Short Communication

Spikelet sterility in F₁ Hybrids between Rice Varieties Silewah and Hayakogane

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In order to analyze the cause of the highly spikelet sterility observed in the F₁ hybrids between Silewah and Hayakogane, reciprocal crosses between Hayakogane and Silewah were conducted. Since F₁ hybrids in the reciprocal crosses showed similarly low spikelet fertility, the spikelet sterility in the F₁ hybrids was not caused by cytoplasmic male sterility. In addition, the F₁ hybrids displayed normal pollen fertility and crossed seed fertility in reciprocal crosses between F₁ hybrids, Silewah/Hayakogane and Hayakogane was normal. These results indicated that pollen and ovule of the F₁ hybrid were normal. The F₁ hybrids between Silewah and Hayakogane showed a large number of indehiscent anthers. Accordingly, it was deduced that the highly spikelet sterility in the F₁ hybrids between Silewah and Hayakogane was mainly caused by indehiscent anthers. When spikelet fertility in the F₁ hybrids between pedigrees of Hayakogane and Silewah was examined, the F₁ hybrid between Norin 15 and Silewah showed the same extremely low spikelet fertility as that of the F₁ hybrid between Silewah and Hayakogane. Furthermore, the F₁ hybrids between either Kyowa or Hokuto and Silewah were partially fertile. The slightly decreased fertility was also observed in the F₁ hybrids between either Hashiribozu or Matsumotomochi. These F₁ hybrids had normal pollen fertility and a number of indehiscent anthers. The F₁ hybrids of the remaining pedigrees of Hayakogane crossed with Silewah showed a normal spikelet fertility in F₁ hybrids crossed with Silewah. These results suggest that varietal differentiation for spikelet sterility in the F₁ hybrids including Silewah may occur in Japonica rice varieties.

KEY WORDS: *Oryza sativa*, indehiscent anther, indica/japonica hybrid, pollen, spikelet sterility.

Introduction

Silewah, an Indonesian native rice variety, is extremely cold-resistant and is compatible with Japonica varieties (SATAKE and TORIYAMA, 1979). Therefore, as a useful gene source for cold-resistance at the booting stage, Silewah has been used for improvement of cold-resistance in Hokkaido rice varieties (ABE *et al.*, 1989). However, F₁ hybrids between Silewah and Hayakogane, a Hokkaido variety showed extremely low spikelet fertility.

This study aimed at analyzing the cause of the very low spikelet fertility in the F₁ hybrids between Silewah and Hayakogane, and to surveying Hokkaido varieties which showed a similar spikelet sterility in F₁ hybrids including Silewah to that of the F₁ hybrid between Silewah and Hayakogane.

Materials and Methods

Hybrids between Silewah, an Javanica type (SARUYAMA and SHINBASHI, 1990) and Leng

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Kwang, an Indica type (SATAKE and TORIYAMA, 1979) were grown in 1985 while Ishikari, Hayakogane, Silewah, Leng Kwang and F₁ hybrids between parental strains were raised in 1987. In addition, Hayakogane, pedigrees of Hayakogane, Silewah and F₁ hybrids between Silewah and pedigrees of Hayakogane including Hayakogane were cultivated in 1989. Four plants were transplanted in a 3 litre pot in the green house. Five immature flowers were expected to open in the next day were collected from each parent and F₁ hybrid in the summer. The pollen grains were stained with a potassium iodide solution (I-KI). Spikelet fertility was expressed as the percentage of number of fertile spikelets to total number of spikelets of five panicles.

Results and Discussion

Spikelet and pollen fertility of F₁ hybrids in diallel crosses among Hayakogane, Ishikari, Silewah and Leng Kwang was presented in Table 1, except for Leng Kwang/Hayakogane and Leng Kwang/Silewah and pollen fertility of Silewah/Leng Kwang. The very low spikelet fertility of the F₁ hybrids in reciprocal crosses between Silewah and Hayakogane suggested that the spikelet fertility was under genic and not under cytoplasmic control. F₁ hybrids in reciprocal crosses between Silewah and Ishikari displayed a normal spikelet fertility, whereas the F₁ hybrids between Leng Kwang and either Hayakogane or Ishikari showed an almost complete sterility with low pollen fertility. The spikelet fertility of F₁ hybrids between Silewah and Leng Kwang was partial. On the basis of these results, it is suggested that the genic constitution for spikelet sterility in the F₁ hybrids between Leng Kwang and either Hayakogane or Ishikari may not be different, but that Hayakogane harbours specific gene(s) for spikelet sterility in the F₁ hybrids with Silewah in contrast to Ishikari.

Pollen fertility in the F₁ hybrids between Silewah and either Hayakogane or Ishikari was

Table 1. Spikelet and pollen fertility of parental strains and F₁ hybrids

Female	Male			
	Hayakogane	Ishikari	Silewah	Leng Kwang
Hayakogane	87.4±3.7 ^{1)a}	88.3±9.8	8.5±2.3	1.2±1.5
	95.1±1.0 ^{2)a}	96.0±2.8	95.4±1.8	10.0±1.7
Ishikari	93.8±7.0	86.2±2.7 ^a	85.1±3.4	0.7±0.8
	95.5±1.4	91.9±1.8 ^a	95.5±2.0	8.6±3.8
Silewah	11.8±4.1	80.1±1.5	84.5±5.0 ^a	43.0±5.2 ^b
	94.5±1.1	91.9±1.5	95.1±3.1 ^a	—
Leng Kwang	—	0.0	—	77.0±5.4 ^a
	—	7.5±3.3	—	95.5±1.1 ^a

1); Spikelet fertility. 2); Pollen fertility

a; Selfed.

b; Tested in 1985.

—; Not tested.

as normal as that of the parents. Furthermore, crossing rates in reciprocal crosses between Hayakogane/Silewah hybrids and Hayakogane were 83.1% and 83.9%, respectively. The F_1 hybrids between Silewah and Hayakogane showed a large number of indehiscent anthers, as presented in Fig. 1. However, several anthers of the hybrids were dehiscent. These results indicated that the spikelet sterility in the F_1 hybrids between Silewah and Hayakogane is caused not by pollen or ovule sterility. Accordingly, it is assumed that the spikelet sterility of the F_1 hybrids between Silewah and Hayakogane may result from a large number of indehiscent anthers.

In order to examine whether only F_1 hybrids between Hayakogane and Silewah showed spikelet sterility or not, the spikelet fertility in the F_1 hybrids between Silewah and pedigrees of Hayakogane was analyzed. As indicated in Table 2, F_1 hybrids between Silewah and Norin 15 showed a similar low spikelet sterility to that of the F_1 hybrids between Silewah and Hayakogane. The spikelet fertility of the F_1 hybrids between Silewah and either Hokuto or Kyowa was partial with large variations. Furthermore, the F_1 hybrids between Silewah and either Matsumotomochi or Hashiribozu displayed a slightly decreased spikelet fertility with moderately large variations, though Hashiribozu showed a slightly low

Fig. 1. Anther indehiscence observed in the F_1 hybrid between Silewah and Hayakogane.

spikelet fertility. These F_1 hybrids possessed a normal pollen fertility and showed a number of indehiscent anthers. The F_1 hybrids of the remaining pedigrees of Hayakogane crossed with Silewah showed a normal spikelet fertility. These results indicated that there were varietal differences in the spikelet fertility of the F_1 hybrids between Silewah and Japonica rice varieties. The relationships between these varieties were as follows; Norin 15 was on the male parental side of Hayakogane, while Hokuto and Kyowa were on the female parental side and Matsumotomochi and Hashiribozu were on the female and male parental sides, respectively. Although the spikelet fertility of F_1 hybrids between Joiku 272 and Silewah has not been examined yet, the spikelet sterility in the F_1 hybrids between Silewah and Norin 15 might be caused by the same gene(s) as those between Silewah and Hayakogane. In order to identify the gene(s) for spikelet sterility in these F_1 hybrids, however, F_1 hybrids between Hokkaido rice varieties which showed spikelet sterility in the hybrids including Silewah are further needed to be crossed with Silewah.

Table 2. Spikelet and pollen fertility of parental strains and F₁ hybrids between pedigrees of Hayakogane and Silewah

Parental strain	SF(%)	PF(%)	Hybrid	
			SF(%)	PF(%)
Hayakogane	92.4±6.9	94.4±0.2	0.8±2.6	91.7±1.3
Hokuto	84.7±9.0	91.5±4.8	39.4±27.8	90.3±6.5
Kyowa	84.2±9.9	96.7±3.2	41.8±24.0	91.7±3.1
Yuukara	91.6±5.5	97.3±2.0	83.0±9.0	96.7±3.2
Norin 15	75.0±11.5	89.6±7.5	0.8±1.8	91.4±4.6
Matsumotomochi	81.4±4.8	97.5±0.9	70.9±13.8	92.9±4.2
Joiku 42	93.2±3.8	98.1±1.7	88.2±8.1	95.3±1.3
Wasefukoku	78.3±7.9	95.1±3.7	86.2±6.2	92.9±10.2
Eiko	92.8±4.5	98.6±1.2	90.1±7.2	96.1±4.1
Hashiribozu	69.3±10.4	89.3±13.5	71.5±14.2	97.2±1.8
Bozu 6	82.9±8.3	90.8±7.0	90.7±5.2	98.1±1.7
Sakigake	79.5±10.4	90.7±3.7	90.6±7.0	97.1±1.6
Bozu	82.9±6.3	95.6±7.6	84.5±9.8	97.6±1.4
Silewah	77.2±8.5	98.1±1.8		

Note. SF and PF mean spikelet fertility and pollen fertility, respectively.

SATAKE and TORIYAMA (1979) reported that Silewah is compatible with Japonica. On the other hand, IKEHASHI and ARAKI (1984, 1986) pointed out that the F₁ hybrids between Silewah and either Japonica or Indica testers showed a partial fertility, but normal pollen fertility. The results obtained in this study demonstrated well that varietal differentiation for the spikelet sterility in the F₁ hybrids including Silewah may occur in Japonica rices.

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イネ品種シレワーとはやこがねとの F_1 雑種に見出された種子不稔

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インドネシア在来イネ品種シレワーと北海道品種はやこがねとの F_1 雑種で極端な種子不稔が見出された。この種子不稔の原因について検討したところ、まず細胞質の影響はなく、また F_1 雑種の花粉稔性は正常であった。そこで、 F_1 雑種の開花時の葯を観察したところ、不裂開葯が多数見出された。これらのことから、 F_1 雑種の種子稔性が低い原因は、多数の葯の不裂開に起因しているのではないかと推察された。そこで、はやこがねとシレワーとの F_1 雑種と同様にシレワーとの F_1 雑種が種子不稔を示す品種が他にあるかどうかを明らかにするために、はやこがねの親系統とシレワーとの間で交雑を行った。その結果、農林15号、北斗および共和との F_1 雑種が種子不稔を示した。従って、シレワーとの F_1 雑種で種子不稔を生ずる品種が日本型イネ内に分化していることが示唆された。