PURPLE STAIN

of Soybean Seeds

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ON THE COVER: A purple discoloration and numerous small cracks in the seed coat make the purple stain disease easy to identify. Contrast diseased seeds (below) with healthy seeds of the same variety (above).

Purple Stain of Soybean Seeds*

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Introduction

The purple stain disease of soybean was first reported in 1921 in Korea (1) where it appeared as a purple discoloration of the seeds. A few years later (2) it was shown that this discoloration is the symptom of a disease caused by growth of a fungus in the seed coats.

In the United States, the disease was first recognized in Indiana in 1924 (3), and North Carolina in 1927 (4). It has since been found in Illinois, Maryland, Delaware, Virginia, South Carolina and probably occurs to some extent in most other states where soybeans are grown. Other names which are sometimes used for the purple stain disease are "purple blotch," "purple speck," and "purple seed stain."

Importance of the Disease

When purple stain was first observed in North Carolina and for several years thereafter, it was recognized only by its appearance on the seeds. At that time, usually less than 1 per cent of the seeds were affected, and the disease appeared to be of little significance in the culture of soybeans.

As time elapsed, purple stain became more prevalent, and since about 1940 there has been a great increase in the percentage of seeds showing symptoms. At present, on certain varieties grown under conditions favorable to the disease, it is not uncommon to find 50 per cent of the seeds discolored and very different in appearance from healthy ones. Individual seeds are often completely discolored and scarcely recognizable as to variety.

Purple stain reduces the value of seed stocks, and the discoloration is frequently mistaken for weather damage.

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Symptoms and Effects

Symptoms of the purple stain disease develop on seeds, pods, stems, and leaves. The disease is more easily recognized on seeds than any other part of the plant. Infected seeds have a discoloration of the seed coats (see cover) which is very different from that produced by other seed-infecting parasites. The discoloration varies from pink or light purple to dark purple and may involve only a small part or all of the seed coat. The purple color penetrates to the inner surface of the seed coat. In severely diseased seeds a light stain may appear on the surface of the embryo seedling. Numerous small cracks often occur in the discolored areas of the seed coat giving it a rough, dull appearance.

When diseased seeds germinate and grow for a few days in a highly humid atmosphere, the fungus that causes purple stain grows from the seed coat into the cotyledons (seed leaves) of the young seedling. An infected cotyledon darkens in color and shrivels (Figure 1) instead of becoming green and enlarged as

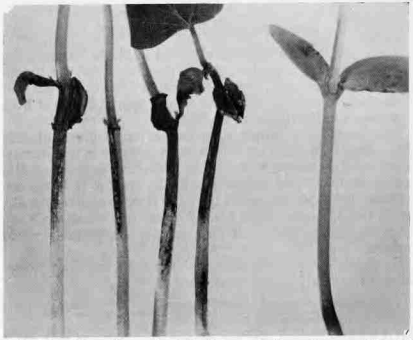

FIGURE 1. When the purple stain fungus attacks soybean seedlings the cotyledons (seed leaves) darken in color and shrivel. The four plants on the left grew from purple seed, while the one on the right is from healthy seed.

on normal seedlings. The diseased cotyledon fails to supply adequate food, and the young seedling grows slowly and becomes weak and stunted.

Usually the fungus invades the stem for some distance above and below the point of attachment of the infected cotyledons, and the diseased plants die slowly. Meanwhile, the causal fungus produces on the surface of the diseased tissue a greyish-white velvety growth, containing a large number of spores.

Spores from diseased seedlings are easily carried by wind to leaves of adjacent plants. Here they produce more or less angular, reddish-purple spots that vary in size from a pinpoint in young infections to half the size of a dime in older infections. New crops of spores produced on diseased leaves cause infections on stems, petioles, and pods.

Pod infections of the purple stain disease are difficult to distinguish from infections of other diseases (Figure 2). To identify this disease on pods one often must use a hand lens or a microscope and determine the kind of spore or fungus fruit body present.

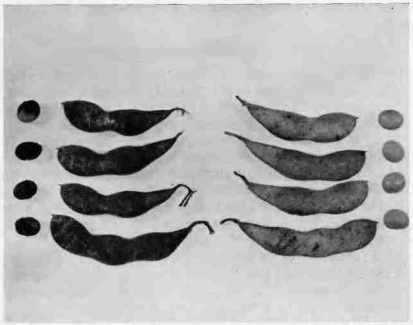

FIGURE 2. The purple stain disease on pods is difficult to distinguish from other soybean diseases. The four pods and the seeds on the left show the dark discoloration caused by the fungus. The pods and seeds on the right are from healthy plants.

The fungus grows through the pod wall and into the seed coat where it produces the characteristic purple stain on seeds. This pink to purple stain on the seed coat may be taken as a sure symptom. No other parasitic fungus is known to produce this discoloration on soybean seeds.

The purple stain disease of soybean is likely to appear on a high proportion of the seeds when the crop matures under rainy conditions favoring weather damage. Tests show, however, that the causal fungus is usually confined to the seed coat. It grows onto the embryo in only a very low proportion of the infected seeds. It is believed that the purple stain disease does not significantly reduce the milling quality of soybean seeds.

Cause of the Disease

The purple stain disease of soybean in North Carolina is caused by a parasitic fungus.[1] This fungus consists of slender, living threads which grow in the leaf, stem, pod, and seed tissues of the plant. When moisture and temperature conditions are favorable, the fungus forms dark, spore-bearing branches and numerous, long, slender spores on the surface of the diseased parts.

Overwintering

During the growing season the purple stain fungus is often found on soybean plants in the field. As the seeds mature, the fungus grows into the seed coats where it remains while the seeds are in storage. Little or no harm is done to the dormant embryo of the seeds until they germinate. When lightly infected seeds germinate, the diseased seed coats may slip off beneath the soil and thus the young seedlings escape infection. On the other hand, severely affected seed coats adhere to and emerge with the seedlings. Then the fungus grows from the seed coats into the cotyledons and stems where it produces great numbers of spores that infect other plants.

This fungus probably survives the winter season in diseased leaves and stems that do not thoroughly decay during the winter. The extent to which the causal fungus may overwinter in this manner has not yet been determined.

[1] This fungus was named *Cercosporina kikuchii* by two Japanese scientists who published an account of the disease in Japan in 1925. Recent studies indicate that the fungus which causes purple stain in the United States is the same as the one which occurs in Korea and Japan (5).

Severity of the Disease

Observations made in 1947 indicated that damage caused by the purple stain disease is greater on some varieties than on others and that the disease is more severe in some locations than in others. In 1948, the varieties grown in soybean nurseries at three locations in North Carolina and one location in South Carolina were sampled to determine the percentage of seeds with purple stain. The percentage of diseased seeds for each variety at each location is recorded in Table 1.

TABLE 1. Purple Stain on Seeds of Varieties and Selections of Soybean Grown at Four Locations in 1948 (Seed from the same source was used for planting at all locations.)

Variety[e]	Derivation	Per cent of purple seeds and maturity dates for varieties grown at					
		Plymouth N.C.	Willard N.C.	McCullers N.C.	Average[a]	Average maturity date[b]	Monetta S.C.
Regional Group VI (Maturity Oct. 1 to 15)							
D-540-1	Ogden x Arksoy	93	34	8	45	−1	25
Dortchsoy 2	Ogden Sel	77	18	24	40	+1	11
Ogden	Tokio x P.I. 54610	77	25	13	38	Oct. 8	22
Arksoy 2913	Arksoy Sel.	67	35	6	36	−1	20
D-517-14	Ark. 2913 x Patoka	74	16	4	31	+2	24
N44-639	Missoy x Ogden	30	26	7	21	+1	13
N45-2994	Ralsoy x Ogden	41	4	8	17	+7	5
N45-2885	Haberlandt x Og.	37	4	4	15	+2	6
F.C. 31745		8				−5	
Hale Ogden 12	Ogden Sel.	73		21		0	18
Average[c]		62	20	10	30		16
Regional Group VII (Maturity October 15-30)							
Ogden		66	47	14	42	Oct. 8	19
N44-937	Ogden x Palmetto	64	29	9	34	+8	8
N42-26	Sel. from Arksoy	32	13	14	20	+12	5
N45-3728	Palmetto x Ogden	37	6	6	17	+11	0
N44-92	Og. x Haberlandt	25	5	8	13	+9	6
N45-3563	Missoy x Ogden	18	6	11	12	+18	1
Volstate	Tokio x P.I. 54610	17	3	5	8	+17	1
Dortchsoy 31	Sel. from Ogden	13	2	6	7	+13	0
N45-3036	Ralsoy x Ogden	9	2	5	5	+18	1
N44-774	Ogden x Missoy	11	1	4	5	+21	0
Roanoke	Sel. mixed seedlot	7	1	4	4	+17	0
Palmetto	P.I. 71587	2	1	1	1	+19	0
CNS	Sel. from Clemson	0	0	0	0	+22	0
Average[d]		21	6	7	11		2

[a] Average for Plymouth, Willard, and McCullers.
[b] Days earlier (−) or later (+) than Ogden; average for Plymouth, Willard, andMcCullers.
[c] Exclusive of F. C. 31745 and Hale Ogden 12.
[d] Exculsive of Ogden and CNS.
[e] Numbered lots are experimental strains from the soybean breeding program conducted in cooperation with the Southern Regional Soybean Laboratory.

The amount of purple stain on the seed was highest at Plymouth, lowest at McCullers, and intermediate at the other two locations. Seed from the same source was planted at all locations, and all the plantings were on land not used for soybeans the previous year. Hence, it is assumed that the disease started at each location from infected seeds. Obviously, conditions favoring infection and development of purple stain were more prevalent at Plymouth than at the other locations in 1948.

The average amount of purple stain in the eight varieties and selections in Group VI was higher at all locations than the average of the eleven entries in Group VII. Most of the entries in Group VI mature during the first half of October while those of Group VII ripen during the second half of that month. Hence, differences in amount of disease may be due in part to differences in pod or seed development at the time spores of the fungus are being distributed.

Certain selections from crosses of the same parental varieties such as N45-2994 (Ralsoy x Ogden) compared with N45-3036 (Ralsoy x Ogden) and N44-639 (Missoy x Ogden) compared with N45-3563 (Missoy x Ogden) illustrate what appears to be a correlation between amount of disease and maturity date. However, there are apparent exceptions to this rule. For example, N45-3728 (Palmetto x Ogden) and N45-2885 (Haberlandt x Ogden) each had essentially the same amount of purple stain, although the former matured nine days later than the latter. Likewise, N42-26 which matured three days later than N44-92 had a higher percentage of diseased seeds.

F. C. 31745 which matured about five days earlier than Ogden had the lowest reading of the varieties planted in Group VI at Plymouth. These and other comparisons indicate that the low disease readings for some of the entries are due to a considerable measure of inherent resistance to the fungus.

Much less purple stain was found on F. C. 31745, Volstate, Dortchsoy 31, Roanoke, and Palmetto than on Ogden, Dortchsoy 2, or Arksoy. No purple stain was found at any location in the variety CNS.

Differences in the amount of the disease on Ralsoy, Ogden, and Roanoke were noted in 1947 and again in 1948. At harvest, the incidence of purple stain was determined in samples of seed drawn from each plot in each replication. Ralsoy, approximately seven days ahead of Ogden and 24 days ahead of Roanoke in maturity date, was intermediate between the latter two varieties

with respect to the amount of purple stain for each treatment (Table 2). The three varieties retained the same order with respect to the disease in 1947.

Control

In areas where the purple stain disease is favored by weather conditions, the best control measure is to choose a resistant variety. Of the two highest yielding varieties, Ogden and Roanoke, Roanoke appears to be much more resistant than Ogden. If the grower prefers Ogden because of earlier maturity or shorter growth type, he should obtain planting seed which does not show purple stain. He should plant in fields where no soybeans grew the year before to avoid exposure to the fungus which may have survived the winter on old soybean plants of a previous crop.

Dusting soybean plants with fungicides has given partial but inadequate control of the purple stain disease. As shown in Table 2, approximately one-half as much purple stain occurred on seeds from plants dusted with Dust A as on plants which received no dust.

Dust A contained both DDT and copper. Use of 45 pounds per acre at each application reduced purple stain more than did 30-pound applications. Application of DDT without copper (Dust

TABLE 2. Effect of Dusting on the Incidence of Purple Stain in Seeds Harvested from Three Varieties of Soybeans Dusted with Preparations Containing Copper and/or DDT at McCullers, North Carolina in 1948

Treatment[a]			Seeds showing purple stain			
Dust	Active Ingredients	Rate per Acre	Ralsoy	Ogden	Roanoke	Average
		pounds	per cent	per cent	per cent	per cent
A[b]	DDT and copper	30	16	28	4	16
A[b]	DDT and copper	45	14	23	3	13
B[c]	DDT, no copper	30	22	43	4	23
	Control; not dusted		28	51	6	28
	L. S. D.[d]		7	7	2	3

[a] Five applications at approximately 11-day intervals beginning July 19 and ending September 2.
[b] 3 per cent DDT, 7 per cent copper as metallic derived from tribasic copper sulphate, 10% wheat flour, balance Cherokee clay.
[c] 3 per cent DDT, 10 per cent wheat flour, balance Cherokee clay.
[d] Least different required for significance at 5 per cent level.

B) resulted in a small reduction of purple stain on each variety, indicating that insects may play some role affecting the spread of the disease. Until more effective fungicidal dusts are found or better schedules of application are worked out the grower will have to rely on other preventive measures.

Greenhouse and laboratory germination tests with certain lots of seed have indicated that soybeans infected with the purple stain fungus and other organisms give lower germination than healthy seeds. In these tests, seed treatment increased germination of the diseased seed (5).

However, tests with other seed lots indicate that if only the purple stain disease and no other is present, the purple-stained seeds give about the same germination as healthy seeds. Apparently, the purple stain fungus alone causes little if any reduction of germination. If rainy weather prevails for several days after germination, however, many of the seedlings emerging from purple-stained seeds will be retarded in growth or killed by the disease.

Treatment of seeds with Arasan or Spergon will largely prevent seedling losses due to the purple stain fungus, as well as seedling losses caused by other fungus parasites. Arasan has given slightly better results than other materials. Treatment of planting seed will not assure freedom from purple stain in the harvested crop.

Summary

The purple stain disease of soybeans was first recognized in North Carolina in 1927. Since that time it has become much more prevalent and now occurs in harmful proportions in some parts of the state.

It is caused by a fungus which survives in infected seeds and spreads from plant to plant by means of wind-blown spores. The disease affects seeds, pods, stems, and leaves but is most easily recognized on seeds where it produces a pink or purple stain of the seed coat.

In all but a very small proportion of infected seeds the fungus in confined to the seed coat. It is doubtful that the disease reduces the value of soybean seed for milling purposes.

Infected seeds germinate almost as well as normal seeds, but seedlings from infected seeds are likely to be stunted or killed after emergence from the soil. Diseased seedlings are the primary source of spores which infect leaves, stems, and pods later in the season.

Soybean seed, whether visibly diseased or not, should be treated with a fungicidal seed protectant before planting. Arasan, or Spergon may be used for this purpose. Apply two ounces of Arasan or Spergon to each bushel of soybean seed. Arasan SL and Spergon SL may be applied as a slurry.

Some varieties of soybeans are more susceptible to purple stain than others. Ogden usually has a much higher percentage of diseased seeds than Roanoke. Farmers who wish to grow the Ogden variety should plant seed that shows no purple stain.

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