PATHOGENICITY AND IDENTIFICATION OF SOME BARLEY DISEASES IN KANSAS

by

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INTRODUCTION

Barley is sixth in economic importance among the crops of the state, and Kansas ranks tenth among the states in barley production (Swanson and Laude, 29). Barley, like other cultivated crops, is subject to many diseases. Diseases are an important factor in limitation and reduction in yield of this crop in the state.

Factors, such as root rot, seedling blight, and scab of barley, are caused by different fungi. These factors usually are related to the reduction of yield and quality of barley. The primary purpose of this investigation was to determine the pathogenicity and identification of some of these causal agents. Curvularia geniculata (Tracy and Earle) Boed., Helminthosporium sativum Pam., King, and Bakke, and Fusarium culmorum (W. A. Sm.) Sacc. are among the leading fungi which are responsible for these diseases.

The author hopes that this study may help in recognition of these different fungi and lead up to the measurements of their effects on barley.

REVIEW OF LITERATURE

Curvularia geniculata (Tracy and Earle) Boed.

Very little work has been done dealing directly with Curvularia species. According to Groves and Skolko (14), the genus Curvularia was separated from Helminthosporium by Boedijin

in 1933, because of different characters in these genera. For Curvularia the conidia usually were curved, the third cell from the base was larger and darker in color, and the end cells were hyaline. Eighteen species of Curvularia were divided into three groups as follows:

1 - Maculans

2 - Lunata

3 - Geniculata

The Geniculata group comprised species which had spores with more than three septa and with measurement of 35-40 X 8-10 u.

Henry (16) isolated several strains of a fungus which he identified as a species of Helminthosporium. His isolations were made from seeds of wheat and roots of wheat and barley. Some of the isolations were highly parasitic and produced foot and root rot on wheat, while others were weakly parasitic. Conidia from the isolations were dark, olivaceous, and usually curved, with a small, hyaline, basal cell. These spores germinated from both ends.

Hynes (17) isolated this Helminthosporium sp. from the roots of wheat, barley and oats. Some strains were extremely virulent on seedlings of wheat, oats, barley, and rye. The conidia were oblong, usually curved to a greater extent on one side than on the other, and mostly four-septate. The large central cell, or cells, were darker in color, with the terminal cells being lighter brown. The conidia germinated readily from each end in tap water and occasionally from the side of the spore. The

measurements of the spores from cultures grown on sterilized wheat heads at 20° Centigrade were varied, but the mean of 100 spore measurements was 33.6 X 13.0 u. This Helminthosporium sp. now is called Curvularia inaequlis (Shear) Boed.

Groves and Skolko (14) did considerable work on the separation of Curvularia geniculata from other Curvularia species. Their isolations were from seeds of cabbage, flax and peas. C. geniculata differed from C. inaequalis, with which it was usually confused, on the basis of the width of the spores. The spores of the latter were reported to be frequently 15-16 u wide. This was moderately wider than C. geniculata, which were mostly 11-14 u wide. Their principal conclusion was that when the length of the spore was divided by the width, it was 2.7 or 2.8 in C. geniculata, while it was frequently 2.4 - 2.5 or 2.3 in C. inaequalis. Another different feature between the two groups was that C. inaequalis was characterized by the rounded end cell, compared with the more pointed end-cells of C. geniculata. The spore measurements from the culture were (21)-28-40-(50) X (10)-11-14-(15) u, and the spores were strongly curved.

Sprague (27) recently pointed out that Curvularia geniculata was generally a common saprophyte on all parts of cereals and grasses, but he indicated that some isolations were found to be parasitic on some crops such as sorghum, crested wheat grass and oats, while these isolations were weakly parasitic on wheat in the greenhouse.

Sprague (28) gave the following key for the North American species of Curvularia on Gramineae:

A Spores sometimes with more than 3 septa.

B Spores averaging 11-14 u wide. C. geniculata

BB Spores averaging 12-16 u wide. C. inaequalis

AA Spores 3-septate.

B Spores usually less than 12 u wide. C. lunata

BB Spores wider, up to 15 u, olive brown. C. trifolii

Helminthosporium sativum Pam., King and Bakke

Spot blotch is one of the most destructive barley diseases. There have been considerable studies on the causal organism, because of the economic importance of this disease. Helminthosporium sativum causes seedling blight, black point, root rot, and spot blotch of barley, wheat, grasses, and many other cereals.

Pammel, King and Bakke (23) first reported spot blotch as a new barley disease in Iowa. They determined that Helminthosporium sativum was the causal fungus.

Bolley (4) called attention to the disease which he called "Black Point."

Johnson (18) did considerable work on the disease and suggested the common name, "Blotch disease".

Christensen (7) made a study of this disease and found that the fungus caused leaf spot, root rot, foot rot, and seedling blight on barley, rye and wheat. He reported that the fungus was widely distributed in the United States' wheat-growing area, as well as other parts of the world. Christensen also described the fungus spores and the damage which was caused by this disease.

Drechsler (12) reported the disease from 24 states. The

conidia on barley and wheat were 60-120 X 15-20 u. These measurements were comparable with those of other investigators.

Kuribayashi (19) reported the ascigerous stage of this fungus which he called Ophiobolus sativus (P. K. B.) Ito and Kuribayashi. He described the perithecia, which developed on dead host tissue on culture media, as black-walled, pseudoparenchymatous bodies, globose, or subglobose, measuring 370-530 X 340-470 u. He described the asci as numerous, hyaline, thin-walled, straight or curved with a roun apex, 110-220 X 32-45 u, containing one to eight, mostly four or eight, ascospores. The ascospores were flagelliform or filliform, with a light olive-green color, 160-360 X 6-9 u., coiled, and varying from six to thirteen septate.

Drechsler (13) recently transferred this species to the genus Cochliobolus because of the coiled arrangement of the asco-spores in the asci. Therefore, he suggested the name of Cochliobolus sativum.

Hynes (17) determined that the average size of the conidia under 24° Centigrade on potato dextrose agar was 68.8 X 23.1 u for one isolation and 69.5 X 23.0 u for another isolation.

Machacek (21) suggested "Kernel Smudge" for the disease which causes discoloration of wheat, barley and rye kernels by fungi classified in the family Dematiaceae (Moniliales - Fungi Imperfecti).

Christensen (7), Drechsler (12), and Henry (16) reported that wheat kernels infected with Helminthosporium sativum germinated poorly and produced seedling blight.

Dickson (9) found that late sowing, moisture, and temperature influence the severity of the disease on the seedling. He reported that under greenhouse conditions, wet soil and high temperatures were highly favorable for seedling blight. The optimum temperature was found to be 70° Fahrenheit.

Fusarium culmorum (W. A. Sm.) Sacc.

Fusarium blight causes pre-emergence killing, root rot of the seedling and head scab of barley, wheat, and many other cereals and grasses. Different species of Gibberella and Fusarium are reported to be responsible for this disease. Fusarium culmorum usually is confused with other species such as Gibberella zeae, Fusarium avenaceum and Fusarium equiseti. For this reason most of the early workers used the name "Scab" for these diseases of wheat and barley.

Dickson (8) assumed that these diseases caused about the same symptoms on the plant. He also indicated that the domination of one species was dependent on the geographical locality. He stated that Gibberella zeae (Schw.) Petch. was mostly dominant in the corn belt section of the United States, while F. culmorum and F. avenaceum were dominant in the Northern part of the United States and Northern Europe.

Bennett (2) reported that the difference between F. graminearum (Gibberella zeae) and F. culmorum was that the first one produced perithecia, but no chlamydospores, while the latter produced chlamydospores, but no perithecia.

Snyder and Hansen (26) combined the Roseum, Arthrosporiella,

Gibbosum and Discolor sections of the Fusaria under Fusarium roseum. The pathogenic forms which belonged to this species and attacked cereals were named F. roseum f. cerealis. However, many workers do not follow this classification (Dickson 10).

Bennett (1) reported that F. culmorum caused the wheat disease called "Thinning out", or "Deaf ear", as well as seedling blight of barley, oats, and rye.

Broadfoot (6) mentioned that both Helminthosporium sativum and Fusarium spp. were associated with foot rot of wheat. He stated that 20-60 per cent of his isolations from the wheat plants were F. culmorum.

Blair (3) observed that F. culmorum in New Zealand caused from 10-46 per cent of the seedling blight in wheat fields.

Machacek and Greaney (22) reported that F. culmorum caused a reduction in wheat yield in Canada, and pointed out the severity of the disease in that country.

Rose (24) stated that F. culmorum var. leteins was very virulant. It caused seedling blight and diseased conditions on mature plants of barley, oats, rye, and other grasses.

Walker (30) explained that F. culmorum on wheat, barley, and oat straw in the soil was a potential source of infection for the underground parts of cereal plants.

Shen (25) reported that seedling infection was favored by low soil moisture and found that infection was greater in sterilized sand or soil bed than unsterilized soil.

MATERIALS AND METHODS

Different samples of spring barley were used in this investigation. These samples belonged to two varieties, Beecher and Flynn. These samples were obtained from the Kansas State Seed Laboratory early in 1951.

Ten rows of each variety were planted in the Kansas State College Plant Pathology Nursery on April 10, 1951. Eight grams of seed were sown in each row. Isolations were made during the growing season from all parts of the plants which showed any disease symptoms.

During the last week of July, 200 heads were gathered at random on the basis of 10 heads from each row. Five seeds which showed some discoloration were taken from each head. Each group of five seeds was planted on a separate petri dish in the laboratory.

The technique of isolation from these seeds or other parts of the plant was the same. In all cases, the material was dipped in 95 per cent alcohol for 15 seconds, then transferred to the disinfecting solution.

Two different disinfecting solutions were used throughout this work. One was a 1/1000 concentration solution of mercuric chloride. The other was a full-strenght, ordinary, bleaching-powder solution which is known commercially as "Clorox". When mercuric chloride was used, it was employed for two minutes only; but, when Clorox solution was used, three minutes were the minimum

time for surface disinfection. These methods and times were shown to be the most significant. After surface disinfection, the seeds were washed thoroughly with sterile, distilled water and placed on the culture media.

Regular potato dextrose agar was the only medium used in this work. Usually plant material was left on the media for one week; then two transfers were made from each fungus growth. One of the two transfers was made to a test tube which was stored in the refrigerator during August. The other transfer was made to a new petri dish for growth and observation.

When two or more different colonies of fungi grew from one seed, they were each transferred to petri dishes and tubes. Some of the seeds did not produce any fungus growth, while the others produced one or more.

The other part of this experiment was carried on in the greenhouse during the following fall (1951). In September the stored cultures were moved under room temperature for one day, then transferred and increased on petri dishes. When the cultures had grown for two weeks, a mycelial and spore water suspension was made from each of the fungi causing a disease represented in this work. The method which was used for making these suspensions consisted of scrubbing most of the culture media from the petri dishes, then adding 100 cc of sterilized distilled water for each petri dish used. The suspension was thoroughly mixed by placing it in the Waring blender for two minutes.

A mixture of three parts of soil to one part of sand was placed in six-inch pots, and sterilized in the autoclave for

three hours, under 15 pounds of pressure.

To find out the effect of each disease on the barley seedling, 16 pots were used for every disease. For each different barley variety, four pots were inoculated with the spore and mycelium suspension, while the rest were used as checks for comparison. The dry inoculation method was used for seed infection.

Before sowing the seed, the top two inches of soil was removed, and then the seed were scattered on the soil surface.

For each inoculated pot, 100 cc of the culture suspension were used. This amount of inoculated material was divided into two parts. The first half was thoroughly mixed with soil which had been removed from the pot. The other half of the solution was poured in the pot and mixed with the soil and seeds. After that, these seeds were covered with the soil culture mixture, derived from the first half of the material. For each pot, 25 seeds were used.

To obtain an accurate result without contamination with bacteria or other fungi from the tap water or the watering facilities, distilled water was used for watering the pots for one week.

Another experiment was conducted on treated barley seed. The material for this experiment was samples of Beecher and Flynn barley seeds, obtained from the Fort Hays Experiment Station. These samples of seed were treated with the hot water treatment. A germination test was run on these seeds and it was found that only 49 per cent of the seeds germinated normally.

Data were recorded daily in the greenhouse for all the experiments.

The different species of fungi involved in this work were studied on standard potato dextrose agar, under room light and temperature. Many times Helminthosporium sativum was noticed to be more changeable in the spore size and culture color than the Fusarium culmorum or Curvularia geniculata, when temperature and light in the room were changed.

EXPERIMENTAL RESULTS

Isolation of Fungi from Seed and Other Plant Parts

From the 200 heads which were gathered from the plants in the field, 1001 colonies of fungi were obtained. Identifications of these colonies were worked as closely as possible. Table 1 shows the way in which these fungi were identified and the percentage of each group or species. Fusarium spp. were the leading fungi isolated, within this group, and it is believed that the Fusarium stage of Gibberella zeae was the most dominant. The reason was that almost 75 per cent of the heads showed some scab symptoms in the field.

From all isolations, Curvularia geniculata was obtained only 21 times, while Fusarium culmorum was obtained 79 times and Helminthosporium sativum, 58 times. Helminthosporium sativum was isolated from spots on leaves, awns, and stems also. Often this fungus was isolated in pure form from the nodal area on the stem of the plant, when it caused a discoloration of the node.

Table 1. Fungi isolated from barley heads, plant pathology nursery, 1951.

Fungus	Percentage
Alternaria spp.	13.8
Curvularia geniculata	2.1
Fusarium culmorum	7.9
Fusarium spp.	47.4
Helminthosporium sativum	5.8
Helminthosporium spp.	7.9
Unidentified fungi	15.2

Identification and Pathogenicity of Curvularia geniculata (Tracy and Earle) Boed.

The color of the fungus on potato dextrose agar under room temperature was black with some dark brown mycelia on the surface of the media. The colony was usually regular and heavily sporulated.

Conidia were brown, mostly four-septate, fusiform and varied in shape. They were straight or curved. The third cell from the base was larger in size and darker in color. Sometimes the fourth cell from the base showed also the same feature as the third cell with large size and dark color. The basal and apex cells of the spore were hyaline and mostly pointed.

However, the basal cell was more acuminate than the others. Spores which germinated on the regular media indicated that germ

tubes were produced from the two end cells only. The spores' cell walls were relatively thin in comparison with the thick walls of the H. sativum.

The spores' measurements from the culture media were found to be smaller than those described in the literature. More than 200 four-septate spores were measured and the average was found to be 29.98 X 10.86 u. Hence, when the length of the spore was divided by the width it gave about 2.76 times, which is near or similar to what Groves and Skolko (14) reported.

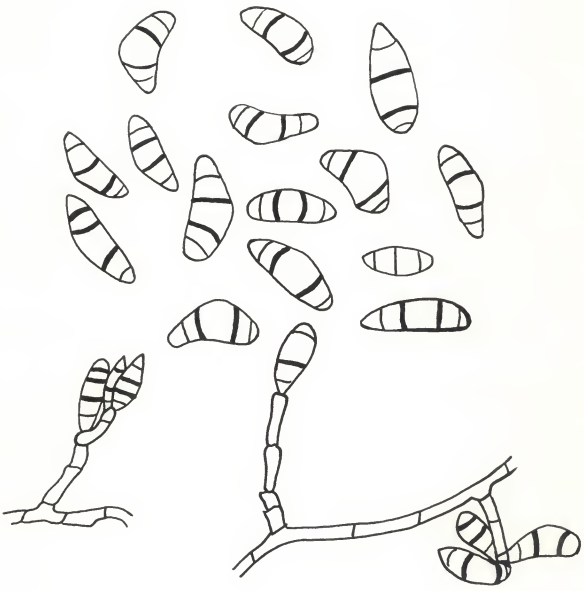
The conidiophores were dark brown, septate, simple, geniculate and varied in size, as shown in Plate I.

This disease was found to be weakly parasitic on barley seedlings and caused a root rot in the greenhouse. When the barley seedlings emerged, it was noticed that there was a yellowish-green color of the leaves with lack of vigor of the seedlings during the first two weeks after germination. The roots were destroyed, which caused the plants to be stunted due to lack of food. After two weeks, the plants started growing faster when new roots were developed, as shown in Plate II. The roots of the seedlings became dark in color and were easy to break. The empty lemma and palea of the germinated seeds became bluish-black in color. When isolations were made from these roots, the only fungus that grew was Curvularia geniculata. After three weeks of stunting, the plants all recovered and new, healthy, roots started to grow. Hence, the primary roots were the only part that was attacked by the fungus. There was no effect on the germination of the seed; neither was there any killing of the seedlings after germination.

EXPLANATION OF PLATE I

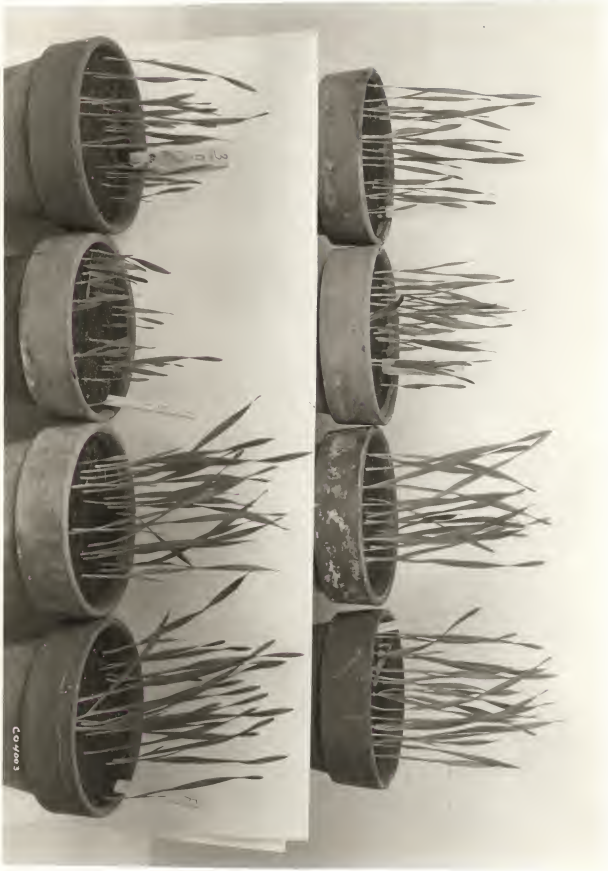
Conidia and conidiophores of Curvularia geniculata, showing the pointed end-cells, the shape of the spores, the geniculate conidiophores, and the way the spores were born.

PLATE I



EXPLANATION OF PLATE II

Pathogenicity of Curvularia geniculata. The upper row of Flynn barley seedlings shows the difference in vigor between the first two pots from the left which were infested with Curvularia geniculata and the two pots on the right, which were not infested. Similar results were obtained with Beecher barley, shown in the bottom row. The picture was taken two weeks after emergence.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Identification and Pathogenicity of *Helminthosporium sativum* Pam., King and Bakke

On potato dextrose agar, *Helminthosporium sativum* produced grayish-olive to black mycelia. The culture was not regular on the medium and did not grow fast. Usually the edge of the culture showed a light brownish ring of growth. When the culture was old, a white, aerial, sterile, compacted mycelium began to grow on the surface of the culture. The culture sporulated abundantly.

The conidia were dark brown with thick walls, usually oval or spindle-shaped, but also a different shape of spore was found. Many spores were slightly bent or mishaped.

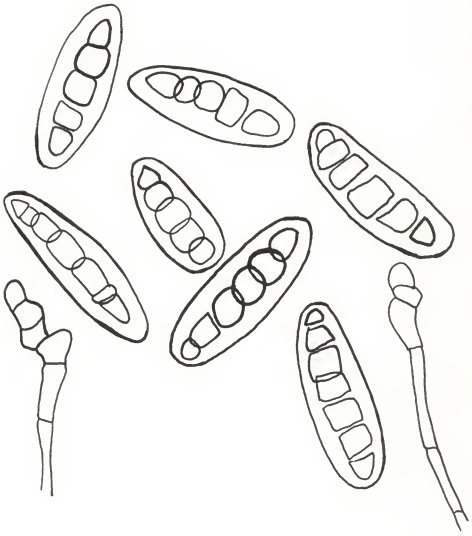
The size of the spores was also variable, even when they had the same number of septa, because of the variation from one culture to another. Most of the spores had five, six, or seven septa. The five-septate spores averaged 51.82 X 17.5 u. The six-septate spores averaged 59.2 X 19.67 u, and the 7-septate spores averaged 63.4 X 21.1 u. The basal cell of the spore usually was rounded more than the apex cell. The spore germinated readily on the potato dextrose agar. Only the end cells produced germ tubes. Spores were wider on the central portion; thus, the measurement of the width was applied to the widest area on the spore.

Conidiophores were brown in color, septate, with a short geniculate end, as shown in Plate III. The spores usually looked as if they were in a cluster, due to the shortness of the conidiophore cells.

EXPLANATION OF PLATE III

Conidiophores of Helminthosporium sativum and conidia showing the thick walled spores and the geniculate, septate conidiophores.

PLATE III



H. sativum was found to be a highly parasitic fungus on barley seedlings (Tables 2 and 3). From 200 untreated seeds, grown in soil infested with this fungus (Table 2), 168 seedlings germinated. From those which germinated, 160 seedlings had a dark basal sheath and 52 seedlings showed dark-brown, primary lesions on the leaves. Three weeks after germination, 82 seedlings had died. The seedlings which were not killed were very weak.

Table 2. Pathogenicity of Helminthosporium sativum. Untreated seeds. Greenhouse, 1951*

Variety	Pot No.	No. of seedlings emerged		Dark basal leaf sheath		Primary lesions on leaves		Plants dead 3 weeks after emergence	
		Inoculated	Check	Inoculated	Check	Inoculated	Check	Inoculated	Check
Beecher	1	23	23	23	0	8	0	11	0
	2	21	22	21	0	7	0	12	0
	3	17	20	16	0	6	0	9	0
	4	20	22	20	1	8	1**	8	0
Flynn	5	18	19	18	0	6	0	10	0
	6	21	22	21	0	4	0	13	0
	7	23	20	20	0	7	0	8	0
	8	25	22	21	0	6	0	11	0
Total		168	170	160	1	52	1	82	0

*Twenty-five seeds planted in each six-inch pot.
**The diseased plant may be due to the presence of the fungus on the seeds.

Table 3. Pathogenicity of Helminthosporium sativum. Hot water treated seed. Greenhouse, 1951*.

Variety	Pot No.	No. of seedlings emerged		Dark basal leaf sheath		Primary lesions on leaves		Plants dead 3 weeks after emergence	
		Inoculated	Check	Inoculated	Check	Inoculated	Check	Inoculated	Check
Beecher	1	8	9	8	0	3	0	3	0
	2	8	8	7	0	2	0	1	0
	3	8	9	8	0	2	0	4	0
	4	13	10	10	0	4	0	4	0
Flynn	5	12	13	12	0	4	0	4	0
	6	12	14	12	0	3	0	6	0
	7	12	11	12	0	3	0	3	0
	8	11	11	9	0	5	0	6	0
Total		84	85	78	0	26	0	31	0

*Seed treated by the modified hot-water method. Twenty-five seeds planted in each six-inch pot.

Treated seeds were low in germination (Table 3). However, from the 84 seedlings which germinated in the inoculated pots, 31 seedlings were killed. The percentages of seedlings killed, as shown in both tables, were different. For the treated seed, only 36.9 per cent of the seedlings were killed, while 48.8 per cent were killed in untreated seeds. It is possible that this difference was due to the crowding of the untreated seeds in the pots, as the treated seeds were not grown under crowded conditions. The seedlings from the treated seeds grew faster and recovered better from the disease.

The symptoms of the disease on the seedlings are shown in Plate IV. Plants were severely attacked at the ground level; dark brown spots appeared on the coleoptile area and extended to below the soil surface. Some of the seedlings' first leaves did not push out of the soil. These leaves were mishaped and rotted. Seedlings which were killed at early stages usually did not produce the central shoots.

In the seedlings that produced tillers, the killing was produced by rotting of the central shoot, followed by the rotting of the coleoptile area at the soil level. Leaves of the infected seedlings were shorter with a darker green color than those of the healthy plants. Usually they had straight margins, which gave the appearance of more width than was normal.

In many cases, the first leaf of the seedling arose from below the soil level; dark spots were produced on the blades of these leaves below the surface of the soil. This symptom was

EXPLANATION OF PLATE IV

Pathogenicity of Helminthosporium sativum Beecher (A) and Flynn (C) grown in infested soil, compared with the same varieties, B and D respectively, grown in non-infested soil.

PLATE IV

A B

C D

accompanied by a drying of the leaf. This feature is illustrated in Plate VI. After two weeks of growth, dark brown blotches, variable in size, appeared on the leaves. These spots began to increase in size and number as the plant grew larger. A few spots were measured and they ranged between .05-.2 X .1-1 inch. The blotches were scattered on the leaves, showing a tendency to be near the edge of the leaf. As the number of spots increased on the leaf, the color of the leaf changed to yellow, and the leaf died.

Seedlings not killed were stunted, and when they started tillering, some of their tillers were killed, while others grew normally.

The root systems of the stunted plants were not as well developed as in normal plants. This is illustrated in Plate VI, which shows the infected plants with small root systems.

It should be mentioned here that H. sativum was isolated from various parts of plants which were grown in the nursery. Long, dark-brown spots on the nodes were very common on the stem. These spots usually extended from the node on to both the upper and lower internodes.

Heads of barley also were severely infected in the field. Some of the kernels were not formed. The empty glumes dried early before the entire head matured. This was accompanied generally by a brown discoloration. Also kernels were noticed to have shrunken severely, especially on the heads which formed later in the season.

Although not all of the kernels on the head were discolored, some of the plump kernels showed a dark discoloration at the germ end.

Often the awns of the severely-attacked heads turned black in appearance because of the many small brown spots on them.

Identification and Pathogenicity of *Fusarium culmorum* (W. A. Sm.) Sacc.

On culture media the fungus usually produced different colors with different amounts of light and different temperatures. Under room light and temperature, the mycelia appeared to be white and fluffy, but soon changed to red with the substratum becoming carmine red. When the culture grew on the potato dextrose agar medium for two weeks or more, a yellowish color on the upper surface of the culture started showing on the central portion of the culture.

The fungus did not produce a large amount of conidia as compared with other sporulated fungi and *Fusaria*. The hyphae of the fungus broke easily into small fragments, from few to several cells, when mounted on slides to be studied.

Conidia were thick walled, relatively wide at the center, and gradually tapered to the ends. They were orange to red in color in masses, or yellowish-red when examined singly. The conidia were mostly straight, having slightly curving basal cells, which served as distinguishing characteristics. The size of the spores varied with the number of septa in each spore. The spores ranged from zero to nine-septate, with three to five septa being

the most common. The three-septate spores averaged 30.9 X 5.2 u and the five-septate spores averaged 31.1 X 5.9 u.

F. culmorum was found to be highly parasitic on the barley seedlings. The results of seed inoculation by this fungus are shown in Tables 4 and 5. In Table 4 the total germination of the inoculated untreated seeds was 181 seedlings. From this total, three weeks after germination, 94 seedlings were stunted, while 51 seedlings were killed. The death of the seedlings occurred during different steges of growth. The uninoculated seeds showed only two stunted seedlings and no killing.

It seemed reasonable to assume that not all of the seedlings were infected in the inoculated pots and not all the seedlings infected with F. culmorum were subjected to death. From these data it appeared that about 52 per cent of the inoculated seedlings showed severe symptoms of the disease and indicated that about 28.1 per cent of the total seedlings were killed.

Table 5, concerning the hot water treated seeds, indicates that 37.9 per cent of the germinated seeds of the inoculated pots were severely infected. Of the 87 seedlings, only 33 were stunted and 24 were killed. This amounts to 27.6 per cent killing.

Even though there was some difference between the two data, concerning percentages of the infected and stunted plants, there were obvious relationships between the percentages of the plants which were killed and those which germinated.

It is possible that the higher percentages of diseased seedlings in the untreated seeds appeared because of the original

Table 4. Pathogenicity of Fusarium culmorum. Untreated seeds. Greenhouse, 1951.*

Variety	Pot No.	Seedlings emerged		Three weeks after emergence: Plants showing severe symptoms		Plants dead	
		Inoc.	Check	Inoc.	Check	Inoc.	Check
Beecher	1	23	23	12	0	6	0
	2	20	23	12	0	5	0
	3	20	21	14	0	5	0
	4	22	23	13	0	7	0
Flynn	5	25	24	9	0	6	1**
	6	24	25	10	0	8	0
	7	23	25	13	0	7	0
	8	24	24	11	0	7	1**
Total		181	188	94	0	51	2

*Twenty-five seeds planted in each six-inch pot.
**One of these diseased seedlings showed H. sativum symptoms. The other was stunted, but the cause was not known.

Table 5. Pathogenicity of Fusarium culmorum. Hot water treated seed. Greenhouse, 1951.*

Variety	Pot No.	Seedlings emerged		Three weeks after emergence: Plants showing severe symptoms		Plants dead	
		Inoc.	Check	Inoc.	Check	Inoc.	Check
Beecher	1	9	8	2	0	2	0
	2	8	8	3	0	2	0
	3	11	13	5	0	3	0
	4	10	10	3	0	4	0
Flynn	5	12	13	4	0	3	0
	6	11	13	5	0	3	0
	7	12	14	4	0	4	0
	8	14	13	7	0	3	0
Total		87	92	33	0	24	0

*Twenty-five seeds planted in each six-inch pot.

presence of the disease on the seed or the presence of other fungi besides F. culmorum.

Since the percentage of the seedlings which were killed by this fungus was about 28.1 - 27.6 per cent of the total germinated seeds, it is evident that F. culmorum was highly parasitic on barley seedlings in the greenhouse.

The symptoms of this disease on barley seedlings are shown on Plates V and VI. In Plate V, the inoculated pots showed a reduction in the number of the standing seedlings as well as the stunting of the infected plants which did not die. The first symptom on the plants was the reddish-brown discoloration of the coleoptile area. Some seedlings produced only one leaf before they died; the others produced only few leaves. The disease attacked the plants below the soil surface and caused a discoloration and rotting of the infected area. Roots of the infected seedlings darkened and rotted. The sheath of the first leaf was usually damaged first, but when the plant became older, large, elongated, yellowish-brown spots appeared on the leaves. These spots often started at the base of the leaf blades. They caused the leaves to bend and dry from the tip down. The leaves from the infected plants were noticed to dry early and to shatter from the plants before they reached maturity.

Symptoms of the disease were very hard to distinguish on the heads in the field, because other fungi which were present at the same time on the same heads produced similar symptoms. In many cases when isolations were made from scabbed heads from the field,

EXPLANATION OF PLATE V

A and C are seedlings of Beecher and Flynn barley, which were inoculated with Fusarium culmorum. B and D are the healthy seedlings of the same varieties respectively.

PLATE V

EXPLANATION OF PLATE VI

Healthy and diseased seedlings:

A - Healthy.

B - Infected with *Fusarium culmorum*.

C - Infected with *Helminthosporium sativum*.

D - Infected with *Curvularia geniculata*.

The seeds were planted at the same time and grown under similar environment.


A
B
C
D

other Fusaria were isolated besides F. culmorum. Gibberella zeae was associated the most with this fungus.

SUMMARY

A study was made to determine the severity and distinguishing characteristics of three diseases of barley caused by Curvularia geniculata, Helminthosporium sativum, and Fusarium culmorum.

Isolation and identification of fungi from barley heads in the field showed that Fusarium spp. were the most common fungi, followed by Alternaria spp., Fusarium culmorum, Helminthosporium spp., Helminthosporium sativum, and Curvularia geniculata.

Studies on pathogenicity indicated that Curvularia geniculata was a weak parasite, causing a root rot of seedlings.

Helminthosporium sativum was a virulent parasite causing seedling blight, spot blotch, and head discoloration.

Fusarium culmorum was highly parasitic, causing seedling and head blight.

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ABSTRACT OF THESIS

PATHOGENICITY AND IDENTIFICATION OF SOME BARLEY DISEASES IN KANSAS

by

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The objectives of the investigation reported in this thesis were to determine the pathogenicity and to distinguish the symptoms and characteristics of three different diseases of barley caused by the following fungi:

Curvularia geniculata (Tracy and Earle) Boed.

Helminthosporium sativum Pam. King and Bakke

Fusarium culmorum (W. A. Sm.) Sacc.

The experiments designed to cover this study were conducted in the plant pathology nursery, laboratory and greenhouse.

Beecher and Flynn were the varieties of spring barley used in these investigations.

The fungi were isolated from barley heads grown in the nursery. They were increased on potato dextrose agar medium for the study of characteristics. For determination of pathogenicity, two experiments were conducted on seedlings in the greenhouse. One experiment was conducted on untreated seed and the other experiment on hot water treated seed.

It was found that Curvularia geniculata was a weak, parasitic fungus on barley seedlings in sterilized soil, under greenhouse conditions. It caused discoloration and root rot of the primary roots.

Helminthosporium sativum was a virulent parasite on seedlings, causing seedling blight. It produced lesions on the leaves of seedlings and also caused spot blotch and head discoloration on the mature plants.

Seed inoculated with Fusarium culmorum indicated that this fungus was highly parasitic on barley, causing seedling blight and head blight.