three leaves including flag leaf are associated with grain yield and dry matter. The objective of this study was to characterize morphological characters in relation to grain yield in aromatic rice cultivars.

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MATERIAL AND METHODS

A field experiment was carried out during *Kharif* 2010-2011 at Students' Farm, College of Agriculture, Rajendranagar, Hyderabad with eight aromatic rice genotypes *viz.*, PUSA-1121, Chittimuthyalu, Godavari Isukalu, RNR-19186, RNR-2378, RNR 2354, RNR-2465 and Sumathi. The experiment was laid out in Randomized Block Design with three replications. Nursery was sown on 15 th July, 2010 and transplanted after thirty five days in main field by following a spacing of 20x15 cm. Fertilizers were applied in the form of urea, single super phosphate and muriate of potash at the rate of 100:60:40 N, P_2O_5 and K_2O kg ha^{-1}. Scheduled irrigation and weed management were followed. Later

harvesting and threshing were done.

Observations were recorded at fortnightly interval. Plant height was measured from the base of the stem to the tip of the longest leaf during vegetative stage and from ground level to the tip of the panicle of the tallest tiller after panicle emergence. The number of tillers in five hills was counted and computed per square meter. Total number of leaves was determined by counting the leaves from the top to bottom of all the tillers in a hill and the mean values of the five hills was taken from each genotype and was expressed per hill basis and leaf area was measured by using LI-3100 leaf area meter (LICOR-Lincoln, Nebraska, USA). Dry matter of the plant and root was recorded at fortnightly interval by destructive sampling of five hills from the third row in every plot. After shade drying, the samples were subjected to 70°C temperature in hot air oven till constant weights were obtained. After complete drying, dry matter was expressed in g m^{-2}. Root length was measured using a standard scale from the ground level to the tip of the root. Root volume was measured by water displacement method by dipping the properly washed roots in a 1000 ml measuring cylinder containing water up to a certain point. Root volume was determined by displaced water (in ml) in the cylinder after root dipping. Mean of five values was obtained and expressed as root length and volume per hill, respectively.At harvest weight of grains and straw were recorded.

RESULTS AND DISCUSSION

A significant difference for the plant height among the genotype throughout the growth stages was observed (Table 1). Growth in terms of plant height increased rapidly up to 60 DAT later the increase in plant height was not much up to maturity. Maximum plant height at harvesting was recorded in genotype Chittimuthyalu (133.9 cm) and minimum was recorded in genotypes RNR 2378 (82.8cm), similar results were also reported by Sinha *et al*. (2009).

The size of photosynthetic surface in terms of number of leaves per hill was found significantly different in all cultivars of aromatic rice and increased from 15 DAT to 60 DAT thereafter declined till maturity (Table 2). Maximum number of leaves per hill was recorded in RNR 2354 during all growth stages and minimum number of leaves was found in Godavari Isukalu. The decrease in leaf number towards maturity can be attributed to senescence of older leaves. Leaf number is determined by temperature, photoperiod and genetic

Table 1: Plant height (cm) in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting					
	15	30	45	60	75	90
Pusa1121	53.4	73.4	91.1	92.2	94.2	95.8
Chittimuthyalu	58.3	78.7	107.4	120.5	131.0	133.9
Godavari Isukalu	58.4	76.7	100.2	113.2	124.2	126.7
RNR 19186	51.6	68.4	88.9	93.7	95.5	96.9
RNR 2378	42.2	56.9	76.2	80.2	81.9	82.8
RNR 2354	51.3	64.9	79.5	83.2	84.6	85.5
RNR 2465	48.2	63.0	79.5	82.9	83.8	84.7
Sumathi	47.0	64.0	81.4	90.3	97.4	100.2
S.E.±	0.75	0.82	1.09	0.36	0.67	0.59
C.D. (0.05)	2.29	2.48	3.32	1.11	2.05	1.81

Table 2: Number of leaves $hill^{-1}$ in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting					
	15	30	45	60	75	90
Pusa1121	16.00	39.00	42.00	47.33	37.33	32.33
Chittimuthyalu	15.00	34.33	41.33	45.00	39.00	33.00
Godavari Isukalu	12.33	37.33	39.00	42.33	36.33	31.33
RNR 19186	16.33	44.33	47.33	54.00	40.00	34.33
RNR 2378	18.00	35.33	46.00	54.33	43.33	37.00
RNR 2354	17.33	49.00	51.00	61.00	46.33	41.33
RNR 2465	17.00	42.00	43.00	47.00	39.00	34.00
Sumathi	17.00	40.00	42.00	48.00	34.33	30.00
SEm±	0.97	2.69	2.27	1.85	2.06	1.82
CD (0.05)	2.95	8.16	6.89	5.63	6.24	5.52

characteristics in rice (Streck *et al*., 2008). Higher numbers of leaves with consequently higher photosynthetic productivity are responsible for high yields in rice varieties (Thwe and Zamora, 2009).

The number of tillers per square meter was significantly different among the aromatic rice genotypes at 60 DAT stage only and rest of the stages showed no significant variation for number of tillers per meter square. Progressive increase for number of tillers per square meter was found up to 60 DAT after that declined up to the maturity because of drying of unproductive tillers (Table 3). Maximum number of effective tillers per square meter (308) was produced by the genotype

Table 3: Number of tillers m^{-2} in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting					
	15	30	45	60	75	90
Pusa1121	133	267	319	377	297	264
Chittimuthyalu	111	244	308	334	286	264
Godavari Isukalu	89	256	308	333	286	275
RNR 19186	155	322	374	400	341	298
RNR 2378	133	287	352	389	308	297
RNR 2354	156	321	374	422	341	308
RNR 2465	155	289	319	334	286	275
Sumathi	133	322	319	411	286	275
S.E.±	15.5	22.2	19.8	18.1	25.0	16.4
C.D. (0.05)	NS	NS	NS	55.0	NS	NS

NS=Non-significant

Table 4: Root length (cm) in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting					
	15	30	45	60	75	90
Pusa1121	9.3	16.2	20.5	22.0	22.1	22.2
Chittimuthyalu	12.2	22.1	22.5	25.0	25.0	25.1
Godavari Isukalu	11.6	20.5	22.5	24.5	24.5	24.5
RNR 19186	12.8	17.5	21.5	26.0	26.0	26.1
RNR 2378	9.5	17.7	20.5	24.0	24.6	24.8
RNR 2354	13.3	22.7	24.5	27.5	27.5	27.6
RNR 2465	13.2	20.8	21.5	23.0	23.0	23.1
Sumathi	11.8	20.5	26.0	27.0	27.0	27.1
S.E.±	0.59	0.39	1.12	0.37	0.95	0.92
C.D. (0.05)	1.81	1.18	3.40	2.23	2.88	2.79

Table 5: Root volume (ml $hill^{-1}$) in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting				
	30	45	60	75	90
Pusa1121	10.2	19.0	25.0	23.4	19.0
Chittimuthyalu	15.7	24.7	28.0	27.0	22.5
Godavari Isukalu	14.2	24.0	26.0	24.5	20.5
RNR 19186	24.0	25.5	28.1	27.0	22.5
RNR 2378	14.2	24.5	29.5	25.5	22.9
RNR 2354	24.2	27.0	37.5	30.5	26.5
RNR 2465	18.7	24.5	30.5	29.0	21.7
Sumathi	17.5	23.5	34.5	28.5	25.5
S.E.±	0.57	1.94	1.75	1.45	0.78
C.D. (0.05)	1.73	NS	5.32	NS	2.37

NS=Non-significant

RNR 2354 and where as minimum of 264 were produced in Pusa1121 and Chittimuthyalu (264) at harvest. The difference in the tiller production among cultivars may be attributed to varietal character (Enamul Kabir *et al.*, 2004). Effective tillers were positively associated with grain yield in rice.

Significant variation was found for root length among the aromatic rice genotypes tested. Root length increased gradually up to 75 DAT after that the increase was very negligible (Table 4). Maximum root length of 27.6 cm was recorded in genotypes RNR 2354 at 90 DAT and minimum of

Table 6: Root weight (g hill^{-1}) in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting					
	15	30	45	60	75	90
Pusa1121	0.13	0.54	0.89	1.67	1.55	1.45
Chittimuthyalu	0.20	0.86	1.01	2.20	2.04	1.55
Godavari Isukalu	0.20	0.65	1.22	1.70	1.65	1.55
RNR 19186	0.16	0.91	1.25	1.96	1.87	1.84
RNR 2378	0.15	0.91	1.14	1.91	1.75	1.50
RNR 2354	0.32	0.99	1.36	2.25	2.05	1.95
RNR 2465	0.16	0.80	1.25	1.79	1.70	1.61
Sumathi	0.18	0.87	1.15	1.73	1.63	1.60
S.E.±	0.04	0.02	0.03	0.03	0.04	0.05
C.D. (0.05)	NS	0.07	0.09	0.11	0.13	0.18

NS=Non-significant

Table 7: Area of first three leaves (cm^2) from the top in aromatic rice genotypes during *Kharif* season

Genotypes	Leaf area (cm^2)		
	Flag leaf	Second leaf from top	Third leaf from top
Pusa1121	23.84	29.46	14.71
Chittimuthyalu	26.86	27.40	22.63
Godavari Isukalu	26.58	26.85	17.41
RNR 19186	22.18	38.33	18.27
RNR 2378	26.70	31.59	29.91
RNR 2354	38.40	48.00	32.70
RNR 2465	28.32	39.19	38.75
Sumathi	21.89	26.98	24.70
S.E.±	1.14	1.92	1.27
C.D. (0.05)	3.47	5.82	3.87

Table 8: Total dry matter production (g m^{-2}) and Grain yield (kg ha^{-1}) in aromatic rice genotypes during *Kharif* season

Genotypes	Days after transplanting						Grain yield (kg ha^{-1})
	15	30	45	60	75	90	
Pusa1121	59.66	201.09	395.72	713.15	986.68	1107.33	3960
Chittimuthyalu	53.77	218.42	419.63	734.92	1031.78	1178.99	4603
Godavari Isukalu	66.66	192.31	401.29	801.03	1029.90	1122.22	5003
RNR 19186	65.33	258.30	484.58	888.80	1179.21	1314.98	5403
RNR 2378	47.44	220.20	471.73	882.13	1216.76	1343.75	5850
RNR 2354	48.99	256.19	489.06	912.46	1228.76	1365.97	6176
RNR 2465	54.77	216.64	438.73	834.58	1094.56	1197.21	5203
Sumathi	53.32	219.97	419.40	765.03	1075.89	1210.32	5303
S.E.±	4.97	4.64	6.59	13.79	14.07	25.40	116.64
C.D. (0.05)	NS	14.09	20.01	41.85	42.67	77.05	353.81

22.2 cm was recorded in genotypes Pusa1121 at 90 DAT. Similar results were reported by Kanbar *et al*. (2009) and they have further proved that higher root length was positively associated with grain yield and dry matter production.

Root volume and root weight showed significant variation among the aromatic rice cultivars. There was progressive increase in root volume and root weight in all the genotype up to 60 DAT thereafter declined till maturity (Table 5 and 6). Maximum root volume (37.5 ml $hill^{-1}$) and root weight (2.25 g $hill^{-1}$) were recorded in RNR 2354 and minimum root volume (25.0 ml $hill^{-1}$) and root dry weight (1.67 g $hill^{-1}$) was observed in genotypes Pusa1121. Root volume and root weight were positively associated with grain yield and dry matter production which are in agreement with result of Kumar *et al.* (2008).

Combined leaf area of first three leaves including flag leaf from the top was found significantly different for all aromatic rice cultivars and maximum combined leaf area of first three leaves from the top was found in genotype RNR 2354 and minimum was recorded in variety Pusa 1121 (Table 7). Highest flag leaf area of 38.4 cm^2 was recorded in RNR 2354. Area of first three leaves from the top had a positive association with yield. Similar significant association between the leaf area of top three leaves with grain yield was reported by Briggs and Aylenfisu (1980) and Jun *et al*. (2006).

Total dry matter production (g m^{-2}) for aromatic rice genotypes presented in Table 8 have shown significant difference from 30 DAT to maturity. There was a steady increase in total dry weight in all the stages till maturity. The highest dry matter production of 1365.97 g m^{-2} was recorded in genotypes RNR 2354 while minimum dry matter production of 1107.33 g m^{-2} was recorded for the genotypes Pusa 1121.

Total dry matter produced and its further translocation to sink is the major factor that governs the economic yield of the aromatic rice. Higher dry matter production was associated with higher grain yield. Present study confirms the results of Sinha *et al*. (2009) and Cheng *et al.* (2010).

Perusal of the data on yield revealed that varieties exhibited significant differences in grain yield (Table 8), among the varieties highest grain yield of 6176 kg ha^{-1} was recorded in genotypes RNR 2354 followed by RNR 2378 with 5850 kg ha^{-1}. The lowest grain yield was recorded in Pusa 1121 (3960 kg ha^{-1}). Similar results for grain yield were also reported by Ashrafuzzaman *et al*. (2009).

From the above results it can be concluded that highest yield in RNR 2354 can be attributed to highest total dry matter production, number of effective tillers, root length, root weight, root volume, size of photosynthetic surface in terms of number of leaves and area of top three leaves including flag leaf.

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