Grower Summary

FV446

Leeks: Investigating control measures for White Tip

Final Report 2018

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The results and conclusions in this report are based on investigations conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

AHDB Horticulture is a Division of the Agriculture and Horticulture Development Board.

GROWER SUMMARY

Headline

White Tip (*Phytophthora porri*) severity reduction is possible by variety selection and understanding that two days of heavy rain heighten infection risk. Application pre-Christmas of some novel fungicides can result in a greater number of healthy new leaves at harvest.

Background

Fungicide control of White Tip in leeks (Figure 1) is limited by the number of approved foliar fungicide products and the number of applications permitted for each. Fungicide products for other oomycetes such as downy mildews and potato blight could have potential for the treatment of P. porri on leeks and so required efficacy testing to seek to increase the range of modes of action available to growers. Better targeting of the few applications permitted would be beneficial to the control of White Tip and so examination in this project of weather data in relation to symptom development, and information on this from published research, could help to better understand the conditions leading to disease development.

Figure 1. White Tip on leek in March, caused by P. porri

P. porri oospores are released from infested plant debris and the zoospores released splash up into leaf axils. Crop rotation to deplete oospores is not always possible and chemical soil treatment options are limited. Work elsewhere has shown reduction of oomycete activity following incorporation of one or other of Limex and Gypsum (inexpensive waste products), and a small-scale trial was needed to see if these products might be effective against P. porri. There are indications that some leek varieties are more susceptible than others to White Tip. Infection “escape mechanisms” related to shank height have been proposed, although a hypersensitive response as seen in leek plant breeding lines following inoculation tests may be involved in stopping lesion development. Comparison was needed of varieties alongside each other with a similar level of P. porri inoculum. Variety resistance is unlikely to give total disease control, but chemical fungicide use could be reduced, and biostimulants or biofungicides able to stimulate the plant’s own defence responses could also be integrated in programmes to improve control. A combination of cultural and chemical measures is likely to continue to be required to reduce White Tip incidence and severity.

Summary

A number of work packages (WP) were carried out between 2016 and 2018 to improve the control of *P. porri* on leeks. In WP1, to determine by inoculated test if there are differences in leek cultivar susceptibility to infection by *P. porri,* ten varieties were sown into module trays in June 2016. The varieties were sourced from five different breeding companies and included Triton and Lexton, selected because of reported susceptibility to White Tip, and the cultivars Pluston and LV446, reported by growers to appear to have a lower susceptibility. Other commonly grown varieties (Mancurian, Curling, O96, Belton, Krypton and Longton) with unknown susceptibility were included. Plots of 10 plants were arranged in a randomised block design outdoors under overhead irrigation at ADAS Boxworth. They were inoculated in a leaf sheath with a suspension of *P. porri* zoospores in September and November 2016. Up to the end of January 2017 there was no statistically significant differences in either incidence (mean 10% of plants with White Tip) or severity (1% of leaf area, principally at the tips), although it was noted that no leeks of cv. Mancurian had exhibited symptoms. Some further plants had White Tip symptoms by late 24 April 2017 in all varieties (mean 34% of plants). The only significant difference between varieties was in their vigour, with Pluston and Longton significantly stronger growing than O96, LV446, Lexton and Krypton, with plants showing less than 3% of leaf area affected by White Tip compared with the mean 6.6%.

In WP2, novel conventional fungicides, biological control products and elicitors which could be of benefit against *P. porri* were reviewed. A number of the fungicides reviewed, which had potential for off-label approval for foliar application to leeks, were put into two field trials (WP 5 and 6), as AHDB coded products, and others were to be included for use at propagation in WP3. Information was included on the potential development of fungicide resistance, and the effect of biofungicides/biostimulants whereby host defence mechanisms may be elicited.

In WP4, to determine by inoculated tests whether treatments applied to soil may lead to subsequent reduction in White Tip on the plants, treatments of Limex (a by-product of sugar beet processing, containing mainly phosphate, magnesium and sulphur) and Gypsum (calcium sulphate) were incorporated into containers of soil-based growing-media. In June 2016, oospores of *P. porri* were artificially produced and inoculated onto growing-media that had been treated with the equivalent of 5 kg/ha of either product three days earlier. Ten 6 to 7 leaf (three month old) module-grown leek plants were transplanted into each container two days after inoculation. The potentially susceptible variety Triton was planted in half the containers and cv. Pandora in the other half of the untreated, Limex and Gypsum plots. The containers were arranged outdoors in randomised blocks at ADAS Boxworth and subject to heavy irrigation droplets twice daily in order to splash spores from the soil into the leaf sheaths. By September 2016, a mean 30% of the plants had developed White Tip with no significant difference following either the Limex or the Gypsum treatment in comparison with the untreated. Triton and Pandora were equally affected, with only a minimal (0.3%) leaf area affected by White Tip per plant by September, and no further symptom development in any of the plants by mid-October.

In WP 6, a field trial was carried out in the east of the UK (Nottinghamshire) in 2016/17 to evaluate foliar applied plant protection products against *P. porri.* A randomised block experiment was set up in a commercial crop of cv. Pluston sown on land with a recent history of White Tip. Products either in use, or pending registration, against *Phytophthora* spp. or downy mildews on other crops, and with potential for off-label registration on leeks, were selected. There were eight experimental products and two products approved on leeks; Invader (mancozeb + dimethomorph) and Infinito (fluopicolide + propamocarb). Two treatments remained untreated to give a total of 12 treatments with four replications. Each product was applied experimentally three times in succession, at timings when the weather was forecast to become wet and so favourable to White Tip infestation of plants by soil-splash of soil-borne spores. Applications were made using an Oxford precision knapsack sprayer at 400 L/ha on 7 September, 9 November 2016 and 6 February 2017 to the four-row beds, with 5 m plot lengths for assessment. First symptoms were seen in August 2016, but did not progress until January 2017. By February virtually all the leeks had White Tip, with a mean 7.2% of leaf area affected per plant in the untreated plots, rising to 13.6% by 1 March 2017. No significant differences were found in the incidence or severity of White Tip between the untreated and treated plots, indicating that none of the products had protected the crop from infection. Weather data including rainfall were recorded using a transmitting station nearby.

A second year of foliar fungicide evaluation (WP5) was carried out in 2017/18, but in Lancashire, using the same procedures as for the Nottinghamshire site but with the variety Triton. All but one of the experimental products of 2016/17 were tested again with Invader (mancozeb + dimethomorph) as the standard. Instead of F219, one treatment used two of the experimental products in a programme with Infinito (fluopicolide). Spray applications triggered by rain forecasts took place on 7 September, 30 October and 19 December 2017. White Tip was first confirmed on the final spray date and affected up to 13.8% of the leaf area on plants with symptoms, although less than 1% of plants were affected and there were no significant differences between treatments. By 8 February a mean 17% of plants had symptoms and affected plants had a mean 18.6% leaf area with White Tip, without any significant differences either between treatments or between them and the untreated. By 21 March 2018, the infection incidence had changed little, with a mean 19% of plants with White Tip and still no treatment differences. By March, most fungicide treatments had significantly more (P<0.001) central (newer) leaves without visible White Tip i.e. two more than the untreated. Plots receiving three applications of Invader (currently used by growers against White Tip) had a lower number of healthy leaves, equivalent to untreated plants (Figure 2).

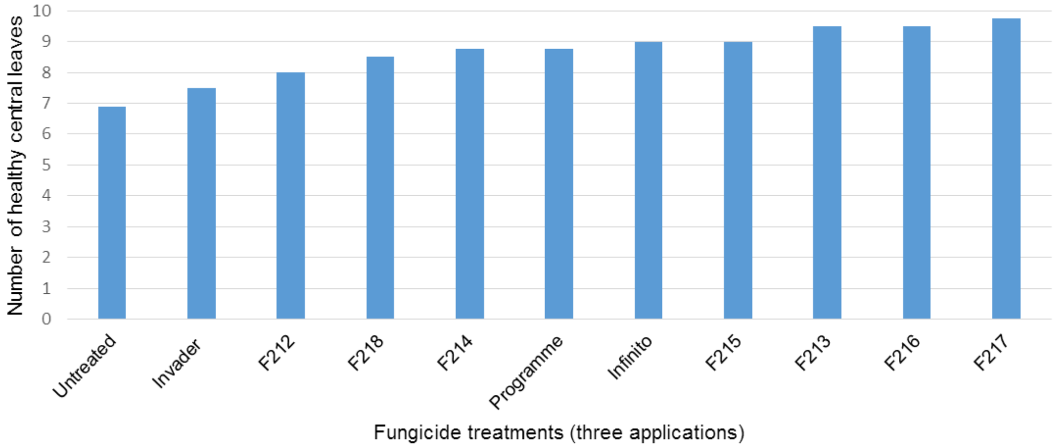

Figure 2. Lancashire. The modal number of central leaves without visible White Tip by 21 March 2018 following fungicide applications on 7 September, 30 October and 19 December 2017. Significantly more (P<0.001) leaves were healthy in F214, F215, F213, F216, F217, the programme (F212, Infinito, F218) and Infinito alone than following the use of Invader (mancozeb + dimethomorph) as the standard (L.s.d. 1.155).

In WP7, from in-field weather station readings from 2016/7 and 2017/18 when at least two wet days were followed by a day with over 35 mm rain (on 21 November 2016 and on 22 November 2017) then White Tip incidence increased. It was hypothesised that, as illustrated in Figure 3, wet days in mid-November 2017 provided conditions for zoospore release in the soil and, after a day with heavy rain splashing zoospores into leaf axils, first symptoms would have developed a fortnight later, i.e. the published interval for lesions to show at mean daily temperatures of 8°C.

When plant growth is slow the incidence of White Tip could be underestimated for perhaps a month or more because it is likely that the symptoms on leaf tips infected by zoospores in water inside the shank would not be visible until the new leaf emerged through the leaf axil. Therefore, although the apparent incidence of White Tip was low when fungicides were applied on 19 December 2017 there would have already been infection resulting from zoospore splash on 22 November. In order to give better awareness of the likelihood of crop infestation then knowledge will be required per crop field of the soil type/water penetration and the likelihood of puddle formation.

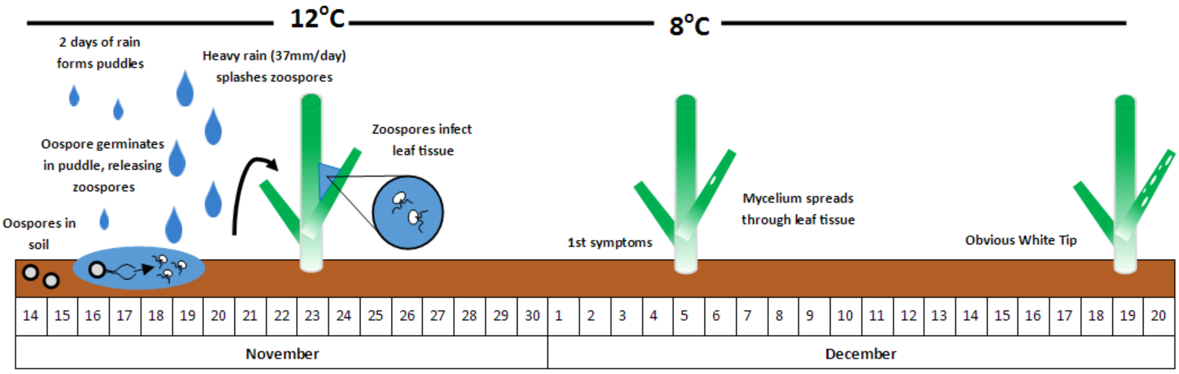

Figure 3. Timeline for leek infection from oospores and White Tip symptoms in the Lancashire field trial in 2017, showing required preceding puddle formation and heavy rain.

WP3, to assess the use of products in propagation against White Tip, was commenced but difficulties in multiplying-up the *P. porri* culture for inoculation, and in producing plants to produce open leaf axils suitable for receiving zoospores, meant that this work was not completed.

An additional work package (WP10) was started in 2017 to investigate any varietal susceptibility of field grown plants to White Tip from natural *P. porri* infection. Twelve varieties, principally those grown overwinter in the UK, were sown in 2.5 m long beds and given no fungicide treatments from August 2017. By 8 February 2018, White Tip incidence was higher than in the adjacent efficacy trial, with a mean 71% of plants visibly affected. With over 40% White Tip on affected plants significantly more ($P<0.001$) Krypton and Comanche plants were affected than Lexton, Pluston, a Triton seedstock, Galvani and Longton (Figure 4).

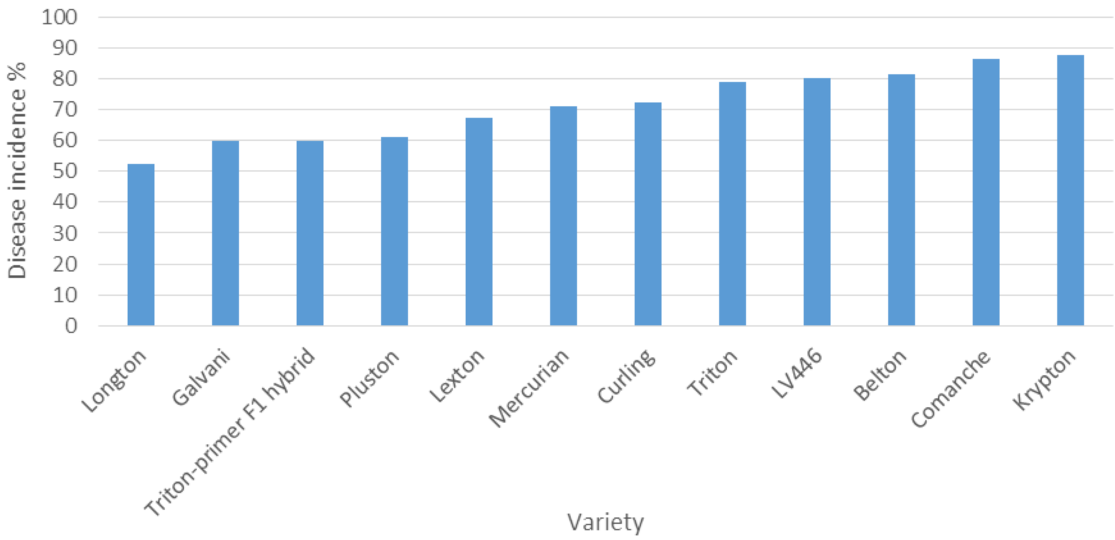

Figure 4. The proportion of leek plants in each variety with White Tip on 8 February 2018 (P<0.001, L.s.d. 16.24) following natural infection by P. porri at the Lancashire trial site. Longton, Galvani and Triton-primer had a significantly lower incidence than LV446, Belton, Comanche and Krypton with 80% or more plants affected.

By March 2018, no significant differences remained and the incidence in all varieties had decreased to a mean 18% because damaged leaf tissue was lost, leaving around five healthy central leaves. Shank height differed significantly ($P<0.001$) between varieties by March, with Galvani being the shortest and Lexton the tallest, but no correlation was found in March between variety height and the proportion of plants per variety with White Tip.

Financial Benefits

Although leek white tip is a sporadic disease of mainly late crop leeks, when active it can cause very serious losses. Given a yield loss estimate of 7.5% this would equate to a financial loss of £2.25 million annually for leeks where current fungicide control measures cannot be used. In a wetter than average winter the severe losses experienced late season can give losses of £3,250/ha when 50% of a crop is affected, (based on production costs of £6,500/ha).

Action Points

- Be aware of any history of White Tip in fields being considered for growing leeks, and if possible leave at least three years between leek crops
- No benefit was shown from the application of either Limex or Gypsum pre-crop
- The selection of certain varieties, such as Lexton, Pluston, Galvani and Longton could reduce the severity of White Tip infection. Taller shanks do not improve resistance.
- Zoospores are released and splashed from puddles, so avoid soil compaction, including in sprayer and irrigator wheelings, and improve drainage in problem areas
- Be aware that heavy irrigation that splashes soil onto the crop can spread White Tip
- There is potential for a nurse crop of cereals to provide soil cover and prevent soil splash in the early life of a leek crop until herbicide breakdown of the cereal plants
- Target foliar fungicide application to periods of forecast heavy rain, especially when the ground is already saturated so allowing puddle formation, as this is when conditions are right for the pathogen to splash onto leaves
- Application of products such as Infinito and certain experimental products pre-Christmas can increase the number of healthy new leaves produced by March
- Before deciding to spray, consider other potential physiological causes of white tipping on leeks. Fresh *P. porri* lesions tend to be a bright white, usually with a sharp boundary with green tissue, although lesions are soon invaded by secondary fungi
- It may be prudent to lift leek crops with White Tip earlier than intended, however without heavy rain the infection of further plants may be unlikely and outer infected leaves (due to be trimmed) are likely to die in Spring and healthy new leaves develop
- Removal of infested leek debris will stop *P. porri* resting spores entering field soil