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Soil-borne Diseases of Barley in Korea Caused by *Fusarium spp.*

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韓國에서의 Fusarium菌에 依한 보리의 土壤傳染性病

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ABSTRACT

Fusarium spp. were isolated from field grown rice, wheat and barley in 1976. The pathogens isolated included *Fusarium* (*Calonectria*) *nivale*, *F.* (*Gibberella*) *moniliforme* and *F.* (*Gibberella*) *roseum* 'Graminearum' and 'Avenaceum'. Among the saprophytes *F.* (*Nectria*) *episphaeria* was isolated. In each of these isolated both the Fusarium and perfect stages were found.

F. nivale, and *F. episphaeria* with there Calonectria, and Nectria stages do not seem to have been recorded previously in Korea.

Of the Fusaria isolated, 66.3% from rice were *F. moniliforme*, and 68.2% from wheat and barley were *F. roseum* 'Graminearum'. Perithecia also were produced under laboratory conditions. *F. moniliforme* was recovered wheat heads and also from barley seed.

INTRODUCTION

Two of Korea's major crops are rice and barley. These are often grown in rotation throughout the ır in the southern part of the country. Therefore, re is an unusual opportunity for the maintenance accumulation in the field of certain pathogens which ıck both crops.

Diseases common to both barley and rice include n rots incited by *Fusarium* and *Helminthosporium*, ıe of which also infect the seed. As might be icipated, soil borne diseases are prevalent in these other Korean crops, yet few studies or reports ve been made on them.

Many fields of barley and rice appear from their top-growth to be healthy. But upon digging these plants many are found to be infected with root and stem diseases. Superior new varieties can not be expected to yield the quality and quantity of seed to their full potential when the roots and underground stems are partially rotted.

Collections of barley plants made throuhout the season show clearly that the below-groun parts were often severely damaged, with an obvious impact upon yield.

The purpose of the 1976 study of below-ground pathogens was to confirm their identities of pathogenicities and perfect stages.

MATERIALS AND METHODS

Healthy-appearing barley plants were collected at random from a number of fields, at different periods of growth and taken to the laboratory for immediate study. They were examined perior to washing, then washed and cultured in a variety of ways. Some were surface disinfected by a one minute dip in 1% sodium hypochlorite solution, and all were cultured on Water Agar, acidified Potato Dextrose Agar, and the Nash PCNB Agar selective medium for isolating *Fusarium*, of simply in water.

All were incubated out-of-doors at a north window.

Collections of obviously diseased plants also were made and cultured similarly.

The stubble and crop debris of the previous season were collected in some barley fields and checked in the laboratory for the presence of possible pathogens. Frequently stems of cron or of rice were found in barley fields, with perithecia of *Gibaerella* alive on them. The species identities of these were determined by their culture on agar, or by their ascospores.

Seeds of barley and of other crops were occasionally cultured for seed-borne pathogens.

Inoculation tests were made of expected pathogens by spraying plants in the field with spores produced in culture, by introducing the fungus into the soil before planting or by direct insertion of fungus into the stem.

RESULTS AND DISCUSSION

Fusarium spp. were isolated from field-grown rice, wheat, and barley. (Tablel) *F.nivale*, and *F.episphaeria* (a saprophte) were found with perithecia. Many saprophytic members of *F. roseum* were present as secondary organisms on the roots of cereals, including *F. esphaeria* and its perfect state, *Nectria episphaeria*.

Table. 1. *Fusarium spp.* isolated from roots or stems of barley and rice during the 1976 season.

Barley		
Fusarium roseum	'Graminearum'	plus 'Gibberella State.
〃	〃 'Avenaceum'	
〃	*moniliforme*	
〃	*nivale*	plus 'Calonectria state
Rice		
Fusarium moniliforme		plus Gibberella state
〃	*roseum* 'Graminear'	plus Gibberella

Among *Fusarium* spp. shown in Table 2, the percentage of *F.moniliforme* was shown to 63.3% on seed, root and seedling of rice and that of *F.roseum* 'Graminearum' to be 68.2% on stem, root and head of barley and wheat.

Brodfoot(3), Bruehl(4), and Snyder (12) confirmed that the Graminearum cultivar of *F.roseum* LK. emend. Snyd. & Hans. f. sp. *cerealis*(cke) causes head blight as well as root and stalk rots of a wide variety of cereal crops.

F. moniliforme (noted as parasites of rice and corn produces perithecia belonging to the genus *Gibberella*.

F. roseum 'Graminearum' also found on rye head and Triticale heads.

F. roseum 'Avenaceum' was isolated from barley stems. Many Kernels on the plants showed mild symptoms of scab and on agar media. R.James Cook(5) reported that head blight with pinkish sporulation developed within 1~2 weeks on all inoculated heads.

F. moniliforme was found on roots and stems when barley or wheat were grown on rice lands. Accordi to Sung(12) prior abundant perithecia of the Gibberella state, *Gibberella moniliformis* were observed a harv on dying rice, accounting for some of the wide spr inoculum present on seed.

F. nivale occurred frequently on the earliest ro and stems of wheat and barley, with its perfect st *Calonectria*. Early in the growing season cereals w exposed to very much rain, and very cool weat favorable to this pathogen.

Gibberella perithecia were observed in the field infected refuse from the previous season as follows: corn stems, 5 rice stems 4 barley stems, 5 wheat ste 5 rice seeds, 10 wheat heads, 10 barley heads as sh in Talbe 3.

Collections of stubble showed the presence of *Gi rella* perithecia. After washing and incubating stuble, the perithecia matured rapidly and in n cases yielded the 3-spetate ascospores representativ *Gibberella rosea 'Graminearum'* (Syn.*G. zeae*). Th when cultured. produced colonies of *F. roseum* 'Gr nearum'. *Calonectria* perithecia were observed on ir ted refuse from barley sheaths.

Table. 2. Percentages of *Fusarium* spp. recovered from cereal crops during the 1976 season

	No of plants tested	*F. roseum* 'Graminearum' No. isolated	Perith.	*F. moniliforme* No. isolated	Perith.	*F. roseum* 'Avenaceum' No. isolated	Perith.	*F. nivale* No. isolated	Perith.
Rice seed	10	4	40	5	50				
Rice seedling	10	—	—	8	80				
Rice root	10	2	20	6	60			1	
Average			20		63.3				
Barley stem	28	15	53.6	3	10.6			5	
Barley root	70	25	35.7			1			
Barley head	30	28	93.3			2			
Wheat head	32	29	90.6			3			
Average			68.2						
Rye head	4	4	100						
Triticali	4	4	100						

Fusarium (*Calonectria*) *nivale* was common but eviously unrecognized as an early pathogen of barley in Korea. (Baker and Snyder (1), Sung and Snyder (13) (14).

Table. 3. Observation of perithecia formed on hosts in the field

Host name	No. of observed	Formed perithecia	Perfect stage	Imperfect stage
Corn stem	10	+	*Gibberella*	*F.roseum* 'Gram'
Rice stem	5	+	〃	〃
Barley stem	4	+	〃	〃
Wheat stem	5	+	〃	〃
Rice seed	5	+	〃	〃
Wheat head	10	+	〃	〃
Barley head	10	+	+	〃
Barley sheath	5	−	*Calonectria nivalis*	*F. nivale*

Table. 4. Formation of perithecia in the laboratory

Host name	Formation of perithecia	Perfect stage	Imperfect stage
Barley stem	+	*Gibberella*	*F. roseum* 'Graminearum'
Boiled barley	+	〃	〃
Boiled rice	+	〃	〃
Carnation leaves	+	〃	〃
Rice seed	+	*Nectria episphaeria*	*F. episphaeria*

n the laboratory(Table 4) perithecia were formed on host and on water agar. In addition perithecia were readily formed on barley stems, carnation leaf and rice seed. *Gibberella rosea* 'Graminearum', boiled barley-

rice and rice stems and seed. The above results coincided with those of Booth (2) and Snyder (10) who showed that strains that will form perithecia on wheat straw in flasks from singly-spore cultures and perithecia of *Nectria episphaeria* may be produced in the laboratory. There was no differences between the perithecia produced in the laboratory and those from nature in either shape or color.

Also the Gibberella state was found on stems and heads of barley and wheat in many fields. It was reported that in the Makpo district in July wheat fields showed "100 percent infection with scab" after several days or rain.

The identification of the *Fusaria* in these collections was verified in the laboratory and the *Fusarium* states obtained in culture.

It was evident from these observations that *Fusarium roseum* 'Graminearum' with its perfect state *Gibberella* is major pathogen on cereals in Korea, causing root and stem rot, as well as head blight (scab) during periods of wet weather. The lack of farm sanitation provides ample air-borne ascospores as primary inoculum from infected debris of the previous season's crops. This was observed in the current season's crops. This was observed in the current season's crops of barley, wheat and rice.

Seeds for commercial sowings of barley and rice also showed high counts of these and other pathogens.

Wheat heads inoculated with *F. roseum* 'Graminearum' were compeltely infected and showed much sporulation on the heads. Infected heads turned a pinkish color but *F. moniliforme* did not develp on all heads only on occasional seed. Infected grains were plated on P.D.A. and after a week showed sporulation of the respective fungi.

Week-old seedlings were inoculated with *F. roseum* 'Graminearum' and *F. moniliforme*. Specimens were collected from the check and from inoculated beds and cultured on P.D.A. agar. Roots of seedlings inoculated with *F. roseum* 'Graminearum' showed a reddish color on the agar and produced *Fusarium roseum* is generally considered to be of primary importance as cereal root rot pathogens. Plants inoculated with *F. moniliforme* showed the usual microconidia in chains for this fungus and its typical macroconidia. Checks were cultured and some showed the presence of spores of *F. roseum* 'Gibbosum' (a saprophyte).

This test showed that *Fusarium moniliforme* is able to infect barley seedlings.

摘　　要

Fusarium spp가 1976년 포장에서 채집한 벼밀 보리에서 分離되었다. 病原性이 있는 것은 *Fuarium*(*Calonectria*) *nivale*, *F.*(*Gibberella*) *moniliforme*와 *F.*(*Gibberella*) *roseum* 'Graminearum'과 'Avenaceum'이었다. 부생균가운데 *F.* (Nectria) episphaeria가 분리되었다. *Fusasium* 시대와 완전시대가 발견되었다.

*F. nivale*와 *F. episphaeria*의 完全時代인 *Calonectria Nectria*가 發見되었고 이것들은 한국에서 報告되지 않은 것으로 보인다.

分離된 Fusaria는 벼에서 66.3%가 *F. moniliforme*이고 보리, 밀에서 68.2%가 *F. roseum* 'Graminearum'이었다. 자낭각은 실험실 조건하에서 형성되었고 *F. moniliforme*는 밀이삭, 보리씨에 접종한 結果 病原性이 나타났다.

LITERATURE CITED

1) Baker, K.F. and Snyder W.C. 1965
Ecology of soil-borne disease plant pathogens, prelude to biological control.
California Univ. press, BerKeley 571p

2) Booth, C. 1971
The genus *Fusarium*.
CMI Institute Kew Surry 237p

3) Broadfoot, W.C. 1934
Studies on foot and root rot of wheat IV Effe of crop rotation and cultural practice on the r lative prevalence of *Helminthosporium sativu* and *Fusarium* spp. as indicated by isolation frc wheat plants. Can. Jour. Res 10:115~124

4) Bruehl, G.W. and Phill Lai 1965
Prior-colonization as a factor in the saprophy survival of several fungi in wheat straw.
Phytopathology 56:766~768

5) Cook, R.J. 1967
Gibberella avenacea sp. n, perfect stage of *F arium roseum* f. sp. *cerealis* 'Aveanceum'.
Phytopathology 57:732~736

6) Dickson, J.G. 1923
Influence of soil temperature and mositure on

development of the seedling blight of wheat and corn caused by *Gibberella scabinettii.* Jour. Agr. Res.(U.S.) 23:837~870

7) HAAIV, I.T. De 1937.
Untersuchengem "Uber pas A auftereten der Keimlings Fusariose bei Gerete, Hafer, Maisund Reis. Phytopathology Z. 10:235~305

8) Johnston, C.L., and F.L. Greaney, 1942
Studies on the pathogenicity of Fusarium species associated with root rot of wheat.
Phytopathology 32:670~684

9) Nisskado, Y ,and Masumoto. H. 1933
Studies on the physiological specialization of *Gibberella fujikuroi*, the causal fungus of the rice-bakanae disease. Transaction of the Tottoria Soc. of Agr. Science, 4:200~211

10) Snyder, W.C.and T.A Toussoun 1955
Current status of Taxonomy in *Fusarium* species and their perfect stages.
Phytopathology 55(8)833~837

11) Snyder, W.C.,H.N. Hansen and J,W. Oswald, 1957
Cultivars of the fungus *Fusarium.*
J. Madras Univ. 27:185~192

12) Sung, J.M. and Snyder, W.C. 1976
Bakanae disease of rice in Korea (in press)

13) Sung, J.M. and Snyder, W.C. 1976
Fusarium (*Giaberella*) *roseum* on cereals in Korea, 1976(in press)

14) Sung, J.M. and Snyder, W.C. 1976
Fusarium(*Calonectria*) *nivale* on barley in Korea during 1976(in press).

15) H.L. Warren and Thor Kommedahl
Prevalence and pathogenicity to corn of *Fusarium* species from corn root, rhizosphere and soil.
Phytopathology 63:1288~1290