High humidity and plant diseases

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High air humidity promotes the development of fungal diseases. Fungal spores, for instance of the dreaded Botrytis, are often present in the greenhouse air. It is a matter of conditions if these spores lead to infection and to an outbreak of the disease. This article describes what measures can be taken to reduce Botrytis and some other diseases. It is based on work of plant pathologists in The Netherlands, New Zealand and other countries.

Botrytis
Botrytis, or grey (gray) mould, can affect almost all greenhouse crops, including vegetables, cut flowers, pot plants, in all above-ground plant parts: flowers, fruit, leaves, stems. The symptoms are brown spots (lesions) and dying plant parts, with numerous sporophores growing on the necrotic tissue. Once the main stem is infected the plant will decay. Sometimes symptoms only appear after harvest. A serious outbreak dramatically reduces yields and may devastate the crop.
The risk and the extent of infection depend on two things: firstly the number of spores present in the greenhouse and secondly the conditions. Generally, a small number of spores is present 'everywhere', and when the conditions are suitable some spores establish and multiply. Especially injured plants or old leaves laying on the ground are the cradle for millions of Botrytis spores. Sporophores form spores at very high relative humidity (RH), while a temperature of 15-25 °C is favourable. But lower or higher temperatures can be good as well. The spores are formed on old leaves and infected plant parts. Spores are released when this spore-bearing plant material is disturbed or when the relative humidity (RH) changes rapidly, e.g. in the morning and late afternoon. The spores are transported by air currents and may land on other plants.

The role of humidity
The spores themselves contain very little water, and need to absorb water from the environment for germination. This explains why the disease is associated with very high RH. Spores germinate well in free water, especially if the water contains nutrients (sugars). Condensation on leaves is a good condition for spore germination. A short dry period (of about 2 hours) does not harm the germinating spores, and they continue germinating when the humidity gets very high again. In longer periods of low RH (order of 60%) the spores will dry out and die.
It is not easy to say at what humidity the spores are formed, or at what humidity they germinate and infect the plants. Moreover, RH may vary substantially over a rather small distance in the greenhouse. When RH of 93% or more is measured, it is likely that RH is 100% on colder spots, and Botrytis infection is imminent. However, the humidity sensor is often at least 5% wrong and humidity differences in the greenhouse are easily 5%. Therefore it is safe to work with RH of 85% as the allowed maximum humidity level.

Stem Botrytis
Infection by Botrytis of the stems, e.g. in tomatoes, is different. The stems are infected in wounds, for instance after deleafing. Fresh wounds supply enough moisture (plant sap) to the spores to enable the start of germination. The further development of stem infection is favoured by high RH, partly because under high RH it takes more time for the wound to dry. A special aspect of stem infection is that spores can be encapsulated inside in the stem and cause symptoms later.

Controlling humidity for preventing Botrytis

In general, Botrytis infection of leaves, flowers and fruit can be reduced by climate control. The relative humidity (RH) should not be too high for a long period (hours). From the view point of Botrytis control it would be ideal to control RH at 85 % maximum. To reduce the release of spores it would help to avoid rapid changes in RH, if possible. Another important and very effective measure is to keep the canopy open, and so to enable air movement through the crop to dry the plants.

Avoiding spores to spread

Also important in the fight against Botrytis is removing old leaves on which spores can be formed and removing infected plant parts as much as possible out of the greenhouse. For tomatoes a practical recommendation by Michael Eden (HortResearch) is that infected (spore-bearing!) plant material should be removed from the crop, the day before deleafing and lowering. The reason is that work on the crop, like lowering the crop, disturbs and shakes the leaves and causes infected leaves to release millions of Botrytis spores. If this shaking happens at the same time as deleafing is done, many spores will land directly on the fresh deleafing wounds and start new infections there. So better remove the infected plant parts a day before deleafing and lowering, which will reduce the number of spores in the air and in the wounds.
Stem infection is not only depending on humidity and is sometimes very hard to control. Michael Eden and Robert Hill reported that Botrytis stem infection in tomatoes can be controlled very effectively by biologicals (see article in Commercial Grower of March 1996).

Powdery mildew thrives in low humidity

There is a wide range of plant diseases on various crops that thrive under high air humidity or wet conditions. An outbreak or further spread of these diseases can often be controlled to some extent by adequate climate control and cultural measures as described above for Botrytis. But in contrast to Botrytis and most other diseases, there are a few fungi that thrive under dry conditions. Renown is powdery mildew, caused by different fungi in different crops. We often see severe powdery mildew on cucumber plants in the middle of summer. The powdery mildew spores contain much water (70%), so they do not need water for germination. For further growth they obtain water from the leaves that they infect. Powdery mildew even establishes and grows at RH as low as 30%. Water and high RH can be used to control powdery mildew: spores that have been soaked in water for three hours are not very viable anymore, and one or two days high RH has the same effect. But as said before: powdery mildew is an exception, and most fungi can be controlled by creating dry conditions and an open canopy.