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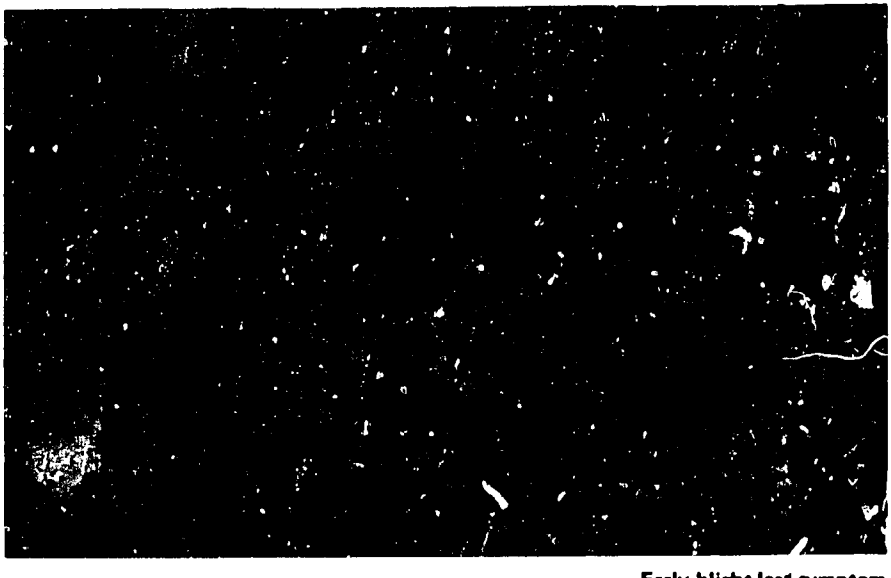
Early Blight of Potato

Alternaria solani

Rainer Zachmann



Early blight leaf symptom

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INTERNATIONAL POTATO CENTER (CIP)

Lima — Peru

Technical Information Bulletin 17

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Objectives. Study of this bulletin should enable you to:

- explain the importance of early blight,
- describe the symptoms,
- describe disease development (epidemiology),
- explain the biology of the fungus,
- discuss methods of monitoring spore propagation,
- discuss methods of control,
- demonstrate methods of disease evaluation.

Study materials.

- Infected plants and tubers to demonstrate symptoms.
- Spore trap, trapped spores and microscope to demonstrate trapping method.
- Fields with different varieties to practice disease evaluation.

Practicum.

- Observe and discuss early blight attack and possible control measures in the field.
- Set up a spore trap and observe the results one or a few days later (depending on intensity of secondary spore propagation).
- Practice different disease evaluation methods in the field.

Questionnaire.

1. How serious is early blight in your country?
2. On which plant parts does the disease occur?
3. How can you distinguish early blight from late blight symptoms?
4. How does *A. solani* inoculum survive?
5. What is the damage of primary infection?
6. Which climatic conditions favor early blight incidence?
7. What is the epidemiological importance of primary infection?
8. How can you observe start of secondary spore propagation visually?
9. How can you reduce disease incidence by proper agronomic management?
10. What is the relation between crop maturity or maturity type of varieties and disease incidence?
11. Why should infected residues be removed from the field after harvest?
12. Which effect has crop rotation as control measure?
13. How would you best schedule fungicide applications?
14. Which are the most resistant varieties in your country?

Early Blight of Potato

Alternaria solani

1 Introduction.
2 Importance of early blight.
3 Symptoms.
4 Epidemiology.
5 Biology.
6 Monitoring spore propagation.
7 Control.
8 Disease evaluation.
9 Additional reading.

1 INTRODUCTION

Early blight of potato is caused by the fungus *Alternaria solani*. It attacks principally potato foliage, but also tubers. The disease is an important problem in many areas that are too warm and dry for *late* blight, another fungal disease caused by *Phytophthora infestans*. Various possibilities for control of early blight exist.

2 IMPORTANCE OF EARLY BLIGHT

Early blight was first described in 1882. It is a serious problem in many areas of the world where it not only affects potato, but also tomato and other solanaceous plants. Early blight has received less study than late blight, but in recent years it has been observed as an important disease in many of the warmer potato growing areas.

The disease occurs on foliage and sometimes also on tubers. Yield reductions caused by foliage attack reach more than 50 %. The effect of early blight may sometimes be obscured by severe incidence of other diseases, such as verticillium wilt.

In stored potatoes, losses caused by *A. solani* may be substantial and reach 80 % of tubers affected by early blight lesions. In some instances, tuber infection has caused large losses in potatoes stored for processing at temperatures of 10 °C or higher.

3 SYMPTOMS

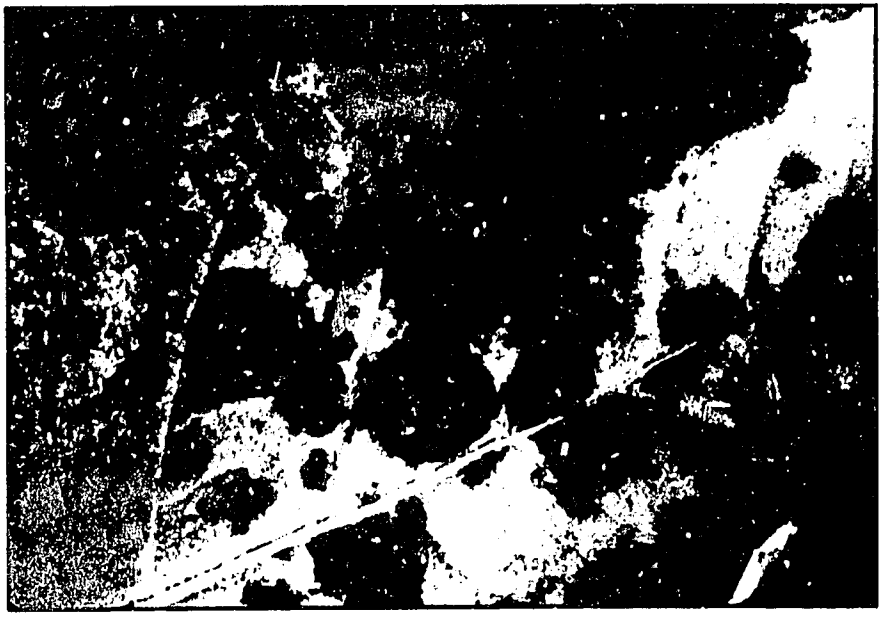
Symptoms occur on foliage and tubers.

On leaves, dark brown, more or less circular lesions, with concentrically arranged rings resembling a target board, first develop on the lower, older leaves. Depending on environmental conditions and potato variety, lesions enlarge to 0.5 to 2.0 cm in diameter, and become associated with chlorotic leaf area around and between the lesions. Under dry conditions lesions may drop out leaving a hole (shot-hole appearance). Leaves eventually become totally chlorotic, dry and die. The disease generally leads to defoliation but drying leaves remain sometimes hanging on the plant. Similar lesions also occur on petioles and stems. Stem infection may cause breaking of stems and death of the uninfected plant portions above the lesion. Foliage symptoms can be confounded with early maturity and verticillium wilt symptoms.

Tuber infections are characterized by irregular, sunken lesions with elevated borders. They are randomly distributed on the tuber surface. Their color varies from gray, to brown or purple to black. The tissue below the lesions is dark brown, solid and dry, and extends into the tuber from a few millimeters up to 2-3 cm. It is often surrounded by a narrow water soaked zone.

Early blight symptoms should not be confused with those caused by *Phytophthora infestans* (late blight). Late blight lesions on leaves are usually not zonate. Under high relative humidity they show sporulation in the form of a white mildew on the underside of leaves, which early blight does not. In contrast to early blight, late blight typically occurs under prolonged humid and cool conditions. Tuber lesions caused by early blight do not extend irregularly into the flesh as in late blight. (See: "Late blight of potato", section 9 of this bulletin).

In the humid tropics leaf lesions may additionally be caused by other fungi, such as *Alternaria alternata*, and *Phoma*, *Septoria* and *Macrophomina* spp. Symptoms are sometimes similar and can be confused with those caused by *A. solani*.



On leaves, early blight lesions present a characteristic zonate or target board appearance. Under dry conditions they may drop out leaving a hole.

4 EPIDEMIOLOGY

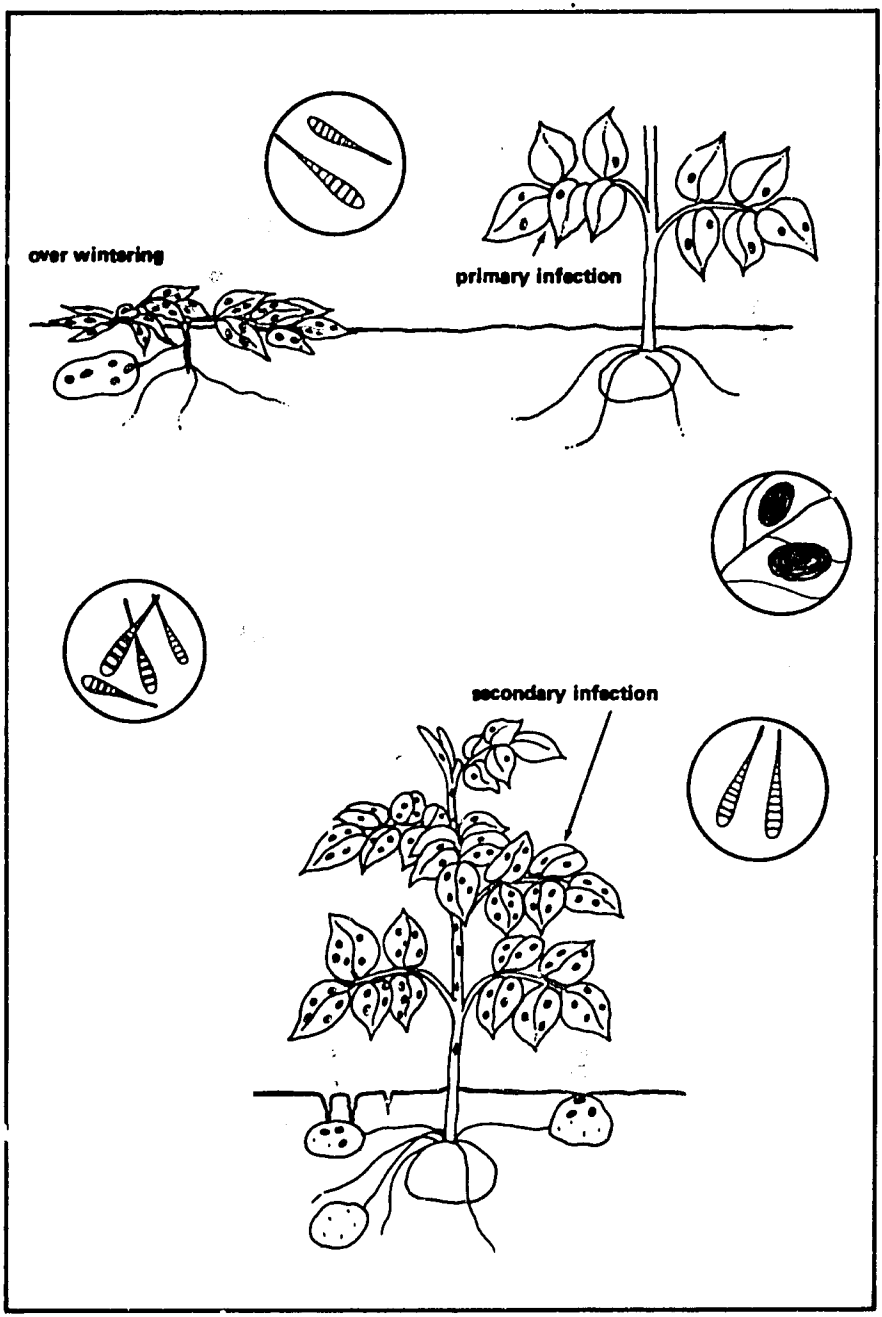
A. solani inoculum survives from season to season, but not over several years, as mycelium or spores on plant debris or at the soil surface from where spores spread by wind. Inoculum may also survive on tubers. Initial, *primary*, spread from this soil borne inoculum may remain restricted, but it is the basis for often heavy *secondary* disease propagation. Young leaves appear to be resistant to the primary development of the fungus. They may be infected but do not show symptoms for several weeks. When leaves begin to senesce, typical lesions develop, predominantly on the lower leaves. Middle and top leaves continue to appear healthy even though they may be as heavily infected as bottom leaves.

The relatively few lesions developing on the lower leaves are the source of *secondary* sporulation which leads to heavy infection later in the season. Since primary lesions are often inconspicuous, the beginning of secondary sporulation is hard to notice. It can be monitored by spore traps which reveal secondary sporulation long before spread of the disease (see section 6 below).

Relationship between disease development and plant maturity may be confirmed by several observations. Varieties maturing early often show heavier secondary infection. They may serve as a source of inoculum for later maturing varieties. Heaviest infection generally develops towards the end of the growing season. The effect of early blight is difficult to assess when other adverse conditions, such as drought and verticillium wilt, contribute to early senescence of a crop.

Foliar infection is favored by warm (around 25 °C) and wet conditions. Rainfall promotes the disease but is not required if heavy dew is frequent. Other factors that increase loss include overhead sprinkler irrigation, mechanical harvesting and storage at elevated temperatures (above 10 °C).

Inoculum present on infected foliage or on the soil surface infects injured tubers at harvest time. Tubers become less susceptible to mechanical damage and consequently to early blight infection when proper measures are taken to reduce tuber injuries.



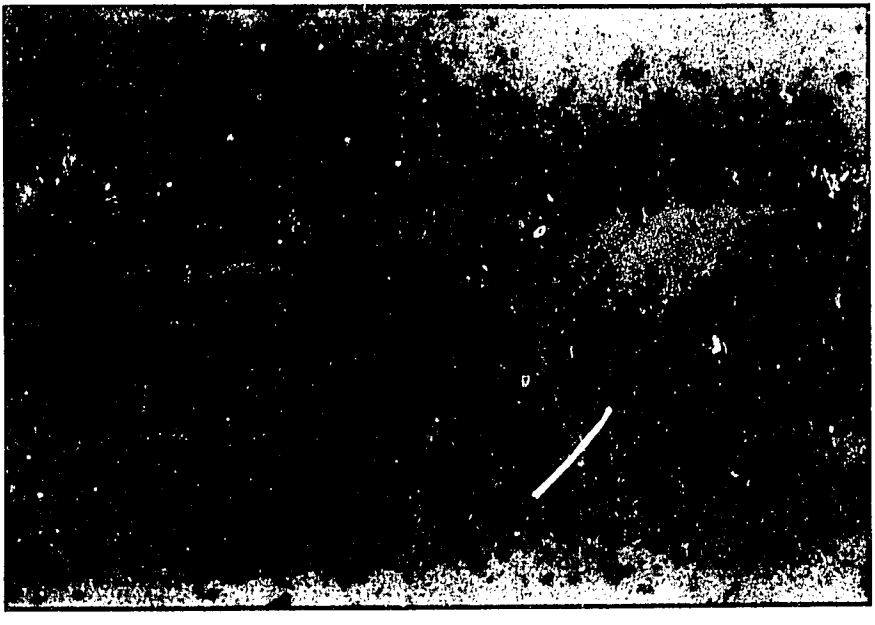
Epidemiological cycle of early blight. Inoculum survives on plant debris or soil. Upon *primary* infection, lesions develop on lower leaves. These are the source for *secondary* sporulation which leads to heavy infection later in the season.

5 BIOLOGY

The fungus *Alternaria solani* Sorauer (family *Dematiaceae,* form-class Deuteromycetes) is spread by spores, called *conidia.* Conidia are elliptic, oblong or club shaped, dark in color, transversally septated but often without longitudinal cell walls, and ending in a long terminal cell. They are microscopically small, 15 to 20 μm wide and 150 to 300 μm long. The terminal cell narrows towards its end to 2.5 to 5.0 μm.

Under optimum conditions of high moisture and temperatures between 24 and 34 °C, conidia germination is initiated within 30 minutes. The developing germ tube penetrates leaves through the epidermis or stomata. The septated and branched mycelium expands within the leaves. Due to toxic substances produced by the fungus, damage extends in advance to growth of the mycelium. In pure culture optimum growth is around 28 °C.

The spore bearing *conidiophores* are produced singly or in small groups. Light and temperatures between 19 and 23 °C stimulate development of conidiophores.



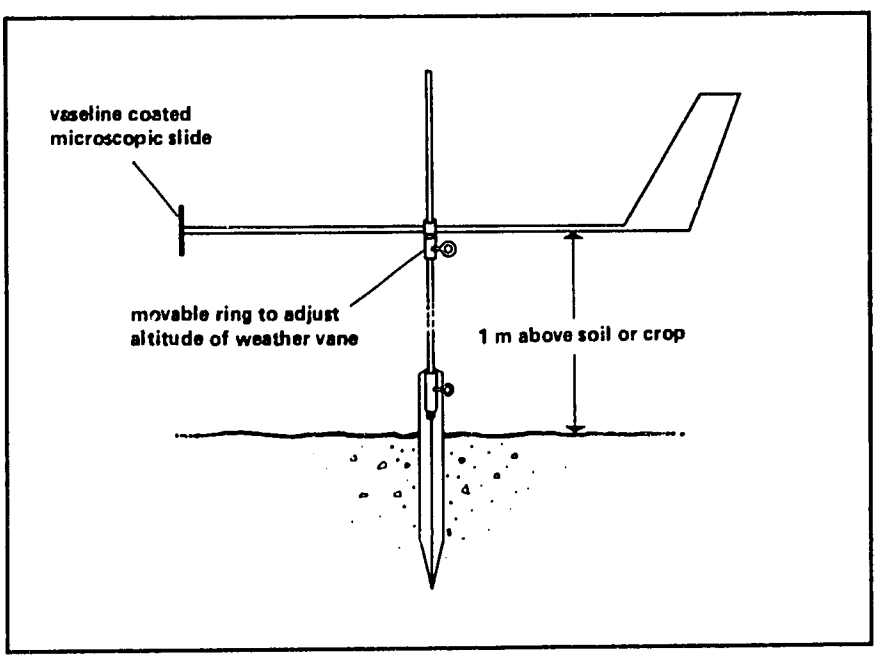
***A. solani* spores, so-called *conidia*, are club-like in shape, septated, ending in a long terminal cell, and dark in color. Under optimum conditions they may start to germinate within 30 minutes.**

6 MONITORING SPORE PROPAGATION

Primary infection has little economic effect, but it is important for epidemic development of the disease because it may lead to significant secondary spore propagation. Knowledge about the start of this secondary spore propagation is important for scheduling control measures.

Secondary spore propagation starts with the development of primary lesions on lower leaves. Development of these lesions may be monitored visually. However, primary lesions are difficult to see and may be easily overlooked. Considerable spore propagation might have started before the first lesions are detected visually.

A relatively easy trapping method may be carried out by experimental stations that own a simple microscope to provide an alerting service to potato growers of a region. The spore trap consists of a microscopic slide coated with vaseline attached to a weather vane which holds the slide against the wind. Air-borne *Alternaria* spores stick to the vaseline coating and can be easily distinguished under 100x magnification. (For details see under "Additional reading"). Spore trapping may not be practical for the individual potato grower.



The spore trap consists of a vaseline coated microscopic slide attached to a weather vane.

7 CONTROL

Control of early blight includes

- precautions during crop management,
- chemical control and
- use of resistant varieties.

Precautions during crop management. Because the development of early blight is related to crop vigor and maturity, agronomic management which promotes vigor and avoids rapid foliage senescence and plant weakness helps to reduce disease incidence. This includes correct irrigation and fertilizer application (observe local recommendations). Consider that sprinkler irrigation may promote disease development.

Because early maturing varieties contribute to heavy secondary spore propagation, plantings should be located so that wind-borne spores do not easily reach later varieties (down wind).

To prevent tuber infection, infected foliage should be eliminated some days before harvest and tubers left in the soil until the skin is mature and more resistant against mechanical damage.

As *A. solani* persists on plant debris, all infected residues should be removed from the field after harvest.

Although the organism is capable of overwintering from one season to another it cannot survive longer periods. Thus, crop rotation may help to reduce inoculum quantity in a field.

Chemical control. Early blight can be effectively controlled by a few fungicide applications, provided spraying is timed according to secondary sporulation. Earlier applications are of little effect, and indiscriminate continuous spray schedules do not improve the result. (They just cost more). Spore trap data give a good indication of fungus activity and secondary spore propagation.

The same protective fungicides used for the control of late blight are generally effective against early blight. At present, most frequently used are dithiocarbamates, zineb, maneb, captafol, chlorothalonil and triphenyl-tin-hydroxide. Note that fungicides specifically designed for late blight control (e.g. Ridomil) may be ineffective for early blight.

Use of resistant varieties. Potato varieties show different levels of field resistance but none are immune. Susceptibility is associated with early maturity. Later maturing varieties are generally less affected. Because resistance is the best means of control, varietal improvement programs should study the resistance of prevailing varieties or new breeding materials.

8 DISEASE EVALUATION

For comparing resistance of potato varieties or efficiency of control measures several evaluation methods have been proposed. Because the disease incidence is related to the physiological condition of a crop, plant maturity should also be recorded.

Plant maturity. Plant maturity can be evaluated at a certain date or at regular intervals (weekly) on a scale of one to five:

1 = very early, plants mature;
5 = very late, plants green and in bloom.

Percentage of leaves infected. Number of infected leaflets can be counted and related to the total number of leaflets, or the percentage of infected leaflets may be roughly estimated visually.

Lesion size and severity. Lesion size and severity can be evaluated on a one to five scale:

1 = very small leaf lesions (approx. 1 mm),
2 = moderate leaf lesions,
3 = large leaf lesions (approx. 1 cm),
4 = leaf lesions plus small stem lesions,
5 = leaf lesions plus severe stem lesions.

Percentage of defoliation. Visual estimations may be expressed as percentage of leaf area destroyed, or on a scale basis. Frequently used is a scale ranging from 0 (no visible damage) to 5 (total destruction). CIP uses such a system for estimation of late blight (*P. infestans*) which may be applicable for early blight evaluation also (see Henfling, 1979, in "Additional reading").

9 ADDITIONAL READING

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