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The Effect of Different Light Intensities on the Growth and Yield of Tomato (*Lycopersicon Esculentum Mill*.)

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ABSTRACT: Tomato (Lycopersicon Esculentum Mill.) is one of the popular fruit vegetables, especially rich in vitamins, minerals, and antioxidants. Inconsistent light intensity, due to unfavorable weather conditions, reduced tomato performance. Response of one tomato variety (Diamante Max F1), under different light intensities (T1: Control, T2: Single net T3: Double net,) was assessed in field trials. The experimental design was a randomized complete block design (RCBD). Effects of different light intensities were measured in terms of plant height, number of days to flower, number of fruits, the weight of fruits, yield per hectare, and light intensity received in every treatment. All results were significantly different at a 1% level of significance for all parameters. Treatment 2 manifested the highest mean for plant height, treatment 1 for the number of days to flower, and treatment 3 for the number of fruits. Treatment 3 obtained the highest yield per hectare and Treatment 1 for the highest light intensity received per treatment. Treatment 2 has the least mean for all parameters measured, in conclusion, the effect using a double net is highly recommended in tomato production.

KEYWORDS: ANOVA, RCBD, Light Intensity, Vegetable, Antioxidant.

INTRODUCTION

Tomato (Lycopersicon Esculentum Mill.) belongs to the Solanaceae family and is one of the most popular fruit vegetables in the Philippines and other places worldwide. It is cultivated for its fleshly fruits and harvested when fully formed and mature green and eaten fresh or processed. They are a good source of vitamins, minerals, and antioxidants which help control cancer and other health problems, and improve the general well-being of man (Antonio et al., 2004). Apart from its use as a vegetable, it is also used for several purposes as sauce, juice, and ketchup (Encyclopedia of Food and Culture, 2003). However, despite the nutritional values of tomatoes and their geographical distribution, as well as their adaptability to varying climatic conditions, the yield of tomatoes is still very low. Its attributed to unstable climatic conditions. Normally, tomato being a tropical plant grows well under warm conditions with sufficient moisture levels and light intensities. With the recent climate change, the yield of tomatoes has been reduced. Unfavorable climatic conditions such as drought, edaphic factors, and excess or lowlight intensity can damage the quality and reduce the production (Agbogidi and Nweke, 2005).

Light is an absolute requirement for plant growth and development next to the water. It is because an increase in light intensity will increase the rate of photosynthesis. Light modifies the anatomy and physiology of the leaf (Wilson and Coope, 1969). As reported, plants grown under high light intensity are capable of faster photosynthesis than those grown under weaker light (Knorr and Vegtmann, 1983). Therefore, the current research study aimed to determine the effect of different light intensity reductions using various layer of black nylon net on the growth and yield of tomatoes.

MATERIALS AND METHODS

Site selection and time of study

The study was conducted at Western Mindanao State University, College of Agriculture San Ramon, Zamboanga City, Philippines.

Zamboanga City Map

Figure 1. Location Map of the Experimental area.

MATERIALS AND METHODS

Experimental Design

The experimental design used in this study was a Randomized Complete Block Design (RCBD) with three (3) treatments to be replicated three (3) times.

The treatments are as follows:

Treatment 1 (T1): Control (without net)

Treatment 2 (T2): Single Layered Black net

Treatment 3 (T3): Double Layered Black net

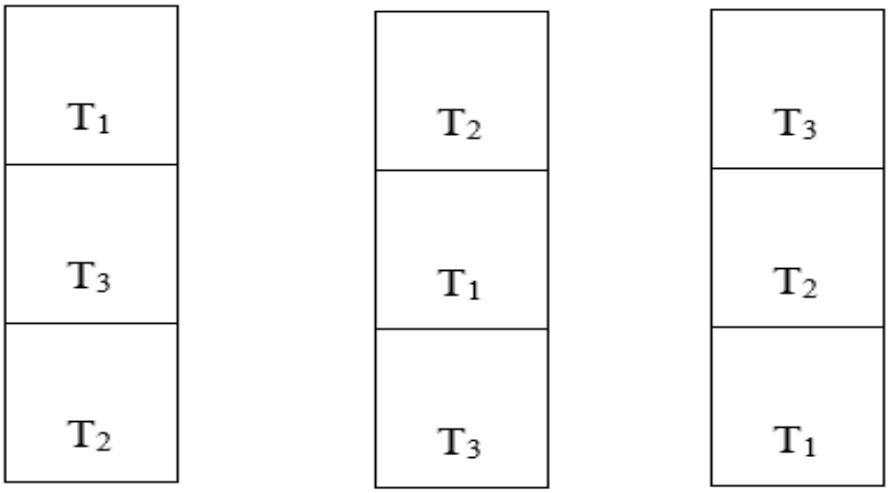

Figure 2. Field layout showing the three (3) treatments replicated three (3) times in Randomized Complete Block Design (RCBD).

Soil Sample and Analysis

The soil sample was taken in the experimental area. The sample was brought to the Department of Agriculture Bureau of Soil Laboratory at Zamboanga City, for soil analysis and to know the right amount of fertilizer nutrient needed by the plant based on their recommendations.

Procedures:

Land Preparation

Weeds and other unwanted materials were removed from the study area. Then the area was divided into three blocks to represent the replication and each block is subdivided into three plots where the different treatments were assigned.

Plowing

The experimental area was plowed twice using the tractor to assure a well-prepared land for planting, the weeds in the area were cleared by cutting with the use of a bolo knife.

Harrowing

This was done through the use of a tractor harrow. Harrowing is often carried out on fields to follow the rough finish left by plowing operations. The purpose of this harrowing is generally to break up clods (lumps of soil) and to provide a finer finish.

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Seedlings Preparation

A seed tray was used for the sowing of seeds. The seed tray was mixed with 1/2-inch of soil and a pair of seeds was placed on top of the soil each one near the center of the pot. And was covered with a ¼-inch layer of Vermicast.

Sowing

Seeds were sown by drilling, watered daily using water can and other cultural practices were observed until the seedlings were ready for transplanting.

Hardening

The seedling was hardened through gradual exposure to the heat of the sun to adapt to the condition in the field.

Transplanting

Four weeks old seedlings were transplanted at a distance of 40 cm between hills and 50cm between furrows.

Fertilizer Application

Organic and inorganic fertilizer was used in the study. This will incorporate with the soil during land preparation.

Light Intensity Gathering

A light meter was used in the study to be able to measure the light intensity that enters the plot.

Water Management

Watering was done every morning and afternoon with the use of a sprinkler to minimize water stress to allow sufficient availability of moisture in the plants.

Trellising

In trellising ipil-ipil sticks was used as trellis post and straws were used as tying material. The use of a trellis was done to minimize the branches and leaves from folding.

Net Installation

To reduce light intensity using the black net, four (4) wooden poles at a height of 1.5 m were placed at each corner to support the net on the plot. The net was intertwined with the poles to reduce the light that enters the plot. The net was installed 5 days after transplanting the seedlings in the field.

Weeding

Weed control was done by the hand-weeding method. Weeding was done to ensure that weeds do not compete with nutrients on the plant.

Insect Pest Management

A hot pepper extract was used in the study to control the insect pest in the area. The hot pepper extract was prepared by collecting the hot pepper and was squeezed and the extract was diluted into water.

Harvesting

Tomato fruit was harvested 40-45 days after transplanting and it was done early in the morning to prevent rotting. This was done by hand-picking those that are fully red and firm. The tomato fruit was placed in a box with newspaper to prevent fruit damage.

GATHERING OF DATA

The following data gathered were:

1. **Plant height** The height of plants was collected by measuring the six samples of plants per plot from the base of the plant up to the tip of the uppermost leaves. Plant height was taken up to the flowering stage.
2. **Number of days to Flowering** This was done by counting the number of days from planting to the first harvest.
3. **The number of fruits** was taken by counting the fruits from representative plants. The total number of fruits per plant in each sample was used to represent the number of fruits per plant.
4. **Weight of fruits** The average weight of the fruits were taken by weighing the matured fruits per harvest. The total cumulative harvested fruit was used to determine the average yield of tomatoes per plot.
5. **Yield per hectare** This was taken from the cumulative weight of fruits per plot. The accumulated yield per plot was converted to a hectare basis using the following formula.
6. Yield (kg/ha) = $\frac{10{,}000\ m^2/\text{ha}}{\text{Plot size } (m^2/\text{ plot})}$ x Yield (kg/plot)
7. **Light intensity received in every treatment (lux)**The light intensities within and outside were measured using a light meter three times a week in the morning (10:00 am), (12:00nn), and afternoon (3:00 pm).

DATA ANALYSIS

The data collected was done by tabulating and was analyzed using an appropriate tool which is the Analysis of Variance (ANOVA) to identify and determine the growth and yield performance of corn (Zea mays) as affected by both the application of different organic fertilizers

RESULTS AND DISCUSSION

Plant Height

The plant height of the tomato was measured in centimeters as grown in different light intensities, as shown in Table 1. As noted in the data, plants grown in treatment 2 obtained the highest plant height with a mean of 30.7014 cm, followed by treatment 3 with a 28.944 cm mean. The shortest plants with a mean of 25.569 cm were observed in treatment 1. The observed numerical differences in the plant height of tomatoes were not significantly different observed in the plant height. The result indicates that using the single net and double net failed to influence significant growth in plant height.

Table 1 .Plant height of tomato

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	22.29	25.91	28.50	76.69	25.56
T2-Single net	30.27	30.18	31.66	92.10	30.70
T3- double net	25.46	31.46	29.92	86.83	28.94
Block total	78.01	87.54	90.07		
Block mean	26.01	29.18	30.03		
Total				255.63	
Grand mean					28.40

ns= not significant

cv= 6.4305%

Table 2. Number of days to Flower

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	37.33	42.50	38.83	118.67	39.56
T2-Single net	37.33	39.67	39.00	116.00	38.67
T3- double net	37.33	48.33	51.33	137.00	45.67
Block total	112.00	130.50	129.17		
Block mean	37.33	43.50	43.06		
Grand total				371.67	
Grand mean					41.30

ns- not significant

cv=8.92%

The days of the flower tomato, as grown in different light intensities, are shown in Table 2. The plants are grown in treatment (T2) produced the flower earliest with a mean of 38.67 days, followed by treatment (T1) with a mean of 39.56 days, and the plants with a late number of days to flower with a mean of 45.67 were observed in treatment 3. The observed numerical differences in the number of days to the flower of tomato obtained F computed of 3.2202 is less than the F tabular value of 6.94 at a 5% level of significance as revealed by the analysis of variance

Number of Fruits

The number of fruit in tomatoes grown in different light intensities is shown in Table 3. As shown plants grown in treatment 3 produced the most fruit with a mean of 7.58, followed by treatment 2 with a mean of 6.47, and the plants with the least number of fruit with a mean of 4.66 were observed in treatment 1.

The analysis of variance reveals that there were no significant differences observed in the number of fruits. The result indicates that using the single net and double net failed to influence the growth of numerous fruits

Table 3. Number of Fruit

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	4.81	4.13	5.03	13.89	4.66
T2-Single net	6.70	5133.00	7.57	19.40	6.47
T3- double net	11.73	6.40	4.62	22.75	7.58
Block total	23.25	15.67	17.22		
Block mean	7.75	5.22	5.74		
Grand total				56.13	
Grand mean					6.24

Weight of fruits

The weight of fruits of tomato as grown in different light intensities was shown in Table 4. As shown plants grown in treatment 3 produced more weight with a mean of 524.44 g, followed by treatment 2 with a mean of 344.44 g, and the plants with the least weight were grown in treatment 1 with a mean of 241.78 g. The observed numerical differences in the weight of tomato fruit were not significantly different observed in the weight of fruits. The result indicates that using the single net and double net failed to influence the plant height.

Table 4. Weight of Fruits in Kilograms

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	253.33	216.00	256.00	725.33	241.78
T2-Single net	329.33	363.00	341.00	1033.33	344.44
T3- double net	492.33	498.33	582.67	1573.33	524.44
Block total	1075.00	1077.33	1179.67		
Block mean	358.33	359.11	393.22		
Grand total				3332.11	
Grand mean					370.22

Yield per Hectare

The yield per hectare of tomato as grown in different light intensities is shown in Table 5. As shown plants grown in treatment 3 produced the biggest yield per hectare with a mean of 11,654.3 kg, followed by treatment 2 with a mean of 7,654.3 kg, and the plants with the least yield per hectare were grown in treatment 1 with a mean of 5,372.63 kg.

The observed numerical differences in the yield per hectare of tomato obtained F computed of 57.05 is greater than the F tabular value of 18.00 at a 1% level of significance as revealed by the analysis of variance.$LSD_{0.05}$ shows that each treatment was significantly different from the other. This agrees with the study of Liao, Zou, Ge, and Chang that plants grown in low light intensities produces larger leaf area and higher yield compared to unprotected plants.

Table 5. Yield per Hectare in Kilogram

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	5,629.00	4,800.00	5,688.89	16,117.89	5,372.63c
T2-Single net	7,318.44	8,066.67	7,577.00	22,962.89	7,654.3b
T3- double net	10,940.67	11,074.00	12,948.22	34,962.89	11,654.3a
Block total	23,888.11	23,940.67	12,948.22		
Block mean	7,962.70	7,980.20	8,738.29		
Grand total				74,043.67	
Grand mean					8,227.10

**= significant at 1% level

cv= 8.86%

LSD¬0.06= 1,938.07 g

Light received in every Treatment

The light received in every treatment in different light intensities is shown in Table 6. As shown, plants grown in treatment 1 has more light received with a mean of 3086.356 lux followed by treatment 2 with a mean of 1830.578 lux, and the plant with less light intensity was grown in treatment 3 with a mean of 1140.378 lux.

The observed numerical differences in the light received in every treatment of tomato obtained F computed 11, 077.78 is greater than the F tabular value of 18.00 at a 1% level of significance as revealed by the analysis of variance.

LSD¬0.05 shows that treatments 1, 2, and 3 were significantly different from one another. The study agrees with Chapman and Carter, the minimum limit for the process of photosynthesis in most plants is between 100 and 200 fc or 1,076 lux to 2,150 lux (1976). Likewise, excessive light intensity can scorch leaves and reduce yields as reported by Edmond et. al (1978). Light occupies a prominent position among other factors affecting transpiration since it has a dominating effect on stomatal movement. The stomates of the plant exposed to light are opened allowing transpiration to occur as stated by Robert Devlin; furthermore, the rate of transpiration must be less than that of absorption (1977).

Started by Bormann that the rate of photosynthesis

Table 6. Light Intensity Received in every Treatment (lux)

TREATMENT	REPLICATION			TOTAL	MEAN
	I	II	III		
T1-Without net (Control)	5,629.00	4,800.00	5,688.89	16,117.89	5,372.63c
T2-Single net	7,318.44	8,066.67	7,577.00	22,962.89	7,654.3b
T3- double net	10,940.67	11,074.00	12,948.22	34,962.89	11,654.3a
Block total	23,888.11	23,940.67	12,948.22		
Block mean	7,962.70	7,980.20	8,738.29		
Grand total				74,043.67	
Grand mean					8,227.10

**significant at 1% level

Cv=0.804%

LSD¬0.05= 43.157 lux

Table 6.1 Analysis of Variance

CONCLUSION

The result showed that there are significant influences by the different light intensities compared to the control treatment measured through the measured parameters. Based on the findings, the treatments are comparable with each other in terms of plant height, days to maturity, number of fruits, and weight of fruits per hectare, and light intensities were significantly different. It agrees with the findings of Brouwer stated that light intensity affects the growth rate of roots generally more than that of shoots (1963).

The researcher highly recommends using double netting to reduce the light intensity because based on the study treatment 3 or double layer of net has a mean of 1140.3778 lux compared to the unprotected treatment of 3086.3556 lux. And also, treatment 3 or double netting produced the heaviest weight of fruits with a mean of 22.895 g. For further study, the use of colored nets, and potted plants can be used as experimental samples because the rate of transpiration can be measured

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