SABRAO Journals
of Breeding and Genetics
37(1) 51-54, 2005

HIGH-YIELDING *Japonica* RICE LINE CARRYING *Ur1* (Undulated rachis -1) GENE, A PRELIMINARY REPORT

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SUMMARY

An incompletely dominant gene *Ur1* increases spikelet number per panicle producing a greater sink size in rice. An elite line carrying *Ur1*, Murai 79, has been selected out of the progeny lines from the F_1 of 'Nishihikari', a *Ur1* isogenic line of Taichung 65. Murai 79, 'Nishihikari' and a high-yielding *indica*-type variety Suweon 258 were grown and compared. The yield of Murai 79 was 170 g/m^2, which is 37% higher than that of 'Nishihikari' owing to its greater spikelet number per panicle; whereas, they were similar to each other in panicle number per m^2, ripened-grain percentage, and 1000 grain weight. At 80% heading date, Murai 79 was 18 days later than 'Nishihikari'. The yield of Suweon 258 was similar to or slightly lower than that of Murai 79. Murai 79 could be used as a prominently high-yielding and extremely late-heading variety in southern Japan.

Key words: *Oryza sativa,* rice, *Ur1*, spikelet number per panicle, yield, yield components, sink size.

An incompletely dominant gene *Ur1* increases spikelet number per panicle in rice but has small or no effect on panicle number per m^2 (Nagao *et al.*, 1958; Murai and Iizawa, 1994; Murai *et al.*, 2002). This genic effect increased grain yield in both *Ur1/Ur1* and *Ur1/*+ genotypes by enlarging sink size under the genetic background of a *japonica* variety, Taichung 65, despite the reduction in ripened-grain percentage (Murai *et al.*, 1997; 2002). Hence, *Ur1* could be a new breeding tool to pursue high yield.

Murai *et al.* (1997; 2003) reported a high-yielding F_1 hybrid between a Japanese variety 'Nishihikari' and a *Ur1* isogenic line of Taichung 65. Out of the progeny lines derived from the F_1, several prospective lines carrying *Ur1* have been selected. The most promising *Ur1* line Murai 79 were grown together with 'Nishihikari' and a high-yielding *indica*-type variety Suweon 258. Thus, we examined the yield ability of the elite *Ur1* line.

MATERIALS AND METHODS

The highest-yielding F_1 hybrid in the experiment by Murai *et al.* (1997) was used to develop recombinant inbred lines with and without *Ur1*. The maternal and paternal parents were 'Nishihikari' and the isogenic line of Taichung 65 carrying both *Ur1* and *sd1-d* originating from 'Dee-geo-woo-gen', respectively. 'Nishihikari' is a short-culm and panicle-number type variety possessing the highest lodging tolerance in southern Japan

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(Nishiyama, 1982; Murai *et al.*, 2003). The F_2 population was grown in 1992 and the generation was progressed to F_8 without selection in glasshouses. In 1999, 108 F_9 lines originating from the respective 108 F_2 plants were grown in a paddy field; "Murai 79", the most well-ripened line carrying *Ur1* and other prospective lines were selected from *Ur1*-carrying lines by field observation. The uniformity (non-segregation) of Murai 79 was confirmed in 2000 and 2001. Murai 79, 'Nishihikari', Suweon 258 and four other lines variety were used for the field experiment in 2002. The Korean *indica*-type variety Suweon 258 has a much higher yield ability with larger panicles than ordinary Japanese varieties in southern Japan (Komatsu *et al.*, 1984; Kubota *et al.*, 1988).

On May 9, 2002, 26-day-old seedlings of the seven lines/varieties were transplanted to a paddy field of the Faculty of Agriculture, Kochi University, Japan with two seedlings per hill at a spacing of 22.2 hills per m^2 (30.0x15.0 cm), with three replications. Of the total of 10.0 g/m^2 for each of N, P_2O_5, and K_2O, 2.4 g/m^2 was applied by basal dressing with an ordinary chemical fertilizer and 7.6 g/m^2 was applied by top dressing with a slow-release coated fertilizer nine days after transplanting.

Each plot comprised 132 hills (33 hills x 4 rows) and samplings were conducted for the central two rows except for the first three and last three hills in each row. Measurements of yield and other traits in the present study were the same as those in Murai *et al.* (2002). Hulled ripened-grain weight (yield) was measured after sieving at 1.7 mm and yield at 15% moisture was estimated after moisture measurement.

RESULTS

Yield and other traits of Murai 79, 'Nishihikari', and Suweon 258 are shown in Table 1 (data of the other four lines/variety not shown). The yield of Murai 79 was 170 g/m^2, 37% higher than that of 'Nishihikari'. Murai 79 had 36% more spikelets per panicle than 'Nishihikari'. Regarding panicle number per m^2 as well as 1000 grain weight, Murai 79 and 'Nishihikari' were similar to each other. Murai 79 was similar to 'Nishihikari' in ripened-grain percentage (ripened grains / all spikelets), since they were almost equal in fertilized-spikelet percentage (fertilized spikelets / all spikelets) as well as percentage of ripened grains to fertilized spikelets. Consequently, the higher yield in Murai 79 was due to its large number of spikelets per panicle. In fact, Murai 79 possessed a large sink size (sink size-1 and sink size-2 in Table 1), resulting from its larger spikelet number per m^2 compared with 'Nishihikari'. Murai 79 exceeded 'Nishihikari' not only in total weight per m^2 but also in harvest index. The culm length of Murai 79 was longer than that of 'Nishihikari'; however, it was rather short in southern Japan. Murai 79 did not lodge at maturity despite its heavy panicles. In panicle length, Murai 79 and 'Nishihikari' were the same. Regarding 80% heading date, Murai 79 was 18 days later than 'Nishihikari'.

The yield of Suweon 258 was similar to or slightly lower than that of Murai 79 (Table 1). Suweon 258 had a lower spikelet number per panicle but a higher 1000 grain weight than Murai 79. It had a lower total weight per m^2 but a higher harvest index than Murai 79. In culm length, Suweon 258 was the shortest.

DISCUSSION

Murai 79 had a much higher yield than 'Nishihikari', a high-yielding variety in southern Japan, resulting from its large sink size caused by *Ur1* and its fairly high ripened-grain percentage (Table 1). According to Murai *et al.* (2003; 2005), its paternal parent, *viz.* the *Ur1-sd1-d* isogenic line of Taichung 65 as well as the *Ur1* isogenic line of 'Nishihikari' had a high percentage of ripened grains to fertilized spikelets at Kochi University in 2000; however, the former and latter lines were low (79.0%) and high (95.6%), respectively, in fertilized-spikelet percentage. Hence, the most well-ripened *Ur1*-carrying line, Murai 79 may have inherited genes which enhance ripened-grain percentage in the coexistence of *Ur1*, principally from 'Nishihikari'.

Murai 79 showed an exceptionally late heading date, compared with the rather late heading variety 'Nishihikari' (Table 1). To middle- and large-scale rice farmers in southern Japan, Murai 79 could offer extremely late maturity, which enables new cultivation system(s) to be developed combined with middle and late maturing varieties. In southern Japan and other areas, both white-backed and milky-white grains occur conspicuously when maturing temperature is too high in summer (Iwashita *et al.*, 1973). Murai 79 is too late in heading to produce such damaged grains: its maturing season is not so hot. In Murai 79, other damaged grains such as white core and white belly grains were rarely observed not only in this experiment but also in other experimental years, indicating its highly ranked grain appearance. Its taste is very good although it is not as excellent as the Japanese variety 'Koshihikari'.

Thus, Murai 79 possesses a notably high yielding ability in southern Japan; besides, its exceptionally late maturity is appreciated. However, more field tests in different locations and years should be performed to confirm the above and other characteristics of Murai 79.

Table 1. Yield and other traits of Murai 79, 'Nishihikari', and Suweon 258.

Trait	Murai 79		'Nishihikari'	Suweon 258	$LSD_{(5\%)}$ [1]
Yield (g/m^2)	631^{a}	(137) [2]	461^{b}	616^{a}	44
Spikelets/panicle	114.8^{a}	(136)	84.2^{c}	100.4^{b}	7.4
Panicles/m^2	334^{a}	(99)	336^{a}	316^{a}	26
Ripened-grain percentage	83.7^{a}	(102)	82.4^{a}	87.2^{a}	6.3
Fertilized-spikelet percentage	91.2^{b}	(101)	90.5^{b}	93.3^{a}	1.9
Percentage of ripened grains [3]	91.7^{a}	(101)	91.0^{a}	93.5^{a}	5.8
1000 grain weight (g)	19.7^{b}	(99)	19.8^{b}	22.3^{a}	0.6
Spikelets/m^2 (x 100)	384^{a}	(136)	282^{c}	317^{b}	29
Sink size-1 [4] (g/m^2)	755^{a}	(135)	560^{b}	707^{a}	49
Sink size-2 [5] (g/m^2)	689^{a}	(136)	507^{b}	660^{a}	35
Total weight at maturity [6] (g/m^2)	1778^{a}	(119)	1491^{b}	$.1258^{c}$	92
Harvest index [6] (%)	30.1^{b}	(115)	26.3^{c}	41.7^{a}	1.8
Culm length [7] (cm)	74.0^{a}	(121)	61.1^{b}	55.4^{c}	1.6
Panicle length [7] (cm)	19.5^{b}	(100)	19.5^{b}	20.8^{a}	0.8
80%-heading date	Aug. 29	-	Aug. 11	July 30	-

[1] Calculated from the analysis of variance using all seven lines-varieties. [2] Murai 79 / Nishihikari' (%). [3] To fertilized spikelets, excluding unfertilized spikelets. [4] Single grain weight x spikelets/m^2. [5] Single grain weight x fertilized spikelets/m^2. [6] Dry matter basis. [7] Measured for the longest culm of each hill at maturity.
Values followed by the same letter within a row are not significantly different at the 5% level, determined by LSDs in the table.

ACKNOWLEDGMENT

We are indebted to Mr. Daisuke Kondo, Mr. Gen Nishimiya, Mr. Y. Takemura, and Mr. M. Urabe of Kochi University for their cooperation in carrying out the experiment.

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