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AMYLOSE CONTENT AND 1000-GRAIN WEIGHT OF THE RECOMBINANT INBRED LINES DERIVED FROM THE CROSS BETWEEN BASMATI 370 AND PUSA BASMATI 1

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ABSTRACT

The amylose content in the recombinant inbred lines (RILs) ranged from low (18.15%) to high (22.80%), whereas in parents the percentage of amylose was recorded as 20.29% for Basmati 370 and 19.00% for Pusa Basmati 1. A minimum value of 15.10g and a maximum value of 28.40g has been observed for the 1000-grain weight in the RIL population. In the parents Basmati 370 and Pusa Basmati 1, the 1000- grain weight was recorded as 23.24g and 22.40g respectively. Analysis of variance was found to be highly significant for both amylose content and 1000- grain weight. Amylose content showed a positive ($r = 0.067$) but no significant correlation with 1000- grain weight. The study suggested the recombinant inbred lines can be used as efficient genetic resources for carrying out breeding programmes and 1000- grain weight and amylose content are important traits which should be used as selection criteria to develop high yielding and better quality varieties in Basmati rice.

KEY WORDS
Amylose content
Basmati rice (*Oryza sativa* L.)
Variance
Recombinant inbred lines.

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INTRODUCTION

Rice (*Oryza sativa* L.), is one of the most important cereal grains and is consumed as staple food by approximately 3.5 billion heads across the globe (IRRI, 2013). Among different rice varieties, Basmati rice, "The Scented Pearl" is nature's exclusive gift to the Indian sub- continent (Allam *et al*., 2015). In the Asian sub- continent rice occupies a premier place and is often termed as the "Grain of Life" (Dhurai *et al.,* 2014). Apart from being the primary source of dietary carbohydrates, Basmati rice has a great export potential and hence boosts up the economy of the nation (Agasimani *et al*., 2013 and Kumar, 2015). Traditional Basmati rice varieties known for their exquisite aroma, are generally low yielding, hence the need of the hour is to develop the rice varieties having the grain quality attributes of Basmati rice but with increased yield (Amarawathi *et al*., 2008). Both grain yield and quality in rice are complex traits controlled by many genes and hence are not susceptible to selection (Kumar *et al*., 2013a and Kumar *et al*., 2013b). 1000- Grain weight (GW) and Amylose content (AC) are the important components of grain yield and quality in Basmati rice. Determination of the physico-chemical characteristics of the rice kernels *i.e.* AC and 1000- GW will prove useful for the overall assessment of the rice grains (Ge *et al*., 2008). The knowledge about the correlation between different yield (1000- GW) and quality (Amylose content) traits will prove effective in improving the yield without sacrificing the distinctive quality features of Basmati rice (Allam *et* al., 2015). The estimation of AC and 1000-GW in rice is an important aspect for the development of improved varieties with high grain quality in order to satisfy the customer demands (Ni *et al.,* 2011). In this regard, a number of quality works in aromatic and non- aromatic rices has been reported by a number of workers viz., Yadav *et al*. (2007), Verma *et al*. (2015), Thomas *et al*. (2013), Ahmed *et al*. (2015), Allam *et al*. (2015), Kumar *et al*. (2015) and Yumnam *et al*. (2015). Hence the present study was conducted with the aim to evaluate the parents and the transgressive lines (RIL population) for the amount of amylose and 1000- GW and to unravel the correlation between amylose content and 1000- grain weight in Basmati rice.

MATERIALS AND METHODS

The experimental plant material consisted of 140 F_7 individuals obtained from the cross between Basmati 370 and Pusa Basmati 1. During Kharif 2015, seeds of the 140 F_7 individuals along with parental lines were sown and raised in nursery bed and the thirty day old seedlings were transplanted in a randomized complete block design (RCBD) with three replications. The material was transplanted in 5 meter row length with planting density of 15 × 20 cm. Recommended package practices were followed for the production of crop. The grains were harvested upon maturity. The observations for 1000- thousand grain weight of the paddy samples were recorded. The samples were then dehusked and all the plants were evaluated individually for the AC.

Estimation of amylose Content

Amylose content in the parents and the recombinant inbred lines was based on the iodine- binding procedure as described by Juliano (1971). In brief, 100 mg of the powered sample was mixed with 1ml of distilled ethanol and 10ml of 1N NaOH. The mixture was left overnight. After making up the volume to 100ml in a volumetric flask, approximately 2.5 ml of the extract was taken out and diluted with 20ml water. 2 to 3 drops of phenolphthalein indicator were added till the appearance of light pink colour. The sample was titrated using 0.1N HCl till the pink colour disappeared. Addition of iodine reagent produced a blue- coloured complex and the absorbance was read at 590nm using UV visible spectrophotometer (UV-1601, Shimadzu, Japan). Amylose content in the samples was determined based on the standard curve prepared using potato amylose (A0512, Sigma Aldrich Co.).

1000-grain weight

The weight of 1000 grains from each genotype was recorded in grams per 1000 grains as per the procedure given in the Standard Evaluation System for Rice, IRRI, 2002. 1000 well developed grains from each sample were counted randomly; moisture content was dried and weighed using a precision balance.

Statistical analysis

All the analysis was carried out in triplicates. For determining the statistical significance of the data, Analysis of variance (one way- ANOVA) was performed for AC and 1000- Grain weight. The mean values were separated by Duncan's Multiple Range Test (DMRT) as suggested by Steel and Torrie (1960). Variance of AC and 1000- Grain weight was determined using paired- t test. The Pearson's Correlation Coefficients (r) was calculated using SPSS (version 20.0).

RESULTS AND DISCUSSION

Evaluation of RIL population for amylose content and 1000-grain weight

The parents (B370 and PB1) along with the transgressive lines obtained from them were evaluated for Amylose content and 1000- Grain weight. Table 1 shows the mean values of 1000 GW and AC recorded for the parents B370 (P_1), PB1 (P_2) and RILs.

AC of rice is the key factor in determining its cooking and eating qualities (Amarawathi *et al.*, 2008 and Ge *et al.*, 2008).On the basis of the amount of amylose present, the milled rice has been classified into four categories: waxy (0-

Table 1: Mean ± SE and range of amylose content (%) and 1000-grain weight (g) in parents and the recombinant inbred lines (RILs)

	Basmati370	Pusa Basmati1	RIL Population			
	Mean ± SE	Mean ± SE	Mean ± SE	Maximum	Minimum	Range
Amylose content	20.29±0.058	19.00±0.058	20.25±0.048	22.80	18.15	18.15- 22.80
1000- Grain weight	23.24±0.058	22.40±0.404	22.33±0.082	28.40	15.10	15.10- 28.40

Table 2: Analysis of variance for amylose content and 1000-grain weight in the recombinant inbred lines

Source of Variation	df	Mean Sum Square Amylose Content	1000- Grain Weight
Genotype	139	2.508**	24.777**
Replication	2	23.739**	33.028**
Error	278	0.0602	0.0658

**Significant at 1% level of significance

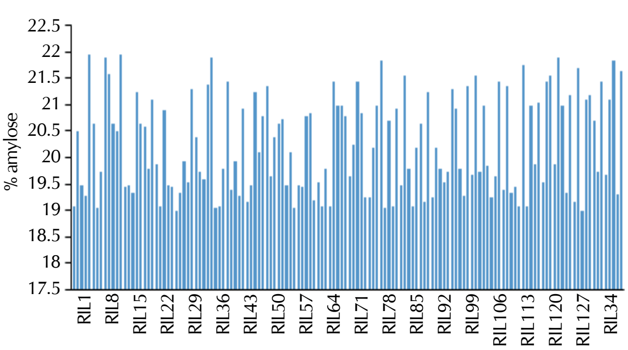

Figure 1: Amylose content (%) of the evaluated recombinant inbred lines

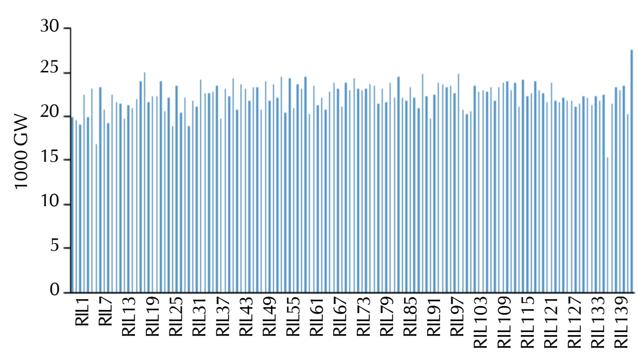

Figure 2: 1000-Grain weight (g) of the evaluated recombinant inbred lines

Table 3: Variation among Amylose content (AC) and 1000-grain weight (GW) in the parents and the recombinant inbred lines of Basmati 370× Pusa Basmati1

Genotype	Mean± SD* AC	1000- GW	t- value/df AC/1000- GW	p- value
P1	20.290±0.100[6,7,8,9,10,11,12,13,14,15,16,17,18,19]	19.000±0.100[3,4]	22.343/2	0.002
P2	23.240±0.100[30]	22.400±0.700[19,21,22,23,24,25,26,27,28,29,30]	2.425/2	0.136
RIL-01	19.100±0.400[1,2,3]	20.000±0.400[4,5,6,7,8,9]	-15.588/2	0.004
RIL-02	20.500±0.300[8,9,10,11,12,13,14,15,16,17,18,19,20,21]	19.600±0.500[3,4,5,6]	7.794/2	0.016
RIL03	19.500±0.200[1,2,3,4,5,6,7]	19.100±0.600[3,4]	1.732/2	0.225
RIL-04	19.300±0.200[1,2,3,4,5,6]	22.500±0.700[20,21,22,23,24,25,26,27,28,29,30,31]	-11.085/2	0.008
RIL-05	21.950±0.600[29]	20.500±0.800[4,5,6,7,8,9]	16.887/2	0.003
RIL-06	20.650±0.100[10,11,12,13,14,15,16,17,18,19,20,21,22,23]	23.100±0.900[26,27,28,29,30,31,32,33,34,35,36,37]	-5.304	0.034
RIL-07	18.780±0.460[1]	16.900±0.100[2]	8.616/2	0.013
RIL-08	19.750±0.700[1,2,3,4,5,6,7,8,9,10,11]	23.400±0.200[29,30,31,32,33,34,35,36,37,38,39,40]	-12.644/2	0.006
RIL-09	21.900±0.900[28,29]	20.800±0.300[8,9,10,11,12,13,14,15]	3.175/2	0.086
RIL-10	21.600±0.300[23,24,25,26,27,28,29]	19.300±0.400[3,4,5]	39.837/2	0.001
RIL-11	20.650±0.500[10,11,12,13,14,15,16,17,18,19,20,21,22,23]	22.500±0.450[20,21,22,23,24,25,26,27,28,29,30,31]	-64.086/2	0.000
RIL-12	20.500±0.300[8,9,10,11,12,13,14,15,16,17,18,19,20,21]	21.600±0.550[13,14,15,16,17,18,19,20,21,22]	-7.621/2	0.017
RIL-13	21.950±0.800[29]	21.400±0.650[11,12,13,14,15,16,17,18,19,20]	6.351/2	0.024
RIL-14	19.450±0.400[1,2,3,4,5,6,7]	19.700±0.750[3,4,5,6,7]	-1.237/2	0.342
RIL-15	19.500±0.500[1,2,3,4,5,6,7]	21.300±0.850[10,11,12,13,14,15,16,17,18,19]	-8.908/2	0.012
RIL-16	19.350±0.200[1,2,3,4,5,6]	21.000±0.100[9,10,11,12,13,14,15,16]	-28.579/2	0.001
RIL-17	21.250±0.100[19,20,21,22,23,24,25,26,27,28,29]	22.000±0.150[16,17,18,19,20,21,22,23,24,25,26]	-25.981/2	0.001
RIL-18	20.650±0.700[10,11,12,13,14,15,16,17,18,19,20,21,22,23]	24.100±0.300[36,37,38,39.40,41.42,43]	-14.939/2	0.004
RIL-19	20.600±0.400[9,10,11,12,13,14,15,16,17,18,19,20,21,22]	25.000±0.350[43]	-152.420/2	0.000
RIL-20	19.800±0.700[2,3,4,5,6,7,8,9,10,11,12]	21.600±0.450[13,14,15,16,17,18,19,20,21,22]	-12.471/2	0.006
RIL-21	21.100±0.900[17,18,19,20,21,22,23,24,25,26,27,28,29]	22.300±0.550[18,19,20,21,22,23,24,25,26,27,28,29]	-5.938/2	0.027
RIL-22	19.900±0.800[2,3,4,5,6,7,8,9,10,11,12,13,14]	22.300±0.650[18,19,20,21,22,23,24,25,26,27,28,29]	-27.713/2	0.001
RIL-23	19.100±0.300[1,2,3]	24.100±0.750[36,37,38,39.40,41.42,43]	-19.245/2	0.003
RIL-24	20.900±0.200[15,16,17,18,19,20,21,22,23,24,25,26,27]	20.600±0.850[6,7,8,9,10,11,12,13]	0.799/2	0.508
RIL-25	19.500±0.300[1,2,3,4,5,6,7]	22.100±0.100[16,17,18,19,20,21,22,23,24,25,26,27]	-22.517/2	0.002
RIL-26	19.450±0.200[1,2,3,4,5,6,7]	18.900±0.200[3]	9.526/2	0.011
RIL-27	19.000±0.300[1,2]	23.500±0.250[30,31,32,33,34,35,36,37,38,39,40,41]	-155.885/2	0.000
RIL-28	19.350±0.200[1,2,3,4,5,6]	20.400±0.400[6,7,8,9,10,11]	-9.093/2	0.012
RIL-29	19.950±0.600[2,3,4,5,6,7,8,9,10,11,12,13,14,15]	22.200±0.450[17,18,19,20,21,22,23,24,25,26,27,28]	-25.981/2	0.001
RIL-30	19.550±0.400[1,2,3,4,5,6,7,8]	18.900±0.600[3]	5.629/2	0.030
RIL-31	21.300±0.300[20,21,22,23,24,25,26,27,28,29]	21.800±0.650[14,15,16,17,18,19,20,21,22,23,24]	-2.474/2	0.132
RIL-32	20.400±0.200[7,8,9,10,11,12,13,14,15,16,17,18,19,20]	21.200±0.800[10,11,12,13,14,15,16,17,18]	-2.309/2	0.147
RIL-33	19.750±0.700[1,2,3,4,5,6,7,8,9,10,11]	24.200±0.850[37,38,39.40,41.42,43]	-51.384/2	0.000
RIL-34	19.600±0.500[1,2,3,4,5,6,7,8]	22.600±0.500[21,22,23,24,25,26,27,28,29,30,31,32]	-51.962/2	0.000
RIL-35	21.400±0.400[21,22,23,24,25,26,27,28,29]	22.600±0.150[21,22,23,24,25,26,27,28,29,30,31,32]	-8.314/2	0.014
RIL-36	21.900±0.800[28,29]	22.800±0.250[23,24,25,26,27,28,29,30,31,32,33,34]	-2.834/2	0.105
RIL-37	19.050±0.900[1,2]	23.600±0.350[31,32,33,34,35,36,37,38,39,40,41]	-14.329/2	0.005
RIL-38	19.100±0.100[1,2,3]	19.800±0.500[3,4,5,6,7,8]	-3.031/2	0.094
RIL-39	19.800±0.800[2,3,4,5,6,7,8,9,10,11,12]	23.200±0.550[27,28,29,30,31,32,33,34,35,36,37,38]	-23.556/2	0.002
RIL-40	21.450±0.400[21,22,23,24,25,26,27,28,29]	22.300±0.700[18,19,20,21,22,23,24,25,26,27,28,29]	-4.907/2	0.039
RIL-41	19.400±0.100[1,2,3,4,5,6]	24.300±0.800[38,39.40,41.42,43]	-12.124/2	0.007
RIL-42	19.950±0.300[2,3,4,5,6,7,8,9,10,11,12,13,14,15]	20.800±0.900[8,9,10,11,12,13,14,15]	-2.454/2	0.134
RIL-43	19.300±0.100[1,2,3,4,5,6]	23.700±0.100[32,33,34,35,36,37,38,39,40,41]	-65.818/2	0.000
RIL-44	20.950±0.800[16,17,18,19,20,21,22,23,24,25,26,27,28]	23.100±0.200[26,27,28,,29,30,31,32,33,34,35,36,37]	-6.804/2	0.021
RIL-45	19.190±0.100[1,2,3]	21.900±0.250[15,16,17,18,19,20,21,22,23,24,25]	-31.292/2	0.001
RIL-46	19.500±0.300[1,2,3,4,5,6,7]	23.400±0.350[29,30,31,32,33,34,35,36,37,38,39,40]	-135.100/2	0.000
RIL-47	21.250±0.200[19,20,21,22,23,24,25,26,27,28,29]	23.400±0.500[29,30,31,32,33,34,35,36,37,38,39,40]	-12.413/2	0.006
RIL-48	20.100±0.800[3,4,5,6,7,8,9,10,11,12,13,14,15,16]	20.800±0.550[8,9,10,11,12,13,14,15]	-4.850/2	0.040
RIL-49	20.800±0.600[13,14,15,16,17,18,19,20,21,22,23,24,25,26]	24.000±0.650[35,36,37,38,39,40,41,42,43]	-110.851/2	0.000
RIL-50	21.350±0.300[.20,21,22,23,24,25,26,27,28,29]	21.900±0.800[15,16,17,18,19,20,21,22,23,24,25]	-1.905/2	0.197
RIL-51	19.650±0.590[1,2,3,4,5,6,7,8,9]	23.700±0.850[32,33,34,35,36,37,38,39,40,41]	-20.042/2	0.002
RIL-52	20.400±0.200[7,8,9,10,11,12,13,14,15,16,17,18,19,20]	22.200±0.100[17,18,19,20,21,22,23,24,25,26,27,28]	-31.177/2	0.001
RIL-53	20.650±0.600[10,11,12,13,14,15,16,17,18,19,20,21,22,23]	24.600±0.150[41.42,43]	-15.205/2	0.004

2% amylose, dry basis), low (10-20%), intermediate (20-25%) and high (>25) (Yadav *et al*., 2007). Amylose content for the parents B370 and PB1 was found to be 20.29% and 19.00%. Both the parents seemed to possess intermediate levels of amylose while the RIL's had both low and intermediate amylose contents (Fig.1). Basmati rice with intermediate amylose content (20 to 25%) is preferred for consumption as it remains moist and soft as compared to the rice with high or low amylose contents (Thomas *et al*., 2013). A similar range of amylose content (14-25%) was observed in the rice varieties

Table 3: Cont......

RIL-54	$20.750 \pm 0.500^{12,13,14,15,16,17,18,19,20,21,22,23,24,25}$	$20.500 \pm 0.250^{6,7,8,9,10,11,12}$	1.732/2	0.225
RIL-55	$19.500 \pm 0.400^{1,2,3,4,5,6,7}$	$24.300 \pm 0.400^{38,39,40,41.42,43}$	-83.138/2	0.000
RIL-56	$20.100 \pm 0.100^{3,4,5,6,7,8,9,10,11,12,13,14,15,16}$	$21.000 \pm 0.500^{9,10,11,12,13,14,15,16}$	-3.897/2	0.060
RIL-57	$19.050 \pm 0.700^{1,2}$	$23.700 \pm 0.550^{32,33,34,35,36,37,38,39,40,41}$	-53.694/2	0.000
RIL-58	$19.500 \pm 0.400^{1,2,3,4,5,6,7}$	$23.200 \pm 0.650^{28,29,30,31,32,33,34,35,36,37,38}$	-25.634/2	0.002
RIL-59	$19.516 \pm 0.208^{3,4,5,6,7,8}$	$24.500 \pm 0.750^{40,41,42,43}$	-15.608/2	0.004
RIL-60	$20.800 \pm 0.800^{13,14,15,16,17,18,19,20,21,22,23,24,25,26}$	$20.300 \pm 0.900^{5,6,7,8,9,10}$	8.660/2	0.013
RIL-61	$20.850 \pm 0.600^{14,15,16,17,18,19,20,21,22,23,24,25,26}$	$23.500 \pm 0.500^{30,31,32,33,34,35,36,37,38,39,40,41}$	-45.899/2	0.000
RIL-62	$19.200 \pm 0.100^{1,2,3,4}$	$21.300 \pm 0.150^{10,11,12,13,14,15,16,17,18,19}$	-72.746/2	0.000
RIL-63	$19.550 \pm 0.200^{1,2,3,4,5,6,7,8}$	$22.100 \pm 0.250^{16,17,18,19,20,21,22,23,24,25,26,27}$	-88.335/2	0.000
RIL-64	$19.100 \pm 0.500^{1,2,3}$	$20.800 \pm 0.400^{8,9,10,11,12,13,14,15}$	-29.445/2	0.001
RIL-65	$19.800 \pm 0.800^{2,3,4,5,6,7,8,9,10,11,12}$	$22.800 \pm 0.450^{23,24,25,26,27,28,29,30,31,32,33,34}$	-14.846/2	0.005
RIL-66	$19.100 \pm 0.200^{1,2,3}$	$23.800 \pm 0.600^{33,34,35,36,37,38,39,40,41}$	-20.352/2	0.002
RIL-67	$21.450 \pm 0.200^{21,22,23,24,25,26,27,28,29}$	$23.200 \pm 0.650^{27,28,29,30,31,32,33,34,35,36,37,38}$	-6.736/2	0.021
RIL-68	$21.000 \pm 0.100^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$21.100 \pm 0.750^{10,11,12,13,14,15,16,17}$	-0.266/2	0.815
RIL-69	$21.000 \pm 0.400^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$23.800 \pm 0.850^{33,34,35,36,37,38,39,40,41}$	-10.777/2	0.009
RIL-70	$20.800 \pm 0.800^{13,14,15,16,17,18,19,20,21,22,23,24,25,26}$	$23.000 \pm 0.500^{25,26,27,28,29,30,31,32,33,34,35,36}$	12.702/2	0.006
RIL-71	$19.650 \pm 0.300^{1,2,3,4,5,6,7,8,9}$	$24.400 \pm 0.150^{39,40,41,42,43}$	-54.848/2	0.000
RIL-72	$20.250 \pm 0.200^{6,7,8,9,10,11,12,13,14,15,16,17,18}$	$23.100 \pm 0.250^{26,27,28,29,30,31,32,33,34,35,36,37}$	-98.727/2	0.000
RIL-73	$21.450 \pm 0.100^{21,22,23,24,25,26,27,28,29}$	$23.000 \pm 0.350^{25,26,27,28,29,30,31,32,33,34,35,36}$	-10.739/2	0.009
RIL-74	$20.850 \pm 0.600^{14,15,16,17,18,19,20,21,22,23,24,25,26}$	$23.100 \pm 0.450^{26,27,28,29,30,31,32,33,34,35,36,37}$	-25.981/2	0.001
RIL-75	$19.250 \pm 0.200^{1,2,3,4,5}$	$23.700 \pm 0.550^{32,33,34,35,36,37,38,39,40,41}$	-22.022/2	0.002
RIL-76	$19.250 \pm 0.100^{1,2,3,4,5}$	$23.500 \pm 0.650^{30,31,32,33,34,35,36,37,38,39,40,41}$	-13.384/2	0.006
RIL-77	$20.190 \pm 0.300^{4,5,6,7,8,9,10,11,12,13,14,15,16,17}$	$21.500 \pm 0.750^{12,13,14,15,16,17,18,19,20,21}$	-5.042/2	0.037
RIL-78	$21.000 \pm 0.300^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$23.200 \pm 0.500^{27,28,29,30,31,32,33,34,35,36,37,38}$	-19.053/2	0.003
RIL-79	$21.850 \pm 0.500^{27,28,29}$	$21.700 \pm 0.150^{14,15,16,17,18,19,20,21,22,23}$	0.742/2	0.535
RIL-80	$19.050 \pm 0.300^{1,2}$	$23.800 \pm 0.200^{33,34,35,36,37,38,39,40,41}$	-82.272/2	0.000
RIL-81	$20.700 \pm 0.500^{11,12,13,14,15,16,17,18,19,20,21,22,23,24}$	$22.200 \pm 0.300^{17,18,19,20,21,22,23,24,25,26,27,28}$	12.990/2	0.006
RIL-82	$19.100 \pm 0.100^{1,2,3}$	$24.500 \pm 0.400^{40,41,42,43}$	-31.177/2	0.001
RIL-83	$20.950 \pm 0.200^{16,17,18,19,20,21,22,23,24,25,26,27,28}$	$22.200 \pm 0.500^{17,18,19,20,21,22,23,24,25,26,27,28}$	-7.217/2	0.019
RIL-84	$19.500 \pm 0.200^{1,2,3,4,5,6,7}$	$21.900 \pm 0.650^{15,16,17,18,19,20,21,22,23,24,25}$	-9.238/2	0.012
RIL-85	$21.550 \pm 0.300^{22,23,24,25,26,27,28,29}$	$23.300 \pm 0.700^{28,29,30,31,32,33,34,35,36,37,38,39}$	-7.578/2	0.017
RIL-86	$19.800 \pm 0.200^{2,3,4,5,6,7,8,9,10,11,12}$	$22.100 \pm 0.800^{16,17,18,19,20,21,22,23,24,25,26,27}$	-6.640/2	0.022
RIL-87	$19.100 \pm 0.400^{1,2,3}$	$21.000 \pm 0.450^{9,10,11,12,13,14,15,16}$	-65.818/2	0.000
RIL-88	$20.200 \pm 0.200^{5,6,7,8,9,10,11,12,13,14,15,16,17}$	$24.900 \pm 0.550^{42,43}$	-23.259/2	0.002
RIL-89	$20.617 \pm 0.551^{9,10,11,12,13,14,15,16,17,18,19,20,21,22,23}$	$22.300 \pm 0.200^{18,19,20,21,22,23,24,25,26,27,28,29}$	-8.302/2	0.014
RIL-90	$19.190 \pm 0.100^{1,2,3}$	$19.700 \pm 0.300^{3,4,5,6,7}$	-4.417/2	0.048
RIL-91	$21.250 \pm 0.100^{19,20,21,22,23,24,25,26,27,28,29}$	$22.500 \pm 0.400^{21,22,23,24,25,26,27,28,29,30,31}$	-7.217/2	0.019
RIL-92	$19.250 \pm 0.200^{1,2,3,4,5}$	$23.900 \pm 0.500^{34,35,36,37,38,39,40,41,42}$	-26.847/2	0.001
RIL-93	$20.200 \pm 0.800^{5,6,7,8,9,10,11,12,13,14,15,16,17}$	$23.700 \pm 0.600^{32,33,34,35,36,37,38,39,40,41}$	-30.311/2	0.001
RIL-94	$19.800 \pm 0.600^{2,3,4,5,6,7,8,9,10,11,12}$	$23.400 \pm 0.700^{29,30,31,32,33,34,35,36,37,38,39,40}$	-62.354/2	0.000
RIL-95	$19.550 \pm 0.500^{1,2,3,4,5,6,7,8}$	$23.500 \pm 0.800^{30,31,32,33,34,35,36,37,38,39,40,41}$	-22.805/2	0.002
RIL-96	$19.750 \pm 0.600^{1,2,3,4,5,6,7,8,9,10,11}$	$22.600 \pm 0.450^{21,22,23,24,25,26,27,28,29,30,31,32}$	-32.909/2	0.001
RIL-97	$21.300 \pm 0.300^{20,21,22,23,24,25,26,27,28,29}$	$24.916 \pm 0.570^{42,43}$	-22.748/2	0.002
RIL-98	$20.950 \pm 0.200^{16,17,18,19,20,21,22,23,24,25,26,27,28}$	$20.800 \pm 0.200^{8,9,10,11,12,13,14,15}$	2.598/2	0.122
RIL-99	$19.800 \pm 0.700^{2,3,4,5,6,7,8,9,10,11,12}$	$20.300 \pm 0.300^{5,6,7,8,9,10}$	-1.732/2	0.225
RIL-100	$19.300 \pm 0.300^{1,2,3,4,5,6}$	$20.700 \pm 0.400^{7,8,9,10,11,12,13,14}$	-24.249/2	0.002
RIL-101	$21.350 \pm 0.100^{20,21,22,23,24,25,26,27,28,29}$	$23.500 \pm 0.500^{30,31,32,33,34,35,36,37,38,39,40,41}$	-9.310/2	0.011
RIL-102	$19.700 \pm 0.200^{1,2,3,4,5,6,7,8,9,10}$	$22.900 \pm 0.600^{24,25,26,27,28,29,30,31,32,33,34,35}$	-13.856/2	0.005
RIL-103	$21.550 \pm 0.400^{22,23,24,25,26,27,28,29}$	$23.000 \pm 0.700^{26,27,28,29,30,31,32,33,34,35,36}$	-8.372/2	0.014
RIL-104	$19.750 \pm 0.700^{1,2,3,4,5,6,7,8,9,10,11}$	$22.900 \pm 0.800^{24,25,26,27,28,29,30,31,32,33,34,35}$	-54.560/2	0.000
RIL-105	$21.000 \pm 0.400^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$23.300 \pm 0.450^{28,29,30,31,32,33,34,35,36,37,38,39}$	-79.674/2	0.000
RIL-106	$19.850 \pm 0.200^{2,3,4,5,6,7,8,9,10,11,12,13}$	$21.900 \pm 0.550^{15,16,17,18,19,20,21,22,23,24,25}$	-10.145/2	0.010
RIL-107	$19.250 \pm 0.100^{1,2,3,4,5}$	$23.300 \pm 0.200^{28,29,30,31,32,33,34,35,36,37,38,39}$	-70.148/2	0.000
RIL-108	$19.650 \pm 0.500^{1,2,3,4,5,6,7,8,9}$	$23.800 \pm 0.300^{33,34,35,36,37,38,39,40,41}$	-35.940/2	0.001
RIL-109	$21.450 \pm 0.100^{21,22,23,24,25,26,27,28,29}$	$24.100 \pm 0.400^{36,37,38,39,40,41,42,43}$	-15.300/2	0.004
RIL-110	$19.400 \pm 0.200^{1,2,3,4,5,6}$	$23.000 \pm 0.500^{25,26,27,28,29,30,31,32,33,34,35,36}$	-20.785/2	0.002
RIL-111	$21.350 \pm 0.200^{20,21,22,23,24,25,26,27,28,29}$	$23.900 \pm 0.600^{34,35,36,37,38,39,40,41,42}$	-11.042/2	0.008
RIL-112	$19.350 \pm 0.300^{1,2,3,4,5,6}$	$21.200 \pm 0.700^{10,11,12,13,14,15,16,17,18}$	-8.011/2	0.015

from Goa (Bhonsle and Sellappan, 2010). The range of the amylose observed in this study is confirmed by the earlier findings of Dipti *et al.*, (2003) and Bultosa, (2007) who reported that the AC in different rice varieties range from 18.60 to 28.0% and 20.0 to 25.8% respectively. Verma *et al.,* (2015) also reported intermediate amylose content (approximately 20%) in both Basmati 370 and Pusa Basmati 1. Furthermore, it has been reported that the progenies derived from parents with intermediate AC have low AC, whereas the progenies with intermediate AC have at least one of the parents with

Table 3: Cont......

RIL-113	$19.450 \pm 0.200^{1,2,3,4,5,6,7}$	$24.200 \pm 0.800^{37,38,39,40,41,42,43}$	-13.712/2	0.005
RIL-114	$19.100 \pm 0.700^{1,2,3}$	$22.400 \pm 0.450^{19,20,21,22,23,24,25,26,27,28,29,30}$	-22.863/2	0.002
RIL-115	$21.750 \pm 0.600^{26,27,28,29}$	$22.600 \pm 0.550^{21,22,23,24,25,26,27,28,29,30,31,32}$	-29.445/2	0.001
RIL-116	$19.100 \pm 0.700^{1,2,3}$	$24.000 \pm 0.200^{35,36,37,38,39,40,41,42,43}$	-12.124/2	0.007
RIL-117	$21.000 \pm 0.600^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$23.000 \pm 0.300^{25,26,27,28,29,30,31,32,33,34,35,36}$	-11.547/2	0.007
RIL-118	$19.900 \pm 0.700^{2,3,4,5,6,7,8,9,10,11,12,13,14}$	$22.700 \pm 0.400^{23,24,25,26,27,28,29,30,31,32,33}$	-16.166/2	0.004
RIL-119	$21.050 \pm 0.800^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$21.600 \pm 0.500^{13,14,15,16,17,18,19,20,21,22}$	-3.175/2	0.086
RIL-120	$19.550 \pm 0.500^{1,2,3,4,5,6,7,8}$	$23.800 \pm 0.600^{33,34,35,36,37,38,39,40,41}$	-73.612/2	0.000
RIL-121	$21.450 \pm 0.100^{21,22,23,24,25,26,27,28,29}$	$21.800 \pm 0.700^{14,15,16,17,18,19,20,21,22,23,24}$	-1.010/2	0.419
RIL-122	$21.550 \pm 0.300^{22,23,24,25,26,27,28,29}$	$21.600 \pm 0.800^{13,14,15,16,17,18,19,20,21,22}$	-0.173/2	0.878
RIL-123	$19.900 \pm 0.800^{2,3,4,5,6,7,8,9,10,11,12,13,14}$	$22.100 \pm 0.450^{16,17,18,19,20,21,22,23,24,25,26,27}$	-10.887/2	0.008
RIL-124	$21.900 \pm 0.900^{28,29}$	$21.900 \pm 0.550^{15,16,17,18,19,20,21,22,23,24,25}$	0.000/2	1.000
RIL-125	$21.000 \pm 0.300^{16,17,18,19,20,21,22,23,24,25,26,27,28,29}$	$21.800 \pm 0.200^{14,15,16,17,18,19,20,21,22,23,24}$	-13.856/2	0.005
RIL-126	$19.350 \pm 0.200^{1,2,3,4,5,6}$	$21.100 \pm 0.300^{10,11,12,13,14,15,16,17}$	-30.311/2	0.001
RIL-127	$21.200 \pm 0.600^{18,19,20,21,22,23,24,25,26,27,28,29}$	$21.500 \pm 0.400^{12,13,14,15,16,17,18,19,20,21}$	-2.598/2	0.122
RIL-128	$19.190 \pm 0.800^{1,2,3}$	$22.300 \pm 0.500^{18,19,20,21,22,23,24,25,26,27,28,29}$	-17.956/2	0.003
RIL-129	$21.700 \pm 0.700^{25,26,27,28,29}$	$22.200 \pm 0.600^{17,18,19,20,21,22,23,24,25,26,27,28}$	-8.660/2	0.013
RIL-130	$19.000 \pm 0.200^{1,2}$	$21.300 \pm 0.700^{10,11,12,13,14,15,16,17,18,19}$	-7.967/2	0.015
RIL-131	$21.100 \pm 0.400^{17,18,19,20,21,22,23,24,25,26,27,28,29}$	$22.300 \pm 0.800^{18,19,20,21,22,23,24,25,26,27,28,29}$	-5.196/2	0.035
RIL-132	$21.200 \pm 0.800^{18,19,20,21,22,23,24,25,26,27,28,29}$	$21.800 \pm 0.450^{14,15,16,17,18,19,20,21,22,23,24}$	-2.969/2	0.097
RIL-133	$20.700 \pm 0.500^{11,12,13,14,15,16,17,18,19,20,21,22,23,24}$	$22.500 \pm 0.550^{20,21,22,23,24,25,26,27,28,29,30,31}$	-62.354/2	0.000
RIL-134	$19.750 \pm 0.200^{1,2,3,4,5,6,7,8,9,10,11}$	15.400 ± 0.200^{1}	75.344/2	0.000
RIL-135	$21.450 \pm 0.100^{21,22,23,24,25,26,27,28,29}$	$21.400 \pm 0.300^{11,12,13,14,15,16,17,18,19,20}$	0.433/2	0.707
RIL-136	$19.700 \pm 0.600^{1,2,3,4,5,6,7,8,9,10}$	$23.300 \pm 0.400^{28,29,30,31,32,33,34,35,36,37,38,39}$	-31.177/2	0.001
RIL-137	$21.100 \pm 0.600^{17,18,19,20,21,22,23,24,25,26,27,28,29}$	$23.000 \pm 0.500^{25,26,27,28,29,30,31,32,33,34,35,36}$	-32.909/2	0.001
RIL-138	$21.850 \pm 0.800^{27,28,29}$	$23.500 \pm 0.600^{30,31,32,33,34,35,36,37,38,39,40,41}$	-14.289/2	0.005
RIL-139	$19.330 \pm 0.300^{1,2,3,4,5,6}$	$20.300 \pm 0.700^{5,6,7,8,9,10}$	-4.200/2	0.052
RIL-140	$21.650 \pm 0.200^{24,25,26,27,28,29}$	27.600 ± 0.800^{44}	-17.176/2	0.003

Note: *Mean ± SD values with different superscripts between the genotypes within the same column are significantly different from each other (DUNCAN post-hoc; $P < 0.05$); P1: Basmati 370; P2: Pusa Basmati1

intermediate AC, indicating that AC has a complex mode of inheritance (Sartaj and Abeysekera, 2001).

Grain yield in rice is a multifactorial trait governed by a number of traits and 1000GW is the most important among them. 1000GW for the parents B370 and PB1 was found to be 23.24g and 22.40g respectively while in RILs 1000GW ranged from 15.10g- 28.40g. Verma *et al.,* (2015) observed the test weight (in grams) for Basmati 370 and Pusa Basmati 1 as 21.57g and 22.13g respectively. The range of the 1000GW obtained in this study (Fig. 2) is in accordance with that obtained in the previous studies (Yadav *et al*., 2007; Thomas *et al.,* 2013; Srivastava and Jaiswal, 2013 and Nirmaladevi *et al.,* 2015). Ahmed *et al.,* (2015) observed a similar range of 1000- grain weight (16.52- 30.02g) in the Kartiksail rice (*Oryza sativa* L.) land races of Bangladesh.

The genotypes with intermediate AC and higher 1000GW are of special significance in the local breeding programmes for improving the quantity and quality of the rice crop (Fasahat *et al*., 2012)

Variation in amylose content and 1000-grain weight among the genotypes and within the genotypes

Analysis of variance (ANOVA) (Table2) revealed significant differences among the genotypes indicating the existence of sufficient amount of variability whereas among the genotypes, the comparison of AC and 1000GW within the genotypes indicated that these traits are significantly different except for few genotypes (Table3). Nascimento *et al.,* (2011) while studying 146 accessions of upland rice for 14 quantitative traits also found significance differences. Fukuoka *et al*. (2006) studied aromatic rice land races also observed significant variation among aromatic rice land races for quantitative traits. Similar results were also reported by Dhanwani *et al*. (2013); Dhurai *et al*. (2014) and Ahmed *et al*. (2015).

Correlation among amylose content and 1000-grain weight

Positive non- significant correlation was found between AC and 1000GW ($r = 0.067$; $p < 0.05$) indicating that any improvement in the amylose content will have a positive effect on the 1000GW and vice-versa; as such there are many environmental factors like field location and temperature which govern the amount of amylose and 1000GW. In an earlier study on recombinant inbred lines of basmati derivative and Pusa Basmati1, AC and 1000GW showed positive but non-significant correlation ($r = 0.065$; $p < 0.05$) (Yumnam *et al*., 2015). Allam *et al*. (2015) also reported a positive but non-significant correlation ($r = 0.200$; $p < 0.05$) between test weight and amylose content. Hence, it can be interpreted that genetic improvement of these characters through selection would be helpful in improving the grain yield and quality in rice.

REFERENCES

Agasimani, S., Selvakumar, G., Joelc, A. J. and Ramc, S. G. 2013. A Simple and Rapid Single Kernel Screening Method to Estimate Amylose Content in Rice Grains. *Photochemical Analysis.* **24(6):** 569- 573.

Ahmed, M. S. U., Parveen, S., Khalequzzaman, M., Shamsuddin, A. K. M. 2015. Morpho physicochemical characterization of Kartiksail rice (*Oryza sativa* L.) land races of Bangladesh. *International J. Agronomy and Agricultural Research.* **7(3):** 25- 37.

Allam, C. R., Jaiswal, H. K. and Qamar, A. 2015. Character association and path analysis studies of yield and quality parameters in Basmati rice (*Oryza sativa*, L.). *The Bioscan (Supplement on Genetics and Plant Breeding).* **9(4):** 1733-1737.

Amarawathi, Y., Singh, R., Singh, A. K., Singh, V. P., Mohapatra, T., Sharma, T. R. and Singh, N. K. 2008. Mapping of quantitative trait loci for basmati quality traits in rice (*Oryza sativa* L.). *Molecular Breeding.* **21:** 49-65.

Bhonsle, S. J. and Sellappan, K. 2010. Grain quality evaluation of traditionally cultivated rice varieties of GOA, India. *Recent Research in Science and Technology.* **2(6):** 88-97.

Bultosa, G. 2007. Physicochemical characteristics of grain and flour in 13 Tef [*Eragrostis tef* (Zucc.) Trotter] grain varieties. *J. Applied Sciences and Research.* **3(12):** 2042-2051.

Dhanwani, R. K., Sarawgi, A. K., Solanki, A. and Tiwari, J. K. 2013. Genetic variability analysis for various yield attributing and quality traits in rice (O. sativa L.). *The Bioscan*. **8(4):** 1403-1407.

Dhurai, S. Y., Bhati, P. K. and Saroj, S. K. 2014. Studies on genetic variability for yield and quality characters in rice (*Oryza sativa* L.) under integrated fertilizer management. *The Bioscan (Supplement on Genetics and Plant Breeding)*. **9(2):** 745-748.

Dipti, S. S., Bari, M. N. and Kabir, K.A. 2003. Grain Quality Characteristics of Some Beruin Rice Varieties of Bangladesh. *Pakistan J. Nutrition.* **2:** 242-245.

Fasahat, P., Muhammad, K., Abdullah, A. and Ratnam, W. 2012. Amylose Content and Grain Length of New Rice Transgressive Variants Derived from a Cross Between *O. rufipogon* and Malaysian Rice Cultivar MR219. *International J. on Advanced Science Engineering Information Technology.* **2(4):** 20-23.

Fukuoka, S., Suu, T. D., Ebanna, K., Trinh, L. N. 2006. Diversity in phenotypic profiles in land races populations of Vietnamese rice: a case study of agronomic characters for conserving crop genetic diversity on farm. *Genetic Resources and Crop Evolution*. **53:** 753-761.

Ge, G. K., Shi, C. H., Wu, J. G. and Ye, Z. H. 2008. Analysis of the genetic relationships from different genetic systems between the amylose content and the appearance quality of indica rice across environments. *Genetics and Molecular Biology*. **31(3):** 711-716.

International Rice Research Institute. 2013. *World Rice Statistics 2013*. Los Banos, the Philippines: IRRI. June 29, 2013.

Juliano, B. O. 1971. Simplified assay for milled-rice amylose. *Cereal Science Today*. **16:** 334-340.

Kumar, N., Joshi, V. N. and Dagla, M. C. 2013a. Multivariate analysis for yield and its component traits in maize (Zea mays L.) under high and low N levels. *The Bioscan*. **8(3):** 959-964.

Kumar, N., Tikka, S. B. S., Dagla, M. C., Ram, B. and Meena, H. P. 2013b. Genotypic adaptability for seed yield and physiological traits in sesame (*Sesamum indicum* L.). *The Bioscan (Supplement on Genetics and Plant Breeding).* **8(4):** 1503-1509.

Kumar, V. 2015. Variability and correlation studies for grain physicochemical characteristics of rice (*Oryza sativa* L.). *The Bioscan*. **10(2):** 917-922.

Nascimento, W. F., Silva, E. F. and Veasey, E. A. 2011. Agro-morphological characterization of upland rice accessions. *Scientia Agricola.* **68(6):** 652-60.

Ni, D. H., Zhang, S. L., Chen, S., Xu, Y., Li, L., Li, H., Wang, Z. Y., Cai, X. L., Li, Z. F. and Yang, J. B. 2011. Improving cooking and eating quality of Xieyou57, an elite *indica* hybrid rice, by marker-assisted selection of the *Wx* locus. *Euphytica*. **179:** 355-362.

Nirmaladevi, G., Padmavathi, G., Kota, S. and Babu, V. R. 2015. Genetic variability, Heritability and Correlation coefficients of grain quality characters in rice (*Oryza sativa* L.). *SABRAO J. Breeding and Genetics.* **47(4):** 424-433.

Sartaj, Z. and Abeysekera, S. W. 2001. Present status of hybrid rice grain quality in Sri Lanka. *Annual symposium of the Department of Agriculture in Sri Lanka*. **3:** 217-223.

Srivastava, A. K. and Jaiswal, H. K. 2013. Grain Characteristics and Cooking Quality of Indigenous Aromatic and Non-Aromatic Genotypes of Rice (*Oryza sativa* L.). *International J. Scientific Research and Reviews.* **2(1):** 36-41.

Stell, R. G. D and Torrie, J. H. 1960. *Principles and procedures of statistics with especial reference to biological science. New York, USA: Mcgraw Hill Books* Co. Inc. p.187.

Thomas, R., Wan-Nadiah, W. A. and Bhat, R. 2013. Physiochemical properties, proximate composition, and cooking qualities of locally grown and imported rice varieties marketed in Penang, Malaysia. *International Food Research J.* **20(3):** 1345-1351.

Verma, D. K., Mohan, M., Prabhakar, P. K. and Srivastav, P. P. 2015. Physicochemical and cooking characteristics of Azad Basmati. *International Food Research J.* **22(4):** 1380-1389.

Yadav, R. B., Khatkar, B. S. and Yadav, B.S. 2007. Morphological, physicochemical and cooking properties of some Indian rice (*Oryza sativa* L.) cultivars. *J. Agricultural Technology*. **3(2):** 203- 210.

Yumnam, S., Sawarkar, A., Patil, S. G. and Senapati, B. K. 2015. Multivariate Analysis of Recombinant Inbred Lines (F_6) of Basmati Derivative. *The Ecoscan (Supplement on Rice).* **9(1,2):** 289-294.