ERGOT:

A Recurring Problem of Grasses and Small Grains

Fig. 1. Heads showing ergotized grain.

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Environmental conditions during the 1971 crop year were particularly conducive in certain locations of the United States and Canada for the infection of hard red spring wheat by the ergot fungus, **Claviceps purpurea.** While the extent of the outbreak was minimal and produced a spring wheat crop in North Dakota averaging 0.08% ergot—well below the 0.3% level required to be graded "Ergoty" by the U.S. Grain Standards—concern and interest in the problem of ergot has been expressed. Consequently, this brief description of ergot, what it is, how it grows, what it does, may provide useful information.

Ergot is caused by a fungus which attacks grasses and cereals all over the world. This plant disease has been thought to date back to biblical times. It was described in Germany in 1582, and its medical application and physiological effect on animals have been known for many centuries. Generally it is considered to be aesthetically undesirable.

The ergot fungus is endemic to the Northern Plains of North America and it affects grasses each year in a region extending roughly from the Kansas area in the south through the prairie provinces of Canada to the north. The prevalence of this plant disease is dependent upon a number of environmental factors; consequently, outbreaks of the disease may be severe in certain local areas. The incidence of ergot varies from year to year. Severity of the disease development depends upon the availability of spores produced by the fungus which overwinters as sclerotia on the ground and upon the weather conditions prevailing during the flowering of grasses and grains.

Of interest is the report by Wanda Weniger about the ergot epidemic of 1921 which appeared in the April, 1924, Bulletin of the North Dakota Agricultural Experiment Station. It was reported that more than 50 per cent of the heads of durum were

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infected and many lots of wheat contained 10 per cent by count of ergotized grain after threshing. Counts of two to five per cent were very common.

Probably ergot is best known as a disease of rye, but it also affects wheat, barley and other small grains. During the 1971 crop year, climatic and environmental conditions were more favorable for infection of hard red spring wheat by the fungus than rye. This was most unusual. Rye was affected less than usual by ergot, durum about as usual—about 0.01 per cent.

The Life Cycle of Ergot

While a number of technical publications have been devoted to the complex life history of the fungus, **Claviceps purpurea**, the real relation of plant disease and the fungus has been known only since 1841. While most people familiar with the grain trade recognize the characteristic dark purple bodies present in grain as ergot, it may be helpful to briefly sketch the annual life cycle leading up to the production of these large, dark colored bodies.

During the harvest season, ergot bodies may fall from the mature heads of grain where they remain over winter on the ground or in material that might potentially be used for seed. The following spring, the ergot structure produces a fungus growth similar to a tiny mushroom, which completes a phase of the life cycle by the production of ascospores. These spores are blown primarily by the wind or carried by insects to the grasses and cereals and affect the cereal flower during the bloom stage. In the case of wheat, this stage is

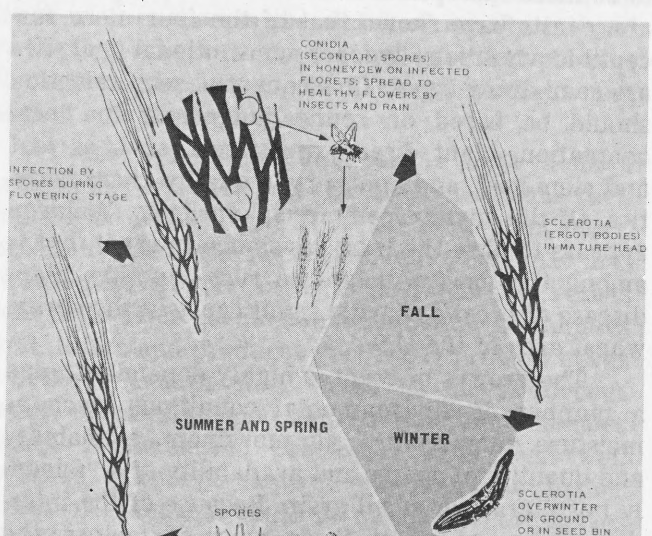

Fig. 2. The annual life cycle of ergot.

reached about three to eight days after heading. The fungus enters the ovaries of the young seed grain, destroys them, and ergot bodies later develop in the place of normal seeds. As this mold develops, it crowds out all of the normal tissues that would constitute the grain; the fungus produces millions of conidia in sticky "honeydew", which later develops the appearance of a single ergotized grain. This process is shown diagrammatically in the attached figure. Series A represents stages of development of the ergotized grain, and Series B represents stages of the unaffected grain of corresponding ages. For purposes of illustration, Item No. B-5 is normal mature grain and the preceding numbers would depict the grain at roughly seven-day intervals prior to maturity.

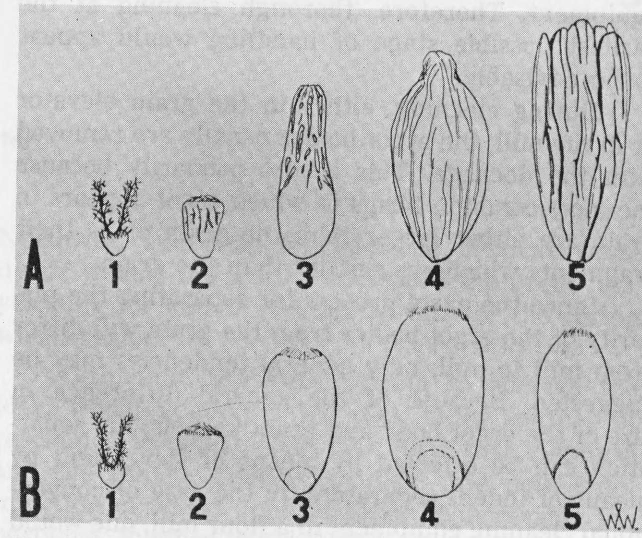

Fig. 3. Stages of grain development.

To complete the cycle, the ergotized grain grows to maturity, some falls from the head, returns to the soil and the life cycle will be repeated in subsequent years providing the growing conditions are conducive for its propagation.

What Happens?

During storage, ergot bodies remain separate entities. The mold is in a resting state and does not affect the grains stored in common bins. From the standpoint of growth, the ergot body (sclerotium) must rest for a period of about two months. After this period, sporulation will occur only under conditions of appropriate heat and moisture. Normal storage conditions found in grain bins would not encourage the sporulation of ergot.

During handling and in transit, the ergot may tend to become fragmented because the ergot bodies tend to be less structurally sound than the adjacent kernels of wheat. In addition, during transit the ergot bodies may tend to rise toward the top of the transporting vehicle because the density of the ergot body is less than the density of wheat. As a consequence, two effects may be observed at the end of a transit period. When grain containing ergot arrives at its destination, the ergot bodies may have tended to concentrate at the top of the shipment. They also may appear to have increased in number, but this is due to fracturing of the whole bodies during the loading and unloading process.

How to Remove It?

Because ergot bodies usually are larger than wheat kernels, it is possible to separate most of the ergot by means of conventional grain cleaning equipment. Therefore, thorough cleaning at the earliest possible stage of handling would appear to be advisable.

During cleaning, either in the grain elevator or in the mill, the ergot bodies usually are removed with the dockage. This occurs primarily because the most common forms in which ergot appears in grain are either larger than the grain or as their fragments which are smaller than the grain.

Since the exact process for separating the majority of the ergot bodies from the grain will differ from mill to mill, only general tendencies may be suggested. Because of the general difference in size of the ergot body and grain kernels, the separation can be effected by means of sieves and by means of indent separators. In the case of conventional cleaning equipment in a flour mill, one would anticipate that approximately 40 per cent of the ergot would be removed by these types of devices. For that portion of the ergot bodies that would remain, separation is most readily effected by means of a gravity separator because the ergot bodies have a lower density than wheat. Electronic separators and flotation techniques, which are not commonly available in elevators and flour mills, also can be used to further remove the low-density ergot bodies.

During milling, the ergot bodies would be reduced in particle size in a manner not completely known. In fact, during a recent literature review, it has become apparent that very little current technical information is available.

How to Solve the Problem?

The solution to the problem of ergot in wheat may be divided into two concepts; 1) what can be done with the current crop? and 2) what measures can be taken to minimize the possibility of recurrence of the problem?

Present

The current crop should be isolated and that portion having ergot should be cleaned thoroughly to reduce the ergot content. Conventional cleaning equipment should be augmented with the use of gravity tables wherever possible. Most appropriately, this intensive cleaning should be accomplished at the country or subterminal elevators. While the facilities are not commonly available, it is possible to separate wheat from ergot bodies by an electronic device; moreover, flotation in 20 per cent aqueous salt solution (sodium chloride) permits the lighter ergot bodies to be skimmed readily from the surface of the liquid.

After the wheat has been cleaned, further dilution of the ergot may be accomplished by prudent blending. If mixes contain approximately 25 per cent of wheat having ergot, a three-fourths reduction in the final product will be effected.

Future

Because all cereals are susceptible to ergot infection to a greater or lesser degree, several courses of action seem appropriate for future crop production. Good farm management is essential; clean seed, clean fields, removal of weeds and grasses from areas adjacent to fields and crop rotation are basic considerations. "There are no known varieties resistant to ergot infection" (Circular 294, Montana Cooperative Extension Service).

However, wheat varieties display a range of susceptibility. Manitou has appeared to be about three times as susceptible as Kenya Farmer [Nature 266: 770 (1970)], and Waldron has been observed to be more susceptible than Chris. Moreover, laboratory tests have shown that of the four more susceptible varieties, two are conventional and two are semi-dwarf types. Consequently, seed selection should be based on sound judgement for local adaptation, plant disease resistance, such as leaf and stem rust, and appropriate quality characteristics. Of the current commercial varieties, Waldron appears to have the least resistance to ergot, but is among the most resistant to rust—another plant disease of great economic significance in the spring wheat area of the U.S.

The growth of ergot is highly dependent upon a number of environmental conditions, such as moisture, temperature, air movement, availability and quantity of spores and availability of a "friendly host" grass or small grain. Because of the interdependence of all of these types of factors, the incidence of ergot varies from year to year. Usually, two successive crop years are not identical. The optimist looks forward to improved conditions next year.