White blister on vegetable Brassicas

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White blister (Albugo candida) occurs frequently in vegetable Brassica crops and has a widespread distribution covering most vegetable Brassica production areas in the UK. It is also referred to as white rust. The disease was common in UK production during the 1950s but largely disappeared until the 1980s in the UK. White blister like many leaf spot pathogens has specific requirements for its development in vegetable Brassica crops. White blister has a long incubation period between infection and appearance of the disease. This means that success or failure of control is only apparent in some cases weeks after fungicide applications. Often this leads to diseases becoming well established in crops before the disease is really visible.

Action points

- Use healthy transplants.
- Monitor crops regularly and be aware of potential for spread of white blister from infected crops to nearby fields.
- Use fungicides when first symptoms are found, particularly to protect the buttons of Brussels sprouts and heads of green cabbage. Several treatments may be required to maintain protection whilst temperatures are favourable for disease development.

Background

White blister is caused by the oomycete pathogen *Albugo candida* and is a common disease of many economically important vegetable Brassica and oilseed crops worldwide. Significant yield losses from this disease have been reported on the oilseed crops of *Brassica rapa* (turnip rape) and *Brassica juncea* (mustard). Whilst it can affect susceptible lines of *B. napus* (the predominant oilseed type in the UK), it has not been recorded in commercial oilseed rape crops apart from spring turnip rape in Scotland. Affected vegetables include broccoli, Brussels sprouts, cauliflower, radish, mustard, Chinese cabbage and turnip. The impact of disease in these crops is of a cosmetic nature and can render crops unmarketable. In Australia the disease has been commercially important in vegetable production since 2002.

1. White blister lesions on cabbage
2. White blister infection on Brussels sprout buttons can cause significant yield losses
To date, more than 10 distinct biological races of A. candida have been identified and classified based on the host plants they attack. Race 9 infects vegetable Brassicas and is considered to have caused the recent outbreaks of white blister on broccoli in Australia. Strains affecting radish are unlikely to affect leafy Brassicas. White blister is common on various cruciferous ornamental species and weeds such as Shepherd’s purse weeds (Capsella bursa-pastoris) and plants but the latter strain does not infect vegetables. Disease management strategies to control the disease are largely based on routine spray programmes in the UK. Improved management of the disease can be achieved by utilising information from a white blister disease risk computer forecast program called BrassicaSpot. This program has also been used in all parts of Australia where it can be used to schedule irrigation periods which limit disease development.

**Symptoms**

White blister symptoms first appear as yellow spots on leaves and these eventually become white in colour (Figure 1). However, often the yellow spots on leaves do not develop further (especially on older leaves) and white lesions are not formed. Often infected tissues become distorted especially when immature. This facilitates spore dispersal as infected tissues are more exposed to air streams within the crop. Hollows in leaves also aid in dispersal by creating funnelling which is important because the airborne spores of white blister are relatively large and need assistance to become airborne over wider areas. White blister infects only young immature tissue and this is the reason that on some older leaves the white lesions are not readily formed. The maturity of the tissue is also affected by the time between infection and symptom appearance. Once tissues are mature they cannot show symptoms. If symptoms occur on inflorescences they can result in distortion of tissues, a symptom which is often referred to as stagshead. Stagshead can result in significant yield loss in seed crops and on Brussels sprout buttons (Figure 2). The distortion makes the Brussels sprout button unsaleable but the occurrence on leaf tissues also affects marketability. Oospore (the sexual spore form) formation may occur on inflorescences or on tissues showing stagshead symptoms. Oospores can germinate directly on the plant by germ tube formation or by zoospore release. It is common for white blister to form systemic asymptomatic infections that are not visible for long periods of time. Downy mildew (Hyaloperonospora parasitica) sometimes grows on white blister lesions and can confuse diagnosis. Small root galls may develop on radish.

**Epidemiology**

Disease outbreaks are initiated from oospores in soil or plant debris, though during the growing season air-borne spores are likely to be more important in the spread between nearby crops. White blister like other pathogens of vegetable Brassicas requires free water for infection by the zoospore (the main infective propagule). Once the disease is established, relatively short dewfall periods can be very favourable for white blister development. High temperatures result in relatively short periods of time elapsing between infection and symptom appearance on the plant. This is dependent on the temperature under which the plants are grown. White blister symptoms do not develop at temperatures below 8°C. However the optimal temperature for symptom development is at temperatures of 20°C and above. This explains why white blister is not prevalent in Scotland and many northerly areas of vegetable Brassica production. The results indicate that epidemics will not develop in areas with cool daily average temperatures because there is not sufficient time for white blister symptoms to occur.

**Life Cycle**

The life cycle of white blister is quite complex (Figure 3) with both a sexual and asexual stage. In the UK the sexual stage is not often observed but may be present within lesions associated with specific environmental conditions. In Australia, white blister (Race 9) sexual stages are sometimes observed as galls on the stems of seedlings. The asexual stages are commonly called zoosporangia and are the white spores most commonly associated with white blister lesions. Zoosporangia germinate in the presence of free water to release zoospores however zoospore release is not associated with high temperatures and occurs more frequently if the water is at approximately 4°C. Released zoospores quickly stop moving if the temperature of the water rises above 10°C. For these reasons white blister infection is frequently associated with dew on the crop. Infection of immature tissues occurs within 4 hours at temperatures of 10-24°C. Infection rarely occurs below 6°C or above 26°C. No symptom expression occurs at 8°C or below. The time between infection and symptom appearance is approximately 2-3 days at a constant temperature of 20°C, but can be up to 14 days at a constant temperature of 10°C.

BrassicaSpot models predicting the length of incubation period can be used to determine spray intervals for white blister in the field. Infection models can be used to determine when infection periods are first observed and when infection is no longer possible during the growing season.
Fungus overwinters as oospores in soil/infected Brassica crops or in transplant production

Primary inoculum produces zoospores

Infection

Sporangia, zoospores

Further sporangia, zoospores produced

Pustules develop on infected leaves and buttons

Oogonia, antheridia formed

zoospores released (motile in free water)

Disease is observed 2-3 weeks after infection

2. Life cycle of white blister on vegetable Brassicas

Control

Varietal resistance
Tests in the UK with Brussels sprouts (cv. Adonis), broccoli (cv. Shogun), cauliflower (cv. Belot), red cabbage (cv. Rodon) and savoy cabbage (cv. Tarvoy) showed little variation in infection and in time to symptom development. This suggests that races found on vegetables in the UK may be able to infect all Brassica types. There is little information on differences between current varieties. Other races of white blister in other areas of the world may have specific host ranges. Given that only immature tissues can become infected it is likely that varieties differing in growth habit might vary in their susceptibility to white blister infection. For this reason early season cultivars of Brussels sprouts might have a higher chance of becoming infected with white blister. Additionally early season cultivars usually grow at times of the year when environmental conditions are more favourable for white blister infection.

Products
See separate insert ‘Chemical control of Brassica diseases’.

Agronomy issues
Regular crop monitoring is required to detect the early stages of the disease. It is occasionally found on transplants. Several fungicide treatments are likely to be required to maintain protection. Brussels sprouts and cabbage are most at risk. Control is difficult to achieve if the disease becomes well established in the crop.