

INDIANA PLANT DISEASES, 1923.¹

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This is the fifth of a series of annual summaries² of the plant disease situation in Indiana and is based upon a report prepared for the Federal Plant Disease Survey Office.

WEATHER CONDITIONS

The general features of the weather during the growing season may be noted by reference to figure 1 in which the departures from normal

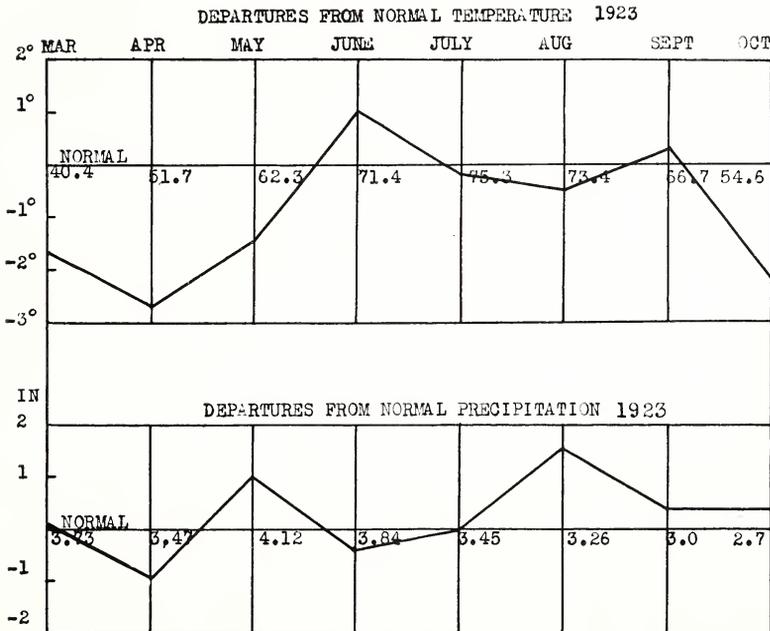


Fig. 1. Departures from normal temperature and precipitation, 1923, based upon monthly averages supplied by J. H. Armington in the Indiana Section of "Climatological Data."

¹ Contribution from the Botanical Department of Purdue University Agricultural Experiment Station, LaFayette, Ind.

² The writer wishes to acknowledge the co-operation of H. S. Jackson, E. B. Mains, G. N. Hoffer, J. B. Kendrick, C. T. Gregory, F. P. Cullinan, Laurenz Greene, C. L. Burkholder, F. C. Gaylord, H. H. Swaim, C. E. Baker, H. D. Brown, and E. J. Kohl.

³ Gardner, Max W. Indiana plant diseases, 1919. Proc. Ind. Acad. Sci. 1919:135-156. 1921. Indiana plant diseases, 1920. Same, 1920:187-208. 1921. Indiana plant diseases, 1921. Same, 1923:163-201. 1924. Indiana plant diseases, 1922. Same, 1923:202-211. 1924.

temperatures and precipitation are plotted. The salient features are the cool weather of March, April, and May, the high rainfall in May, and the hot dry June followed by a cool July and a cool very wet August. The cool wet May greatly favored apple blotch and fireblight and crown rust of oats. The wet weather in August increased the severity of tomato leaf spot, apple bitter rot, and brown rot of stone fruits. The cool July and August lessened the severity of the Fusarium wilt and yellows diseases.

DISEASES ARRANGED ALPHABETICALLY BY HOSTS.

Alfalfa: Leaf spot due to *Pseudopeziza medicaginis* was severe and more or less co-existent with its host. Mains found the leaf blotch due to *Pyrenopeziza medicaginis* and reported rust (*Uromyces medicaginis*) less prevalent than usual. A root rot characterized by the blighting of the tops in circular areas in the field and the presence of black lesions on runners and roots was noted in June in Marshall County. In October another type of root rot characterized by black, scabby, elevated, elliptical lesions on the root cortex occurred in Laporte County.

Apple: Blotch⁴, caused by *Phyllosticta solitaria*, was worse than usual, due probably to the high rainfall in May. Fruit infection was noted as early as June 7 on Ben Davis in Orange County, and petiole infection was observed June 11 at Lafayette. Considerable fruit infection occurred on Grimes and Jonathan in the vicinity of blotch carriers. The 2-, 4-, and 6-weeks spray schedule failed to prevent early fruit infection in southern Indiana, especially on Rome, and the addition of an earlier spray seems advisable in that region. Cankers were noted on Grimes, Winter Maiden Blush, and Fallawater and fruit infection was noted on Fallawater, Red June, Oliver, Doctor Mathews, Turley, Clayton, White Pippin, Siberian crab, Fameuse, Gideon, Arkansas, Salome, Winter Banana, and Ralls. A trace of leaf infection was noted on Jonathan. Blotch was reported on the Mann variety in Fulton County, and was found on a few Mann and Oldenburg trees in Miami County. In a young orchard in Miami County a careful search revealed blotch cankers of nursery origin on only one tree. In a shipment of nursery trees of susceptible varieties, cankers were found on four of the ten Ben Davis, four of the five Rome, and three of the ten Oldenburg trees. The presence of the blotch fungus in the outer scales of terminal buds taken from badly diseased Oldenburg trees at Mitchell in October was proved in the case of four out of 22 buds by tissue cultures in agar plates.

Scab, caused by *Venturia inaequalis*, was less severe than usual owing probably to the low rainfall in April. Under Indiana conditions, Cullinan and Baker⁵ have found that the pre-pink spray is necessary for scab control, in addition to the pink, petal-fall, and 2-weeks sprays, and that sulfur dust is unreliable. In Indiana, scab is particularly severe

⁴ Gardner, Max W. Apple blotch in Indiana. Trans. Ind. State Hort. Soc. 63 (1923):71-80. 1924.

⁵ Cullinan, F. P., and Baker, Clarence E. Lime sulfur sprays versus sulfur dusts for apples. Purdue Univ. Agr. Exp. Sta. Bul. 283:1-22. 1924.

on Delicious, Winter Banana, Ben Davis, Fameuse, Red June, Rome, and Moyer, while York, Grimes, and Transparent show considerable resistance. Pin-head fruit lesions were found on June 4 on Jonathan and Grimes in Clark County, on June 8 on Northwestern in Fountain County, and on Delicious in Brown County on June 19. Owing possibly to the cool wet August there was considerable late fruit infection, much of which developed in storage in the shape of jet-black lesions or jet-black extensions from field lesions.

Black rot, caused by *Phytophthora malorum*, was worse than usual this year, particularly in its frog-eye leaf spot phase. The latter was first noted June 1 in Montgomery County and there was little evidence this season that the scab and blotch sprays control this disease. Much of the shot-hole effect was noted. The Delicious variety showed some degree of resistance to frog-eye spot. Zonated, calyx-end, fruit lesions on Ben Davis were noted in Gibson County on July 25. Black rot was serious on Rome fruit on the trees in Orange County as a secondary invader of cracked blotch lesions. Mummies were noted on Neverfail trees in October. Black rot cankers following rust lesions on 1922 twigs of Rome were noted in Orange County. In general black rot canker is not a serious problem except in old, neglected orchards. As a rule the cankers remain more or less superficial and do not penetrate to the cambium.

The outstanding apple disease of the season was the severe epiphytotic of fireblight (due to *Bacillus amylovorus*), the worst that had occurred in a number of years. It is probable that the high rainfall of May bore some causative relationship to this outbreak. There appeared to be two waves of infection, one of blossom blight in late May and a more serious outbreak of twig blight early in June. The disease was worse in the southern two-thirds of the state and was recorded from 18 counties. In a large orchard in Franklin County, in which the disease has been present to a certain extent every season, old cankers were found in only one tree, an isolated Esopus. This tree has very likely served as a perennial source of infection. In certain other orchards, near-by pear trees served as sources of primary infection.

Observations upon varietal susceptibility in orchards of mixed varieties were made with the assistance of Mr. Cullinan. In general it may be said that Jonathan suffered severely, as did also Esopus and young Maiden Blush. The disease was somewhat less serious on Rome, Transparent, King, Vandevere, Wealthy and Rambo, and occurred to a considerable extent on Northern Spy, Early Harvest, Winesap, Stayman, Indian, Black Twig, York and Stark. Very light infection was noted on Oldenburg, Akin, Russett, Ben Davis, Baldwin, Astrachan, Wolf River, and Delicious. Grimes showed very little twig blight but suffered considerably from blossom blight. In a block of young Oldenburg trees which were badly blighted in 1922, very little occurred this year. The occurrence of blight in this block seems to be correlated with the seasons in which there is bloom in a large pear orchard about one mile distant and this year there was no bloom in this pear orchard. Of the important commercial varieties, Delicious showed marked resistance

to twig blight, Grimes somewhat less, Winesap and Stayman less than Grimes, Ben Davis and Oldenburg still less, while Rome and Transparent proved rather susceptible.

Because, no doubt, of the high rainfall in August, bitter rot, caused by *Glomerella cingulata*, was destructive locally in southern Indiana. In one large orchard in Warrick County in which the disease was severe in 1922, it was worse this year and appeared a month sooner (June 26) even though Bordeaux sprays were applied. This orchard was visited on July 25 and it was found that the disease was most severe on Collins, especially on trees with limbs killed by the San Jose scale and under mummied 1922 fruits that remained hanging in the trees. Grimes was less severely infected. Late in August a scattered infection of bitter rot occurred in a well-cared-for orchard in Knox County. Usually there was only one lesion on each fruit and no mummies nor cankers could be found. The infection occurred on Winesap, Jonathan, and Grimes. Considerable scale-killed wood had been removed from this orchard the previous winter and piled in a gully near the section in which bitter rot occurred. It is suspected that this outbreak was due to wind-borne ascospores of the fungus, since the organism was found to produce ascospores readily in culture on agar and on apple twigs. Scattered infection was also found on four unsprayed Grimes trees in a large orchard in Orange County. This variety, because of its susceptibility to spray injury, and the consequent tendency for growers to omit the fungicidal sprays, presents a real problem in a bitter rot epiphytotic. The disease also occurred in Brown and Franklin counties. A suspicion, perhaps not any too well founded, is felt that the bitter rot fungus may establish itself in wood killed by San Jose scale and spread thence to the fruit the next wet season.

Rust (*Gymnosporangium juniperi-virginianae*) was much less severe than in 1922 and was noted on Vandevere, Jonathan, Rome, and Wealthy foliage. Very little fruit infection was found.

Blister canker, caused by *Nummularia discreta*, was reported from six counties. While Ben Davis is its usual host, Gregory found it on Transparent. One orchardist in Miami County has succeeded in eliminating the disease from an orchard of Grimes and Ben Davis by drastic cutting-out methods.

Sooty blotch (*Phyllachora pomigena*) was extremely severe this year, due apparently to the rains in September, and was a very objectionable blemish on light varieties such as Grimes where careful grading was practiced. In Orange County this disease appeared the last week in September and was worst on shaded limbs and north slopes. It was especially bad on limbs shaded by vines such as Ampelopsis. One specimen of the fly speck fungus on an apple twig was sent in from Franklin County.

Another result of the wet summer was the occurrence of Phytophthora rot in the same localities in Tippecanoe and Miami counties where it occurred in 1921. At Lafayette, the three Grimes trees in a low spot that were affected in 1921 were again affected this year.

Brown rot (*Sclerotinia* sp.) occurred on apples shipped from Orange Co. and spongy dry rot, caused by *Volutella fructi*, occurred on

Wealthy near Lafayette. Core mold⁶, usually an *Alternaria* sp., was found rather commonly in Delicious, Stayman, and Winesap, and was usually attributable to a short, open, calyx tube. *Alternaria* spots centered around lenticels were found in stored fruit (Ralls).

Among the non-parasitic diseases, bitter pit was much worse than usual this year, especially on Grimes and Stark, and was noted on Moyer, Baldwin, Esopus, Stayman, and McIntosh. On Grimes the lesions were frequently so near the skin as to produce a brown, necrotic, surface spot. Jonathan spot occurred on Jonathan, and occasionally on Grimes and Rome. Brown bark spot was sent in from Spencer Co. Bordeaux russet occurred on Ben Davis sprayed for blotch and Grimes and Collins sprayed for bitter rot. Frost bands were noted on Delicious in Franklin Co. Storage scald occurred on Grimes. On badly scalded R. I. Greenings it was noted that definite zones around bitter pit lesions and around wounds remained free from the discoloration. In storage tests, Baker⁷ found that shredded paraffin paper scattered through the barrel gave a good control of scald in Grimes.

Barley: Gregory noted loose smut, covered smut, leaf rust, and stripe (*Helminthosporium gramineum*) in Harrison Co. and reported that loose smut caused losses of 12 to 47 per cent where untreated seed was used.

Bean: Blight, caused by *Bact. phaseoli*, was not as serious as usual. In a plot of 59 varieties planted late, Golden-eye Wax, White Dutch Runner (*Phaseolus coccineus*, var. *albus*) and Scarlet Runner (*P. coccineus* L.) escaped infection and only a trace occurred on Lazy Wife, Horticultural Cranberry, and Rustless Golden Wax. Infection occurred on White Dutch Case-knife, a variety of *P. vulgaris* erroneously cited as *P. multiflorus* in the 1921 report (p. 172). Bacterial blight infection was also found on the native weed, trailing wild bean (*Strophostyles helvola*), at Lafayette.⁸

Mosaic, mostly of seed origin, was noted in 38 of the 59 varieties above mentioned. Of the bean varieties escaping infection in 1921 and 1922, Black Valentine showed eight per cent mosaic while Wardwell's Kidney Wax remained free from mosaic. Mosaic was also noted on White Dutch Runner (*Phaseolus coccineus* var. *albus*), broad bean (*Vicia faba*), three varieties of velvet bean (*Stizolobium deeringianum*), and by Mains on trailing wild bean (*Strophostyles helvola*).

Anthrachnose (*Colletotrichum lindemuthianum*) was rather general in gardens for the first time in at least five years, and its severity was no doubt attributable to the wet season. Fusarium wilt was noted near Lafayette.

Lima and sieva beans: The disease previously reported as due to *Phyllosticta phascolina* has proved to be the bacterial spot disease re-

⁶ Longyear, B. O. A new apple rot. Col. Agr. Exp. Sta. Bul. 105:1-12. 1905.

⁷ Baker, Clarence E. The use of oiled wraps in the prevention of storage troubles. Trans. Ind. Hort. Soc. 63 (1923):80-85. 1924.

⁸ Gardner, Max W. A native weed host for bacterial blight of bean. Phytopath. 14:341. 1924.

cently described by Tisdale and Williamson⁹. The causal organism has been found by cross inoculation and cultural tests to be identical with *Bact. vignae*¹⁰. This is a very common and rather destructive disease of lima beans in gardens, especially in wet seasons, but has not been noted in the canning crop. Other hosts of this parasite are cowpea, catjang, Adsuki bean, velvet bean, bonavist or hyacinth bean, and tick trefoil.

Beet: Leaf spot, due to *Cercospora beticola*, was worse than usual this year. It was reported destructive on mangels in Jefferson Co. and was noted on sugar beets in Lake Co. The peculiar leaf-rolling mosaic disease described in the 1921 report was noted on sugar beets and on red and yellow mangels. Severe losses from damping-off were reported in the sugar beet fields. Damping-off necessitates replanting which results in later maturity, a condition reported to be associated with a low sugar content.

Blackberry: Leaf spot, due to *Mycosphaerella rubi*, was found in Sullivan Co. Orange rust (*Kunkelia nitens*) was occasionally serious in plantations and was reported to have killed one patch in Floyd Co. The leaf rust (*Kuchneola albida*) was sent in from Bartholomew Co. in the fall. Anthracnose (*Plectodiscella veneta*) was noted on wild and cultivated plants, but is not nearly as serious as on black raspberries. Burkholder reported the Eldorado variety relatively resistant to this disease.

Buckwheat: Leaf infection of *Ramularia anomala* Pk.¹¹ was found by Mains near Lafayette in the fall. The fungus was isolated and successful inoculations of buckwheat and the common black bindweed (*Polygonum convolvulus*) were obtained in the greenhouse.

Cabbage: Yellows¹², due to *Fusarium conglutinans*, was much less destructive than usual, due to the cool season. However, Gregory had reports of the disease from practically every county in the state. Dr. J. C. Arthur found this disease on sea kale (*Crambe maritima*). Black rot, due to *Bact. campestre*, was worse than usual, according to Gregory, who reported fields ruined by this disease in Jackson Co. Gregory also found black leg, caused by *Phoma lingam*, very serious in market gardens. Club root, hitherto reported only from Lake Co., was found in LaPorte by Dr. G. K. K. Link.

Cantaloupe: Bacterial wilt was less severe than usual. Mosaic was very severe in August in Tippecanoe and Knox counties. The mosaic carriers, milkweed, pokeweed, and ground cherry, are very abundant in Indiana. The *Alternaria* leaf blight was serious in Knox Co., particularly in fields used previously for this crop.

⁹ Tisdale, W. B., and Williamson, Maude Miller. Bacterial spot of lima bean. Jour. Agr. Res. 25:141-155. 1923.

¹⁰ Gardner, Max W., and Kendrick, James B. Bacterial spot of cowpea and lima bean. In press, Jour. Agr. Res.

¹¹ Davis, J. J. Notes on parasitic fungi from Wisconsin VI. Trans. Wis. Acad. Sci. 19:705-715. 1919.

¹² Gregory, C. T. Cabbage yellows. Purdue Agr. Ext. Bul. 104:1-8. 1922.

Carrot: Nematode root-knot occurred in a garden near Lafayette.

Celery: The *Fusarium* yellows disease (fig. 2) of the Golden Self-blanching variety was less severe than usual. Early blight, due to *Cercospora apii*, was very serious.



Fig. 2. The *Fusarium* yellows disease of celery. The rows in the foreground show blank spaces and yellowish stunted plants due to this disease. Resistant variety in the background. The diseased plant at the right is sliced longitudinally to show the brown discoloration of the interior tissues of one side of the crown, a condition characteristic of advanced stages of the disease.

Cherry: Leaf spot, caused by *Coccomyces hiemalis*, remains the worst disease of cherries, and causes premature defoliation and consequent devitalization of the trees. Brown rot, due to *Sclerotinia cinerea*, was much worse than usual, both as a blossom blight and a fruit rot. Powdery mildew (*Podosphaera oxycanthae*) was more prevalent than usual.

Clover: Powdery mildew, so prevalent in 1922, occurred only to a slight extent this year. Mosaic was of common occurrence. A leaf spot of alsike clover due to *Cercospora zebrina* Pass. was found by Mains at Lafayette. The sooty leaf spot of white clover due to *Phyllachora trifolii* was very prevalent in Lafayette in the fall.

Corn: Bacterial wilt caused by *Aplanobacter stewartii* was destructive on Golden Bantam sweet corn in gardens. Smut was more prevalent and rust was less prevalent than usual. Frost found *Physotherma zae-maydis*. Hoffer reports a five per cent loss in the crop due to root, stalk, and ear rots caused by *Gibberella* and *Fusarium* species.

Cowpea: Bacterial spot, caused by *Bact. vignae*, occurred in a number of cowpea varieties and catjang peas at Lafayette and was noted in Knox Co. The same organism attacks lima bean, Adzuki bean, velvet bean, bonavist or hyacinth bean (*Dolichos lablab*), and the weed,

tick trefoil (*Desmodium canescens*) (see footnote 10). Mosaic was noted to a limited extent in Knox Co. and in experimental plots where it occurred in four varieties and on the catjang (*Vigna catjang*) and the asparagus bean (*V. sesquipedalis*). A Cladosporium spot disease occurred on the pods of the Early Buff variety of cowpeas in the experimental plots.

Cucumber: Bacterial wilt, caused by *Bacillus tracheiphilus*, was less serious than usual. Mosaic was worse than usual and is the limiting factor in the crop grown for pickling purposes, owing to the increasing reservoir of mosaic in the weed carriers, milkweed, pokeweed, and ground cherry. This disease has caused the abandonment of many salting stations in the state and it is due largely to the inroads of this disease that the usual period of operation of a salting station in any one locality is only 10 to 12 years. Anthracnose (*Colletotrichum lagenarium*) was serious in certain greenhouses and further evidence of the relation of overhead watering to this disease was obtained. Watering with a hand hose is preferable to the overhead sprinkler system. Downy mildew (*Peronosplasmopara cubensis*) occurred in the same greenhouse at Terre Haute in which it was noted in 1920.

Eggplant: Fruit spot, due to *Phomopsis vexans*, was worse than usual. Mosaic was noted in plantings near mosaic peppers. Phytophthora rot occurred in the same garden in which it occurred in 1921.

Grape: Black rot, caused by *Guignardia bidwellii*, was worse than usual. Downy mildew (*Plasmopara viticola*) was found destroying the fruit clusters in Pulaski Co. early in August.

Lettuce: Gregory found downy mildew (*Bremia lactucae*) worse in greenhouses in southern Indiana than around Indianapolis and found drop, caused by *Sclerotinia libertiana*, serious in the winter crops. He also found nematode root-knot in one greenhouse. The stunting apparently due to an excess of soluble salts in the soil was probably the worst difficulty with greenhouse lettuce.

New Zealand spinach (*Tetragonia expansa*): The Cercospora leaf-spot (fig. 3) occurred mainly on the older leaves and the lesions were seldom abundant. The fungus has not sporulated in culture, hence spore inoculations have not been made.

Oats: Halo blight, due to *Bact. coronafaciens*, was found near Lafayette by Hoffer. The smuts were generally prevalent, as usual, and Gregory noted losses as high as 15 per cent where untreated seed was used. Mains found crown rust worse than usual, causing a two per cent loss, and attributes this to the low spring temperatures.

Onion: Smut (*Urocystis cepulae*) has been found only in Lake and Jasper counties. Fusarium rot, neck rot, and bacterial soft rot were reported by the federal Bureau of Markets in a very small percentage of Indiana carlot shipments.

Pea: Among seven varieties of peas grown in pots in the greenhouse, bacterial spot, caused by *Bact. pisi*, occurred in one variety

(American Wonder) apparently as a result of seed-borne infection, a phenomenon previously observed by Coons²³. Kendrick isolated the organism and with it obtained infection of sweet peas (*Lathyrus odoratus*) as well as field peas.

Peach: Bacterial spot, caused by *Bact. pruni*, was the worst disease in commercial orchards. The fruit attack was much worse than usual on Elberta and Hale in Knox Co., and very large fruit lesions were produced on Redbird. However, the premature defoliation is the most serious effect of this disease. The Elberta variety proved fully as susceptible as Hale this season.

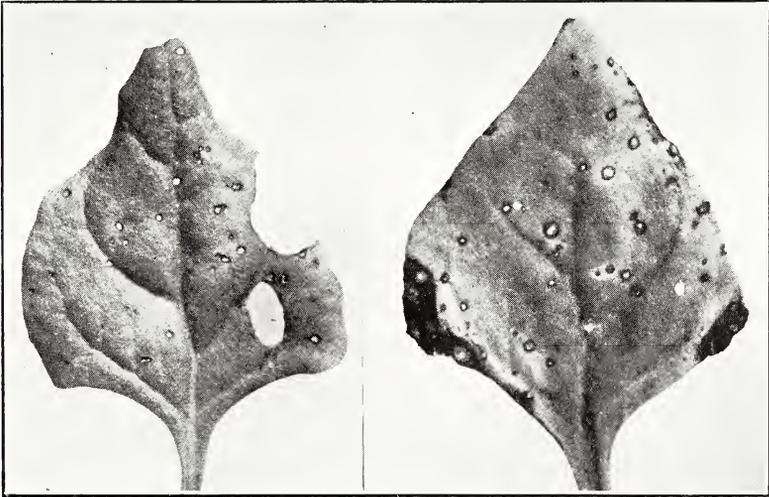


Fig. 3. *Cercospora* leaf spot of New Zealand spinach.

In an experimental block of badly infected young Elberta trees in Lawrence Co., Cullinan made a test of sodium nitrate applications at the rate of three and five pounds per tree in 1922 and 1923. Mr. H. E. Newland kept a record of the rate of defoliation of 18 trees representing the different treatments and was unable to demonstrate any beneficial effects from any of the treatments. His records do show, however, the amazing rapidity of defoliation caused by this disease. During the nine-day period between July 26 and August 3, single trees lost as many as 1226, 1340, 1538, and even 1848 leaves, the lowest loss being 314. The average daily rate of leaf fall varied from 52 to 205 per tree, a condition which is really appalling and which forcibly demonstrates the destructiveness of this disease in southern Indiana.

The data presented above were obtained after a period of dry weather. After the abundant rainfall of early August, another series of counts were made on the same trees covering the five-day

²³ Coons, G. H. Michigan plant disease survey for 1917. Mich. Acad. Sci. Rep. 20 (1918):425-450. 1919.

period from Aug. 15 to Aug. 20 and the average daily rate of defoliation was found to be much lower, ranging from 8 to 56 per tree.

Adjacent to this block of Elbertas were single row plantings of a number of other varieties, all badly infected. Newland also counted the leaves which fell from two representative trees of each of these varieties during the two-day period, Aug. 3 and 4, and the six-day period, Aug. 15 to 20 inclusive. The average daily leaf fall per tree among the different varieties was as follows: Greensboro, 34; Champion, 23; Salwey, 20; Gold Drop, 19; Rochester, 19; Heath, 15; Big Red, 15; Krummel, 12; Crosby, 12; Belle, 11; Captain Ede, 10; Hale, 9; Carman, 6; Hiley, 5. Here again, the rate of leaf fall was much lower during the second than during the first period, possibly because of the intervening rainfall.

No bacterial spot had been noted in the Elberta block until these varieties were planted adjacent to it and the evidence indicated that the disease had been brought in with the later planting. Certain older orchards have remained free from the disease and it seems very certain that it is carried on nursery stock. Coalescent marginal infection of the leaves was noted on Carman, Belle, and Krummel. An exudate was noted (July 30) on the lower epidermis of the leaf lesions on Rochester and red globules of gum were noted on the cankers on Krummel and Crosby.

Leaf curl, caused by *Exoascus deformans*, was very serious on unsprayed trees in May, causing defoliation. A few red, wart-like, fruit lesions were noted. Cullinan found the disease severe on all of the 15 varieties above mentioned. Scab, caused by *Cladosporium carpophilum*, and brown rot, caused by *Sclerotinia cinerea*, were worse than usual, the latter occurring to a considerable extent even in the best orchards. The fruit rot caused by *Rhizopus nigricans* was noted in Knox county. Sunscald of the fruit occurred locally.

Pear: Fireblight was very destructive throughout the state, although not as severe on pears as on apples. Scab, due to *Venturia pyrina*, and sooty blotch (*Phyllachora pomigena*) were noted.

Pepper: In an experimental garden, Phytophthora rot was noted and mosaic was especially severe on Chili peppers, among which the mosaic plants failed to set fruit.

Plum: Black knot was reported from Hamilton, Randolph, and Shelby counties. Leaf spot, due to *Coccomyces prunophorae*, was noted on the Burbank variety, and in one case observed, a Japanese plum adjacent to badly diseased native varieties remained free from infection. Twig infection (1922) of *Exoascus pruni* was noted in Montgomery Co. Brown rot was much worse than usual.

Potato: The Fusarium wilt was not serious this year. This disease as it occurs in Indiana closely resembles in its symptoms the wilt caused by *Fusarium eumartii*¹⁴, and the low temperature requirements

¹⁴Goss, R. W. Potato wilt and stem-end rot caused by *Fusarium eumartii*. Neb. Agr. Exp. Sta. Res. Bul. 27:1-83. 1924.

of this fungus as compared with *F. oxysporum* would assist in explaining why the disease has usually been more prevalent in northern than in southern Indiana. Gregory noted black leg on Cobblers in June in Vanderburgh Co. and Kendrick found the disease serious near Indianapolis on July 3. This disease appears to be serious only in the early crop. Gregory reported the canker effect of *Rhizoctonia solani* serious in the late crop in St. Joseph Co., and the black scurf stage was very prevalent. Early blight was worse than usual and scab occurred very generally.

Our tests¹⁵ have shown that leaf roll is the chief cause of the degeneration of Rural seed stocks and the consequent decreased yields in the late crop. The disease was also noted in June in the early crop in southern Indiana. Mosaic can be recognized in the field with more certainty than leaf roll and has proved to be rather prevalent in the early crop. The stipple streak type of mosaic seems to predominate. Greenhouse tests carried out by Brown and Hoffman showed the presence of much of this type of mosaic in Cobbler seed stock from southern Michigan. Under Indiana conditions, mosaic has such a destructive effect that, fortunately, it tends to eliminate itself. Mosaic lowers the germinability of the seed tubers very materially and such tubers as do germinate usually send up stunted, weak sprouts which die early in the season and hence do not long exist as sources of infection. Very few plants from mosaic seed ever produce any tubers.

Radish: Black root, caused by *Nematosporangium aphanidermatum* (Edson) Fitzpatrick, was serious in gardens in the spring. In a plot of 22 varieties on infested soil, Kendrick¹⁶ found that the White Chinese variety showed some degree of resistance. The disease was found in one instance in sod land not previously used for radishes at least for a period of five years or more.

Black raspberry: Anthracnose, caused by *Plectodiscella veneta*, was the limiting factor in this crop inasmuch as the disease seems to be almost co-existent with its host and its effects frequently prevent any profit because the bearing canes are girdled and die just before the crop of fruit is matured. Fruiting spurs are also seriously injured and leaf infection is common but not particularly injurious. While the more destructive type of infection, that near the bases of the canes, occurs early in the spring, new infection was found on the growing tips until rather late in the season (Aug. 15). Abundant infection was noted on wild plants.

A number of patches were examined in Floyd, Brown, and Montgomery counties where co-operative spray tests were conducted by Burkholder and it was found that good control was obtained with the Wisconsin schedule¹⁷. Burkholder has found it unsafe to use lime-sulphur

¹⁵ Gardner, Max W., and Kendrick, James B. Potato leaf roll in Indiana. Purdue Univ. Agr. Exp. Sta. Bul. 284:1-23. 1924.

¹⁶ Kendrick, James B. Infection-court in radish black-root. Abs. in Phyto. 14:66. 1924.

¹⁷ Jones, Leon K. Anthracnose of cane fruits and its control on black raspberries in Wisconsin. Wis. Agr. Exp. Sta. Research Bul. 59:1-26. 1924.

for the second spray in Indiana. In one patch, the Plum Farmer variety showed more resistance than Cumberland, the variety generally grown in this state. Leaf spot, caused by *Mycosphaerella rubi*, was worse than usual, especially in southern Indiana. Crown gall was reported.

Next to anthracnose, the virus disease, leaf curl, is probably the most serious disease of this crop and was found very destructive in three out of 13 fields examined. It occurred in the Cumberland and Scarf varieties and also on wild bushes. Mosaic was found on the Scarf variety and eastern bluestem in the Cumberland variety in Montgomery Co. by R. B. Wilcox.

A wilt disease apparently of fungus origin was very destructive in one patch of the Scarf variety in Montgomery Co. in July. The leaves on the young canes wilted or turned yellow and the canes died one at a time. A broad, dark blue stripe under which the wood and pith were brown usually involved one side of each diseased cane. The disease resembled cane blight in some respects although no pycnidia of the fungus were found on the canes. Kendrick isolated a pycnidial fungus from the discolored tissues of the canes.

A root rot was found in Brown and Floyd counties in June and was probably attributable to poor soil inasmuch as heavily fertilized plants had apparently escaped the disease. Kendrick isolated a similar *Fusarium* from the root tissues in both cases.

Red raspberry: Mosaic was found on the Cuthbert variety in Montgomery Co. and Burkholder reports crown gall prevalent in this variety. Anthracnose is not nearly as severe as on the black varieties.

Rye: Gregory found anthracnose of considerable importance in Pulaski Co. Mains reported leaf rust less prevalent than usual. He has found no resistant varieties but has developed resistant strains within the varieties¹⁸.

Soybean: Mosaic was found serious in one commercial field in LaPorte County by F. E. Robbins who noted the disease in only four out of 27 fields examined. Bacterial blight caused by *Bact. glycineum* was widespread, as usual. Kendrick found a few cases of the stem rot due to *Diaporthe sojae* in LaPorte Co. in the varieties Midwest and Dunfield.

Strawberry: Leaf spot, caused by *Mycosphaerella fragariae*, was worse than usual and occasioned numerous complaints. The disease is carried with transplants and thus secures an early start in new beds. In a large planting in Montgomery Co. the Roosevelt variety proved much more susceptible than Gibson, Everbearing, or Charles the First. Gregory found the Parson's Beauty, Kellogg's Rockhill, Dunlap, and Glenmary varieties very susceptible in Jefferson Co., while Aroma and Progressive showed resistance. Leaf scorch¹⁹, caused by *Mollisia carli-*

¹⁸ Mains, E. B., and Leighty, C. E. Resistance in rye to leaf rust, *Puccinia dispersa* Erikss. Jour. Agr. Res. 25:243-252. 1923.

¹⁹ Stone, R. E. Leaf scorch or Mollisiose of the strawberry. Phyto. 12:375-380. 1922.

ana, was found in Montgomery and Gibson counties. One case of what resembles a mosaic disease, characterized by a yellowing and stunting, occurred among a plot of Everbearing plants received from a Michigan grower.

Sweet potato: Black rot, caused by *Ceratostomella fimbriata*, was found in Warrick and Vigo counties.

Tobacco: Blackfire, caused by *Bact. angulatum*, and wildfire, caused by *Bact. tabacum*, were found serious in Spencer, Floyd and Clark counties by Gregory, who also found root rot due to *Thielavia basicola* in Jefferson Co., frog-eye spot, caused by *Cercospora nicotianae*, in Parke Co., and mosaic along the Ohio River generally. Kendrick inoculated tobacco plants in the greenhouse with the virus of the winter blight stage or type of tomato mosaic and obtained typical mosaic mottling and also a necrotic spotting of the tobacco leaves, a mosaic symptom in tobacco recognized in 1886 by Mayer²⁰ and by Beyerinck in 1898 and Koning²¹ in 1899. Many workers have held that necrotic spotting does not occur as a manifestation of the mosaic disease of tobacco. Iwanowski in 1890 described this as "pockenkrankheit" and in his later work²² holds that it is a separate and distinct disease. Hunger²³ agrees with Iwanowski. But Kendrick's results indicate that Mayer, Beyerinck, and Koning very likely were correct in their interpretation of the symptom.

Timothy: Stripe smut (*Ustilago striaeformis*) was found at Lafayette in June, and the same fungus was also found on *Poa compressa*.

Tomato: There was an extremely destructive epiphytotic of Septoria leaf spot in the canning crop due to the wet weather in August. The rainfall during that month in Orange Co. was 6.64 inches,—almost 100 per cent above normal. Fusarium wilt was not at all severe in the canning crop, probably because of the cool weather, although it was reported that 18 million southern-grown plants were used in Indiana. In artificially inoculated soil at Kempton, many plants which became infected during the hot weather of June later recovered and produced a crop.

Mosaic was less serious than usual in the canning crop but occurred in its destructive winter blight form in the fall crop in a Lafayette greenhouse. In Indiana it seems to be a dangerous practice to attempt to grow a fall crop of tomatoes in the greenhouse because, until the field reservoir of mosaic is destroyed by frost, it is almost a certainty that the disease will be carried by insects to the greenhouse crop. In connection with the history of the mosaic disease of tomatoes it has been

²⁰ Mayer, Ad. Über die Mosaikkrankheit des Tabaks. Landw. Versuchstation 32:451-467. 1886.

²¹ Koning, C. J. Die Flecken-oder Mosaikkrankheit des holländischen Tabaks. Zeit. für Pflanzenkrank. 9:65-80. 1899.

²² Iwanowski, D. Über die Mosaikkrankheit der Tabakspflanze. Zeit. für Pflanzenkrank. 13:1-41. 1903.

²³ Hunger, F. W. T. Untersuchungen und Betrachtungen über die Mosaikkrankheit der Tabakspflanze. Zeit. für Pflanzenkrank. 15:157-311. 1905.

found that Plowright²⁴ gives an account of what was undoubtedly this disease as it occurred, accompanied by leaf mold, in a greenhouse in England in 1887. With regard to the persistence of the disease in the weed carriers, it is of interest to note that mosaic ground cherry rootstocks planted in a garden in 1920 have sent up mosaic shoots every spring, this year being the third.

In the greenhouse epiphytotic above mentioned, there was, in addition to the typical mosaic mottling of the leaves, an abundance of brown, necrotic spotting of the leaves, streaking of the stems, and wilting and outright blighting of the growing tips. A variety of striking symptoms was evinced by the young fruits. These were characterized by brown, necrotic surface lesions of various shapes and patterns, which are subject to invasion by rot-producing organisms, by patches of brown dead tissue scattered throughout the interior of the fruit, and by the most peculiar malformations and ruptures of the fruit wall caused by the early occurrence of zones of dead cells and their interference with normal development. A histological study²⁵ of the badly affected fruits showed that the disease causes the death of isolated plates or pockets of cells in all of the tissues and organs of the fruit and that the tendency of the surrounding or adjacent cells is to enlarge, divide, and resume growth, crushing the cells of the necrotic region. Thus each necrotic patch is surrounded or bounded by zones of proliferating cells. As a response to a necrosis of the epidermal cells, surface blisters or intumescences are produced by proliferation of the underlying cells, and internal intumescences are also produced on the inner surface of the fruit wall. As a result of the internal proliferations very firm but abnormal adhesions are formed between the fruit wall and the seed pulp and seeds.

Similar necrotic plates and pockets accompanied by a proliferation of the adjacent parenchyma cells were found in the peduncles, pedicels, and stems, especially near the nodes in the stems. Necrotic strips in the cortex of the stem were accompanied by hyperplasia or proliferation of the underlying cells and necrotic cavities were found in the pith. Of peculiar interest was the response to necrotic zones in the xylem. In such cases, hyperplastic growths extended inward from the cambium layer toward the necrotic area, and in longitudinal section it was discovered that these growths were composed of more or less isodiametric parenchyma cells instead of the vascular elements which should normally have been formed. Such abnormal growths invading and traversing the xylem must of necessity interfere with the normal functioning of the conducting tissue, and the possibility is suggested that this may explain the wilting which often occurs in the tips of badly affected plants.

Bacterial spot, due to *Bact. vesicatorium*, was more prevalent than usual in the canning crop owing to the wet weather and the use of so

²⁴ Plowright, Charles B. Tomato disease. *Gardeners' Chronicle*, Ser. 3, Vol. 1, p. 532. 1887.

²⁵ Gardner, Max W. Necrosis, hyperplasia, and adhesions in mosaic tomato fruits. In press, *Jour. Agr. Res.*

many southern plants, grown, to a certain extent at least, from untreated seed.

Early blight, due to *Alternaria solani*, was worse than usual, particularly the collar rot effect which is due to early stem infection in the seed bed or plant bed. Under Indiana conditions early blight may be a serious plant-bed disease in wet seasons such as this was. Gregory found collar rot in Floyd and Jackson counties and it again occurred in Hancock Co. where it caused trouble in 1921. Bacterial wilt, caused by *Bact. solanacearum*, was found in a few plants in a canning crop field in Gibson Co. in June. On August 28 this field was visited and, while many of the infected plants had recovered, cultures proved the organism present in their tissues.

Leaf mold (*Cladosporium fulvum*) was rather prevalent in the field crop about Lafayette in August and caused a yellowing of the older leaves. In a fall greenhouse crop the leaf-mold fungus was found causing a black stem-end rot of both the green and ripe fruits²⁶. It was found that the fungus could not infect the fruit directly because there are no stomata in the fruit at any stage of its development. Fruit invasion results from very early stomatal infection of the sepals, torus, or pedicel and the subsequent growth of the mycelium down into the fruit. Infected fruits are frequently lop-sided with the atrophied side under the sepals which were originally infected. The fungus produces composite mycelial strands or aggregates in the intercellular spaces and rather definite sclerotial bodies. The mycelium seems to accumulate most abundantly in the parenchyma immediately surrounding vascular bundles but does not invade the latter. The fungus invades the hilum end of the seed producing sclerotial bodies both within and upon the seed coat. The endosperm is not invaded. During germination, the cotyledons must emerge through the infected hilum region of the seed coat and, since the fungus sporulates readily, are dangerously exposed to infection. Infected seeds were planted in sterilized soil and a few cases of cotyledon infection occurred, a result which proved that the leaf-mold disease may be seed-borne.

Anthracnose, caused by *Gloeosporium phomoides*, was noted on the fruit in Marion and Gibson counties. Soil rot, caused by *Rhizoetonia solani*, was found early in September in Tipton Co. Buckeye rot, caused by *Phytophthora terrestris*, was found by Kendrick in a few greenhouses near Indianapolis and in the field plot at Lafayette where the disease occurred the year before. The causative fungus evidently persists in the soil.

Watermelon: Anthracnose was very prevalent owing to the wet weather of this season, while the lower temperatures decreased the severity of Fusarium wilt.

Wheat: Loose smut was serious in southern Indiana and Gregory found it very severe in Shelby and Jennings counties. Bunt (*Tilletia laevis*) was worse than usual. Gregory noted speckled leaf blotch due

²⁶ Gardner, Max W. Cladosporium leaf mold of tomato: Fruit invasion and seed transmission. In press, Jour. Agr. Res.

to *Septoria tritici* and found anthracnose killing small areas in wheat fields in Posey Co., a condition attributed in part to the use of old wheat straw as a winter mulch. Beeson, who had charge of the barberry eradication, was able to find very little stem rust and reports that none was found in 20 localities where the disease was severe prior to the removal of barberries. Scab, caused by *Gibberella saubinetii*, occurred in Floyd and Benton counties. Leaf rust was much less prevalent than in 1921 and 1922. Mains attributes this to the failure of the rust to over-winter and the consequent late spring appearance of the disease. In 1921 and in 1922, he found the fungus overwintering locally in abundance.

Forest and shade trees: On slippery elm (*Ulmus fulva*) a leaf spot due to *Phyllosticta ulmicola* was found in Tipton Co. *Microstroma juglandis* was noted on hickory leaves near Lafayette. Bacterial leaf spot of mulberry, due to *Bact. mori*, was found at Lafayette. Persimmon leaf spot, due to *Phyllosticta asiminae*, was found in Franklin Co. Poplar canker, due to *Dothichiza populea*, was found killing the lower limbs of Lombardy poplars at Lafayette. Abundant spore exudation was noted during rains late in May. Quince leaf spot, due to *Fabraea maculata*, was found at Lafayette.

Ornamentals: Aster rust was abundant and carnation rust was common in greenhouses. Geranium leaf spot, due to *Bact. erodii*, was sent in from Elkhart. Leaf spot of iris, due to *Didymellina iridis*, a Sclerotium crown rot, and a bacterial soft rot of the corms occurred at Lafayette. Leaf spot of June grass, due to *Helminthosporium vagans* Drechsler, was prevalent during May at Lafayette and stripe smut (*Ustilago striaeformis*) was noted on both June grass and Canadian blue grass (*Poa compressa*). Lilac powdery mildew was prevalent. Mosaic was noted on petunias and primroses and a mosaic disease of dahlias was observed in a neighboring state. Botrytis leaf blotch of peony was common at Lafayette. Rose black spot, due to *Diplocarpon rosae*, caused defoliation in greenhouses. Powdery mildew of roses was less destructive than usual. Crown canker of greenhouse roses due to *Cylindrocladium scoparium* caused severe losses to a number of growers. In one instance it was worst on the Butterfly variety. Snapdragon rust was serious in greenhouses and outdoors as well. Harry Dietz found the snapdragon canker due to *Phyllosticta antirrhini* in Indianapolis greenhouses. A Gloeosporium leaf and fruit spot of snowberry (*Symphoricarpus racemosa*) was found at Lafayette.

Weed mosaics: Because of the importance of weeds and wild plants as mosaic carriers for certain crops, it is worth while to record the occurrence of mosaic symptoms on the following species: pokeweed (*Phytolacca decandra*), Jimson weed (*Datura stramonium*), nightshade (*Solanum nigrum*), horse nettle (*Solanum carolinense*), Physalis species, trailing wild bean (*Strophostyles helvola*), wild blackberry, wild black raspberry (leaf curl), motherwort (*Leonurus cardiaca*), wild bergamot (*Monarda fistulosa*), giant hyssop (*Agastache scrophulariacifolia*), catnip (*Nepeta cataria*), *Rumex* sp., and two species of Erigeron.

SUMMARY.

The most destructive diseases noted this season were apple scab, blotch, fire blight, and bitter pit, cherry leaf spot, peach bacterial spot, plum brown rot, black raspberry anthracnose and leaf curl, and tomato leaf spot. Fire blight attracted the most attention.

The diseases or parasites not previously recorded for the state were as follows: Apple, *Volutella fructi*, *Alternaria* core mold and lenticel spot; lima and sieva bean, *Bact. vignae*; blackberry, mosaic; buckwheat, *Ramularia anomala*; Canadian blue grass, *Ustilago striaeformis*; slippery elm, *Phyllosticta ulmicola*; hickory, *Microstroma juglandis*; June grass, *Helminthosporium vagans*; Mulberry, *Bact. mori*; peach, Rhizopus rot; petunia, mosaic; Lombardy poplar, *Dothichiza populea*; raspberry, mosaic, leaf curl, eastern bluestem; rose, *Cylindrocladium scoparium*; snapdragon, *Phyllosticta antirrhini*; sweet pea, *Bact. pisi*; soybean, *Diaporthe sojae*; tobacco, *Cercospora nicotianae*, *Bact. tabacum*; tomato, Rhizoctonia soil rot. In an experimental plot, mosaic was noted on velvet bean, broad bean (*Vicia faba*), scarlet runner bean (*Phaseolus coccineus*), asparagus bean (*Vigna sesquipedalis*), and *Vigna catjang*.

