



Sunburn and Aphid Injury of Soybeans and Cowpeas

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**SUNBURN AND APHID INJURY OF SOYBEANS
AND COWPEAS**



By Frederick Gibson
Fellow Assistant in Plant Pathology

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*On leave.

SUNBURN AND APHID INJURY OF SOYBEANS AND COWPEAS

By *Frederick Gibson*
Fellow Assistant in Plant Pathology

INTRODUCTION

In a country where the soil is naturally deficient in organic matter, the problem of green manuring is important. For the purpose of supplying this need, and also as cover and forage crops, cowpeas (*Vigna sinensis*) and soybeans (*Soja max*) have been introduced into Arizona. Since the value of these plants for green manure, cover, and forage crops depends chiefly on the production of abundant foliage, any condition which favors injury to the green parts must be taken into account in the selection of varieties, and therefore susceptibility to sunburn and to parasitic diseases, which may result in the destruction of a large part of the leaf surface, are factors which must be considered.

During the fall of 1920, the attention of the writer was directed to a spotting of the leaves of cowpeas and soybeans growing on the Salt River Valley Farm near Mesa, Arizona. Indications of sunburn as well as the presence of aphids and a dense fungal growth, in spots, led to the cultural and histological studies that are described in this paper. It is hoped that the results may prove helpful in the selection of varieties of cowpeas and soybeans suited to the semi-arid conditions that prevail in Arizona and other southwestern states. In pursuing the investigation, field studies were supplemented with laboratory work and with inoculations of plants grown in the greenhouse at the University of Arizona at Tucson.

FIELD STUDY

In the spring of 1921, the Department of Agronomy of the Experiment Station planted plots of soybeans to determine the effect of the time of planting on the amount of growth and on the quantity and quality of the seed produced, and these plots were placed at the disposal of the writer for pathological study. The varieties used in the plots were Oootan, Biloxi, Virginia, and Mandarin. Planting was

The author gratefully acknowledges the assistance and the advice of Professor J. G. Brown, Plant Pathologist of the Agricultural Experiment Station, under whom this work was instituted as a thesis for the degree of Master of Science.

begun on April 5 and was continued on the first and fifteenth days of each month following until August 15. All four varieties were planted on each of these dates. Other soybeans under observation were Bar-chet, Shanghai, Tokio, and Peking. In addition, several acres of Blackeye cowpeas grown as a field crop on the Salt River Valley Farm were studied.

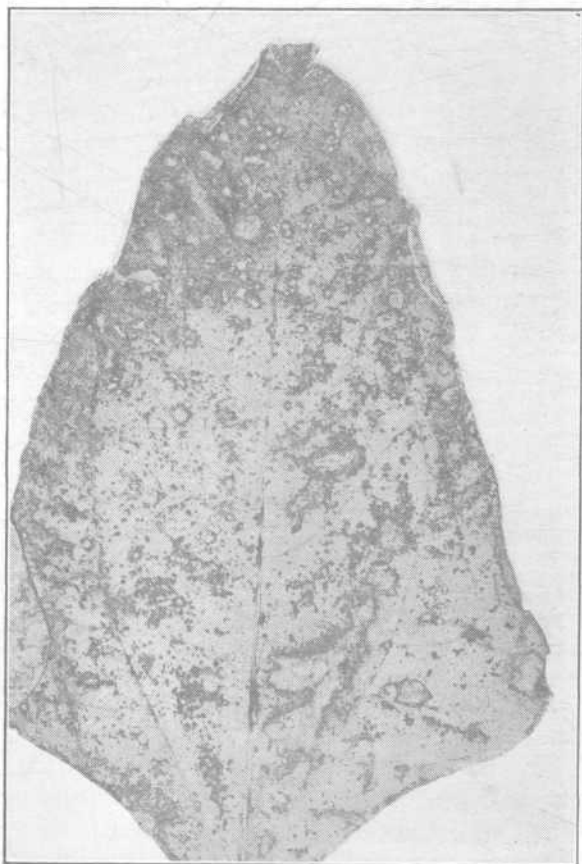


FIG. 1

Cowpea leaflet with all stages of injury. Notice sooty-black fungal growth on upper left portion.

SYMPTOMS OF THE DISEASE

The foliage of both cowpeas and soybeans shows, as the first indication of injury, very small, brick-red spots on the upper surface of the leaves, which are confined to the areas between the veins. In severe cases, the brick-red color spreads over the veins or follows along them longitudinally. The size and color of the spots depend on the rapidity of their development and whether or not there is coalescence. On the lower surface of the leaf the spots appear at first as a red discoloration, directly under those on the upper surface. Many spots, after increasing to a diameter of four millimeters, have a brownish center and often crack open, which results in a rapid drying of the tissues and in the appearance of a dead area on the under surface of the leaf. This dead area resembles that on the upper surface of the leaf, except that it lacks the brown center. Spots larger than four millimeters in diameter have brown centers on both surfaces of the leaf, and sometimes a sooty-black fungal growth is present on the larger spots. In a dried leaf all spots are elevated, and when there is a brown center, it resembles a sunken crater. The leaf surface included in the spots may be so large that the leaf is easily broken and torn by wind. The older plants, especially Virginia soybeans, have a weather-beaten appearance due to the lack of healthy foliage.

Spots on the petioles and stems are elongated, brick-red, and also are invaded by the sooty-black fungus. In the absence of the fungus they might be mistaken for bacterial spots when compared with the spots on old bean stems.

Diseased spots on the pods of cowpeas have not been observed, but they are plentiful on the Virginia soybean and have been found on the other varieties of soybeans named, except the Biloxi. These spots are brown, cover a large area, and have present the fungal growth. Pubescence and the natural brown color of the pods render the spots less noticeable here than those on the foliage.

HISTOLOGY

Many serial sections of both naturally and artificially diseased parts were mounted for microscopic study. In these the region of disorder is most striking in the center of a spot. In passing from the margin of a spot to its center, the tissues show a gradual change from normal to plasmolyzed cells, then to a shrivelled and finally to a broken-down con-

dition. Hyphae of *Alternaria* are numerous in the center, and they may extend a short distance into the normal cells. There is a slightly greater degree of plasmolysis in the cells of the palisade tissue than in those of the spongy tissue located at the same distance from the margin of a spot. The fungus is chiefly saprophytic in habit, but the occurrence of a few hyphae in living cells indicates a parasitic tendency.

CULTURES

About one hundred pieces of diseased leaves, petioles, stems, and pods of cowpeas and soybeans were used for cultural purposes. The pieces were first surface-sterilized by dipping into 95 percent alcohol, then immersing in 1:1000 mercuric chloride solution for one minute, after which they were placed on agar slants. Dilution cultures were poured into Petri dishes and all organisms isolated in pure cultures. The predominant organism which was found on the culture media in the test tubes and which also appeared on the surface of the diseased parts as a sooty-black fungal growth, was a species of *Alternaria*. This was accompanied by a species of *Penicillium*, and bacteria also were present in a few cultures. All these organisms were isolated and used in inoculation experiments.

INOCULATIONS

All inoculation work was done on Blackeye cowpeas and Virginia soybeans in the greenhouse of the Experiment Station in Tucson. The plants inoculated were six inches to a foot in height, except the cowpeas which attained a height of two feet and bore pods. In making inoculations, the needle-puncture water-suspension method was followed with some of the plants; other plants were sprayed over their entire surface with a water suspension and then the leaves and stems were rubbed between the fingers of the investigator in order to insure closer contact between the plant surface and the water films. A third method tried was the artificial sunburning of areas of varying sizes by means of a reading lens. After observation, these artificially sunburned areas were inoculated with *Alternaria* spores carried on a sterilized platinum loop. Since the bacteria and the *Penicillium* species isolated in cultures of cowpea and soybean leaves failed to develop on all previous inoculations, they were not tried on the artificially burned spots. Some of the inoculated plants were placed under bell jars, but the greater number were exposed to the air of the greenhouse. For comparison, aphids

were allowed to infest both healthy and inoculated plants, and the resulting injury to the leaves and stems was studied. Plants spotted by the activities of the aphids were afterward sprayed with a water suspension of *Alternaria* spores.

The results of the treatments and the inoculations previously described appear to be conclusive. Mechanical injury by burning and by needle punctures produced the characteristic brick-red spots, and aphid injury resulted in areas identical in appearance. Sunburn by means of the lens, when the rays were partly concentrated, caused brick-red spots like the smaller ones observed in the open; stronger concentration produced sunburned areas with brown centers like the large spots seen in the field. Inoculations with *Alternaria* spores resulted in the infection of sunburned areas, both in the air of the greenhouse and under bell jars; also in the infection of needle punctures and spots showing aphid injury; the bacterial inoculations and those made from the *Penicillium* cultures failed in every case.

From these results it appears that the spotting of the leaves of soybeans and cowpeas is primarily caused either by sunburn or by aphid injury. The fungal infection is secondary and is due to a species of *Alternaria*.

DESCRIPTION OF FUNGUS

Growth profuse, sooty-black, restricted to spots on both surfaces of the leaf; conidiophores erect, solitary or grouped, one to several from a single hypha, light brown, commonly 4-septate, 47μ — 81.2μ by 6.2μ — 9.4μ ; mycelial cells 3.5μ — 4.9μ in diameter when measured in leaf sections, larger on the surface, with much variation in length; conidia clavate, obovate to club-shaped, dark brown, solitary or in chains of 2 to 6 with 1-2 hyaline cells in isthmus, 5-11 transverse septa, 0-2 longitudinal septa, 38μ — 119μ by 15.6μ — 25μ . This species appears to be undescribed. The name *Alternaria atrans* is provisionally suggested for it.

SUSCEPTIBILITY

Of the varieties under observation, the Virginia soybean is most susceptible to sunburn, aphid injury, and fungal infection; the Biloxi soybean is most resistant; none is absolutely immune. The degree of injury appears to be related to the time of planting and it probably varies somewhat from year to year. On July 1, 1921, the first two

plots of Virginia soybeans, which had been planted three and three and one-half months respectively, were severely affected. All plots were diseased on October 9, but only three leaves were burned on the plants of the last planting, and no fungal growth was found. At this time aphids were beginning to congregate on a few leaves of plants of the last planting. Blackeye cowpeas had very few spots in 1921, but were badly diseased during the two previous years.

DISCUSSION

The loss of foliage to the plant is the chief damage resulting from sunburn, aphid injury, and fungal infection. Because of this loss, Virginia soybeans grown in southern Arizona as a green manure crop probably will not produce enough vegetation to compare favorably with the growth of other similar plants that are better adapted to our climatic conditions. Healthy plants of Virginia soybeans are medium in height, and leafy—characters which in themselves make this variety desirable for green manure and cover crops, but since they are affected with this disease every year with a resultant heavy loss of foliage, they may prove unprofitable as a green manure crop. The main loss with the Blackeye cowpeas is in the quality of forage, with possibly a reduced seed yield, because of the devitalized condition of the plants.

SUMMARY

1. Ootootan, Biloxi, Virginia, Barchet, Shanghai, Tokio, and Peking soybeans and Blackeye cowpeas in southern Arizona are injured in varying degree in summer by sunburn and aphid injury followed by infection with a species of *Alternaria*.
2. The symptoms of sunburn and aphid injury are similar, namely, the appearance of brick-red spots which enlarge, become brown in the center, and later are often covered with a sooty-black growth of *Alternaria*.
3. The *Alternaria* species is weakly parasitic. It grows in needle puncture inoculations in healthy plants and in leaves punctured by aphids; also in sunburned areas. The species appears to be undescribed, and for it the name *Alternaria atrans* is proposed.
4. Loss of leaves is greatest in the Virginia soybean and in this variety it is extensive enough to seriously lessen the value of the plant for green manure, cover, and forage. Biloxi soybeans are the most resistant of the varieties studied.

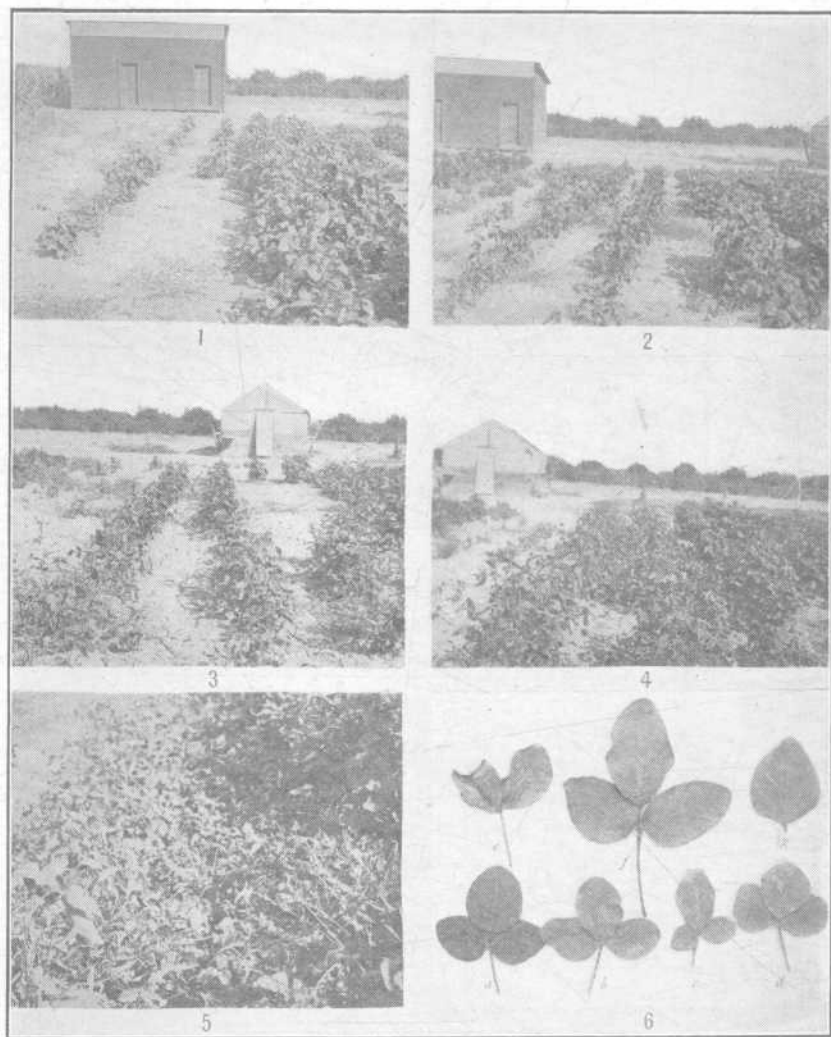


PLATE I

- Figs. 1, 2, 3, 4 with Virginia soybeans at left and Biloxi variety at right. Photographed September 9, 1921.
- Fig. 5.—Close view of Virginia soybeans showing unhealthy condition of leaves and drooping state of plants.
- Fig. 6.—a, b, c, d, e. Progressive stages of aphid injury on Virginia soybean leaves. f. Peking soybean leaf with many aphids and slightly spotted at margins. g. Natural discoloration due to age of tissue between veins of primary leaflet.

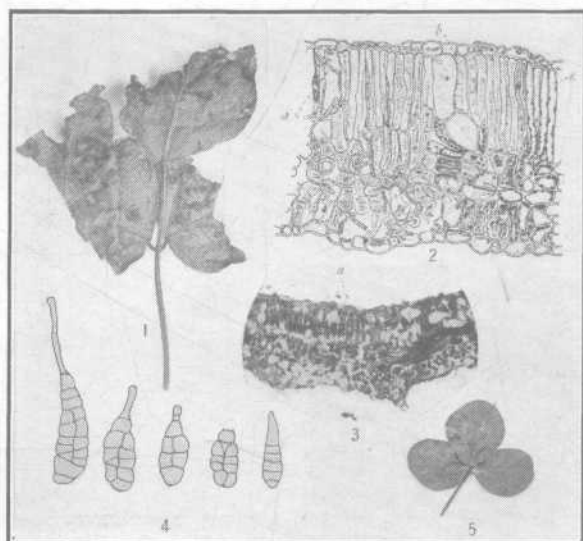


PLATE II

- Fig. 1.—Soybean leaf with fungal growth in dark patches $\times \frac{1}{2}$.
 Fig. 2.—Soybean leaf section at edge of a spot. a. Mycelium of fungus; b. Plasmolyzed cells; c. Normal cells. (Camera-lucida drawing $\times 100$.)
 Fig. 3.—Section of leaf with all cells dead in center of spot. a.—Spores on surface of leaf section. (Photomicrograph $\times 66$.)
 Fig. 4.—Typical *Alternaria* spores from leaf spots. (Camera-lucida drawing $\times 223$.)
 Fig. 5.—Virginia soybean leaf inoculated with *Alternaria* spores after sunburn.