Research Article

Mutagenic Role of Artificial Ultraviolet (UV-C) Irradiation on the Growth and Yield of Tomato (*Solanum Lycopersicon* L.)

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ABSTRACT

Effects of artificial ultraviolet (UV-C) radiation (254nm) on the growth and yield of Solanum lycopersicon (tomato) accession NGB 01301 were studied. Viable seeds were irradiated with handheld UV lamp (model UVGL-55; Science company, USA) for 0, 10, 20, 30, 40, 50 and 60 min. Treated seeds were sown in plastic buckets at the screened house of the Botanical garden of the University of Ilorin, Nigeria in five replicates. Quantitative data were obtained at maturity, 20 WAS (Weeks After Sowing) and subjected to Analysis of variance using SPSS 16.0 for Windows. Highest germination (93.33%) was obtained in 30 min treatment and the lowest (63.33%) in 10 min exposure. Maximum plant height (53.37 cm) was recorded in 10 min while the least (47.60cm) was in 60 min treatment. Petiole length was highest (2.40 cm) in treatment for 10min, treatment with 50 min produced least petiole length (1.37±0.26 cm). With respect to leaf parameters, optimum performance was recorded in 30 min treatment. However, highest performance in response to UV irradiation with respect to petiole length, number of branches and leaf number occurred in 10 min treatment. Among the exposure time evaluated, 30 min produced early maturing plants with highest fruit yield.

Keywords: Mutagenic, Ultraviolent light, radiation, treatment, Solanum lycopersicon.

1. INTRODUCTION

(Ultra violet) light (UV- C) is an electromagnetic radiation which ranges from 100 nm to 400 nm (1nm = 10^{-9}m) with a short wavelength and invisible to the human eyes but longer than X-rays. The International Commission on Illumination (CIE) has classified UV spectrum into three bands: UV-A (long-wave) from 315 to 400 nm; UVB (medium-wave) from 280 to 315 nm and UV -C (short-wave) from 100 to 280 nm. UV-C is the radiation with the shortest wavelength, or rather with the higher associated energy [1]. UV-C action on microorganisms in water, on surfaces and in air is extremely germicidal [2]. The amount of UV-C getting to the earth's surface is very low because this form of radiation is strongly affected by the ozone layer in the stratosphere except in the mountains as temperature increases along with altitude as a result of absorption of UV by ozone [3]. A human activity that releases dangerous chemicals, such as chlorofluorocarbons (CFC) into the atmosphere contributes significantly to the depletion of ozone protective layer. It is envisaged that in the future UV-C radiation would increase due to atmospheric pollution triggered by the depletion of

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the ozone stratosphere. And this has ecological implication of increasing UV-C radiation on natural ecosystems and on agricultural productions [4]. It is therefore important to study the effect of this radiation on some crops which are of great economic importance.

Tomato (*Solanum lycopersicon*) is grown worldwide for its edible fruits, with thousands of cultivars with varying fruit types, shape and colour. It contains vitamins, minerals, fibers and is of high nutritional values. Anti-oxidants such as lycopene that can protect against cancer of the prostate, lung and stomach are said to be present in tomato [5]. Lycopene has also been shown to improve the skin's ability to protect against harmful UV rays [6]. Tomato is cultivated almost throughout Nigeria and the country ranked 13th in the world production with an average of 1,701,000 tons (FAO, 2010).Tomato production ranks second after potato in global vegetable production with an estimate of about 458.2 million ha being used for its cultivation globally with yield of about 32.8 tons/ha [7]. This crop is no doubt of great economic importance and the study of its response to UV – C irradiation in terms of growth and yield will be of importance in plant breeding programs.

2. MATERIALS AND METHOD

Assessment of the effect of UV-C irradiation on tomato (*Solanumlycopersicon*) was studied by using an irradiation box (19cm x 27cm x 22cm) coated with aluminum sheets and equipped with a UV-C handheld lamp, model UVGL-55(Science company, US),6W, 254nm/365nm/50 Hz. Seeds were obtained from the National Agency for Genetic Resources and Biotechnology (NAGRAB) Ibadan, Nigeria. Seeds were divided into seven groups based on irradiation duration. Seeds were placed at a distance of 22cm in the box and were irradiated at durations of 0, 10, 20, 30, 40, 50 and 60 minutes at exposure of 0.14kJ/m^2 - 3.7kJ/m^2 (254nm).

5 seeds were sown in plastic buckets of 10 liter capacity filled with sandy- loam soil in 5 replicates for all treatments in Randomized Complete Block Design (CRBD)in the screen house at the Botanical Garden of the University of Ilorin, Nigeria. Plants were irrigated daily and necessary cultural practices were provided. Data were collected on germination of the seed and the percentage germinations were estimated. Quantitative growth and morphological data, floral and fruit characteristics data were also collected. Data were subjected to Analysis of Variance with SPSS 16.0 for windows. The means were separated with Duncan Multiple Range Test (DMRT) at level of significance $P \leq 0.05$.

Table 1.Percentage Germination of NGB01301

Treatments duration	Germination rate (%)
0 min	35.00^{c}
10 min	63.33^{b}
20 min	76.67^{ab}
30 min	93.33^{a}
40 min	83.33^{ab}
50 min	86.67^{ab}
60 min	66.67^{ab}

3. RESULTS

The irradiated seed germinated 4-6 days after sowing; germination percentage in the 7 treatments was between 93.33 % and 63.33% (Table 1). Significant variations were observed in the treatment mean of some growth and yield parameters under study. Plant height showed significant difference among the treatment duration.Highest plant height was in treatment of 10 min (53.37cm) while the least was in treatment at 60min (47.60cm). Exposure for 10 min produced the highest petiole length of 2.40 cm with the shortest in 50 min (1. 37cm). Highest leaf width was recorded in 30 min (2.03 cm) while the least was in 20 min (1.27 cm) (Table 2). Similarly, maximum leaf length was produced in the 30 min (3.87cm) treatment with the least in 60 min (2.30cm). No significant differences were observed among the treatment mean in the number of branches at $p \leq 0.05$ (Table 2).

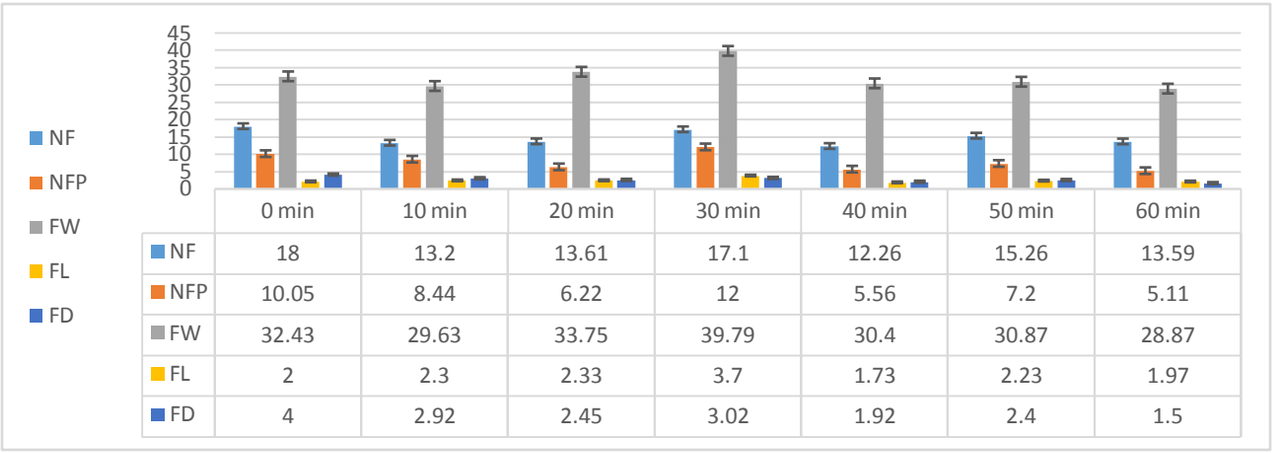
Highest number of leaf was in 10 min (25.33) and the least was obtained in 50 min (12.00). Table 2

Earliest flowering (65.33 days after sowing (DAS)) was obtained in 30min treatment as compared to the 71.67 (DAS) of the 60 min treatment.

Table 2: Means of vegetative parameters of NGB 01301 at maturity (20 WAP)

TREATMENTS	PH (cm)	PL (cm)	LW(cm)	LL (cm)	NB	NL
10 min	53.37^{b}±0.23	2.40^{ab}±0.15	1.90^{bc}±0.40	3.40^{bc}±0.35	12.67^{b}±1.86	25.33^{ab}±10.68
20 min	52.17^{c}±0.18	1.90^{bc}±0.10	1.27^{c}±0.17m	2.57^{cd}±0.37	11.67^{b}±1.20	18.67^{bcd}±6.74
30 min	51.07^{d}±0.29	1.83^{bc}±0.17	2.03^{b}±0.34	3.87^{ab}±0.34	10.67^{b}±0.88	21.00^{abc}±8.50
40 min	49.70^{e}±0.32	1.63^{c}±0.45	1.97^{bc}±0.33	2.93^{bcd}±0.32	10.67^{b}±1.20	16.67^{bcd}±11.85
50 min	48.33^{f}±0.26	1.37^{c}±0.26	1.67^{bc}±0.15	2.30^{d}±0.55	9.33^{b}±1.67	15.33^{d}±14.36
60 min	47.60^{g}±0.26	1.27^{c}±0.27	1.43^{bc}±0.20	1.07^{bcd}±0.23	6 .33^{b}±2.03	10.05^{cd}±5.70
0 min	55.50^{a}±0.00	3.00^{a}±0.00	2.80^{a}±0.00	4.70^{a}±0.00	18.00^{a}±0.00	30.00^{a}±0.00

Key: PH= plant height, PL= petiole length, LW= leaf width, LL= leaf length, NB= number of branches, NL= number of leaf



	0 min	10 min	20 min	30 min	40 min	50 min	60 min
NF	18	13.2	13.61	17.1	12.26	15.26	13.59
NFP	10.05	8.44	6.22	12	5.56	7.2	5.11
FW	32.43	29.63	33.75	39.79	30.4	30.87	28.87
FL	2	2.3	2.33	3.7	1.73	2.23	1.97
FD	4	2.92	2.45	3.02	1.92	2.4	1.5

Figure 1. Floral and Fruit characteristics of UV effect on S. Lycopersicon. Key: NF: number of flowers, NFP: number of fruit/plant, FW: fruit weight, FL: fruit length, FD: fruit diameter.

Highest numbers of fruits (12.00) with an average weight of 39.79g were produced in 30 min, lowest number of fruit (5.11) was in 60 min having an average weight of (28.87g). 3.70 cm was the highest fruit length and was in 30 min, however the shortest fruit was in 60 min (1.97 cm).Fig 1 showed the mean values of the floral and fruit characteristics evaluated for the treatments. Fig 2 showed the effect of UV-C irradiation on shape and size of *Solanum lycopersicon.*

4. DISCUSSION

Higher exposure to UV-C irradiation has produced reduction in plant growth when compared to the control in this study. This agrees with the work of [8]on UV-C irradiated *Juncus effuses* plants, which showed significant reduction in plant growth and biomass. The values obtained for plant height is in consonance with the work of [9] in their work showed that lower dosage produces higher vegetative results and higher level of UV-C irradiation on tomatoes plant can lead to plant death. Shorter UV seed irradiation period increases plant height while longer periods of exposures reduce plant height [10]. [11]opined that increase in exposition time to UV-C light causes inhibition of essential enzymatic reactions thereby leading to decrease in the uptake and partitioning of nutrients.Treatment at 30 min in this study produced the highest fruit parameters, The recorded highest fruit parameters in the 30 min exposure time among the treatment may not be unconnected to the fact that lower irradiation (0 to 30 min) allows normal physiological recovery partially [9].

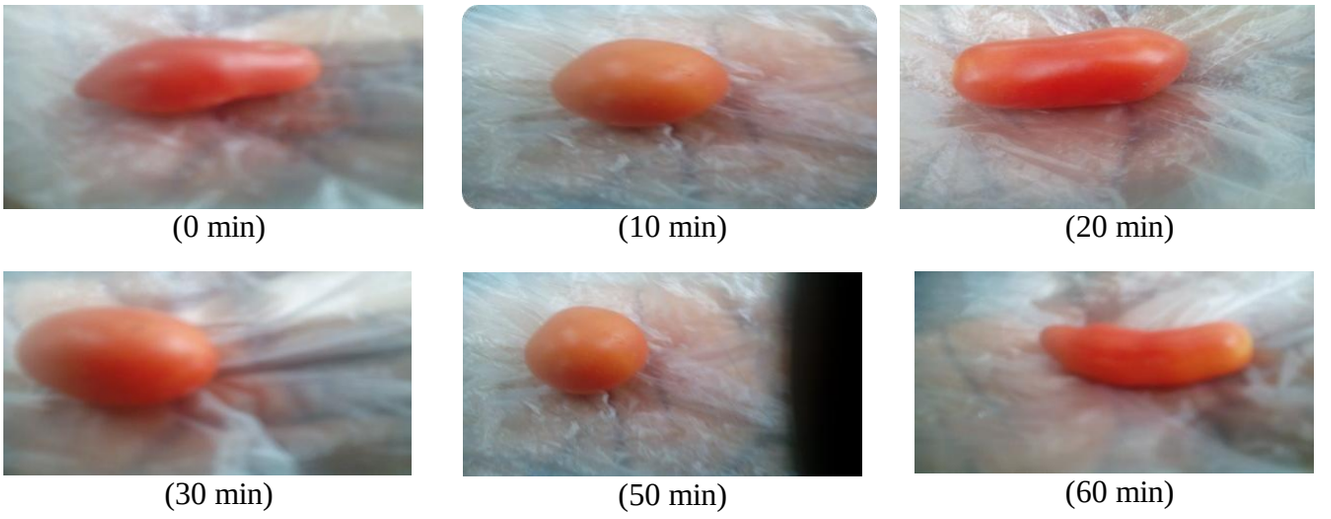


Figure 2. Effects of UV-C irradiation on the size and shape of the fruits of *Solanum lycopersicon*

The treatment of tomato seeds with minimal dosage (up to 30min) of ultra violet irradiation can be used in crop improvement while high dosage (60min and above) of UV-C affects not only the physiological but also the anatomical integrity of the plant. The pigments in the plants can also be affected by the treatment and this may be as a result of photoxidation of chlorophyll [9].

5. CONCLUSION

It is important to find the optimal doses for seed pretreatment for each species. This study has shown that 30 min exposition and with UV- C exposure at 254 nm produced the highest yield in the treatment mean. Though exposition at 60 min did not cause plant death but a reduction in yield was recorded compared to the control. Therefore for the purpose of growth and yield improvement using UV-C irradiation in *Solanum lycopersicon* 30 min is recommended.

6. ACKNOWLEDGEMENTS

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