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Development of Wide-Compatibility Rice Line, Norin PL 9

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Abstract

Norin PL 9 was developed by using Ketan Nangka as a source of wide-compatibility (WC). It has japonica-like characteristics and a compatibility with several indica as well as with japonica varieties. The WC varieties, including Norin PL 9, are expected to contribute to the rice breeding program, especially indica-japonica cross breeding, by means of their broad capabilities of overcoming sterility problems caused by remote crossing.

Discipline: Crop production
Additional key words: indica, japonica, remote crossing, sterility

Introduction

Indica varieties play an important role as genetic resources in the rice breeding program of Japan. A number of indica varieties are presently under an extensive use for crossing with japonica varieties at agricultural experiment stations. However, the indica-japonica cross breeding is hampered in its efficiency due to several difficulties. One of the serious problems relates to hybrid sterility. It is well known that the F_1 plants of hybrids between indica and japonica varieties generally induce low fertility and segregate a wide range of semi-sterile plants in their successive generations.

Past studies on hybridization among cultivated rice varieties showed that several specific materials had provided a high F_1-fertility in their crosses with indica as well as with japonica varieties, with a great fluctuation of results[1,4,5]. In this connection, Ikehashi emphasized the need for systematic screening and utilization of those varieties which have a wide-compatibility in order to efficiently overcome the sterility problem taking place in the remote crosses[2].

During the period 1981 to 1985, a genetic study on hybrid compatibility was conducted at the Okinawa Branch, Tropical Agriculture Research Center (TARC), with an emphasis on the analysis of genetic behavior of WC and hybrid sterility[3]. In the course of implementation of that genetic study, Norin PL 9 was developed as one of the WC materials. It is expected that the use of this line would contribute in making the breeding of indica-japonica hybridizations more efficient and effective.

Breeding process and characteristics of PL9

1) Pedigree and breeding process

The pedigree of Norin PL 9 is shown in Fig. 1. The breeding objective was to develop early maturing japonica type lines with a WC and a short stature like Akihikari as well. The source of WC is Ketan Nangka (KN), which is a tall and late maturing Indonesian variety. NK 4 is one of the breeding materials, which were selected from the cross between KN and Nihon Masari, an improved japonica variety. Although NK 4 has a WC gene, its agronomic characteristics are not well suited to practical use

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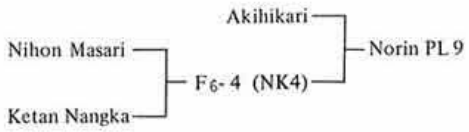

Fig. 1. Pedigree of Norin PL 9

in farming. Akihikari is a high-yielding early variety with a short stature (Table 4).

Hereafter, the breeding process of Norin PL 9 is outlined. In the second season of 1982, an artificial crossing between Akihikari and NK 4 was made. The F_2 population of this hybrid was grown with a dense planting, and subjected to mass selection with regard to apiculus color, since the gene pertaining to this character was known to be closely linked with a WC gene. In the F_3 population, 20 individuals were selected from 100 plants based on apiculus color, heading time and plant height. In each of the F_4 through F_6 generations, a line selection was made on the same criteria as above. Compatibility was checked by test-crossing with an indica variety (IR 36 or IR 50). Yield trials were undertaken in the second season of 1985 and the first season of 1986, at the Okinawa Branch, TARC, located at about 24°N Lat., employing Toyonishiki as a control variety for comparison. Through these experiments, one pedigree was selected, being named "Nekken 1" in 1985. In 1986, Nekken 1 and some hybrids with indica varieties were tested for agronomic characters at several breeding stations in the higher latitudes of Japan. In 1987, Nekken 1 was registered as Norin PL 9.

2) Major characteristics of Norin PL 9

(1) Compatibility with indica varieties

Spikelet fertilities of the F_1 hybrids between Norin PL 9 and five indica varieties at the Okinawa Branch, TARC are shown in Table 1. The data obtained indicate that those F_1s have higher spikelet fertilities than the case of IR 36/Akihikari, a standard indica-japonica crossing.

Data on spikelet fertilities of the F_1 plants from the same crosses were also taken in other places located at 36°–39°N Lat.; the results of which are shown in Table 2. It is indicated that Norin PL 9 produces F_1 plants compatible with indica varieties in the mainland of Japan as in Okinawa.

Segregations of fertilities in the F_2 populations are shown in Table 3. The crossing of Norin PL 9/IR 36 showed a slightly higher fertility on an average in the F_2 generation than the cross of IR 36/Akihikari did. It is generally recognized that the hybrids with Norin PL 9 segregate a greater number of fertile plants in F_2 generation than the other indica-japonica crosses.

Table 1. Fertilities of the F_1 hybrids between Norin PL 9 and several indica varieties tested at Okinawa Branch, TARC

Cross combination	Testing year and season	Fertility	
		Pollens	Spikelets
		%	%
Norin PL 9/IR 50	1985, 1st	72.9	82.3
Norin PL 9/IR 36	1985, 2nd	61.3	81.3
IR 36/Akihikari (cont.)	1985, 2nd	41.7	37.0
Norin PL 9/IR 36	1986, 1st	—	77.7
Norin PL 9/Milyang 23	1986, 1st	—	89.2
Norin PL 9/Suweon 258	1986, 1st	—	82.4
Norin PL 9/Nanjing 11	1986, 1st	—	76.7
Norin PL 9	1986, 1st	—	94.1
Akihikari	1986, 1st	—	95.3

Table 2. Spikelet fertilities of the F_1 hybrids between Norin PL 9 and several indica varieties tested in several breeding stations of Japan (1986)

Cross combination	Experiment station[a)]		
	Tohoku	Hokuriku	Kanto
	%	%	%
Norin PL 9/IR 36	76.2	74.7	76.9
Norin PL 9/Milyang 23	89.0	94.2	87.3
Norin PL 9/Suweon 258	79.1	80.3	74.2
Norin PL 9/Nanjing 11	— [c)]	— [c)]	90.9[b)]
Milyang 23/Akihikari	—	—	66.0
Akihikari/Milyang 23	—	54.5	—

a): Tohoku: Tohoku Nat. Agr. Exp. Sta. (Oomagari, Akita: 39° N),
Hokuriku: Hokuriku Nat. Agr. Exp. Sta. (Joetsu, Niigata: 37° N),
Kanto: Nat. Agr. Res. Center (Tsukuba, Ibaraki: 36° N).

b): Immatured. Based on the florets of primary rachis branch.

c): Immatured.

Table 3. Segregations of fertilities in the F_2 populations of hybrids between Norin PL 9 or Akihikari and IR 36 (1986)

Cross combination	Total no. of plants	Ratios of plants in each fertility level						Mean fertility
		—50	—60	—70	—80	—90	—100 (%)	
								%
Norin PL 9/IR 36[a)]	85	10	9	21	28	26	6	71.8
IR 36/Akihikari[a)]	95	38	17	23	12	10	0	56.4
Norin PL 9/IR 36[b)]	73	5	4	4	15	19	53	86.3
IR 36/Akihikari[b)]	52	14	10	16	17	20	23	72.6

a): Data from Okinawa Branch, TARC, Ishigaki, Japan.
b): Data from Nat. Agr. Res. Cen., Tsukuba, Japan.

Table 4. Agronomic characteristics of Norin PL 9*

Variety and line	Heading date	Culm length	Ear length	Ears/plant	Glutinous	Apiculus color
		cm	cm			
Norin PL 9	20 Apr.	75	21.0	13	Non	Purple
Toyonishiki	20 Apr.	73	21.0	13	Non	Straw
Akihikari	13 Apr.	63	18.7	15	Non	Straw
Ketan Nangka	13 May	109	32.0	6	Glutinous	Purple
NK 4	26 Apr.	97	26.1	10	Non	Purple

* Data from F_7 line nursery in the first season 1986 at Okinawa Branch, TARC, Japan.

Table 5. Yield trials of Norin PL 9 at Okinawa Branch, TARC

Line and variety	Year and season	Heading date	Culm length	Ear length	Ears/m^2	Yield	Comparative yield
			cm	cm		kg/a	%
Norin PL 9	1985. 2nd	12 Oct.	69	18.7	307	31.0	102
	1986. 1st	20 Apr.	70	18.6	324	32.0	102
	Average		70	18.7	316	31.5	102
Toyonishiki (Control)	1985. 2nd	11 Oct.	70	19.1	313	30.3	100
	1986. 1st	20 Apr.	66	17.4	315	31.5	100
	Average		68	18.3	314	30.9	100
Akihikari (Check)	1985. 2nd	10 Oct.	69	18.8	296	34.4	114
	1986. 1st	13 Apr.	61	17.8	330	33.5	106
	Average		65	18.3	313	34.0	110

(2) Agronomic characteristics

Norin PL 9 has a japonica-like plant type in major agronomic characteristics as shown in Table 4. It is comparable to a japonica variety, including Toyonishiki which was a leading variety in Okinawa Prefecture in late 1986. The agronomic characters such as heading time, stature and ear length of Norin PL 9 are similar to those of Toyonishiki.

Results of the yield trials are presented in Table 5. The data indicate that Norin PL 9 has a high-yielding ability close to Toyonishiki and Akihikari.

Norin PL 9 has deep purple apiculus transferred from Ketan Nangka. Since this apiculus color is genetically linked closely with a WC gene, it is useful to utilize this character for indirect selection of the WC in the breeding program.

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