

Steering plants in generative or vegetative direction

Bert Houter & Elly Nederhoff

CropHouse Ltd, New Zealand

Elly@CropHouse.co.nz

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Plants in a greenhouse receive ample light and high temperature, and therefore they grow fast and produce heaps. The grower is mainly interested in the fruit (in the case of tomatoes, capsicums, cucumbers etc), but the plants also need the other parts: leaves for photosynthesis, and roots for uptake of water and nutrients. Sometimes plants produce too much or not enough leaf mass; in other words, plants can be too vegetative or too generative. This is often due to environmental conditions. It is possible to keep plants in balance or to steer them back in the required direction, either to the vegetative or generative side. The tools to do this are light, temperature, humidity, CO₂, irrigation, nutrition and plant management. In essence, plants become vegetative in favourable mild growing conditions, and become generative in harsh growing conditions. This article explains how greenhouse climate control can be used to steer plants. First we briefly summarise the characteristics of vegetative and generative plants, as discussed in part 3 of this series.

Vegetative and generative plants

Vegetative plants have a strong head and not a lot of fruit growing on them. Vegetative tomato plants have (at the top!) a thick stem that is sometimes oval rather than round. They grow fast and so the head is quite far above the highest truss. The truss stem in vegetative tomatoes stands rather upright, close to the plant stem. Capsicum plants that are very vegetative have a strong head, and show strong length growth, and carry few growing fruit. Generative plants are harder to recognise, especially in capsicum. Generative plants show limited growth of the green parts and have a thin head. In generative tomatoes the truss stem is fairly small and bended. Generative capsicum plants have a relatively small and "open" head, and the plants show little or no length growth. They may carry a lot of fruit, but high fruit load is not the main characteristic of generativity. The main criterion of plant balance is always the condition of the plant head.

How to diagnose

Determining if plants are vegetative or generative is not easy, because it differs between varieties, season, etc. We are talking about relatively small differences in growing factors and fairly subtle effects. Although they are small changes they may have great impact on the outcome in the long term.

Determining the plant balance requires accurate observation of the plants. An excellent method is using so-called crop registration or crop recording. The observations and records will show differences with previous week, trends over some weeks, and deviations from the ideal situation. Plant measurements and recording may tell you that the heads gradually get thinner, which means the plants get generative. If the change is slow and steady, you wouldn't notice it without crop recording.

The sooner you detect such trends, the earlier you can take corrective measures. Also, over time you will learn that certain weather conditions have a generative or vegetative effect. If such conditions occur you can take preventative action to counteract the weather effects. Crop recording will help you "read" the plants, and be pro-active and in control.

Many influences

The way plants grow is influenced by many factors, including genetics (variety), grafting, plant density, plant stage, season, weather, environmental conditions, growing system, growing medium, root-zone conditions, irrigation regime and plant management.

Controlling plant growth - part 5

It starts with the genes: one variety tends to be vegetative, whereas another is more generative. Grafting on a strong root-stock makes plants vegetative. Plant stage is a factor, too, as very young plants produce stems and leaves (vegetative growth), and should only start reproducing (generative development) later. Note that the vegetative growth can be fast (as in young tomatoes) or slower (as in capsicums).

The type of greenhouse has an effect. Double-skin plastic greenhouses have slightly mellower light and higher humidity than glasshouses. The milder climate in plastic houses makes plants slightly softer and lusher, and thus more vegetative.

Also the growing system, growing medium and irrigation regime have a strong effect. Ample water availability stimulates vegetative growth, whereas a drier way of growing has a generative effect. Also, environmental conditions caused by season, weather and greenhouse climate control are very important for plant balance.

Need for control

If many factors work in one direction, the grower will need to steer the plants into opposite direction. For instance if a vegetative variety or a grafted plant is grown in a twin-skin plastic house on a wet growing medium, and if it is mild spring weather with nice high humidity, the plants will have an enormous growing power. So they are very vegetative. In order to get production the plants have to be forced into flowering and fruit set, i.e. in generative direction. Another example is the summer situation, when everything is governed by high radiation. High radiation increases plant temperature and transpiration, and causes plant stress. In addition, the air humidity can be very low in summer in some areas. This all hampers lush growth and thus works generatively, so this requires steering in vegetative direction.

Note that plants are influenced by the conditions that are given (growing system, weather) and by conditions controlled by the grower (temperature, humidity). Below we discuss them and try to put them in one overview (see Table). Other means of control will be discussed later.

Temperature control

A lower (milder) day-time temperature makes plants grow more vegetatively, while a higher day-time temperature has a generative effect. A special steering tool is the pre-night temperature at the end of the afternoon, around sunset. Growers can set a pre-night temperature drop to stimulate transport of assimilates towards the fruit. This clearly has a generative effect. However, whenever choosing a temperature regime, be aware of the 24 hour temperature. High day temperature combined with high 24 hour temperature wears the plants out and makes them very thin. Also note that not a lot can be done about temperature in hot summer weather.

Humidity control

Air humidity effects are strong: a high humidity stimulates lush soft vegetative growth, while low humidity is hard on plants and makes them generative. Obviously a high humidity increases the risks of diseases, so disease prevention gets priority in the control. In summer, there are periods with low humidity when the needs of the plants should come first. Plants tend to get too generative due to hot and dry weather. Options for temperature control are limited on hot days, but what can be done is reducing the venting on the wind-side in late afternoon to increase the air humidity. It can make a difference and it does stimulate vegetative growth.

Other environmental factors

Above it was mentioned that double-skin plastic houses have a vegetative effect on plants, in comparison to glasshouses. Similarly, a screen has a vegetative effect on plants. Screening increases the humidity, reduces the pipe temperature and makes that the heads don't get very cold. Growers in cold climates use transparent screens during day time to create milder conditions and hence stimulate vegetative growth in young capsicum plants.

Controlling plant growth - part 5

Elevated CO₂ concentration makes plants more generative. This is partly because higher CO₂ increases the photosynthesis and thus provides more assimilates (sugars). This results in better setting and less fruit abortion (especially in capsicum and cucumber), hence more fruit on the plant. This has a generative effect.

Root temperature influences plants, in that cold roots hamper water uptake and therefore have a generative effect, while warm roots stimulate vegetative growth.

Irrigation and plant management

Sometimes climate control cannot do enough, and the grower has to use other means such as plant management actions and irrigation regime, which can be very effective.

Plant management can alter the ratio of leaves and flowers/fruit and thus tip the balance from vegetative to generative, or vice versa. Possible measures include plant density, extra lateral (extra stem), removing older leaves or very young leaves, truss pruning, fruit thinning, or early picking.

Irrigation regime includes start and stop times, volume and frequency of irrigation, EC (or CF). They influence the average wetness of the growing medium, and hence the plant balance. A wetter medium has a vegetative effect. Reducing the EC is very effective and often used; this makes water uptake easier and hence makes plants more vegetative.

Irrigation regime and plant management for plant control will be discussed in following issues.

Factors and control actions that steer plants in vegetative or generative direction. In short:
favourable mild growing conditions make plants lush (vegetative); harsh conditions make plants hard (generative).

Plant balance	Plants are too vegetative (head strong and leafy, top of plant heavy, growing fast, not enough flowers)	Plants are too generative (head small, top of plant meagre, growing very slow, many new flowers, possibly many fruit)
Possible causes		
Genetics	Vegetative variety	Generative variety
Grafting	Grafted on strong root-stock	Not grafted on strong root-stock
Plant stage	Young	Mature
Season	Autumn, winter, spring	Summer
Growing system & medium and irrigation *	Ample water availability, or wet growing media (e.g. NFT)	Poor water availability, e.g. dry growing media
Plant management *	*	*
Growing conditions	Favourable, mild	Harsh, excessive (e.g. radiation)
Greenhouse	Lower/softer radiation, higher humidity (e.g. double skin plastic)	Higher/sharper radiation, slightly lower humidity (e.g. glass)
Energy screen, shade screen	Increasing humidity, and lower radiation under shade screen	No screen used
Stress	Little or no stress	Stress from heat or dryness

Possible control	To steer in generative direction	To steer in vegetative direction
Radiation	Allow higher radiation	Shade to avoid excessive radiation
Temperature	Give higher day temperature (be aware of 24 h temperature)	Reduce day temperature (if needed increase night temperature)
Pipe temperature	Give higher pipe temperature (combined with venting if needed)	Lower the pipe temperature
Air humidity	Give lower (harsher) air humidity	Give higher (milder) air humidity (by screening, adjusted venting, fogging, misting, roof sprinklers)
CO₂	Increase the CO ₂ level	Lower the CO ₂ level
EC or CF *	Give higher EC (or CF)	Give lower EC (or CF)
Water in root-zone or growing medium *	Drier root-zone	Wetter root-zone

* To be dealt with in next article.