Inheritance of floral traits in spontaneous mutant in rice (*Oryza sativa* L.)

Mutations are the building blocks of genetic variation. Spontaneous mutations occur regularly in all crop plants. However, most of these are not noticed because of the minimal changes involved. By contrast, mutations with major morphological alterations can be easily selected. Thus, floral abnormality as a cause of spikelet sterility or fertility has great significance on floral mutations of rice plants. Rice (*Oryza sativa* L.), a self-pollinated, monocot model plant, consists of florets with two glumes, two lodicules, six stamens and one pistil. Naturally, the floral biology shows that one floret provides one caryopsis. However, a range of floral mutants such as pistil hyperplasia (55.6%), represented by an increase in the number of pistils and also stamen hyperplasia (3.7%), represented by an increase in the number of stamens have been reported. Stamen hypoplasia (7%), represented by a decrease in the number of stamens has also been reported in cultivar Kimzay. These kinds of floral malformities are due to either environmental stresses or genetic factors, which are considered as major causes for sterility in rice. The fertile sept-pistillate mutant was also observed in rice cultivar, TDC 72. This sept-pistillate mutant gave a goodness-of-fit of segregation ratio to the expected Mendelian monogenic action of 3 : 1 ($\chi^2 = 1.78$). Multiple-pistillate mutants in rice were reported; these mutants are male fertile and the trait has been transferred to the cytoplasmic male sterile (CMS) background to breed elite CMS lines. The extra glumes (eg 2) mutants are characterized by the presence of extra palea and lemma was noticed in the cultivar IR 36. Not all the spikelets in a panicle of the mutant have extra glumes.

Rice accessions of indica (IR 36, IR 64 and IR 72), japonica (Taichung 65, Akhikari and Palawan) and javanica (PRR 5, PRR 10 and PRR 16) sub-species were transplanted in a hybridization block in the kharif (wet) season of 2000-01 in the experimental area of Paddy Breeding Station, Tamil Nadu Agricultural University, Coimbatore. Many spontaneous mutants were identified in javanica accession PRR 16. These mutants were more vigorous and dissimilar from mother plants of PRR 16 in most of the traits, viz. floral abnormality, purple pigmentation in leaf sheath, leaf blade (Figure 1a), stigma (Figure 1f), and g, bi-pistillate and tri-pistillate, apiculus and the presence of extra palea and lemma (eg 2; Figure 1b). The mutant plants were evaluated in both wet and dry seasons of 2001-02. Selfing of panicle was carried out in all seasons to confirm seed setting, which showed that there was seed set in the mutant plants in all seasons. The evaluation confirmed that the occurrence of mutation was heritable. Spikelets were collected during all seasons at heading time and studied under a stereomicroscope to investigate the morphological changes in the floral parts. These mutant panicles had both bi-pistillate and tri-pistillate florets. Bi-pistillate florets appeared predominantly and produced double kernel seeds (Figure 1c). The frequency of appearance of tri-pistillate florets was low and produced the triple kernel seeds (Figure 1d). Few multipistillate florets were also found in a panicle and became sterile due to immature sexual organogenesis. Floral abnormality was studied across four seasons, which confirmed the stability of mutant traits.
The spikelets of this mutant are characterized by the presence of extra palea and lemma (eg 2). The gene, although completely penetrant, does not have 100% expressivity. Not all the spikelets in a panicle of the mutant have extra glumes during all seasons. The germination test was carried out which showed that the double kernel seeds produced healthy twin seedlings (Figure 1 e), but the triple kernel seeds did not produce healthy triple seedlings. This may be due to nutrient imbalance to the tender growing seedlings.

Hand emasculation was carried out on the mother plant of PRR 16 and crossed with mutant PRR 16 to produce F1 hybrids for identifying the inheritance patterns of mutations that occurred in the rice accession PRR 16. The F1 plants produced single kernel seed per floret. All F1 plants were advanced to F2 generation for studying the inheritance of spontaneous floral mutant. In F2 generation, 200 individual plants were raised and observed (143 normal and 52 mutant plants).

The segregation of F2 populations showed the Mendelian segregation frequencies of goodness-of-fit to 3 normal : 1 mutant plant (χ^2 = 0.240; Table 1). All mutant plants of the segregating population had extra glumes, but not all the spikelets in a panicle of the mutant have extra glumes. The eg 2, mutant was reported to be located on chromosome 6, by crossing the mutant with the chromosome 6 primary trisomic of IR 36. The co-segregation of this floral mutant with extra glumes suggested that the occurrence of this floral mutant may be located on chromosome 6. This floral mutant, PRR 16, is controlled by a single recessive gene, which can be introgressed into the elite cultivars using backcross breeding method. This novel floral mutant could be exploited for molecular floral biological study.

Table 1. Segregation pattern of pistils in PRR 16/PRR 16 mutant crosses

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Normal</th>
<th>Mutant</th>
<th>Expected ratio</th>
<th>χ^2</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1 (PRR 16/PRR 16 mutant)</td>
<td>42</td>
<td>0</td>
<td>3.1</td>
<td>0.240</td>
<td>0.50–0.75</td>
</tr>
<tr>
<td>F2</td>
<td>143</td>
<td>52</td>
<td>3.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


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