Sustainable roots: a roadmap towards integrated management of soilborne diseases in onion

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ABSTRACT

Plant diseases are caused by a range of infectious organisms leading to reduced plant yield and quality, lower resource efficiency, and increased food waste across supply chains (Chakraborty and Newton, 2011). This is particularly true of soilborne diseases which, due to their hidden nature and persistency, can result in fields becoming unproductive for many years or decades. Furthermore, the specialist and limited areas used for the production of vegetables such as onion, exacerbates this problem resulting in up to 15% of the UK crop (worth £7M in value) being lost to soilborne diseases each year (Clarkson, 2016).

In general, two soilborne diseases cause losses in onion. *Allium* white rot (AWR), caused by the fungus *Sclerotium cepivorum*, results in the infection and eventual rotting of the plants roots leading to wilting and plant death. This pathogen is particularly persistent, as it produces poppy seed sized resting bodies or survival structures (called sclerotia), which are able to survive for up to 20 years in soil (Coley-Smith et al., 1990). The second, Fusarium basal rot, caused by the fungus *Fusarium oxysporum* f. sp. *cepae* (FOC), also results in root rot, wilting and death and causes the onion bulb to rot during the long storage period after harvest. This leads to contamination which can spread to other bulbs rendering the whole stored crop unmarketable.

Historically the management of soilborne diseases included the use of soil- or seed-applied fungicides or soil fumigants, but these are no longer permitted for use in the UK and EU or are soon to be withdrawn from use. This is as consequence of changing EU legislation and opinion on the use of crop protection products (pesticides), and their potential risks to the environment and human health. Consequently, growers are left with fewer chemical options each year, and potentially at higher risk of crop losses.

Sustainable alternatives to chemical plant protection products come in a variety of guises such as; newer chemical options, biological control agents (BCAs), biological processes (e.g biofumigation or plant biostimulants) and physical/technological measures. However many of these areas still require significant research and development to make them useable, with this being the focus of current work at the University of Warwick's, Warwick Crop Centre (WCC). This work also aims to integrate individual practices, forming a sustainable roadmap for growers similar to the models of integrated pest management (IPM) adopted for agricultural pests. For example, in the management of AWR we are investigating the use of garlic based products to lower pathogen levels in the soil. This involves mimicking the exudates of onion roots, which trick the infection structures (sclerotia) to germinate. Once germinated they become vulnerable and die leading to lower levels of disease in following crops (Coley-Smith and King, 1969). This approach could be followed by the use of newer chemical options and BCAs to the growing crop, further reducing disease levels. Our work in FOC management involves the use of DNA diagnostics to detect pathogen levels in the soil, providing a grower with a risk assessment before planting. If a site is infected then a resistant variety might be used which is immune to the disease, but currently few such commercial varieties exist. Consequently, alongside the Warwick Genetic Resources Unit (GRU) and other stakeholders, several sources of genetic resistance have been identified (Taylor *et al*., 2019) and are currently being developed into commercial varieties. If a resistant variety is not used, then newer fungicides or BCAs could be employed, with technology such as band applications or disease mapping allowing for targeted applications. This allows an optimised amount of

pesticides or BCA to be applied where it is needed, saving both costs and decreasing pesticide usage.

Alongside both of these management options for AWR and FOC, other innovations are required, but are currently outside of the WCC's remit. These include a systems approach or thinking, to engage growers, processors and the public. For example as to the social factors which may limit the adoption of new products, processes/techniques, or how technology can be used to benefit, improve and support crop management decisions.

In summary, this paper will explore sustainable solutions to disease management undertaken by the WCC. It proposes that together these solutions can form the basis of a roadmap for the integrated management of soilborne diseases, leading to improved sustainability.

References

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