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**Research Paper**

# Study of Inheritance pattern for basal leaf sheath colour in rice (*Oryza sativa*L.)

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***Abstract***
*This study concentrated on the phenotypic marker i.e. basal leaf sheath colour which is useful for varietal identification and linkage study with other qualitative and quantitative traits in rice. An inheritance study of the basal leaf sheath colour in the cross ofIC- 388728 x Chandrahasini and IC-389860 × Samleshwariwere conductedduring two consecutive Kharif 2016 and Rabi 2016-17 at the Research and Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, Chhattisgarhwhich included the parents, $F_2$ andsubsequent $F_3$ segregants. The inheritance of basal leaf sheath colour followed normal digenic ratio 9 (Green) : 3 (Light purple) : 3 (Line Purple) : 1 (Purple) which is control by two major gene.*
***Key Words:*** *Phenotypic marker, Linkage, qualitative, Quantitative traits, Inheritance, Segregants.*

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## I. 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. The global rice production has to be enhanced by 70 per cent by 2050 to meet the demand of growing population (FAO, 2009; NRRI, 2013). Apart from increase yield, it is very crucial to study the morphological traits and their inheritance of these traits which are act as morphological markers. These morphological markers are heritable qualitative attributes of gross morphology, structure or plant organ that remain constant as they are transmitted from generation to generation within the species or when the species are involved in hybridization with related species. These traits are used for the varietal identification during the seed certification. So, it needs the study of basal leaf sheath colour which is an important morphological marker.

Basal leaf sheath colour in rice is a very important trait, used as morphological marker for identification and rouging of off type plant at very early stage from production field. Besides, confers several others selective features like disease resistance/tolerance to the rice plants (Hector, 2002). Hector (1922a) studied inheritance of leaf-sheath pigmentation and reported F2 segregation ratios of 3:1, 9:7, 15:1 and 27:37 of purple to green. Panda (1962) reported the ratios 81:175 and 162:94 of coloured sheath to green, which were due to four genes (including 2 basic genes A and C) involved in the expression of pigmentation on leaf sheath. Shrivastava *et al.*, 1968 reported monogenic inheritance of leaf sheath colour. Dhullappanavar (1973) observed the digenic complementary ratio for the leaf sheath colour. Eruotor (1983 and 1986) studied mode of inheritance of leaf-sheath colour in rice at Nigeria and reported that purple leaf sheath was dominant to green. Ramesh (1984) reported trigenic complementary gene action for expressing purple leaf-sheath colour in the cross of two green indica varieties IR8 and Basmati. The F1 plants exhibited purple leaf-sheath and $F_2$ and $F_3$ segregation ratios indicated trigenic complementary gene action. The following genotypes were proposed on the basis of the complementary genes A (activator) and C (chromogen) and the pigment localization gene Psh (leaf-sheath): IR8- AAccpshpsh and for Basmati-aaCCPshPsh. Mode of segregation of leaf-sheath pigment in F2 generation was reported to be monogenic by Majumdar (1985). Rao and Misro (1986) observed the digenic complementary ratio for basal leaf sheath character.

Singh et al. (1990) reported the ratio of 162:94 for leaf sheath character. Sahu (1991) reported the ratio of 27 purple sheath : 229 green sheath in F2 of the cross Surekha × Naumohar (purple leaf-sheath) and suggested the presence of three complementary genes A, C and Psh (localization gene) in the parent Naumohar and one inhibitory gene Jpsh in Surekha. Nadaf et al. (1994) revealed that the anthocyanin pigmentation is controlled by three to five genes in rice. 6 Cunha and Nascimento (1995a) studied the inheritance of anthocyanin colouration from the cross between IR8 x Sagrimao and reported the ratio of 39 colourless : 25 coloured, suggesting that presence pigment in the leaf sheath was controlled by two duplicate genes with additive effects (RJ and R2), interacting with one non dominant inhibitor gene. Pavithran et al. (1995) observed ratios of 9:7, 27:37 and 45:19 for the expression of leaf-sheath pigmentation and explained that one basic gene interacting with 2 complementary genes in respect of purple colour of leaf sheath and other anthocyanin pigmented traits.

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. Panda and Mohapatra (1997) reported two dominant complementary genes for pigmentation of leaf sheath. Hsu and Lu (1999) concluded that there is a considerable variation in the intensity and distribution of anthocyanin pigmentation in the leaf sheath with domination of the purple colour in the $F_1$. Shukla (1999) found that a trigenic ratio in $F_2$ of 54 green: 10 purple was obtained for purple leaf-sheath and suggested that three genes were responsible for expression of pigmentation. Hector (2002) found that a dominance type of gene action with a ratio of 9:7 of the pigmented to non-pigmented for the basal leaf sheath pigmentation in rice. Therefore, there is an involvement of the two complementary genes for the pigmentation in the basal leaf sheath in the *O. rufipogon* is concluded. Sahu (2006) studied the inheritance of leaf sheath colour which was inherited in the ratio 3: 1 (purple leaf sheath to green leaf sheath) indicating the presence of single dominant gene in a cross between Ram-Laxman and Dodna. 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. An $F_2$ 7 population derived from ssp. japonica cv. Tainung 72 (TNG72) with purple leaf sheath (PSH) crossed with ssp. indica cv. Taichung Sen 17 (TCS17) with green leaf sheath (GSH) was utilized to isolate a gene conferring leaf sheath colour. OsC1 is responsible for purple leaf sheath, and much new information about OsC1 is provided e.g., new alleles, non-domestication syndrome, and incongruence of genealogy with geographic distribution.

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). Digenic inheritance of the pigmentation in the awn and lemma and palea was found with the segregation ratio of 11 pigmented: 5 nonpigmented. A tetragenic ratio with inhibitory gene action (81 pigmented: 175 non-pigmented) was observed for the internode colour. A pleiotropic gene action of one of the basal leaf sheath pigmentation with that for the stigma and internode pigmentation was found.

## II. Material and Methods

Different basal leaf sheath colour, two crosses for purple and green colour were made. The observations recorded on basal leaf sheath colour (purple, light purple, line purple and green). The experimental material consisted of two segregating populations ($F_2$ and $F_3$) using four parents (Table 1) representing two crosses for basal leaf sheath colour (purple, light purple, line purple and green) 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 of inheritance by χ2 (Chi-square) test as suggested by Fisher (1936).

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

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 rainfedbunded 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 rainfedbunded "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 | - | - |

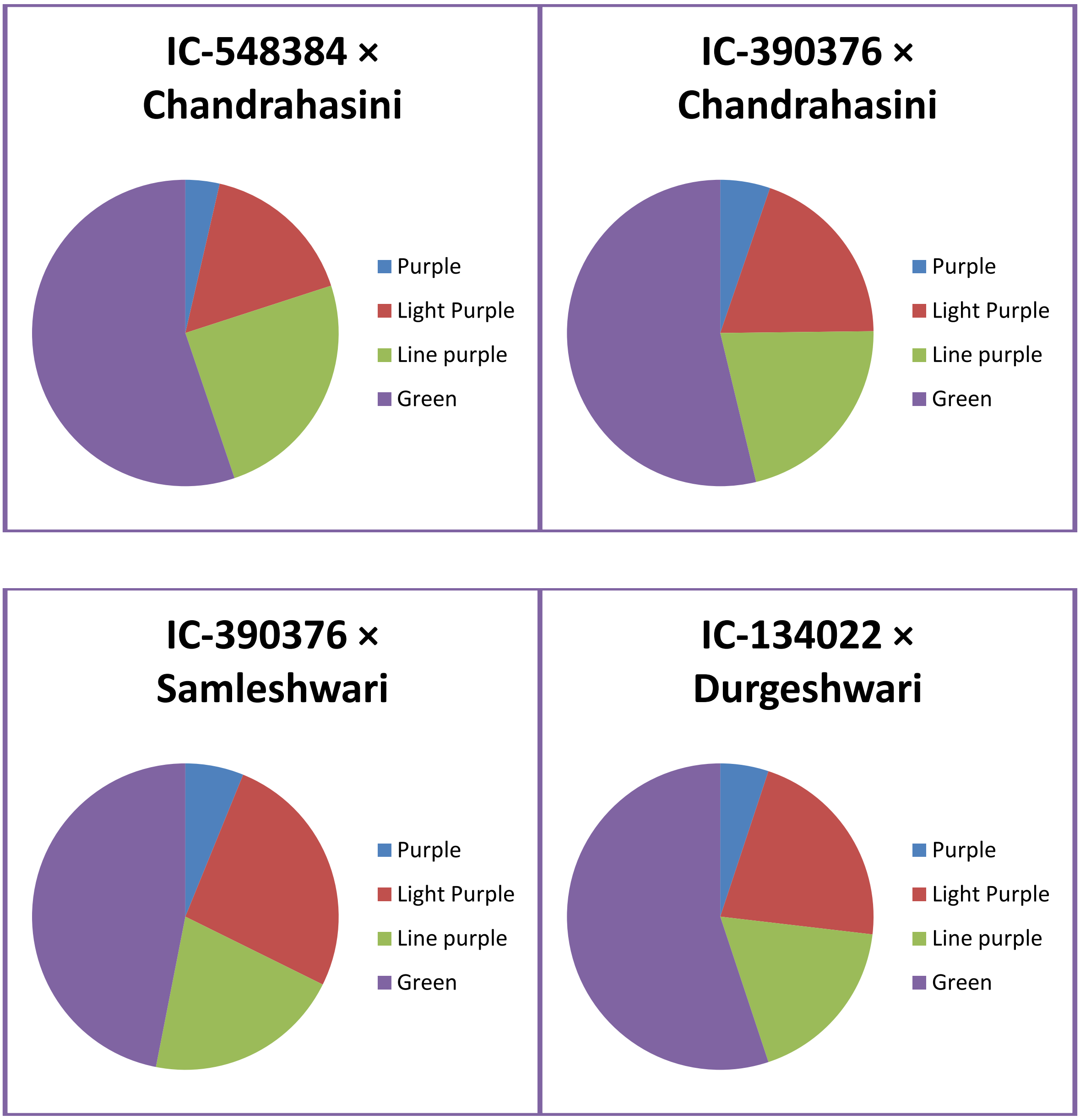
## III. Results and Discussion

Basal colour in rice is a very important trait, used as morphological marker for identification and rouging of off type plant at very early stage from production field. Besides, confers several others selective features like disease resistance/tolerance to the rice plants (Hector 2002; Kadam and D'cruz 2000). The 6 crosses of purple and green pigmented basal leaf sheath comprised 8 parentages were segregated into an average of 246 (13 purple, 49 light purple, 53 line purple and 131 green) plants in $F_2$ and 302 (22 purple, 81 light purple, 89 line purple and 216 green) plants in $F_3$ population (Table 2 and Figure 1, 2). The chi-squire results indicated that except in the segregants of two crosses (IC-548384 × Chandrahasini and IC-390376 × Samleshwari), basal leaf pigmentation in rest of the populations is conferred by two major genes with dominant gene interaction (9:3:3:1) (Pandey et al. 2016).

**Table 2: Segregation for basal leaf sheath colour character in $F_2$ population in rice**

| **Basal Leaf Sheath Colour** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **$F_2$ generation** | | | | | | | | |
| **Crosses** | **$P_1$** | **$P_2$** | **Purple** | **Light Purple** | **Line purple** | **Green** | **Total** | **$X^2$-value** |
| IC-548384 × Chandrahasini | Light Purple | Green | 9 | 41 | 62 | 138 | 250 | 8.47* |
| IC-390376 × Chandrahasini | Purple | Green | 14 | 52 | 57 | 143 | 266 | 1.82 |
| IC-390376 × Samleshwari | Purple | Green | 16 | 68 | 54 | 122 | 260 | 12.19** |
| IC-134022 × Durgeshwari | Purple | Green | 11 | 47 | 39 | 119 | 216 | 1.61 |
| IC-388728 × Chandrahasini | Purple | Green | 10 | 39 | 51 | 135 | 235 | 3.23 |
| IC-389860 × Samleshwari | Purple | Green | 18 | 45 | 56 | 131 | 250 | 2.87 |
| Pooled value | | | 13 | 49 | 53 | 131 | 246 | 4.34 |
| **$F_3$ generation** | | | | | | | | |
| IC-548384 × Chandrahasini | Light Purple | Green | 28 | 90 | 102 | 256 | 476 | 2.45 |
| IC-390376 × Chandrahasini | Purple | Green | 20 | 56 | 84 | 168 | 328 | 10.21* |
| IC-390376 × Samleshwari | Purple | Green | 30 | 120 | 98 | 247 | 495 | 11.83* |
| IC-134022 × Durgeshwari | Purple | Green | 18 | 88 | 121 | 273 | 500 | 14.13** |
| IC-388728 × Chandrahasini | Purple | Green | 13 | 47 | 52 | 110 | 222 | 5.11 |
| IC-389860 × Samleshwari | Purple | Green | 25 | 83 | 78 | 243 | 429 | 0.29 |
| Pooled value | | | 22 | 81 | 89 | 216 | 302 | 7.34* |

**Figure 1. Inheritance Pattern of $F_2$ population**



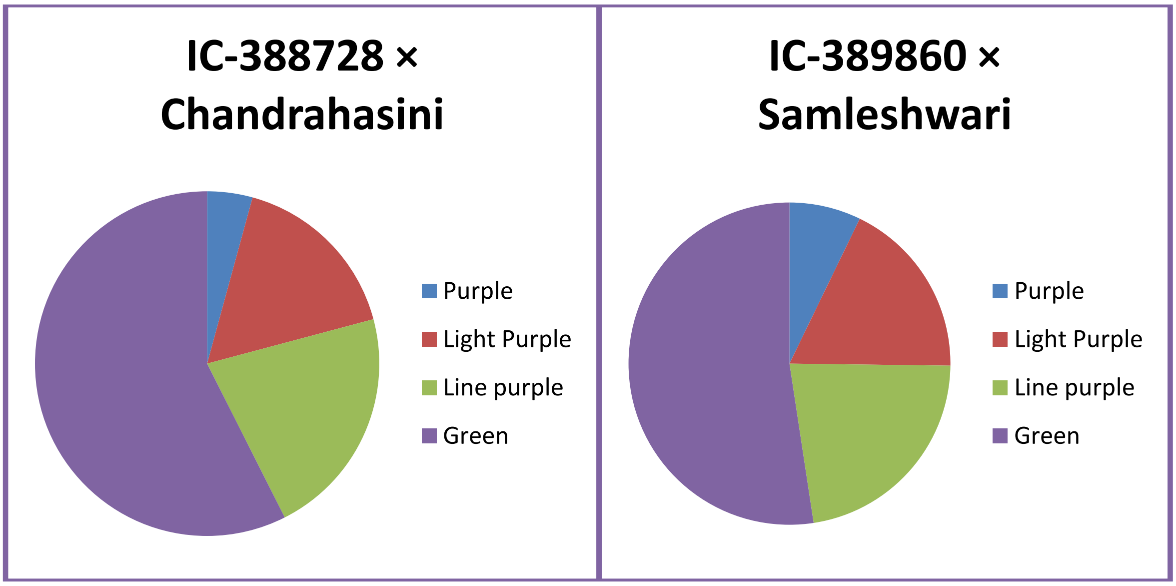
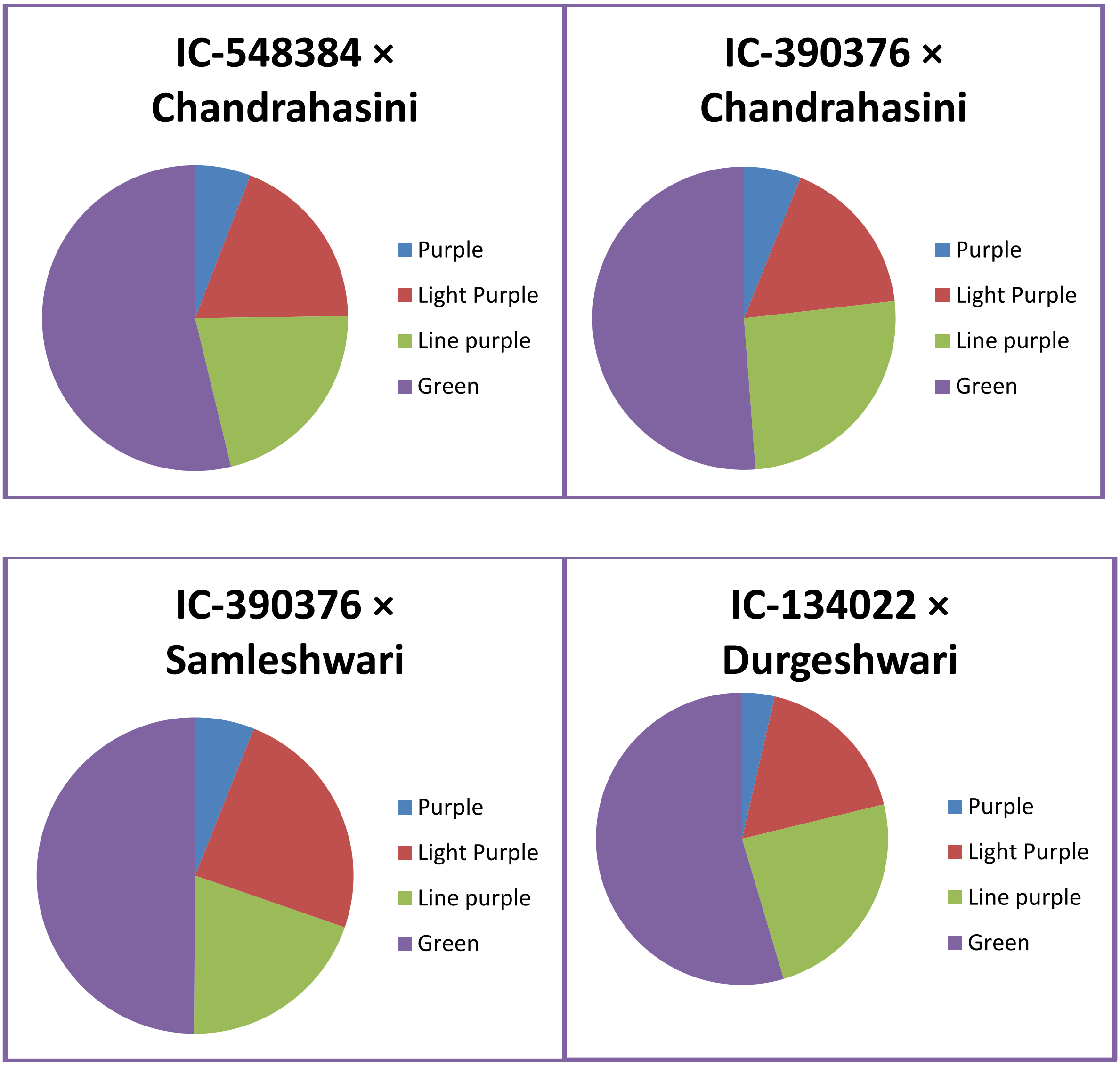
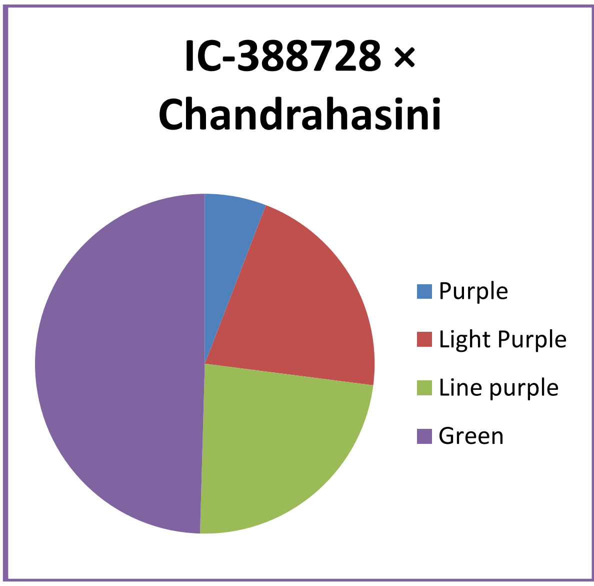
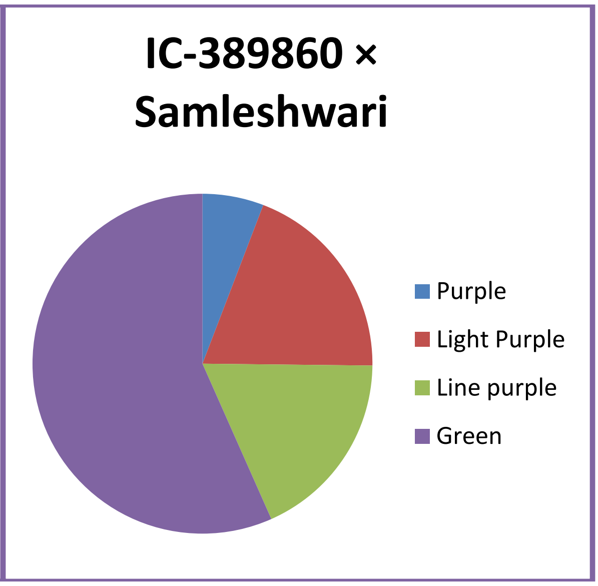



**Figure 2. Inheritance Pattern of $F_3$ population**






## IV. CONCLUSION

Some minor morphological and genetical characters in rice have been shown to possess greatvalue as morphological markers. The valuable markers identified include basal leaf sheath colour, ligule colour, auricle colour, stigma colour, pigmentation of apiculous/awn. Themorphological markers*i.e.* basal leaf sheath colour can be employed in the varietal identification and also aid in the understanding of the population dynamics of the indigenous species of *Oryza sativa*.Which is controlled by two major genes and segregates in the ratio 9 (Green) : 3 (Light Purple) : 3 (Line Purple) : 1 (Purple).

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