Protocol on how to safe water & fertilizers in horticulture

Ornamentals – Annuals

1. Reduction of water input

1.1 By the use of tools

- Which sensors?

Soil sensors that measure water content of the substrate, e.g. WET-sensor (fast, cheap, user friendly) or a tensiometer coupled with a datalogger (real-time measurements). These sensors can be used to monitor the effect of water reduction on the substrate and the plant. More advanced plant-based tools are also available, e.g. dendrometers, but advice and help of researchers or other external parties is recommended.

- How to use soil sensors?

- *Discontinuous soil sensors (e.g. W.E.T.-sensor)*: Perform scattered measurements every 1 to 2 weeks. If reduction in irrigation started, measure every 3-4 days to monitor the moisture content of the soil/substrate more closely.
- *Continuous soil sensors (e.g. tensiometer)*: Place sensors scattered in the greenhouse. Tensiometers are coupled with a datalogger, the characteristics of the soil are continuously monitored.
- Short periods of mild/severe drought stress can be tolerated without heavily effecting commercial plant quality.

➔ On the Bio4safe project page (https://bio4safe.eu/sensors), you can find information leaflets about different types of soil sensors and dendrometers.

1.2 By combining tools and biostimulants

Soil sensors and the more advanced tools can be used in combination with biostimulants, which can influence plant tolerance against drought stress. You can find the most suitable biostimulant for your case in our online Bio4safe database.

- How to use Bio4safe-database?

- Surf to https://bio4safe.eu/
- Click on the button '**Crop group**' and select '**Annuals**'
- If you want, you can further filter your search result for the desired effect. (E.g. 'Increased drought stress tolerance')
- Click on one of the listed products you are interested in for more detailed information.

2. Reduction of nutrient input

2.1 By the use of tools

- Which sensors?

Non-destructive optical sensors that detect indicators of nutrient stress such as an early decrease in chlorophyll and increase in secondary stress metabolites (phenolics, anthocyanins), e.g. Dualex Scientific (fast, cheap and easy to use, but control needed) or Greenseeker (fast, cheap and easy to use). These sensors can give a good indication of the presence of stress if slight color differences become visible. If there is nothing noticeable visually, it is recommended to combine the sensors with isotope analyzes or other destructive laboratory analyzes.

- How to use non-destructive optical sensors?

- Perform scattered measurements on the youngest, fully developed leaves (Dualex) or on a constant distance above the crop (Greenseeker) every 1 or 2 weeks. Remind yourself that the pigment content doesn't change quickly when a plant experiences stress.
- Compare indices of plants in nutrient stress with plants in optimal conditions to verify whether there is a shift in the pigment composition (less chlorophyll and more secondary metabolites) due to the presence of stress.

➔ On the Bio4safe project page (https://bio4safe.eu/sensors), you can find information leaflets about different non-destructive optical sensors.

2.2 By combining tools and biostimulants

Non-destructive optical sensors can be used in combination with biostimulants, which can influence the nutrient use efficiency of plants. You can find the most suitable biostimulant for your situation in our online Bio4safe database.

- How to use Bio4safe-database?

- Surf to https://bio4safe.eu/
- Click on the button '**Crop group**' and select '**Annuals**'
- If you want, you can further filter your search result for the desired effect. (E.g. 'Increased nitrogen 'N' use efficiency'; 'Increased phosphorous 'P' use efficiency'…)
- Click on one of the listed products you are interested in.

Case study: Chrysanthum (*Chrysanthemum indicum* Purple Star)

To prevent the disturbing effects of natural precipitation, the trials with chrysanthemums were carried out in a greenhouse. To control both irrigation and fertilization as well as possible, the plants were grown in containers filled with potting soil. This is not a common system for greenhouse cultivation in soil. By growing in containers placed on a concrete floor, it was possible to visually monitor the occurrence of drain from the containers. Irrigation was stopped if the containers of the reference (most irrigation) started to leak water. The emphasis of the trials was on creating drought and/or nutrient stress to investigate the effects of biostimulants. The aim of the trials was not on determining the lower limit of irrigation and fertilization while maintaining maximum production.

One of the most important quality characteristics of cut chrysanthemums is branch weight.

1. *Reduction in irrigation*

A reduction in irrigation of 50 % and 65 % resulted in respectively 25% and 35 % loss in branch weight compared to the untreated optimal control.

2. *Reduction in fertilizers*

A reduction in fertilization of 50 % and 65 % resulted in respectively 25 % and 39 % loss of branch weight compared to the untreated optimal control.

3. *Effect of biostimulants*

Under certain stress conditions - so not in all - significant positive effects of biostimulants on e.g. branch weight were observed. In these specific situations the use of Seamel^{Pure} led to 22% heavier branches, the use of Phylgreen led to 23% heavier branches and the use a biostimulant of the locally (NL) produced seaweed *Saccharina latissima* led to 24% heavier branches, all compared to the untreated stressed plants. In two trials, the application of Kelpak - again under specific stress conditions - led to significantly heavier branches (+22% and 28%), compared to the untreated stressed plants.