Yield and Inheritance of Non-Photoperiod Sensitivity and Semi-Dwarf Genes By Molecular Markers of Glutinous Rice RD 6 Lines

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ABSTRACT

This research was conducted to study on the inheritance of photoperiod sensitivity characteristics as controlled by the gene, Hdl/hd1, in the rice population of BC₄F₂-51-501-6211-2320-414-9006, which originated from the “Project on Glutinous Rice Improvement of RD 6 for Non-Photoperiod Sensitivity by Molecular Marker-Assisted Backcrossing for Off-Season Planting”. The photoperiod sensitive RD 6 variety served as the donor gene containing the genotype HdlHd1 together with the non-photoperiod sensitive Taichung 65 variety containing the genotype hd1hd1. A total of 70 plants of the BC₄F₂-51-501-6211-2320-414-9006 line were planted on March 14, 2009 and exposed to sunlight for 12 hours/day. It was found that the ratio of Hdl/hd1 genes and phenotype of photoperiod and non-photoperiod sensitivities followed the First Law of Mendel as shown by 21 non-photoperiod sensitive plants which were observed to flower on July 2009 (13.4 hours sunlight). Genotypic analysis of these plants using the primer Hdl exon2F+Hdl exon2R+DoT65hd1exon2R which was a part of the gene, Hdl/hd1, showed that rice plants which flowered during long days contained only the genotype hd1hd1. Meanwhile, the study on the genetic inheritance of plant height controlled by the genes, Sdl/sdl, was conducted using the rice population, BC₄F₂-2630-127-4121-2745-358-9007, which originated from the “Project on the Glutinous Rice Improvement of RD 6 for Semi-Dwarf Plant Height by Molecular Marker-Assisted Backcrossing”. The tall RD 6 rice variety was used as the recipient gene (Sd1Sd1) while RD 1 served as the donor (sd1sd1). Results of this study indicated that when 69 plants were measured for their height, 8 plants showed a height ranging from 80.7-102.0 cm, thus considered as semi-dwarf plants. Further analysis of the genotype of these rice plants using the primer RD6Sd1VS3F+sd1MW3F+sd1MW3R which was a part of the gene Sdl/sdl, only one
type of genotype, sd1sd1, was found. Results also showed that the ratio of genotype and phenotype did not follow the First law of Mendel thus another study was conducted using additional 40 plants of BC$_{6}$F$_{2}$-127-4121-2630-358-1687-710-1705 during the rainy season of 2009. Results showed that 7 plants were found to have a height of 90-106 cm and genotypic analysis using the primer RD6Sd1VS3F+sd1MW3F+sd1MW3R, a part of the gene, Sdl/sd1, indicated that they contained the sd1sd1 genotype only. Study of the genotypic and phenotypic ratios showed the results conforming to the First Law of Mendel. When photoperiod sensitivity and height of plants were studied together by crossing the rice lines BC$_{3}$F$_{1}$-51-501-6211-2320-414 which contained the genotype Hd1hd1 (mother) with plants from BC$_{4}$F$_{1}$-2630-127-4121-2745-358 containing the genotype Sdlsd1 (father), the resulting plants of F$_{1}$ (BC$_{5}$F$_{1}$-51-501-6211-2320-414 x BC$_{4}$F$_{1}$-2630-127-4121-2745-358)-1556, were then self-crossed and later used to study the genetic inheritance of the genes, Hd1/hd1 and Sdl/sd1, in F$_{2}$ generation using 98 plants during a long day period on March 14, 2009 (12 hours of sunlight). Results showed that flowering took place in one plant (exposed to 13.4 hours sunlight) and was semi-dwarf. Genotypic study using two primers, Hdl exon2F+Hdl exon2R+DoT65hd1exon2R, a part of the gene, Hdl/hd1 and RD6Sd1VS3F+sd1MW3F+sd1MW3R, a part of the gene, Sdl/sd1, showed the presence of genotype hd1hd1sd1sd1 while study of genotypic and phenotypic ratio of the two characteristics being studied together indicated that the genotypic ratio followed the Second Law of Mendel but not the phenotypic ratio.

Meanwhile, comparison of yields, seed physical characteristics and cooking quality of 4 lines of glutinous rice RD 6, namely: photoperiod sensitive and tall (Hd1Hd1Sd1Sd1); photoperiod sensitive and semi-dwarf (Hd1Hd1sd1sd1); non-photoperiod sensitive and tall (hd1hd1Sd1Sd1); and non-photoperiod sensitive and semi-dwarf (hd1hd1sd1sd1), were studied during the rice paddy season of 2008 in Maejo University (Chiang Mai province) using the Randomized Complete Block Design (RCBD) with 3 replications. The 4 lines consisted of F$_{3}$ generation of BC$_{4}$F$_{1}$-51-501-6211-2255 containing the genotype Hd1hd1Sd1Sd1 that resulted from the “Project on Glutinous Rice Improvement of RD 6 for Non-Photoperiod Sensitivity by Molecular Marker-Assisted Backcrossing for Off-Season Planting” crossed with BC$_{4}$F$_{1}$-127-412-2630 with genotype Hd1Hd1Sd1sd1 from the “Project on Glutinous Rice Improvement of RD 6 for Semi-Dwarf Plant Height by Molecular Marker-Assisted...
Backcrossing”. Results showed that yield and important agronomic characteristics of the 4 rice lines were not significantly different except the age of flowering and plant height which were highly significantly different as known by their yields at 626, 812, 669 and 772 kg/rai, respectively. As for age of flowering, the photoperiod sensitive and tall plants (Hd1Hd1Sd1Sd1) (108 days) and photoperiod sensitive and semi-dwarf plants (Hd1Hd1sd1sd1) (108 days) had longer days to flower than lines of non-photoperiod sensitive and tall plants (hd1hd1Sd1Sd1) (99 days) and non-photoperiod sensitive and semi-dwarf plants (hd1hd1sd1sd1) (99 days). Meanwhile, the height of photoperiod sensitive and tall plants (Hd1Hd1Sd1Sd1) (189 cm) was found to be higher than non-photoperiod sensitive and tall plants (hd1hd1Sd1Sd1) (168 cm), and both these two lines were much taller than photosensitive and semi-dwarf plants (Hd1Hd1sd1sd1) (117 cm), and non-photoperiod sensitive and semi-dwarf plants (hd1hd1sd1sd1) (114 cm). On seed physical characteristics, it was found that the width, length and thickness of 4 lines of paddy and brown rice were not significantly different, although 1000-seed weights were found to have high significant difference. Meanwhile, cooking qualities consisting of percentage amylose, gel consistency, alkali test and elongation ratio during cooking, including the aroma of the 4 lines were not statistically different, from the original line of RD 6.