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**Research Article**

# Studies on correlation of amylose content and grain dimensions in Basmati rice (*Oryza sativa* L.)

**Rakhi Bhardwaj, R. K. Salgotra and Manmohan Sharma**
School of Biotechnology, Sher-e-Kashmir University of Agricultural Sciences & Technology of Jammu (J&K)-180 009
**E-Mail:** rakhibhardwaj0908@gmail.com

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**Abstract**

Basmati rice grain quality traits are the parameters which determine the export potential. Among various parameters, amylose content along with grain dimensions are important grain quality traits of Basmati rice. A total of 140 recombinant inbred lines (RILs) developed by crossing Basmati 370 and Pusa Basmati 1 were used in the present study to determine the relationship between amylose content and grain dimensions namely, grain length, breadth and length breadth ratio. Significant variations for grain length and amylose content were observed among the RILs. Grain length ranged from 6.3 mm (RIL 40) to 8.1 mm (RIL 101) whereas the amylose content ranged from low (18.1%) to intermediate (24.5%). Amylose content showed a positive and significant correlation with grain length and grain breadth whereas it was found to be negatively correlated with grain length to grain breadth ratio. This study suggested that for better cooking quality in basmati rice an optimum balance has to be maintained between the grain dimensions, particularly grain length and amylose content.

**Keyword**

Basmati rice, amylose content, recombinant inbred lines (RILs), grain length, grain breadth, correlation.

## Introduction

Rice (*Oryza sativa* L.) is the most important self pollinated cereal crop which serves as the source of food for more than half of the world population. Since rice is cooked and consumed mainly as whole grains, grain quality ranks top among consumers' preference (Hossain *et al.*, 2009). Physical quality of rice is determined by size, shape, uniformity and general appearance (Cruz and Khush, 2000; Sellappan *et al.*, 2009). Grain dimensions such as kernel length, kernel breadth and grain length to grain breadth ratio are important quality attributes (Rita and Sarawgi, 2008). Among the chemical quality attributes of rice grain, amylose-the linear fraction of starch, plays an important role in determining the cooking quality (Lisle *et al.*, 2000; Ahmed *et al.*, 2007). On the basis of amylose content, rice varieties have been classified into waxy (0 to 2%), very low (3 to 9%), low (10 to 19%), intermediate (20 to 25%), and high (> 25%) (Juliano, 1979). The *japonica* rice varieties have low amylose content (2 to 19 %) while *indica* varieties have intermediate amylose content (20-25 %). The aromatic basmati rice is preferred as long grains with intermediate amylose content and high volume and length wise expansion after cooking. Determination of correlation between grain quality traits is helpful in making choice for parents and selection in segregating populations (Khatun *et al.*, 2003) irrespective of rice types, for development of improved breeding lines with superior grain quality traits. The present study was conducted to find out correlation between amylose content and grain dimensions in basmati rice using $F_7$ recombinant inbred line (RIL) population derived by single seed descent method from the cross Basmati 370 x Pusa Basmati 1.

## Materials and Methods

In the present study, an immortal $F_7$ recombinant inbred line (RIL) population developed from a cross between basmati rice cultivars i.e. Pusa Basmati 1 and Basmati 370 and advanced through single seed descent method (SSD) was used. The RIL population, comprising of 140 lines, along with parents was grown and evaluated in a randomized complete block design with three replications at the Experimental Farm of School of Biotechnology, SKUAST-Jammu during *Kharif* 2013 and 2014, following recommended package of practices. Grain length (mm) and grain breadth (mm) were recorded on dehusked grains from random samples of the bulk produce of each line and parents using Vernier Caliper; and average values were worked out. Grain length breadth ratio was calculated by dividing the average grain length by average grain breadth for each sample. For estimation of amylose content (%), the procedure of Juliano (1971) with certain modifications was followed. The sample for spectrometry study was prepared by adding 1ml of iodine reagent to 2.5 ml of defatted rice starch preparation and making up the volume to 50 ml by adding distilled water. The absorbance of amylose-iodine colour of each sample was measured at 590 nm using UV spectrometer. The content of amylose was expressed as percentage by mass on dry basis of milled rice. Data were analyzed by the Analysis of Variance (ANOVA) and Pearson's correlation coefficients among traits values were estimated using SPSS (version 20.0).

**Results and Discussion**

Both the parents viz. Basmati 370 and Pusa Basmati 1 along with the RILs were evaluated for amylose content and grain dimensions (grain length, grain breadth and grain length/grain breadth ratio). Analysis of variance (ANOVA) for different quality characters revealed highly significant variation among 140 RILs with respect to grain length and amylose content (Table 1). Grain dimensions i.e. grain length and grain breadth, constitute an important quality trait particularly in basmati rice. The minimum grain length and length breadth ration for a 'A' grade basmati rice are 7.0 mm and 3.5 mm, respectively (Anonymous, 2003). In this study, Basmati 370 and Pusa Basmati 1 had grain length of 6.7 mm and 7.6 mm, respectively, whereas the grain length among RILs ranged from 6.3 mm (RIL 40) to 8.1 mm (RIL 101). Samaranayake *et al.* (2018) studied the long grain varieties of rice for different traits and observed significant variation among them. Similar trends in grain length variation in basmati rice populations have been reported earlier in studies carried out by Yadav *et al.* (2007); Fasahat *et al*. (2012); Qiang-ming *et al*. (2013); Zhang *et al.* (2014) and Nirmaladevi *et al*. (2015).

Amylose content is another important trait determining the cooking and eating quality in rice. The amylose content is a chemical quality trait that determines the texture of cooked rice. Results obtained in this study (Table 2) depict that amylose content among RILs varied from 18.1 percent (RIL 23) to 24.5 percent (RIL 103). Based on amylose content, RIL population could be categorized into two groups i.e. low and intermediate amylose content. Eight RILs had less than 20 percent amylose content (low) while 132 RILs had more than 20 percent amylose content (intermediate). Both the parents had intermediate amylose content. Verma *et al.*, (2015) also reported intermediate value of amylose content (approximately 20%) in rice varieties Basmati 370 and Pusa Basmati 1. Similar results have been reported by Dipti *et al.* (2003); Qiang-ming et al. (2013) and Nirmaladevi *et al.* (2015).

Amylose content was observed to be positively and significantly correlated with grain length (r= 0.29) and grain breadth (r= 0.31), indicating thereby that any improvement in the grain dimensions would lead to increase in amylose content and vice versa. It could be attributed to the net increase in endosperm content of grain with larger grain dimensions, thereby leading to higher starch and amylose content. Thus, selection for these significantly and positively correlated traits will improve the overall grain qiality. However, amylose content showed negative and significant correlation with grain length to grain breadth ration (r = -0.25). Similar correlation between amylose content and grain dimensions have been reported by Lou *et al.* (2009); Nirmaladevi *et al.* (2015) and Graham-Acquaah *et al.* (2018). Therefore, for better cooking quality in basmati rice an optimum balance has to be maintained between the grain dimensions, particularly grain length and amylose content.

The RIL population showed presence of transgressive segregants particularly for grain dimensions. RIL 101 with longest grain length (8.1 mm), length breadth ratio of 4.2 and intermediate amylose content (24.2%) has been identified as an elite line which after confirmation of other agro-morphological and quality traits might be shortlisted as a promising genotype for release as a popular variety.

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**Table 1. Pooled analysis of variance for amylose and grain quality characters in RIL population in Basmati rice genotypes**

| Source of variation | df | Grain length (L) (mm) | Grain breadth (B) (mm) | L/B ratio | Amylose content (%) |
|---|---|---|---|---|---|
| Replication | 2 | 35.50 | 35.50 | 35.50 | 35.50 |
| Genotypes | 139 | 0.35** | 0.066 | 0.28 | 5.94** |
| Error | 278 | 0.19 | 0.065 | 0.22 | 0.06 |

** significant at 1% level of significance

**Table 2. Pooled minimum and maximum values among genotypes along with parental values**

| Characters | Basmati 370 | Pusa Basmati 1 | Minimum | Maximum |
|---|---|---|---|---|
| Amylose content (%) | 21.0 | 20.5 | 18.1 (RIL 23) | 24.5 (RIL 103) |
| Grain length (mm) | 6.7 | 7.6 | 6.3 (RIL 40) | 8.1 (RIL 101) |
| Grain breadth (mm) | 1.9 | 1.8 | 1.8 | 2.0 |
| Length/ Breadth | 3.5 | 4.2 | 3.1 (RIL 40) | 4.3 (RIL 42) |

**Table 3. Pooled estimates of coefficient of correlation for amylose content and grain quality traits in Basmati rice genotypes**

| Characters | Grain length (mm) | Grain breadth (mm) | Length breadth ratio | Amylose content (%) |
|---|---|---|---|---|
| Grain length (mm) | 1 | 0.77** | -0.52** | 0.29** |
| Grain breadth(mm) | | 1 | -0.90** | 0.31** |
| Length breadth ratio | | | 1 | -0.25** |
| Amylose content (%) | | | | 1 |

**Correlation is significant at 1% level; *Correlation is significant at 5% level

**Table 4. Pooled mean values of grain dimensions and amylose content in basmati RIL population**

| Genotypes | Grain length (mm) | Grain breadth (mm) | Length Breadth ratio | Amylose (%) |
|---|---|---|---|---|
| Basmati370 | 6.7 | 1.9 | 3.5 | 21.0 |
| Pusa Basmati 1 | 7.6 | 1.8 | 4.2 | 20.5 |
| RIL1 | 7.1 | 1.9 | 3.8 | 20.1 |
| RIL2 | 7.5 | 1.9 | 3.9 | 19.5 |
| RIL3 | 7.1 | 2.0 | 3.7 | 18.5 |
| RIL4 | 7.4 | 1.9 | 3.8 | 20.3 |
| RIL5 | 6.7 | 2.0 | 3.5 | 20.9 |
| RIL6 | 7.0 | 1.9 | 3.6 | 19.6 |
| RIL7 | 7.6 | 2.0 | 4.0 | 20.0 |
| RIL8 | 7.1 | 1.9 | 3.7 | 18.7 |
| RIL9 | 7.0 | 1.8 | 3.8 | 20.9 |
| RIL10 | 7.0 | 1.8 | 3.8 | 20.8 |
| RIL11 | 7.6 | 1.9 | 4.0 | 19.6 |
| RIL12 | 7.2 | 1.9 | 3.8 | 19.5 |
| RIL13 | 7.4 | 1.9 | 3.9 | 20.9 |
| RIL14 | 7.1 | 1.9 | 3.8 | 20.4 |
| RIL15 | 8.0 | 1.9 | 4.2 | 20.5 |
| RIL16 | 7.5 | 2.0 | 4.0 | 20.3 |
| RIL17 | 6.8 | 1.9 | 3.6 | 20.2 |
| RIL18 | 7.2 | 1.9 | 3.7 | 19.6 |
| RIL19 | 7.5 | 1.9 | 3.9 | 19.6 |
| RIL20 | 7.2 | 1.9 | 3.8 | 18.8 |
| RIL21 | 6.7 | 1.9 | 3.6 | 20.1 |
| RIL22 | 7.2 | 1.9 | 3.8 | 20.9 |
| RIL23 | 7.3 | 1.9 | 3.9 | 18.1 |
| RIL24 | 7.1 | 1.8 | 3.9 | 19.9 |
| RIL25 | 7.1 | 1.8 | 3.9 | 20.5 |
| RIL26 | 7.5 | 1.8 | 4.2 | 21.4 |
| RIL27 | 7.3 | 1.8 | 3.9 | 20.0 |
| RIL28 | 7.3 | 1.9 | 3.8 | 20.3 |
| RIL29 | 7.5 | 1.9 | 3.9 | 20.9 |
| RIL30 | 7.1 | 1.9 | 3.8 | 20.5 |
| RIL31 | 6.9 | 1.9 | 3.6 | 21.3 |
| RIL32 | 7.2 | 1.8 | 4.0 | 19.4 |
| RIL33 | 7.1 | 1.9 | 3.7 | 20.7 |
| RIL34 | 7.3 | 1.9 | 3.9 | 18.6 |
| RIL35 | 7.4 | 1.8 | 4.0 | 23.4 |
| RIL36 | 7.2 | 1.9 | 3.8 | 20.9 |
| RIL37 | 6.8 | 2.0 | 3.4 | 21.0 |
| RIL38 | 7.1 | 1.8 | 3.8 | 20.1 |
| RIL39 | 7.3 | 1.8 | 3.8 | 22.8 |
| RIL40 | 6.3 | 2.0 | 3.1 | 21.4 |
| RIL41 | 7.2 | 1.9 | 3.9 | 20.4 |
| RIL42 | 7.9 | 1.9 | 4.3 | 22.9 |
| RIL43 | 7.2 | 1.8 | 3.9 | 20.3 |
| RIL44 | 7.3 | 1.8 | 4.0 | 19.9 |
| RIL45 | 6.9 | 1.8 | 3.6 | 22.1 |
| RIL46 | 7.0 | 1.9 | 3.8 | 20.5 |
| RIL47 | 7.3 | 1.9 | 3.9 | 21.2 |
| RIL48 | 7.1 | 1.9 | 3.7 | 19.1 |
| RIL49 | 7.1 | 1.9 | 3.6 | 19.8 |
| RIL50 | 6.9 | 1.9 | 3.7 | 21.3 |
| RIL51 | 7.5 | 1.9 | 4.1 | 18.6 |
| RIL52 | 7.5 | 1.8 | 4.0 | 19.4 |
| RIL53 | 7.6 | 1.8 | 4.1 | 19.6 |
| RIL54 | 7.7 | 1.9 | 4.0 | 22.7 |
| RIL55 | 6.9 | 1.8 | 3.7 | 20.5 |
| RIL56 | 7.4 | 1.9 | 3.9 | 19.1 |
| RIL57 | 6.6 | 1.9 | 3.4 | 19.0 |
| RIL58 | 7.2 | 1.9 | 3.8 | 20.5 |
| RIL59 | 7.3 | 2.0 | 3.7 | 19.2 |
| RIL60 | 7.2 | 1.8 | 3.9 | 19.8 |
| RIL61 | 7.4 | 1.9 | 4.0 | 19.8 |
| RIL62 | 7.1 | 1.9 | 3.7 | 20.2 |
| RIL63 | 7.1 | 1.9 | 3.7 | 20.5 |
| RIL64 | 7.2 | 1.9 | 3.8 | 20.1 |
| RIL65 | 7.1 | 1.9 | 3.6 | 20.8 |
| RIL66 | 7.6 | 1.9 | 4.2 | 20.1 |
| RIL67 | 7.0 | 2.0 | 3.6 | 21.4 |
| RIL68 | 7.7 | 2.0 | 3.9 | 21.0 |

| | | | | |
|---|---|---|---|---|
| RIL69 | 7.6 | 1.9 | 4.0 | 21.0 |
| RIL70 | 7.2 | 1.9 | 3.8 | 19.8 |
| RIL 71 | 7.1 | 1.8 | 3.8 | 20.6 |
| RIL72 | 7.1 | 1.9 | 3.6 | 19.2 |
| RIL73 | 7.5 | 1.9 | 3.9 | 21.4 |
| RIL74 | 7.4 | 1.9 | 3.9 | 19.8 |
| RIL75 | 7.4 | 1.9 | 4.0 | 20.2 |
| RIL76 | 7.2 | 1.9 | 3.8 | 20.2 |
| RIL77 | 6.6 | 1.9 | 3.5 | 19.1 |
| RIL78 | 6.7 | 1.9 | 3.6 | 21.0 |
| RIL79 | 7.7 | 1.9 | 4.0 | 21.8 |
| RIL80 | 7.0 | 1.9 | 3.7 | 20.0 |
| RIL81 | 7.2 | 1.9 | 3.8 | 19.7 |
| RIL82 | 7.4 | 1.9 | 3.9 | 20.1 |
| RIL83 | 7.0 | 1.9 | 3.8 | 19.9 |
| RIL84 | 7.5 | 1.9 | 3.9 | 20.5 |
| RIL85 | 7.2 | 1.9 | 3.9 | 21.5 |
| RIL86 | 6.6 | 1.9 | 3.4 | 20.8 |
| RIL87 | 7.2 | 1.8 | 4.0 | 20.1 |
| RIL88 | 6.8 | 1.9 | 3.7 | 19.2 |
| RIL89 | 6.9 | 2.0 | 3.5 | 19.6 |
| RIL90 | 7.0 | 1.8 | 3.9 | 20.1 |
| RIL91 | 7.0 | 1.8 | 3.8 | 21.2 |
| RIL92 | 7.1 | 2.0 | 3.6 | 20.2 |
| RIL93 | 6.9 | 1.9 | 3.8 | 22.2 |
| RIL94 | 6.9 | 1.8 | 3.7 | 20.8 |
| RIL95 | 7.5 | 1.9 | 3.9 | 20.5 |
| RIL96 | 7.3 | 1.9 | 3.8 | 20.7 |
| RIL97 | 7.2 | 2.0 | 3.7 | 21.3 |
| RIL98 | 6.7 | 1.9 | 3.5 | 19.9 |
| RIL99 | 6.9 | 1.9 | 3.7 | 20.8 |
| RIL100 | 7.1 | 1.9 | 3.8 | 20.3 |
| RIL101 | 8.1 | 1.9 | 4.2 | 24.3 |
| RIL102 | 7.4 | 1.9 | 3.9 | 22.7 |
| RIL103 | 7.5 | 1.9 | 3.8 | 24.5 |
| RIL104 | 7.4 | 1.9 | 3.8 | 22.7 |
| RIL105 | 7.1 | 1.9 | 3.8 | 24.0 |
| RIL106 | 7.3 | 1.8 | 4.0 | 22.8 |
| RIL107 | 7.3 | 1.9 | 3.6 | 22.2 |
| RIL 108 | 7.5 | 1.9 | 4.0 | 20.6 |
| RIL109 | 7.7 | 1.9 | 4.1 | 21.4 |
| RIL110 | 7.5 | 1.9 | 3.9 | 20.4 |
| RIL111 | 7.5 | 2.0 | 3.8 | 21.3 |
| RIL112 | 7.4 | 1.9 | 3.9 | 22.3 |
| RIL113 | 7.2 | 1.9 | 3.8 | 22.4 |
| RIL114 | 7.1 | 2.0 | 3.6 | 22.1 |
| RIL115 | 7.4 | 2.0 | 3.8 | 21.7 |
| RIL116 | 7.6 | 1.8 | 4.2 | 21.1 |
| RIL117 | 7.5 | 1.9 | 4.1 | 21.0 |
| RIL118 | 7.1 | 1.9 | 3.7 | 20.9 |
| RIL119 | 7.8 | 1.9 | 4.2 | 21.0 |
| RIL120 | 7.2 | 1.9 | 3.9 | 20.5 |
| RIL121 | 7.7 | 1.9 | 4.2 | 21.4 |
| RIL122 | 6.8 | 1.9 | 3.6 | 21.5 |
| RIL123 | 6.9 | 1.9 | 3.7 | 20.9 |
| RIL124 | 6.7 | 1.9 | 3.5 | 21.9 |
| RIL125 | 7.1 | 1.9 | 3.7 | 21.0 |
| RIL126 | 7.0 | 1.9 | 3.8 | 22.3 |
| RIL127 | 7.3 | 1.9 | 3.8 | 21.2 |
| RIL128 | 6.9 | 1.9 | 3.6 | 22.1 |
| RIL129 | 6.9 | 1.9 | 3.6 | 21.7 |
| RIL130 | 7.7 | 2.0 | 4.0 | 22.0 |
| RIL131 | 7.3 | 2.0 | 3.7 | 21.1 |
| RIL132 | 7.0 | 1.9 | 3.7 | 21.2 |
| RIL133 | 6.8 | 2.0 | 3.5 | 19.7 |
| RIL134 | 6.7 | 1.8 | 3.7 | 18.7 |
| RIL135 | 7.4 | 2.0 | 3.7 | 21.4 |
| RIL136 | 6.7 | 1.9 | 3.6 | 22.7 |
| RIL137 | 7.2 | 1.9 | 3.7 | 21.1 |
| RIL138 | 6.4 | 1.9 | 3.5 | 21.8 |
| RIL139 | 7.2 | 1.9 | 3.7 | 22.3 |
| RIL140 | 7.3 | 1.9 | 3.7 | 21.6 |
| SE(0.05) ± | 0.25 | 0.14 | 0.30 | 0.14 |

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