DISEASES OF ONIONS IN NEW ZEALAND

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ABSTRACT

This paper presents an overview of onion diseases in New Zealand. For each a brief account of the life cycle is provided together with details of distribution, importance and control measures. Particular emphasis is given to white rot and bacterial soft rot both of which are considered to be causing significant economic losses.

Additional Key Words: diseases, Allium, *onion, white rot, bacterial soft rot, New Zealand.*

INTRODUCTION

Onion *(Allium cepa* L.*)* is a major vegetable crop in New Zealand. Annual production is in the order of 70,000 tonnes from an area of approximately 2,000 ha. Most of the crop is exported, principally to Japan. Exports in 1984 were 50,000 tonnes, declining to 27,000 tonnes in 1985. The Pukekohe district, South Auckland. accounts for 75% of total production and all of the export production. The remainder is produced in other districts throughout the North and South Islands.

One of the principal cost factors in onion production is disease control. Although 37 species of fungi, three species of bacteria and one virus have been recorded from onion in New Zealand (Pennycook, pers. comm.) only a few diseases constantly pose a threat to production. In this paper we examine the various diseases that affect onion and comment on the options available for their control. Emphasis is given here to diseases that cannot be adequately controlled by conventional chemical methods.

BACTERIAL SOFT ROT

Onion soft rot, also termed "vinegar rot", "onion rot" and more recently "bacterial soft rot" has been a cause for concern in the Pukekohe district in recent years (Callaghan, 1983).

Early in the season (August-September) young plants may be affected by a slimy, grey-brown rot at the base of the lower leaves. Plants may collapse completely and often have a characteristic vinegary smell (hence "vinegar rot"). Early season disease is favoured by cool wet conditions. Surveys have shown that the incidence of infection may be as high as 14% (Callaghan, 1983). Later in the season (October-November), as the onions are bulbing, collapse of some scale leaves within the bulb may occur. In other cases the scale leaves brown and dry out. During harvest, storage and transit, heavy losses can be sustained from the collapse of bulbs. A rot develops internally eventually destroying the whole bulb; often rotting bulbs also have a characteristic vinegary smell. Because the early stages are not readily detectable externally this poses special problems in crops destined for export. Warm wet conditions at maturity and during field curing and harvest are thought to increase the incidence of storage rots.

The relationship between soft rots that occur during the growing season and those seen during storage is not at all clear. In the past it has been generally assumed that the incidence of storage rot is directly related to incidence of soft rot during the growing season. However, during the 1984/85 and 1985/86 seasons, disease early in the season was insignificant but there was considerable postharvest spoilage. Furthermore, the spectrum of organisms associated with rots of growing plants is different from that of rotted bulbs (Watson & Hale, 1984). Several bacteria are consistently isolated from early season soft rots particularly *Pseudomonas viridiflava* (Burkholder, 1930) Dowson 1939 and other fluorescent *Pseudomonas* species which are capable of causing soft rots (Hale, unpublished). Rotted mature bulbs sampled after the 1986 harvest yielded very few fluorescent pseudomonads. *Erwinia carotovora* pv. *carotovora* (Jones, 1901) Bergey et al. 1923 was present as well as non-fluorescent pseudomonads, which are capable of causing rots. *Botrytis allii* Munn was also commonly found associated with spoiled bulbs.

Soft rot is one of the most complex and intractable problems faced by growers as no effective control measures are known. Trials to evaluate the effect of copper sprays on incidence of early season soft rot are in progress and preliminary investigations have shown that there is a possibility of selecting cultivars tolerant of infection with *P. viridiflava* (Hale, unpublished). Excessive use of nitrogenous fertilisers should be avoided as lush, leafy plants may be predisposed to infection (Callaghan, 1983). Field curing time should be kept to a minimum to reduce the risk of exposure to unseasonal wet conditions. In the UK, forced air drying has been adopted as the most effective means of reducing postharvest losses from soft rots. Losses in transit may be avoided by carrying onions at 0-5 °C.

ONION WHITE ROT

Onion white rot, caused by the fungus *Sclerotium cepivorum* Berk., was first recorded in New Zealand in 1922 (Cunningham, 1922). It is present in all onion growing areas and has been of increasing concern in the Pukekohe

district in recent years.

The disease is soil borne, affecting plants throughout the growing season but predominantly during the first 3-4 months. It can also continue as a bulb rot during storage but this phase of the disease is not a problem in New Zealand.

The fungus survives in the soil as minute black sclerotia (0.2-0.5 mm in diameter). The sclerotia are very resistant to adverse conditions. It has been shown experimentally that 75% of sclerotia were still infective after 4 years in soil under 'outside' conditions in Britain (Coley-Smith, 1959) and it is likely they can persist for much longer. The sclerotia germinate only in response to the presence of roots of *Allium* spp. (Coley-Smith, 1960) and infect the roots and stem base.

First symptoms are a subtle change in leaf colour to a deep blue-green. The leaves soon turn yellow and the plant wilts. Coincident with the above ground symptoms, white fluffy fungal growth can be seen on the roots and base of the scales. The roots are often rotted completely and diseased plants are easily lifted from the soil. Infection causes an extensive soft rot of the stem base. After several days, masses of tiny black sclerotia form in the rotted tissue. Root and stem contact can spread the disease from plant to plant during the season.

Sclerotia are readily transmitted from field to field in drainage water and in soil and trash carried on vehicles, implements and bins. Since the fungus is highly infective (inoculum levels as low as 1 sclerotium per 1000 gm of soil can give up to 10% infection in the field (Crowe *et al.*, 1980)), the disease can readily become established in new areas.

The overall effect of the disease is to reduce plant populations. It often appears in distinct patches in infected fields. Continued cropping of infected fields can lead to very high levels of disease and production then becomes uneconomic.

Control measures have concentrated on chemical treatments. They were of limited success until the advent of systemic fungicides. Benomyl (Benlate) showed some promise in trials in New Zealand in 1971 and 1972 but results were variable and the chemical has never been widely used against white rot (Wood, 1980). More recently the dicarboximide fungicides iprodione (Rovral) and vinclozolin (Ronilan) have given the best control world wide. Trials at Pukekohe in 1979 demonstrated a dramatic reduction in infection (from 38% to 1%) after seed treatments and foliar sprays of iprodione (Wood, 1980). Foliar sprays of vinclozolin were also highly effective. Since that time it has been recommended practice to apply a seed treatment followed by 3 or 4 foliar sprays (at monthly intervals) using either of these chemicals. Initially the programme was very effective in reducing white rot. Recent trial work (Fullerton and Stewart, unpublished) has shown however that iprodione and vinclozolin are now relatively ineffective in the Pukekohe district. Loss of effectiveness of these fungicides has been noted in Britain (Entwhistle, 1983) and is considered to be due to increased microbial degradation occurring in soils following repeated applications of the chemical (Walker *et al.*, 1986). A related chemical procymidone (Sumisclex) has shown promise (Fullerton and Stewart, unpublished) but is presently not registered for use on onion crops. It is possible that this chemical too will lose effectiveness with continued use.

Biological control utilizing fungi and bacteria antagonistic to the white rot fungus offers a possible alternative to chemicals (Utkhede and Rahe, 1978). The search for resistance is continuing in New Zealand.

If white rot is not present on a property, every precaution should be taken to prevent its introduction. Because of its persistent nature in the soil, once established it is virtually impossible to eradicate. Long term rotations, even if practicable, are not likely to be completely effective.

BOTRYTIS

Four species of *Botrytis* are recorded (Dingley, 1969) as pathogens of onions in New Zealand:

B. squamosa Wallr. — tip dieback of young leaves
B. byssoidea J.C. Walker — bulb rot
B. allii Munn — neck rot
B. cinerea Pers.: Fr. — bulb rot

All species may be found from time to time but only *B. allii* is considered to cause economic losses.

B. allii affects onion crops at all stages of growth. Early in the season it can cause death of seedlings, later it can cause extensive tip dieback of foliage. It is most damaging as the cause of neck rot of mature onions in storage. There, a soft brown rot develops downwards from the neck of the bulb. The affected area becomes sunken and masses of black sclerotia are found in the rotted tissue. In severe cases up to 50% of onions can be lost in storage (Harrow, 1969).

The fungus is seedborne. In surveys of New Zealand onion seed in 1977 and 1978 up to 70% of seed in some seed lines was found to carry *B. allii* (Sinclair, 1978; B.T. Hawthorne and J. Rees-George, unpublished). In Britain, the fungus in, or on, the seed coat has been shown to invade the cotyledon immediately after germination and remain as a symptomless infection in the leaf tissue. As the plant matures the fungus colonizes the tissue at the neck of the bulb and can subsequently cause neck rot (Maude and Presly, 1977). The disease can also be spread by airborne spores produced from sclerotia overwintering in the soil or from infected debris from a previous crop. Airborne spores can directly infect the foliage of the growing plant and can infect the open necks of bulbs at harvest to initiate neck rot. The relative importance of seed-borne and airborne infection in causing the disease in New Zealand is not known.

Routine control measures include a seed treatment (Ronilan or Benlate) to control *B. allii* on the seed followed by foliar sprays of Ronilan during the growing season to reduce leaf infection by airborne spores. The onions should be well matured before harvest to reduce the chances of infection through the neck region of the bulb. Neck rot is favoured by warm moist conditions during the summer. Forced air drying has been adopted in Britain as an effective means of reducing postharvest losses due to neck

rot. Trials in New Zealand have shown that field curing the bulbs for 7-10 days followed by artificial curing at 38°C for 5 days is effective in controlling the disease (Harrow, 1969; Harrow and Harris, 1969). Artificial curing has not been widely adopted in New Zealand probably because of the high establishment and running costs and because of the fact that the disease has not been of major significance in recent years.

B. squamosa occasionally causes damage to foliage during warm humid weather in September and October. Salad onion crops can also be affected in the autumn. The organism is associated with white spots (ghost spots) on the leaves sometimes coalescing to form a tip dieback. Due to the sporadic appearance of the disease control measures are not in use.

SCLEROTIUM ROLFSII

The fungus *Sclerotium rolfsii* Saccardo attacks onions principally as they near maturity or during field curing. It is soil-borne, and becomes active during periods of warm moist weather (Punja, 1985). Conspicuous white fungal threads and fan-like growths of mycelium grow upwards from the base of infected bulbs. The fungus is usually restricted to the below-ground parts of the plant but in very wet conditions can extend above ground. In the early stages the disease could be mistaken for white rot but there are a number of important differences. The mycelium of *S. rolfsii* is often aggregated into strands lightly appressed to the surface of the bulb. Distinctive, globose sclerotia 1-2 mm diameter, at first cream in colour later becoming light then dark brown, form separately or in clumps on the surface. In contrast, the white rot fungus always has a fine fluffy mycelial growth, it causes a conspicuous soft rot and forms masses of minute black sclerotia in the rotted tissue.

S. rolfsii is very common in onion crops but in most cases is restricted to the outer scale leaves. Under very moist conditions it will penetrate the outer storage leaves and can render bulbs unsaleable. It survives between seasons as sclerotia in the soil.

Losses due to this fungus are normally insignificant except when very warm wet conditions occur during maturation and curing. Provided onions are well cured at harvest, no problems should occur in storage.

Control measures are not considered necessary.

DOWNY MILDEW

Downy mildew, caused by the fungus *Peronospora destructor* (Berk.) Fr. is widespread in New Zealand. It is capable of causing extensive losses particularly during wet weather.

The disease may occur at any stage of plant growth. On the leaves, small light coloured spots appear which turn yellow then white. The spots enlarge during wet weather and affected areas become watersoaked with a white streaked appearance. Greyish-violet spore masses develop on infected tissues. Affected leaves eventually dry out giving the plant a burnt appearance. In seed crops the disease attacks the seed stalks causing twisting and distortion and sometimes lodging. Bulbs from severely infected plants are spongy and tend to be susceptible to post harvest rots (Brien *et al.*, 1959).

The fungus can survive between crops in the soil in debris from infected plants and on perennial plants. Spores formed on infected tissues are readily carried by wind and rain splash within a crop. The disease is favoured by showery weather with cool night temperatures and relatively warm days.

The fungus is normally effectively controlled by chemical sprays and a protective spray programme is employed by most growers. Chemicals commonly used are maneb or zineb applied at 7-10 day intervals throughout the season (Hawthorne, 1980b). The chemical metalaxyl (Ridomil) is effective but its use is generally restricted to 1 or 2 applications per season because of the risk of resistance to the chemical being developed by the fungus.

PINK ROOT ROT

Caused by the fungus *Pyrenochaeta terrestris* (Hansen) Gorenz, Walker and Larsen, pink root rot symptoms are particularly noticeable towards the end of the season. Affected roots have a characteristic bright pink discoloration. The disease has generally been regarded as of minor importance. Another fungus *Fusarium oxysporum* Schlecht: Fr, is often found associated with *P. terrestris* in onion roots affected by pink root-rot. *F. oxysporum* is itself a root pathogen but the relationships between these fungi and the effect they have on onions in New Zealand has yet to be determined. Several sources of resistance to pink root rot are being evaluated under New Zealand conditions (D. Grant, unpublished).

DAMPING-OFF

Pre- and post-emergence damping off in onions can be caused by a variety of fungi including species of *Pythium (P. afertile* Kanouse and Humphrey, *P. coloratum* Vaartaja, *P. irregulare* Buisman, *P. ultimum* Trow) and *Rhizoctonia solani* Kuhn.

The fungi are all soil-borne and present a continual threat to germinating and newly emerged seedlings. Affected plants turn yellow, wilt, and dry out. The disease is favoured by cool wet soil conditions, thus in New Zealand seed treatment is essential for successful onion seedling establishment. Effective protection is provided by captan applied to the seed as a dust, slurry, or in pellets in combination with iprodione or vinclozolin.

SMUT

Caused by the fungus *Urocystis cepulae* Frost: Farlow, this disease was first recorded in Canterbury by Gibbs (1938). For many years the disease appeared to be confined to the Marshlands area but in 1965 infected plants were found in the Pukekohe area (Harrow, 1970a). A subsequent survey showed the disease was present in a few fields only.

The fungus is carried over in the soil as spore balls and hyphae. They are highly resistant to adverse conditions and it is estimated they can remain viable for up to 15 years.

Infection of onions takes place via the first young leaf soon after germination. Affected plants develop dark lead coloured streaks on the leaves and sometimes on the scales

of young bulbs. Affected leaves are often twisted and distorted. The streaks develop into silvery blisters (sori) which rupture to release black masses of spore balls. Some plants are killed as seedlings; others severely stunted. Some make almost normal top growth but continue to produce sori on newly forming leaves and on the bulbs: the bulbs remain small.

Dissemination of the fungus is accomplished by spore balls carried on infected plants, or in soil transported by wind, drainage water, or on tractors, implements, bins, footwear, etc.

In the past, satisfactory control was achieved by a formalin drip (0.8-1.6%) applied into the furrow at planting. Harrow (1970a) demonstrated that the disease is readily controlled by seed treatment using benomyl (12.5% *ai* w/w). The fungus can be eradicated from soil by fumigation with methyl bromide (Harrow, 1970b). Because the presence of the disease in the Pukekohe district presented a threat to the export trade, all affected areas were fumigated. The use of benomyl treated seed is still recommended in those areas which previously contained the disease.

OTHER DISEASES

A number of other fungi have been recorded from onions in New Zealand (Pennycook, pers. com.). The fungi and the diseases they cause are:

Alternaria porri (Ellis) Ciferri — purple blotch
Puccinia allii Rud. — rust
Fusarium oxysporum Schlecht. ex Fr. f.sp. *cepae* (Hanz.) Snyder & Hansen — basal rot (leaners)
Embellisia allii (Campanile) Simmons — soot
Penicillium expansum Link emend.Thom. — blue mould
Aspergillus niger van Tiegh — black mould
Colletotrichum circinans (Berk.) Vogl. — smudge
Sclerotinia sclerotiorum (Lib.) de Bary — soft rot
Pleospora herbarum (Pers. ex Fr.) Rabenh.

All of these fungi are found from time to time but are not considered to be of economic importance.

Onion yellow dwarf virus, an aphid transmitted virus, was a threat to onion production in the South Island until 1939 when control regulations were introduced. The disease is now of no commercial significance (Dingley, 1969).

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