MUSHROOM PEST & DISEASE

MU16003

fact sheet #7

Internal Stipe Necrosis

GROWERS' NOTES

- Internal Stipe Necrosis is characterised by browning and necrosis of affected stipe tissue.
- Internal Stipe Necrosis is caused by the bacterium *Ewingella americana*.
- Symptoms are more pronounced when there is an imbalance in water relations, particularly when growing with black peat.
- The bacterium is transported along the *Agaricus* stipe via the mushroom's conductive tissue.
- The impact of Internal Stipe Necrosis can be reduced by managing the room environment. Ensure compost temperatures are regulated and there is sufficient evaporation at all times.

Figure 1 Internal Stipe Necrosis symptomology expressed on mushrooms from an Australian farm. Note the variable severity of symptom expression on different stipes. *Image: Judy Allan*

1. INTRODUCTION

Internal Stipe Necrosis was recognised in the late 1980s and early 1990s as a significant emerging threat to the United Kingdom mushroom industry.

With the *A. bisporus* wholesale market at the time valued at around £250 million, losses of up to 10% were reported by some United Kingdom mushroom producers with one grower estimating the incidence of Internal Stipe Necrosis on his farm totalled 0.3% of mushrooms harvested at the button stage and 5.6% of mushrooms harvested at the open, flat cap stage.

Internal Stipe Necrosis has been observed sporadically on Australian mushroom farms over the past 10 years or so and its appearance is consistent with the widespread adoption of wetter and heavier black peat as a significant component of mushroom casing.

The disorder expresses as an unsightly browning and necrosis of internal stipe tissue which cannot be detected before harvest, resulting in significant loss of quality.

2. SYMPTOMOLOGY

On *A. bisporus*, Internal Stipe Necrosis symptoms are largely confined to the stipe (Fig. 1). The ring of tissue surrounding the inner soft central column of the stipe becomes brown and necrotic with areas of necrosis sometimes extending towards the outer edge of the stipe.

The affected tissue dries and completely collapses, leaving a column of dead, corky tissue attached to the base of the mushroom cap. In some instances, the browning may extend upwards along the stipe to the cap where the stipe attaches.

There is no outward symptomology as the characteristic brown discolouration is confined to the internal stipe tissue and is only visible after harvest, once the stems are cut. Some affected mushrooms may, however, appear wet during early development.

3. THE PATHOGEN

From samples of symptomatic mushrooms collected from three United Kingdom farms over a three-year period, a bacterium identified as *Ewingella americana* was detected in 93% of the affected mushrooms.

In Koch's postulate trials, inoculation of mushrooms with *E. americana* resulted in 40% of infected mushrooms expressing Internal Stipe Necrosis symptoms of 'typical severity'. *Ewingella americana* was re-isolated from all symptomatic *E. americana*-injected mushrooms.

Interestingly, *E. americana* was also isolated from control treatments injected with a sterile broth, suggesting that the pathogen may be endemic to the microflora of these mushrooms.

Ewingella americana is a ubiquitous Gram-negative flagellate rod which inhabits a wide range of natural and man-made environments such as mammals, fish, insects, molluscs, plants, fungi (including naturally occurring mushrooms such as *Tuber borchii*, *Suillus tormentus*, *Cantharellus* sp, *Rhizophagus irregularis* and *Tricholoma matsutake*), foodstuffs (including processed meats, poultry and fish, dairy products and fermented vegetables), waste treatment facilities, landfill sites, office buildings and household surfaces.

Significantly, *E. americana* has been isolated from symptomatic mushrooms of artificially cultivated varieties grown on sterilized sawdust substrates such as Shiitake (*Lentinula edodes*), grey oyster *(Pleurotus ostreatus) King oyster (Pleurotus eryngii*), Enokitake (*Flammulina velutipes*) and Lion's mane (*Hericium erinaceus*).

4. DISEASE DEVELOPMENT

Little is known about the aetiology of *E. americana* on cultivated *A. bisporus* and the primary source of infection in the mushroom farm environment has not been identified. The bacterium has been isolated from neither casing nor compost and air samples taken from an Internal Stipe Necrosis-affected grow room tested negative for the bacterium. Furthermore, the isolation of the bacterium from mushrooms growing on sterilized sawdust substrates (see Section 3 above) provides further evidence that infection does not originate in the *Agaricus* substrate.

The major structural component of mushroom cell walls is chitin and *E. americana* strains isolated from Internal Stipe Necrosis-symptomatic button mushrooms all produce a chitinase enzyme which allows the bacterium to degrade mushroom cell walls.

Moreover, the *E. americana* chitinase enzyme specifically degrades the type of chitin found within the walls of mushroom stipe cells. This ability not only confirms the bacterium as a pathogen of *A. bisporus* but identifies it as a potential pathogen of other mushrooms, confirmed by reports of *E. americana* eliciting disease symptoms on other cultivated and naturally occurring mushroom species (see Section 3).

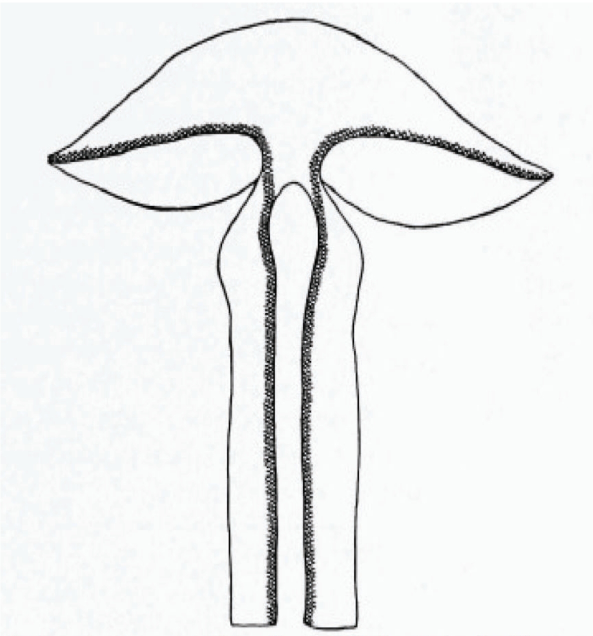

Figure 2 Cross-section of a typical agaric basidiocarp, showing the distribution of the conductive tissue (hatched area). *Image: Schütte (1956)*

Water plays a critical role in Internal Stipe Necrosis expression. During an investigation into the causes of mushroom water stress symptoms, the incidence of a 'brown core' syndrome was reported which increased under a heavy watering regime on black peat.

The act of drying off a crop and the resultant increase in transpiration rate, in association with heavier black peat and a generally wetter growing environment, may lead to *E. americana* being taken up into the stipe tissue via the conductive cells.

The distribution of necrotic tissue seen in Internal Stipe Necrosis-affected stipes does correspond to the distribution of conductive tissue responsible for water uptake in *Agaricus* (Fig. 2).

Furthermore, it is thought that Internal Stipe Necrosis expression may be associated with waterlogging of the stems at an early stage of their development and that abnormally low compost temperatures at pinning may be influential on Internal Stipe Necrosis expression.

Significantly, Internal Stipe Necrosis has expressed in Australia since black peat and a wetter cultivation system were adopted by growers.

While the role of water and water relations in the mushroom bed plays a significant role in disease expression, water has not been investigated as the source of on-farm infections.

Given that mushrooms growing artificially on sterile wood-based substrates also express Internal Stipe Necrosis symptoms, water appears to be the only commonality with compost-based *Agaricus* crops. Further investigation into the role of water as a potential source of on-farm infection is warranted.

5. MANAGEMENT STRATEGY

Due to the association between crop water relations – specifically a wet casing – and the expression of Internal Stipe Necrosis, maintaining a good evaporation rate is essential to effectively manage this disorder. Calibrate air handling units to ensure correct and consistent bed temperatures and sufficient evaporation are maintained at all times.

Irrigating the bed with 100ppm chlorine (or equivalent using a APVMA-registered product for mushroom farms) has been shown to reduce bacterial numbers in the mushroom environment generally (Fletcher & Gaze 2008) and will eliminate irrigation water as a possible source of the pathogen.

6. KEY READING

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