Potassium Deficiency and JA-dependent Responses to Biotic Stress in Barley

Jayne Davis[1,2], Patrick Armengaud[1], Adrian Newton[2], Philip White[2] and Anna Amtmann[1]

[1] Plant Science Group, FBLS, University of Glasgow, Glasgow G12 8QQ, [2] Scottish Crop Research Institute, Errol Road, Invergowrie, Dundee DD2 5DA

Background

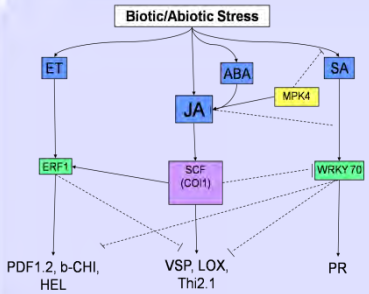

Figure 1. Plant stress hormone signalling network.

Potassium (K) is an essential element required for growth development and metabolism (1). Microarray studies have identified Jasmonic acid (JA) related genes to be upregulated in response to K deficiency in *Arabidopsis thaliana* (2).

JA is a phytohormone important to growth, development and stress signalling (3). JA is part of a complex signalling network used by plant to respond to various stresses Figure 1

Questions

- Does the JA-response to K-deficiency occur in plants other than *A. thaliana*?
- Do increased JA levels in K-deficient plants effect response to stress, and how?

Methods

Barley (Optic) seeds were germinated on paper and then transferred to control or K free hydroponic systems for 14 days (figure 4a.).

The 2nd leaf was cut into 4cm pieces and separated into tips, middle and base segments (figure 2b.), placed on 0.5% agar plates and allowed to recover for 24 h in a 17°C light incubator. Then inoculated with Rhychosporium or Powdery mildew spores

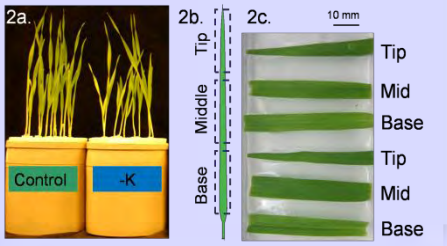

Figure 2. Setting up detached leaf assays

JA levels in K starved Barley plants

5 plants grown in control or –K solution were pooled every 3 days, figure show the mean expression level of JA related genes 12 days after seedlings were transferred to hydroponics (± SE) of 3 replicate experiments.

Expression levels of JA biosynthesis gene LOX2 and JA induced genes JIP23, JIP37 and JIP60 are increased in response to low K.

JA level is increased in K deficient barley plants

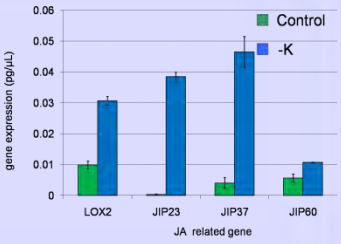

Figure 3. JA related gene expression increases in response to K deficiency

K deficiency and *Rhynchosporium secalis*

A hemi-biotrophic fungus that grows symptomlessly in early infection, before producing conidia and causing visual symptoms (Fig. 4a).

Lesions on K-deficient leaf segments were visible earlier (data not shown) and had larger areas than control plants (Fig 4b mean area of lesions (± SE) of 3 replicate experiments (n=40) 9 days after inoculation)

An increase in LOX2 expression is seen 48h after inoculation with *Rhynchosporium*, this is additive to the increase seen in response to K-deficiency (figure 4c)

Increase in JA in response to K deficiency has no or a negative effect on Rhynchosporium resistance.

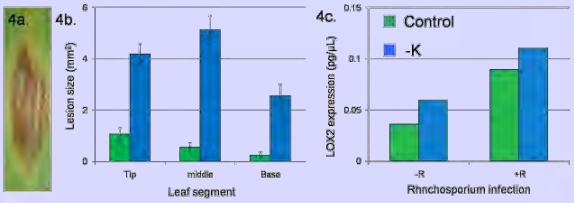

Figure 4. K-deficiency and *Rhynchosporium* infection

K- deficiency and Powdery mildew

An obligate biotroph, Latin name *Blumeria graminis.*

15 days after inoculation with powdery mildew there was no difference in colonies/cm^2 between segment types in control plants, in K-deficient segments there was an increase in colonies/cm^2 from tip to base.

48 hours after powdery mildew inoculation LOX2 expression was reduced in control plants and increased in K-deficient plants compared to control tissue (figure 5c).

The K deficient segments with higher LOX2 expression have fewer colonies indicating JA may have an effect on defence against mildew, however the low LOX2 levels in control samples show other factors are also involved

JA increase in response to K-deficiency may have an effect on powdery mildew infection

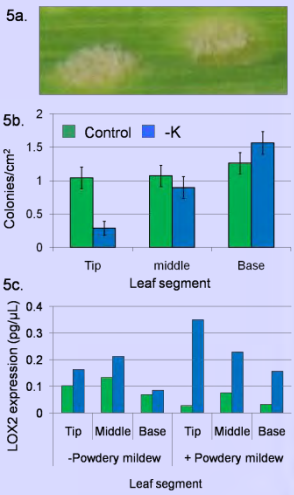

Figure 5. K-deficiency and Powdery mildew infection

Conclusions

- JA increase in response to K deficiency is seen in barley
- K deficiency does have an effect on pathogen infection, the effect is pathogen dependent.

References

1. Schachtmann and Shin (2007) Annu. Rev. Plant Biol. 58, 47-69.

2. Armengaud *et al.* (2004) Plant Physiol. 136, 2556-2576.

3. Wasternack *et al* (2007) Ann. Bot. 100, 681-697.