

Coping with low air humidity

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On hot summer days the air humidity sometimes drops to very low levels. Some regions of New Zealand suffer from almost desert-like conditions where crops struggle to survive. It is generally believed that a relative humidity of around 80-85% is ideal for plant growth (vapour pressure deficit or VPD of 0.6-0.5 kPa at 25 °C), and that 60% is below optimal. A level of 50% RH in combination with high temperatures is considered too low, as it means that the VPD is 1.6 kPa at 25 °C. This article deals with how to cope with low air humidity in summer.

Risks of low humidity

Low air humidity increases crop transpiration, but too low air humidity in combination with high radiation amplifies the transpiration more than the plants can handle. If the water loss by the leaves exceeds the water uptake by the roots, the plants start wilting. Such water stress (or actually drought stress) means that most processes, including growth, come to a temporary stand-still. Water stress in combination with burning sun shine may cause permanent damage in the form of leaf burn. If the dry conditions last for a longer period of time the crop will adjust by forming smaller, thicker, sometimes brittle leaves, which gives the crop a very unhealthy appearance. Its performance is probably still high thanks to the high radiation, but lower than it would be when the leaves were lush. Hot dry conditions may cause special problems in some crops, e.g. blossom-end rot in tomato and capsicum. Low air humidity also favours some pests, e.g. spider mites lay more eggs and spider mite infection develops faster under low humidity. Some predator mites are not effective under low humidity. For all these reasons we would like to mitigate excessive dry conditions in summer.

Transpiration and ventilation

The first method to increase air humidity in the greenhouse is by supporting crop transpiration, as the transpiration brings masses of water vapour into the air. Two things are important: sufficient water supply and optimal water uptake. Ideally, the water supply capacity in a soil-less system must be so high that even on the hottest days still some drain water comes out of the system. The water uptake can peak to as high as 8 litre per m² per day, which amount must be available in the substrate or supplied when needed.

Secondly, the plants should be trained to be able to maintain a high rate of transpiration when needed. To avoid that plants get 'lazy', on dull days the transpiration must be increased by extra ventilation. On hot days some extra ventilation (and pipe heating when the temperatures are low) early in the morning can push the transpiration, in order to have the plant active when the radiation rises fast. Ample ventilation early in the morning does not help the CO₂ enrichment. However, on hot dry days, humidity is of critical importance and should get the highest priority.

In contrast, it can be required to reduce the ventilation a little bit in the middle of the day when the air humidity in the greenhouse is low due to low air humidity outside. If the plants transpire, they bring water vapour into the greenhouse air. But this is lost when the vents are wide open. Slightly closing the vents will keep more water vapour inside. The consequence may be a rise in temperature. Although this is not desirable, it can be better than having the humidity drop further. Again in such conditions the humidity is the highest priority.

White wash

White wash is often used for maintaining a better climate in the greenhouse. By keeping excessive radiation out, it avoids boiling hot temperatures and thus prevents very low relative humidity (RH drops when the temperature rises, see article 2 in this series). However, white-wash reduces the incoming radiation, which reduces the rate of transpiration. Generally this effect does not completely compensate the temperature effect, so the RH in a white-washed greenhouse is generally not as low as under clear glass. However, white-wash 'permanently' reduces light also in hours when light is not in excess, which reduces growth and production. White-wash should therefore be used sparsely and mainly on hot spots, like north wall, main path, work places. A far better option, but also far more expensive, is using a retractable screen. This can be closed when it is too sunny, and opened when the light level is not too extreme.

Roof sprinklers

Sprinklers outside on the roof are meant for cooling, and not directly for increasing the humidity. The principle is that water sprinkled on the glass roof evaporates, which uses lots of energy (heat) from the surrounding. This reduces the temperature of glass and air. In a glasshouse with roof windows and roof sprinklers, the incoming air is cool and humid. The extent of the effect of roof sprinklers depends very much on the air humidity of the outside air. On days with low air humidity, the cooling effect can be many degrees, e.g. 6 °C or more.

Fogging and misting

Fogging is spraying very small droplets of water (5-10 micron), which float in the air and evaporate into water vapour. This increases the relative air humidity (and reduces the VPD) and also reduces the air temperature. The idea is that the crop should stay dry. The crop can get wet when the humidity gets really high, or the fogging is on too long, or the nozzles are too close to the crop. 'Misting' has much bigger droplets than fogging, and misting always makes the crop wet. Leave wetness reduces the photosynthesis and stimulates disease development. It is obvious that fogging is preferred and also that fogging is more effective when the humidity is lower.

Fogging installation

A fogging installation typically consist of a pressure pump, (copper) pipelines for high pressure water (e.g. 1000 PSI), and special nozzles. There are also systems that use high pressure air and low pressure water. One would install one nozzle on each 6-10 m² (or more dense in small greenhouses). The water usage is around 0.1 to 0.2 litre per minute per nozzle, but the nozzle should only be on in intervals (e.g. 30 seconds on, several minutes off). The capacity of the fogging installation should be in the order of 200-500 litres per hour for a 1000 m² greenhouse. A general problem of fogging is blocking of the nozzles. It is very important to have excellent water quality and to filter the water. The pH of the water must be neutral. The nozzles need some maintenance (cleaning) now and then.

The major drawback of fogging is its costs. High investment costs make fogging only economic for regions with regular extremely dry periods, where other methods (see above) are insufficient. Fogging helps to avoid blossom-end rot, but also for this problem other (cheaper) remedies exist. Some growers use the fogging installation for spraying chemicals, thus saving on labour costs, which makes the fogging installation more economic. Of course only chemicals that dissolve extremely well in water, or liquid chemicals, can be sprayed through the fogger.

Fogging as back-stop

Fogging seems to be the ideal method to avoid low humidity, but it has some other disadvantages too, apart from the price. A main concern is that fogging reduces the transpiration, so that the effect of fogging is counteracted by the crop itself. Fogging can make the crop 'lazy': if a crop is grown under almost continuous fogging the root system is not capable of high water uptake anymore.

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So fogging must be used wisely and selectively; actually it should be considered as a back-stop only. If other measures (like stimulating transpiration in an early stage) are not sufficient, fogging can be used during a few hot hours per day. In crops with a low leaf area, the transpiration is often insufficient to maintain a reasonable humidity level and fogging may help. Crops struggling with Pythium or other root problems can be fostered by fogging during the hot hours of the day. Ideally the fogging is controlled via the computer, and activated on the basis of time and measured conditions (e.g. air humidity, radiation, temperature, preferable also air humidity outside).