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Effect of Coloured Shade Nets on Vegetable Production – A Review

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Abstract – The colour shade net approach aims at combining physical protection to the crop wtih modifications in spectro radiometric properties inside the net house which in turn promotes desired physiological responses. The experimental investigations indicated that under clear sunny and cloudy conditions the radiometric properties depends mostly on both net porosity and its' colour. Net reflectance strongly depends on net colour. Transmittance and absorption of electromagnetic spectrum by a particular net primarily depends on colour and secondarily on porosity. Since the nets are composed of holes, in addition to the translucent-photo-selective plastic threads, they actually create mixtures of natural, unmodified light, which is passing through the holes, together with the diffused, spectrally modified light, which is emitted by the photo-selective threads. This changes in electromagnetic spectrum helps in enhancing the crop performance under a particular colour of a net. In this paper a comprehensive review of research work carried out on influence of shade net colour on vegetable production are being presented and the recommendation of a particular colour net for a particular crop is are being presented.

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I. INTRODUCTION

Plants react to changes that occur in the spectrum of electromagnetic radiation to which they are exposed through alterations in morphology and physiological functions that result in adaptation to different environmental conditions (Kasperbauer and Hamilton, 1984). Such alterations are mediated by pigments, known as phytochromes, which have absorption peaks in the red and blue/ultraviolet regions of the spectrum (LI et al., 2000). These photoreceptors are able to detect variations in light composition and induce photo morphogenetic responses, either in vivo or in vitro (Kim et al., 2004; Macedo et al., 2004) that influence growth and development.

More recently, coloured shade netting (shade cloth) designed specifically for manipulating plant development and growth has become available. These nets can be used outdoors as well as in greenhouses. They can provide physical protection (birds, hail, insects, excessive radiation), affect environmental modification (humidity, shade, temperature) (Pe´rez et al., 2006), and increase the relative proportion of diffuse (scattered) light as well as absorb various spectral bands, thereby affecting light quality. The shading of crops results in number of changes on both local microclimate and crop activity. These changes on local microclimate modify CO_2 assimilation and consequently crop growth and development. Further, under shading nets the air temperature is lower than that of the ambient air, depending on the shading intensity and is negatively associated with the rate of shading and is variably affected by the quality of light filtered through the different colored shade nets (Elad et al., 2007). Photo-selective, light-dispersive shade nets provide a unique tool that can be further implemented within protected cultivation practices (Shahak et al., 2008). The effects of light quality on plants are well known, the response of different species to light management is variable (Kim et al., 2004), and it is clearly important to treat plants with the correct type of light filters (Mcmahon and Kelly, 1995), especially medicinal plants with economical interests.

A common light quality management is the supplementation with artificial light sources (Brown et al., 1995) through the use of coloured plastic films (Oyaert et al., 1999), spectral filters (Rajapakse et al., 1992) and reflective coloured mulches (Loughrin and Kasperbauer, 2001) to induce physiological responses in plants. Cromatinet coloured netting modifies the spectrum of the incident radiation in the visible region and enriches the relative content of scattered light such that \transmittance of light by the blue netting is in the 400-540 nm region, whilst that of the red netting is in the 590-760 nm region (Oren-Shamir et al., 2001). Although the red: far red ratio (R: FR), which is the main regulatory factor leading to a phytochrome response, is not greatly modified by the use of such nets, the blue: red ratio (B: R) is enhanced by blue netting and reduced by red netting (Shahak et. al., 2004). Nets have three major uses in agriculture: (i) shading, for protection from too much solar radiation; (ii) protection from environmental hazards such as strong winds, hail and sand storms; (iii) protection from flying pests like birds, fruit bats, etc. Black nets were commonly used so far for shading, while clear, transparent nets are used for environmental-hazard or pest-protection. In collaboration with Poly-sack Plastic Industries, Israel, developed a new group of protective nets, which can alter both the quality as well as quantity of the light intercepted by the plants growing underneath, in addition to providing the desired protection (Shahak et al., 2004).

II. INFLUENCE OF WEATHER UNDER SHADE NET

Among environmental factors, light intensity, temperature and relative humidity influence crop growth and development. Solar radiation consists of different wave-lengths of light, in which the visible portion is useful for crop growth; ultra-violet and infrared radiations are not beneficial for crop growth, as they change molecular levels which lead to cellular disorganization. Temperature is the major regulator of development processes. Higher temperatures have more adverse influence on net photosynthesis than lower temperatures leading to decreased production of photosynthesis above a certain temperature (Reddy et al., 1999). Relative humidity increases availability of net energy for crop growth and improves survival of crops under moisture stress conditions. Relative humidity reduces evaporation loss from plants which lead to optimum utilization of nutrients. It also maintains turgidity of cells which is useful in enzyme activity leading to a higher yield (Reddy et al., 1999).

Fig: 1 Shade net house

The yield of sweet pepper was higher under shade net house due to high relative humidity, which enhanced vegetative growth and improved fruit production. These results agree with findings of (Priya et al. 2002). Tomato, eggplant, capsicum, radish, amaranthus and coriander had higher yield under shade net house due to light compensation for higher photosynthesis. Similar results were reported by (Quaglitto 1976) in sweet pepper. Since, cluster bean, ladies finger and cucumber are tropical crops; the requirement for light is more than chilli. This agrees with findings of (Krishna.M et al. 1993), who suggested that under 25% shade formation of photosynthates and their partitioning and distribution for the final sink were reduced resulting in poor yield in chilli.

III. INFLUENCE OF GROWTH AND DEVELOPMENT OF VEGETABLES

The plant height, number of branches, number of leaves per plant, intermodal length, leaf area and leaf area index were influenced in shade net house due to favourable environment conditions. Studies conducted by Precision Farming Development Centre, Bangalore (Anonymous, 2014) on different colours of shade net recommended that for cultivation of Bombi (red) and Orabella (yellow) coloured capsicum varieties under white coloured shade net, 75% shade factor gave higher yields of (77 & 81 t/ha respectively) during the summer months with drip irrigation as compared to black and green colour shade nets in Bangalore region. (Ramana Rao et.al. 2013) found out that the under 50% shade factor, white coloured shade net the capsicum crop yield was increased by 80 per cent over open field cultivation along with water saving of about 40 per cent. Studies also conducted on different colours (red, white, black and green coloured monofilament nets) and shade factors (35, 50 and 75%) at this centre on tomato crop. The findings of the study includes in green colour shade net (35 % SF) highest UV radiation (0.96 mw/cm^2), light intensity (76843 lux) and air temperature (25.7°c) were observed. And in black colour shade net (75% SF) exhibited the lowest UV radiation (0.34 mw/cm^2), light intensity (29170 lux) and air temperature (22.1°c), where as in red coloured shade net (50% SF) higher yields of 9, 15 and 45% as compared to white, black and green shade nets respectively was obtained for the same shade factor. Among the different shade factors of red coloured net houses, 50% shade factor gave highest tomato yield of 72.7 t/ha, followed by 75% shade factor net (68.79 t/ha) and 35% shade factor net (65.85 t/ha). Patil and Bhagat (2014) conducted a field experiment at Instructional farm of department of Irrigation and Drainage Engineering, Mahatma Phule Krishi Vidyapitha, Rahuri to study the yield response of cucumber grown under shade net house to 35%, 50% and 75% shading and in open field condition. Irrespective of nutrient sources applied, the performance of crop grown inside the shade net was comparatively better than open field condition.

IV. FRUIT YIELD

Bell pepper yields depend on the total number of fruits and fruit size. The number of fruits produced declined with increasing shade level. Thus, increased total fruit yield under moderate shading was caused by increased fruit size. Red and pearl shade-nets significantly increased the total yield by 30% which was associated with both higher productivity per plant and larger fruits. The major response to the photo selective filtration was the production of more fruits per plant, with essentially no reduction of fruit size or quality. Increased fruit size was likely the result of reduced transpiration and improved plant water status and net photosynthesis under shaded conditions.

Shahak 2008 reported that the production of three cultivars of bell pepper increased by 16% to 32% under pearl and red compared with black netting. With roughly 50% shade, commercial production was greater than in full sunlight, although less than with 26% (Rylski, Spigelman, 1986). Shade can increase total and marketable yields of pepper grown in the open field in hot climates, but shade is far more deleterious in a cool and cloudy environment. These studies suggest that shade is more beneficial under high compared with low sunlight intensity on both a daily and a seasonal basis. Tomato plants grown in Egypt fewer than 30% to 40% shade nets over the entire season produced more fruit, thereby giving a higher yield than from plants grown without shade (Abdel Mawgoud et al., 1996).

V. CONCLUSION

The experimental investigations reviewed indicated that the colour and shade factor of shade nets has propounding affect on the vegetable crop production. However, the studies conducted at different locations across the globe concluded the application of particular colour net for a selected crop for a particular purpose. This also varied with the shade factor. It is therefore, wide spread location specific research is need to optimize the photo selective net colour and its shade factor for gaining additional benefits from a particular crop.

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