Effect of a Nanocomposite Covering Film On Greenhouse Heating and Cooling Needs

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INTRODUCTION

Heating losses due to both, conduction/convection through- and radiation from the covers of greenhouse represent the main cause of the high energy consumption in greenhouses.

The existing solutions of common plastics for greenhouse covers are mainly based on Low Density Polyethylene (LDPE) and Ethylene-Vinyl Acetate (EVA)

These covers, commonly face the critical problem of limited or unregulated optical performance

In addition to poor insulation in hot/freezing climates, both of which cause a low energy efficiency within the strictly controlled greenhouse environment

AIM

For all of the above reasons, prototype nanocomposite films were developed through the dispersion of unary and heterogeneous granules in LDPE, capable of regulating the PAR for a given IR thus controlling the degree of brightness or darkness according to the various greenhouse requirements and environmental conditions.

The present study focused on the evaluation of the new covering material (single layered).

This consists mainly of the experimental results analysis from the six (6) month operation period (February to July) in both experimental greenhouses that were used as the test bed of the two covering options.

MATERIAL AND METHODS

Two identical small-scale experimental greenhouses located in western Greece were used as the test bed of the two covering options considered namely glass covering material and nano-covering material

» Interior microclimatic parameters monitored in both greenhouses are:

- the temperature at several locations at the canopy, the greenhouse air
- the relative humidity and the radiation fluxes, incoming solar radiation and Photosynthetically active radiation.

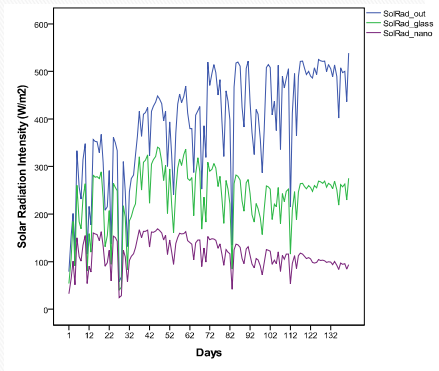
» The outdoor environmental conditions including temperature, wind speed, relative humidity, sky temperature and rain were monitored on a meteorological mast close to the greenhouses.

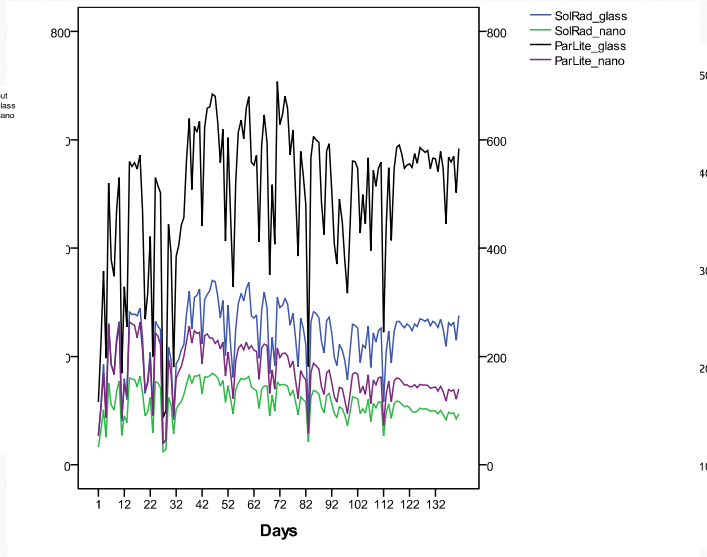
RESULTS

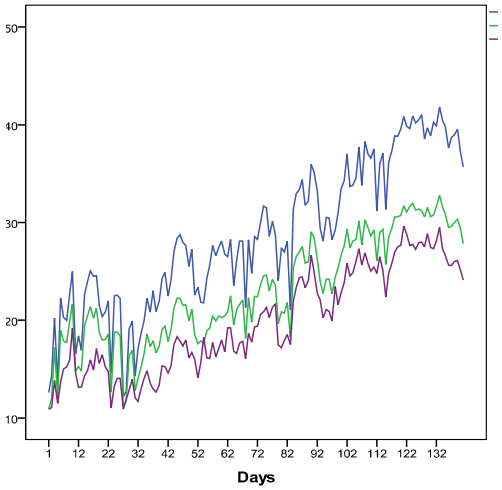
Incoming solar radiation compared to total incident radiation is reduced up to 30% on average in the glass greenhouse and up to 40% on average in the nano-covered greenhouse.

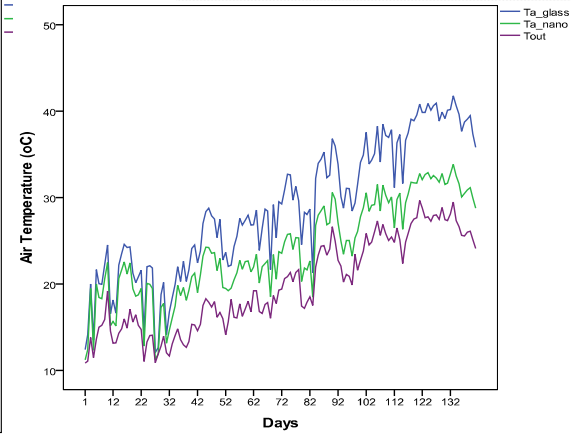
Photosynthetically Active Radiation (PAR) is reduced up to 50% in the glass-covered greenhouse and up to 35% in the nano-covered greenhouse.

Plant canopy and inside air temperatures relative to outside temperature presents a high variance value in the glass greenhouse and lower variance values in the nano-covered greenhouse, depending on environmental conditions









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CONCLUSION

The implementation of the new cover material in two small-scale experimental greenhouses proved to be successful, as it offers improved thermal and optic qualities.

The daily experimental analysis shows that the reduction of the incoming solar radiation leads to lower temperatures in the plant canopy while inside greenhouse air is maintained at significantly lower values. This leads in turn to less overheating of the greenhouse during the summer months, so that dynamic ventilation needs are reduced and therefore energy consumption is reduced.

According to the daily experimental results, the new cover material seems to have improved optic qualities including better light diffusion which make it efficient for use in greenhouses during the summer period.