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Genetics of apiculus, hull and pericarp colour and awnedness in Basmati rice progenies

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ABSTRACT

Genetics of awnedness and colour of rice husk and pericarp were studied in 231 recombinant inbred lines (RILs) derived from a cross between CSR10 X Taraori Basmati. For awnedness and apiculus colour segregation ratios of 1 (awned):15 (awnless) and 1 (coloured): 15 (colourless apiculus) were observed indicating that they are potentially recessive digenic traits with inhibitors. A ratio of 7 hairy: 9 hairless hull surface indicated a digenic action with complementary inhibitors. Notably, the RILs displayed a broad spectrum of hull colours and pericarp colours, 1 red, 65 golden, 115 straw, 47 dark brown and 3 yellow green and 167 white, 27 light brown, 6 brown, 22 red and 9 green, respectively, which is indicative of the genetic interactions of higher order.

Key words: *Rice, genetics, apiculus, awnedness, hull, pericarp colour*

Basmati rices, traditionally grown in north-western states of India, are famous worldwide because of their exquisite aroma, superfine grains and exceptionally good cooking qualities (Ahuja *et al.*, 1995; Kush and dela Kruz, 2002). Traditional Basmati rice varieties are poor yielder with tall plant stature, long crop duration, sensitivity to photoperiod and poor response to fertilizer application (Singh *et al.*, 2000). Several high-yielding Basmati varieties have been developed from crosses between traditional Basmati and semi-dwarf *indica* rice varieties, but most of these varieties fall short of one or more of grain quality parameters (Rani and Singh, 2003). Traders use husk and awn characteristics for identifying these varieties as dull husk help in identification of CSR 10, red apiculus for Super Basmati and long awns for Pusa Basmati. Most of the grain quality traits are complex polygenic traits. Inheritance studies of these traits (especially the Basmati rice traits) and their subsequent use in the selection process would greatly accelerate the efficiency and precision of the Basmati rice breeding programme (Lamba *et al.*, 2007; Jain *et al.*, 2006). In the above background we studied the genetics of variation for apiculus, hull and pericarp colour, hull surface and awnedness among 231 recombinant inbred lines derived from CSR10 x Taraori Basmati cross using single seed descent method.

Two hundred thirty-one CSR10 x HBC19 F_7 recombinant inbred lines (RILs) were transplanted in augmented design during wet season of 2004-05 at CCS HAU Rice Research Station, Kaul. All recommended agronomic practices were followed for raising the crop. CSR10 was developed from a cross between *indica* rice variety Jaya (TN1 x T141) and mutant F1 of CSR-1 (Damodar) having straw coloured husk and greenish white grains. HBC19 was developed from a cross between Basmati-370 x CM7-6 (Mushkain-4 x Muskan-7), Mushkain-4 has reddish brown husk and all others have straw husk and white grains. Both parents possess hairy and golden husk with golden apiculus and white kernels. CSR10 is awnless while HBC19 possesses partial awns. Fifteen plants were randomly selected from each of the 231 lines and observations were recorded for presence/absence of awn, hairy/non-hairy hull texture and colour of apiculus, pericarp, and hull on the basis of colour charts (Antonio *et al.*, 1996).

Among the 231 RILs a segregation ratio of 1:15 was observed for awned:awnless (Table 1), indicating awning to be a recessive digenic trait. Earlier studies have shown awning to be a dominant character and controlled by two genes or polygenes in different crosses (Ramiah and Rao, 1953; Ghose *et al.*, 1960).

Table 1. Segregation ratio for awnedness, apiculus colour and hull surface in CSR10 x HBC19 derived recombinant inbred lines

Character	Parental phenotype		RILs showing presence or absence of a character		Ratio	$\chi 2$ Value
	CSR10	HBC19	Present	Absent		
Presence of awn	Awnless	Partial awn	16	215	1:15	0.180
Apiculus Colour	Colourless	Colourless	12	219	1:15	0.430
Hull surface	Hairy	Hairy	90	141	7:9	2.301

Variable phenotypic expressions of awns and dominant genes inhibiting the expression of awns have also been reported giving a ratio of 13 awnless:3 awned (Tripathi and Rao, 1979; CunhaFilho and Nasimento, 1995).

In paddy, various shades of purple, pale yellow, red and white were observed and purple colour was reported to be dominant being governed by monogenic, digenic and trigenic gene action giving ratios of 3:1, 9:7, 15:1, 27:37 (Ramiah and Rao, 1953; Ghose *et al.*, 1960). In this study, both the parental varieties, CSR10 and HBC19 were having colourless apiculus, while 12 of the 231 RILs possessed coloured apiculus, the rest were colourless showing 1 (coloured): 15 (colourless apiculus) ratio, which showed that two genes (digenic recessive) might be responsible for the inheritance of this trait (Table 1). These results are in concurrence with the results of Rao and Seetharaman (1973) and Oka (1990) on stigma colour and anthocyanin pigments in rice indicating the presence of inhibitors.

A ratio of 51 hairy:9 bristle near apiculus: 4 glabrous in a cross of IR8 x Sagriono cross in F_2 population suggesting a trigenic control with inhibitors was reported by Tripathi and Rao (1979). In the present investigation, hull of both the parents was hairy in texture and in CSR10 x HBC19 RILs a ratio of 7 hairy: 9 hairless were observed (Table 1) indicating digenic action with complementary inhibitors.

Varying shades of hull colour such as straw, golden, purple, black, red, orange, greenish and piebald have been observed in traditional varieties/landraces (Ramiah and Rao 1953). Zaijun *et al*. (2003) observed a ratio of 432 black: 55 straw: 37 golden hull between a cross of IR8 (straw) x JBS 674 (golden) and concluded that two pairs of dominant duplicate genes control straw, the recessive duplicate genes control golden and as many as three genes are responsible for black colour of hull. Similarly, Sidiqqui *et al*. (2007) reported yellow, yellowish brown and dark purple hull colour in 475 accessions collected from 3 rice cultivation zones. Rani *et al*. (2008) also reported various types of hull colours and awn characteristics in short grain aromatic rices. RILs developed from a cross between CSR-10 and HBC-19 having golden hull colour, had the lines with varying hull colours such as gold, straw, brown, yellow green and red indicating complicated gene interactions (Table 2).

While both the parents (CSR10 and HBC19) possessed white kernels, RILs with different pericarp colours including white (167 lines), light brown (27 lines), brown (6 lines), red (22 lines) and green (9 lines) pericarp were observed. This indicated the presence of gene interactions of higher order. In traditional varieties red, purple, brown and white pericarp colours have been reported by Ramiah and Rao 1953. Chu *et al*. (2004) reported rice varieties with green kernel colour with polygenic control and Sidiqqui *et al*. (2007) reported rice genotypes with white and purple pericarp colour.

Table 2. Variation of hull and pericarp colour in CSR10 x HBC19 derived recombinant inbred lines

Character	Parental phenotype		CSR10 X HBC19 RILs				
	CSR10	HBC19					
Hull colour	Golden	Golden	Red 1	Golden 65	Straw 115	Dark brown 47	Yellow green 3
Pericarp colour	White	White	Light brown 27	Brown 6	Red 22	White 167	Green 9

In India, most of the work on this aspect was done on traditional varieties from Bengal and Madras. Misro *et al.* (1961) observed that major genes involved in bimodal inheritance may be found segregating free of modifying genes in advanced generation lines. The present study shows that these RILs display huge variation and segregation ratios for the awnedness, hull and pericarp colour characteristics. Thus, these RILs may serve as ideal population/ material for linkage mapping for these traits.

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