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Photoselective Shade Netting in Vegetable Crops

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SUMMARY

The photoselective netting is a developing system in vegetable crops, which introduces additional benefits, on top of the various protective functions of nettings. These nets are unique in that they both spectrally-modify, as well as scatter the transmitted light. The spectral manipulation is aimed at specifically promoting photomorphogenetic-physiological responses, while light scattering improves light penetration into the inner canopy.

INTRODUCTION

Vegetable production is suffered due to increasing air temperature and solar radiation. Photoselective nets spectrally-modify and scatter the transmitted light. Based on chromatic additives, light dispersive and reflective elements into the netting materials. Protects from excessive solar radiation and ecological hazards. Improves quality, increases fruiting span and productivity. Manipulation of light for vegetable crops has a long history. Initial efforts were directed towards controlling the quantity of light, to optimize it according to the specific requirement of each vegetable crop. Efforts to manipulate plant morphology and physiology using photoselective filters have been ongoing for decades, especially in greenhouse environments (Ilias and Rajapakse. 2005). Additional potential benefits relate to photoselective effects on plant pests, beneficial insects, or diseases. Studies of vegetable crops, traditionally grown in shade-net houses, revealed distinct responses to the various coloured nets, compared with common black nets of the same shading factor. (Shahak *et al*. 2008). Photo-selective netting technology affect quality of the produce as well as biotic and abiotic factors that severely affect the quality of vegetables at harvest and after storage. Overall, photo-selective shade seems to be a cost-effective approach for manipulating crop microclimate properties that regulate not only yield, but also the retail/eating quality as well as functional or bioactive properties that are associated with human health (Folta and Maruhnich. 2007).

Challenges in Vegetable Production

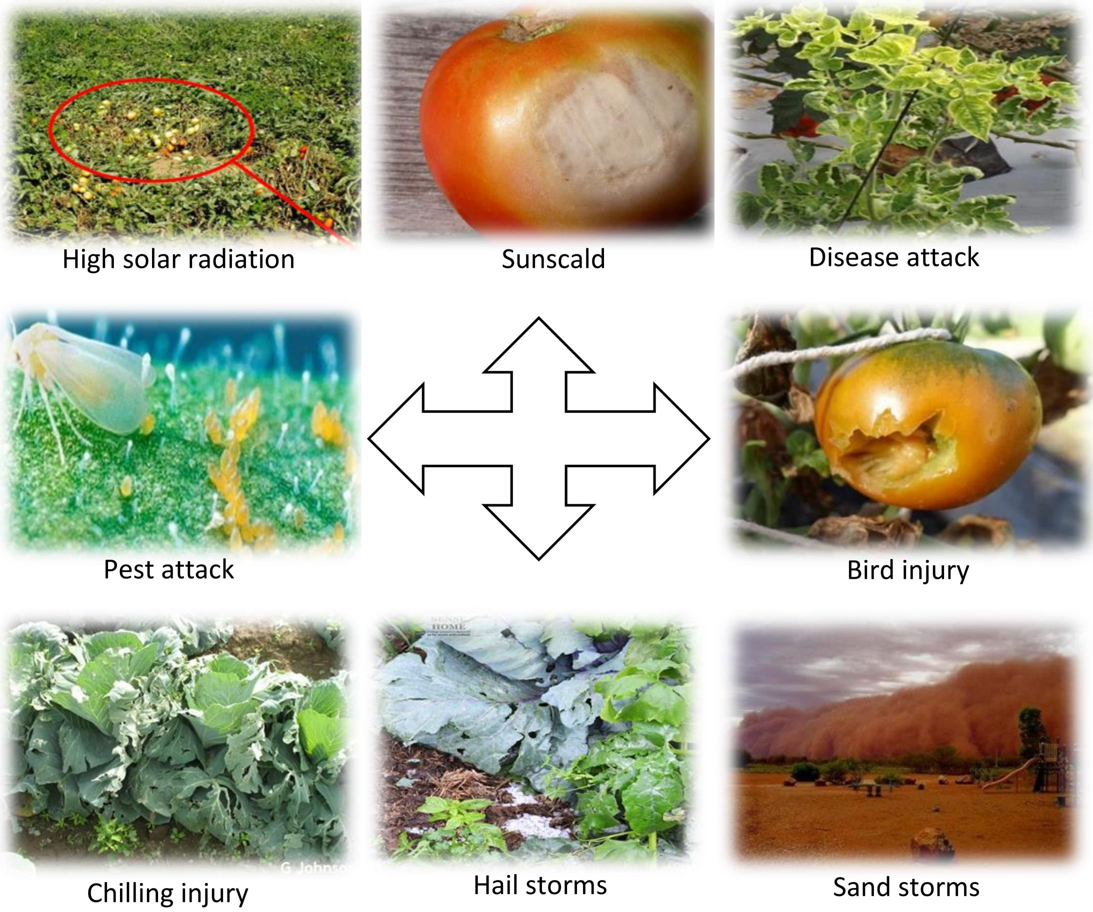
Attaining food security has been a major challenge for the nation since independence. The demand for food and processed commodities is increasing due to growing population and rising per capita income. There are projections that demand for food grains would increase from 192 MT in 2000 to 345 MT in 2030 (Anonymous, 2011). Vegetables play an important role in human nutrition. During recent years, the interest in vegetable production has increased rapidly as a result of great appreciation of food value of vegetables and the place of vegetables in the nation’s food requirements. To achieve the desirable changes, there is a need to implement various technological options effectively. Also changing climate and global warming affects the vegetable production.

Effects of Various Climatic Factors on Vegetable Production

There are various climatic factors which are affecting the vegetable production like solar radiation, temperature, relative humidity, rainfall, wind, pest and diseases. Increase in air temperature (AT) and intensity of solar radiation, sustained high temperatures (35-40 °C) as a result of high solar radiation can also increase the incidence of vegetables biotic and abiotic disorders as the climate changes, which affect overall vegetable production.

What can we do….?

Hi-tech agriculture can provide a solution to overcome this situation by cultivating vegetable crops under controlled atmosphere or protected cultivation. The climatic requirements of crop viz., temperature, humidity, light, CO_2 concentration, radiation should be in permissible range of the crop to obtain higher yield.



(Effects of various climatic factors on overall vegetable production)

Photoselective Shade Nets

The photoselective netting is an emerging approach, which introduces additional benefits, on top of the various protective functions of nettings. The photoselective nets include "coloured-ColourNets" (e.g. Red, Yellow, Green, Blue net products) as well as "neutral- ColourNets" (e.g. Pearl, White and Grey) absorbing spectral bands shorter, or longer than the visible range. Some of the photoselective shade nets contain pigments known to attract whiteflies and thrips (i.e. yellow and blue). Therefore, crops grown under those nets could potentially be at a higher or lower risk for pest infestation.

Characteristics of Various Photoselective Shade Nets

White:
Reflect larger part of infra-red light (~43%), Absorb less heat so major part of infra-red light pass through the shade net (~55%)

Black:
Poor reflectivity (~4%), retains great amount of heat in structure (~73%), Less amount of heat passes through the net (~23%),

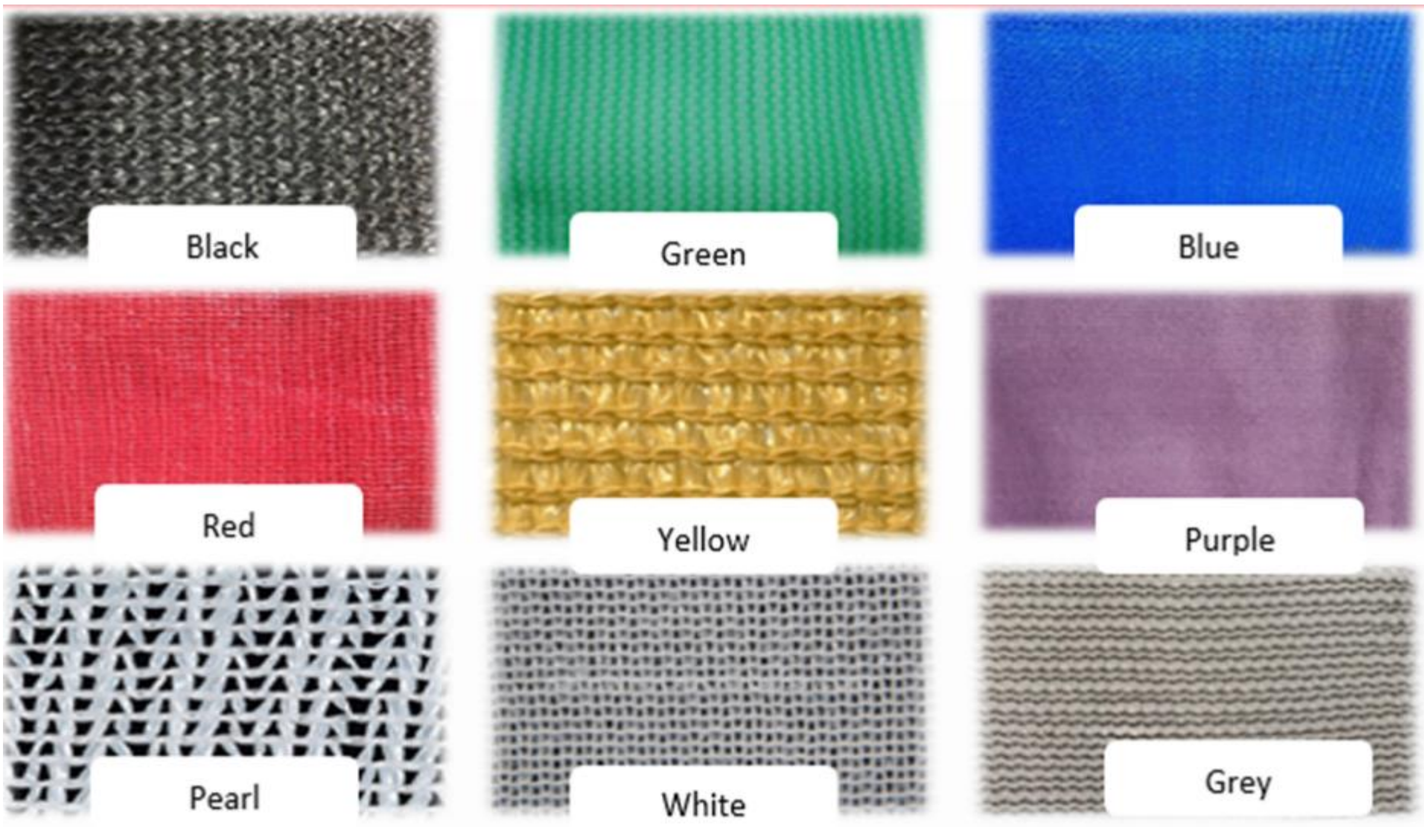
Green:
The transmittance curve of the sun radiation passing through the net has a pick in the green range of the spectrum (λ=500- 550nm)

Yellow: Transmitting light from 500 nm and above.

Red: Transmitting from 590 nm and above. blue: red ratio (B: R) is reduced

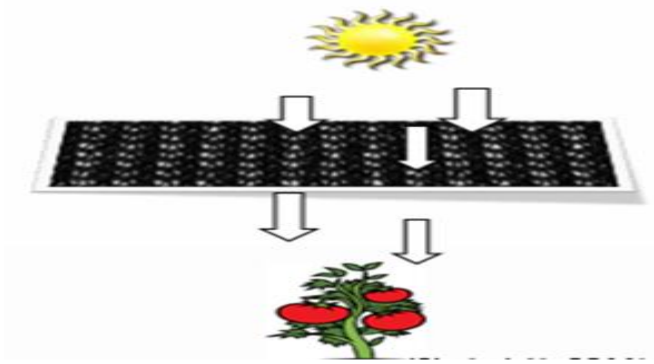
Grey: Stimulate branching and produce bushy plants with short branches and small leaves.

Blue: A wide peak of transmittance in the blue - green region (400-540 nm), cause dwarfism. Blue: red ratio (B: R) is enhanced.



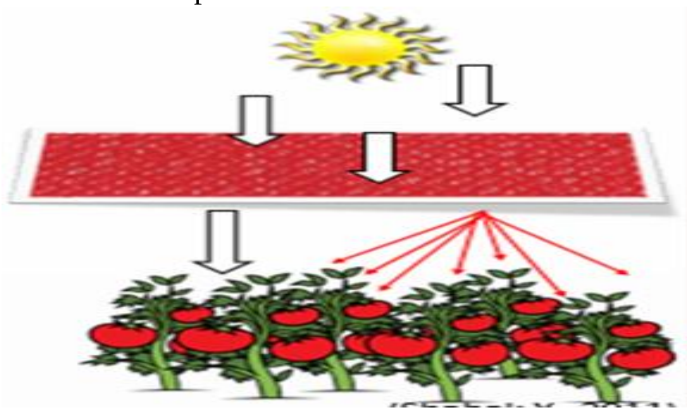
Light transmittance through black shade nets

- Light beams reaching black threads get fully blocked
- While light beams passing through holes remain unchanged
- Resulting light has the same composition as the natural light with only reduced quantity



Light transmittance through photo-selective shade nets

- Light beams pass through the coloured threads become both spectrally modified and scattered
- Plants are exposed to a mixture of modified and unmodified light
- The mixture can be adjusted during manufacturing to fit the crop



Microclimate Effect

Radiation:

Nettings, regardless of colour, reduce radiation reaching crops underneath. Obviously, the higher the shade factor, the more radiation will be blocked. Reductions in radiation resulting from netting will affect temperatures (air, plant, soil) and relative humidities (Stamps, 1994). Besides affecting the amount of radiation, nettings can influence the radiation direction.

Radiation scattering:

Diffuse light has been shown to increase radiation use efficiency, yields (both at the plant and ecosystem level), and even be a factor affecting plant flowering (timing and amounts) (Guenter *et al.*, 2008; Ortiz *et al.*, 2006). Any shade netting can scatter radiation, especially ultraviolet because netting is usually made using ultraviolet-resistant plastic. Coloured shade nets can also increase light scattering by 50% or more and this alone may influence plant development and growth.

Photoselectivity:

Coloured shade nets are being intensively tested primarily because of their ability to manipulate the spectra of radiation reaching the crops below. They can be used to change red to far-red light ratios that are detected by phytochromes, the amounts of radiation available to activate the blue/ultraviolet-A photoreceptor, blue light involved in phototropic responses mediated by phototropins and radiation at other wavelengths that can influence plant growth and development.

Air Movement:

Nettings also reduce wind speeds and wind run (Stamps, 1994), which can affect temperatures, relative humidity and gas concentrations resulting from reductions in air mixing These changes can affect transpiration, photosynthesis, respiration, and other processes.

Temperature:

Shade nets are often deployed over crops to reduce heat however, in enclosed net houses, temperatures during the day are typically higher than outside and may be lower at night, at least during radiation freezes.

Relative Humidity:

Relative humidity is being often higher under netting than outside as a result of water vapour being transpired by the crop and reduced mixing with drier air outside the netted area.

CONCLUSION

Colour shade nets have great potential in adverse weather condition. Radiation and water use efficiency was also found higher under colour shade nets as compared to the corresponding value under control. Colour shade nets provide a new, multi-benefit tool for crop protection. It changes the light intensity and radiation, which influence microenvironment and crop production. The different environmental modifications inside structures covered with black, colored and photoneutral translucent nets, will help to predict or specify plant responses.

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