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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目：
Title of Dissertation

Genetic analyses of genes controlling heading time and their effects on yield and related traits in rice
(イネの出穂性に関する遺伝的解析、および、それに係わる遺伝子が収量および関連形質に及ぼす作用)

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Heading time is an important trait for regional and seasonal adaptabilities in rice, and is controlled by genetic factors in relation with environmental factors, mainly day length and temperature.

The following genes controlling heading were examined for their responses to six different environmental conditions using five early nearly-isogenic lines (NILs) of T65-R and three late NILs of T65wx: two earliness genes, *Ef1* and *Efx* controlling basic vegetative phase (BVG), and *m-Ef1*, the enhancer to the former gene; and two lateness genes, *Se1-pat*(t) and *se-pat* controlling photo-sensitivity and BVG, respectively. T65-R and T65-T were different accessions of Taichung 65. T65wx is a NIL of T65-T carrying *wx*. The five early NILs of T65-R were in the order of ER50 (*Ef1*, *Efx*, *m-Ef1*) < ER40 (*Ef1*, *m-Ef1*) ≤ ER20 (*Ef1*, *Efx*) < ER1 (*Ef1*) ≤ ER21 (*Efx*) < T65-R regarding days to heading (DTH) under spring-sowing and summer-sowing paddy field (PF) conditions. The three late NILs of T65wx were in the order of LF3 (*Se1-pat*(t)) ≤ LF2 (*Se1-pat*(t), *se-pat*) ≤ T65wx < LF1 (*se-pat*) under10-h photoperiod condition and natural short-day condition. The NILs and T65wx were in the order of T65wx < LF3 < LF1 < LF2 under the spring-sowing PF (long day) conditions. T65-R (*Ac-ef1*) was 2.8 or 5.1 days earlier in DTH than T65-T (*ac-ef1*) under the spring-sowing PF conditions. However, T65-R was 19 and 10 days earlier than T65-T under the short-day conditions. Earliness gene(s) and their combinations reduced DTH regardless of photoperiod lengths. *Se1-pat*(t) increased DTH under long-day conditions but decreased it under short-day conditions, while *se-pat* elongated DTH under both short-day and long-day conditions indicating that *se-pat* is responsible for BVG. The *se-pat* increased DTH by adding its effect over that of *Se1-pat*(t) under long-day conditions. However, this increasing effect was almost completely masked when *se-pat* coexisted with *Se1-pat*(t) under the short-day conditions.

Notably, the response of *Ac-ef1* to day length was found to delay heading under the short-day conditions.

An isogenic-line pair of late “L” and early “E” lines were developed from progenies of the F_1 of Suweon 258 × an isogenic line of IR36 carrying *Ur1* gene. The lateness gene for photosensitivity that causes the difference in heading time between L and E was tentatively designated as “*Ex*(t)”, although it’s chromosomal location is unknown. A study was conducted to examine the effects of *Ex*(t) on yield and other related traits under PF conditions. Chemical fertilizers containing N, P_2O_5 and K_2O were applied at the nitrogen levels of 4.00, 9.00 and 18.00 g/m^2 in total, being denoted by “N4”, “N9” and “N18”, respectively. L was later in 80%-heading by 18 or 19 days than E. Regarding total brown rice yield (g/m^2), L and E were 635 and 577, 606 and 548, and 590 and 501, respectively, at N18, N9 and N4, indicating that *Ex*(t) increased this trait by 10 to 18%. *Ex*(t) increased yield of brown rice with grain thickness above 1.5mm (g/m^2), by 9 to 15%. *Ex*(t) increased spikelet number per panicle by 16 to 22% and spikelet number per m^2 by 11 to 18%. Hence, *Ex*(t) increased yield by increasing spikelet number per panicle. It is suggested that *Ex*(t) could be utilized to develop high yielding varieties for warmer regions.

Lodging could be a factor of reducing yield in rice, by diminishing percentage of ripened grains and 1000-grain weight. Effects of *Ex*(t) on lodging resistance and other related traits were examined in a PF condition at three nitrogen levels of N4, N9 and N18. *Ex*(t) significantly increased the length from the base of 4th internode to panicle top (a) and the total fresh weight above the 4th internode inclusive (b), by 6 to 8% and 10 to 18%, respectively, at the three fertilizer levels. On the other hand, *Ex*(t) increased breaking strength with leaf sheaths at the 4th internode (c) by 10 to 18%, at the three fertilizer levels. As the result, index of lodging (ab/c, %) was increased by 6 to 13% in L in comparison with E, indicating that *Ex*(t) diminishes lodging resistance. When we pursue higher yield by introducing *Ex*(t) in rice breeding, diminishing in lodging resistance might be expected even though its extent would not be serious.