

## FORECASTING OF DISEASES IN POTATOES

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### *Summary*

The New Zealand climate and topography make accurate forecasting of potato blight over wide areas very difficult. Before a system could be safely established, records of blight throughout several seasons are needed for correlation with weather records. Until this information is available, an intelligent guess could be made in restricted areas using either an Auchincruive Potato Blight Forecasting Recorder to indicate a blight period on the British system or by using the American system of totalling rainfall for the previous five to ten days. The Manawatu is an area where the study of blight could result in a worthwhile warning service.

THE MOST IMPORTANT potato diseases and pests in New Zealand are as follows:

- (1) Late blight (*Phytophthora infestans*).
- (2) Early blight (*Alternaria solani*).
- (3) Wilt (*Verticillium* sp.).
- (4) Blackleg (*Pectobacterium carotovorum* var. *atroseptica*).
- (5) Rhizoctonia (*Corticium solani*).
- (6) Scab (*Streptomyces scabies*).
- (7) Powdery scab (*Spongospora subterranea*).
- (8) Pink rot (*Phytophthora erythroseptica*).
- (9) Virus diseases (leaf roll, viruses X, Y, A, S, M).
- (10) Aphids.
- (11) Potato tuber moth (*Gnorismochema operculella*).

Some of these pathogens are spread by aerial spores (e.g., 1, 2), others by diseased tubers (3, 4, 5, 6, 7, 9), some are soil borne (3, 5, 6, 7, 8), some spread by contact between healthy and diseased plants (3, 8, 9), and some of the virus diseases are spread by aphids. Some rapidly become epidemic (1, 2), others are slow and insidious. It can be readily understood that these and other factors affect the possibility or not of effectively forecasting the likely occurrence of a disease. Consequently it is of the greatest importance that the whole epidemiology of the disease be understood (in other words, the pathogen/host/environment complex) in order to decide if forecasting is practicable.

The following are the requirements for effective forecasting at the present stage of knowledge:

- (1) There is a source of inoculum almost certain to be present.
- (2) The disease can rapidly spread and build up to epidemic proportions.
- (3) The spread and build up is largely dependent upon environmental conditions which vary greatly from season to season or week to week.
- (4) Control is by chemicals which have only a limited residual effect.
- (5) There is sufficient time lag between the onset of favourable conditions for disease and the onset of an epidemic.
- (6) The forecast should be at least 80% correct in picking blight periods.

The only disease which conforms to the above requirement is potato late blight. To some extent aphids meet the criteria, but generally speaking they have no immediate effect on crop yields and their effect on health of seed stocks through virus spread can be countered by using selected certified seed. Consequently this paper is confined to work on forecasting potato blight.

Potato blight is caused by the fungus *Phytophthora infestans*. Blight spores can be spread by wind or by the spattering of rain-drops, and on leaves the spores may germinate, penetrating the leaf surface and producing a mycelium which spreads inside the leaf killing leaf tissue within four or more days. On the edge of the dead tissue is a ring of infected tissue from which, under conditions of high humidity, is produced aerial mycelium carrying conidia containing zoospores. These conidia are released into the atmosphere to start a new generation of the fungus.

Leaves can be protected from infection by using blight sprays which provide unsuitable conditions for spore germination on the leaf surface. Once the fungus has penetrated the leaf and produced mycelium it cannot be reached by sprays now available. Hence the aim in blight control is to have a suitable spray deposit on the leaves at the time blight spores are present. Under suitable conditions the fungus may produce a complete generation every 4 to 6 days. Sprays are effective for 4 to 8 days, so it can be understood that the timing of spraying is highly important. Spraying when no inoculum is present is a waste of time and spraying after spores have germinated is ineffective.

Blight is carried over from one season to the next in partly diseased seed tubers which produce an infected plant from which spores spread infection before the infected plant dies. (In the Pukekohe area where there is overlapping of crops, blight can be carried from crop to crop.) It can generally be assumed that blight inoculum will be present in an area and very little is needed to start an epidemic. Nevertheless, in very dry seasons, there may be very little carryover in the seed and this may delay the onset of the disease even when conditions are favourable.

The primary foci are not sufficient to start an epidemic, but if weather conditions are suitable in the spring there can be a large secondary spread of infection which survives in stems over dry summer periods and provides the inoculum for further spread. The extent of this early infection determines the rapidity with which an epidemic follows "blight" weather. A generation of the blight fungus may take as little as four days and some four to six or more generations are needed before serious damage results. That is why it is usually three weeks or so after the onset of blight conditions before blight becomes obvious to the naked eye, and during this period it may be possible by spraying to delay the final epidemic stage.

Blight is favoured by moderate temperatures and high humidities and is severely restricted outside certain limits. Consequently, forecasting depends primarily upon an analysis of weather records.

*Beaumont system:* Beaumont (1947) after years of observation postulated that with a temperature between 50° F and 75° F and a relative humidity over 90% for ten hours, followed by a daily temperature below 95° F, blight can sporulate and re-infest the host. Such a blight period is called a "Beaumont" period, and in Britain it is generally assumed that blight will be obvious in the crop within three weeks of a period. Observation has shown blight does not occur before certain dates in each district, consequently no forecast is given before a fixed date. Even in Britain, which does not have the extremes of climate we have, forecasting on Beaumont periods

alone is not always successful, but this is now supplemented by crop inspections, and no forecast given until incipient blight has been seen. No forecasts are given late in the season when spraying is uneconomic. A big difficulty with the Beaumont system is that weather can vary greatly over very small areas. Where there are closely spaced weather stations it is possible to draw synoptic charts which will then delineate more closely the areas where blight conditions exist. This is quite impossible in New Zealand, because of the few weather stations and irregular contours.

Even in Britain, forecasts are given with any degree of accuracy only in the wetter parts of the country, and in America the Beaumont system has not been a great success. Dr J. Grainger of the West of Scotland College of Agriculture, has modified a wet and dry recording thermometer so that the wet bulb thermometer records above the dry bulb when humidity is above 75%. A blight period occurs when this happens for a period of 48 hours with temperatures between 50° F and 75° F. This recorder can be used in the field to give the actual conditions in the crop. Brenchley (1962) has used aerial photography with infra-red film to pinpoint the primary and secondary foci as an aid to forecasting. The method is successful but costly.

*Rainfall:* In America, where the weather pattern differs from Britain, rainfall data have been used to forecast blight attacks (Cook, 1949; Hyre and Bonde, 1955, 1956; Cox and Large, 1960; Wallin, 1962). Two systems are used, moving five, seven or ten day totals, or accumulated seasonal totals.

In the first system, rainfall is added for the previous 5, 7 or 10 days and a forecast is given if the average temperature is under 77° F and the total rainfall is 0.60, 0.73, or 1.05 (sometimes 1.20) in. respectively. These figures have been determined from an examination of rainfall figures plotted against blight incidence and can vary in different areas. This system can work well where rainfall tends to be well distributed and falls on several of the previous days. Where the total fall occurs on one day followed by fine weather, as can happen in Canterbury, the method may be of no use.

In the second method, rainfall is added through the season and a forecast given when the total reaches a certain figure. In Maine, this figure is 11.25 in.

In Jersey, Phillips (1963) has used successfully a variation of the first system. A blight period is one in which on two or more successive days —

- (a) measurable rain fell,
- (b) the five-day mean temperature was 50° F or more in April (=October) or 55° F from May to September (=November to March).
- (c) the five-day total rainfall figure reached or passed 0.60 in.

#### POSSIBILITIES IN NEW ZEALAND

New Zealand has a very variable topography which results in a very variable weather pattern, not merely from season to season, but also from month to month and day to day. A further complication is the fact that no large areas exist which receive the same weather so that a forecast can be accurate for only small areas.

In the Auckland area no forecast may be needed for blight occurs during much of the year. Nevertheless a forecast could reduce spraying in dry summers. In the Manawatu there is a big scope for forecasting for blight is not present the whole season, but can occur as early as December or as late as March. In Hawke's Bay, forecasting would be of little use in most seasons. In Canterbury,

blight occurs only infrequently and hence it is difficult to justify a forecasting service. Nevertheless, forecasting could help a few pockets such as Belfast, Southbridge, and Willowbridge. In Southland blight is more frequent and forecasting could be beneficial.

At Lincoln, an Auchincruive Blight Forecasting Recorder has been operated for the past two seasons, but although blight periods have occurred with a pattern that would have resulted in severe blight in Britain not a single lesion of blight was found. There were reports of blight in the area, but all that was seen by the writer was early blight (*Alternaria*). Cold nights (under 50° F) are very frequent prior to Christmas and from March onwards and occur to some extent even in January and February. Cool rainy weather often results in snow on the hills followed by sunny days and frosts. Hot north-west winds slow up blight development and it is likely that the persistent north-east winds also have an effect. Consequently, in most seasons it is only in sheltered pockets that blight develops at all frequently.

New Zealand has limited weather records compared with, say, Britain, but enough for an analysis of the influence of weather on blight. Unfortunately there are no records of the appearance and development of blight throughout the season in the potato growing areas. This makes it impossible to say with any certainty what method to use. In the meantime the method used in Jersey could be of value in the Manawatu and Southland and possibly in Auckland in the summer. If this could be associated with at least weekly crop inspection and no forecast given until after blight has been found, the forecast could be of much greater value. In New Zealand's climate a forecast should be followed by the proviso that should the weather turn hot and dry, blight will not build up to epidemic proportions. No forecast should be given late in the season, for spraying as the crop is maturing may keep the crop green longer with a greater risk of tuber blight. If blight is severe at this period it can be prevented from reaching the tubers by killing the tops.

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