Rice Science, 2008, 15(1): 29–35

Discovery of and Preliminary studies on a Rapid-Leafing Rice Genotype at the Vegetative Growth Stage

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Abstract: The leafing rates of fourteen rice varieties were measured in a sowing-time experiment, and a rapid leafing genotype at the vegetative growth stage was discovered in an indica variety Yanhui 559. The leaf number on the main culm of Yanhui 559 was always 4–5 leaves more than that of Lemont, and the leafing rate of Yanhui 559 was significantly higher than that of Lemont based on similar growth durations from sowing to heading. Furthermore, the difference of the leafing rate was significant at the vegetative growth stage, but not distinctive at the panicle initiation stage. Genetic analysis of the leafing rates in the two backcross populations of Yanhui 559 and Lemont showed that major and quantitative genes controlled the expression of rapid leafing character. Based on results of investigation for some plants with similar growth durations in the backcrossing populations, the rapid leafing genotypes exhibited earlier tillering and more tiller numbers per plant, and its yield components including the number of panicles per plant and number of grains per panicle were superior to those of the slow leafing genotypes. Further research and application feasibility of the rapid leafing genotype in breeding were discussed.

Key words: rapid leafing; vegetative growth stage; leaf number on the main culm; number of panicles per plant; rice

Fast growth at the vegetative growth stage is one of the characteristics in ideal plant type rice breeding proposed by Huang [1]. High-yielding rice varieties such as Conggui 314 and Conglu 51 were bred just according to Huang's idea. Therefore, the fast growth character at the vegetative growth stage is worth to be studied. Six QTLs conferring seedling growth rate have been identified on chromosomes 1, 3, 4, 10 and 12 respectively in rice [2-3]. However, there was no any report on the relationship between the leafing rate and yield components.

During investigating rice germplasm resources, we found a special indica genotype with a short phyllochron, whose leaves rapidly emerged mainly at the vegetative growth stage. The characteristics of the rapid leafing genotype and their effects on yield components of rice were studied in this experiment, aiming to explore the utilization potential of rapid leafing genotype in super high-yielding rice breeding.

Received: 28 June 2007; **Accepted:** 17 August 2007
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This is an English version of the paper published in Chinese in *Chinese Journal of Rice Science*, Vol. 21, No. 3, 2007, Pages 259–264.

MATERIALS AND METHODS

Plant materials

Twelve indica rice varieties with medium growth duration from different sources were Yanhui 559, Teqing, Minghui 63, Jasmine 85, Minghui 86, R084, R6547, Yangfuxian 2, R527, Zhenxian 122, R814 and II-32. Two American long-grain varieties were Lemont and CPSLO17.

Two backcross populations were developed from two parents with relatively different performances were Lemont/Yanhui 559//Yanhui 559 (No. 51393) and Lemont/Yanhui 559//Lemont (No. 51394).

Methods

The sowing-time experiment

The experiment was done at the experimental field of Yangzhou University in summer of 2004. The fourteen rice varieties were sown eight times with an interval of ten days from 25 April. Before sowing, the seedbed was leveled and divided into squares with

3.3 cm × 3.3 cm. When sowing, the germinating seeds with radicles and plumules of similar length were selected and individually sown on the crossover point of the square lines in order to create similar growing environment for each seed. The leaf age of every variety was marked from the fourth-leaf stage. The 25-day seedlings were transplanted with a single plant per hill at a row spacing of 13.3 cm × 25.0 cm. Each variety was planted three rows with 14 individual plants per row and the 10 plants in the middle of each row were used to investigate the characters.

The lengths of the upmost three leaves for each variety at the sowing time of 25 April, 15 May, 5 June and 25 June were measured every three days (at the seedling stage in nursery bed) or every five days (at the vegetative growth stage in field). The leaf age on the measuring day for each variety was calculated by the formula: The leaf age = the age of top expanded leaf + (the length of the emerging leaf / the ultimate length of the emerging leaf). And relative leafing rate = the average leaf number emerged every day. Days from sowing to heading for each variety were recorded as well.

Analysis of the segregated population

The experiment was done at the experimental field of Yangzhou University in the summer of 2005. The seeds of parents and backcross populations were soaked on 1 May, germinated three days later and sown on 7 May. Seeding was detailed as above.

The seedlings were transplanted individually on 7 June with a row spacing of 13.3 cm×25.0 cm. After reviving (11 June), leaf ages were marked and number of tillers per plant were recorded every five days till full expansion of flag leaf. Each recording must be finished within one day in order to reduce the test error.

Heading date was individually recorded. The plants were individually harvested at maturity, and the number of panicles per plant and number of grains per panicle were recorded.

The whole growth duration was divided into four stages, i.e. the seedling stage (the period from sowing to transplanting), the vegetative growth stage in field (from reviving after transplanting to panicle differentiation), the panicle developmental stage (the growth period of the last 3.5 leaves), and heading to filling stage.

Statistical method

Statistical analysis was conducted by DPS 2000.

RESULTS

Leaf number and the leafing rate of main culm

Leaf numbers on the main culms in the 14 varieties are shown in Table 1. The varieties exhibited the highly significant differences in the leaf number. The largest difference in the leaf number among the tested varieties was 4.57 between Yanhui 559 (the most leaf number) and Lemont (the least leaf number). The difference of growth duration from sowing to heading among the 14 varieties was also significant, but the difference between Yanhui 559 and Lemont was not remarkable. The differences in leafing rate (based on length of the emerging leaf) and relative leafing rate (based on number of emerging leaf) among varieties were significant and the largest difference of leafing rate still existed between Yanhui 559 and Lemont.

As shown in Fig. 1, the leafing rates and relative

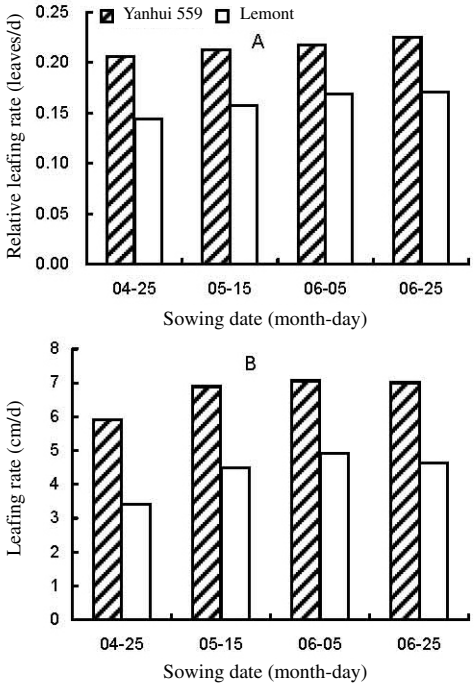

Fig. 1. Leafing rates of rice varieties Yanhui 559 and Lemont.

A, Relative leafing rate based on leaf number; B, Leafing rate based on leaf length.