POWDERY MILDEW OF PEAS; POSSIBLE CAUSES OF RECENT EPIDEMICS AND PROSPECTS FOR CONTROL

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SUMMARY

Powdery mildew of peas (*Pisum sativum* L.), caused by the fungus *Erysiphe pisi* DC. ex St-Am., has become increasingly important to the process pea industry in New Zealand in recent growing seasons. The increase in disease severity may be due to the increase in area of susceptible pea crops grown, and unusually dry weather during the last three summers. Use of suitable systemic fungicides, and cultivars that are resistant to powdery mildew, offer the best means for control of the disease.

INTRODUCTION

Powdery mildew of peas (*Pisum sativum* L.), caused by the fungus *Erysiphe pisi* DC. ex St-Am. (= *E. polygoni* DC.), occurs world-wide, and severely limits pea production in many countries (Dixon 1978). In New Zealand a severe epidemic occurred in 1953-54 (J. Casey, pers. comm.), but otherwise powdery mildew has been considered of little consequence. Brien *et al* (1955) recorded the disease in pea crops throughout the country, but concluded that "there was no evidence of widespread infection causing economic loss". Boesewinkel (1979) observed *E. pisi* "throughout the year" on *P. sativum* and species of *Hebe*, *Lathyrus*, *Lupinus*, and *Melilotus*, but suggested that the fungus was "apparently harmless". However, during the 1986-87, 1987-88, and 1988-89 growing seasons, severe powdery mildew epidemics occurred in both process and dry peas. Severity of the disease has also increased in Tasmania (L. Wilberg, pers. comm.) and the United Kingdom (D.D. Slawson, pers. comm.).

This paper describes powdery mildew of peas, and outlines effects of the disease on production of process peas. Possible reasons for increased disease severity, and available control methods are discussed.

Erysiphe pisi, pea powdery mildew, and effects of the disease

Conidia of *E. pisi* germinate on leaf surfaces, and up to five hyphae develop from each conidium (Falloon *et al* in press). Hyphae grow and branch to form a radiating colony of mycelium on the plant surface. Individual hyphal cells are specialised to produce either conidiophores and conidia, or appressoria which penetrate host epidermis cells. Hyphae, conidiophores, and conidia give infected plant surfaces their characteristic whitish, powdery appearance.

The overwintering cleistothecial stage of *E. pisi* has not been recorded in New Zealand (Boesewinkel 1979), and cleistothecia were not found when pea straw from severely diseased Canterbury crops was examined during autumn and winter, 1988. It is unclear how the fungus survives from year to year, but conidial inoculum from volunteer pea plants or alternative hosts, or seed-borne disease (Uppal *et al* 1935) may cause primary infections in pea crops.

Powdery mildew is first recognised on pea plants as small (1-3 mm diam.), white fungal colonies on upper surfaces of leaves. As the disease progresses, colonies expand and coalesce, and leaf undersurfaces, stems, pods and tendrils can become infected. In severe cases, leaves wither and plants may die.

Importance of the disease

In Canterbury, sowing of process peas begins in late August each year, and continues until late November. Early sown crops are usually harvested for processing in

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early December, and harvesting continues until early February. In most seasons powdery mildew has not been noticed until the last 10 to 14 days of harvesting. In recent seasons, however, the disease has been observed progressively earlier each season, and in 1988-89 was first noted in early December. This was 5 to 6 weeks earlier than usual, and the disease was of economic importance for half the production season.

Yield reductions caused by powdery mildew have not been assessed accurately in New Zealand pea crops, but 10% losses are commonly estimated. In India, 50% yield reductions due to powdery mildew have been recorded (Dixon 1978). In New Zealand the disease hastens crop maturity and disrupts carefully planned harvesting sequences. Severely diseased areas within crops have been left unharvested because peas were beyond optimum harvest condition. The disease may also adversely affect product quality. Peas from diseased crops may be dull in appearance and have an undesirable flavour. "Dust" produced during harvest of mildewed crops has caused breathing problems for operators of field machinery. Extra cleaning procedures and equipment are required to remove mildew dust from harvesters.

Production costs of process peas have increased as powdery mildew epidemics have become more severe. Fungicides have been used increasingly in recent seasons, and application costs can be high. Ground application of fungicides is possible in vegetative crops, but after flowering begins more expensive aerial spraying is necessary to prevent mechanical damage to crops. In 1988-89, one Canterbury company sprayed about one third of their total contracted area, with late-sown crops routinely sprayed twice to control the disease. Grower contracts now include provision for increased production costs associated with powdery mildew control.

CAUSES OF RECENT POWDERY MILDEW EPIDEMICS

The four recognised components of the disease pyramid (Browning *et al* 1977) are a susceptible host, a virulent pathogen, a favourable environment, and time. Recent severe powdery mildew epidemics on peas suggest that the relationship between these components has altered, and their consideration may elucidate reasons for increased incidence and severity of the disease.

The host

Areas of process peas sown in most cropping regions of New Zealand have increased as overseas demand for frozen peas has expanded. In Canterbury production has increased recently as one company has concentrated operations on a large processing factory. All process pea cultivars sown in the last 7 to 8 years are susceptible to *E. pisi*. Large areas of peas susceptible to powdery mildew may have contributed to increased disease prevalence and severity.

The pathogen

Virulence studies on *E. pisi* have not been reported in New Zealand. However, observations that powdery mildew has occurred on late-sown pea crops in most years, that the disease has always been widespread (Brien *et al* 1955), and that a severe epidemic occurred 35 years ago (J. Casey, pers. comm.), suggest that virulent strains of the fungus have been present for a long time.

The environment

Macroclimatic parameters have been examined to determine if changes in weather patterns can explain recent *E. pisi* epidemics in Canterbury. Climate diagrams were constructed which summarise temperature and rainfall patterns, and can reflect climate suitability for powdery mildew development (Weltzien 1978). Thirty year rainfall and temperature normals (New Zealand Meteorological Service 1983a; 1983b) for the Lincoln meteorological station (N.Z. Met. Service No. H32641), and monthly rainfall and mean temperature (calculated from daily means) data from the Broadfield, Lincoln, meteorological station (N.Z. Met. Service No. H32642) for growing seasons between 1983 and 1989 were compared to determine if recent seasons have deviated from normal.

Data of 30-year normals (Fig. 1 A) indicate that rainfall in Canterbury, is generally distributed throughout the year, and the region would not be classified as summer arid (Weltzien 1978). In 1983-84 and 1985-86 (Figs 1 B and C), examples of years when

Fig. 1: Climate diagrams of 30-year (1951-80) monthly temperature and rainfall normals at the Lincoln meteorological station (A), and monthly rainfall and mean temperatures at the Broadfield meteorological station (B to F). Shaded areas indicate "arid" periods (Weltzien 1978).

powdery mildew of peas was not severe, summer rainfall was usually more than 50 mm per month. In 1986-87, 1987-88, and 1988-89, when epidemics were severe, monthly rainfall was usually less than 36 mm during November and December (Figs 1 D, E, and F). The 1987-88 and 1988-89 seasons were particularly dry and warm. Examination of data from the 1953-54 growing season indicated that rainfall for November, December, and January was about 40% lower than normal.

Yarwood (1978) described powdery mildew fungi as "xerophytic", adapted to infecting host plants during periods of low environmental moisture. According to Butt (1978), "the generalisation that powdery mildews are more severe in dry weather is basically true". The approach described above is simplistic, and the relationship of powdery mildew to climatic parameters is likely to be complex. Nevertheless, it seems likely that unusually dry weather during recent summers has contributed to the occurrence of severe pea mildew epidemics.

Time

Pea crops sown in late spring are more likely to be attacked by *E. pisi* than early-sown crops (Dixon 1978). Sowing schedules have been similar in Canterbury for many years, beginning about 20 August and ending about 20 November each year. An exception occurred in the 1988-89 season when some crops were sown in early January. These were routinely sprayed to control *E. pisi*. In recent seasons it has been recognised that all crops sown after 26 October are likely to become affected by powdery mildew.

DISEASE CONTROL

The fungicides sulphur (Cosan, Kumulus S, Suldust, Winsul 80 WP) and benomyl (Benlate) are registered for powdery mildew control in peas. Several unregistered demethylation inhibitor systemic fungicides (cyproconazole, flusilazole, penconazole, triadimefon, triadimenol, triforine, and turbuconazole) have shown promise for disease control in a recent field trial (R.E. Falloon and R.E. Scott; unpublished). Fungicides

must be applied to crops at early stages of disease development, and mode of action and persistence of chemicals must be understood to establish optimum disease control strategies. Future widespread use of systemic fungicides should be accompanied by monitoring for fungicide insensitivity in *E. pisi*. Investigations into the importance of seed-borne *E. pisi* may lead to prevention of year to year transmission of powdery mildew. Use of pea cultivars resistance to *E. pisi* may assist in overcoming effects of the disease, and current plant breeding programmes are incorporating powdery mildew resistance into cultivars adapted to New Zealand conditions.

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