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Study of Inheritance pattern of Stigma colour in rice (*Oryza sativa* L.)

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Abstract

This experiment focused on the morphological marker *i.e.* stigma colour which is useful for varietal identification and linkage study with other major and minor genes. An inheritance study of the stigma colour in the cross of IC-548384 × Chandrahasini, IC-390376 × Chandrahasini, IC-390376 × Samleshwari, IC-134022 × Durgeshwari, IC-134022 × Durgeshwari and IC-389860 × Samleshwari were conducted during two consecutive *Kharif* 2016 and *Rabi* 2016-17 at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarh which included the eight parents, F_2 and subsequent F_3 segregants. The inheritance of stigma colour followed normal monogenic ratio 3 (Purple) : 1 (White) which is control by one major gene.

KEY WORDS: Morphological marker, Linkage, Major gene, Minor gene, Inheritance, Segregants.

INTRODUCTION

Rice belongs to the genus *Oryza*, the family Graminaceae, and is a widely cultivated crop (Syed and Khaliq, 2008). It is the most important staple food crop in the world consumed by more than half of the world population (Kohnaki et al., 2013). In modern rice farming, high yield has accordingly become one of the major objectives of breeders and growers over recent decades (Wang and Li, 2008; Xing and Zhang, 2010). Apart from increase yield, study of qualitative traits also crucial as these are important traits used in varietal identification and also used as morphological marker which can be used linkage study of major and minor genes. Chin *et al.* (2016) reported that anthocyanin accumulates in many plant tissues or organs, in rice for example leading to red, purple red and purple phenotypes for protection from damage by biotic and abiotic stresses and for reproduction. Hemaprabha *et al.* (2007) reported that the anthocyanin pigmentation in rice plays a major role in conferring tolerance to drought. Pandey et al. (2016) concluded that inheritance of anthocyanin pigmentation pattern in the different plant parts was found to be complicated. The segregation of pigmented: non-pigmented for basal leaf sheath, stigma and leaf apex was digenic with complementary gene action (9: 7).

Kadam (1997) concluded that the two duplicate anthocyanin sheath genes in the presence of the chromogen gene produce colour in the sheath group, which consists of sheath, internode, stigma and apiculus. Siddiq *et al.* (1996) reported inheritance of the pigment in the stigma showed a trigenic ratio involving one complementary and two duplicate genes. Kadam and D'cruz (2000) have reported that the basic genes with other specific genes develop colour for the stigma and basal leaf sheath in rice. The inheritance of anthocyanin pigmentation in different parts (internode, stigma and grain) of rice was studied using a F_2 population of a cross between red pigmented TKM 9 and white-pigmented ASD 16 rice cultivars, which segregated into 309 plants with purple stigma and red grain (pericarp) and 68 plants with green internode, colourless stigma and white grain. The results indicated the involvement of 2 major genes with inhibitory action of one gene in the inheritance of pigmentation in stem, stigma and pericarp of rice.

MATERIALS AND METHODS

The observations were recorded for stigma colour. The experimental material consisted of two segregating populations (F_2 and F_3) using eight parents (Table 1) representing six crosses for stigma colour (Table 2 and 3) recorded at early stage of crop.The observations on the parents were recorded on row basis, while F_2 and F_3, population on individual plant basis. The data were analyzed independently for each trait to determine the fitness with diverse segregation ratios to determine mode ofinheritance by χ2 (Chi-square) test as suggested by Fisher (1936).

$$\chi^2 = \sum_{i=0}^{n} \frac{(E_i^2 - O_i^2)^2}{E_i}$$

Where, O_i = Observed frequency of i^{th} class

E_i= Expected frequency of i^{th} class

(n-1)= degree of freedom

n= number of factors studied

Table 1. Parental description of parental cultivar, its pedigree and features

Genotype/crosses	Pedigree	Special features	Recommendation for cultivation
Chandrahasini	Abhaya × Phalguna	High yield potential, export quality grain (non-basmati), hence, highly accepted among farmers	Irrigated and rainfed bunded ecosystem of Chhattisgarh.
Samleshwari	R 310-37 × R 308-6	High amylose, medium gel consistency, high HRR and desirable ASV.	Direct seeded rainfed-uplands and in rainfed bunded "Matasi" soil of Chhattisgarh
Durgeshwari	Mahamaya × NSN 5	Long slender grain, intermediate amylose and gel consistency	Irrigated ecosystem of Chhattisgarh, Odisha and Bihar
IC-134022	Landrace	-	-
IC-548384	Landrace	-	-
IC-388728	Landrace	-	-
IC-389860	Landrace	-	-
IC-390376	Landrace	-	-

Table 2. Characteristics taken under investigation for stigma colour

Characters	Chandrahasini	Samleshwari	Durgeshwari	IC-134022	IC-548384	IC-388728	IC-389860	IC-390376
Stigma	White	White	Purple	Purple	Purple	White	Purple	Purple

RESULTS AND DISCUSSION

Like anthocyanin pigmentation in other part, stigma colour is also equally important in identification and rouging of off types of plant from seed production field, particularly from hybrid rice seed production field at flowering stage. Inheritance of segregating population (170 F_2 and 305 F_3 plants population) of six crosses involves parentage possessing purple and white stigma colour was analysed (Figure 1, 2 and Table 3). The Chi-squire results revealed that gene responding stigma coloration is governed mono-genically following pattern of dominant monogenic inheritance (3:1 ration in both generations) (Kadam et al.1997; Sahu et al. 2006; Pandey et al. 2016).

Table 3. Segregation pattern for Stigma colour in F_2 and F_3 population

Stigma color								
F_2 generation			**Purple**	**White**				**X^2-value**
IC-548384 × Chandrahasini	Purple	White	190	17	0	0	207	1.36
IC-390376 × Chandrahasini	Purple	White	149	12	0	0	161	0.40
IC-390376 × Samleshwari	Purple	White	141	18	0	0	159	6.98
IC-134022 × Durgeshwari	Purple	Purple	176	0	0	0	176	11.73*
IC-388728 × Chandrahasini	White	White	0	141	0	0	141	132.00**
IC-389860 × Samleshwari	Purple	White	164	14	0	0	178	0.79
Pooled value			137	34			170	4.25
F_3 generation								
IC-548384 × Chandrahasini	Purple	White	220	15	0	0	235	0.007
IC-390376 × Chandrahasini	Purple	White	320	21	0	0	341	0.005
IC-390376 × Samleshwari	Purple	White	301	19	0	0	320	0.053
IC-134022 × Durgeshwari	Purple	Purple	483	31	0	0	514	0.042
IC-388728 × Chandrahasini	White	White	0	220	0	0	220	206**
IC-389860 × Samleshwari	Purple	White	186	12	0	0	198	0.012
Pooled value			252	53			305	0.0238

(*) Significantly deviated at 0.05 ($\chi 2$ *(t)* = 7.81 for F_2 and F_3), (**) significantly deviated at 0.01 ($\chi 2$ *(t)* = 11.34 for F_2 and F_3; P_1=parent one and P_2-parent two.

Figure 1. Segregation Pattern of F_2 Population

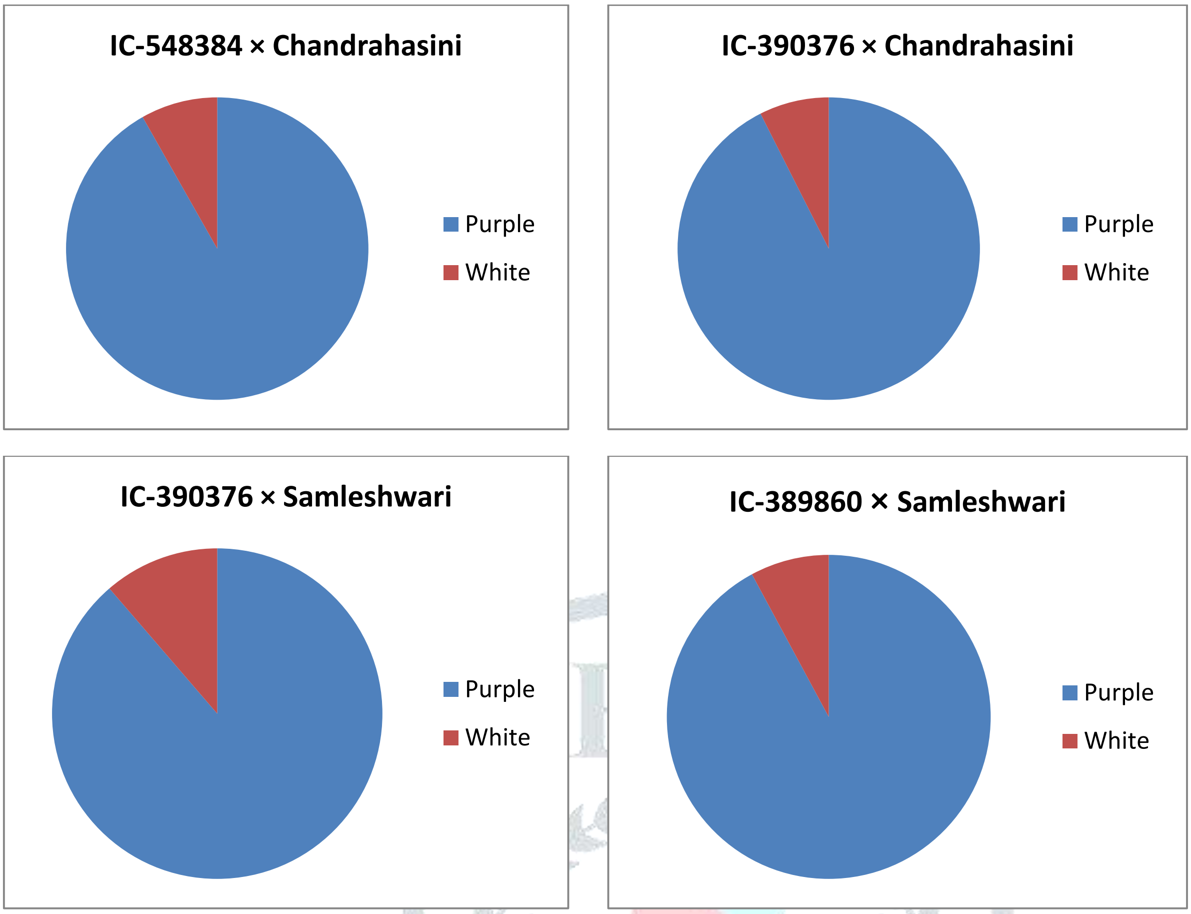
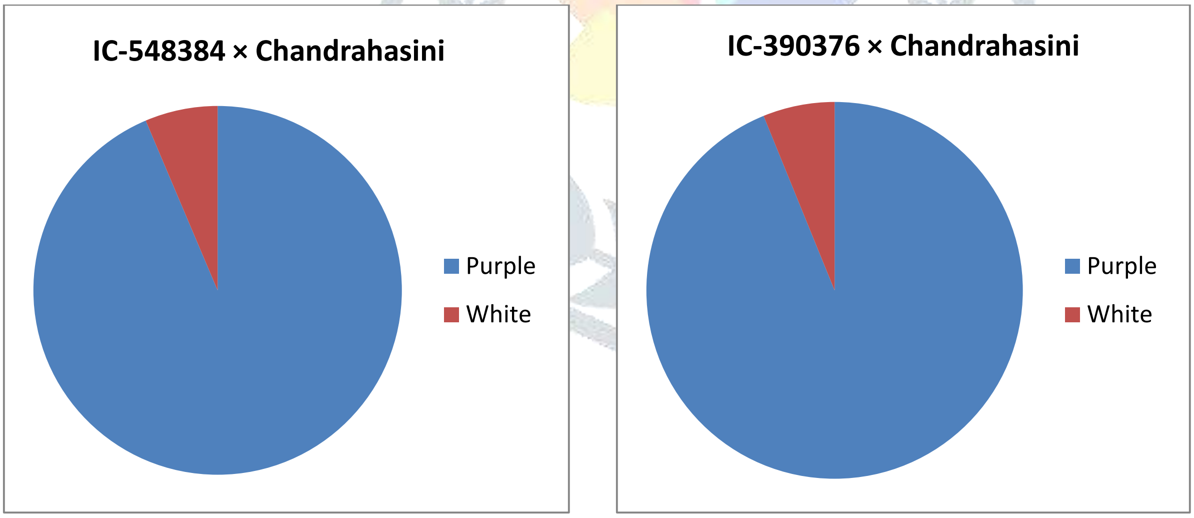
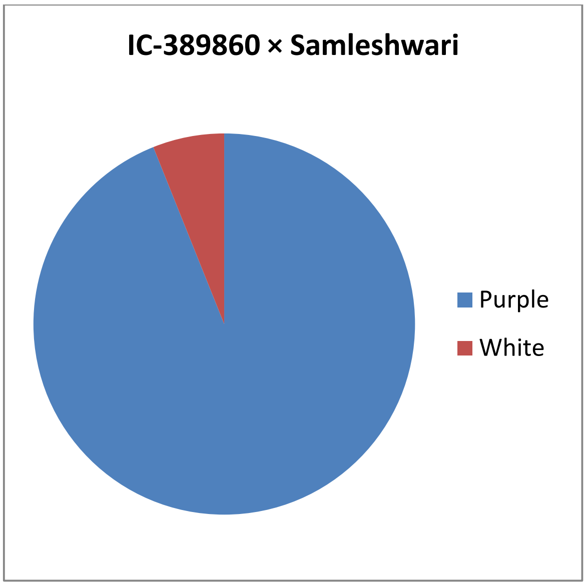
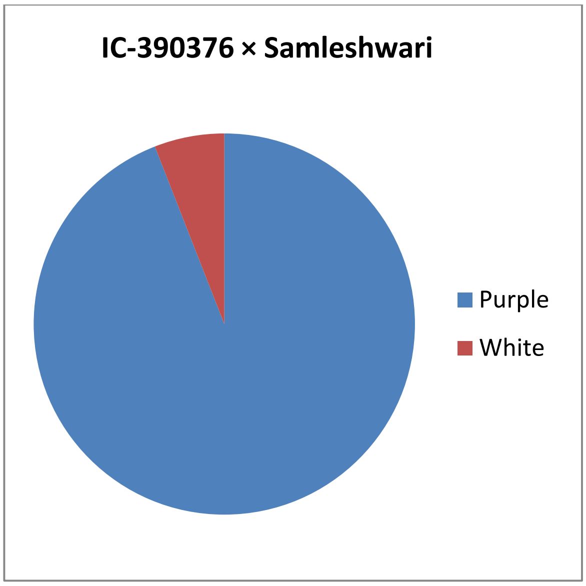


Figure 2. Segregation pattern of F_3 Population







CONCLUSION

Qualitative traits are controlled by one or two genes which control the morphological traits and follow Mendelian segregation pattern. Morphological traits are used for varietal identification during seed certification and also act as morphological markers. In this study stigma colour controlled by single dominant gene and followed a ratio of 3 : 1.

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