BLIGHTING OF FIELD AND GARDEN PEAS,
CHIEFLY DUE TO SEED INFECTION.
POWDERY MILDEW OF THE PEA.

OHIO
Agricultural Experiment Station.

WOOSTER, OHIO, U. S. A., APRIL, 1906.

BULLETIN 173.

EFFECTS OF BLIGHT FUNGUS ON PEA PODS. *Slightly enlarged.*

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The Bulletins of this Sta ion are issued at irregular intervals. They are paged consectutively and an index is included with the Annual Report, which constitutes the final number of each yearly volume.

BULLETIN

OF THE

Ohio Agricultural Experiment Station

NUMBER 173. APRIL, 1906.

INTRODUCTORY NOTE.

In 1903, my attention was called to the prevalence of a disastrous blight of peas grown for cannery use in the vicinity of Chillicothe. Reference was made to this trouble in the writer's report upon plant diseases for the year[1]. It was therein stated that no investigation had then been made by us. The growers who reported the matter laid especial emphasis upon the greater severity of this blight on the second, or any successive crop of peas upon the same soil.

Attention was further called to this blight, late in June, 1904, in a letter received by the Station from the canning firm of The Sears & Nichols Co., Chillicothe, O., wherein the following observations were made:

"We are in need of information concerning a disease which has attacked our pea vines in several places and which seems to be on the increase. It is what is known among canners as "club-root". The first appearance of the vines when attacked by this disease is as if a frost had touched the end of the vines and they soon dry up and wither. It has never attacked any peas for us, unless these have been consecutively in the same soil for two years, and the rotation of crops for two years seems to eliminate it, at least temporarily; but it is not certain to be eliminated by a change to another kind of crop for one year only, if returned to peas immediately after.

[1]Report Ohio State Hort. Soc.: 37: 128, 1903.
Yearbook U. S. Dept. Agr.: 1903: 554.

"We would like to ask whether the Station has any information on this subject and whether the disease can be treated by other means than the rotation suggested above."

The study of this trouble has been continued during the past two years by the Assistant Pathologist, Mr. J. M. Van Hook, whose results and conclusions are given in the following pages. It seems proper to note here the special difficulties surrounding the prevention of a disease of this character. In it the mycelium of the parasitic fungus and even the fruiting bodies, develop within the tissues of the infected seed. It has been found that any seed treatment which destroyed the in-dwelling fungus likewise destroyed the seed peas. Prevention must, therefore, begin with the growth of the seed peas themselves; promising results have been obtained as will appear by Table II, in the prevention of seed infection by supporting the vines and by spraying the plants with Bordeaux mixture. The importance of this initial work in growing healthy seed will bear special emphasis, as will likewise the necessity of crop rotation in field operations. These studies may instruct us as to the far-reaching effects of a mere leaf-spot fungus when it attacks the seed-bearing pods as in the cases of the pea and bean. The results of the investigation should be of aid to seesdmen in producing healthy seed, as well as to canners in their pea growing.

A. D. SELBY, *Botanist.*

I. BLIGHTING OF FIELD AND GARDEN PEAS,

CHIEFLY DUE TO SEED INFECTION.

II. POWDERY MILDEW OF THE PEA.

BY J. M. VAN HOOK.

BLIGHT CHIEFLY DUE TO SEED INFECTION.

For many years, peas have suffered more or less severely from a fungous blight, which usually manifests itself most plainly as a spotting of the leaves and pods (See Figures 3 and 6) and for this reason has been known as leaf-spot or pod-spot of the pea. This appearance on the pod is very similar to that of the anthracnose of beans, so familiar to all who grow them and to those who handle the green or string-beans. The fungus which causes this pea blight, however, is quite distinct from that on the bean, and is known to botanists as *Ascochyta pisi* Lib.

The name "club root" has been erroneously applied to this disease by canners, since, on examining the roots for the cause of dying, the root nodules have been observed. These nodules were thought to be similar to those of cabbage "club root" and the cause of the failure of the peas. They are, however, only the nitrogen gathering nodules, common to the pea family. A similar mistake in the common name has been made by growers in Delaware.[1] They have called it "sun scald", mistaking the symptoms for the disease.

In 1904, the damage in Ohio from this blight was apparently greater than in previous years. It was first noticed on French June field peas, which had been sown with oats as a forage crop on the Station farm. This was on June 24, 1904, and the peas, at this time, were about two feet high and just beginning to bloom. The lower leaves were, for the most part, dead. Many plants were wilting after several days of sunshine following continuous wet weather. Other stunted peas grew among these, some of which never attained a height greater than a few inches.

[1]Powell, Pea Canning in Delaware Del. Sta. Bul. 41, pp. 8—11, 1898.

APPEARANCE OF THE DISEASE ON STEMS, LEAVES, PODS AND SEEDS.

A close examination of the diseased plants showed that the stems had been attacked at many points, frequently as high as one and one-half feet from the ground, though most severely *near* the ground where the disease starts. In the beginning, dead areas were formed on the stem in the shape of oval or elongated lesions (Fig. 1). At a point from the top of the ground to two or three inches above ground, these lesions were so numerous and had spread so rapidly, as to become continuous, leaving the stem encircled by a dead area (Fig. 2). In some cases, the woody part of the stem was also dead, though the greater number of such plants still remained green above. This was due to the excessive amount of moisture in the soil and atmosphere previous to this time. On the leaves were orbicular or oval dead spots, one-eighth to one-half inch in diameter (Fig. 3). These areas are darker at the circumference. Below, the leaves were badly spotted, causing them to die. In the greenhouse experiments, the spotting of leaves failed to develop to any extent, though the attack at germination, and later, at the base of the stem, was more severe than out of doors. In such indoor grown plants, the dead areas at the base do not often extend much above the surface (Fig. 4). Figure 5 shows a condition often met with. The base of the stem is dead and shrunken as is usual when attacked below the ground. A little higher up, (even with the first leaf) may be seen the ordinary lesion due to the fungus. The growing tip is also often attacked. This is frequently the case where no trace of the disease occurs below. The injury to

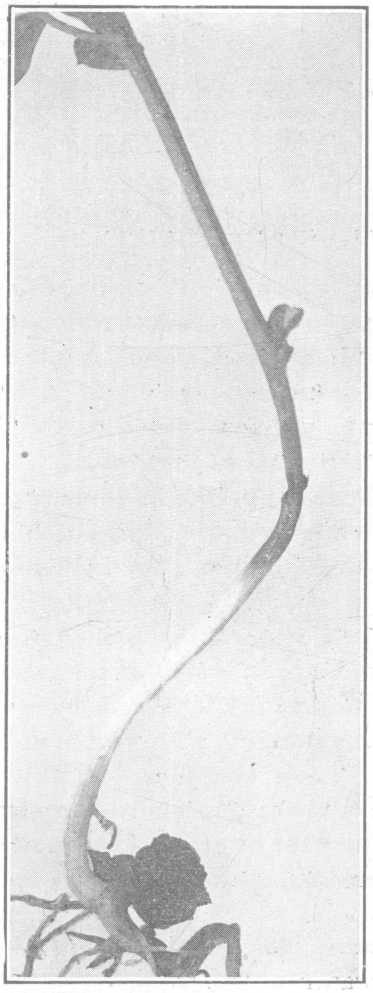

FIG. 1. Pea stem showing lesion from blight fungus, *Ascochyta pisi*. (*Natural size.*)

the original sprout or stem will cause one or more secondary shoots to appear. This explains many cases of the so-called freak peas (Fig. 5). In such cases as illustrated in Figure 5, the secondary stem has been attacked at the tip and death to the plant would have soon resulted. If the injury to the tip be on larger plants, a side branch may be developed prematurely and become the leading shoot.

FIG. 2. Stems almost covered with lesions of the blight fungus. (*Natural size.*)

These effects do not always result from Ascochyta alone, for *any* severe injury to the stem may cause the growth of secondary shoots.

Such plants as are not killed by the fungus before the time of flowering, develop pods in proportion to their vigor. The pods usually become badly attacked and exhibit spots as shown in Figure 6.

Perhaps the most important thing in connection with the life history of the fungus is, that the vegetative part or mycelium, infecting these spots of the pods, grows through the husk into the seed. Frequently it grows entirely through the pod, forming similar spots on both sides. When the fungus grows into the seed, brown spots may be formed on the surface. In the worst cases, half the surface

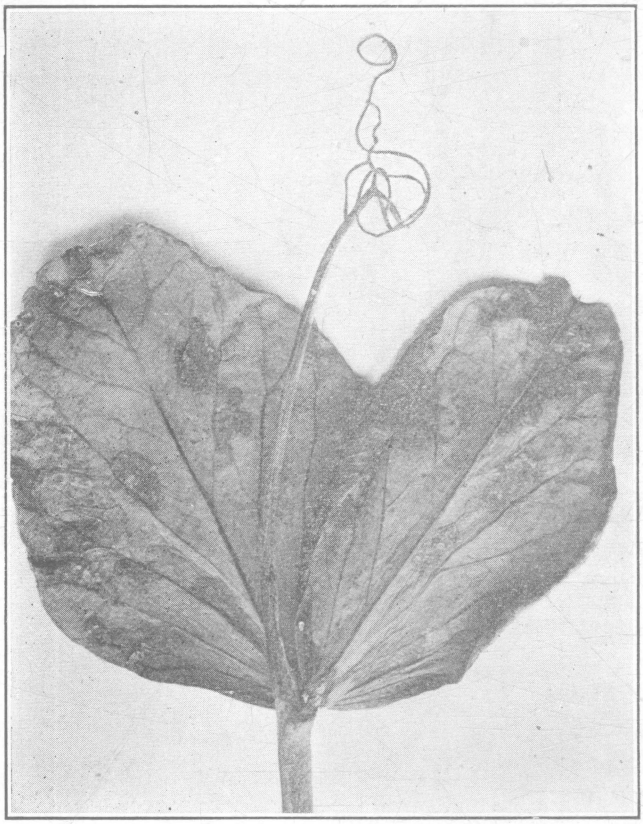

FIG. 3. Leaves showing spots due to the blight fungus
(*Slightly magnified*)

is frequently discolored and the seed adheres to the pod. These areas are much more striking on green colored peas, such as the Market Garden variety, than on the yellowish varieties, such as the Admiral. Pea seed may be badly affected with this fungus and yet escape ordinary observation, as only the most badly diseased ones will show serious spots. When the pea is exposed for a few days to considerable moisture, then spots appear (Fig. 7).

FIG 4. Blighted seedlings of peas showing disease at base of stem and variation in size. A healthy pea at the left. (*Natural size.*)

THE FUNGUS.

If one examines carefully the dead areas on the stems, leaves, pods or seeds, he will notice a number of points just visible without a magnifier. These are made plain by a hand lens. In Figure 8, the peas are magnified about seven diameters and the projections are easily seen. These points are the fruiting bodies (*pycnidia*) of the fungus and contain the spores which spread the disease, especially during the growing season. Figure 8*a* is a pea on which the fruiting bodies developed within the pods. Figure 8*b* showed only discolorations from the fungus and was placed in a moist chamber for about ten days. The fruiting bodies and spores developed during that time. When the spores are mature, they exude in slender columns through circular openings at their tips. Some of these pores may be seen in Figure 8 *a*. Sometimes the outer coat of the seed cracks away in part when attacked by the fungus; in such a case, the fruit dots are formed on the seed beneath (Fig. 10). Upon the seed, the pycnidia are usually of a yellowish or amber color, occur in numbers from a few to several dozen and are sometimes so crowded as to form almost a solid mass for as much as one-fourth inch in diameter. In Figure 9 we have a magnified view of a section of pea stem, taken through a dead area or lesion caused by the fungus. This is the same lesion shown in Figure 1, where the fruiting bodies are just visible.

FIG. 5. Seedling blighted at base and with lesion above. The secondary shoot is also attacked at tip. (*Slightly enlarged.*)

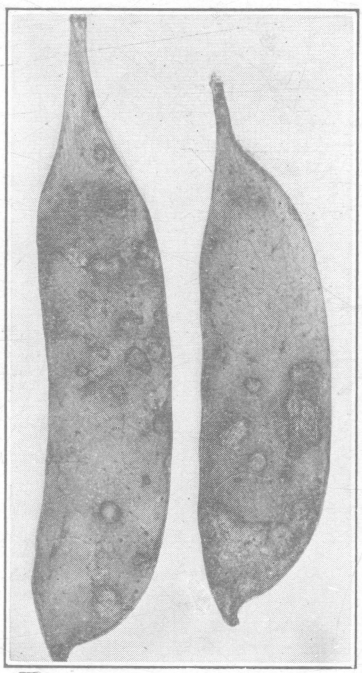

FIG. 6. Pods of French June field pea spotted by *Ascochyta pisi*. (*Slightly enlarged*)

The spores are oblong, usually two-celled and slightly constricted at the middle (Fig. 11). They ordinarily measure from 12 to 16 by 4 to 6 microns (.00047 to .00063 by .00015 to .00023 inch), though this seems to vary with the host and condition of maturity of the spores. They range from 8 to 23 by 3 to 7 microns (.00031 to .0009 by .00012 to .00027 inch) in size and may be one, two, three and even four-celled.

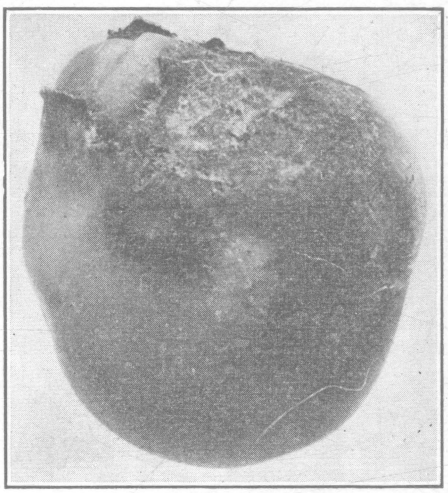

FIG. 7. Spots on the seed, due to the blight fungus. Pea kept several days in a seed germinator. (*Magnified about seven diameters.*)

The spores germinate so readily on acid potato agar that but scant care is needed in growing the fungus in pure cultures. Almost all of them germinate in a few hours (Fig. 11 *a* and *b*), and in seven days pycnidia containing mature spores will be found. Thus we learn how rapidly the fungus may spread in the field.

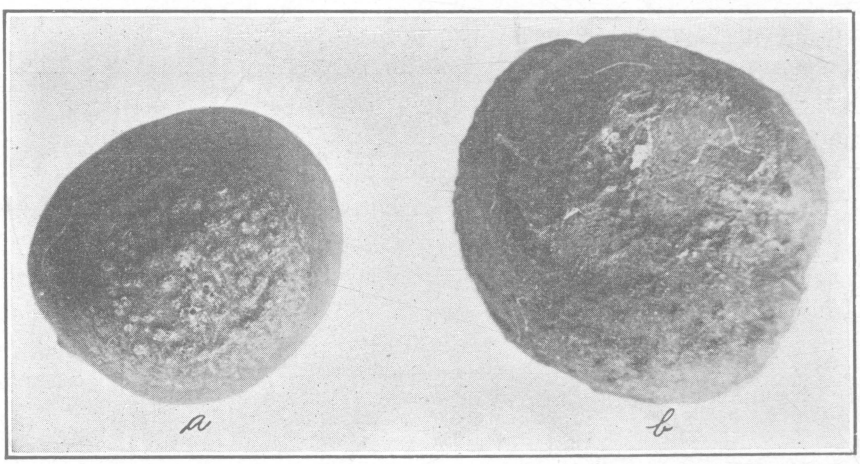

FIG. 8. Two peas showing the fruiting bodies of the fungus. *a*, dry pea; *b*, fruit bodies developed after 10 days in seed germinator (*Magnified about seven diameters.*)

EXPERIMENTS WITH DISEASED SEEDS.

During 1904 and 1905, many experiments were carried on, both in the greenhouse and out of doors, to determine the effects of seed treatment and of spraying.

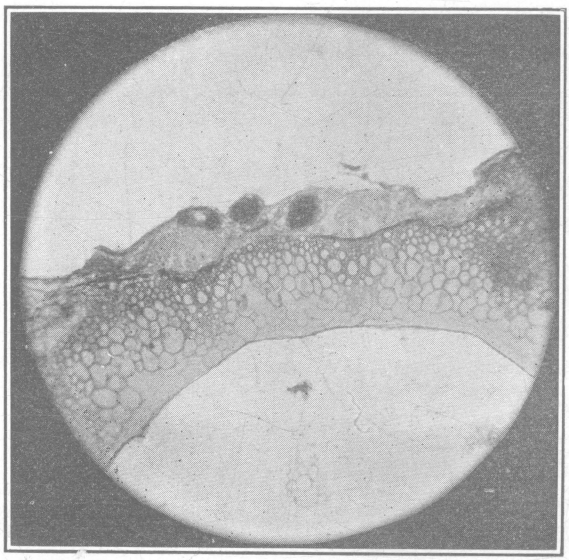

FIG. 9. Cross-section of stem through dead area showing three fruiting bodies. (*Photomicrograph, magnified 150 times.*)

Halsted,[1] who was first (so far as the writer is able to learn) to note and to figure the pea seed affected with this fungus, states that seed peas "apparently healthy when placed in the ground, soon show patches and spots of a dark color, which are also the spore bearing places of Ascochyta." Krueger[2] noticed the presence of the fungus by soaking seed for twenty-four hours in water, when dirty spots would appear (Fig. 7). When left for forty-eight to seventy-two hours, the *mycelium* or vegetative part of the fungus grew out into the water, forming a white mass of radiating threads similar to those of some of the water molds. All these results of Halsted and Krueger were verified.

If one places such diseased peas in a seed germinator for several days, a heavy coat of white mold will be formed about them. On removing these to a covered dish, where less moisture is present, numerous reddish-brown *pycnidia* or fruit bodies will be formed all through and over this white, fluffy mass of mold or mycelium.

[1]Halsted, Some Fungous Diseases of the Pea. N. J. Agr. Coll. Exp. Sta. Report 1893. pp. 357-362.
[2]Krueger, Ungewoehnliches Auftreten von Ascochyta pisi Lib. on Erbsenpflanzen. Centbl. f. Bak. u. Par. 2, 1. p. 620. 1895.

(Of course this mycelium must not be confused with a similar growth of some such fungus as Fusarium, which often contaminates peas and beans, when not kept dry—especially just after harvesting.) Peas which failed to germinate in the ground were removed, with the result that they too, soon developed fruit bodies (pycnidia) on the peas or on the mycelium surrounding them. The germination of such diseased seeds is very poor. Krueger found the germination of very badly affected seed to be 20 percent. In similar experiments conducted by the writer, the germination was only 6 percent. Such peas seldom reach maturity when they do germinate, as the fungus affects the base of the young plant.

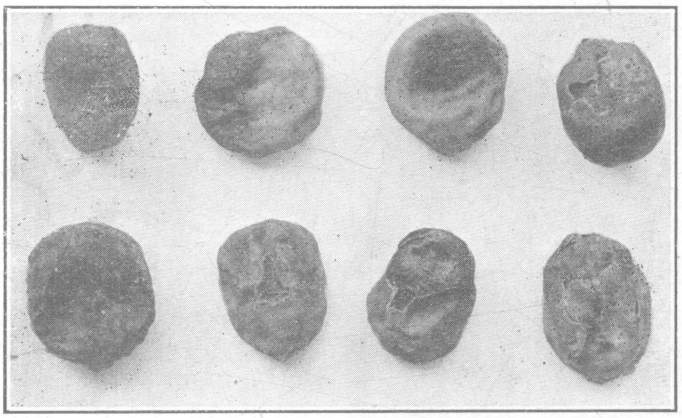

FIG. 10. Peas affected with blight fungus, showing outer seed coat cracked away. (*Enlarged about two diameters.*)

Hiltner[1] has recorded the sudden dying of peas from such attacks at the base of the stem. The fungus was carried over to the young plants by the seed, a fact previously determined through experiments by Jarins.[2] These early attacks by the fungus result in all sizes and vigor of plants. Plants of equal age range in height from two inches to four feet (Fig. 4). In the struggle between the fungus and host, the latter may not noticeably increase in size for a long period; or it may succumb at any time. Young plants six inches high, affected with the fungus, were planted against healthy ones of the same size, with the result that the latter became diseased in a few days. Later, fruit bodies formed on them abundantly.

[1] Hiltner. Erkrankungsmuedigkeit. Sachs. Landw. Zeitung. 1894. No. 18.
[2] Jarins, Ascochyta pisi bei parasitischer und saprophyter Ernaehrung. Bibl. Bot., Heft 34, 1896, c. tab.

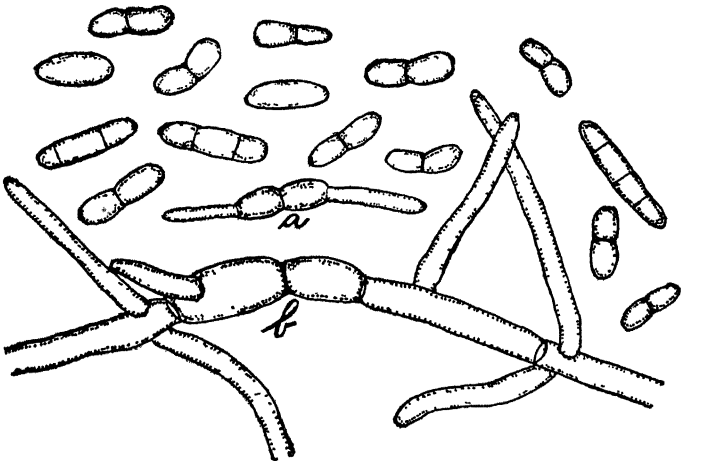

FIG. 11. Spores of the blight fungus. *a* and *b*, germinating spores. (*Magnified 565 times.*)

SEED TREATMENT.

Many experiments in seed treatment by immersion were carried on during 1904 and 1905, but all proved unsuccessful. The presence of the mycelium or the vegetative part of the fungus and the spores *within* the seed has, so far, rendered treatment impossible, since any solution strong enough to kill the fungus, also kills the pea germ. In fact, the fungus is the less susceptible of the two. Still it was hoped to kill such spores as might be merely adhering to the outer seed coat of the peas and thereby increase the percent of germination. The chief chemicals used were formalin and corrosive sublimate. These were used in several strengths and for various lengths of time. The seed was then planted in soil (in the greenhouse) or put into a seed germinator. The results, for the most part, were not only unsuccessful, but negative. Liquid treatment, especially when the seed was immersed for a considerable period, seems to increase bacterial rot (as noted by Halsted[1]) which is also responsible for the failure of some of the seeds to germinate. Direct immersion in hot water, as well as immersing in hot water after soaking, was tried by Krueger, with the result that the vitality of the seed was injured, while the fungus was not. Dry heat was also applied with similar results. Though Krueger found seed treatment with Bordeaux mixture ineffective, experiments carried on by the writer, during the present season, showed a slight increase in germination over check plots, when seed was soaked for an hour in water, rolled in Bordeaux dust and immediately planted. The following table gives the average results obtained by this treatment.

[1]Halsted, Failure of Pea Seed to Grow. N. J. Agr Coll Exp. Sta.Rept. 1893, pp. 359-362.

The figures show the number of grams produced from one foot of row; also the gain or loss in percent. The peas were drilled in rows three feet apart and not sprayed:

TABLE I—EFFECT OF BORDEAUX DUST ON YIELD.

VARIETY	Early planting			Late planting		
	Treated	Untr'd	Gain or loss	Treated	Untr'd	Gain or loss
	Grams	Grams	Percent	Grams	Grams	Percent
Market garden	21.9	21.6	+1 4	4 9	4 3	+14.0
Admiral	29 0	27 3	+4.3	4 2	3 4	+23.5
Telephone	14 8	11 5	+28.7	...*	...	....
French June	21.6	21.4	+.9	.	..	....

*No late planting.

SPRAYING AND TYING UP.

The results of tying up vines, of spraying with Bordeaux and of omitting the last spraying, are shown in the following table:

TABLE II—EFFECT OF SPRAYING AND TYING UP ON YIELD.

VARIETY	Sprayed								Unsprayed		Gain or loss of sp. in early planting
	Tied up	Not tied up	Gain or loss	Sp. late	Not sp. late	Gain or loss	Not tied up nor sp. late	Gain or loss	Early pl.	Late pl.	
	Grams	Grams	Percent	Grams	Grams	Percent	Grams	Percent	Gm.	Gm	P. ct
French June	24.2	25.9	−6.6	12.6	9.5	+32.6	14 7	+29.1	21 4	..*	+21.0
Market Garden	26.3	20.3	+29 5	9.6	8.2	+17 1	19.9	−17.2	21 6	4.5	−6.0

*No late planting made.

The percent of gain or loss of sprayed over unsprayed is computed for the early planting only, as the late crop of unsprayed was planted somewhat later than late planting where spraying was done. Moreover, the almost complete failure was due, in large part, to *powdery mildew*, which *failed to develop in the least on the sprayed crop*. Though the sprayed rows and those tied up produced, in general, more than the checks, the gain was scarcely sufficient to warrant such treatment merely to increase the quantity of peas. *The object, however, of such treatment, is more for the purpose of growing uninfected seed peas* in order that so great loss may not be experienced from a poor stand and to start a crop free from the disease. This, on soil free from the disease, should improve the situation. The spraying was begun when the plants were two to four inches high and repeated at intervals of five to ten days according to the weather.

The early training up of vines is an important factor in securing healthy seed peas, since the fungus makes its first attacks near the ground and gradually works its way up along the stem, branches and leaves. The height (on the plant) to which the fungus will attain in a given time is therefore dependent, to a certain extent, upon how much of the vine lies upon the ground.

SEED GERMINATION.

During the winter of 1905 and 1906 extensive tests in germination of the 1905 crop were carried on, both in a seed germinator and in dry and wet soils. Practically all the seed had been saved at harvest. The results of this germination are briefly stated in the following table:

TABLE III—SHOWING IMPROVED GERMINATION OF SPRAYED OVER UNSPRAYED PEAS.

WHERE GERMINATED	Percent germination from unsprayed crop	Percent germination from sprayed crop	Percent increase by spraying
In seed tester	80 9	96 7	19 5
In moist soil (Greenhouse)	60 6	78 6	29 7
In wet soil (Greenhouse)	44 0	69 4	58.8

In extremely wet weather, seed peas do not seem to germinate as well as when the ground is only slightly moist. For that reason the germination test was made in both moist and wet soils. Not only was the percent of germination much lower in the wet soil, but of those which did germinate the number which afterwards became diseased was also much greater in the wet soil. While this rotting and dying is by no means all due to the fungus Ascochyta, much of it is. Injuries to the pea seed, as well as to the stem which has been mentioned above, are followed by saprophytic rots. For example, those peas eaten by insects usually rot very rapidly. These, in turn, spread the disease to healthy seed near them. It is especially noticeable how quickly such decays extend to the adjacent peas, when placed near each other in a seed germinator. So decays apparently due to bacteria and saprophytic fungi are, in reality, often due to injuries caused by the blight fungus, Ascochyta. Some of the failures in germination however, proved to be entirely due to bacteria.

When peas are used largely for germinating purposes, as in our schools and colleges, the failure to grow or to produce healthy seedlings is, at times, very annoying. This can, in a measure, be remedied by throwing out the discolored and weeviled peas; by selecting a soil in which peas have not previously been grown; by selecting a less organic soil; and by keeping the soil only slightly moist.

However, the large increase in percent of germination, as shown in Table III, must be due to spraying the crop from which the seed was taken. Not only is the blight fungus reduced, but more healthy seed, in general, is produced. Notwithstanding the great care in spraying, the results of 1905 are certainly not what they would be under more favorable conditions of weather. The almost daily rains rendered it impossible to keep a good coat of Bordeaux mixture on the plants. Yet Table III shows a profitable gain in germination of sprayed peas, amounting on the average to 36 percent.

HOSTS.

All the varieties of the common pea (*Pisum sativum*), examined during the past year, were found to be affected with Ascochyta, though some much more seriously than others. The following is a list of those carefully examined:

French June	Very badly affected
Market Garden	" " "
Admiral	Badly "
Dwarf Telephone	Very badly "
Telephone	Badly "
Prosperity	" "
American Wonder	Very badly "
Advancer	Badly "
Alaska	Slightly "

So far as the writer is able to learn, no investigations have been made as to the susceptibility of varieties. However, aside from the genus *Pisum* (the common peas), it has been found to attack alfalfa (*Medicago sativum*),[1] chick pea or Egyptian pea (*Cicer arietinum*),[2] common bean (*Phaseolus vulgaris*).[3] and hairy vetch (*Vicia villosa*).[4] A critical examination of the species of *Leguminosæ* grown at the Station in 1904 and 1905, showed all of the above to be free. Following are the results from the various legumes grown in the variety plots in 1904 and 1905:

[1]Lagerheim, Bihang till K. Svenska Vet. Akad. Handlingar. 1898. Bd. XXIV, Afd. III, No. 4, 21 pp.
[2]Rostrup, "Tidskrift for Landrugets Planteavl" V, No. 14, Kjobenhavn 1898.
[3]Carruthers. Jour. Roy. Agr. Soc. Eng. Ser. 10 (1899) pt. 4. pp. 678-688.
[4]Ducomet, Prog. Agr. et Vit. (Ed L'est) 22 (1901) No. 34, pp. 225-233.

HOST NAME	Examined July 22 1904	Examined July 28 1905
Ha ry Vetch (*Vicia villosa*)	Free	Free
Spring Vetch (*Vicia sativa*)	Slightly on leaves	"
White Lupine (*Lupinus alba*)	Free	No planting
Lentil (*Ervum lens*)	"	" "
Grass Pea (*Lathyrus sylvestris var*)	"	Free
French June Pea (*Pisum arvense var.*)	Very bad	Very bad
Scotch Gray Pea (*Pisum arvense var*)	Slightly on leaves	On leaves and stems
Velvet Bean (*Mucuna utilis*)	Free	No planting
Horse Bean (*Faba vulgaris*)	"	Free
Medium Green Soy Bean (*Glycine hispida var*)	"	No planting
Mammoth Yellow Soy Bean (*Glycine hispida var*)	"	" "
Florida Beggar Weed (*Desmodium tortuosum*)	No planting	Free
Yellow Lupine (*Lupinus luteus*)	" "	"
Flat Pea (*Lathyrus sylvestris var*)	" "	"
Alfalfa (*Medicago sativa*)	Free	"
Egyptian Pea (*Cicer arietinum*)	"	"
Russian Blue Pea (*Pisum arvense var*)	"	"

OUTBREAKS.

Previous outbreaks have occurred. Krueger[1] reports the cultivated field crop in one section (in Europe), a complete failure in 1894. Combes[2] reports it as attacking the pea stems so seriously as to cause a wilting of the tops, in 1879. Lochhead[3] describes a serious outbreak on Egyptian-peas in Ontario in 1903. Yet, while we have experienced an exceptional attack by the fungus during 1904 and 1905, Egyptian-peas have proved to be entirely free of the disease. Excessive moisture during these two years, was doubtless an important factor in the violence of this outbreak. Added to this, is the continual growing of peas on the same ground. When peas have been planted on the same soil for two or more successive years the loss may be considerable, even in ordinary seasons, owing to the increase of the parasite. Two years rotation in other crops relieves the land of this trouble for the time at least, showing that the fungus lives over in the soil or compost, as well as in seed peas.

EXTENT IN 1905.

During 1905 this disease was reported to us from nine Ohio counties, though it doubtless existed in every county. The average results of these reports show that the disease was worse than in 1904, and that the percent of crop injured was 52. The earliest report was from Clermont county in May. Statistics show that the crop in Ohio in 1904 was 1,232,305 pounds, produced from 1071 acres—an average yield of 19.17 bushels per acre.

[1] Krueger, *l. c.*, p. 621.
[2] Combes, Crittogamia agraria, p 473
[3] Lochhead, Ont. Agr Coll and Exp. Farm. An. Rep. 1903, p. 26.

POWDERY MILDEW OF THE PEA.

Although there are many fungous diseases of the pea, which cause considerable damage in both this country and Europe, aside from the blight due to Ascochyta, none seems to require special attention at this time, except powdery mildew. This disease is especially destructive late in the season. Many persons do not sow late crops on account of the mildew.

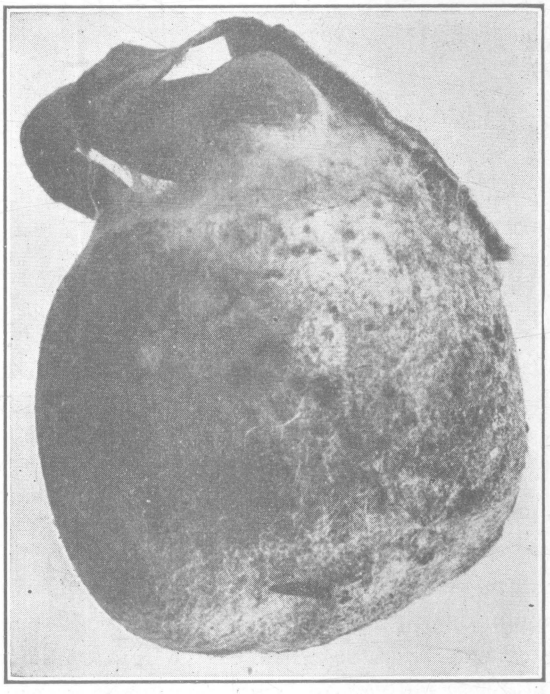

FIG. 12. Powdery mildew with fruit bodies. Developed in germinator in 12 days. (*Enlarged about seven diameters.*)

The powdery mildew fungus [*Erysiphe communis* (Wallr.) Fr.] is exceedingly common on beans, clover, lupines, peas and other members of the family to which the pea belongs, as well as on very many other hosts. It is ordinarily recognized by the whitish or grayish coating on all parts of the pea plant, especially late in the season. The loss from this mildew during the past season was quite large.

The mildew fungus likewise lives over winter on the seed. Figure 12 is from an enlarged photograph of a pea taken from a germinator at the end of twelve days. The pea, though apparently free from any fungus when put into the germinator, soon developed a covering of mold in which hundreds of fruit bodies (*perithecia*), were formed. On account of the habits of the powdery mildew fungus, it is easily prevented by applications of Bordeaux mixture. Unlike the blight fungus, Ascochyta, the vegetative part of the mildew fungus grows mostly on the exterior of the host plant. Hence, the fungicide is not only a preventive, but actually kills the fungus in great part, when sprayed upon it. On account of this manner of growing, many of the powdery mildews are controlled by the use of sulphur alone—applications of which have but little if any effect on most other parasitic fungi.

The sprayed late crop of 1905 showed not a trace of mildew; while the unsprayed late crop was entirely covered. So bad was the attack, that many plants failed to mature good seed. This is, in part, responsible for the very low percent of germination of peas from the unsprayed vines.

ACKNOWLEDGEMENTS.

I wish to record my appreciation of the many valuable suggestions made by Prof. A. D. Selby; to express my gratitude to those who have reported the disease and given estimates of losses in their counties; and to The Sears & Nichols Co., Chillicothe, Ohio, who have furnished valuable data in regard to the blight.

SUMMARY.

1 The blight fungus of peas (*Ascochyta pisi* Lib.) is present every year to some extent; but conditions have been such during the past two years as to cause an excessive development of the fungus. French June field peas, sown among oats, began to blight early in June; later, it was reported on varieties of the common garden pea, in regions where they are grown largely for canning purposes.

2 Plants are often attacked at the base as soon as they begin to grow. Lesions are formed which, in many cases, become continuous, killing the stem near the ground. Sudden dry weather causes such plants to wilt. On the leaves, oval or orbicular spots are formed. This often becomes serious enough on the lower leaves to cause death. On pods, spots very similar to those caused by the ordinary bean anthracnose are formed.

3 Perhaps the most important feature is, that the vegetative part (the mycelium) of the fungus grows through the husk of infected pods into the seed and often produces spores there, by the time the peas are mature. More frequently, however, the peas are mature and dry before fruit bodies (pycnidia)of the fungus develop, though discolored areas may appear on the surface. In many cases there is no sign of the fungus, until the seed is soaked in water for twenty-four hours or more, or planted in moist soil; then dirty green spots appear.

4 The germination of such diseased seed is very poor. Of those selected as being very badly affected, only 6 percent germinated. It has been previously demonstrated that the fungus passes over to the young plant from the seed. The severity of the attack may vary very much, even when such seeds do germinate. Plants of equal age may range in height from two inches to two feet.

5 Seed treatment by immersion in liquid fungicides failed to produce good results, as the fungus within the seed is less susceptible than the pea germ. Heating the seed failed for a similar reason. Rolling the seed in Bordeaux dust increased the percent of germination slightly. Tying up the vines and spraying, while increasing the crop only slightly, produced peas much freer from this and other fungi and is of much value in growing healthy seed peas. Spraying in this manner should prove a commercial success in growing seed peas. Planting such healthy peas in soil free from the fungus is recommended as the best means of reducing the loss from blight.

6 This blight fungus is known to attack alfalfa, chick pea, common bean and hairy vetch. All the varieties of the common pea examined this year were affected; but some varieties much more than others.

7 Powdery mildew, while generally prevalent on late plantings of peas, is easily prevented by Bordeaux mixture.

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