

# FLAX RUST

A PREVENTABLE DISEASE

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## SUMMARY

1. Flax rust attacks both seed and fiber flax and causes losses in yield of seed and in quality of fiber. The disease occurs wherever flax is grown, but its severity varies widely in different fields and in different seasons.
2. There are two conspicuous stages of rust on flax, a red stage which is prevalent during midsummer, and a black stage which follows as the plants approach maturity.
3. The causal organism is a mold-like plant, or fungus, which produces during its lifetime five distinct kinds of seed or spores. It is entirely dependent on flax for its food and is unable to attack any other plants. It lives over winter in the black stage on infected straw.
4. The disease first appears in the field during the latter part of June, spreads rapidly during July, and usually reaches its greatest severity in August.
5. The use of immune varieties is the most promising method of control. Immune strains of several types of seed flax have been found. These have been crossed with fiber flax and with wilt-resistant seed flax. There is every promise that varieties of both seed and fiber flax which are both immune from rust and resistant to wilt will be obtained from these crosses. None is yet ready for distribution.
6. While rust-immune varieties are being developed and increased, other control measures should be taken to prevent losses.
7. The seed should be thoroly cleaned in order to remove bits of straw which sometimes bear fragments of the black stage and which may transmit the rust to the following crop.
8. Rust may be introduced from one locality to another with the seed. It is advisable to grow one's own seed rather than to change each year. The introduction of seed from a foreign country, especially, should be avoided, because of the danger of introducing virulent forms of rust or other diseases.
9. Flax should be rotated with unrelated crops to prevent the accumulation of rust.
10. Early seeding is another preventive measure that should be practiced for controlling rust as well as wilt.
11. As long as rust-susceptible varieties are grown, it is a good plan to avoid low-lying soils for flax and to observe precautionary sanitary measures, such as burning infected straw or removing it from near fields intended for flax, before another crop of flax is sown.

## IMPORTANCE OF THE DISEASE

Flax rust is one of the oldest known diseases of the flax plant and occurs nearly everywhere the crop is grown.

In seed flax the most serious effect of rust is a reduction in yield of seed, sometimes amounting to 10 per cent or more; while crops of fiber flax may be ruined for fiber purposes.

Losses from flax rust vary greatly from season to season and from field to field. Moist, cool weather, which is favorable for the luxuriant growth of flax, is also conducive to the rapid development and spread of the disease.

Rust is caused by a microscopic, mold-like, fungous plant which depends entirely on the flax plants for its food. It multiplies by means of minute seeds (spores); and these must be present, together with proper moisture, temperature, and other conditions necessary for their germination, before flax plants become infected. Under favorable conditions the parasite multiplies very rapidly.

## HOW TO RECOGNIZE FLAX RUST

The disease first appears when the flax plants are half grown. Small reddish or orange-yellow powdery spots may be seen on the leaves (Fig. 1), young stems, and other green parts of the plant. This is the summer stage of the rust, and, while preceded by a less conspicuous stage, it is usually the first to be recognized. Rust spreads rapidly during this stage if weather conditions are favorable, and by midsummer all the plants in a field may be affected. If the rust is very abundant, the leaves drop off prematurely and the whole field may have a reddish tinge. Occasionally the attack is so severe as to kill some of the plants, especially if the variety is very susceptible and the crop has been sown late. Usually, however, the affected plants mature considerable seed but the yield may be materially reduced.

As the plants begin to ripen, the orange-colored spots are replaced by black areas on the stems, leaves, and other parts. By this time, however, most of the leaves have fallen, so that the black areas are most noticeable on the main stems and branches as shown in Figure 2. The black spots are much larger than the red ones and often are found directly under and surrounding the red spots, which gradually disappear. They are smooth and more or less wax-like, not powdery, and form blotches at intervals along the stem. These vary in size; they may be half an inch in length and may encircle the entire stem, altho they usually extend only part way around it. The stems are often slightly swollen where each black blotch occurs, the swelling being most noticeable on the branches. By the time the crop is fully

mature, the stems and branches may be literally plastered with these black blotches. The stems of fiber flax thus affected may be useless or of very inferior quality, as they are brittle at the points of attack and the black masses tend to adhere to the fibers and are not easily removed during the processes of separation of the fiber from the woody parts of the stem.

### LIFE HISTORY OF FLAX RUST

The flax rust fungus grows only on cultivated flax and a few closely related wild species. It does not have an alternate host as does the black stem rust of wheat.

Five different kinds of spores are produced by the flax rust fungus during its life cycle. It survives the winter in the black-spored (1) stage on straw and stubble in the field or on bits of straw mixed with the seed. The black spores remain attached to the straw and lie dormant during the winter but germinate the following summer and produce tiny colorless spores (2) or sporidia. These are relatively short lived but are free to be blown about by the wind. If they happen to fall on growing flax plants, soon after they are produced, they may cause infection. This infection is normally followed in from one to two weeks by the production of tiny yellow spots on leaves or other green parts of the plant. Embedded in these yellow spots are tiny sacs, called pycnia, which contain a third kind of spore (3) known as pycniospores. These are colorless, very small, and, so far as known, are functionless. These yellow spots are followed a few days later by orange-yellow spots in their immediate neighborhood. These contain the spring spores (4) or aeciospores. The latter two stages appear during the last two weeks of June, are usually not abundant and do not damage the flax plants appreciably. The aeciospores are important because they initiate the next stage, the summer or repeating stage, which is also of an orange-yellow color, resembling the spring stage in many respects. This appears on neighboring flax plants about ten days after the spring spores have fallen on them. A new generation of summer spores or urediniospores (5) may be produced about every ten days while the flax plants remain green. Since they are the only spores of this rust that can reproduce themselves and since a new crop of spores can be produced in such a relatively short time, it is readily seen how the fungus can multiply so rapidly during this stage. The chief function of the black spores, which replace the summer spores as the flax plants mature, is to carry the fungus over the winter. So far as is known, the survival of flax rust through the winter depends wholly on these black spores.

There are thus five distinct stages in the life history of the flax-rust fungus, each stage distinguished by the production of a different kind of spore. But they are all produced by the same fungus; and they develop only on flax, an important point to remember when measures for controlling the disease are under consideration.



Fig. 1. Young Flax Plants Showing a Light Infection of the Summer or Uredinial Stage of Flax Rust

The small dark spots on several of the leaves are rust pustules.

## HOW TO CONTROL FLAX RUST

### Use of Immune Varieties

Almost all of our best varieties of both seed and fiber flax are quite susceptible to rust. As the growing of rust-resistant or immune varieties would obviously solve the rust problem most efficiently, numerous varieties of flax have been grown under artificially induced epidemics of rust during the last few years. These tests have demonstrated that a few varieties and unnamed selections are absolutely immune from rust. They remain entirely free from rust while other varieties surrounding them may be very heavily rusted and even killed

by the disease. Some of the immune varieties have blue blossoms and brown seeds, while others have white blossoms and yellow seeds. Several have much larger blossoms and seeds than the flax commonly grown in the United States, while others have medium-sized to small

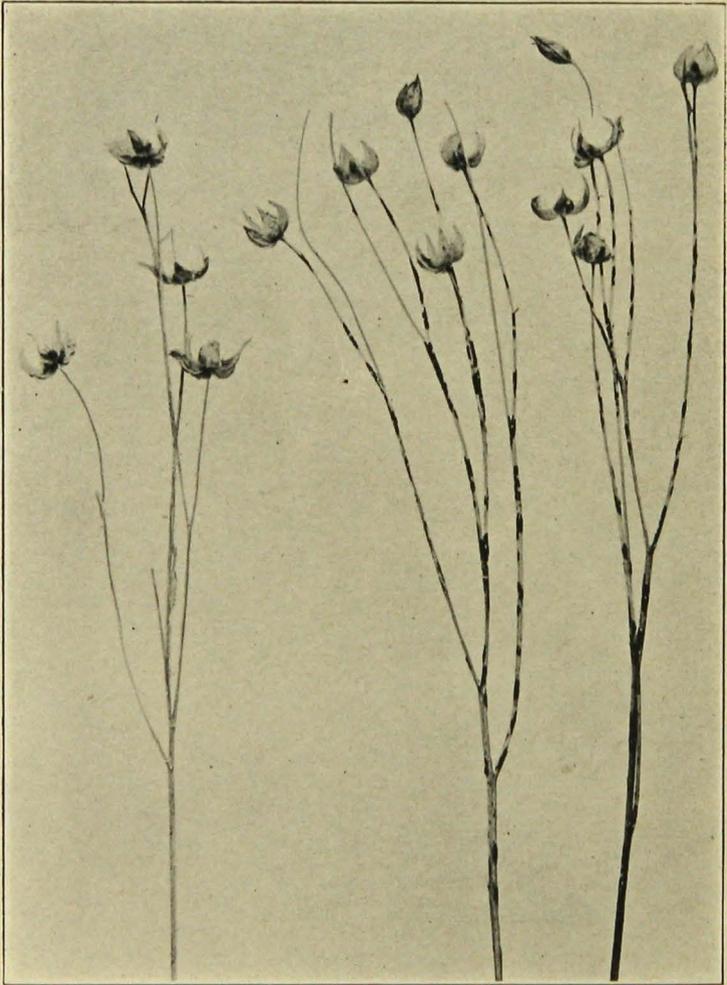


Fig. 2. Flax Rust in the Black Stage

The plant at the left is immune, while the two at the right are susceptible.

blossoms and seeds. No one variety possesses all the desired characteristics, altho some of the selections may be valuable in themselves as seed flax. All the immune strains yet found are too short and coarse in the stem to make good fiber flax. Some are also resistant to wilt, perhaps the most destructive disease of flax, while others are susceptible. The large-blossomed selections shown in the foreground

of the illustration on the cover page are both wilt resistant and immune from rust. The small-blossomed variety in the center of the picture between the rows of large-blossomed flax is highly wilt resistant but very susceptible to rust. The picture shows a section of the flax wilt nursery at University Farm, St. Paul, where the soil is thoroly infested with the wilt organism.



Fig. 3. Uncleaned Flax Seed Containing Bits of Flax Stems Infected with the Black Stage of Flax Rust

Such impurities may transmit the rust to the following crop if they are not removed by thoroly cleaning the seed.

In order to combine as many desired qualities in one variety as possible, crosses have been made between the rust-immune selections and those possessing other desired qualities. For instance several of the rust-immune, wilt-resistant seed flaxes have been crossed with fiber flax in order to combine the length of stem and quality of fiber of the fiber flax with the immunity from rust and resistance to wilt of the seed flax. The breeding work has progressed sufficiently to indicate that immunity from rust can be combined with other desirable characters in both types of flax. However, it will be several years before there is enough seed of desirable rust-immune strains for general distribution. In the meantime, other preventive measures should be taken.

#### Clean Seed a Necessity

While flax rust is not carried by the seed directly, it may be transmitted from one crop to the next if small bits of straw bearing the black stage are sown with the seed. These are often found in samples

of seed flax (Fig. 3). It is obviously advisable to clean the seed thoroly.

The practice of changing seed frequently should be stopped, for several reasons, one of the most important being the danger of introducing such diseases as rust. It is quite possible to introduce, with seed from a foreign country, virulent forms of flax rust or even some disease previously unknown in this country or in a particular locality. For instance, if a form of rust capable of attacking our immune varieties were introduced, the work of developing these would have been in vain. It is best for the grower to obtain seed of a recommended variety from a near-by source if possible, and to grow his own seed each year thereafter rather than get it from an outside source.

### **Crop Rotation a Good Practice**

Failure to practice crop rotation is one reason why flax rust becomes so abundant in certain fields. It is just as important to grow flax in a rotation as any other crop. Apparently some growers think that if they use wilt-resistant varieties they can grow flax successfully year after year on the same land. Such farming is certainly unwise. It provides ideal conditions for the accumulation of rust and other diseases to which the wilt-resistant flax in all probability is susceptible. Flax rust lives over winter on the old, infected straw and stubble, and plenty of this is usually left in the field to cause many centers of infection in flax sown there the following year.

This gives the rust an early start and the result may be an epidemic in that field. By sowing flax after corn, a legume, or some unrelated crop, this danger is avoided and a much better crop may be expected.

### **Early Seeding Helps to Prevent Rust**

Flax sown late is much more likely to be injured by rust than that sown early. Plants of susceptible varieties may be killed by rust if sowing is delayed too long. Since rust does not become sufficiently abundant to be destructive until about the middle of July or later, early-sown flax will escape infection during a large part of its life and will consequently be damaged less than late-sown flax. Early seeding also is a good preventive of wilt.

### **Other Precautions**

In order to lessen still further the danger of rust damage, it is a good plan not to sow flax on low-lying fields where the maturity of the crop is likely to be delayed and where conditions are likely to be especially favorable for rust development. Such sanitary measures as burning the infected straw or removing it in some other way from fields intended for flax, will also aid in controlling flax rust.