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Original Research Article

Effect of green shade nets on yield and quality of tomato (*Lycopersicon esculentum* Mill) in semi-arid region of Punjab.

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Abstract

A field trial was conducted at Central Institute of Post-harvest Engineering and Technology (CIPHET), Abohar (Punjab) during 2011-12 to determine the effect of three green shade nets (35,50 and 75%) along with three height (2, 2.5 and 3.5 metre) bamboo framed structures on yield and quality of tomato. There was no significant difference found in average monthly temperature and humidity inside shade net house and open field (control). Significant difference was recorded in yield. Highest average plant yield of (3.49 kg/plant) was found in 35 % shading net followed by open field (2.27). Lowest yield observed (1.07 kg / plant) in 75 % shading net. The tomatoes grown under shade net structures were glossy in appearance with good colour development as compared to open field (control). Further tomatoes produced in open field were attacked by the pest (*Helicoverpa armigera*) attack. No significant difference was observed in quality attributes viz. TSS, Acidity and ascorbic acid by shade net structures. However the higher TSS (6.1 ^{o}Brix), Acidity (0.69) and ascorbic acid (40.86 mg/100gm) was recorded in 35% shade net compare to control, (5.7, 0.61 and 36.42) respectively. Thus, use of 35 % shade net brought improvement in quality and yield of tomato grown in semi-arid region.

Key words: Tomato, Shade Net, Temperature, Yield, fruit quality, Bio chemical changes.

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1.0 Introduction

Agriculture in India has changed significantly in recent years. For instance, the area under rice in India has declined by 1.09 million ha during 2000-2007 (Directorate of Economics and Statistics, 2007), while the area under vegetables has increased by 1.07 million ha during 2002-2006 (National Horticultural Board, 2006). A similar trend is occurring in several Indian states, including Punjab. The area under vegetables increased to 152,100 ha in 2005-2006 from 54,612 ha in 1990-91 (National Horticultural Board, 2006; Punjab Government, 2009). Growing vegetable demand could be achieved through bringing additional area under cultivation crops, using hybrid crops, and adoption of improved agro-techniques. Tomato (*Lycopersicon esculentum* Mill.) belongs to solanaceae family is one of the most popular and nutritious vegetable crops grown all over the in India. This vegetable extensively grown in Andra Pradesh, Karnataka, Madhya Pradesh, Odisha and Gujarat. Presently, tomato grown in area of 879 thousands hectare with the production of 18226 thousands MT (National Horticultural Board, 2013). Protected cultivation of vegetables could be used to improve yield quantity and quality (Singh et al., 1999; Ganesan, 2004; Shahak et al.). Tomato can be grown in both season (winter and summer) at Punjab but, the extreme low and extreme higher temperature of semi-arid region of Punjab suffer with low fruit set and inferior fruit quality. Tomato grown under field conditions is exposed to abiotic and biotic stress which affects productivity and quality. Protected cultivation has the potential to reduce biotic and abiotic stresses. A shade net house can modify environmental conditions with reduced labour. In northern India particularly at semi-arid region the summer season is from April to July and the rainy season is from July to October (Ramesh and Arumugam, 2010). Winter is from November to February. Protected cultivation could possibly extend the growing season. Protected cultivation of vegetable crops suitable for domestic and export purposes could be a more efficient alternative for land use and other resources (Sanwal et al., 2004). However, profitability in protected cultivation depends upon the choice of structure, selection of crop etc. The protected cultivation could solve the problem of low productivity during extreme weather conditions. Therefore, in the present scenario of perpetual demand for vegetables and drastically shrinking land holdings, protected cultivation of tomato vegetable crops suitable for domestic as well as export purposes is the best alternative for using land and other resources more efficiently (Sanwal et al., 2004). To date, there is not much work available on shade net cultivation of tomato vegetables. There is an urgent need to assess the cultivation and suitability of different vegetables under shade net house to meet the growing demand of the vegetables. Thus, the investigation was aimed to determine the efficacy of shade net cultivation compared to open field on growth, yield of tomato during summer and winter season.

Protected agriculture has expanded now days to help improve agricultural productivity. The shade net houses commonly used as protected cultivation are designed for temperate or moderately warm regions. These design need to be upgraded with climate control to overcome overheating in summer and overcooling in winter when used in warm, arid regions. The greenhouse climate is dictated by the soil inside the greenhouse, which constitutes the major thermal mass the 'greenhouse' effect itself, which can be controlled mainly by ventilation in most greenhouses; the crop's transpiration, which has a dominant effect on temperature and vapor-pressure deficit. Structures commonly used in the region are small (low and small volume) and have inappropriate roof-slopes (reducing light transmission); taller structures with appropriate roofs would improve light transmission, ventilation, inertia against external climatic variations, and drainage of condensation. Some studies under different types of shade net house have been carried out for growing of nursery as well as for production of some important medicinal plants and cut flower etc. in hilly regions of India. But scanty information is available on such type of wooden framed structure, which may be utilized for round year cultivation of tomato in semi-arid region.

2.0 Materials and methods

A field trial was conducted at Central Institute of Post harvest Engineering and Technology (CIPHET), Abohar (Punjab) during winter season of 2011-2012. The experimental site was located on an average elevation of 221.7 metre above mean sea level and situated at $30^{0}4'$N and $74^{0}12'$ Longitudinal. The experiment soil was one metre deep, well drained, sandy loamy

soil in texture with the average pH 8.1(Table 2). The experiment was comprised of ten treatments (Table 1 & Fig 1) to study the effect of green shade nets on yield and quality of

tomato. The experiment was laid out in randomized block design with five replications. Shade net houses of three shading percentages (35, 50 and 75 %) with three heights (2.5, 3.0 and 3.5Metre) was constructed using bamboo. Tomato cultivar *Naveen* was used for winter season and Namdhari F1hybrid *VVNS-500* used for summer season. Nursery of winter crop tomato was raised in October 2010 and transplanted in first week of December 2010 in shade net houses along with open field condition for winter season crop. While for summer season crop tomato nursery was raised in last week of June, 2011 and the one month old healthy seedling with good vigor transplanted in last week of July, 2011in shade nets as well as in open field condition. Plants were grown on raised bed at a spacing of 1.0 X 0.5 Meter.The plants were grown under the recommended package and practices.

Fig.1Bamboo framed shade net houses covered with shading 35, 50 and 75 %

Table 1. Detail of treatments undertaken in investigation.

1. GH1 : Shade net house with shading percentage 35 % and height of structure 2.5 m
2. GH2 : Shade net house with shading percentage 35 % and height of structure 3 m
3. GH3 : Shade net house with shading percentage 35 % and height of structure 3.5 m
4. GH4 : Shade net house with shading percentage 50 % and height of structure 2.5 m
5. GH5 : Shade net house with shading percentage 50 % and height of structure 3 m
6. GH6 : Shade net house with shading percentage 50 % and height of structure 3.5 m
7. GH7 : Shade net house with shading percentage 75 % and height of structure 2.5 m
8. GH8 : Shade net house with shading percentage 75 % and height of structure 3 m

GH9 : Shade net house with shading

2.1 Physical characteristics:

Physical parameters like. Fruit weight (gm) by electronic balance and fruit length (cm) and width (cm) was carried out by vernier calliper.

2.2 Chemical characteristics:

Chemical attributes includes determination of total soluble solids in tomato juice (T.S.S.^{o} Brix) was recorded by digital refractometer; Total acidity (%) was determined by (AOAC 1980).while Ascorbic acid (mg/100gm) by (Ranganna 1994).

2.3 Statistical Analyses

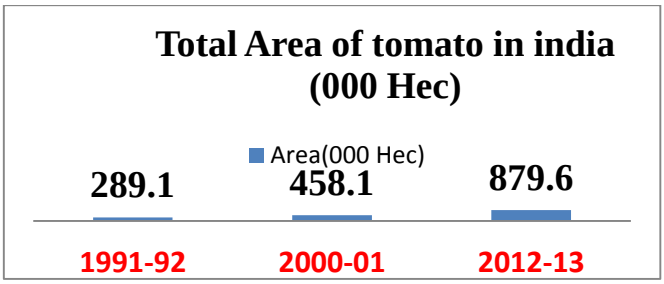
The experiment data were analyzed for analysis of variance (ANOVA) using RBD to test the significance of the observed differences was performed using the Minitab-16 software. The differences in quantified concentrations were evaluated using F test at $P < 0.05$.

3.0 Results and discussion

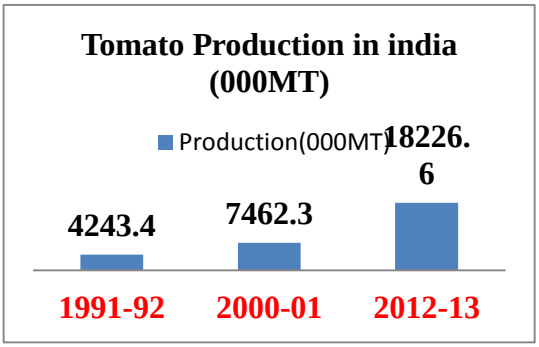
3.1 weather under shade net and open field

The daily temperature, humidity and solar radiation (Lux) data was collected from inside and outside shade net. The average monthly maximum temperature varies from 15 to 33.4 ^{0}C (Fig.2) and humidity varies between 30.4 to 61.2 percent during November to April in day time (Fig 3). There was no significant difference found in temperature and humidity in shade net as compared to open field. The maximum solar radiation was found in open field followed by 30, 50 and 75 % shading nets (Fig 4). The significant difference was observed in solar radiation in open condition and inside shade net house. The maximum solar radiation was recorded in open field condition followed by 30, 50 and 75 % shading nets. There was 43-45 % and 16-

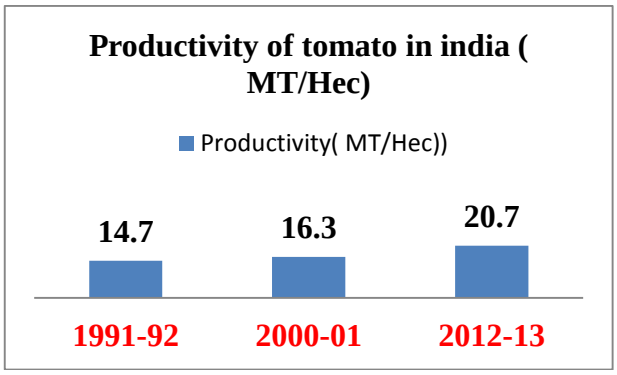
17.5 % reduction was recorded in solar radiation under 35 and 75 % shading net houses, respectively as compared to open field (Fig 4)



3.2 Plant height under shade net and open field:
Plant height was highest under 75 % green shade net house in both seasons compared to open field(Fig 5). This may be due to enhanced photosynthesis and respiration due to the favorable micro-climatic conditions in the shade net house. This agrees with results of Ramesh and Arumugam (2010).

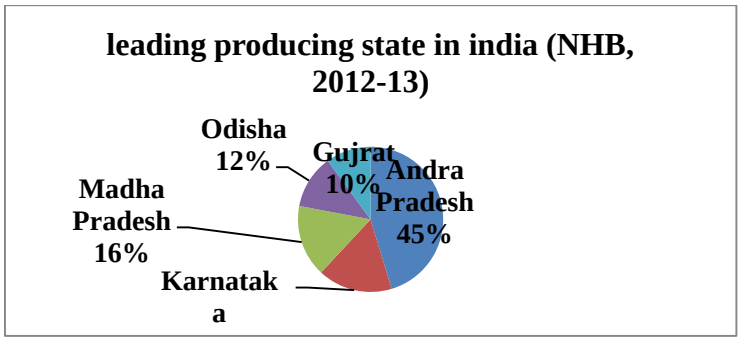


3.3 Yield under shade net and open field:
The yield of tomato recorded in each plucking and mean plant yield of all six plucking was recorded (Table 2). Highest average plant yield of (3.49 kg/plant) was found in 35 % shading net followed by open field (2.27). Lowest yield observed (1.07 kg / plant) in 75 % shading net. The tomatoes grown under shade net structures were glossy in appearance with good colour development as compared to open field (control). Further tomatoes produced in open field were attacked by the pest (*Helicoverpa armigera*) attack. Tomato had higher yield under shadenet house due to light compensation for higher photosynthesis.



Similar results were reported by Quaglitto (1976) and Priya et al. (2002) in sweet pepper. It has been observed that under 35% shade net formation of photosynthates and their partitioning and distribution for the final sink were higher compare to 50 and 75 % green shade nets. The highest leaf area per plant was also recorded in tomato under shade net house during summer and winter seasons. This might be due to leaf physiology and increased number of

stomatoes and photosynthesis. The light intensity in the shade net house was lower than in the open field. Similar result also reported by Rajshekar et al. (2013).



9. percentage 75 % and height of structure 3.5 m
10. Open field
11.

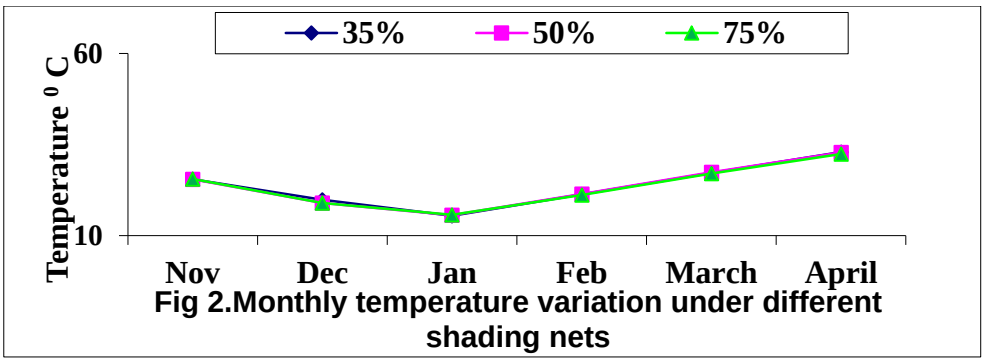


Fig 2.Monthly temperature variation under different shading nets

The tomato produced in open field was seriously attacked by the pest *Helicoverpa armigera.* Incidence of aphid, whitefly, thrips, and mites was also noticed in early season soon after transplanting in open field. The infestation of tobacco caterpillar was seen inside net houses.

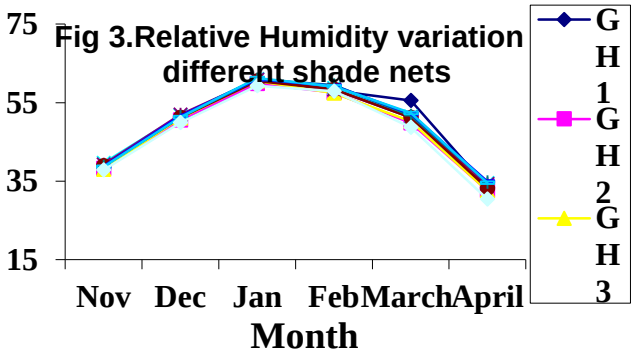


Fig 3.Relative Humidity variation different shade nets

3.5 Plant yield and quality of tomato in shade net and open field

No significant difference was observed in quality attributes viz. TSS, Acidity and ascorbic acid by shade net structures. However the higher TSS (6.1 ºBrix), Acidity (0.69) and ascorbic acid (40.86 mg/100gm) was recorded in 35% shade net compare to control, (5.7, 0.61 and 36.42) respectively. Thus, use of 35 % shade net brought improvement in quality and yield of tomato grown in semi-arid region.

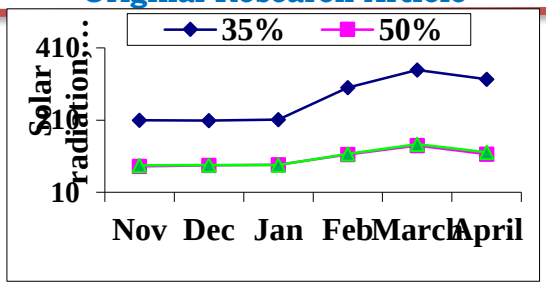


Fig. 4 Monthly solar radiation under different shadining nets

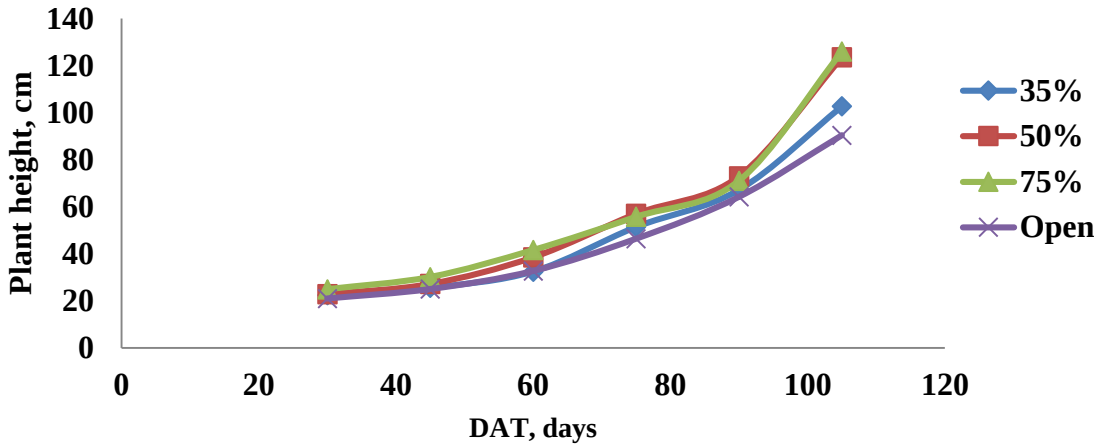


Fig. 5 Plant height under shade nets

3.4 Pest attack in open field:

Fig.6 Tomato pest (*Helicoverpa armigera*) infestation

Table 2: physiochemical property of experimented soil

Sand	69.5 ± 2.47%
Silt	14.2 ± 1.38%
Clay	16.3 ± 0.58%
pH	7.75 to 8.5
WHC	31.4 ± 0.78%
Organic Matter	0.79 ± 0.04% g^{-1}d.wt. soil
Total Nitrogen	190.0 to 265 mg kg^{-1}d.wt.soil
Available Nitrogen	110 –155 mg kg^{-1} d.wt. soil

WHC = Water Holding Capacity

Table. 3. Mean plant yield and quality attributes of tomato in shade nets and open field

Treatment	Yield (kg/plant)	Fruit weight(gm)	TSS (^{0}Brix)	Acidity (%)	Vita –C (mg/100gm)
GH1	3.67	53.3	5.7	0.639	36.36
GH2	3.69	51.6	6	0.699	40.86
GH3	3.11	51.1	6.1	0.686	35.64
GH4	1.69	42	6	0.637	36.9
GH5	1.92	50.3	5.7	0.653	38.16
GH6	1.88	51.7	5.8	0.673	37.26
GH7	1.6	48	5.9	0.680	35.46
GH8	1.85	48.7	5.9	0.705	37.26
GH9	1.67	41.9	5.7	0.669	39.6
Open	2.27	47.1	5.7	0.621	36.72
SEm	0.27	0.86	NS	NS	NS
CD at 5%	0.79	2.48			

4.0 Conclusion

The shade net house with 35 % shading was found suitable for cultivating of tomato in semi-arid region of Punjab. Hence, the growing of tomato, under shade house conditions will be more profitable irrespective of the seasons.The shade net controls the plants from frost and cold waves during winter and from solar injury due to high intensity solar radiation during summer. This positively influenced the morpho-phenological and physiological events of tomato plants.Less pest and disease attack was observed in shade net houses as compared to open field in all crops.It is concluded that the better growth, development and yield of tomato were achieved under shade net due to optimum temperature and humidity. This simple and low cost shade net may be suitable for semi-arid regions like punjab where the temperature falls during winter. The growth and development of tomato plant becomes restricted during the cold winter months of December to February because of its season bound nature. Therefore, if tomato is planted under shade net, will establish good stands and able to produce higher and off- season tomato which fetched premium prices in the market.

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