Grower Summary

CP 074

Ethylene in the control of adventitious rooting

Annual 2012

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

Further information

If you would like a copy of the full report, please email the HDC office (hdc@hdc.ahdb.org.uk), quoting your HDC number, alternatively contact the HDC at the address below.

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Project Number:	CP 074
Project Title:	Ethylene in the control of adventitious rooting
Project Leader:	Dr. Russell Sharp, Moulton College Dr. Ian Dodd, Lancaster University
Contractor:	Moulton College
Industry Representative:	Dr Neal Wright, Micropropagation Services Ltd
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Project Cost:	£64,650

Headline

- The stock plant environment is a contributory factor in successful adventitious root formation.
- There may be optimal soil moisture ranges for stock plants for subsequent rooting that reflect changes to plant physiology.
- Abscisic acid and ethylene are plant stress hormones involved in adventitious root formation.

Background and expected deliverables

There is a great variability between hardy nursery stock subjects in the ability of shoot tissue to produce adventitious roots (AR). Adventitious roots are a subtype of roots that emerge from cuttings and their production is integral to the propagation of countless numbers of elite varieties worldwide, which are of use in horticulture, forestry and timber production, food production and for conservation. It is a complex trait in plant development and is dependent on the interaction between many environmental and internal conditions. However, at the core of the process is the plant growth regulator auxin, long used as an effective synthetic treatment as one of its many analogues in cutting propagation. The plant growth regulator ethylene has also been demonstrated to have a generally promotive role in the rooting process and there may be roles for other environmentally regulated 'stress' hormones such as abscisic acid (ABA).

Most propagation professionals will be unsurprised by the variability in rooting in some varieties on a yearly basis. Although this variation is most often left unexplained, it is most-likely produced by the effect of climatic variations in season from year to year. Stock plants used for cuttings are not always subject to as rigorous a management regime as the subsequent plants that are produced from them, which is somewhat surprising given that the tissue used to produce the new plants has spent most of its time attached to the parent plant. Recent discoveries showing how genes are controlled are giving us more information as to how environmental changes can produce stable alterations in the way genes function within plants, which may even be inherited by sexually-propagated offspring, but most certainly through asexually-propagated cuttings.

- This project is therefore investigating how soil moisture of stock plants can affect subsequent rooting of cuttings and whether this effect is produced by changes in hormone signals.

- It is hoped that the investigation will develop practical advice that will allow nurserymen to produce improvements in rooting from all stock, but especially problem rooting species or varieties.

Summary of the project and main conclusions

First year studies identified a role for ethylene in adventitious rooting from woody species and also trialed the use of ACC (ethylene precursor) as a rooting treatment, however, this proved to be ineffective solution in terms of feasibility and cost.

The study has progressed to focus on the environmental regulation for adventitious rooting in stock plants as outlined in the introduction. Stages in the study are:

1. Does soil moisture content in stock plants influence subsequent rooting?
2. Does this response involve variation in endogenous ethylene and ABA synthesis and response?
3. How stable is any effect in stock plants over time?
4. An online grower survey into stock plant management with respect to irrigation.
5. Field study in local nurseries.
6. Trials for a wide-range of species.

Current results indicate that there may be ranges of soil moisture that promote rooting and that these may be different for different species.

Hypothesis

The hypothesis is that stock plants subject to drought or over-irrigation will increase ABA and ethylene hormone levels to concentrations where they inhibit root formation. The hypothesis is not based on a direct ratio of the two hormones, but on thresholds for each hormone in different moisture ranges. Some species may be less sensitive either to ethylene in waterlogged conditions or ABA in droughted conditions, rendering differences in their potential range of rooting.

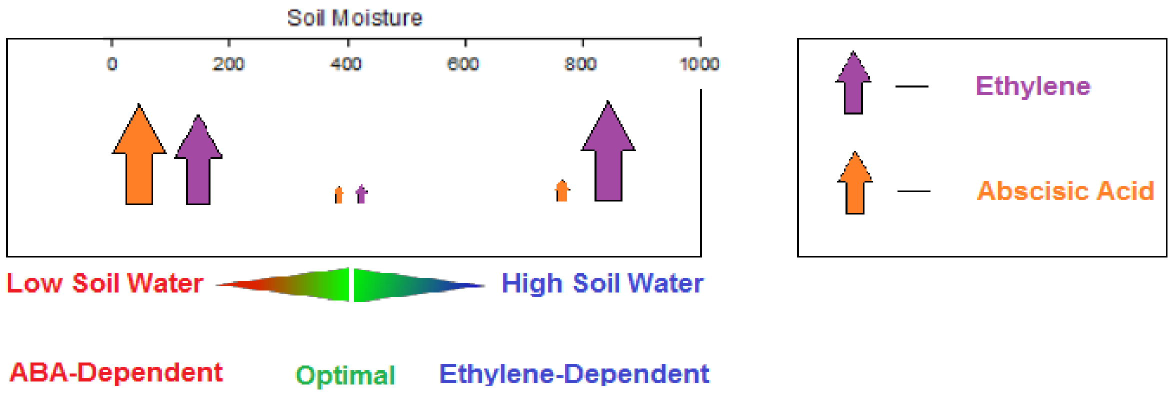

Fig. 1. Hypothetical variation in ABA and ethylene concentrations over the soil moisture range in soil-based substrate, based on literature and current data. Increases in the concentrations beyond the 'permissible' ranges may produce changes that inhibit root induction. Note that there are two distinct 'stress' zones which are primarily dictated by individual hormones.

Year 2: Main Section

1: Water Deficits in Stock Plants

Our current research has identified potential optimal ranges for soil moisture in stock plants for rooting. Experiments investigated the effect of reducing soil moisture in stock plants on cutting rooting. There were two treatments: a well-watered (100% of evapotranspiration; ET) and a deficit-irrigated (50% ET) treatment. Cuttings from deficit-irrigated plants exhibited a statistically significant 26% reduction in rooting after 10 days compared to the well-watered controls. Results from experiments in two *Populus* species both show an optimal response to a defined range of soil moisture (Fig.2.). This may mean that there are specific soil moisture ranges for stock plant for which rooting is promoted or suppressed. In addition, cuttings removed from deficit treated plants showed increased ethylene production at 24 hours after excision to levels that may be inhibitory. Although moderate levels may be stimulatory, higher or lower levels may inhibit root induction.

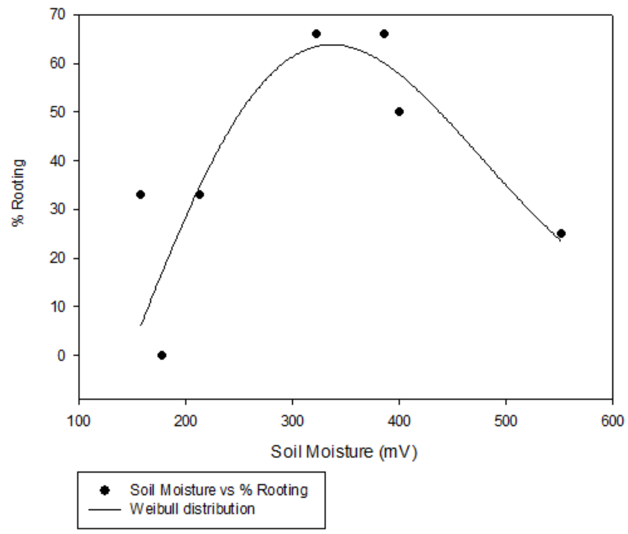

Fig. 2. An optimal soil moisture range for stock plant irrigation for adventitious rooting?

2: A Role for ABA in Adventitious Rooting?

ABA and ethylene are known to be antagonistic in a number of plant processes. ABA has been dubbed the 'water stress hormone' owing to its accumulation and role in plant water relations under drought conditions. Therefore, to initially examine if there is any role for ABA in adventitious rooting we compared rooting by tomato varieties overproducing ABA (sp12 and sp5) and the wild-type, 'Ailsa Craig'. Results indicate that percentage root emergence after 10 days was negatively associated with increased ABA production and, in addition, overproducing mutants had significantly lower ethylene concentrations during the first 24 hours after cutting excision. This provides evidence for a possible role for ABA and an interaction with ethylene in the promotion of AR and therefore gives further justification for studies into how rooting is affected by soil moisture variation.

3: Current Experiments

To clarify if there is any role for stock plant soil moisture in priming for AR and whether variation exists between species, I am currently conducting a larger scale experiment using four *Populus* varieties. The methodology is split into three experimental stages (Fig.3 below) (1) the acclimation period wherein all plants get the same irrigation and are kept within the same soil moisture range; (2) the treatment period wherein there are three different soil moisture treatments corresponding to a low, medium and high soil moisture content and (3) the post-excision or cuttings period, wherein the physiological and rooting response of the cuttings are measured under constant conditions. In all stages various physiological and biochemical data is taken.

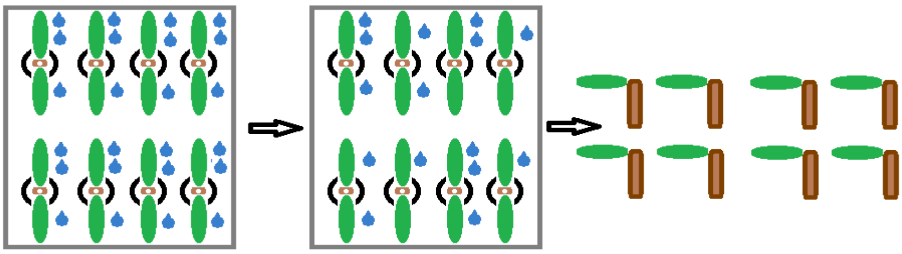

Fig.3. Experimental work-flow for the larger scale soil moisture priming experiment showing the progression from acclimation stage with constant water, to treatment stage with 3 moisture regimes and finally to the cuttings.

Preliminary results indicate that there are promotive ranges for rooting but that effects on rooting may be species-specific, possibly relating to the degree of innate drought/flooding tolerance of each species and their production of ethylene and ABA.

Financial benefits

Development of new stock plant management recommendations provides an easy method of increasing the percentage of rooting (reduction in losses) for a range of recalcitrant and non-recalcitrant species and could allow greater market exposure for species previously considered as being unprofitable due to low rooting response. The adoption of such processes could help to more effectively target water use and mitigate the use of synthetic chemical rooting agents, many of which add significant costs to business and the environment and will be restricted under new EU directives by 2020. In addition, such knowledge can be incorporated into training. Water use is a significant problem for the horticultural industry, both in financial and environmental terms and over-irrigation remains a problem.

Action points for growers

1. Over- or under-irrigation of stock plants may lead to undesirable changes in plant tissues as well as variation in ABA and ethylene levels outside of the conducive range for ARF, although the level of drought tolerance of the species should be considered when making judgements about irrigation.

Growers can improve their practice by incorporating simple record keeping of the environmental variables to which stock plants are subjected on a seasonal (or even monthly) basis as a means to explain losses and in helping to optimise treatment.