GLOBAL JOURNAL OF BIOLOGY, AGRICULTURE & HEALTH SCIENCES
(Published By: Global Institute for Research & Education)
www.gifre.org

EFFECT OF PARTIAL SHADE ON GROWTH AND YIELD OF TOMATO CULTIVARS

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Abstract

An experiment "Response of tomato cultivars to partial shade" was carried out at Ornamental Horticulture Nursery Farm, Department of Horticulture, Khyber Pakhtunkhwa Agricultural University, Peshawar during 2010. The experiment consisted of providing shades (55 percent) and two tomato cultivars (Roma, Rio Grande). The partial shade effects were studied consecutively for three months i.e. from 1stApril, 1st May and 1stJune in comparison with control (full sun) and then remained till end of crop. The experiment was laid out in Randomized Complete Block Design with split plot arrangement. Partial shade effects were studied on various growth parameters of tomato varieties. Maximum increase in plant height (101cm) was recorded in partial shade applied from April. Plant height in control (74.5cm), partial shade from May (74.1cm) and partial shade from June (75.4cm) was almost same. Maximum number of branches per plant was recorded in control (4.1), shade from May (4.1) and shade from June (4.2) while minimum number of branches per plant (3.2) was observed in shade from April. Maximum number flower cluster and flowers per cluster were recorded in control plots (12.6, 5.1) whereas minimum number was recorded in partial shade from April (5, 4.2) respectively. Maximum number of fruits per plant (19.3) was observed in full sun followed by partial shade in June (17.4) and then May (13.1). April shading had least number of fruits (7.4). Fruit size was not affected significantly by shade. Partial shade applied in April and May significantly reduced the yield compared to that applied in June and full sun. On the basis of the results it is concluded that shading tomato during summer is not recommended.

Keywords: Partial Shade, Tomato cultivars, Growth and Yield components

Introduction

Tomato (*Lycopersicon esculentum* L.) belongs to the family Solanaceae and is one of the most popular and widely grown vegetables ranking second in importance to potato in many countries. Its uses in various forms both fresh and processed, played a major role in its wide spread adoption. Tomato is native to South America. Historical records show that tomatoes were taken to Europe by Cortex in 1523. However, the earliest mention of its existence in the old world was made in 1554 by an Italian herbalist, Pier Andrea Mattioli. As for Asia, the Spanish began introducing several agricultural commodities into the Philippines from Mexico in 1751, but it is possible that tomatoes had been taken from Spain to Asia much earlier, perhaps just a few years after the discovery of the Philippines by Ferdinand Magellan in 1521. Trade between the Philippines and the neighbouring countries of China, Japan and India may have been responsible for the spread of tomatoes into these countries. It is reported to have been introduced in the Indo-Pak sub-continent by the Europeans, in the second half of the nineteenth century. In the beginning, tomato was consumed in the subcontinent by the Europeans but later on it became popular amongst the rich classes of local population, and now almost every one uses it in one form or the other (Salam, 2006). It is grown in most home gardens and by market gardeners and truck farmers. It is also produced by forcing in green houses.

Tomato can be eaten either fresh or processed into many different products as sauce, juice, ketchup, chutney, salad, pickle and is served as cooked tomato in many forms. Although tomato is a tender perennial crop, which is susceptible to frost as well as high temperature, but it is being grown in a variety of climatic conditions. Tomatoes grow best under temperatures of 20–27°C. Fruit setting is poor when average temperatures exceed 30°C or fall below 10°C. Tomatoes prefer a well-drained soil because their sensitivity to water logging. Optimum soil pH for tomato is 6.0 to 7.0; disorders such as blossom end rot are common if soil pH is lower than 5.5. Since tomato is a mild season loving crop, therefore it is difficult to grow it and get its optimum yield in a single production unit of Pakistan round the year under natural climatic conditions due to extremeness in temperature. In Pakistan, two crop of tomato are produced annually, one as summer crop for which the seeds are sown in November, and the seedlings are ready for transplanting in February/ March. Harvesting of this crop starts in May and continues up to the end of August. The second one is winter crop, which produced only in places where no frost occurs during winter. Seeds are sown in June and seedlings are transplanted in August. Harvesting of this crop starts from November. In plains of Khyber Pakhtunkhwa, tomato is grown in summer, while in some frost free zones like Dargai, Malakand agency and Bara Killa (Peshawar valley) it is grown in winter. High light intensity and temperature prevailing during early summer not only causes reduction in crop growth and fruit set but also leads to enhanced and forced maturity of fruits being set earlier. This situation leads to glut in the market due to abundant

availability of tomato for a couple of weeks and then scarcity in onward months i.e., late summer months. In Pakistan, the yield per unit area is quite low as compared to other countries. One of the reasons could be the high light intensity and temperature during summer season. High light intensity and temperature damage plants and fruits which adversely effect crop yield. Shade could also be used to reduce the light penetration and temperature for the production of higher yield and quality fruits

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Materials and Methods

The experiment "Response of tomato cultivars to partial shade" was conducted at Ornamental Horticulture Nursery Farm, Department of Horticulture Khyber Pakhtunkhwa Agricultural University Peshawar during 2010.

Layout of the experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD; two factors) with split plot arrangement having three replications. The experiment consisted of partial shades, full sun and two tomato cultivars (Roma, Rio Grande). Green perforated plastic matting with 55 percent shade was used as shade material. The shade effects were studied consecutively for three months in the following manner;

T1= Control (Full sun light)
T2= Partial Shade from 1st April to 10th July, 2010
T3= Partial Shade from 1st May to 10th July, 2010
T4=Partial Shade from 1st June to 10th July, 2010

For putting the shading material, four clubs of 1.5m high were erected above treatment and then shading material was stretched over these clubs in such a way that it was hanging on the sides, but not touching the ground to ensure ventilation. Two tomato cultivars viz. Roma and Rio Grande were planted in sub-plots.

Plant material and transplanting

Seeds of tomato cultivars were obtained from local market. These were sown on January 14, 2010 in separate pots having a mixture of silt, soil and compost (1:1:1 ratio). When seedling were attained the height of transplanting, they were shifted to already prepared seedbeds on March 11, 2010. The plant to plant distance was maintained 30cm while row to row distance was 1m. Each variety had one row on which thirteen plants were planted. The individual plot size was $8m^2$. The data were recorded on the following parameters during the course of
experiment.

Plant Height (cm): Plant height was recorded by measuring the length of the plant from the soil line to the top and average was calculated.

Number of branches plant^{-1}: Number of branches was counted on the plants in each treatment and average branches/plant was calculated.

Number of flowers clusters plant^{-1}: Number of flower clusters per plant was counted on selected plants and average flower clusters/plant was calculated.

Number of flowers cluster^{-1}: Number of flowers per cluster on selected plants was counted and average was calculated.

Number of fruits plant^{-1}: Number of fruits per plant was calculated by the number of fruits picked on selected plants.

Fruit size (cm^3): The size of the fruit was determined by water displacement method.

Total yield (t/ha): The fruits were harvested at fairly red and mature stage. After each picking the yield of tomato fruit was recorded separately for each treatment in each replication. When the picking was over, yield of individual treatment was summed up. Total yield per treatment was noted and yield per hectare was calculated.

Data Analysis: The data recorded on various parameters were subjected to Analysis of Variance method to determine the difference between different treatment and their interactions. While Least Significant Difference (LSD) test was used to determine mean differences at 5% level of significance. Statistical software MSTATC (Michigan State University, USA), was applied for calculating both ANOVA and LSD.

Results and Discussions

Plant height (cm)

The data regarding the plant height are presented in Table 1. The analysis of variance (ANOVA) showed that plant height was significantly affected in case of partial shades. The interaction between the partial shades and tomato cultivars was also significant. The means for partial shades showed that the shade applied from April produced tallest plants (101cm).While the plants in Control (Full sun), shade from May and shade from June were statistically similar to each other having plant height of 74.5, 74.1 and 75.4cm respectively. The same results are evident in the study of Thangam and Thamburaj (2008) who stated that plants grown under shade exhibited better growth in term of plant height as compared to those in open field. Similarly Paez and Lopez (2000) observed that plant height and leaf area increased in the shade. Murakami *et al*. (1997) stated that red light interception caused low ratio of red and far red light which results in increase in plant height.

Number of branches plant^{-1}

The data regarding number of branches per plant are presented in Table 1. The ANOVA showed that partial shades and tomato cultivars had no significant effect on number of branches per plant. The interaction between the shades and tomato cultivars was also non-significant.

Number of flower cluster plant^{-1}

The data regarding number of flower cluster per plant are presented in Table 1. Statistical analysis showed that partial shades and tomato cultivars had no significant effect on number of flower cluster per plant. The interaction between the shades and tomato cultivars was also non-significant. However Control (Full sun) produced maximum number of flower cluster per plant (12.6) followed by shade from May (10.1) and shade from June (10.1).While minimum number of flower cluster per plant was observed in shade from April (5). But statistically all shades had same results. Rylski *et al.* (1994) reported that temperature and irradiation conditions at the early stages of flower development are important factors which determine yield and fruit quality. Low temperature and low irradiation cause improper ovary development, malformation of the flowers and production of unviable pollen in tomato.

Number of flowers cluster^{-1}

The data regarding flowers number per cluster are given in Table 1. The ANOVA showed that flowers number per cluster was significantly affected in case of partial shades. While non-significant differences were found in cultivars as well as interactions. The means for partial shade showed that shade from April produced minimum flowers number per cluster (4.2) while Control (Full sun) produced maximum flowers number per cluster (5.1).

Number of fruits plant^{-1}

The data regarding fruit number per plant are presented in Table 2. The Analysis of variance (ANOVA) showed that fruit number per plant was significantly affected by partial shade while non significant in case of tomato cultivars. The interaction between partial shade and tomato cultivars was also non significant. The means for partial shade showed that control (full sun) produced maximum (19.3) fruits per plant closely followed by partial shade from June (17.4) and shade from May (13.1). While shade from April produced minimum number of fruits per plant (7.4).It is obvious from the results that as the shade duration increased it significantly affect number of fruits per plant. Gent (2008) who stated that shading did not affect the rate of fruit production within three weeks of application, but after more then six weeks, it was 30% less under 0.5 shade density than under no shade. Paez and Lopez (2000) reported that shading contributed to ameliorate the effect on vegetative growth probably by causing a decrease in temperature but did not alter fruit establishment. Thangam and thamburaj (2008) stated that the number of fruits per plant was more in open field than under shade.

Fruit size (cm^3)

The data regarding fruit size (cm^3) are presented in Table 2. The analysis of variance (ANOVA) showed that the response of partial shades and tomato cultivars had no significant effect on fruit size. The interaction between the partial shades and tomato cultivars was also non-significant.

Total yield (kg/ $4m^2$)

The data regarding total yield are given in Table 2. The ANOVA showed that total yield was significantly affected by shades while non-significant in case of cultivars. The interaction between partial shades and tomato cultivars was also non-significant. The means for partial shades showed that plants in control (full sun) produced maximum fruit yield (10) closely followed by partial shade from June (9.1). Plants under partial shade from April produced minimum fruit yield (4.1). Thangam and Thamburaj (2008) observed that the yield under shade was low as compared to open field. Abdel-Mawgoud *et al.* (1996) reported that shade didn't affect tomato fruit yield consistently and its use is not justified. Meanwhile shade can be used to improve fruit quality such as reducing sun burn.

Total yield (t/ ha)

The data regarding total yield are given in Table 2. The means for partial shades showed that plants in control (full sun) produced maximum fruit yield (24.6) closely followed by partial shade from June (22.1). Plants under partial shade from April produced minimum fruit yield (9.4).

Conclusion

It is concluded from the experiment that long duration of partial shade definitely influence the growth and yield of tomato crop in summer. While cultivars of tomato (Roma and Rio Grande) have exactly similar response to partial shade. However, the main purpose of the experiment was to prolong the fruit production season of tomato. But this aim was not achieved in Peshawar. So shading tomato during summer is not recommended. It is also further recommended from the results that this experiment may be repeated using indeterminate varieties of tomato which must be partially shaded during June to August.

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Appendix-

Table 1. Effect of partial shade on plant height, number of branches plant^{-1}, flower cluster plant^{-1} and flowers cluster^{-1} of tomato cultivars.

Cultivars	Plant Height (cm)	Number of branches plant^{-1}	Number of flowers clusters plant^{-1}	Number of flowers cluster^{-1}
Rio Grande	80.2	3.9	9.6	4.8
Roma	82.3	3.8	9.3	4.9
Level of Sign.	*	NS	NS	NS
Partial Shades (Months)				
Control (Full sun)	74.5b	4.1	12.6	5.1a
1st April to 10th July	101a	3.2	5	4.2b
1st May to 10th July	74.1b	4.1	10.1	5.0a
1st June to 10th July	75.4b	4.2	10.1	5.0a
LSD at α 0.05	13.64	NS	NS	0.62
Significance Level	**Interaction (Cultivars X partial Shade)**			
C × S	* (Fig.1)	NS	NS	NS

Table 2. Effect of partial shade on Number of fruits plant^{-1}, fruit size, total yield (kg/4m^2) and total yield (t/ha) of tomato cultivars.

Cultivars	No. of fruits plant^{-1}	Fruit size (cm^3)	Total yield (kg/ 4m^2)	Total yield (t/ha)
dRio Grande	14.2	48	7.1	13.4
Roma	14.3	51	7.3	18.3
Level of Sign.	NS	NS	NS	NS
Partial Shades (Months)				
Control (Full sun)	19.3a	52.1	10a	24.6
1st April to 10th July	7.4c	50.2	4.1b	9.4
1st May to 10th July	13.1b	46	6.1b	15.2
1st June to 10th July	17.4ab	50.3	9.1a	22.1
LSD at α 0.05	5.35	NS	2.61	NS
Significance Level	**Interaction (Cultivars X partial Shade)**			
C × S	NS	NS	NS	NS

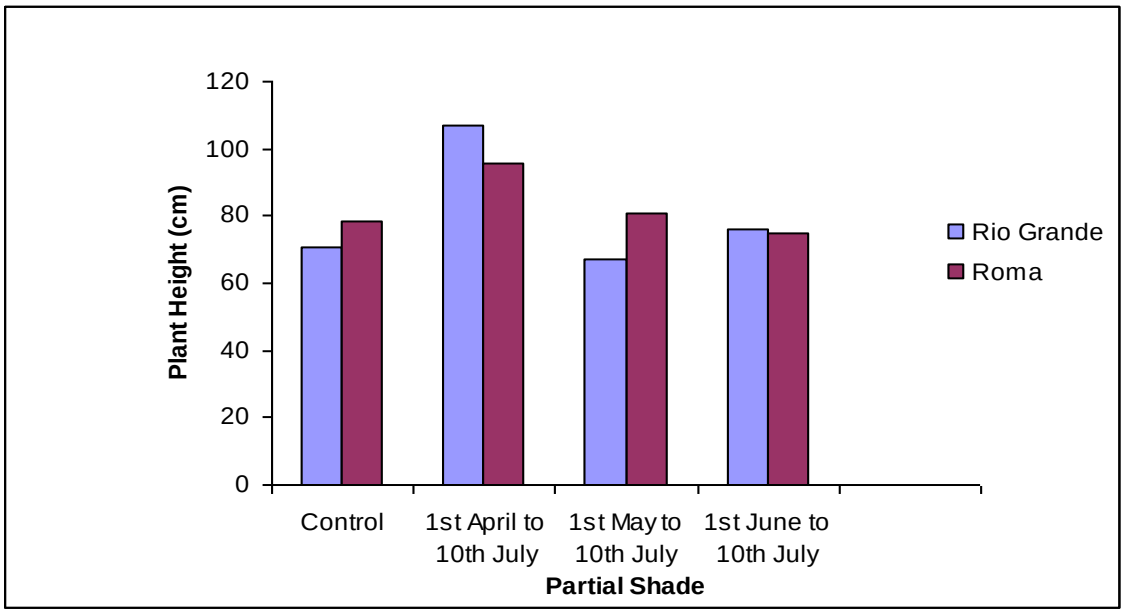

Figure 1: Plant height of tomato cultivars as affected by partial shade