Ultraviolet-B Light Radiation and its Effect on the Growth and Development of Solanum lycopersicum L.

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Abstract

The Effect of Ultra-Violet light radiation on growth and development of tomato plant (Solanum lycopersicum) was carried out within a period of 4 weeks at Etinan L.G.A, Akwa Ibom State, Nigeria. After transplanting, the plants were inserted into a cupboard with different diameters, with chamber openings ranging from 20cm, 15cm 10cm, 0 cm (closed) and control (open). In the control chamber, the plant height, number of leaves, number of branches and number of fruits recorded thus; 14.00, 13.83, 5.00, and 0.00 respectively. Chamber A (20cm) recorded; 16.13, 12.96, 3.830, and 0.00. Chamber B (15cm) recorded; 18.750, 0.00, 0.00, and 0.00, Chamber C (10cm) recorded; 16.29, 15.50, 4.420, and 0.00 and Chamber D (0cm) recorded; 15.42, 0.00, 0.00, and 0.00 respectively. From this research it is observed that UV-B light radiation is very important in the growth and development of Solanum lycopersicum, but it's required in a reduced amount which records increase in their growth parameters. Increased UV-light radiation can result in decreases in biomass or total dry matter production and marketable yield of agriculturally important plants.

Key Terms –Light Radiation,Tomato, Ultraviolet, UV-B,Radiation and *Solanum lycopersicum*.

1. Introduction

All living organisms of the biosphere are exposed to UV-B radiation at intensities that vary with the solar angle and the thickness of the stratospheric ozone layer. The amount or increase of UV-B is dependent mainly on latitude, with the greatest increases in the arctic and Antarctic regions. UV-radiation (UV) is a part of non-ionizing region of the electromagnetic spectrum which comprises approximately 8-9% of the total solar radiation (Coohill, 1989; Frederick, 1993). The ultraviolet radiation that is present in sunlight is divided into three classes: UV-A, UV-B and UV-C. The UV-A, with wavelengths from 320 to 390 nm, is not attenuated by ozone and thus is not affected by depletion of the stratospheric ozone layer. The UV-C, with wavelength shorter than 280 nm, does not reach ground level and this is not expected to change. It is the UV-B radiation that has received most attention because UV-B is absorbed by ozone. Different species have different response to the level of UV-B irradiation (Matthew *et al.*, 1996; Skórska, 1996a, b). Different plant responses to supplemental UV-B radiation have been established, mostly injurious but sometimes beneficial. UV-B can influence plant processes either through direct damage or via various regulatory effects (Potters *et al.*, 2009). The injury can be classified into two categories: direct injury to DNA, which can cause heritable mutations, and direct and indirect injury to plant physiological functions (Lidon, 2012). In plants, wide inter and intra specific differences have been reported in response to UV-B irradiation with respect to growth, production of dry matter and physiological and biochemical changes (Fedina *et al.*, 2010). Some plant species are unaffected by UV-B irradiation and several are apparently stimulated in their growth, but most species are sensitive and results in damages, example; *Oryza sativa* L. (rice) and *Zea mays* L. (maize) (Lidon, 2012). On the other hand, plants have developed protective mechanisms against UV-B stress, such as enhancement of the anti-oxidant system and accumulation of UV-absorbing compounds. Furthermore, numerous environmental factors such as water deficit, high temperature, ambient levels of visible radiation and nutrient status have also been shown to weaken or enhance the responses of plants to UV-light radiation, (Lidon, 2012). Understanding the mechanisms by which physiological processes are damaged, repaired, and/or protected is important for understanding the eco-physiological role of UV-light radiation. The aim of this research is to examine the effect of the varying levels of UV-B radiation on the growth parameters and development of *Solanum lycopersicum*.

2. Materials and Methods

2.1 Study Area

This research work was carried out at Etinan Local Government Area, Akwa Ibom State, Nigeria. Etinan Local Government Area lies between latitude 05001^{0}N and longitude 07054^{0}E. It land mass covers a total of 26 square kilometres South of Uyo the Akwa Ibom State Capital and 24 kilometres North of Eket.

2.2 Collection of Experimental plant

The seeds of the experimental plant (*Solanum lycopersicum*) used in this research was collected fromAkwa Ibom State Agricultural Development Project (AKADEP), local farms and markets in Etinan, Akwa Ibom State. The plant used was identified by a plant taxonomist in the Department of Botany, University of Uyo, Nigeria.

2.3 Bucket/Land Preparation

The sandy- loamy soil used was collected from an abandoned plot land (farm land) in Etinan. The soil was sterilized for two hours and sieved through a 2mm mesh to remove pebbles and mixed with cow dung after which it was transferred into the plastic buckets to raise *Solanum lycopersicum* plant.

2.4 Seed Treatments

The obtained seeds were pretreated by picking out infected seeds. The viable ones were used for this research. Cow dung was used as organic manure for all the treatments. This treatment helps in good seed germination, reduces stress and also overcomes drought effectively (De Ridder and Kuelen, 1990).

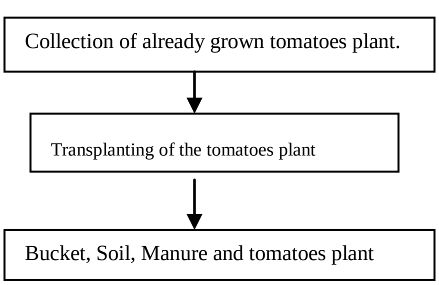
2.5 Weed Control

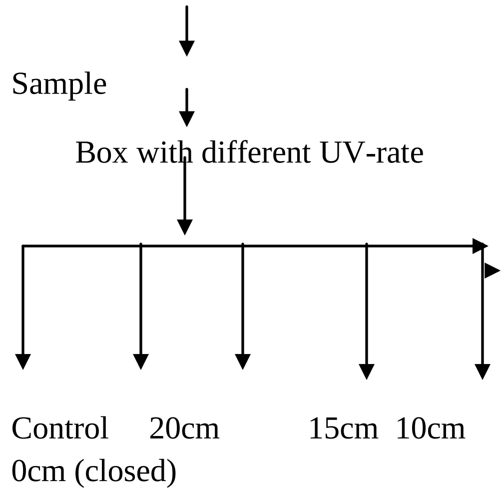
Hand pulling was done for weeding at second week after sowing and subsequently at two weeks interval, to prevent weeds from competing with the crops for nutrients, sunlight and water. The plants were also watered daily.

2.6 Experimental Design

The already grown tomato plants was collected from the bed and then transplanted to the buckets containing soil and the organic manure; there were four buckets with three replications each. The samples were then transferred into the box with different UV-rates. (20cm, 15cm, 10cm, and 0cm), there was also a sample used as the control (open) which was opened to full radiation of the sunlight. The experimental work was carried out in the format shown below; the diameter for the UV rates was measured in centimeter (cm).

Figure 1:chart showing how the experimental work was carried out.





2.7 Determination of growth parameters

Measurement of growth parameters such as plant height, number of leaves, number of branches, and number of flowers in centimeters (cm) and counting was done after four weeks.

2.8 Statistical Analysis

All the data generated during the field work was analyzed using statistical package for social science (SPSS) 19.0 versions on the independent sample.

3. Results

Table 1 shows the initial readings before the plant specimens were exposed to UV-light, the plant in chamber D had the highest plant height, number of leaves and number of branches with 19.25cm, 24.00cm and 5.50cm respectively. The plant used as control (opened) had the lowest plant height (12.55cm). The plant in chamber B had the least number of leaves (11.00), while all the plants had no flowers.

Table 1: The measure of initial growth parameters of *Solanum lycopersicum* before exposure to UV-light radiation.

		Measured	Parameters		
UV-Level	Chambers	Plant Height (cm)	No. of Leaves	No. of Branches	No. of flowers
20	A	12.79	15.50	4.00	0.00
15	B	12.50	11.00	4.00	0.00
10	C	10.75	13.00	4.50	0.00
0	D	19.25	24.00	5.50	0.00
Open	E	12.25	15.00	4.00	0.00

Data is presented as mean of triplicate experiments

Table 2 shows the average readings of *Solanum lycopersicum* after four weeks of exposure to UV-light, the plant specimen in chamber B had the highest plant height with (18.750 cm), while the specimen in chamber C recorded the highest number of leaves with (15.50), The plant specimen in the open (control) had the lowest plant height with 13.83 cm and recorded the highest number of branches (5.00), also, the plant in chamber A, recorded the lowest of branches with (3.83). In chamber D*Solanum lycopersicum* had lost all its branches, leaves and reduced in height drastically (15.42cm). All the specimens had no flowers as at the time of these recordings.

Table 2: The growth parameters of *Solanum lycopersicum*after 4 weeks of exposure to UV-light radiation.

		Measured	Parameters		
UV-Level	Chambers	Plant Height (cm)	No. of Leaves	No. of Branches	No. of flowers
20	A	16.13	12.95	3.830	0.00
15	B	18.750	0.00	0.00	0.00
10	C	16.29	15.50	4.420	0.00
0	D	15.42	0.00	0.00	0.00
Open	E	14.00	13.83	5.00	0.00

Data is presented as mean of triplicate experiments

Table 3 shows the differences in the plant height of *Solanum lycopersicum*after the period of four weeks of exposure to the U-V light at different levels. The plant in chamber B, had the highest increase in plant height (6.25cm), while the plant in chamber D, recorded the lowest in plant height (-3.83cm).

Table 3: The Difference in plant height of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation.

Chambers	Initial value (mean)	Values after 4 weeks (mean)	Difference
A	12.79	16.13	3.38
B	12.50	18.750	6.25
C	10.75	16.29	5.54
D	19.25	15.42	-3.83

E	12.25	14.00	1.75

Table 4 shows the differences in the number of leaves of *Solanum lycopersicum* after four weeks of exposure to U-V at different levels. The plant specimen in chamber C recorded the highest number of leaves with a difference of (2.50); the least in the number of leaves was the plant specimen in chamber D with differences of (-24.00). While all other specimens recorded reduction.

Table 4: The Difference in number of leaves of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation.

Chambers	Initial value (mean)	Values after 4 weeks (mean)	Difference
A	15.50	12.95	-2.54
B	11.00	0.00	-11.00
C	13.00	15.50	2.50
D	24.00	0.00	-24.00
E	15.00	13.83	-1.17

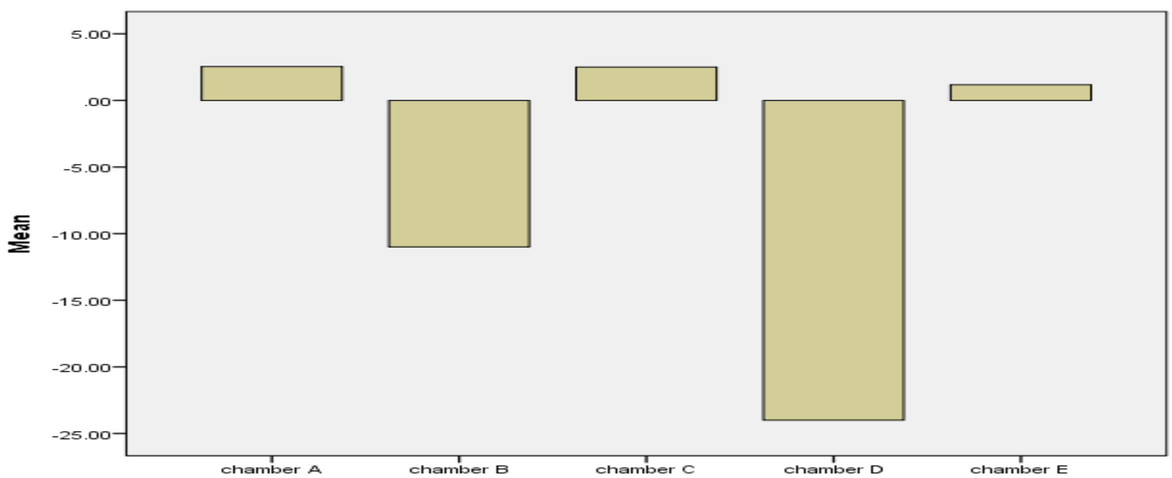
Table 5 shows the differences in the number of branches of *Solanum lycopersicum* after four weeks of exposure to the UV-light. The plant specimen in chamber E had an increase in the number of branches with (1.00); the least in the number of branches was the specimen in chamber D with a difference of (-5.50). While the other entire specimens lost their branches. The entire treatments had no flowers after four weeks of exposure to different levels of UV-B light radiation.

Table 5: The Difference in number of branches of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation.

Chambers	Initial value (mean)	Values after 4 weeks (mean)	Difference
A	4.00	3.830	-0.17
B	4.00	0.00	-4.00
C	4.50	4.420	-0.08
D	5.50	0.00	-5.50
E	4.00	5.00	1.00

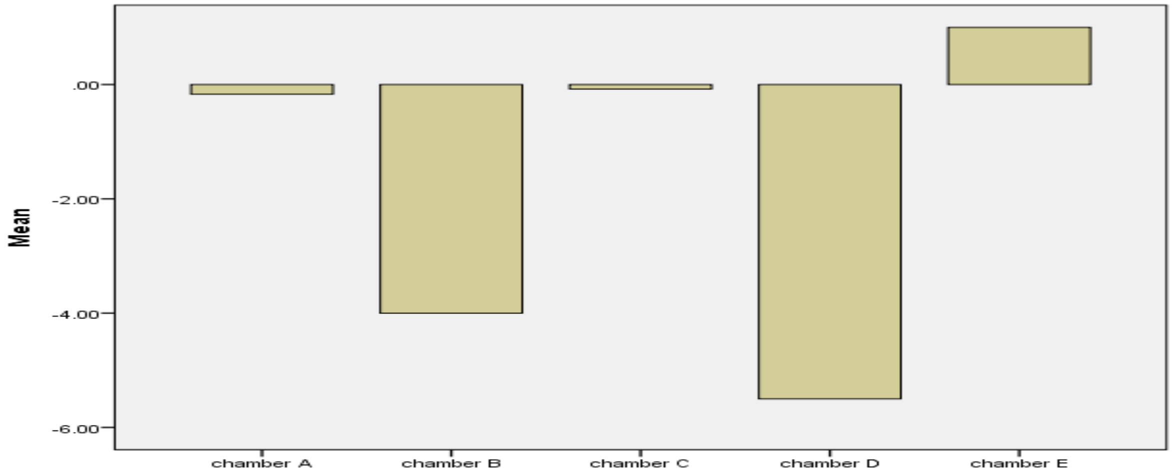
Plant height

Figure 2: Changes in the height of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation



Number of leaves

Figure 3: Changes in the number of leaves of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation



Number of branches

Figure 4: Changes in the number of branches of *Solanum lycopersicum* after 4 weeks of exposure to UV-light radiation

4. Discussion

Light is the main environmental factor affecting plant growth. The *Solanum lycopersicum* grown in chambers under different UV-light radiation had different growth habit and different reaction to UV radiation. Values of the measured parameters before and after experiment, revealed differences in the readings it showed that at reduced and maintained level of UV radiation, growth in the parameters such as the number of leaves and plant height of *Solanum lycopersicum*had grown and increased significantly. It was also observed that *Solanum lycopersicum* would not grow and develop faster under an increased UV-light radiation. This is in line with the work of Zuk-Golaszewska *et al.* (2003) who reported species *Avena fatua* and *Setaria viridis* grown in the greenhouse under the UV-B radiation had different growth habit and different reaction to UV-B radiation. The high level of irradiation caused leaf curling, especially at the *Setaria viridis.*Similarly, Barness *et al.* (1988), Greenberg *et al.* (1997) and Furness *et al.* (1999),they reported the distinguished changes in the morphological traits such as the plant height and the leaf area reduction and the curling of leaves. This could be as a result of the different sunlight conditions in the series of the experiment. Middleton and Teramura (1994) reported that plant species (and groups) vary considerably in their response to UV-light, depending on experimental set up, treatment regimes and duration.UV-B radiation may be very significant and more effective to growth and development of *Solanum lycopersicum*at a reduced rate but the plant may completely stop to grow, shrink or dry up completely if absent as observed in this work. Chamber D, which was completely closed and had no sources to UV-light radiation started shrinking at just three days of transplant. It was also observed that transplanting had effect on the plants; the UV radiation helped the tomato plants to stabilize and acclimatize to the environment because the specimen in chamber D had lost all its branches little over five days after the transplant was done.Increased UV-light radiation can result in decreases in biomass or total dry matter production and marketable yield. Correia *et al.* (1999) reported that increased UV radiation have negative effect on some plants example, Wheat plants (*Triticum aestivum* L.) was exposed to high UV radiation levels showed a reduction in total plant biomass, leaf area and net photosynthetic rate compared to the control that was exposed to ambient UV radiation.Apart from the negative effect caused by increased Ultra-violet radiation, it also played important role in some species of plants helping in DNA repair, showing that both genetic and epigenetic effects controls DNA repair in plants like in *Zea mays* and *Arabidopsis thaliana* (Campi *et al.*, 2012).

5. Conclusion

Based on this research it is clear and obvious that UV-B light radiation is a vital environmental factor that can affect the growth and development of *Solanum lycopersicum*either positively or negatively depending on the amount of exposure of these plants to UV-B light. The absences of UV-B light lead to poor growth of the plant and may even lead to the death. It was also observed that UV-B light is very important in the growth and development*Solanum lycopersicum*, but it's required in a reduced amount which records increase in their parameters. Increased UV-B light radiation can result in decreases in biomass or total dry matter production and marketable yield.

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