The effect of episodic drought stress on cereal aphid populations

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Project background

Most models used to predict changes in climatic conditions indicate decreases in summer precipitation and increases in winter precipitation across Europe (Blenkinsop and Fowler, 2007) and the US. Many studies demonstrate that prolonged drought not only has direct adverse effects on plant growth and survival, but may also trigger more frequent or severe outbreaks of phytophagous insects (Jactel *et al*,. 2012). Aphids are significant pests of many agricultural species and under future climate scenarios may develop increased populations. Significant economic losses can result from aphid infestation, due to either a reduction in yield or the use of costly pesticides. Aphids feed on phloem sap, which under water stressed conditions becomes more concentrated and contains a greater proportion of small nitrogenous molecules. It is hypothesised that this would be of benefit to aphids since they are frequently limited by available nitrogen in their diet. However increased populations have not always been found in experimental studies comparing aphid numbers on drought stressed and well watered plants (Huberty and Denno, 2004). It is postulated that this is due to the timing and severity of drought events, with intermittent drought most likely to lead to pest outbreaks. A recent controlled environment study at Edinburgh University has demonstrated that the population of the rose-grain aphid (*Metopolophium dirhodum*) on barley (*Hordeum vulgare*) was increased on mildly drought stressed plants, probably due to increased leaf temperature and soluble nitrogen concentration (Simpson *et al*., 2012).

Apterous rose-grain aphids (*Metopolophium dirhodum)* feeding on barley.

Key research questions

To build on work already carried out, the rose-grain aphid and barley would be the focus of this PhD. This is a well-researched system of economic importance. The hypothesis that barley will be negatively impacted by intermittent drought stress and the synergistic impact of increased rose-grain aphid populations will be tested by three main areas of work:

Methodology

Year 1. Controlled environment studies in which barley is grown in a factorial experiment with and without aphids and with and without intermittent drought stress. It is well established that mild, intermittent drought stress leads to increased populations (Simpson, 2012), but this work would (i) look at how the biochemistry and physiology of the plant is changed to the benefit of the aphids and (ii) investigate slightly more severe and intermittent drought scenarios.

Year 2. The establishment of rain exclusion experiment, using a barley experimental field at Boghall Farm, 8 miles south of the Kings Buildings. Clear plastic screens, (chosen to transmit almost all of the natural light) will be erected over areas of the field to exclude rainfall, which will be channeled away from the crop. Natural rainfall will be simulated for replicated areas of the crop by irrigation.

Year 3. Investigation of historic rose grain aphid numbers recorded by the network of aphid suction traps across Britain. This would be correlated with historic meteorological variables – with particular reference to rainfall events.

Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. Training will also be provided in the use of all necessary equipment and facilities. This will include biochemical analyses of plant material and plant physiological analysis, for example the measurement of photosynthesis, stomatal conductance and water potential. Statistics and modelling will also be taught.

Requirements

We are looking for a highly motivated individual with a first or 2:1 undergraduate degree in a biological discipline. The student should have good quantitative skills and a strong interest in ecology, entomology and agricultural production.

References

Blenkinsop S. and Fowler H.J., 2007. Changes in drought frequency and severity over the British Isles projected by the PRUDENCE regional climate models. Journal of Hydrology, **342,** 50-71.

Jactel H., Petit J., Desprez-Loustau M., Delzon S., Piou D., Battisti A., Koricheva J. 2012. Drought effects on damage by forest insects and pathogens: a metaanalysis. Global Change Biology **18**, 267–276.

Huberty A.F. and Denno R.F. 2004. Plant water stress and its consequences for herbivorous insects: a new synthesis. Ecology **85**, 1383–1398.

Simpson K.L.S. 2012. Interactions between aphids and their host plants under drought stress. PhD thesis. University of Edinburgh.