

THE UNIVERSITY
OF ILLINOIS

LIBRARY

630.7
I f 6 b
no. 377-89
cop. 2

NOTICE: Return or renew all Library Materials! The Minimum Fee for each Lost Book is \$50.00.

The person charging this material is responsible for its return to the library from which it was withdrawn on or before the **Latest Date** stamped below.

Theft, mutilation, and underlining of books are reasons for disciplinary action and may result in dismissal from the University.
To renew call Telephone Center, 333-8400

UNIVERSITY OF ILLINOIS LIBRARY AT URBANA-CHAMPAIGN

~~SEP 24 1995~~

SEP 28 1995

JAN 15 1997

JAN 28 2000

FEB 03 2000



Anthracnose and Gray Bark of Red Raspberries

Identification and Control

By H. W. ANDERSON
and K. J. KADOW

UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT STATION
BULLETIN 383

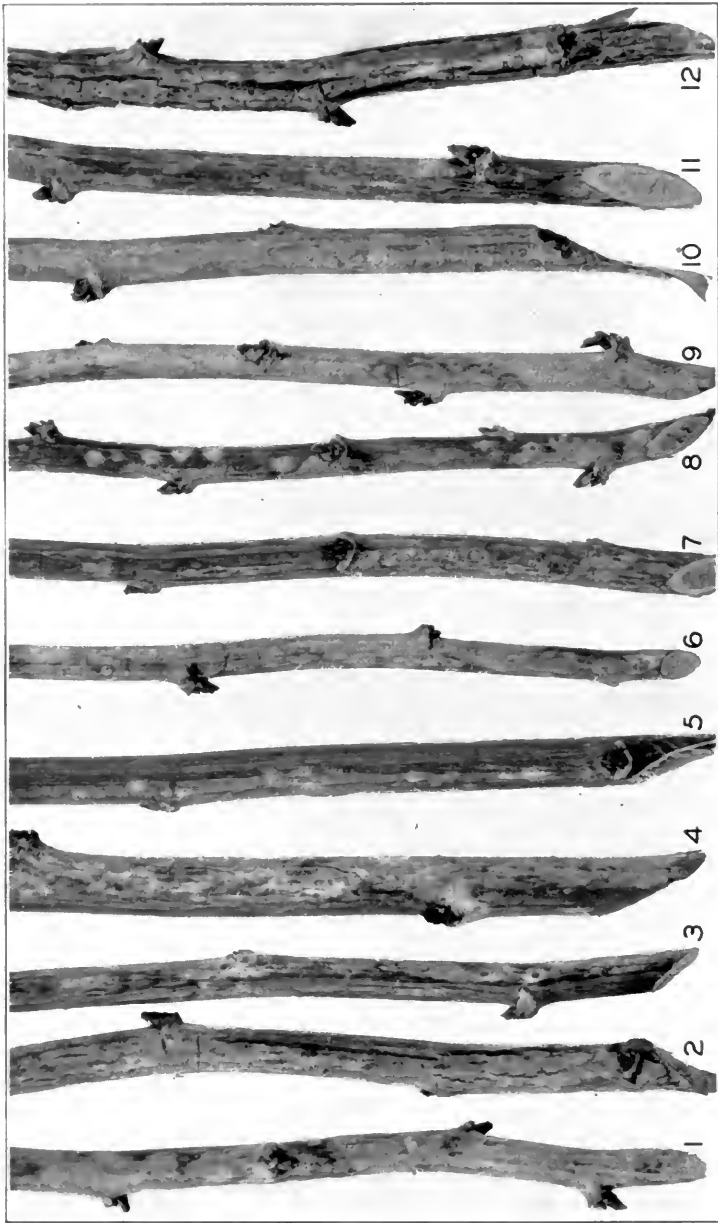


FIG. 1.—GRAY BARK ON DORMANT CANES OF LATHAM

Canes 5, 7, and 8 show separate lesions; Nos. 1, 2, 9, and 10 show coalesced lesions; No. 12 shows splitting of outer bark.

Anthracnose and Gray Bark of Red Raspberries

Identification and Control

By H. W. ANDERSON, Chief in Pomological Pathology and
K. J. KADOW, Assistant in Pomology

THIS BULLETIN presents the results of certain experiments and observations on an apparently new disease of red raspberries which appeared on Latham in southern Illinois shortly after its introduction in 1925. The disease has been found on other varieties of red raspberries and appears to be similar to, if not identical with, anthracnose of the black raspberry, blackberry, and dewberry. Since the "gray bark" phase of the disease has never been described in America, and since it has been regarded as a distinct disease, the control of which was not known, it is thought worth while to present the results of this study on the life history of the organism and methods of control. It is not the purpose of this bulletin to discuss anthracnose of other brambles, since in other publications of this Station¹ the important facts concerning this disease are presented.

HISTORY OF THE DISEASE IN ILLINOIS

In 1925 Latham red raspberry was introduced into southern Illinois from Minnesota. A limited experience with this variety led the growers to believe that it could be successfully and profitably grown and more extensive plantings were made. The problem of its adaptability was complicated by the appearance in 1929 of an apparently new disease which the growers called "gray bark." Since that date this disease has been found on the Latham thruout the state, and other varieties of red raspberries, tho not so susceptible, are frequently attacked.

The appearance of the disease in a severe form in 1929 was probably due to the unusually heavy rains of that season. In 1930 very dry conditions prevailed thruout the spring and summer and the disease was so rare that it was thought to be of little importance. In the autumn of 1931 it again appeared in a moderately severe form and it was thought worth while to study it more extensively. Some effort had been made during previous years to identify the causal fungus, but without success.

¹Diseases of Brambles in Illinois and Their Control. Ill. Agr. Exp. Sta. Circ. 305, 1926 (out of print). Diseases of Illinois Fruits. Ill. Agr. Exp. Sta. Circ. 241, 1920.

SYMPTOMS

On the Fruiting Canes.—The most striking symptom and one which attracts the attention of the grower is the light gray appearance of the canes in the autumn after the leaves are shed (Fig. 1). This is usually more noticeable on the lower half of the cane but may extend to the top. During the two seasons that this disease has been under observation the lesions have appeared much more abundantly on the south



FIG. 2.—FRUITING BODIES (ACERVULI) OF GRAY BARK

Note concentric arrangement and irregular outline of the acervuli. A typical lesion on dormant cane enlarged $4\frac{1}{2}$ times.



FIG. 3.—PIT LESIONS OF GRAY BARK ON LATHAM

(A) Fruiting laterals, (B) new shoots. These lesions were the result of natural infection.

exposure of the canes. A closer examination of this gray area reveals the fact that it is made up of numerous smaller lesions which in most cases have fused. Where the disease is light, these lesions are evident as oval areas from an eighth to a half inch in length. Numerous small, dark brown to black dots may be seen scattered over the surface of this gray area. In the individual lesions these are arranged in a concentric manner as indicated in Fig. 2. These black dots are the fruiting bodies of the fungus and they become more pronounced in the early spring, especially under moist conditions.

The bark attacked by this fungus separates from the layer immedi-

ately below and may be peeled off without any apparent injury to the cane. A microscopic examination revealed the fact that this outer layer was only a few cells in thickness and that the corky layer formed beneath gave ample protection to the cane.

On the Fruiting Laterals and Young Shoots.—It was not until the spring of 1932 that the disease was found in the actively growing parts of the plant. Lesions typical of anthracnose on red raspberries were found first on the fruiting laterals the middle of May. These were

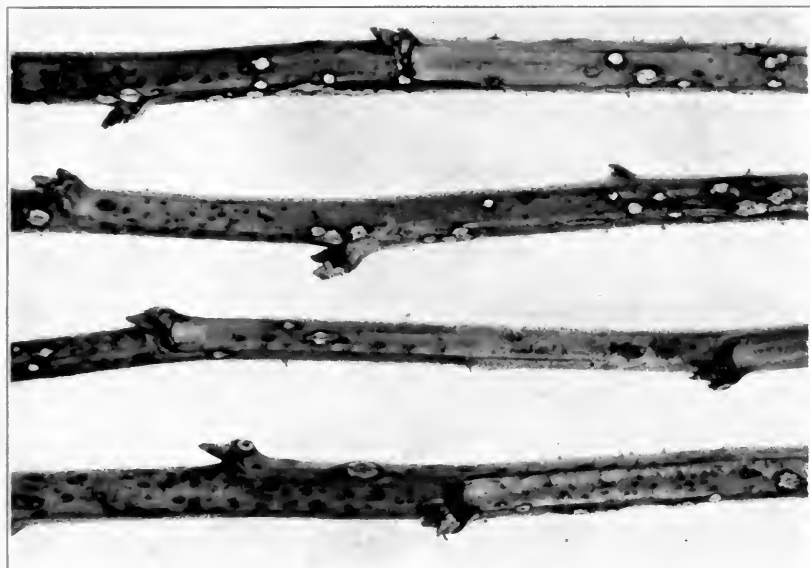


FIG. 4.—ORIGIN OF SUPERFICIAL GRAY BARK CANKERS

The dark spots in the above figure are small purplish areas of new lesions which develop into the gray bark phase later in the season. The white areas are old sterile pit lesions. Photograph taken September 3, 1932.

later found on the stems of the new shoots and on other parts of the plant, including leaf blades, petioles, pedicels, and the calyces of the unopened flowers.

The lesions on the fruiting laterals appear first as small purple dots, which later elongate to from an eighth to a fourth of an inch. The center of the lesion soon turns white and is surrounded by a narrow purple border (Fig. 3, A). The lesion on the petiole is similar but is decidedly elongated.

On the young shoots the spots are larger and, owing to the rapid expansion of the cane, are more circular in outline (Fig. 3, B). They are most abundant at the base of the cane.

These typical anthracnose lesions on the actively growing parts are sunken and the fungus extends rather deeply into the tissues of the host. They are quite different from the superficial lesions which appear later in the season on the canes which are to produce the crop the following year. They will be referred to as "pit lesions" to distinguish them from the lesions described below.

Superficial Lesions.—During midsummer no new lesions are to be seen on the developing canes and the pit lesions become inconspicuous. An examination of many plantations in late July, 1931, failed to reveal any evidence of the "gray bark" disease. In late August, however, the disease was plainly evident. At this time small, rather indefinite, purplish areas were noticed (Fig. 4). These later developed into the typical gray areas described above. These lesions are quite distinct from the typical anthracnose pit lesions formed in the spring. Harris¹ has called them "superficial" lesions and this name will be used in the future to designate these late, gray, superficial areas. The dark brown fruiting bodies become distinct in early fall but do not produce spores.

THE CAUSAL FUNGUS

The "gray bark" disease was first observed late in 1929. Efforts to identify it at that time failed owing to the fact that no fungus spores could be found. Attempts to produce the spores by subjecting the dormant canes to summer temperatures and moist conditions were unsuccessful. The symptoms were not typical of any described disease of the raspberry.

During the winter of 1931-32 specimens were again examined for spores and subjected to favorable conditions for spore development. Since the spores did not develop, efforts were made to isolate the fungus from the lesions. Cultures made from the bark of the lesions resulted in almost pure cultures of an *Altenaria* which was at first suspected of being the causal fungus.

Later the brown spots suspected of being the acervuli (fruiting bodies) of the fungus were carefully picked out and isolations attempted. A few of these developed a very slow-growing fungus which at first had the characteristic growth of *Plectodiscella veneta*, the fungus causing anthracnose of black raspberry. In April some dormant canes which had been left for several days in a moist chamber produced spores (conidia) in the acervuli, and these were later compared with the conidia of *Plectodiscella veneta*. The measurements were as

¹Raspberry Cane Spot. Jour. Pomol. and Hort. Sci. 9, 73-99. 1931.

follows: average of 100 spores from fruiting lesions of *Plectodiscella veneta* on black raspberries, $7.4 \mu \times 3.3 \mu$; average of 100 spores from gray bark on red raspberries (superficial canker), $7.3 \mu \times 3.5 \mu$. A comparison of the conidia from young pit lesions of the reds with those from the superficial cankers showed that they corresponded closely. The perfect stage of the fungus was not found.

Comparison of Cultural Characters.—A pure culture of *Plectodiscella veneta* was obtained from the Department of Plant Pathology of Cornell University. This culture had originally been isolated by Dr. L. K. Jones in Wisconsin. The two fungi were grown on corn meal and potato dextrose agar. The difference in the type of growth of the two organisms was decided, altho both showed the typical heaped character of the colonies (Fig. 5).

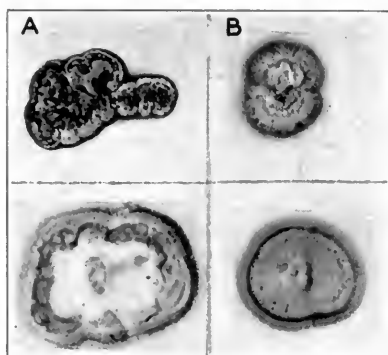


FIG. 5.—GRAY BARK FUNGUS FROM ILLINOIS (ABOVE) AND ANTHRACNOSE CULTURE FROM WISCONSIN (BELOW)

These cultures were a month old when photographed: (A) potato dextrose agar, (B) prune agar.

Single spore isolations were made at Urbana from typical pit lesions of both red and black raspberries. These were grown on corn meal, potato, dextrose, bean pod and prune agar in plate culture. At the end of three weeks no marked difference in the cultures could be determined (Fig. 6). It is outside the scope of this publication to discuss the possible reasons for the difference between the Cornell culture and those obtained at Urbana. It is possible that so-called strains or varieties of the anthracnose organism occur. This phase of the problem is being investigated.

Cross Inoculation.—In the cultural studies of the gray bark fungus it was found that abundant conidia were produced on corn meal agar,

while the black raspberry anthracnose organism obtained from Cornell University failed to develop spores.

In the first inoculation tests two Latham (red) and two Cumberland (black) raspberry plants were placed in a damp chamber for 24 hours and then sprayed with a suspension of gray bark spores from corn meal agar. They were allowed to remain for 48 hours more in

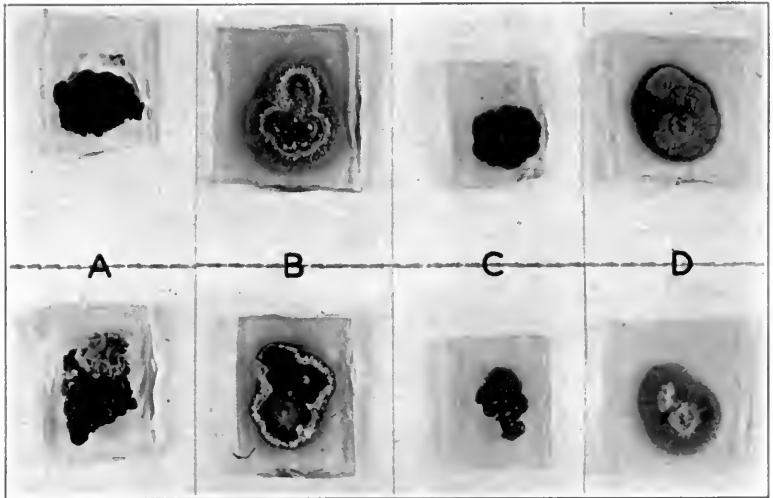


FIG. 6.—COMPARISON OF GRAY BARK (ABOVE) AND ANTHRACNOSE (BELOW) ON DIFFERENT AGAR MEDIA

The anthracnose cultures were obtained by isolation from pit lesions on black raspberry at Urbana. The photographs were taken after one month's growth at optimal temperature: (A) potato dextrose agar, (B) prune agar, (C) bean pod agar, (D) corn meal agar. Slight differences may be noted between the culture on corn meal and that on prune.

the damp chamber and then held under greenhouse conditions. One week after inoculation they were again placed in the damp chamber for 24 hours. Shortly thereafter the first symptoms of infection were evident. Both reds and blacks showed positive inoculation results. On the blacks the symptoms were practically identical with natural field symptoms of anthracnose on blacks (Fig. 7, A), but on the reds the symptoms were at first not quite typical of natural gray bark infections on reds (Fig. 7, C). All the inoculations thus far have produced only the pit lesions stage of the disease.

The gray bark fungus was successfully reisolated from both reds and blacks. The check plants, one Latham and one Cumberland, re-

mained healthy. They were sprayed with water at the time the inoculations were made and otherwise treated the same as the inoculated plants.

Inoculation experiments in which red and black raspberries were used as above but inoculated with a spore suspension of anthracnose obtained from pit lesions on black raspberries were inconclusive, owing to injury from sprays used to combat red spider.

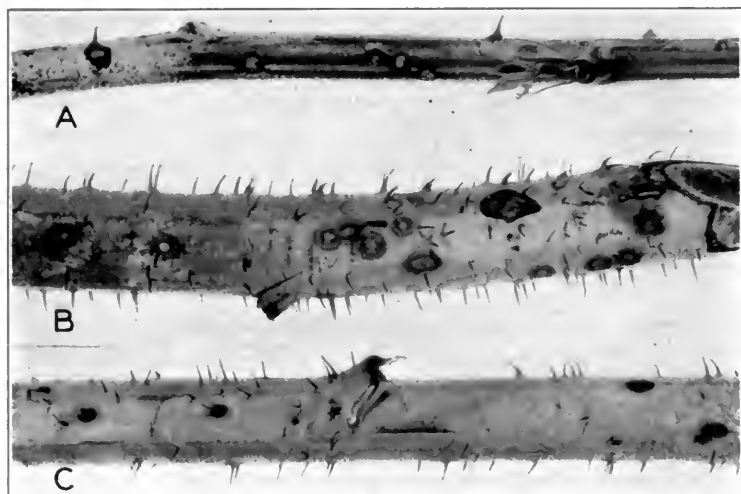


FIG. 7.—PIT LESIONS ON CANES OF BLACK RASPBERRY AND LATHAM

(A) Lesions produced by artificial inoculation with the spores from gray bark culture, (B) lesions produced by natural infection, both on black raspberry; and (C) lesions produced by artificial inoculation on Latham.

These limited tests indicate that the organism on red raspberry causing the gray bark disease will also cause typical anthracnose lesions on the black varieties. This does not imply that there is no difference between the organisms. This point can be determined only by more extensive studies.

Evidence From Field Observations.—Additional information concerning the probable relationship between gray bark and anthracnose was obtained from the spraying experiments described on pages 291 and 292. In these experiments the pit lesions typical of anthracnose appeared in much greater numbers on the unsprayed plants. These plants had been sprayed in the delayed dormant stage when the shoots which were later infected were either in the bud or under the ground. Therefore the shoots which were later exposed to infection were not covered by any spray material.

If infection had resulted from spores carried from a distance, all plants, both sprayed and unsprayed, would have showed approximately the same number of lesions. It seems reasonable to suppose, therefore, that infection on the unsprayed plants came from the immediate vicinity. This was further evidenced by the location of the lesions on the fruiting laterals. These were always more abundant near the gray bark infected cane than at a distance. The new shoots which were under the old canes were more heavily infected than those near the outside of the rows. Furthermore, while superficial lesions on the unsprayed canes produced abundant conidia, those on the sprayed canes were barren or rarely developed a few conidia.

After the isolation tests had established the possible close relationship of the gray bark fungus with *Plectodiscella veneta* there came to the attention of the authors an English publication by Harris,¹ who appears to have been the first to describe the superficial cankers caused by the late infection on red raspberries. His description of these is as follows:

"During the seven seasons (1924-30) in which the disease has been under observation a considerable infection of the canes of susceptible varieties has taken place late in the season, i.e., from the latter part of August onwards. The result of these infections has been the appearance, late in the season, of large numbers of small circular purple spots not larger than 1 mm. in diameter. These spots unlike the earlier infections, do not grow further in size or become sunken, but as the canes in ripening change from green to brown, they become grayish white in color, and from early October onwards, are seen to be covered with minute black dots just visible to the naked eye and easily seen with a lens. These dots are acervuli or fructifications of the causal fungus, on which summer spores or conidia are produced and from many of them ascospores will be ejected the following spring."

DISCUSSION

It seems evident that the so-called "gray bark" disease is one phase of a disease similar to, if not identical with, that of anthracnose of black raspberries. In the late summer, infection takes place on the new canes which are to produce the crop the following year. The infected areas continue to develop during the autumn and as the cane changes from green to brown they appear as white or light grayish areas. The fruiting bodies, or acervuli, are produced as small groups of brown cells at this time but do not function until spring. That spore production in these acervuli appears to be tied up with the seasonal development of the plant is evidenced by the fact that dormant canes brought into the laboratory and placed under moist conditions do not

¹See citation on page 286.

result in spore production, while if brought in in early spring spores are produced within a few days.

In the spring the acervuli on the gray bark lesions produce conidia in abundance and these are washed onto the lateral fruiting shoots and later onto the new canes, resulting in pit lesions typical of anthracnose. It is these pit lesions which are responsible for the most damage to the plants, since they may be numerous enough to stunt the fruiting shoots. It is probable that the gray bark phase causes little damage. The pit lesions produce the spores which are later responsible for the gray bark superficial lesions.

CONTROL

Before the true nature of the fungus was discovered it was thought that bordeaux sprays applied in the latter part of the summer would control the gray bark disease. On this assumption several growers made applications in July and August of 1930. Owing to the very dry summer, no gray bark developed that autumn. Since the dormant canes were not infected, the disease did not appear in the anthracnose stage in the spring of 1931. Few growers attempted further spraying in 1931, so that no evidence was secured as to the effectiveness of these late applications.

As soon as it was discovered that gray bark was a stage of anthracnose, the possibility of control by the use of a delayed dormant spray was suggested. Spraying experiments were conducted on the University farm on Latham, which was heavily infected with the gray bark disease in 1931.

The sprays applied were: (1) bordeaux mixture 12-12-100 to which 1 pint of fish oil was added; (2) liquid lime sulfur 1-12.

Three rows were sprayed with each of the above materials and four rows were left unsprayed to serve as checks.

A single application was made on April 8, at which time the tips of the leaves were pushing from the buds. No later sprays were applied since it had been found in spraying for anthracnose that the delayed dormant spray was the most important one and it was thought best to avoid possible injury by later applications.

By the middle of May it was apparent that the fruiting laterals of the check were much more heavily infected than were those of the sprayed rows.

On May 31 the infection was advanced to the point where definite counts could be made. The results obtained are recorded in the accompanying table.

RESULTS OF SPRAYING LATHAM RASPBERRIES FOR THE
CONTROL OF GRAY BARK

Treatment	Total canes examined	Percentage infection on fruiting laterals			Percentage infection on new shoots		
		None	Light	Severe	None	Light	Severe
Unsprayed.....	200.....	.5	17.5	82	.....	.....	.....
	115.....	.....	.....	.....	26.96	12.17	60.87
Bordeaux 12-12-100...	200.....	87	10.5	2.5	.....	.....	.....
	113.....	.....	.....	.....	99.12	.88	0
Lime sulfur 1-12.....	200.....	79	17	4	.....	.....	.....
	100.....	.....	.....	.....	99	1	0

It is evident from these results that a single application of a dormant spray, either lime sulfur or bordeaux mixture, will control anthracnose or gray bark if applied at the proper time. Apparently the effectiveness of the spray is due to the fact that the initial development of conidia in the overwintering acervuli is prevented. The superficial nature of these acervuli aids in making the spray more effective. It is necessary to have a thoro coverage of the canes in order to secure effective control.

SUMMARY

1. The disease of red raspberries known as "gray bark" is generally distributed over Illinois and is especially prevalent on the Latham variety.
2. The gray bark phase of the disease may appear in epidemic form without serious injury to the plants.
3. As a result of these investigations gray bark of red raspberries was definitely determined to be a phase of a much more serious disease, similar to, if not identical with, anthracnose.
4. Control was secured by applying a single delayed dormant spray which served to prevent the discharge of spores from the overwintering acervuli.





UNIVERSITY OF ILLINOIS-URBANA

Q 630 71L6B C002
BULLETIN URBANA
377-389 1932-33



3 0112 019529228