THE OCCURRENCE OF WHEAT DOWNY MILDEW IN THE UNITED STATES

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Monograph

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A disease of wheat, which, although long recognized in Europe, has hitherto been unknown in the United States, has recently been found in Tennessee and Kentucky. The disease is not recognized as such by the farmers of these States, nor is it given any common name by them, but since it is caused by a fungous parasite, *Sclerospora macrospora* Sacc., one of the downy mildews (Peronosporaceæ), it may be referred to conveniently as *Sclerospora* or downy mildew of wheat. It is not especially destructive in so far as is known at present, but in view of the losses it has caused in Europe it should be carefully watched. During the present season it has been encountered only in Jackson County (Jackson) and in Obion County (Rives, Hoosier Valley, Union City, and Woodward Mills) in Tennessee, and in Fulton County (Jordan and vicinity) in Kentucky, but it seems probable that it will be found in adjacent Illinois, and possibly across the Mississippi River in Arkansas and Missouri as well. In addition, diseased specimens in the pathologic herbarium at the California Agricultural Experiment Station show that the downy mildew occurred on wheat in Kings County, Calif., in May, 1919.

A preliminary study in Tennessee and Kentucky has shown that the disease is restricted almost entirely to low-lying, poorly drained fields or parts of fields in which the young seedlings of winter wheat have been subjected to excessive moisture. In such localities the *Sclerospora* occurs especially along depressions where water has stood, while few, if any cases are found on higher land in the same field.

The general indications from field conditions in the infected regions are that the disease is not of sudden or recent appearance, but has been present for many years. Evidences of this are the facts that the *Sclerospora* is widely distributed there, that it occurs commonly on wheat from seed grown for many years in this region, and that it does not cause a serious outbreak but persists in the low bottom lands, causing slight but constant losses.

The disease is found not only on the three or four varieties of soft Red Winter wheat which are grown in these localities, but also on

Bromus commutatus Schrad., a grass similar to "cheat" and very common both in the wheat and around field borders.

With respect to their appearance, the three following general types of diseased wheat plants may be recognized in fields not yet mature:

(1) The diseased plants show excessive tillering, as many successive shoots grow up until a few inches high, then rapidly wither and turn brown, resulting in a clump of small, closely crowded, dead plants.

(2) The internodes fail to develop normally; the plants remain short and stunted, while their leaves, instead of being dark green and hanging flexibly in normal, graceful curves, become striped or almost completely yellow and fleshy. The leaf tissue thickens abnormally, causing the leaves to twist or curl and stand out in stiff, unnatural positions.

(3) The leaves are somewhat yellowed, thickened, and twisted, but the growth of the attacked plant is not so conspicuously arrested as in the two preceding types and continues at a rate only little less than normal.

These types are, of course, only approximate, and some plants attacked by the disease do not fit in general appearance into any one of them exactly, while others show some characteristics of all three. Infected plants of the "cheat"-like grass (*Bromus commutatus*) in almost all cases are of the second or third type mentioned above.

The gross appearance of the diseased plants, which has just been described, closely resembles that resulting from a number of other causes, but there is one unfailing mark by which this *Sclerospora* disease can always be recognized. When leaves of plants infected with this fungus are held up toward the sky, so that the light shines through them, and are studied carefully with a hand lens or pocket magnifying glass, it is seen that within the tissue of the leaf, which, when healthy, is a clear solid green, there are innumerable clear dots running more or less in rows along the small veins or even in the veins themselves. The presence of these innumerable minute dots in the leaf tissue is a sure sign that the plant is infected with the *Sclerospora*. When a bit of such tissue is scraped out into a drop of water and examined under the microscope, it is seen that these dots are the large, clear resting spores or reproductive bodies of the fungus. It is these spores that are set free in the soil by the eventual decay of the plant and remain there to bring about the infection of future wheat or grass plants.

The subsequent development of wheat plants attacked by the disease varies in the different types. Plants which show the excessive tillering which characterizes the first type invariably die early without reaching maturity. Plants of the second and third types struggle along to greater age and occasionally, though rarely, head out, producing distorted and abnormal heads with few, if any, viable seeds. Infected plants of *Bromus*, however, usually are less severely injured and frequently produce their inflorescences, which are only slightly less vigorous and well developed than normal.

The losses occasioned by this disease on wheat in the west Tennessee and Kentucky district apparently are slight. In wet, poorly drained localities which favor the disease, large numbers of plants are affected and destroyed, but as such poorly drained areas represent a very small proportion of the whole district and as the disease is closely restricted to such localities, the total loss is not very great. This loss is persistent, however, for the fungus survives, between wheat crops, on *Bromus* or in the soil and continues year after year, crop after crop, taking a toll which, although slight, represents a considerable loss in the aggregate.

Unfortunately, no really practical suggestions for control can be made as yet. In Italy, attempts have been made to diminish the disease by collecting and burning the infected plants, but with little success. As effective methods of control can be devised only from a thorough understanding of the very obscure life history of the causal *Sclerospora*, this phase of the problem is now being studied by the Office of Cereal Investigations.

At present it is important that the disease should be watched, because of its possibilities for future destruction. Its history in Europe, and especially in Italy, where it has been known for more than 40 years, indicates that it may prove much more troublesome in the future. In Italy it has been found especially on wheat and maize, but occasionally also on oats, barley, rice, and on several wild grasses of the genera *Phalaris*, *Phragmites*, *Glyceria*, *Agropyron*, and *Lolium*. It is very probable, therefore, that under favorable circumstances the disease may attack any of these hosts in our own country. In Europe, moreover, there have been occasional reports of very severe destruction of wheat and maize which the disease has caused in regions subject to flood or excessive moisture. In all cases this loss has been sporadic, severe destruction occurring in restricted areas where circumstances were favorable, while areas more fortunately situated in the vicinity suffered only slight losses. There is every reason to believe, therefore, that under conditions favorable to the disease, more or less restricted areas of our own wheat or corn raising regions will lose a considerable percentage of their crop because of this downy mildew.

In order to determine the extent of the disease, its distribution throughout our wheat-growing States, and its occurrence on corn and other hosts, there is need of the help of those who are in the field or in touch with the field situation during the present season. It is hoped that this brief note may direct the attention of pathologists and other investigators to the disease, so that it may be discovered and reported as soon as possible. In the case of wheat, it may be recognized by the characteristic symptoms which have been

described in this circular and which are well illustrated in a bulletin by Peglion (1). In corn, its presence may be noted by the twisted and abnormal growth, particularly of the tassel, which is described and figured by Ippolito and Traverso (2) and by Gabotto (3). In rice also, the plant, and particularly the head, is deformed, as is shown in the illustrations of Gabotto (4). Similar deformations of any of these plants, however, might result from other causes; but the presence of its innumerable spores in the tissue of the infected plant and the pellucid dotted appearance of such tissue when examined with a hand lens by transmitted light are sure signs of the presence of the fungus. The Office of Cereal Investigations of the Bureau of Plant Industry is making a study of this disease and will be very glad to examine and report on any material which may be sent in.

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