Importance of Seed Anthracnose on Beans Research Review

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Abstract

Disease infected seed can have reduced storability, decreased germination, loss of seed weight and reduced meal and oil quality. Optimum storage conditions to limit fungal growth includes: Seed free from fungi or other pests, Clean seed without organic or other waste material, Less than 12% moisture, and Cool uniform storage temperature. Management options to minimize diseases on seed: Start with clean seed (pathogen free) and use resistant varieties when available. Fungicide options Seed treatments can help reduced seed to seedling disease transfer. Foliar fungicides can help reduced the risk to pod and seed infection by some fungi. Tillage and crop rotation – bury the inoculum from disease-infested residue and further reduced the inoculum by planting a non-host the next season. When at threshold levels, control pests, such as bean leaf beetle, and other insects that injure the pod, opening the door to fungal infection. Infected seed also can introduce new races of the pathogen into different geographic regions. Anthracnose can move into new fields with infected seed, which give rise to diseased seedlings that act as a source of inoculums of the anthracnose fungus that is spread to adjacent plants by splashing rain. Sowing infected seed also results in poorer emergence and reduced seedling vigor. Seed producers need to maintain very high standards of disease control in order to maximize yield and provide bean producers with high quality, disease-free seed. Growers should have seed samples tested to ensure they are not infected. The use of disease-free seed is a critical component of any strategy to prevent losses caused by this disease.

Key words: anthracnose, disease, resistance, yield.

Introduction

Anthracnose on beans can reduce both yield and quality. The disease is distinct from the anthracnose that affects lentils. Anthracnose, caused by *Colletotrichum lindemuthiana*, occurs worldwide except in hot dry areas and infects all aerial parts of the plants. The fungus is pathogenic to common bean, scarlet runner bean, mung bean, cowpea, and fava bean. Anthracnose can occur in many different pathogenic strains or races. Anthracnose on common bean occurs throughout the world and is especially devastating in temperate and subtropical

areas. Yield losses can reach 100% if the disease is not managed. In recent year dray seed production has, rapidly expanded to more than 200,000 acres in Manitoba.
However, this increase in acreage has been threatened by an outbreak of bean anthracnose. Anthracnose, caused by the fungus *Colletotrichum lindemuthianum*, can severely reduce seed yield, quality and marketability in all the major bean classes. Disease surveys have determined that anthracnose was present in a high percentage of dry bean fields throughout southern Manitoba. The anthracnose fungus causes dark brown lesions to form on all the aboveground parts of the plant. On the leaves, lesions typically occur along the veins and are most obvious from the underside of the leaf. Heavy infection of the leaves often results in early defoliation. Anthracnose also causes the formation of sunken lesions on the stems and pods. Within these lesions a pinkish exudate is present that consists of spores embedded in a mucilaginous substrate. Pod infection ultimately results in the formation of dark brown lesions on the seed.

The pathogen is primarily spread by infected seed and can survive on infected crop stubble. Frequent rainfalls favor sporulation and infection of beans by *C. lindemuthianum*. Once lesions begin to form on the seedlings, the spores of the fungus can be spread by splashing rain from infected plants to healthy plants. Splashing rain also moves the disease further up the plant and onto the pods. Temperatures above 28C will inhibit infection and interfere with the growth of the anthracnose fungus. However in Manitoba, high temperatures are not a major factor in reducing disease buildup, since high daytime temperatures are offset by low nighttime temperatures that are conducive for the spread of anthracnose.

Literature review

Seed Hygiene

Seed hygiene is a highly significant aspect of agricultural production, with both nation and international implications. Nationally, seed hygiene is an important factor in the reproduction, utilization and storage of seed crops. Internationally, seed hygiene has quarantine and quality assurance implications for both the importing and exporting of seed lots. Seed hygiene may be considered from two points of view: ether qualitatively (whether seed is infected with pathogens, infested with pests or contaminated by noxious or prohibited weed seeds) or quantitavely (the level of infection, infestation or contamination.

Pathogens

A pathogen can be defined as any entity capable of causing a disease and in plants the major organisms causing disease are fungi, bacteria, viruses and nematodes. Those organisms carried in, on, or with seed are termed seed borne pathogens, and since most crops are propagated by seed, they are subject to infection by a number of seed – borne diseases unless appropriate strategies are implemented. Control of seed-borne diseases should be directed against those parts of the life cycle of the pathogen that are most sensitive (Neergaard, 1979).

Avoidance or elimination of the pathogen, by means of appropriate quarantine precautions for improved seed, or eliminating pathogens in domestic seed lots through health testing, seed certification, seed treatment, etc. For example, New Zealand quarantine regulations require imported seed of various grasses to be tested for the presence of dwarf bunt (Tilletia contraversa Kuhn), a pathogen not established in New Zealand: and seed certification regulation for Bromus spp. Require that seed crops be rejected from certification at field inspection if standards for the presence of head smut (Ustilago bullata Berk) are exceeded, and recommended that all B. sitchensis Trin. Seed be appropriately fungicides treated before sowing. Similarly, seed certification regulation for Lucerne cultivar Wairaus state that the crop will be rejected if coryne bacterium insidiosum Jensen(bacterial wilt) is found at field inspection or following a serololgical heath test (Anon., 1995).

Reducing established inoculums in the soil, in alternate hosts and plant residues and in seed. For example burning or deep ploughing of crop residues after harvest is one method of reducing inoculums levels of Claviceps spp.(ergot) and Gloeotinia granigena T.Schumacher(blind seed disease). However, for environmental and agronomic reason this is not always possible, and both this disease continue to adversely affect quality in grass seed crops. Cage(1987) reported that ergot levels has increased in Czechoslovakia, affecting 13% of Italian ryegrass, 42% of red fescue and 77% of Kentucky bluegrass seed crops in 1985 and resulting in downgrading or rejection from certification and important losses of grass seed growers. In New Zealand, poor germination in perennial ryegrass seed lot is still often explained by the presence of blind seed disease, as although nationally the disease incidence has declined localize outbreaks may still occur. Although sclerotia of clover rot are often removed during seed cleaning, control of the disease in the field is difficult because of the longevity of sclreotia in soil and pathogens wide host range (Latch and Skipp, 1987). Slowing down development and spread of inoculums by utilizing climatic differences, influencing the microclimate, or impeding the spared of inoculums through isolation, vector control and hygiene. For example, Hampton (1984) cultivars of Lucerne are used to control bacteria wilt and nematodes (Ditylenchus dipsaci Kuhn) Filipjev (close et al., 1982). Improving condition for plant develop through good agronomic management. For example, perennial rye grass seed crops require around 130kg of available nitrogen per hectare and Hampton (1987) has demonstrated that providing this requirement can improve seed quality by reducing blind seed disease incidence. In legumes such as red clover Fulton and Hanson(1960) have conclude that control of Fusariu spp.(root rot) involves encouraging vigor plant growth through suitable lime and fertilizer use, proper crop rotation and avoidance of plant stress.

Storage fungi

Storage fungi can invade and destroy seeds over a wide range of temperature (4 - 45 degree centigrade) and relative humidity (65-100%) (Christensen and Kaufmann, 1969). Their activity is larger determined by the physical condition, vitality and moisture content of the seed and the ambient temperature and relative humidity of the storage area. Consequently, the population of the storage fungi reflect the kind of post-harvest handling, conditioning and storage environment of a given seed lot (Kulik, 1995). Much of the information we have on seed storage fungi has come from studies on stored cereals, but their activity is also an important dimension of quality in forage grasses and legumes (Hill and Crosbie, 1966). The strong inclusive properties of small seeds rapidly result in high seed temperatures as a result of fungal growth. Finally heated hot spots in seed commonly reach temperatures in excess of 50 degree celces, and may rise higher if the seed lot contains damaged seed.

Incidence

Anthracnose was once the most economically important edible bean disease in Ontario but recently has been well managed with resistant varieties and seed treatments. In fields where the disease does develop as a result of the delta strain infection of the fungus, significant damage can result.

Diagnostic Methods

In the field: Look for characteristic lesions as described in the symptoms section. In moist weather, a pink mound of spores may be present in the center of the lesion and can be seen using a hand lens.

In the lab: Look for lesions as described in the symptoms section. Place sample in moist chamber to induce sporulation within the lesions. Wet-mount spores onto a microscope slide. *C. lindemuthianum* conidia are unicellular (no cross walls), clear to light tan, and cylindrical with rounded ends or with a narrow base). Size range for conidia is 2.5-5.5 X 9.5-22 µm.

Appearance

Plant symptoms include round, angular or oval lesions on the leaves, stems and pods. The lesions are sunken or "crater-like,"with a distinct black ring along the edge of the lesion. Often, the centre of the lesion is covered with numerous small, black spore masses. The veins on the lower leaf surface are often red-brown or purple-red. Yield loss is due to early leaf senescence and plant death, shrunken seed and an increase in "pick" (seed that has disease lesions on the seed coat.

Biology

The fungus that causes anthracnose is seed- and stubble_borne. Production of spores and initial infection is favored by temperatures of 13ºC to 26ºC (55ºF to 79ºF) with an optimum of 17ºC (63ºF). Relative humidity above 92% and free moisture also favor infection. Epidemics are brought on by frequent showers especially accompanied by driving winds.

Disease Cycle

The fungus survives from year to year primarily as spores or lesions on the seed. Planting clean seed is critical to controlling the disease. Once initial infection occurs in a field, the disease can be spread by the movement of farm machinery, animals and humans, both within the field and between an infected field and a non-infected field. Rainy weather favours this disease, as spores are splashed from diseased areas and carried in wind-borne water droplets or by surface water throughout the field. Wet conditions over a prolonged period of time can result in epidemics. *C.lindemuthianum* overwinters in crop debris and conidia are spread through seed, wind and rain. *C. lindemuthianum* is also seedborne. The temperature range for infection is 55-80°F and high relative humidity (>90%) is also required.

There are several races (or strains) of anthracnose. All races of the disease cause the same plant symptoms. All of the currently recommended varieties of white bean are resistant to beta and gamma races of anthracnose. Consult the OMAFRA Factsheet, Performance Trials for Dry Edible Beans, or visit the Web site at http://www.omafra.gov.on.ca/english/crops/index.html each year, for varieties resistant to the alpha and delta races.

Management Strategies

To avoid anthracnose, plant disease-free seed and use a fungicide seed treatment. Incorporate infected bean debris into the soil after harvest and rotate beans with other non-host crops for at least 2 years. Stay out of bean fields when the plants are wet. Seed-treatment fungicides are available that reduce transmission of anthracnose to the seedlings. However, seed treatment will not eliminate the disease from heavily infected seed. A seed treatment study in 2001 demonstrated that DCT (diazinon, captan and thiophanate-methyl) was more effective in reducing seed-borne transmission of anthracnose than other seed-treatments registered for disease control in beans. Several foliar fungicides also will decrease the spread of the disease.

A study at field sites in Morden and Winkler demonstrated that application of the foliar fungicide Headline could reduce losses in seed yield and quality from this disease. The timing of application was a critical factor in determining the effectiveness of the spray application in reducing disease severity and seed infection. Applications of head line prior to flowering reduced yield losses if there was an early disease buildup, but did not prevent late infection of the pods and seed. Spray applications at the early or late bloom stage minimized yield losses and reduced seed infection. Application of Headline at ten days after the end of flowering did not always prevent yield losses or high incidences of seed infection. Headline application during flowering reduced yield losses by 33% if severe infection occurred early in the growing season and by 11% where the buildup of anthracnose occurred late in the season.

The anthracnose fungus has a limited host range that includes faba beans, mung beans and scarlet runner beans, so dry beans are the most important crop on the prairies that is affected by this pathogen. This provides the growers with many options for selecting alternate crops for inclusion in long term rotations. Field studies have shown that the anthracnose fungus can survive on infected crop debris for up to two years. Bean anthracnose can be controlled by crop rotation for 2-3 years with non-host crops and by planting disease-free seed. Anthracnose has been reported to be most severe in fields where beans have been grown for more than one year on the same field. Worldwide, a large number of races of the anthracnose fungus have been identified. To date, researchers have detected six or seven races of *C. lindemuthianum* in Ontario. However, the identity of the prevalent races in Manitoba has not been determined. Research has recently been initiated to identify the prevalent anthracnose races in Manitoba. Resistance too many of the common races of the anthracnose fungus has been identified in cultivars developed in Ontario.

However, anthracnose is a new problem in western Canada, so cultivars specifically developed for this region have not been selected for resistance to anthracnose. For that reason, many of the bean cultivars grown in the Prairie Provinces are highly susceptible to the common races of anthracnose. A joint research project is underway, involving researchers from the Morden Research Station, Lethbridge Research Centre, the Greenhouse and Processing Crops Research Centre in Harrow, Ontario and the Crop Development Centre at the University of Saskatchewan,that is focusing on the development of resistant bean cultivars for the Canadian prairies. In this study, advanced breeding lines and registered cultivars are being evaluated for their reaction to the Alpha, Alpha Brazil and Delta races of the anthracnose fungus. Information from ongoing studies on race identification, resistance and fungicidal control will form the basis of an integrated management system that should eliminate bean anthracnose as a major concern in dry bean production on the prairies.

- Resistant cultivars are available.
- Start with certified, disease-free seed or treat seed with fungicides.
- Rotate for 2-3 years with non-host crops such as cereal or corn.
- Reduce plant density to promote rapid drying of foliage and pods.
- Preventive fungicide sprays have limited effectiveness. If applications are made they should coincide with flower initiation. Registered materials include maneb, chlorothalonil (Bravo), thiophanate-methyl (Topsin), and pyraclostrobin (Headline).

Resistant cultivars of common bean are available. Check with seed companies for the most current varieties. The NCSU Horticulture Department maintains a list of bean cultivars and their disease resistance (including anthracnose resistance): If anthracnose is already established in the field, a 2-3 year rotation away from beans and other legumes is recommended. Corn and solanaceous crops (tomatoes, potatoes, eggplant, etc) are possible non-host rotation crops. Bury infected debris to avoid spreading the disease in the following season. Mulch to prevent soil from splashing onto plants during watering. Effective foliar fungicides are available and, if used, should be applied during flower set, late flowering, and at pod fill to control symptoms to reduce direct yield losses. Consult the North Carolina Agriculture Chemicals Manual: http://ipm.ncsu.edu/agchem/agchem.html (Refer to the section on vegetable diseases and table titled 'Relative effectiveness of various chemicals for foliar disease control in the bean.

Symptoms

Symptoms on leaves consist of angular red brown spots and red brown sections of leaf veins. Stems and petioles develop sunken, elliptical lesions with darker margins. The pathogen can infect the hypocotyl and cause stem collapse when the stem is girdled. Pods also develop sunken, brown lesions and seed can become infected. Affected seed may have yellow or brown lesions, be shriveled, and fail to germinate. Severe infection results in defoliation and pod distortion.

C. lindemuthiana survives in crop residues and in seed. It is disseminated within fields by rain, wind, and splashing water. The disease is favored by cool temperatures, frequent rainfall, and high humidity. Anthracnose affects all above ground parts of the plant including leaves, petioles and pods. Seedlings can also be affected. Lesions on the leaves and petioles can occur on both sides of the leaf surface and may appear to be elongated and/or form along the leaf veins. The lesions start as reddish-purple specks that progress into brown-black lesions. Symptoms on pods are reddish rust colored lesions or specks that develop into sunken tan colored lesions surrounded by black rings. Lesions on pods range from 1-10 mm in diameter. In humid weather masses of tan or pink colored spores may form in the center of the lesions.

Conclusion and Recommendation

Plant seed that is as free of anthracnose as possible and/or treat with a recommended fungicide. Plant crops other than beans for two to three years before replanting a field to beans. Choose cultivars that are resistant to the common races of anthracnose that are found in your region. There are several common races (ex, alpha, beta, gamma, delta and lambda) and individual cultivars may have resistance to some but not all of them. Use a foliar fungicide, if available, should the anthracnose infection be apparent prior to pod development.

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