

学位論文要旨  
Dissertation Abstract

氏名 :

Name Mukunda Bhattarai

学位論文題目 : Effects of dwarfing allele *sd1-d* at the *sd1* locus on yield and  
Title of Dissertation related traits, compared with tall alleles, in *indica* rice.

(イネの*sd1*座の矮性対立遺伝子*sd1-d*が*indica*品種の遺伝的背景において収量および関連形質に及ぼす作用)

学位論文要旨 :

Dissertation Abstract

The *sd1-d* originating from an *indica* variety ‘Dee-geo-woo-gen’ is a dwarfing allele at the *sd1* locus on chromosome 1 in rice. This allele has been intensively utilized to develop high-yielding *indica* varieties adaptable to higher fertilizer-application, and is harbored by almost all elite varieties in Southeast Asia such as IR8, IR36 and IR72.

The wild type allele *SD1* encodes a gibberellin biosynthetic enzyme GA20 oxidase (*GA20ox-2*) that catalyzes late steps of gibberellin biosynthesis, while *sd1-d* includes the deletion of 383 bp between the two sites of the exon 1 and exon 2, resulting in the loss of the enzymic function. The dominant allele *SD1* at the locus is differentiated into *SD1-in* and *SD1-ja* which is harbored in *indica* and *japonica* subspecies, respectively. The effect of elongating culm was higher in the *SD1-in* than in the *SD1-ja*, which could be one of the causes of intersub-specific difference in height. Nonsynonymous single-nucleotide polymorphisms between *SD1-in* and *SD1-ja* were detected at the two sites in the exon 1 and exon 3 of the *sd1* locus.

In the present study, the effects of *sd1-d* on not only yielding ability but also lodging resistance, compared with *SD1-in* and *SD1-ja*, were examined, using the two tall isogenic lines carrying *SD1-in* and *SD1-ja* of IR36 described below.

The *sd1-d* of *indica* IR36 was substituted with *SD1-in* or *SD1-ja* by recurrent backcrossing with IR36, and two tall isogenic lines (“5867-36” and “Koshi-36”) regarding the respective tall alleles were developed.

The effects of *SD1-in* and *SD1-ja* on yielding ability and related traits, particularly grain and spikelet characteristics, compared with *sd1-d*, were examined on the common genetic background of IR36. IR36, 5867-36 and Koshi-36 were grown in an experimental paddy field in 2017, 2018 and 2019. Yield and its related traits were measured. *SD1-in* decreased panicle number per m<sup>2</sup> but increased spikelet number per

panicle and 1000-grain weight, compared with *sd1-d*, resulting in the increase of yield (brown rice weight per m<sup>2</sup>, with the thickness above 1.5 mm). The increase of 1000-grain weight by *SD1-in*, caused by the increases of length, width and thickness of grain, was due to the increases of the length and width of lemma. *SD1-ja* did not significantly affect yield, mainly because the decrease of panicle number per m<sup>2</sup> was compensated by the enlarged grain size owing to the increase of lemma length. Serious lodging was observed in long-culmed 5867-36, suggesting that *sd1-d* is indispensable for *indica* breeding programs.

The effects of *sd1-d* on lodging resistance and related traits, compared with *SD1-in* and *SD1-ja*, were examined, using the same materials of the two tall lines and IR36 grown in 2017. Regarding 4th-panicle length (the length from the base of the 4th internode to panicle top, cm), the lines-variety were in the order 5867-36 (118.7) > Koshi-36 (97.6) > IR36 (78.6) on the 21st day after 80% heading, where “>” indicates significant difference at the 5% level of probability. Regarding 4th-top weight (the total weight of panicle, the first to fourth internodes, leaf sheaths and leaf blades, g), the lines-variety were in the order 5867-36 (12.2) > Koshi-36 (10.2) > IR36 (9.6). Breaking strength (g) at the fourth internode was in the order IR36 (1649) ≥ 5867-36 (1493) ≥ Koshi-36 (1360) (IR36 > Koshi-36), where “≥” indicates that the former is higher than the latter but being not significant statistically at the 5% level of probability. The index of lodging (g·cm/g) is calculated by the formula of (4th-panicle length × 4th-top weight) ÷ Breaking strength × 100. This trait was in the order 5867-36 (97.4) > Koshi-36 (74.1) > IR36 (46.0) on the 21st day after 80%-heading, and they were in the same order on the 10th day after 80%-heading. Consequently, it is inferred that *sd1-d* enhances lodging resistance due to the decreases in the length and weight above the 4th internode inclusive, and the increase of breaking strength; and the effect of *SD1-in* on lodging resistance is lower than that of *SD1-ja*.