



A retractable-roof greenhouse offers all the physiological benefits of growing crops outdoors under natural conditions, with few of the risks, since you can protect your crop from inclement weather.

RETRACTABLE- ROOF Do They Grow Better Plants? GREENHOUSES

by Edward Bent

Cravo Equipment's first Italian house, the Modello Piccirilli, offers a good excuse to look at the physiological effects on plants grown in retractable-roof greenhouses.

Retractable and open-roof greenhouse technology is increasingly impacting on the way growers cultivate plants. Commercialized within the last 15 years, today there are numerous greenhouses with various methods of opening and closing the roof.

Retractable styles include the roll-up (such as from Rovero) and the curtain type (such as Cravo); while the open-roof types (which most often have polycarbonate or glass glazing) include peak-hinged (DeForche) and gutter-hinged styles (Van Wingerden).

Cravo's "Modello Piccirilli"

While the open-roof types are generally considered as solid as regular greenhouses

(because of their rigid coverings), growers may have been concerned about potential problems associated with retractable roof greenhouses. Perhaps the most frequent criticism is that these structures are not capable of resisting strong winds, especially if the roof is half-open; the wind enters under the roof covering and can blow it out.

After various technical discussions with Cravo Equipment, the Canadian company that manufactures a range of retractable roof structures including the "Modello Piccirilli" (first Cravo structure erected in Italy), the fears that growers might have concerning roof "blowout" can be laid to rest. To date, these Cravo structures have resisted hurricane-force winds in the US when conventional greenhouses suffered

severe damage. A spokesman for Cravo states that no roof on their retractable structures has ever been lost. (Readers might like to consult testimonials in the file "Hurricane Brochure" at Cravo's Web site, www.cravo.com).

The main reason is that the covering material is held underneath the stainless steel guide wires of the roof. The roof material is connected to these wires by hooks. Retractable roofs with an A-frame structure have now been designed by Cravo to withstand winds up to 200 kph (124 mph); their flat-roof structures can withstand up to 180 kph (112 mph). The roof material is made of woven reinforced polyethylene film that resists tearing and has a lifespan of seven to ten years. The roof material of the flat roof

structures is porous so that rain will pass through it, but it will still hold in heat.

In the case of the Modello Piccirilli, built at S. Stefano al Mare in Liguria, the roof structure is a modified A-frame with a 10% slope (about 18 degrees). The roof material is waterproof, so when closed water will run off due to the slope. It will also support a snow load.

The roof of the 4,000 m² Modello Piccirilli can be opened or closed in 2.5 minutes. The position of the roof is automatically controlled by sensors linked to a climate control computer and weather station. Sidewalls can also be opened to enable cross flow of air to reduce insect populations and help keep plants more compact. This also helps reduce temperature during hot days when the roof is closed 85% to provide shading and cooling. Sidewalls can also consist of insect screens.

Think like a plant

The logic behind the positive effects of using retractable roof structures is simple, but not so easy to explain, especially to growers who have become expert in using traditional greenhouse structures with complex high-tech systems of climate control and ventilation. It requires an open mind and willingness to go back to the drawing board, placing oneself in the position of "thinking like a plant."

Trials with retractable roof greenhouses have demonstrated that crops can be grown with a reduction of between 10% and 100% in the application rate of plant chemicals such as fungicides, insecticides and plant growth regulators. Growers of outdoor crops often find a significant reduction (up to 50%) in the length of crop production cycles.

It has been found that containerized tree and shrub liners (young plants) under retractable roof structures grow faster. Young plants potted in the spring are ready for transplanting in the autumn. The resulting liners are also taller, with a greater caliper and root mass, and have a high survival rate on transplanting to the field.

Other trials in the US have demonstrated the highly effective use of retractable roof structures in the production of aromatic herbs (either for the fresh cut market) or as potted plants. Data demonstrates that the clear polyethylene roof coverings of retractable roof greenhouses (about 25% shading) is more effective at preventing heat buildup in plant containers

when compared to no roof or 50% black shadecloth.

Retractable structures are suited to most cut and potted ornamental crops and many high value (or slightly delicate) vegetable and fruit crops.

Physiological aspects of an open roof

The simplest suggestion to growers is to arm themselves with some appropriate hand-held instruments to measure light levels, moisture and temperature at various times of the day, outside the greenhouse and inside the greenhouse, in the air above the crop at the leaf surface and at the soil or substrate surface. Armed with a few of these measurements, a number of vital questions will immediately come to mind.

The speed and quality of growth is greatly improved when plants are exposed to optimal growing conditions. These conditions create optimal levels of plant stress which influence how plants develop. Retractable roof structures expose plants to the best of both the natural outdoor growing environment and a controlled greenhouse environment while avoiding most of the negative aspects of each.

This is easily achieved if the greenhouse roof is closed when the temperature is below 17C (63F) to trap the heat and opened when the outside temperature is between 18C and 28C (65F and 83F) to allow plants to increase both speed of growth and plant quality.

Retractable roof structures permit increased air movement, reducing relative humidity. They also permit higher exposure to UV light and greater infrared radiation. These contribute to increasing "normal" plant stress and allowing plants to transpire normal amounts of water. In general, plants lose too much water outside and not enough inside a greenhouse. If a plant loses a lot of water it will take steps to ensure a more constant water supply by growing more roots. Leaves tend to be smaller and thicker. By making it easier for plants to take up and transport minerals to the growing points, important deficiencies (such as calcium) are avoided.

More oxygen is drawn down to the roots, and an increased level of water stress helps plants develop an active root system and smaller, more natural-sized leaves with thick cuticles. Such leaves are more resistant to insects and diseases and help the plant protect itself against excessive transpira-

tion. Risk of foliar diseases such as botrytis is lessened since leaf surfaces will dry off quickly.

An increase in PAR light, CO₂ availability and leaf and soil temperatures will improve plant quality through increased photosynthesis. Internodes will be shorter and more regular, and you can expect a natural balance between roots and shoots with an increased level of generative growth. This leads to an increase in the number of flowers and the yield of fruit.

The roof is closed 85% when the outside temperature is greater than 29C to provide some shade and cooling. This reduces the level of infrared radiation and as a result it prevents negative effects such as excessive leaf, flower and fruit temperatures and water stress.

Excessive temperatures lead to the bleaching of leaves or flowers and excessive transpiration. By preventing excessive transpiration the stomata will remain open, or their closing will be delayed, and photosynthesis can continue around midday. Plants will also retain their turgidity, making them less attractive to insects (it is easier for insects to attack droopy, flaccid leaves).

Also, assuming the roof is left open most of the time, retractable-roof structures (because of their outdoor-like growing environment) can be less attractive to insects than conventional greenhouses. Insects do not like being in direct sun in the daytime or being in high wind. And the plastic roof cladding of greenhouses blocks a great deal of infrared radiation, creating a more attractive environment for insects.

Also, pollination and resistance to heat is favored by retractable roof structures. In a Cravo demonstration unit in Mexico, almost 100% pollination took place in crops of cucumbers, tomatoes and peppers without the use of bees. There were no signs of heat stress despite air temperatures in excess of 35C (95F).

Retractable roofs are not for every grower in every climate. But they have gained favor with many growers, producing many crops. And they have proven to be for more than just frost protection.

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