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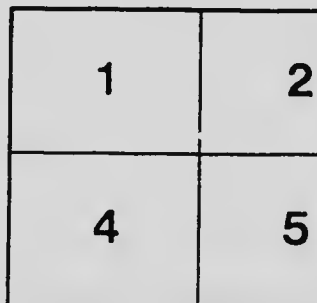
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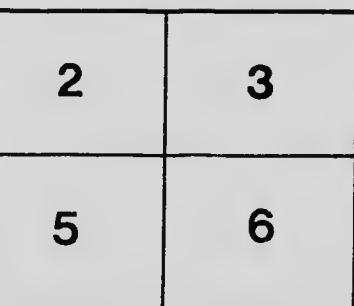
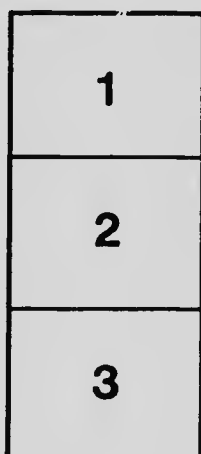
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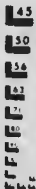
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J. H. GRISDALE, B.Agr., D.Sc.A., Director.

BEAN ANTHRACNOSE.

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Bean anthracnose, sometimes called pod spot, and incorrectly called rust, is a very common and destructive disease, particularly in Quebec and the Maritime Provinces and, some years, in Ontario. It is almost invariably present but not always severe enough to be noticeable. It attacks the stem, leaves, pods and seeds, causing dark spots, resulting in greatly decreased yields and an inferior quality of crop. It is caused by a microscopic fungus, carried chiefly by the seed. It can be greatly reduced, if not controlled, by taking proper precautions.

SYMPTOMS.

Field Appearance: When infected seed has been planted and the weather is wet or cloudy, the disease develops rapidly. Skips or vacant spaces occur in the row where the seed has failed to germinate or where the young plants have died and completely disappeared. Frequently considerable portions of the row may be marked only by bare stalks, or small, sickly plants bearing a few faded leaves.

However, an abundance of foliage does not necessarily mean freedom from anthracnoses. Infection under favourable climatic conditions may spread rapidly and become serious even after the plants are quite large; under such conditions it is not noticeable without carefully examining the stem, leaves and pods.

On the Seed: The seed may be slightly or badly infected and in severe cases appears rotted or weathered. Slightly infected seed may show little or no discoloration or only a light brown stain. Badly infected seed shows well marked, dark brown or black spots varying from the size of a pin head to a degree where the whole seed is involved. In such cases the seed coat is usually ruptured and the spots more or less sunken, with a grayish centre, indicating that the invading fungus is producing fruiting bodies. Badly infected beans are unfit for table consumption and even the slightest spot injures the bean for seed purposes.

On the Cotyledons (fleshy seed leaves): Diseased seed invariably produces diseased cotyledons; one or both may be affected. The lesion or canker is of a brownish colour with a definite outline and involving all or part of the cotyledon. If damp weather prevails the diseased area enlarges and the pinl. pore-masses of the fungus are produced in abundance.

On the Stem: The fungus may spread from the cotyledon to the stem, infecting and destroying the growing point, leaving a bare stalk. If the stem infection takes place early and conditions are favourable, the stem may rot off at the surface of the ground and disappear entirely. Infected stems show well-marked, brown or black, elongated streaks. Severe stem infection practically prevents the plant from setting any pods.

On the Leaves: The disease appears on the lower side of the leaves as black streaks on the mid-rib and veins. This condition sometimes results in a puckering of the surface. The leaves, particularly when the petioles are affected, turn yellow and fall prematurely, leaving small, weak plants incapable of producing a maximum crop.

On the Pods: The lesions are most noticeable on the pods, at first as minute, dark-red spots, which rapidly enlarge and become sunken or saucer-shaped, with a definite dark-red or black border. The sunken appearance disappears as the pods become mature and dry. In other cases, when infection has been extensive, the numerous small lesions coalesce, giving the pods a brownish, black-pitted appearance. The centre of the larger spots may be brown, black, pink or grey, depending on the age-condition of the fungus.

CAUSAL ORGANISM.

Bean anthracnose is caused by the fungus *Colletotrichum Lindemuthianum* Sacc. and Magn. The vegetative mycelium consists of hair-like tubes, at first colourless but later brown; invisible to the unaided eye except in clusters or tufts such as are sometimes seen in the centre of old lesions. A network of this mycelium develops beneath the epidermis of the infected spot causing the characteristic appearance of the disease, and later produces small erect branches or conidiophores bearing the elliptical or kidney-shaped spores, stuck together by their mucilaginous envelopes. In masses the spores are pink or cream-coloured. These spores are scattered by numerous means to other parts of the plant and even considerable distances to other plants. If there is a supply of moisture, they germinate immediately by sending out one or more germ tubes, which enter the healthy tissue, and in turn its mycelium develops, producing a fresh lesion and a new generation of spores.

LIFE HISTORY.

The fungus passes the winter in a dormant condition in the seed, in diseased bean refuse, or in the soil, but chiefly in the seed. The bean seed upon germination is pushed above the ground, both halves forming the cotyledons or rudimentary leaves, which serve as a primary source of food during germination and until the plant has become established. Consequently, infected seed invariably produces infected cotyledons. The moisture taken up by the seed during germination is sufficient to enable the fungus to commence growth and produce spores. These spores are brushed off on the soil as the cotyledons push toward the surface, and immediately come in contact with the young tender stem, ready to germinate and attack the new plant. The cotyledons remain on the stem for a considerable period after the true leaves have appeared and, if weather conditions are favourable such as plenty of moisture, and not too much sunlight, the spores are produced in large numbers from diseased cotyledons. These are washed down the stem by rain and spread by other means to all parts of the plant and adjacent plants. The cotyledons thus serve as the nest, in which is produced the new generation of spores and from which they can most easily be spread.

These spores now attack the leaves and stem, setting up disease and weakening the plants. By the time the pods are setting, more spores have been produced from these new lesions and the pods become infected. The fungus mycelium attacks and penetrates the pods causing serious injury and finally enters the new crop of seed in which it lives in a dormant condition until germination takes place the following spring.

The fungus is also capable of wintering over in diseased stems, old pods and leaves, and if these are applied to the soil the new crop infection will take place. Probably it is capable of living on organic matter in the soil for a few years and, if a reasonable rotation is not practised, infection from soil-carried organisms may be expected.

LOSS CAUSED BY THE DISEASE.

A conservative estimate of the decreased value of the Canadian bean crop, caused by this one disease, is probably over 10 per cent. In some localities and during some seasons it is undoubtedly much more; many fields have been examined where the crop was reduced by from 50 to 75 per cent. The total annual loss on the dried bean crop alone amounts to over 300,000 bushels, and to this must be added the loss caused to string beans which are grown in every garden. This loss is manifest in several ways. The first and most important is decreased yield, which loss may vary from little or nothing to almost a complete failure. Beans from badly and even moderately infected fields are not suitable for seed purposes unless very thoroughly hand-picked, and even then diseased beans are sure to escape. Probably the growers of string beans, where the green pods are used for table or canning purposes, suffer the greatest proportional loss as infected pods are unmarketable.

SPREAD AND DEVELOPMENT OF THE DISEASE.

The disease, as previously stated, is propagated from year to year chiefly by planting diseased seed and to a lesser extent by using infected bean refuse as fertilizer, or failure on the part of the grower to practise a reasonable crop rotation. The spread and development of the disease in the field is influenced to a large extent by the prevailing climatic and soil conditions. During a bright, dry season little damage is caused, but during wet, cloudy weather it spreads and develops rapidly. This is because of three conditions: (1) The spores have a mucilaginous envelope which holds them together when dry and retards their being carried from the diseased lesion to healthy plants by the wind. (2) The spores are produced most abundantly during wet weather. (3) They can germinate and gain entrance to healthy tissue only when moisture is present.

Beans grown on low, wet, or poorly drained soil are usually more severely injured than those grown on high, dry soil. This is probably due to a greater amount of moisture in the atmosphere surrounding the plants and to the fact that an abundance of soil moisture encourages an early rapid growth of the fungus contained in or on the infected seed during germination. The same condition is brought about even on high soil if the seed is planted too early and during wet weather.

Healthy leaves become infected by brushing against moist, spore-bearing lesions. Spores are carried from one plant to another by cultivating machinery and on the hands of the picker. It is therefore advisable to avoid working among beans when the ground is wet.

CONTROL MEASURES.

Numerous suggestions for the control of anthracnose have been made from time to time but these have failed, partly because of their inefficiency but largely due to the fact that the growers have failed to put them into practice carefully and continuously. The chief point to keep in mind is that diseased seed produces diseased plants and these serve as a source of infection to healthy plants. It would seem that a combination of control measures might give the best result. The various steps are here described separately but should be practised collectively.

Pod selection: Disease-free seed can be most easily obtained by gathering sound pods from a field as nearly disease-free as is available. In selecting these pods care should be taken to select from plants which appear resistant to the disease high yielders and true to the desired type.

As an additional precaution, the pods should be immersed in one of the following solutions for two or three minutes:

- (a) Copper sulphate, 1 lb. in 50 gallons of water.
- (b) Formalin, 1 pint in 30 gallons of water.
- (c) Corrosive sublimate, 1 oz. in 8 gallons of water.

The pods are then thoroughly dried, threshed and the seed stored in a clean sack; care should be taken to avoid reinfection of the seed. If it is impracticable to select enough pods to supply seed for planting, the whole of the next year's crop, sufficient should be selected for a seed plot.

Seed plot: A seed plot is nothing more nor less than a plot on which is propagated desirable seed, of pure variety, true to type, high yielding and free from diseases, in sufficient quantity to supply seed for planting the main crop the following year. The very best seed obtainable should be secured for planting the seed plot. This practice has given excellent results with other crops and might profitably be practised by seed growers.

Seed selection: Where pod selection has not been practised, and even if it has, the beans should be carefully hand-picked, removing all discoloured, spotted, shrunken, or inferior seed before planting. This will not remove all the infected seed but will materially reduce the amount. Several preliminary experiments in careful hand-selection gave very promising results, not only as a control for anthracnose but as a means of eliminating inferior seed and disease in general.

Seed treatment: Treatment of seed beans has not given wholly reliable results, probably due to the fact that the organism causing the disease penetrates deeply into the tissue, and cannot be easily destroyed without injuring the germinating quality of the seed. Nevertheless, after the seed has been carefully hand-selected, treatment will help by destroying slight surface infections. Preliminary experiments with various seed treatments indicate that soaking the seed for three minutes in any of the solutions given above reduces the amount of disease and increases the yield.

Copper sulphate and corrosive sublimate are poisons and beans treated with them should not be used for table purposes or fed to animals.

Spraying: Spraying beans for the control of anthracnose has not proved entirely successful or economical; the disease can be checked to some extent but not controlled. When great importance is attached to freedom from disease such as on a seed plot or where beans are being grown for seed purposes, they should be sprayed with a 2:2:40 or 4:4:40 Bordeaux mixture, the first application being made when the plants are quite small, and succeeding applications at intervals of one week or 10 days.

In addition to the above practices, the grower should observe the following precautions:—

1. Select a marketable variety known to show resistance to the disease in his neighbourhood.
2. Plant on dry, well-drained soil.
3. Avoid the use of bean refuse as fertilizer on the bean field.
4. Plant beans in the same field not oftener than once in three years.
5. Avoid cultivating, picking, or doing any other work among the beans during wet weather.





