Colored Shade Nets
A New Agro-Technology

Current Research in Ornamental

Summarized by Yosepha Shahak

INTRODUCTION

Plants depend on light as their ultimate source of energy. Photosynthesis converts light energy into chemical energy required for plant growth and development. It is not surprising that plants are exquisitely sensitive to both the quality and quantity of light.

Manipulation of light for agricultural and horticultural purposes has a long history. Initial efforts were directed towards controlling the quantity of light, to optimize it according to the specific requirement of each crop. However, plants also respond to the quality (spectral distribution) of the incident light. This response is mediated by a number of pigment-based photoreceptor systems that control the varying stages in plant development.

A research team headed by Prof. Yosepha SHAHAK and Dr. Michal OREN-SHAMIR of the Agricultural Research Organization (ARO) — The Volcani Center, Israel, together with Polysack Plastic Industries (Nir-Yitzhak — Sufa, Israel) have recently developed a new approach for improving the utilization of solar radiation by agricultural crops. The approach is based on plastic shade nets (= shade cloths) of special optical properties.

A series of colored shade nets were developed, each one specifically modifies (i) the spectrum of the filtered light (in the Ultra-Violet, the visible or the Far-Red spectral regions), (ii) and/or enhances its relative content of scattered-diffused light, (iii) and/or affects its thermal components (the Infra-Red region). Depending on the chromatic additives to the plastic, and on the knitting design, the nets provide varying mixtures of natural, unmodified light, together with spectrally modified diffused light.

The term Colored Shade Nets is used here in its broad sense, to include nets which look colored to the human eye (e.g. Blue, Yellow, Red), as well as nets that do not look colored, yet modify the non-visible spectrum and/or enhance light scattering (e.g. Gray, Aluminet, Pearl).

The new technology promotes differential stimulation of desirable physiological responses, which are light regulated, in addition to physical protection provided by the nets. The target physiological responses are those determining the commercial value of each crop, including the yield, the quality of the product, the rate of maturation, and more. Some of these targets are currently achieved by intensive use of growth regulators and other chemicals, and by labour-requiring practices (pruning, training, thinning etc.). Additional benefits of the netting, which are not directly related to the specific chromatic properties of the nets, include protection from too much light, environmental hazards (hail, winds, extreme day/night temperatures) and/or flying pests (birds, bats, insects).

ORNAMENTALS

Green Decorative Branches

Most green-decorative branches ("greens") require shading for their commercial growth. The commonly used shade net is black. Our first question was very simple-minded: Why black? Can we produce more sophisticated shades? Can we design shading material to also promote specific physiological responses to shape up the plants the way we want them?

The major model plant was the perennial green ***Pittosporum variegatum***. The knitting design of all nets was adjusted to yield 50% shading in the PAR (photosynthetically active radiation) region. Single layer of each of the tested nets was used during the winter, while 2 layers (75% shading) during the summer. Light, microclimate and horticultural parameters were

Pittosporum experiment in Shdema.

Photographs taken in the second year after planting.

In the photos: *the research assistant Ada Nissim-Levi under*

the commercial black (top), Red (center) and Blue net (bottom)

monitored during 3 years in an experimental site located in a commercial farm in Shdema, central Israel.

The main results obtained for *Pittosporum variegatum*:

- Pronounced stimulation of the vegetative growth by the Red net;
- Dwarfing by the Blue net;
- Enhanced branching by the Gray net, yielding "bushy" plants with short branches;
- The reflective, thermal net (Aluminet®) enhanced long branching; (v) leaf size was the smallest under the Grey net, and largest under the Red and Green;
- Variegation was the least under the Grey while best under the Blue net.
- The yield of branches of commercial length (relative to the commercial Black net) was 167% (1st year) and 140% (2nd year) in the Grey net, 144% (1st) and 120% (2nd) in the Red net 150% (1st) and 113% (2nd) in the Aluminet®.
- Practical applications: The commercial value of the branches depends on both their length and appearance. Since the appearance of the branches from the Grey net was less desirable in the market (smaller leaves and less variegation), and since the Aluminet® is more expensive than all other nets of Polysack, the growers chose the Red, and started already to use it.

The results were recently published in the Journal of Horticultural Science and Biotechnology [1]. An interview with Y. Shahak and M. Oren-Shamir was published in FlowerTECH [2].

Leather-leaf fern and ***Ruscus hypoglossum:*** In both crops there was 10-15% higher yield under the Grey and Aluminet®, while larger (longer and wider) branches under the Red. Both responses have economical advantages, depending on local market preferences.

Aralia and **Philadendron-Monstera:** This experiment is carried out with another commercial grower in Ometz. In this case all nets are of 60% shading factor. The Red and Yellow nets caused huge plants, while the Blue caused dwarfing (see photos on page 3).

The stimulating effect of the Yellow is mostly expressed in longer and wider stems. The unique quality of the Yellow net branches was recognized

Monstera under blue net

Monstera under red net

Monstera trial in Ometz. Net application: May 1, 2000. Photo: October 29, 2000.
In the photos: Prof. Yosepha Shahak with extention speciallist Tamar Lahav.

Aralia under blue net

Aralia under yellow net

Aralia trial in Ometz. Colored nets (60% shading) were applied on May 1, 2000. Photographed: October 29, 2000.
In the photos: Prof. Yosepha Shahak with extention speciallist Tamar Lahav.

Lupines in the Bsor experiment shortly before flowering. Sowing: mid October, 1999. Photo: January 24, 2000.
The stimulated growth under the Yellow, and dwarfing under the Blue net are demonstarted. Both nets were of 50% shading.
In the photos: Dr. Michal Oren-Shamir, and Prof. Yosepha Shahak (in the background).

in the European Bourse, gaining better prices. In Monstera the leaves under the commercial net are too large for export, so the grower is much more happy with the Blue net. Yet, there are local market niches that prefer the large products of the Red net. Based on these results, the growers can now cover sections of the field by few different colored nets, to produce few different phenotypes of the same crop.

Cut flowers

Experiments were carried at the B'sor experimental station, southern Israel, in high tunnels, each covered by a different colored shade net. ***Lupinus luteus*** seeds were sown in October, 1999 and harvested during January-February 2000.

An experiment with ***Lisianthus*** plants was carried under similar conditions during July - September 1999. All shading nets were designed to give 50% shade in the PAR (400-700nm) region, except for an anti-hale net of only 12% shade.

Influence on vegetative growth

An important parameter determining the commercial value of cut flowers is the length and weight of the flowering stems.

- In the ***Lisianthus*** experiment,length of flowering stems were found to be 10cm longer under the Red and the Yellow net , compared with the black (reference) net.
- Plants grown under the Yellow net were also exceptional in their heavier flowering stems.
- Under the Gray net, *Lisianthus* yielded the highest number of flowering stems per plant, compared with any other net.
- In **Lupines** the vegetative responses were similar to the *Lisianthus* (see photos on page 3)

Influence on flowering

- The flowering dates of the *Lupinus luteus* were differentially affected by the colored nets.
- The effect on the flowering date was not related to the effect on the vegetative growth. Thus, while both Red and Yellow stimulated elongation to a similar extent, the Yellow induced a two weeks delay in flowering. The flowering date under the dwarfing (Blue) net was similar to the Yellow. Both stimulation and delay of flowering have commercial advantages.

LITERATURE ON COLORNETS

Articles

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3. Shamir, M., Shahak, Y., Spiegel, E., Gussakovsky, E., Giller, Yu., Ratner, K., Nissim-Levi, A., Ovadia, R., Bachar, A., Gal, Z. and Pardo, L. (2001) Improvement of the yield and quality of green decorative branches by colored shade nets.
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Relevant web-sites

http://www.agri.gov.il/Horticulture/Citriculture/YosephaShahak.html

http://www.agri.gov.il/Horticulture/Ornamental/MichalOrenShamir.html

http://www.polysack.com