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Identification of Fusarium leaf spot(*Fusarium nivale*) newly reported in Korea

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水稻褐色葉枯病(*Fusarium nivale*)의 同定

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적 요

새로운 水稻品種 統一에 發生하는 갈색엽고병 유사증상을 發見하여 그 病斑에서 病原菌을 分離하여 그 형태를 조사하였으며 分生胞子, 病斑上에 形成하는 자낭, 자낭포자의 기재를 他硏究者들의 문헌과 比較한 結果, 이는 日本에서도 報告된바 있는 갈색엽고병임이 確認되었으며 病原菌이 *Fusarium nivale* 로 同定되었다. 또한 圃場條件下에서는 本病은 多질소구에서 그 發生이 현저히 많았음을 觀察하였고, 本菌의 生育適溫은 24°C였다.

Abstract

From the new rice variety Tong-il, disease symptoms similar to Fusarium leaf spot reported in Japan was observed in Korea. Causal organism was isolated and identified as *Fusarium nivale* causing Fusarium leaf spot through the study of conidia shape, ascus formation on diseased spot, and ascospore. These results also showed good agreement with that of other investigators. Under the field condition, marked occurrence of this disease has observed by heavy nitrogen application. The optimum temperature for the growth of this fungus was 24°C.

Introduction

Recently, acreage of a new rice variety "Tong-il" is remarkably increasing. However, greyish or dark brown discolored spots together with yellowish-red physiological discoloration called Jyok-ko-byung were observed in "Tong-il field at Kimpo and Keumgok KAERI experimental farm in 1971. From the diseased lesions, fungus was isolated and the disease turned out to be similar to Fusarium leaf spot which is reported in Japan as Katshoku-Hagare-Byo, in Latin America[1] as leaf scald, and in Southeast asian countries.

There was no report so far concerning this fungus in Korea. While, Tomohisa[2] and Ahn *et al.*[3] reported this for the first time and subsequently Hashioka and Ikegami[4] named this disease rice leaf scald. Recently Kitani and Ohhata[5] and Koshimitzu *et al.*[6] have also reported this disease and Dominaga[7] identified this fungus as *Fusarium nivale* in Japan. Therefore, this experiment was conducted to identify the fungus isolated from the diseased lesions showing above described symptoms in a new rice variety "Tong-il".

I. Observation of disease symptom under field condition

This disease different from stifle disease, Jyok-ko-

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byung, was first observed in August 1971 in Kimpo, where KAERI experimental farm was located. The symptoms become distinct from the beginning of August showing big irregular circle of greyish brown and dark brown bands starting from tip or edges of the leaves. As the disease progresses, the lesions are enlarged and coalescing together. Sometimes the upper half of the entire leaf may become affected showing dirty discoloration. In case of mild symptom, reddish brown small spots are progressed along the vein. A long elliptical or rectangular and purplish black necrotic spots are formed between veins on the leaf sheath. The circumference of the spot turn to light purplish brown and to light grey later. As the disease progresses, spots are enlarged, the entire sheath turning purplish brown. Disease spots on neck of panicle is similar to that of sheath: a lot of purplish brown and faint spots are formed and then they surround entire neck showing neither clear spots like a neck blast nor distinct streak like a Helminthosporium blight(See photos 1 and 2).

This disease has markedly occured especially at the margin of the leaves after heading. In the year 1971, "Tong-il" cultivated at Kimpo showed a distinct disease occurrence, nevertheless only poor development of the disease was observed in a native variety "Poong-Kwang" under the same field condition. And also heavy application of nitrogen fertilizer made the disease severe. On the contrary it seems to be no significant relation with silicate fertilizer application(Table 1.). In 1972, the variety "Tong-il" was slightly suffered with this disease. These results imply that the occurrence of this disease greatly rely on year and variety together with the amounts of nitrogen fertilizer application.

Table 1. Estimation of leaf blight caused by *Fusarium nivale* after heading in the variety Tong-il grown at Kimpo experimental field in 1971.

Si-level / N-level	kg/ha Si-0	kg/ha Si-300	kg/ha Si-600
N-10 kg/ha	+	+	+
N-15	+++	+++	++++
N-20	++++	+++	+++—++++

\+ : few leaves with typical cloud-shaped lesions.
++ : several leaves with cloud-shaped lesions.
+++ : many leaves with cloud-shaped lesions.
++++ : disease severely occured and shows poor panicles.

II. Shape and formation of conidia

Conidia which have one septum or absolutely not is pyramidal, a slightly curved, and hyaline (Photo 3). With regard to conidiashape, our experimental results was compared with that of other investigators and represented in Table 2. Until now microconidia was not reported. Our results concerning number of septum, sporodochia production, and single or grouped conidia on conidiophores are well agree with that of other investigators(Photo 4). As shown in Table 2, width of conidia were more or less identical in their results, but average length of the conidia was a little shorter.

Table 2. Comparison of characteristics of conidia investigated by three different workers.

Name of workers	Length and width of conidia	Septa	Formation from conidiophore
YAMAGUCHI. KWON	4.0—18.0×2.0—4.8 (9.0×3.4)	0—1	Single
HASHIOKA. IKEGAMI	8.6—13.5×3.1—3.7 (11.1×3.3)	0—1	Single or Many
KOSHIMITZU. NAITO	8.0—19.2×2.4—4.8 (12.0×3.7)	0—1	Single

Growth of aerial mycelia on artificial media were vigorous showing white to pink color, and the aerial mycelia diminish later. Usually after one or two weeks salmon pink slime mass are produced sporadically on the colony. Slime mass is a gathering of conidia and sometimes a whole colony is covered by it. By transfering spores to media, only slime mass produced although aerial mycelium develops slowly. There is almost no conidia formation on the dry diseased spots of leaves, but if it is kept in moist chamber for one day, conidia are formed.

III. Perithecium on diseased leaves

Perithecium formation were observed from dead diseased spots and it is dispersedly formed between secondary veins and submerged under the epidemic tissue

Table 3. Comparison of observation of perithecia, ascus and ascospore.

Subjects \ Investigators		YAMAGUCHI. KWON	KOSHIMITZU. NAITO
Perithecia	Formation	in the tissue, scattered at every parts	in the tissue, scattered between secondary viens.
	Shape, colour	globular, dark brown	Same
	Size	47−182×38−176	52−181×52−147
Ascus		club shape, straight or slightly curved, 8 spores arranged in a single row	spores layed in a single row or irregularly
Ascospore		spindle shape, hyaline or olive, septa 3-4, 9−29×3−9	Same 11−27×4−8

(Photo 5). Eight ascospores are contained in a ascus. The spores having 3-4 septa are hyaline or occasionally olive in color. Comparision of our observation with that of Koshimitzu *et al.* [6] regarding perithecium and ascospore are shown in Table 3.

The perithecia are formed under the epidemic cells and they were scattered throughout the diseased area. Koshimitzu *et al.*[6] pointed out that they are formed between secondary veins. However, it was not clear with our observation. Nevertheless, it showed good agreement in shape and color, and size of perithecium. If the perithecium absorb water, the asci are oozed. The shape of ascus which is linear or a little curved is similar to a club and eight ascospores are linearly arranged in it(Photos 6 and 7). But Koshimitzu *et al.* asserted that ascospores are arrayed irregularly. Pyramidal ascospores are ejected from the ascus and it has 3 to 4 septa. In shape, good agreement with the report made by Koshimitzu *et al.* was shown.

From these results, this isolate clearly belong to Ascomycetes and the imperfect stage is thought to be *Fusarim nivale*. On the perfect stage, Koshimitzu *et al.* proposed that it belongs to the genus *Phragmaspherma*, while Tominaga[7] suggested as *Micronectriella*. Confirmation to this confusion would ce expected in future depending upon decision of taxonomist.

IV. Relationship between Fusarium leaf spot fungus and temperature.

To clarify the relationship of this fungus growth with temperature, this fungus was cultured on PDA media. Then, after full development, a portion of colony(3mm in diameter) was taken with cork borer and transferred to another PDA media. The inoculated media are kept for an adequate time at different temperature. The colony was measured and the results are indicated in Fig. 1.

The optimum temperature for this fungus was around 24°C. By increasing temperature up to more than 27°C the growth of colony was significantly reduced. Especially high temperature of above 33°C caused suspension of growth(Photo 8). Therefore it is assumed that this fungus is actively developing at the end of August or in the year of low temperature.

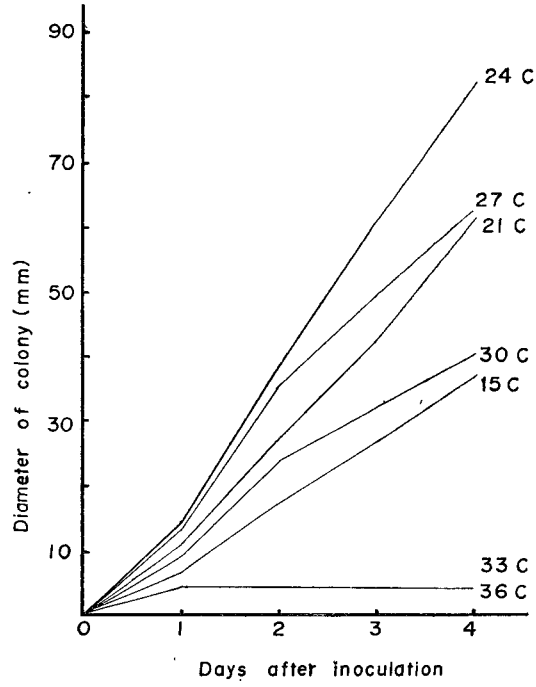

Fig 1. Mycelial development of *Fusarium nivale* at several different temperatures.

V. Discussion

In 1971, diseased portions similar to Fusarium leaf spot were collected from new rice variety Tong-il at KAERI experimental farm. Through the processes like fungus isolation from the diseased parts, inoculation, and reisolation, the pathogenicity was confirmed. Depending upon the disease symptom and characteristics of fungus, this disease is considered to be Fusarium leaf spot prevailing in Japan, Latin America and South East Asia and the fungus is identified as *Fusarium nivale*. The scientific name for the perfect stage is not established, notwithstanding finding of perfect stage, *Fusarium nivale*. This is because there is a controversy on this subject among Japanese taxonomist and the settlement is expected in future.

This disease has occured severely in variety Tong-il, while slightly in other Korean native varieties. Therefore it is confirmed that there are varietal differences in resistance to this disease and also this finding coincides well with the reports in Japan. Furthermore in Thailand it severely occurs in IR-8 which is mother variety of Tong-il. This fact gives warning to expansion of cultivation area of the new variety Tong-il.

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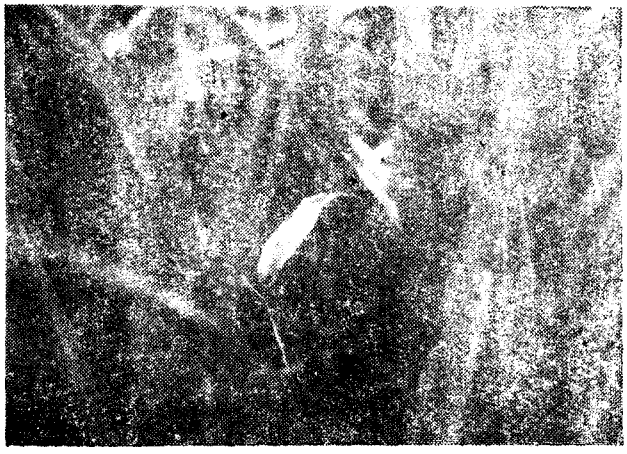

Photo 1. Fusarium leaf spot(*Fusarium nivale*) symptom under field condition.

Photo 2. Fusarium leaf spot(left). Physiological discoloration called Jyok-ko-byung(right).

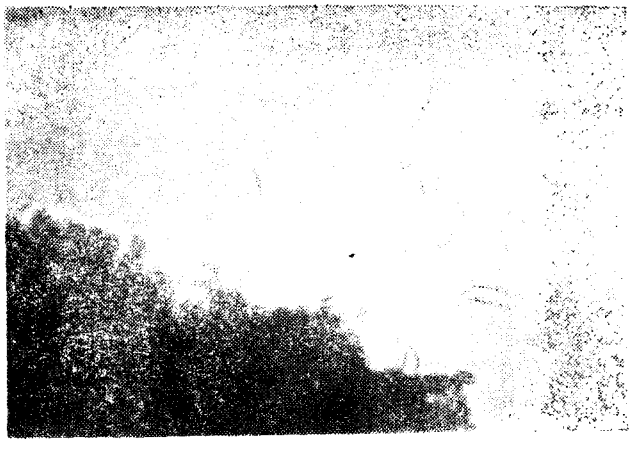

Photo 3. Conidia released from the diseased portions of Fusarium leaf spot.

Photo 4. Spores of *Fusarium nivale* foun don the diseased spots.

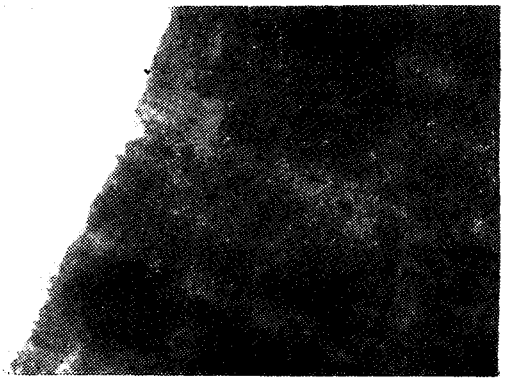

Photo 5. Perithecium of *Fusarium nivale* are formed between secondary veins on diseased spots and submerged under the epidemic tissue.

Photo 6. Perithecium of *Fusarium nivale* By absorbing water, the asci are released

Photo 7. Ascospores of *Fusarium nivale* released from ascus.

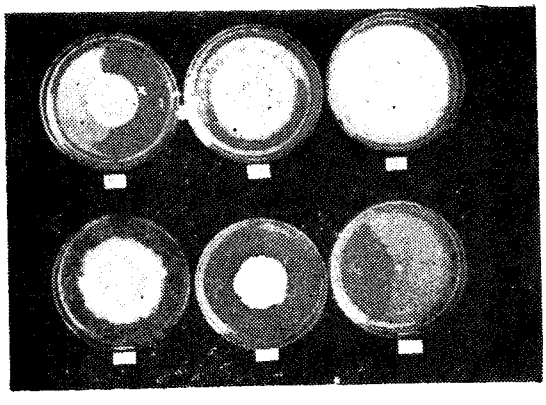

Photo 8. Development of colony(*Fusarium nivale*) at different temperature.