Breeding of Resistant Variety to Corn-Streaked Dwarf Virus

By SHIRO SOEJIMA

Breeding Division, Miyakonojo Branch
Miyazaki Agricultural Experiment Station

Black-streaked dwarf of the rice family plant (it is called streaked dwarf virus (SDV) in corn and wheat), which was discovered in the rice at Nagano Prefecture in 1950, is a viral disease transmitted by the smaller brown plant hopper *delphacodes striatella*. An outbreak of this disease on corns was recorded in Yamanashi Prefecture in 1955.

Breeding test of corns was begun at our stations since 1962 when the outbreak of this disease a created turmoil. An indigenous variety with disease resistance has been found while the test under natural incidence of the disease was conducted and from its F_1 hybrid a variety with disease resistance could be bred tentatively. At present, a parent plant with high disease resistance is under breeding by artificial infection. Following is the description of the process:

Disease resistance of the variety[1)]

According to the results by the growing districts which have been examining approximately 500 varieties for several years since 1963, native varieties at the foot of Mt. Fuji and varieties introduced from Thailand and Formosa mostly are high resistant, those in Spain and Yugoslavia are generally weak, those in the United States, Mexico, Brazil, Cambodia, Iraq and Italy are moderate susceptible, and those introduced from India as well as from Japan are mostly medium. Varieties with strong disease resistance are as follows:

1) Varieties with strong disease resistance —Kamigane-1, Narusawa Saiko-3 (Yamanashi Prefetcure) and Prabudhabat (Thailand).

2) Varieties with somewhat strong disease resistance—Suyama Inno-1 (Shizuoka Prefecture), Hirano, Kamigane Kami Hagiwara-3 (Yamanashi Prefecture), Tsukui Yoshino (Kanagawa Prefecture), Guatemala-Chyukan No. 1 (Thailand), RGS X and XI (Formosa).

That there are varieties with strong disease resistance among native ones at the foot of Mt. Fuji imply that natural selection has been made resulting from the fact that streaked dwarf has often broken out there and the pollen of the affected plants does not disperse.

It is considered that disease resistance is a characteristic factor of the variety since a certain tendency is not recognized in the relationship between disease resistance and other characteristics.

Disease resistance of the first filial generation (F_1)[1)]

When parents' variety has strong disease resistance as shown in Table 1, its F_1 also has a strong one, and conversely, F_1 crossed among varieties with weak disease resistance has a weak one. When a parent has disease resistance, F_1 has one of almost medium degree between parents. Consequently, it is said that the disease resistance is heritable.

Table 1. Disease resistance of F_1 hybrid

Varieties & cross combination		Infected plants %	Infection indices	Resistance grade
Native varieties (1963)	Kamigane-1	13.5	0.4	Strong
	Guatemala Prabudhabat	16.1	0.3	Strong
	Kagawa local variety	92.4	4.6	Weak
	White dent corn	83.0	3.9	Weak
Hybrids (1966)	Kamigane-1×Prabudhabat	19.4	0.5	Strong
	Kamigane-1×White dent corn	21.9	0.6	Strong
	Prabudhabat×White dent corn	28.1	1.2	Medium
	White dent corn×Kagawa local variety	65.5	2.4	Weak

Note: Infection index 0 indicates the strongest and 6 weakest

Breeding of variety with disease resistance, "Sujishirazu"[2)]

As streaked dwarf has outspread in the Kanto District since 1967, several hybrids crossbred among varieties with a parent having disease resistance have been distributed to the prefectures which request them and have been examined.

As a result, it has been proved that Toko No. 38 (Kamigane-1 × White dent corn) is superior to native varieties, such as, it has strong disease resistance and a large amount of yield. Then, it has been applied as the incentive variety in Gunma Prefecture since 1971, and put on sale under the name of "Sujishirazu".

Trial of the examination of the varietal resistance to corn-streaked dwarf virus

A breeding method for the rice variety with stripe-disease resistance was reported by the Chugoku National Agricultural Experiment Station in 1966[3)]. The method has been applied to corns since the disease is also a virus carrying delphacodes striatella.

At present, the experimental results obtained in regard with carrying virus are summarized as follows:

1) It is so easy to acquire virus of delphacodes striatella because they are young[4)].

2) Intermediary insects could be highly acquired from the newly emerged tillers' affected rice plant infected by black-streaked dwarf[4)] and the rate of infective insects is increased at pretty high temperature.

3) The ability to transmit virus is not shown until the acquisition in the insect body (7 to 21 days) passes after the acquisition of virus, but afterwards the viruliterous remains until the insects grow old[4)].

4) As the virus of streaked dwarf is

Table 2. Temperature during the acquisition of virus by insects and disease percentage of corn plants (1970)

Temperature	Day after inoculation	Percentage of infected plants
28°C (variable)	51	13.2%
	67	24.2
	86	30.9
20°C	51	4.9%
	67	14.8
	86	20.7

Note: 1) Mediatorial insects laid eggs on the rice plants infected by black-streaked dwarf virus (Sept.2). The larvae hatched from the eggs were kept under the intended experimental temperature (high or low) until they attained their second or third instar
2) The corn seeds were shown on Oct. 10 and then the inoculated plants were cultivated inside the vinyl house. The percentages of infected plants are the mean values of for varieties

Table 3. Cultivation temperature of inoculated seedlings and disease percentage (1970)

Cultivation temperature	Day after inoculation	Percentage of infected plants
High temperature (inside the vinyl house)	30	14.2%
	47	23.2
	50	24.0
Natural temperature (open field)	30	0 %
	47	9.5
	50	14.6

Note: 1) The corn seeds were shown on June 2
2) The percentages are the mean values of five varieties

incapable of virus passage through eggs, in the breeding season, it is necessary to feed the infective vector each time.

5) As intermediary insects could be bred on the rice, but die within several days on corns, many infective insects are required for the virus inoculation.

6) The breeding season of delphacodes striatella in the natural condition is about the middle of June at Miyakonojo (the average temperature is 22.1°C and the day length is 14 hours and 14 minutes). Before and after the month they have few population autumn and are active but do not transmit virus from autumn to winter when they enter the hibernation period.

7) When the plant is in the early growing period, the contagion rate is high and it is apt to be attacked by the disease, which is quickened at rather high temperature after the contagion.

It has become easy to transmit virus after the above mentioned has been proved. As shown in Table 4, the varieties with strong disease resistance due to natural attack are also strong in seeding test for varietal resistance. Consequently it is possible to decide the degree of the disease resistance to the variety and the system by artificial infection.

Table 4. Inoculated and not inoculated disease percentages

Varieties	Not inoculated disease percentage		Inoculated disease percentage
	Infected plants	Infection indices	Infected plants
Kamigane-1	13.5%	0.4	0 %
Suyama inno-1	24.4	0.7	3.2
Morozuka-4	64.3	3.4	61.9
Tonegawa	90.7	5.3	30.4

Selection of the individual with disease resistance by the seedling inoculation test

The examination is conducted in the following methods;

1) Time of test: The test is conducted at the beginning of March in spring and in October in autumn when the frequency of typhoon becomes low. The unaffected seedling is planted on the field (in a vinyl house in autumn).

2) Virus (pathogenic virus): Newly emerged tillers' affected rice plants are used as inoculum. They are bred in a vinyl house in winter and outdoors in summer.

3) Feeding of intermediary insects: Rice seedlings are cultivated on culture dish with a diameter of 9 cm in a constant temperature room with a temperature of 20°C and the time of day length is 14 hours, and successive feeding remains.

4) Feeding of infective insects: Infective insects lay egg as follows: the reproductive paddy rice plant affected is planted on a pot covered with a transparent cylinder in which 100 male and female adults with no virus are left free. The temperature is kept 28°C until the larvae hatched on the affected rice plant and afterwards they are moved to the sprout plants of rice and used for inoculation as infective insects.

5) Preparation of test plant: Every 20 seeds of corns are sowed in culture dish with a diameter of 9 cm about the time when infective insects begin to grow wings.

6) Inocculation methods: Three adult imagoes per sprout plant of corn feed on the diseased plants for 48 hours, and after the inoculation every plant is put in a

polyethylene pot with a 15 cm diameter which is grown in a vinyl house at a temperature ranging from 25°C to 30°C.

7) Test: As most of plants infected are attacked by the disease in about 30 days after the inoculation, the plants showing no symptoms are selected and transplanted on the field. When strains which are slightly affected with the disease appear in the later growing period, healthy strains are treated according to the purpose and the seeds are gathered.

In order to breed the variety with high disease resistance, since 1967 the varieties with high ability of crossing have been returned to the ones with disease resistance to be crossbred, from which F_1 the plants without disease have been selected by the young plant infection.

Future plan for breeding the variety with disease resistance

1) As the indigenous varieties of corns are inconsistent hereditarily, and even susceptible varieties are not often infected by the disease. Consequently, in order to breed the parent sample with disease resistance, those with high ability of crossing are selected from the ones without disease by the young infected plants over several generations.

2) As the indigenous F_1 varieties have many merits such as high yield, there is a problem in the method of seed production. The method is simplified by breeding the composite variety from several ones which include indigenous ones with disease resistance, when they are used for soiling, and those with disease resistance are selected in the process of breeding.

3) The parent sample of sweet corn with disease resistance is bred by selecting them after F_2 ones without disease with which flint ones having disease resistance are crossbred since the former is generally susceptible.

References

1) Soejima, S., Nozaki, K. & Matsunaga, Y.: Study on the disease occurence and varietal resistance of maize streaked dwarf in Miyazaki Prefecture. *Bull. Miyazaki Agr. Exp. Sta.*, **2**, 36–41 (1967). [In Japanese.]
2) Soejima, S.: Annual description of maize new variety "Sujishirazu" for 1971. *Nogyogijutsu*, **26** (8), 377–378 (1971). [In Japanese.]
3) Toriyama, K. et al.: Breeding of resistant varieties for the stripe-disease of rice. *Nogyogijutsu*, **21** (1), 16–20 (1966). [In Japanese.]
4) Shinkai, A.: Study on the insects transmission of rice virus disease. *Bull. Nat. Inst. Agr. Sci.*, **C 14**, 77–107 (1962). [In Japanese with English summary.]
5) Ishii, S. & Yoshimura, S.: Mechanism of disease occurence and control for maize streaked dwarf. *Agr. and Hort.*, **46** (9), 1327–1332 (1971). [In Japanese.]
6) Obi, M. & Kosuge, K.: On the infections occasion of maize streaked dwarf. *Kantobyocyuho*, **6**, 22 (1959). [In Japanese.]