

Fusarium oxysporum f.sp.adzukicolaによるアズキ萎ちょう病(新称)とその三つのレース

誌名	日本植物病理學會報 = Annals of the Phytopathological Society of Japan
ISSN	00319473
著者名	近藤,則夫 児玉,不二雄
発行元	日本植物病理學會
巻/号	55巻4号
巻号補足	
掲載ページ	p. 451-457
発行年月	1989年10月

農林水産省 農林水産技術会議事務局筑波産学連携支援センター
Tsukuba Business-Academia Cooperation Support Center, Agriculture, Forestry and Fisheries Research Council
Secretariat



Fusarium oxysporum f. sp. *adzukicola*, Causal Agent of Adzuki Bean Wilt, and Detection of Three Races of the Fungus

Norio KONDO* and Fujio KODAMA*

Abstract

We confirmed that a wilt of adzuki bean (*Vigna angularis* (Willd.) Ohwi & Ohashi) in Hokkaido is caused by a new forma specialis of *Fusarium oxysporum* reported by Kitazawa and Yanagita as *Fusarium oxysporum* f. sp. *adzukicola*. We also suggested "Adzuki icho-byo" as the Japanese name of adzuki bean wilt caused by *Fusarium oxysporum* f. sp. *adzukicola*. The susceptibility of adzuki bean cultivars and lines to adzuki bean wilt was determined in greenhouse and field tests. For greenhouse tests, the roots of 7- to 10-day-old seedlings grown in sterilized vermiculite were dipped for about 1 hr in a suspension of spores of *Fusarium oxysporum* f. sp. *adzukicola* (10^6 microconidia/ml) and the seedlings were then transplanted into pots filled with sterilized soil. Plants for these tests were grown at temperatures between 18~33 C. Initial symptoms on susceptible plants appeared about 10~14 days after inoculation. The typical symptoms observed in the greenhouse test were similar to those observed on plants grown in fields. The response of 22 cultivars and lines to eight isolates of *F. o. f. sp. adzukicola* resulted in the identification of three races of the fungus. The reaction of cultivars in field tests were similar to those for race 3 in greenhouse tests. It was concluded that screening of adzuki bean germ plasm in greenhouse tests is effective in selecting for resistance.

(Received March 11, 1989)

Key words: adzuki bean, wilt, *Fusarium oxysporum* f. sp. *adzukicola*, race, screening, disease resistance.

INTRODUCTION

Adzuki bean (*Vigna angularis* (Willd.) Ohwi & Ohashi) wilt was first discovered in 1906 by Hanzawa¹⁾ who reported that a *Fusarium* sp. was the causal agent of this disease. The disease has been reported several times since this initial publication^{2,3,8,13)}. In 1980, Matsuo⁸⁾ reported that the isolate collected at Watanabe¹³⁾ was *Fusarium oxysporum* f. sp. *phaseoli*. This was the first identification of the species or forma specialis of this fungus, although *F. oxysporum* had been suggested earlier in a report by Hara⁹⁾. Matsuo also reported that adzuki bean plants inoculated with this isolate showed only vascular discoloration.

Recently, a destructive wilt of adzuki bean has occurred in Hokkaido, the northern island of Japan, and it has become an important disease. Kitazawa and Yanagita⁴⁾ reported that the isolate of *F. oxysporum* collected from diseased adzuki beans showed specific pathogenicity to adzuki bean and proposed a new forma specialis: *F. oxysporum* f. sp. *adzukicola*⁵⁾. We have also proposed a new forma specialis for this fungus, *F. oxysporum* f. sp. *angularis*⁷⁾, followed comparative pathogenicity tests with *F. o. f. sp. phaseoli*. But *F. oxysporum* f. sp. *adzukicola*

* Hokkaido Central Agricultural Experiment Station, Naganuma, Hokkaido 069-13, Japan 北海
道立中央農業試験場

should be used instead of *F. oxysporum* f. sp. *angularis* in conformity with the regulation of priority of claim.

The purpose of this report is to confirm the existence of a new forma specialis based upon pathogenicity tests with eighteen species of plants. Also, in the inoculation test with four supplementary species and one variety of subgenus *Ceratotropis* (genus *Vigna*) we compare the pathogenicity of *F. o. f. sp. adzukicola* with that of *F. o. f. sp. phaseoli*. In addition, we report a suitable and reproducible technique for testing the reaction of plant to this pathogen, compare the reaction of adzuki bean cultivars in the greenhouse to *F. o. f. sp. adzukicola* with the reaction in an infested field, and document the existence of the three races.

MATERIALS AND METHODS

Isolates and preparation of inoculum. Three forma speciales of *Fusarium oxysporum* Schl. were used in this study: *F. o. f. sp. phaseoli* (ATCC 18131, ATCC 42145); *F. o. f. sp. tracheiphilum* (ATCC 16608, ATCC 16609, ATCC 16610); and *F. o. f. sp. medicagnis* (FO5 from Rinzo Sato, Hokkaido National Agricultural Experiment Station). The following isolates of *F. o. f. sp. adzukicola* were also used: KF654, KF648, KF895, KF1025 isolated from diseased adzuki beans collected in 1984~1987 from Shinshinotsu; KF654, KF655, KF843 collected in 1984~1987 from Fukagawa; F285 collected in 1988 from Nakafurano; and FA5 collected in 1984 from Bibai.

Inoculum was produced on potato sucrose agar (PSA) plates incubated at 25 C for 3 weeks. Spore suspensions, including microconidia and macroconidia, were prepared by adding about 5 ml of distilled water to each PSA plate and scrapping the surface of the culture with a glass slide. The suspension was passed through four layers of cheesecloth, centrifuged at 3,500 rpm, and the pellet was then resuspended in distilled water. The concentration was adjusted to the desired amount with the aid of a hemacytometer.

Soil inoculation. Sterilized soil was infested with spores (10^5 /g of dry soil) of isolate FA5. After thorough mixing, seeds of the 18 species listed in Table 1 were planted in the infested soil in 15-cm-diameter clay pots. Three replicates of each treatment were placed in a greenhouse at temperatures ranging between 20 to 28 C.

Root inoculation. Seedlings of all leguminous plants listed in Tables 2, 3, and 4 were inoculated by a root-dip technique^{9,10}. They were grown in vermiculite until the primary leaves were fully expanded (about 7~10 days), then they were removed from the soil and their root system was washed gently. They were then dipped for about 1 hr in the spore suspension at the desired concentration. Inoculated seedlings were transplanted into 10- or 15-cm-diameter plastic pots (generally 4~6 seedlings per pot) filled with sterilized soil.

To estimate the effect of inoculum dosage of *F. o. f. sp. adzukicola*, plants of cultivars Koto-buki-shozu, Takara-shozu, and Hikari-shozu were inoculated with 10^4 , 10^5 , and 10^6 spores/ml. To compare the resistance of adzuki bean cultivars, 22 cultivars and lines were inoculated with strains of *F. o. f. sp. adzukicola*. Plants were grown in a greenhouse at temperatures ranging between 18 to 33 C. Uninoculated plants served as controls. The experiment was repeated twice.

The reaction of individual plants was scored according to a disease severity rating (DSR) of 1 to 10^3 , where 1=healthy, no external symptoms and no vascular discoloration; 10^1 =plants showing vascular discoloration, but no external symptoms; 10^2 =plants showing leaf necrosis, stunting or wilting; 10^3 =plants dead. Disease severity index (DSI) was calculated from the formula: $DSI = \log(\text{mean (DSR)})$. Plants with $DSI \leq 1.0$ were rated resistant and plants with $DSI > 1.0$ were considered susceptible.

A field test was conducted in 1988 in a naturally infested field in Shinshinotsu to measure the reaction of plants to adzuki bean wilt under natural conditions. A randomized complete block design was used with two replications. Each plot consisted of a single row, 4 m long

with 40 seeds planted/m. Rows were spaced 60 cm apart. The same 22 cultivars and lines used in the greenhouse test were used in the field trial. Seeds of the 22 cultivars and lines were planted in August and the DSI for each cultivar was determined in September (55 days after planting) by the method described previously.

RESULTS

Host range study

The *Fusarium oxysporum* (reported as *F. o. f. sp. adzukicola*) isolated from wilted adzuki bean plants was only pathogenic to adzuki bean in the soil inoculation experiment (Table 1). Also, in the root-dip inoculation experiment the fungus was pathogenic to adzuki bean (*Vigna angularis*) and *Vigna angularis* var. *nipponensis* causing external symptoms of wilt (Table 2). The results of this pathogenicity test agreed with those reported by Kitazawa and Yanagita⁵⁾. *F. o. f. sp. phaseoli*, *F. o. f. sp. tracheiphilum*, and *F. o. f. sp. medicagnis* were not pathogenic to adzuki bean. Adzuki bean plants exhibited only vascular discoloration when inoculated with *F. o. f. sp. phaseoli* (ATCC 18131) and *F. o. f. sp. tracheiphilum* (ATCC 16608, ATCC 16609). The pathogen of adzuki bean wilt was, thereby, accepted as *F. o. f. sp. adzukicola* Kitazawa et Yanagita⁵⁾.

Effect of inoculum density on disease incidence and severity

Plants of cultivar Kotobuki-shozu, which is known to be susceptible to adzuki bean wilt, exhibited typical symptoms (leaf necrosis and wilting) of the disease within 2 weeks after being inoculated with a suspension of 10^5 or 10^6 spores of *F. o. f. sp. adzukicola*. Fifty percent of the plants died within 4 weeks after inoculation (DSI=2.7 with 10^6 , Table 3). In contrast, plants of the cultivar Hikari-shozu, which is known to be resistant in the field, showed no external symptoms and only vascular discoloration (DSI $\leq$ 0.5). The concentration of 10^6 spores per milliliter was used in all subsequent tests.

Table 1. Pathogenicity of *Fusarium oxysporum* f. sp. *adzukicola* (isolate FA5) to several species of plants in a soil-inoculation experiment^{a)}

Plant species	Cultivar	No. of seedlings inoculated	No. of plants diseased
<i>Vigna angularis</i>	Kotobuki-shozu	30	30
<i>Phaseolus vulgaris</i>	Taisho-kintoki	21	0
<i>Glycine max</i>	Kitamishiro	21	0
<i>Solanum melongena</i>	Senryo-nasu	53	0
<i>Lycopersicon esculentum</i>	Momotaro	57	0
<i>Cucumis sativus</i>	Hikari No. 3	60	0
<i>Cucumis melo</i>	King melty	30	0
<i>Lagenaria siceraria</i>	FR aioi	21	0
<i>Citrullus lanatus</i>	Shimao-suika	57	0
<i>Allium fistulosum</i>	Ishikuraippon-negi	57	0
<i>Allium cepa</i>	Furanui	66	0
<i>Oryza sativa</i>	Michikogane	60	0
<i>Triticum aestivum</i>	Horoshiri-komugi	60	0
<i>Avena sativa</i>	—	51	0
<i>Zea mays</i>	Honey bantam	30	0
<i>Raphanus sativus</i>	Taibyosobutori	59	0
<i>Spinacia oleracea</i>	Clement	54	0
<i>Daucus carota</i>	Gosun-futonaga	30	0

a) In this test, isolate FA5 from Bibai was used with the concentration of 10^5 spores/g dry soil. The number of diseased plants was determined 28 days after inoculation.

Table 2. Pathogenicity of four formae speciales of *Fusarium oxysporum* to leguminous species

Plant species	Cultivar	<i>F. oxysporum</i> f. sp.						
		<i>adzukiicola</i>	<i>phaseoli</i>		<i>tracheiphilum</i>			<i>medicagnis</i>
		KF843	ATCC 18131	ATCC 42145	ATCC 16608	ATCC 16609	ATCC 16610	F05
<i>Vigna angularis</i>	Kotobuki-shozu	15/15 ^{a)} (+) ^{b)}	0/15 (+)	0/15 (-)	0/15 (+)	0/15 (+)	0/15 (-)	0/15 (-)
<i>Vigna angularis</i> var. <i>nipponensis</i>	—	2/10 (+)	0/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Vigna mungo</i>	—	0/10 (-)	0/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Vigna radiata</i>	Shoryu-ryokuto	0/10 (-)	0/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
	No. 1	0/10 (-)	0/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
	Chokako-ryokuto	0/10 (-)	0/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Vigna umbellata</i>	—	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Vigna unguiculata</i>	Juroku-sasage	0/10 (-)	3/10 (+)	0/10 (-)	10/10 (+)	2/10 (+)	4/10 (+)	0/10 (-)
	Akatane-sanjaku-sasage	0/10 (-)	2/10 (+)	0/10 (-)	7/10 (+)	0/10 (-)	4/10 (+)	0/10 (-)
<i>Phaseolus vulgaris</i>	Taisho-kintoki	0/10 (-)	10/10 (+)	5/10 (+)	9 ^{c)} /10 (-)	5*/10 (-)	0/10 (-)	0/10 (-)
	Kairyowase-ofuku	0/10 (-)	10/10 (+)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Glycine max</i>	Shiotsurunoko	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)
<i>Pisum sativum</i>	Wase-kinusayaendo	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)	0/10 (-)

a) No. of plants diseased/no. of plants inoculated.

b) (+) indicates vascular discoloration, (-) indicates no vascular discoloration.

c) Asterisk (*) indicates root rot was observed, while vascular discoloration was not observed.

Table 3. Effect of inoculum density of *Fusarium oxysporum* f.sp. *adzukiicola* on severity of adzuki bean wilt in a greenhouse

Inoculum density (spores/ml)	Cultivar		
	Kotobuki-shozu	Takara-shozu	Hikari-shozu
0 (water check)	0 ^{a)}	0	0
10 ⁴	0	0.6	0
10 ⁵	1.4	1.2	0.3
10 ⁶	2.0	2.4	0.5

a) Disease severity rating (DSR) was determined 40 days after inoculation using a scale of 1=no symptoms to 10³=plants dead. Disease severity indexes (DSI) were calculated with the formula of DSI=log (mean (DSR)). Ten plants were included per treatment.

Symptomatology

The initial symptoms on susceptible plants appeared about 10~14 days after inoculation. These were characterized as wilting and necrosis, especially on the upper true leaves. By 3 weeks after inoculation, almost all the leaves showed epinasty, rugosity, chlorosis, necrosis and wilting. Plants at this stage of the infection also showed pronounced stunting. Severely infected plants were completely defoliated or dead 4 weeks after inoculation. At this stage

of disease development, the dead stems were covered with white-pink sporodochia of *F. o. f. sp. adzukicola*. The typical symptoms observed on infected plants in the greenhouse were similar to those observed in fields in Hokkaido where adzuki bean wilt occurs naturally. Vascular discoloration was evident on all susceptible plants and was apparent before the initial appearance of leaf necrosis.

Reaction of adzuki bean cultivars and lines to *F. o. f. sp. adzukicola*

It was evident that there are three pathogenic races of *F. o. f. sp. adzukicola*, based upon the differential reaction of inoculated cultivars (Table 4). We designated isolates KF646, KF895 and F285 as race 1, KF648, KF654 and KF655 as race 2, and KF843 and KF1025 as race 3. Three cultivars (Kari No. 71, Akamame and Toiku No. 123) and three lines (Tokei No. 325, Acc 68 and Kari 63) were considered resistant under the severe disease pressure in the greenhouse test with *F. o. f. sp. adzukicola* race 3. In the field test, the reaction of cultivars was the same as those of cultivars inoculated with race 3. Because isolate KF646 and KF1025 were isolated from the same field, it appears that naturally infested field soil may contain two or more races.

DISCUSSION

We confirmed that the *Fusarium oxysporum* isolated from wilted adzuki bean in Hokkaido shows a characteristic pathogenicity, that is, this fungus is pathogenic to adzuki bean and *Vigna angularis* var. *nipponensis*. Therefore, its identification by Kitazawa and Yanagita⁵⁾ as a new forma specialis of *Fusarium oxysporum*, which they called *Fusarium oxysporum* f. sp. *adzukicola*, should be accepted. The symptoms of adzuki bean wilt differ from those reported by Watanabe¹³⁾ who said that '... when this disease occurred at the stage of young plant soon after emergence in early August, adzuki bean showed damping-off with slender hypocotyl ...' and '... in early September discoloration of stem at the soil line was observed ...'. In another report⁹⁾ there was a description as follows: '... dark brown to red brown discoloration was observed at the soil line and developed into the upper part of stem or petioles along the one side of stem ...'. These symptoms are not as characteristic of adzuki bean wilt as they are of *Phytophthora* stem-rot⁶⁾. In our field tests and greenhouse tests, neither damping-off nor discoloration of stem at the soil line were observed. Necrosis of leaves and discoloration of vascular bundles, which are the typical symptoms of the disease that has recently occurred in Hokkaido, were not described in these previous reports. Consequently, the disease called "Tachigare-byo" in Japanese may be different from the disease that we have been studying. In addition, an isolate from Watanabe was identified as *F. o. f. sp. phaseoli* by Matsuo. Therefore, we propose a new Japanese name "Adzuki icho-byo" for the adzuki bean wilt caused by *F. o. f. sp. adzukicola*.

In the central area of Hokkaido, the *Phytophthora* stem-rot resistant cultivar Kotobukishozu was introduced and cultivated¹²⁾ in a number of paddy fields that had been recently converted to upland fields. In these fields, this cultivar was susceptible to *F. o. f. sp. adzukicola*. This has prompted a search for resistant cultivars. The root dip inoculation procedure with an inoculum density of 10⁶ spores per milliliter was highly effective in screening for resistance to *F. o. f. sp. adzukicola*. It is very interesting that a close relationship was found between the reaction of different cultivars and lines of adzuki bean to *F. o. f. sp. adzukicola* race 3 in the greenhouse and in the naturally infested field. This shows that adzuki bean can be screened for resistance under greenhouse conditions, thereby eliminating the susceptible lines without a field test.

In Hokkaido, adzuki bean brown stem rot, which is a soil borne disease caused by *Phialophora gregata*, is an important disease that is distributed in the adzuki bean region of Hokkaido¹¹⁾, especially in the southeastern areas (Tokachi area). In contrast, adzuki bean wilt is restricted to the central areas, especially Kamikawa, Sorachi and Ishikari. If adzuki bean wilt should

Table 4. Reactions of adzuki bean cultivars and lines to inoculation with different isolates of *Fusarium oxysporum* f. sp. *adzukiicola*

Resistant to race(s)	Cultivar or line	Isolate ^{a)}								Field test ^{d)}
		KF646	KF895	F285	KF648	KF654	KF655	KF843	KF1025	
1, 2, & 3	Kari No. 71	0 ^{b)} R ^{c)}	—	0 R	—	0.2 R	—	0.2 R	0.2 R	0.1 R
	Kari No. 63	0 R	—	0 R	—	0 R	—	0 R	0 R	0.9 R
	Acc68	0 R	0 R	0 R	0 R	0 R	0 R	0 R	0 R	0.6 R
	Akamame	0 R	0 R	0 R	—	0 R	—	0.7 R	0.4 R	0.2 R
	Toiku No. 123 ^{*e)}	0 R	0 R	0 R	0 R	0.2 R	0 R	0 R	0 R	0.3 R
1 & 2	Takei No. 325	0 R	0 R	0 R	0 R	0 R	0.4 R	0.2 R	0 R	0.3 R
	Hatsune-shozu*	0 R	0 R	0 R	0 R	0.4 R	0 R	1.9 S	1.8 S	1.2 S
	Wasetaiyu 1	0 R	0.3 R	0.2 R	0.7 R	0.4 R	0.9 R	1.4 S	1.3 S	1.5 S
1	Wasedainagon	0 R	0 R	0.2 R	2.1 S	1.3 S	2.4 S	2.0 S	1.4 S	1.4 S
	Hikari-shozu*	0.4 R	0 R	0 R	1.1 S	1.5 S	1.3 S	1.8 S	2.5 S	1.2 S
	Toiku No. 122	0.7 R	0.5 R	0.2 R	1.6 S	1.6 S	1.5 S	1.4 S	1.7 S	1.7 S
none	Kari No. 71	1.8 S	1.8 S	1.8 S	—	2.0 S	—	2.7 S	2.7 S	1.9 S
	Kari No. 47	2.4 S	—	—	—	2.5 S	—	2.9 S	—	2.6 S
	Ken No. 3	1.3 S	2.3 S	—	—	2.4 S	—	2.9 S	2.5 S	2.4 S
	Buchishoryu 1	2.1 S	—	2.6 S	—	2.7 S	—	3.0 S	2.9 S	2.9 S
	Chagarawase	2.4 S	2.2 S	—	—	1.9 S	—	3.0 S	2.8 S	2.1 S
	Takara-shozu	2.5 S	2.2 S	2.2 S	2.4 S	2.7 S	2.8 S	2.7 S	3.0 S	2.6 S
	Kotobuki-shozu*	2.8 S	2.1 S	2.2 S	2.2 S	2.8 S	2.7 S	3.0 S	2.8 S	2.9 S
	Sakae-shozu	2.1 S	1.6 S	1.9 S	2.2 S	2.6 S	2.6 S	2.9 S	2.8 S	2.5 S
	Hayate-shozu	2.5 S	—	—	—	3.0 S	—	3.0 S	—	2.9 S
	Erimo-shozu	1.6 S	1.6 S	—	1.1 S	2.5 S	2.4 S	3.0 S	2.7 S	2.5 S
	Toiku No. 120	2.1 S	2.4 S	—	—	2.2 S	—	2.8 S	2.5 S	2.5 S

a) Inoculum density was 10⁶ spores/ml.b) Disease severity rating (DSR) was determined 40 days after inoculation using a scale of 1=no symptoms to 10³=plants dead. Disease severity indexes (DSI) were calculated with the formula of DSI=log (mean (DSR)). Twelve to fifteen plants were included per cultivars. Uninoculated control plants (dipped in water) of all cultivars remained free of *Fusarium* wilt.c) Reaction class was based on the DSI scale: 1 $\geq$ resistant (R), and 1<susceptible (S).

d) The field test was conducted in 1988 at a naturally infested field in Shinshinotsu. Isolates KF646 and KF1025 were isolated from adzuki bean collected from this field.

e) Asterisk (*) indicates the cultivar or line designated as one of the differentials to determine the three races of the pathogen.

break out in the Tokachi area, we will need to produce cultivars resistant to both *F. o. f. sp. adzukicola* and *P. gregata*. We believe the greenhouse inoculation procedure can be used to accelerate breeding for resistance to these diseases. This inoculation procedure can also be used confidently to determine the inheritance of resistance to the pathogen.

In this study, three races of *F. o. f. sp. adzukicola* were identified. We suggest the following cultivars be used as differentials to identify these races of *F. o. f. sp. adzukicola*: Toiku 123 (resistant to all three races), Hatsune-shozu (resistant to race 1 and race 2), Hikari-shozu (resistant to only race 1), and Kotobuki-shozu (susceptible to all three races).

Disease symptoms produced in greenhouse tests were remarkably similar to those produced under field conditions. Disease progress in the fields on infected plants, however, was generally slower. This may be the reason that *F. o. f. sp. adzukicola* in naturally infested fields is unevenly distributed.

The authors wish to thank Dr. J. E. Hunter and Dr. G. S. Abawi, Professor of Cornell University, for critical reading of the manuscript, and also Kippe Murata, Hokkaido Prefectural Tokachi Agricultural Experiment Station, for providing seeds of cultivars of adzuki bean.

Literature cited

1. Hanzawa, J. (1906). Kono Zasshi 14: 176.
2. Hara, S. (1942). Nogyo oyobi Engei 17: 631.
3. Ikata, S. (1949). Syokuyosakumotsubyogaku (I). Asakura Shoten, Tokyo. pp. 201-202.
4. Kitazawa, K. and Yanagita, K. (1984). Ann. Phytopath. Soc. Japan 50: 643-645.
5. Kitazawa, K. and Yanagita, K. (1989). Ibid. 55: 76-78.
6. Kitazawa, K., Tsuchiya, S., Kodama, F., Kamjaipay, W., Ogoshi, A. and Yanagita, K. (1978). Ibid. 44: 528-531.
7. Kondo, N. and Kodama, F. (1989). Ibid. 55: 113-114.
8. Matsuo, T. (1980). Fusarium Disease of Cultivated Plants. Zenkoku Noson Kyoiku Kyokai, Tokyo. pp. 31-36, 469.
9. Pastor-Corrales, M.A. and Abawi, G.S. (1987). Pl. Dis. 71: 990-993.
10. Ribeiro, R. de L.D. and Hagedorn, D.J. (1979). Phytopathology 69: 272-276.
11. Tanaka, F. (1983). Soil Borne Diseases in Hokkaido. Dep. of Agriculture in Hikkaido Univ., Sapporo. pp. 196-202.
12. Tsuchiya, S. (1983). Ibid. pp. 99-108.
13. Watanabe, T. (1960). Nogyo oyobi Engei 35: 1312-1316.

和 文 摘 要

近藤則夫・児玉不二雄：*Fusarium oxysporum* f. sp. *adzukicola* によるアズキ萎ちょう病（新称）とその三つのレース

北海道におけるアズキの萎ちょう症状は、北沢・柳田（1989）により報告された新分化型 *Fusarium oxysporum* f. sp. *adzukicola* が起こすことを確認した。また、既報に記載されたアズキ立枯病および類似病害との病徴比較ならびに近縁分化型に対してアズキが示す症状などから、*Fusarium oxysporum* f. sp. *phaseoli* による病気を「立枯病」、*Fusarium oxysporum* f. sp. *adzukicola* による病気を「萎ちょう病」とするのがよいと提案した。なお、著者らはこの新分化型を *F. oxysporum* f. sp. *angularis* と報告したが、先名種の関係から *F. oxysporum* f. sp. *adzukicola* をとることにした。さらにアズキの品種（系統）の本病に対する感受性を温室試験あるいはほ場試験で検討した。殺菌パーミキュライトで 7~10 日間生育させた幼苗の根部を本菌の孢子懸濁液（ 10^6 孢子/ml）に 1 時間浸漬して殺菌土に移植し、温室内（18~33 C）で育てた。罹病性品種には接種 10~14 日後に症状が現れ、葉脈えそ、葉の黄化あるいは縮葉などの典型的症状はほ場における症状と同様であり、幼苗接種法は病原性検定に有効であることが明らかになった。また 22 品種（系統）の本菌 8 菌株に対する反応から三つのレースが存在することを明らかにした。このなかでもっとも広範囲の品種（系統）を侵す race 3 を供試して幼苗接種したときの各品種（系統）の反応が、ほ場での反応と一致したことから、温室試験においても抵抗性品種選抜が可能であると結論した。