A High Yielding Indica-Japonica-Hybrid Rice Variety "Hoshiyutaka"

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Introduction

All rice varieties which are cultivated in Japan are the japonica types with short grains. These varieties have been developed aiming at the adaptability to natural and cultural conditions of this country. Boiled rice of them is sticky, because the Japanese prefer sticky rice, and is suitable for the Japanese traditional cooking style.

Recently, the eating habit of the Japanese has been greatly changed, and a foreign type of cooking has become popular. The cooking of rice also partially changed to foreign style such as pilaff or gratin.

The varieties in Japan are not adapted to the new cooking style due to their sticky grain quality. Demand for less sticky of rice like indica rice has increased, but any variety so far developed in Japan can not meet the demand. A variety "Hoshiyutaka" developed in the Chugoku National Agricultural Experiment Station in 1987 is the first variety in Japan which has long and slender grains with high amylose content like indica rice.

Breeding process

As given in Fig. 1 and Table 1, the variety Hoshiyutaka was developed from a cross between Chugoku 55 and KC 89 conducted in 1971 at the Chugoku National Agricultural Experiment Station. The objective of this cross was to breed the variety with resistance to diseases and insect pests, high yielding ability, and fine grain quality. One parent (Chugoku 55), a pure japonica line with excellent grain quality, was bred in 1970 at the Chugoku National Agricultural Experiment Station. The other (KC 89) was an indica-japonica-hybrid line with large panicles bred by C. Kaneda[1] of the Tropical Agriculture Research Center as a breeding material (a parental line for breeding new varieties with high resistance to brown planthopper, and rice stripe virus).

The progeny of the cross were grown in a greenhouse for advancing generation cycle during the period from 1971 winter (F_1) to 1973 (F_3). Then, F_5 population was grown in a paddy field in 1974. In 1975, eight plants were selected from 1,100 F_6 plants. From the eight F_7 lines, one line was selected in 1976. The selected line was grown without selection in 1977 and 1978. Since 1979 (F_{10}), the line was subjected to selection and fixation following the pedigree method.

The selected line did not inherit the resistant gene to brown planthopper from KC 89, but it showed very unique characteristics in plant type and grain shape and quality inherited from the indica ancestor. Under the name of Tashukei 3, this line was tested for high-yielding ability, local adaptability, and other specific characters in the breeding station and other experimental sites since 1980 (F_{11}). Furthermore, the line was named Chugoku 96, and its adaptability to

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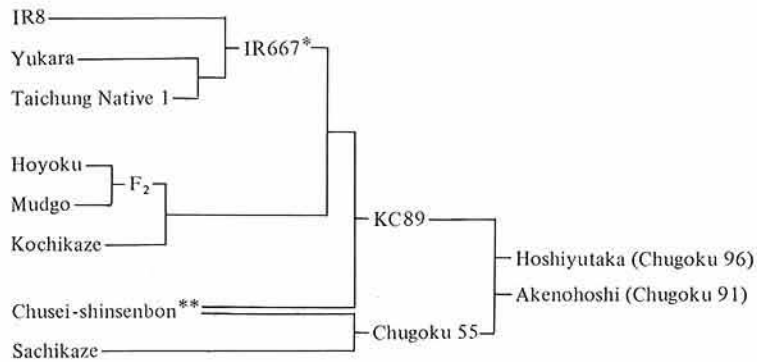

Fig. 1. Genealogy of Hoshiyutaka
* IR 667 is the sister line of the Korean variety, Tongil.
** Often called Nakate-shinsenbon.

Table 1. Selection record of Hoshiyutaka

Year	'71–'73	'74	'75	'76	'77	'78	'79	'80	'81	'82	'83	'84	'85	'86	'87
Generation	F_0–F_4	F_5	F_6	F_7	F_8	F_9	F_{10}	F_{11}	F_{12}	F_{13}	F_{14}	F_{15}	F_{16}	F_{17}	F_{18}
No. of line groups	(bulk)	(bulk)	IS*	LS**	1	1	1	1	1	1	1	1	1	1	1
No. of lines	(Generation advance in greenhouse)			8	1	1	3	3	3	10	5	5	5	5	5
No. of plants/line	(850, F_2–F_4)	(1100)	(1100)	32	32	32	32	32	32	32	64	64	64	64	64
No. of selected lines				1	1	1	1	1	1	1	1	1	1	1	1

* Individual selection.
** Line selection.

each prefecture, mainly in the western part of Japan was examined since 1984 (F_{15}). Through these tests, the line was proved to be an excellent high-yielding variety with specific grain characters. It was registered as paddy rice Norin 286 and named Hoshiyutaka in 1987. The generation of this variety reached F_{19} in 1988. This variety is the sister variety of Akenohoshi, released in 1984.

It must be added that the development of Hoshiyutaka was promoted intensively as a part of the "Project of research for developing extremely high-yielding crops" that started in 1981.

Main characteristics of Hoshiyutaka

1) Agronomic characteristics

Heading date and maturing date of the variety are about 15 and 25 days, respectively, later than Nipponbare (the leading variety in the western part of Japan). These dates are extremely late in the San-yo district. As compared with Nipponbare, the variety has culm length about 10 cm longer, panicle length about 1 cm longer, and the smaller number of panicles per unit area (Plates 1 and 2). Hoshiyutaka is a non-glutinous and super heavy panicle type variety (Table 2).

Its leaf blades are slightly wide, and erect. Leaf blades and sheaths are deep green. Withering of lower leaves occurs late. The culms are thick and stiff. Panicles are characterized by no awn, yellow apiculus, higher density of grains on the panicle, and low viviparity.

The brown rice (hulled rice) is slim like indica rice (Plate 3). Its ratio of length/width is about 2.4 (medium rice according to the international standard). The milled rice is highly transparent, without white core or

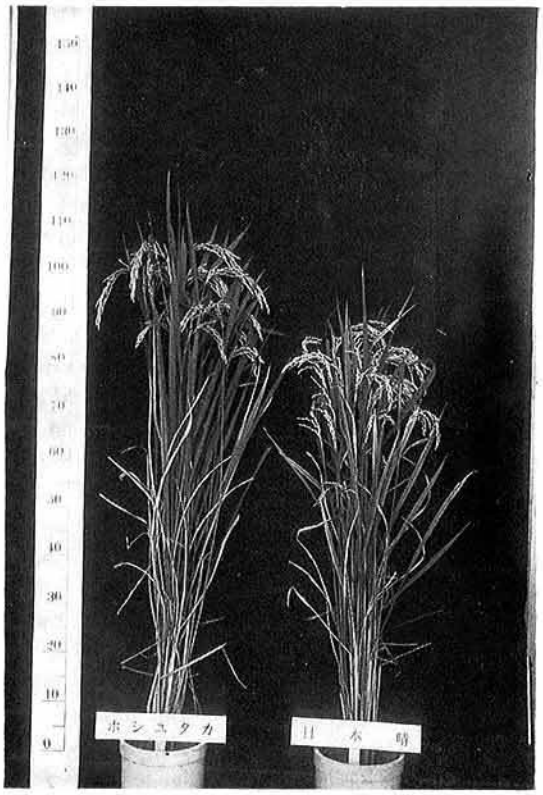

Plate 1. Plants of Hoshiyutaka (left) and Nipponbare (right)

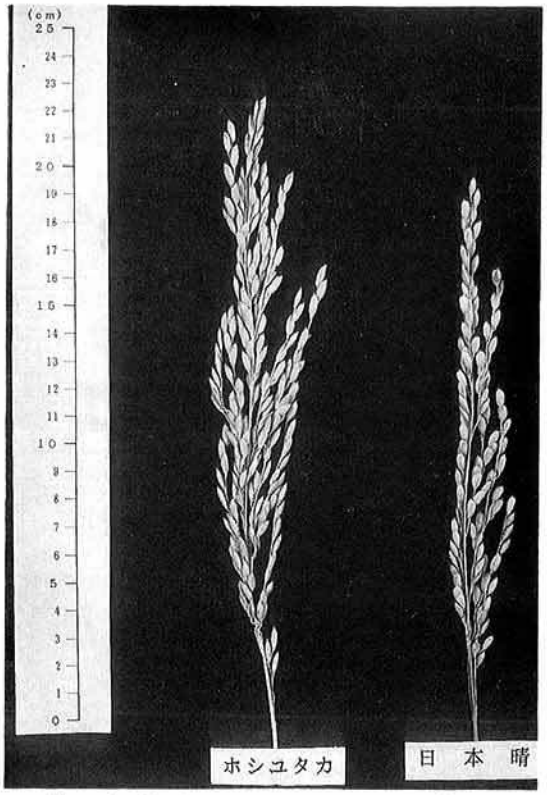

Plate 2. Panicles of Hoshiyutaka (left) and Nipponbare (right)

Table 2. Agronomic characteristics of Hoshiyutaka*

Variety	Heading date (month. date)	Maturing date	From heading to maturity (days)	Culm length (cm)	Panicle length (cm)	No. of panicles ($/m^2$)
Hoshiyutaka	9. 4	11. 4	63	93	21.1	326
Nipponbare	8.20	10. 9	51	81	20.1	386
Akenohoshi	8.24	10.29	67	81	22.7	311
Chusei-shinsenbon	8.24	10.14	52	81	19.2	416

* Grown in 1985 and 1986 following the standard method of transplanting culture in the Chugoku National Agricultural Experiment Station.

Table 3. Characteristics of brown rice of Hoshiyutaka

Variety	1000 kernel weight	Appearance grade*	Amylose content (%)	Length (mm)	Width (mm)	Thickness (mm)	Length/ width
Hoshiyutaka	18.6	4.5	27.4	6.0	2.5	1.8	2.4
Nipponbare	21.9	5.0	21.3	5.1	3.0	2.1	1.7
Akenohoshi	20.8	6.0	19.0	5.1	2.8	2.8	1.8
Chusei-shinsenbon	22.0	5.5	—	5.1	2.9	2.9	1.8

* Grades from 1 (extremely fine) to 9 (extremely bad).

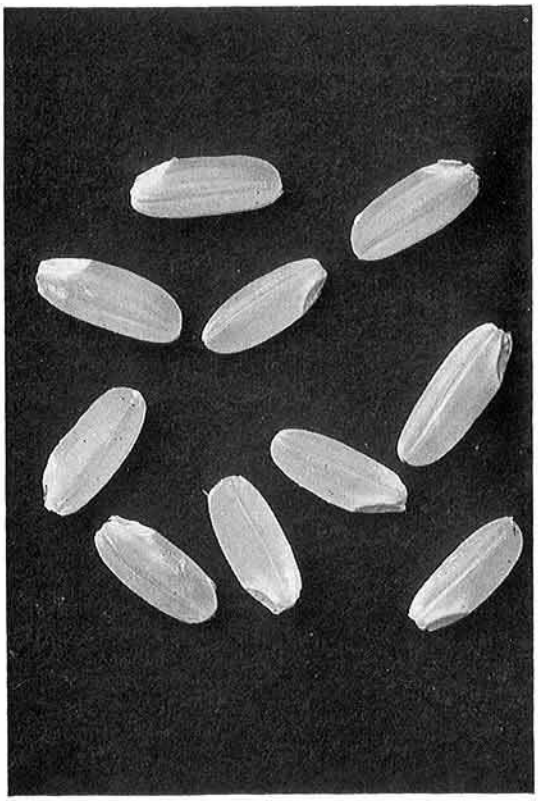

Plate 3. Brown rice of Hoshiyutaka

white belly. The appearance of rice is superior to that of Nipponbare. The amylose content of rice is about 27%; fairly higher than ca. 20% of most Japanese varieties (Table 3).

The eating quality of boiled rice is not good because of low stickiness.

2) *Resistance to diseases, insect pests, or other damages*

The response of Hoshiyutaka to various races of blast pathogen was examined by the seedling test in 1982 and 1984 at the Tohoku National Agricultural Experiment Station. Its field resistance to blast was examined in the breeding station and other experimental sites by the upland nursery test or field test.

Hoshiyutaka seems to possess the true resistant genes *Pi-i* and *Pi-k* for blast disease. Its field resistance to blast is slightly higher than that of Todorokiwase.

The resistance to bacterial leaf blight examined in the breeding station and the Miyazaki Prefectural Agricultural Experiment Station suggests that Hoshiyutaka has not the true resistant gene, and the field resistance to bacterial leaf blight is as low as that of Chusei-shinsenbon.

From the seedling test in the breeding station, Hoshiyutaka was ranked as resistant to rice stripe virus, probably due to the resistant gene inherited from the indica variety.

Crop damage by sheath blight was slight because of late maturity of the variety.

Hoshiyutaka was found susceptible to brown planthopper, white backed planthopper and green leafhopper by tests at some experimental sites. It shows stem borer damage similar to that of japonica varieties, cold tolerance lower than that of Nipponbare, but high germination ability in cold environment. It also shows high lodging resistance, despite of its long culms (Table 4).

3) *Yielding ability of Hoshiyutaka*

Hoshiyutaka has proved its high-yielding ability in the breeding station and in other experimental sites since 1980. It has many characteristics enabling to increase dry mat-

Table 4. Resistance of Hoshiyutaka to diseases, insect pest or other damages

Variety	Disease resistance					Resistance to brown planthopper	Cold tolerance	Lodging resistance
	Blast resistant major gene	Blast field resistance (leaf)	Blast field resistance (panicle)	Bacterial leaf bright	Rice stripe virus			
Hoshiyutaka	*Pi-i, Pi-k*	MR	MR	S	R	S	S	R
Nipponbare	+	M	MS	M	S	S	M	MR
Akenohoshi	*Pi-k*	MS	M	S	R	S	S	MR
Chusei-shinsenbon	*Pi-a*	M	M	S	S	S	MS	M

Table 5. Yielding ability of Hoshiyutaka*

Variety	Aerial part weight (kg/a)	Straw weight (kg/a)	Rough rice weight (kg/a)	Brown rice weight (kg/a) (%)
Hoshiyutaka	197.3	114.4	82.9	65.3 (112)
Nipponbare	166.7	93.5	73.2	58.5 (100)
Akenohoshi	173.8	92.2	81.6	63.1 (108)
Chusei-shinsenbon	173.7	97.5	76.2	60.9 (104)

* See Table 2.

ter production, such as large panicles, culm stiffness and erect leaves with late senescence. It yielded about 200 kg/a of the aerial part (20% higher than that of Nipponbare), and about 65 kg/a of brown rice (higher than that of Nipponbare by more than 10%) in yield tests by transplanting culture at the breeding station in 1985 and 1986 (Table 5). Hoshiyutaka is one of the most productive varieties in the western part of Japan. The yield of more than 70 kg/a of brown rice was obtained by mechanical transplanting culture in 1988 at the breeding station.

Prospect of extension and utilization

Hoshiyutaka is not adaptable to cold districts and mountainous districts due to its late maturity and low cold tolerance, and also to areas infested with bacterial leaf bright, whereas it is adaptable to fertile plains (excluding late-planting areas) of Kinki, Chugoku (the San-yo district), Shikoku and some part of Kyushu.

Due to high yields and resistance to lodging, blast, and rice stripe virus, Hoshiyutaka is suitable for low-cost rice production. As boiled rice is not so sticky, Hoshiyutaka is not suitable for the Japanese traditional cooking method of rice, but suitable for European or Chinese cooking style. It is considered to be usable in food industry or restaurant business. Also Hoshiyutaka is suitable for whole-crop silage use because of its high dry-matter productivity.

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