Studies on Pathogenicity of Wheat Scab Fungus (*Gibberella zeae*) to Various Crop Seedlings

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Summary

1. Purpose of this experiment is to investigate the influence of wheat scab fungus(*Gibberella zeae*) remaining in soil or residues of infected plants to the growth of the seedlings of 14 different crops.

2. Susceptibility of these crops to the infection by *G. zeae* was investigated by planting these crops both to the artificially inoculated soils and naturally infected soils where both serious and light wheat scab epidemic have occurred previously.

3. In artificial inoculation tests, barley, wheat, rye, soybean, rice, buckwheat, corn, cotton and greenbean has shown susceptible reaction, while indianbean, sesame, sorghum, chinese cabbage and radish has shown resistant reaction.

4. In artificial inoculation tests, there was significant difference in the germination ratio of the susceptible crops between the plants planted in inoculated soils and uninoculated soils with the exception of rice, corn and cotton. Preemergence seedling blight was confined only to barley and corn, whereas postemergence seedling blight was confined to rye, wheat, rice, buckwheat, barley and corn. In most of the susceptible crops secondary roots were almost rotted and the primary roots were either partially rotted or discolorated in inoculated soil. There was significant difference in the stem length of the plants grown in inoculated soils and uninoculated soils in susceptible crops.

5. No infection by *G. zeae* was observed when wheat, barley and rye plants were sown to the soils where both serious and light wheat scab epidemic occurred naturally.

Introduction

In 1963, wheat scab fungus, *Gibberella zeae*, caused serious damages on barley, wheat, and rye in Korea. It was the first report of great epidemic of wheat scab in this country although the disease was recognized previously with less destructiveness and attention. In gereral, mycelium, conidia and ascospores of *G. zeae* are carried over on infected kernels and sown the following season to cause seedling blight when wheather conditions are favorable. Seedling blight occurs either when scabbed kernels are used as seed or when poor seed of unadapted varieties are sown in infested soil. The fungus attacks the seedling during and following germination of the host seeds.

In Korea, it is known that conidia and ascospores are blown massively from latter part of April to early part of May. Unfortunately this period coincides with the heading seasoon of barley, wheat and rye. Thus when the weather conditions are favorable the disease occurence may be increased, and likewise its damages are also destructive. Furthermore, the fungus left over either in soil or infected residues will become the active cause of serious damage in successive crops. Therefore, the author intended to investigate the pathogenicity of *G. zeae* on seedlings of barley, wheat, rye and their successive major crops. On the other hand, it is also aimed to find an effective control measure based on afore-mentioned correlation between fungus and various crop seedlings.

Materals and Methods

(a) Artificial Inoculation Tests : 14 species of crops were used in this experiment. They were barley(Kwanchigi

No 1), wheat(Nonglim No 1), rye(Joius jokioinen), corn(Whangkok No 1), soybean(Hamandelip), greenbean(Deabaiknokdu), indianbean(Pajoojukdu), cotton(Suwon No 1), rice(Paldal), buckwheat(Local var.), radish(Paiksugoongung), chinese cabbage(Kyungdo No 3), sorghum(Moktak) and sesame(90 days sesame). These crops were obtained from the Division of Agronomy, Office of Rural Development, Suwon Korea.

G. zeae isolated from barley(Kwanchigi No 1) by single spore isolation was cultured on sterilized barley-wheat mixture in Erlenmeyer flasks. After 10 days of growth the culture was fragmented by Waring Blendor and mixed with sterile soil in pots. Seeds of barley, wheat and rye were disinfected by the hot water treatment method and seeds of remaining crops wer surface-disinfected by soaking in alcohol(70 per cent) for one minute prior to the planting in each pot. The pots were placed in a greenhouse of approximately 20~28°C. And each pots were covered with polyethylen film to maintain saturated moisture.

Notes were taken for all crops at 15 days after planting(except rice which was taken notes 25 days after planting) for their growth condition, stem length, pre-and postemergence seedling blight and germination ratio.

(b) Natural Infested Soil Tests: Barley(Kwanchigi No 1), wheat(Nonglim No 12) and rye(Joius jokioinen) varieties which were known to be susceptible to wheat scab fungus were used in this experiment. The soil samples were obtained from two different localities, one from Jinjoo, Kyungnam province where wheat scab epidemic was serious in 1963, and other from Suwon, Kyunggi province where the disease was less severe in the same year. The method used in this experiment is similar to the afore-mentioned artificial inoculation test except that the soil was not artificially inoculated, but naturally infested one.

Experimental Results

(a) Artificial Inoculation Tests: The influence on the seedling and the germination of various plant seeds which were sown to the artificially inoculated soil by *G. zeae* shown in Table. 1.

Table 1. Influence of Gibberella zeae on various crop seedlings.

Crop	Treatment	No. of planted seed	No. of germinated seed	No. of seedling blight		Stem length
				Preemergence	Postemergence	
barley	I.S. 1	120	35(29.3%)	2	5	5.1(cm)
	U.S. 2	〃	75(62.5)**	0	0	6.6*
wheat	I.S.	〃	4(3.3)	0	0	1.5
	U.S.	〃	72(60.0)**	0	0	10.9**
rye	I.S.	〃	2(1.7)	0	2	5.6
	U.S.	〃	47(39.2)**	0	0	15.7**
soybean	I.S.	〃	0(0.0)	—	—	—
	U.S.	〃	105(87.5)	0	0	8.1
rice	I.S.	〃	120(100.0)	0	32	15.8
	U.S.	〃	120(100.0)	0	0	26.1**
corn	I.S.	〃	116(97.8)	0	5	13.6
	U.S.	〃	116(97.8)	0	0	20.9**
greenbean	I.S.	〃	102(85.0)	0	5	7.3
	U.S.	〃	112(93.3)*	0	0	9.5*
cotton	I.S.	〃	117(97.5)	0	0	6.6
	U.S.	〃	104(86.7)	0	0	7.2*
buckwheat	I.S.	〃	87(72.5)	0	22	7.7
	U.S.	〃	98(82.7)**	0	0	8.9*
indianbean	I.S.	〃	110(90.1)	0	0	10.7
	U.S.	〃	109(90.1)	0	0	10.3
sesame	I.S.	〃	79(65.8)	0	0	3.8
	U.S.	〃	72(60.0)	0	0	3.2
sorghum	I.S.	〃	52(43.3)	0	0	8.3
	U.S.	〃	50(41.7)	0	0	11.7

						*
chinese cabbage	I.S.	〃	103(85.0)	0	0	—
	U.S.	〃	103(85.0)	0	0	—
radish	I.S.	〃	59(49.1)	0	0	—
	U.S.	〃	64(53.3)	0	0	—

1) I.S.; Inoculated Soil. 2) U.S.; Uninoculated Soil.

As shown in Table 1, there was significant difference in the germination ratio of barley, wheat, rye, soybean, rice, corn, greenbean, cotton and buckwheat seedlings between inoculated soils and uninoculated soils. Ungerminated seeds of these crops due to the fungus were also scored in large amount. Soybean seeds were completely infected before germination and a lump of mycelium was visible the ungerminated rotten seeds. But the influential attack of *G. zeae* before germination was not serious in rice, corn and cotton preemergence seedling blight occured only on barley and corn, whereas postemergence seedling blight occurred on barley, wheat, rye, rice, corn, greenbean, buckwheat. In regarding these data, rye and barley were seriously attacked at seedling stage, but the remaining crops had grown to certain extent once they germinated. Both pre-and postemergence seedling blight on cotton was invisible, although the secondary roots were rotted and the primary roots were discolorated in inoculated soils. Root system of blighted seedlings of these crops was completely rotted, and even the root system of healthy plants was disordered in inoculated soils(plate 1). There was considerable difference in the growth condition between the plants planted in uninoculated soils and inoculated soils. The difference in stem length between the plants planted in the inoculated soils and uninoculated soils was statistically significant. Plants growing in the uninoculated soil showed healthy, green color while plants in the inoculated soil were light brown.

G. zeae was apparently not influential to indianbean, sesame, sorghum, chinese cabbage and radish. The disability of germination of these plant seeds seemed not to be caused by *G. zeae* since no fungus was isolated from the ungerminated grains that were planted in the inoculated soils and also the root system was free from the infection of the fungus.

Plate 1. Comparison of barley *seedlings grown in uninoculated* soil(control) and inoculated soil (treat).

(b) Natural Infested Soils Tests : An experiment was performed in order to study the influences of naturally infested soil to the growth of successive crops. The result was shown in Table 2.

Crop	Treatment	No. of planted seed	No. of germinated seed	No. of seedling blight		Stem length
				Preemergence	Postemergence	
barley	S [1]	120	97(80.8%)	0	0	6.72(cm)
	L [2]	〃	99(82.5)	0	0	8.26
	C [3]	〃	103(85.8)	0	0	8.00
wheat	S.	〃	102(85.0)	0	0	9.84
	L.	〃	101(84.2)	0	0	11.82
	C.	〃	101(84.2)	0	0	11.79
rye	S.	〃	85(70.8)	0	0	11.99
	L.	〃	82(68.3)	0	0	11.78
	C.	〃	81(67.7)	0	0	11.09

1). S: Sample soil where wheat scab have occurred Serious.
L: Sample soil where wheat scab have occurred Lightly.
C: Serile soil for Check.

In this experiment, there was no significant difference of the germination ratio, pre-and postemergence seedling blight of barley, wheat, and rye crops grown in each soil samples. *G. zeae* was not isolated from the ungerminated grains.

The difference in stem length of plants growing in each sample soil was insignificant. The root system of the above listed crops remained healthy and *G. zeae* was not isolated from the root.

Discussion and Conclusion

This experiments shows the fact that many ungerminated grains were due to *Gibberella zeae*. Infected seedlings were in general small, blighted, or chlorotic due to root rot and developed poor root system in inoculated soils. This results agree with that of other workers in their previous experiments of barley [9,14,15], wheat [1,2,3,6,11,13,15], rye [9,17], rice [5,7,10], and corn [11,16,18,19].

Franco[4] described that the cotton was infected by *G. saubinetii*. However, according to this experiment, the cotton root showed some development of root rot but no seedling blight resulted.

No previous reports on the disease of soybean and greenbean caused by *G. zeae* were available. Miyake found that *G. zeae* was a causal fungus of wilt disease of horsebean and morsebean, and that infection occurred in the late spring in bean crops succeeding irrigated rice. In this experiment soybean was infected by 100 per cent before germination and in the greenbean, infection occurred both before and after germination. Thus the seedlings of soybean, greenbean, horsebean and morsebean are considered susceptible to *G. zeae*. In this experiment, however, indianbean showed resistant reaction to the fungus. But more study is necessary to make it clear whether it was brought by the characteristics of indianbean itself or the physiologic races of the fungus.

MacInnes and Fogelman[8] reported that the radish was susceptible to *Gibberella saubinettii* when it was planted in the soil which was inoculated with wheat scab organism. Lutterll[12] has succeeded to isolate *Gibberella saubinetii* from sorghum grains. However, in this experiment, these varieties were shown to be resistant to *G. zeae*. Therefore further experiment and studies are necessary in regard to varietal differences in the resistance of sorghum and radish.

Many reports are available on the infection of various crop seedlings by *G. zeae* in naturally infested soil. In this experiment, however, no infection by *G. zeae* was observed when wheat, barley and rye were sown to the soils where both serious and light wheat scab epidemic have occured in the same year. It admits further research on the intensity of the *G. zeae* left over in soil, environmental conditions, and both physical and chemical natures of soil or antagonism concerning to the development of wheat scab fungus.

摘 要

1. 本試驗은 罹病된 植物의 殘滓物 또는 土壤中에 있는 麥類赤徵病菌(*Gibberella zeae* (Mont.) Sacc.)이 14種의 作物幼苗에 미치는 病原性을 檢定하고자 하였다.

2. 이들 作物은 病原菌을 人工的으로 接種한 土壤, 그리고 麥類赤徵病의 發生이 自然的으로 甚했던 곳과 輕했던 곳의 土壤에 供試하여 本菌에 對한 罹病性을 檢定하였다.

3. 人工接種試驗에 있어서, 보리, 밀, 호밀, 귀, 벼, 메밀, 옥수수, 목화, 녹두는 罹病性이었고 콩, 참깨, 수수, 무우, 배추 등은 抵抗性을 나타내었다.

4. 人工接種試驗에 있어서, 罹病性作物의 發芽率은 벼, 옥수수, 목화를 除外하고 接種土壤과 非接種土壤에 있어 顯著한 有意差가 있었다. 芽時前立枯는 보리, 옥수수에서만, 芽時後立枯는 호밀, 밀, 벼, 메밀, 보리, 옥수수에서 일어났다. 罹病性作物의 大部分은 第2次根이 거의 腐敗하였고 第1次根도 腐敗 乃至 變色되어 있었다. 罹病性作物은 草長이 接種土壤과 非接種土壤에 있어 顯著한 有意差가 있었다.

5. 自然狀態에서 麥類赤徵病의 發生이 甚했던 곳과 輕했던 곳의 土壤에 보리, 밀, 호밀을 播種하였으나 本菌에 依한 侵害나 影響을 發見할 수 없었다.

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