



Berries

5 Steps to improving quality, productivity and profitability...

and the 1 critical step that allows owners of automatic retractable roof greenhouses and cooling houses to seriously outperform conventional tunnels.

Which of these problems are currently limiting your profitability and customer satisfaction?

- Transplanting is delayed due to excessive heat or cold.
- Plants develop stems with longer internodes and more leaves which reduces fruit production and causes a reduction in plant density.
- Pollination may be inconsistent since the plastic cover traps heat and humidity and can reduce the effectiveness of bees.
- Fruit can be soft and has a lower brix, especially when outside conditions are too hot or humid.
- Fruit can ripen too fast making it impossible to harvest before the fruit becomes too soft.
- #1 quality fruit is less than 95% of total harvest.
- Difficult to achieve high yields when growing organically.
- Difficult to reach higher price windows due to excessive cold or heat.
- High pressure of botrytis and powdery causing frequent fungicide applications.
- High insect pressure of spotted wing drosophila, whitefly and thrip causing frequent insecticide applications.
- High harvest costs during periods of excessive heat since workers may move slower or have to stop work midday.
- Weather extremes cause huge increases or decreases in the harvest causing a negative impact on your customer.

There is 1 cause to most of these problems.
We know the cause and have the solution!
“Optimize the growing environment.”



5 Steps to improving quality, productivity and profitability...

Step 1: Harvest Timing:

Determine whether you want to achieve your peak harvest before or after the industry peak production period. This will impact on whether it is more important to be able to warm up or cool down plants during periods of extreme temperatures.

Step 2: Genetics:

Select the best genetics.

Step 3: Climate Optimization:

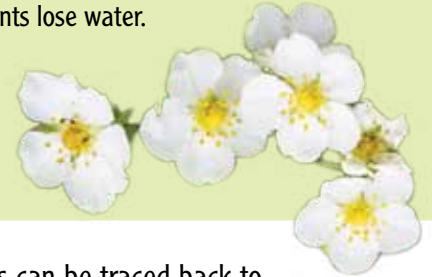
Optimize light levels, increase or reduce plant temperatures and the transpiration rate (the rate at which the plants lose water) to maximize fruit quantity, size, firmness and brix while simultaneously minimizing foliar disease and insect pressure.

Step 4: Plant Density and Growing Media:

Grow plants that are more compact with shorter internodes so that you can increase plant density. The ability to optimize the growing environment can also influence whether you choose to grow in the soil or use hydroponics.

Step 5: Irrigation:

Irrigation frequency must be based on soil media wetness, not based on a time interval since the roof position will dramatically change the rate that plants lose water.



The cause of most problems that growers face when growing in tunnels can be traced back to

Step 3, Climate Optimization.

Growers in tunnels are unable to optimize the growing environment hour by hour to be able to actively influence plant balance and fruit quality while minimizing foliar disease and reduce insect reproduction.

Climate optimization is easily accomplished when growing in automatic retractable roof greenhouses and cooling houses.



Retracting the roofs exposes crops to higher light levels and increased heat from the direct sunlight causing leaf and fruit temperatures to increase. The warmer leaves combined with wind and lower humidity levels dry the leaves and cause higher transpiration rates resulting - balanced plants with large fruit and smaller leaves.



Closing the roof protects crops from rain, hail, excessive heat and cold. However, the increase in air temperature and humidity will cause condensation on the colder leaves and fruit resulting in both low transpiration rates and a higher incidence of foliar disease.

The 9 principles for growers to achieve the best possible results when growing in an automatic retractable roof house while simultaneously protecting crops from damage due to frost, rain, hail, wind and excessive heat.

1. Focus on managing the plant development instead of focusing on the climate by asking yourself: Are you happy with how the plant is developing? If not, what do you want to change?

2. Managing plant temperature is more important than managing air temperature. The plant temperature in the direct sunlight is different than air temperature. Increasing the plant temperature will help increase the rate that the plants lose water and closing the roof will block the direct sunlight causing the plant temperature to go down which will then in turn reduce the transpiration rate.

3. Managing the transpiration rate (the rate that plants lose water) **is more important to the plant than managing humidity levels.** You could have optimal humidity levels but still have insufficient transpiration resulting in excessive vegetative growth. Plant balance is very much

controlled by the amount of water it is losing. If you have excessive vegetative growth then you need to make the plants lose more water, whereas if you have excessive generative growth, you need to change the environment to make the plant lose less water.

4. Irrigation must be based on the moisture content around the roots, not on irrigating based on a certain frequency. The amount of water that plants lose changes based on whether the plant is exposed to outdoor conditions or a protected environment.

5. The fruit quantity, size, firmness and brix is increased more effectively by making the plant lose more water rather than reducing irrigation.

6. Foliar pressure can be easily reduced by retracting the roof when outdoor conditions are optimal since the plants will now be exposed to direct

sunlight, lower humidity levels and wind which will rapidly dry off the leaves and fruit and help cause the plants to develop thicker wax cuticles on the leaves.

7. Reduce insect pressure by keeping the sidewalls closed when insect pressure outside is high to reduce the rate of entry into the house and by growing plants that develop a thick layer of wax on the leaves since the wax reduces the attractiveness of the plant to insects.

8. Program the climate computer to automatically close the roof or walls when outside temperatures are too cold, too hot, when it is raining, when it is too windy or when rain is forecast.

9. The timing of flowering for varieties that go dormant in the winter is influenced mostly by plants warming up whereas varieties that naturally flower in the summer are more influenced by changes in day length.

1. Focus on managing the plant development instead of focusing on the climate by asking yourself: Are you happy with how the plant is developing? If not, what do you want to change?

Plants grown in a retractable roof tend to produce more fruit that matures earlier than in a tunnel.



Picture taken April 24 in the UK.



Picture taken June 24 in the UK.

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3. Managing the transpiration rate (or the rate that plants lose water) is more important to the plant than managing humidity levels. You could have optimal humidity levels but still have insufficient transpiration resulting in excessive vegetative growth. Plant balance is very much controlled by the amount of water it is losing. If you have excessive vegetative growth then you need to make the plants lose more water whereas if you have excessive generative growth, you need to change the environment to make the plant lose less water.

Retractable roof
Conventional fertilizer

Plant developed more stems and less leaves at the base of the plant. Conventional fertilizer helped plant grow larger than the plant with organic fertilizer.

Retractable roof
Organic fertilizer

Plant was better balanced with more upright stems than the plant that was grown in the tunnel with organic fertilizer.

Conventional tunnel
Organic fertilizer

Plant developed more leaves and many smaller stems especially at the base of the plant. Plant is developing more vegetation in response to the low transpiration rate in the tunnel.



37 stems

17 stems

9 stems



RETRACTABLE ROOF



TUNNEL

Increased stem development was also observed in raspberry production.

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6. Foliar disease can be easily reduced by retracting the roof when outdoor conditions are optimal since the plants will now be exposed to direct sunlight, lower humidity levels and wind which will rapidly dry off the leaves and fruit and help cause the plants to develop thicker wax cuticles on the leaves.



Pictures taken September 11 in the UK on the same farm. Conventional tunnel on the right and a retractable roof on the left.

7. Reduce insect pressure by keeping the sidewalls closed when insect pressure outside is high to reduce the rate of entry into the house and by growing plants that have developed a thick layer of wax on the leaves since the wax reduces the attractiveness of the plant to insects.



Open walls on tunnels facilitates high insect pressure since the open walls provide easy entry for spotted wing drosophila, whitefly and thrip. The lush growth that occurs in tunnels with combined with a sheltered humid environment and high supply of soft fruit provides excellent conditions for rapid reproduction which then necessitates frequent insecticide applications.



Managing the climate through the roof allows the walls to be left closed which helps reduce the entry of insects. Pest populations tend to be lower in a retractable roof house since the climate is less hospitable to insects and leaves have a thick layer of wax and fruit tends to be firmer. Roof can be used to slow down ripening to ensure that fruit is picked before it becomes overripe.

Other benefits of growing crops in an automated retractable roof house:



- **Easier to transplant early or late** since the excessive heat or cold can be better managed.
- **Easier to produce organically** since it is easier to manage foliar disease and insects and the ability to increase transpiration rates makes it easier for the plants to absorb and distribute the organic fertilizer.
- **Plant density can be increased** compared to a tunnel since plants develop a more compact structure.
- **Easier to ensure proper pollination** since humidity can be better managed to ensure pollen stays viable and climate can be better regulated to ensure high activity of bumble or honey bees.
- **Easier to prevent tip burn** due to a lack of calcium since it is easier to regulate the transpiration rate.
- **Meet your customer requirements by speeding up or slowing down fruit ripening.**
- **Easier to attract labor** when harvest occurs before or after the peak season and when the working environment is ideal (not too hot, too cold, too wet or too windy).
- **Harvest costs can be reduced** by preventing the need to stop the harvest during excessively hot conditions.
- **Packing lines can work more efficiently** if additional harvest occurs away from the peak production period.
- **Labor never has to be redeployed from plant management or harvest to move plastic covers.**
- **Increased production per plant and per hectare can reduce the number of hectares of land needed.**



Strawberry / Blueberry - young plant production



Multiple layer strawberry production.



Retractable roofs can also be used to improve production of crops grown in the soil.



Propagation of young blueberry plants.



Motorized spray systems can be incorporated into the structure which can reduce labor cost.

Contact Cravo if you want to see for yourself how easy it is to manage hectares of berry production more profitably using the Cravo retractable roof production system.



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