19. PROBLEMS ON SOME RICE DISEASES IN JAPAN

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Introduction

There are as many as 25 rice diseases in Japan caused by fungi, bacteria and viruses. However, the number of major diseases such as blast, bacterial leaf blight, brown spot, sheath blight, stem rot, downy mildew and two different virus diseases, dwarf and stripe is few.

Japan has witnessed a far reaching changes and progress in her rice cultivation practices in the last two decades. And such changes and progress have brought about a great impact on the outbreak and prevalence of major diseases. This paper intends to give the outline on some of those major diseases in connection with the changes in rice cultivation practices.

Yearly Fluctuation in the Outbreak of Some Major Diseases during the Period, 1956–1965.

Blast caused by *Pyricularia oryzae* Cav. is the most widely spread and the most serious in Japan shown as Fig. 1[9]. The acreage infected by blast reaches to more than 600,000 ha each year.

Bacterial leaf blight caused by *Xanthomonas oryzae* (Uyeda et Ishiyama) Dowon, is a typical disease in the southern part of Japan. Recently it has spread toward the northern part with a gradual increase of the acreage of infection as shown in Fig. 1[9].

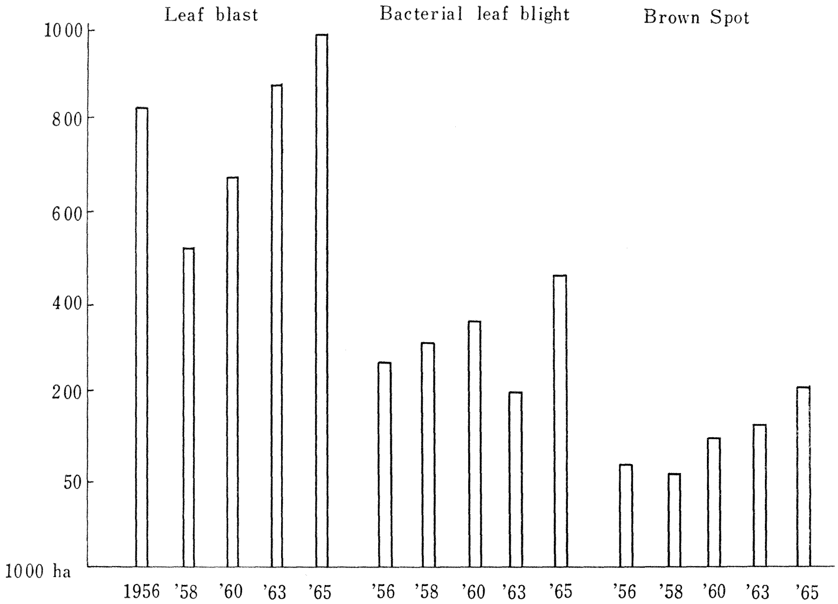

Fig. 1. Yearly fluctuaticn of disease occurrence on some major diseases. I. (1956–1965)

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Brown spot caused by *Cochliobolus miyabeanus* (S. Ito et Kuribayashi) Drechsler, is characterized by the appearence of black brown spots with yellow halo on old leaf blade. The acreage infected by this disease was much larger 20 years ago than in recent years. And the disease has been recognized as a panicular disease in the southwestern warm districts, characterized by the infection of branches of rachis and glumes of grain by the causal fungus of the disease. In most cases the panicles of infected culm are accompanied with affected neck and the grains are not filled.

Problems on above three diseases are only outlined in this paper as the same diseases have already been discussed in the Symposium. Yearly fluctuation of other diseases of rice are shown in Fig. 2.

Sheath blight caused by *Pellicularia Sasakii* (Shirai) S. Ito, is the second major paddy rice disease ranked in Japan and the infected acreage amounts to more than 600, 000 ha each year.

Stem rot is composed of two kinds diseases, that is, stem rot and irregular stem rot. The disease outbreak of major magnitude was witnessed throughout Japan from 1940 to 1955. The infected acreage during the same period must have covered about 500, 000 ha or more. It is very interesting to note that the infected acreage by the disease decreased remarkably in recent year shown as Fig. 2[9].

Dwarf and stripe are known as two kinds of virus diseases of rice in Japan. In the case of dwarf the green leafhopper is a vector, and in the case of stripe, the smaller brown planthopper. The acreage of dwarf infected field has increased since 1957 to about 200, 000 ha in each year. Remarkable increase of stripe infected areas in recent years is shown in Fig. 2, exceeding 500, 000 ha in 1965.

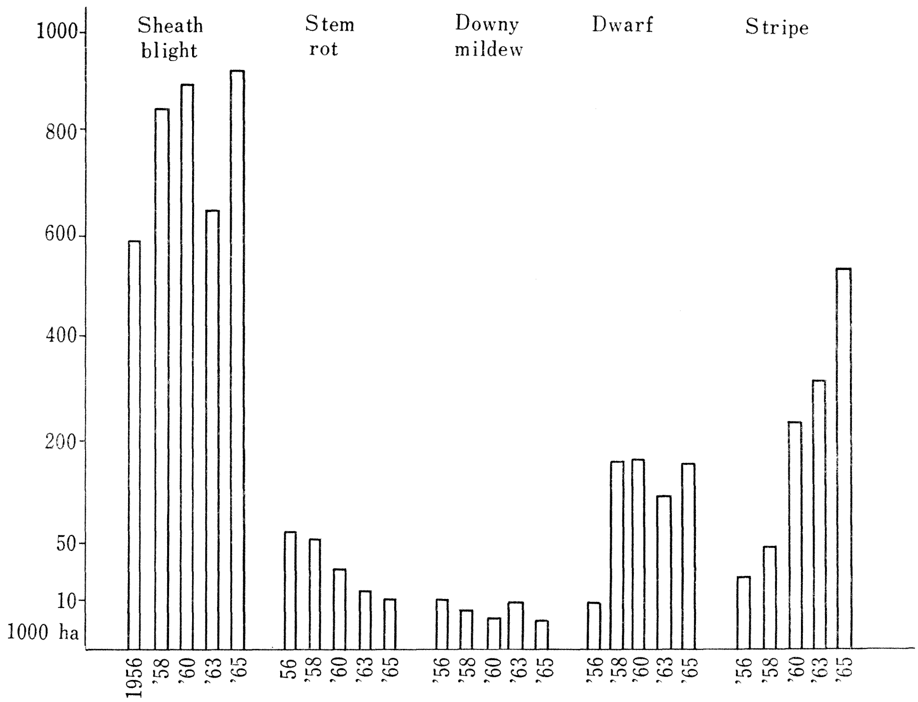

Fig. 2. Yearly fluctuation of disease occurrence on some major diseases. II. (1956–1965)

As mentioned above, the fluctuation in the prevalence on some major diseases since 1945, must have occured by the changes of rice growing practices.

One remarkable change in rice culture is an increase in the rate of fertilizer application as shown in Fig. 3[8]. The application of nitrogen, phosphate and potash per hectare increased from 40 kg in 1948 to 89 kg in 1961, 35 kg to 67 kg and 4 kg to 71 kg respectively. It has been well known that the heavy application of nitrogen makes the paddy rice to be susceptible to the infection of pathogenic organisms. On the other hand, optimum application of fertilizer, particularly, sufficient use of phosphate and potash seemed to have reduced the outbreak of brown spot and stem rot. These two diseases wery severe due to the shortage of fertilizer supply for some years after the War.

The second important change in rice growing practices is the transition of the growing season. Early transplanting of rice has been adopted since 1953 as means of to evade the typhoon which chronically visits the southern part of the country each year and the damage caused by cold weather in summer in the north. This practice of early rice culture seemed to induce more severe ortbreak of some major diseases such as sheath blight, bacterial leaf blight and virus diseases. For example, sheath blight and bacterial leaf blight are known as

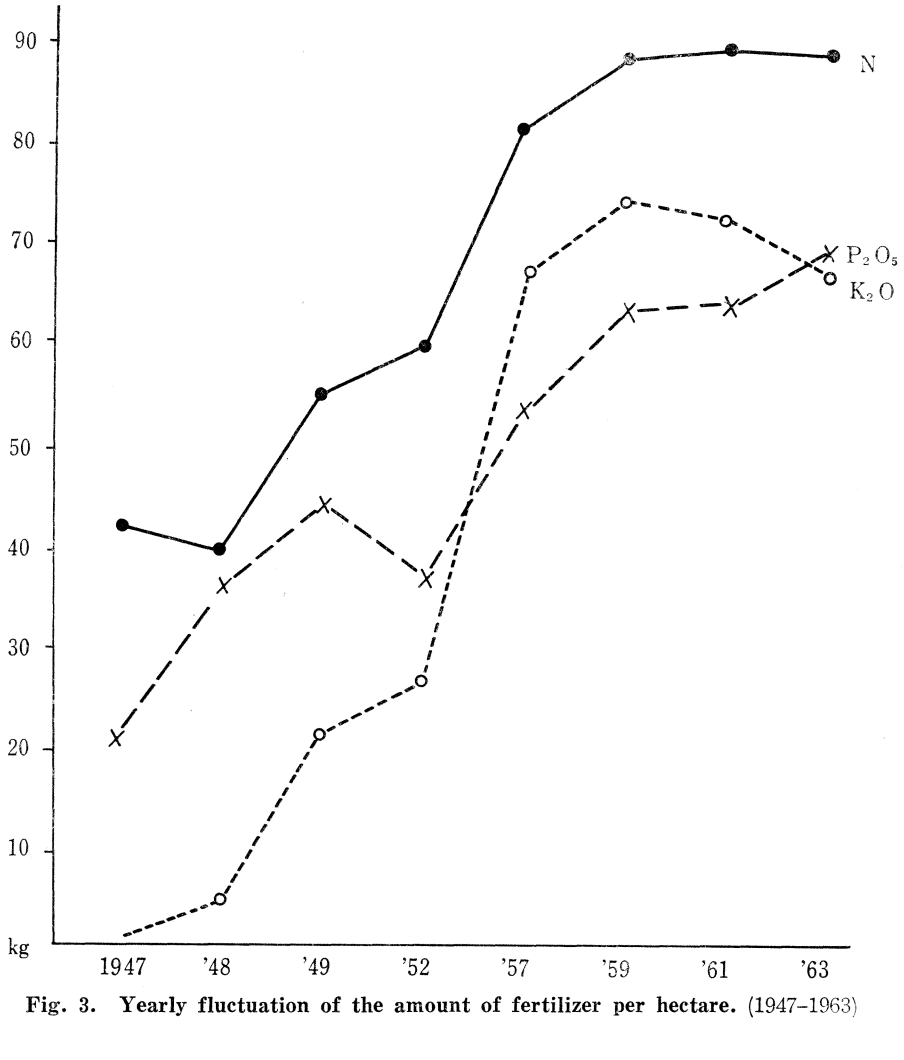

Fig. 3. Yearly fluctuation of the amount of fertilizer per hectare. (1947–1963)

the typical diseases in the southern part of the country, but the diseases are established recently in the north as well.

The third important change in rice culture practices is the adoptation of planting in cluster, accompanied with high dosage of fertilization. High humidity and temperature among plants created by thick growing under such a practice invited a favorable conditions for the outbreak of sheath blight and bacterial leaf blight.

Problems on Some Other Diseases and Their Control

Sheath Blight

The major inoculum is the overwintered sclerotia. They are floating on the irrigation water in paddy fields when young rice plants are being prepared for transplanting. The infection normally starts when the rice plant grows up to the tillering stage and the symptom appeared on leaf sheath as greenish grey in color and elliptical in shape. Lesion gradually enlarges and turns greyish white with brown tint in margin. The affected leafsheath and leafblades become withered and curled up when the disease become severe under favorable conditions, and grains are not or poorly filled.

Generally, the intensity of primary infection was closely related with the number of sclerotia attached to the rice plant, and the rate of subsequent disease development was greatly influenced by environmental conditions and by susceptibility of rice varieties. The susceptibilities to leafsheath and leafblades are also closely related with their ages; the 5–6 weelss or older leafsheath and leafblade being more susceptible than the younger ones such as 2–3 weeks old after its opening[3]. As for environmental conditions on the disease development; high temperature above 22–23°C, and high humidity among growing rice plants above 95–96% are necessary for the infection and favorable for the spread of the mycelium on rice plants. Kozaka[3] advocated that there are three representative types of the disease outbreak in Japan under respective temperature conditions as follows:

A type: High temperature during the whole rice growth season, in the case of special early varieties in the ordiary cultivation.

B type: High temperature prior to the heading and low in the subsequent period, in the case of late varieties in ordinary cultivation or late sowing and transplanting cultivation.

C type: High temperature after heading and low in prior season, in the case of early sowing and transplanting cultivation.

The yield loss by the disease is most severe when the plants are infected up to their uppermost leaves and sheaths, as is seen from A and C types of disease outbreak. Table 1

Table 1. Relationships between the rate of diseased plants and the rice growing season.(Inoue, 1966)

Heading time	Rate of diseased plants		Grade of diseased plants	Type
Before June 15	1958, '59, '60	90.2%	72.8×	C & A
After June 16	1958, '59, '60	87.7%	51.9×	A & C
Before August 31	1958, '59, '60	22.2%	56.4×	C & B
After September 1	1958, '59, '60	27.0%	39.8	B

× critical disease grade for application of fungicides is shown as an example of the above relationships[2].

The outbreak of the sheash blight become wide spread, and serious in both A and C types after the adoptation of early rice culture practice. Many fungicides were tested for the control of the disease. The results, clarified that organic arsine compounds showed remarkable inhibition against the enlargement of lesion by their eradicative activities. Through the field trials, chemical control measure of the sheath blight has been established as follows; spraying or dusting of organic arsine fungicides once a year at the booting stage is sufficient for practical control, but in the year of serious outbreak two applications be necessary i. e., soon after infection period and at the booting period. Adequate concentrations and amounts of the fungicides are shown as Table 2.

Table 2. Direction of the use of organoarsine fugicides

		Active ingredient		Concentration	Dosage per ha
Monzet	Wettable powder	20%	Urbasid	1 : 2500	1000 ~ 1200 liter
	Dust	0. 23 0. 22	Urbasid Calium methylarsonate	—	30–40 kg
Asozin	Wettable powder	5. 0	Methylarsine sulfide	1 : 2000	1000 ~ 1200 liter
	Dust	0. 4	Ferric monomethyl arsonate	—	30–30 kg

Most of organic compounds may cause phytotoxity if there are applied in excess in regards to the concentration or the amount. Toxic symptoms of fungicides appear as a local lesion type showing brown spot or white spot and a systemic type showing yellowing on the plant, with severe decrease of yield. Moreover, even though the symptom was not recognized about one % decrease of the yield was still estimated by ideal application of the fungicide as compared with non treated one.

Consequently, economically effective application of this fungicide may be available only in the case of the paddy field 20 days before the heading period, showing 40% or more infection rate of diseased rice plants[3].

Other kinds of non-phytotoxic fungicides to rice plant, are desirable. An antibiotic, Polioxin discovered in 1965[6], is a quite effective fungicide against sheath blight without phytotoxicity. The practical use of Polioxin to sheath blight is now under investigation.

Stem Rot

The name of this disease includes two kinds of diseases as mentioned above, that is, stem rot caused by *Helminthosporium sigmoideum* Cavara and irregular stem rot by *Helminthosporium sigmoideum* Cavara var. irregulare Cralley et Tullis. Major inoculum of these diseases is the overwintered small black sclerotia remained with diseased stubbles in paddy fields. on surface of the irrigation water come into contact with rice plants by wind or stream.

Primary lesions are formed usually near the water surface at the part of the lowermost leaf sheath as a result of infection through contact by germ tube from the sclerotia. Since the pathogen penetrates into the leafsheath, the causal fungus of the stem rot soon invades the culm, forming sclerotia there, while the irregular stem rot fungus develops sclerotia in the leafsheath at first and successively invades the culm.

The stem rot fungus invades the sclerenchyma and small vascudlar bundles of the culm while the irregular stem rot fungus infects the parenchyma and main vascular bundles[5].

Generally, the stem rot outbreaks in the ill-drained paddy field, especially in case of late earing varieties, while the irregular stem rot outbreaks in the welldrained paddy field especially in early earing varieties. Infected rice plants by both diseases are liable to lodge at the maturing stage with increased damage.

As mentioned above, the infected acreage by these diseases decreased remarkably in recent years. The causes of the decrease are considered as follows; land improvement (depressing of stem rot outbreak), use of sufficient potassic fertilizer (effective in control of stem rot)[4], as shown in Table 3, and the use of organomercuric fungicides for the control of blast (simultaneously control the stem rot and the irregular stem rot).

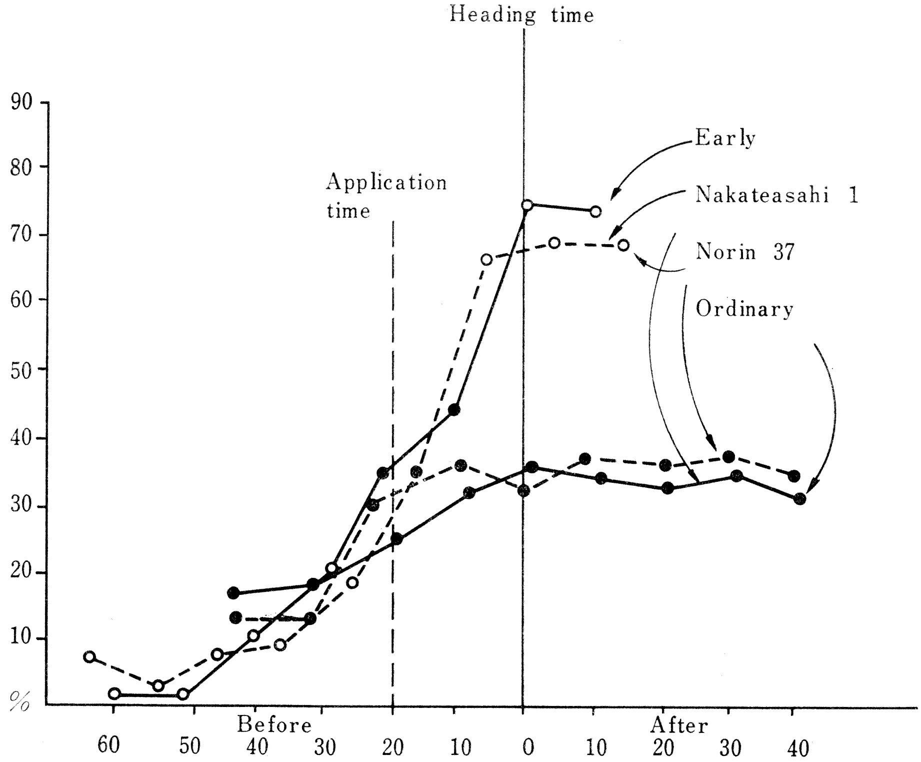

Fig. 4. Comparison of the transition of sheath blight in early and ordinary growing season.

Table 3. Effects of potassic fertilizer against the occurrence of stem rot. (Okamoto, 1949)

	Rate of diseased plants/a				Comparison of the yield			
KCl / $(NH)_2SO_4$	0	5.63	11.25	22.50 kg	0	5.62	11.25	22.50 kg
0	29.1%	4.5	5.5	—	100%	—	117.4	—
5.63	43.0	9.1	2.6	3.0	101.2	125.9	122.9	139.2
22.50 kg	61.9	51.2	22.9	15.2	76.3	119.5	158.5	159.4

Stripe

Smaller brown planthopper is the vector of stripe. The populations of this viruriferous intecs may have been brought about by the early setting of nursery and early planting. Moreover, the adoptation of denser space planting accompanied with heavy fertilization, create higher humidity and temperature on rice plants and is believed to favor the propagation of the planthopper. Transmission is conducted very effectively through the adults of the first generation and the larvae of the second in the nursery and in the paddy field just after transplanting.

The diseased rice plants may be observed at the tillering stage in the paddy field in case of early growing and soon after transplanting in case of ordinary rice growing. The symptom of the stripe is characterized by the appearance of yellowish mottles or stripes along veins at first, then newly developed leaves fail to extend, lose vigor and decay. Infected rice plant is somewhat stunted and the tillering remarkably depressed, with poorly ripened heads in most cases.

In order to control the stripe, population density of the adults of the first genration and the larvae of the second should be suppressed by means of the application of insecticides, BHC, malathion and other organophosphates as well as carbamates. But it has been experienced that to obtain the satisfactory suppression of the stripe, insecticides were required to apply more than twice in the adequate periods, preferably more than three times. Thus, it has been long desired whether there is any other measure other than the method of controlling the vector. Very recently, two varieties, St. 1 and Chugoku 31, were selected as the highly resistant during the study of breeding for resistant varieties[7]. It is believed that the cooperative studies by breeders and pathologists must have contributed to the breeding of stripe resistant varieties.

Summary

The rise and fall of the outbreak of annual disease since 1945 can be outlined as follows. The outbreaks brown spot and stem rot were serious spreading widely immediately after 1945 but these outbreaks have declined annually since then. On the contrary, dwarf, stripe, yellow dwarf, sheath blight and blast outbreaks were not so severe for sometimes after 1945 but rapidly increased and became very destructive. And during the same period the diseases which were not serious were downy mildew and bacterial leaf blight.

Thus, the study is concerned with the factors which cause those variations in the outbreaks of diseases in connection with the changes in rice culture practice.

Discussion

D. V. W. Abeygunawardena, Ceylon: Do you consider the occurrence of sheath blight to be related to any special soil conditions or widespread throughout the country?

Answer: we find out no correlation among soil condition and the disease occurrence. This disease mainly distribute in the southern part of Japan.

D. V. W. Abeygunawardena, Ceylon: Have you recognized varietal difference to sheath blight in Japan.

Answer: We could not find out any resistant varieties in Japan.

S. C. Hsieh, Taiwan: Did you find any varietal resistance to sheath blight in Japan? If you have, please tell us. In Taiwan, no resistant varieties to this disease was found among more than 300 varieties tested so far.

Answer: As mentioned before, we could not, the same as you experienced.

P. Kanjanasoon, Thailand: Your first slide iedicated that blast disease was most widely distributed in Japan in 1956, but for the last 5 years (1962–1966) decreased. And there was no blast prodlem in Thailand as you have seen. What is your opinion about this?

Answer: In general, blast occurrence is closely related to weather conditions. As you know we had so many rainy days in 1965 during the rice cultivation period. Blast was not so severe in Thailand as you said. I suppose that nitrogenous fertilizer application there is not so much as compared with that in Japan.

References for Paper 19

1. Inoue, Y., (1963), Studies on sheath blight of rice plant caused by *Pellicularia sasakii* (Shirai) S. Ito. Subsidized Experiment in Yamaguchi prefecture, Agriculture, Forestry and Fishery Council, Ministry of Agriculture and Forestry, Japan. Plant Diseases and Insect Pests No. 4.
2. Inoue, Y., (1966), On the adequate application of fungicides for the control of sheath blight. Plant Protection, 20 (6): 8–12.
3. Kozaka, T., (1961), Ecological studies on sheath blight of rice caused by *Pellicularia saskii* (Shirai) S. Ito and its chemical control.
4. Okamoto, H., (1949), On the influence of potassium to the stem rot of rice plant. Journal of Hokuriku Agr. 1 (1); 64–74.
5. Ono, K., (1960), Studies on Mechanism of infection and ecology of blast and stem rot of rice plant. Plant Protection Section, Ministry of Agriculture and Foreetry, Special Report of the Plant Diseases and Insect Pests Forecasting Service No. 4: 1–160.
6. Suzuki, S., (1966), Studies on Polioxin, Ann. Phytopath. Japan 32 (2): 99.
7. Toriyama, K., et al. (1966), Breeding for the stripe resistant variety, Nogyogijutsu, 21(1): 16–20.
8. Year Book of Fertilizer, (1964), Japan Fertilizer Association.
9. Year Report of Plant Protection, 1956–'65, Plant Protection Section, Ministry of Agriculture and Forestry, Japan.