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EFFECTS OF ULTRAVIOLET RADIATION ON THE GROWTH AND GERMINATION OF SORGHUM (*SORGHUM BICOLOR)*

Shehu Sadiq Olayinka*, Olorunmaiye K. S., Yahaya G. M.,

Alabi F. B., and Olayinka B. U.

Department of Plant Biology, Faculty of Life Sciences,
University of Ilorin, Ilorin, Nigeria.

*Corresponding Author's Email: sadiqolayinka09@gmail.com

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ABSTRACT: *The essential requirement for plant growth is the sun. UV radiation, the damaging component of solar radiation, can reduce plant growth by decreasing the metabolic rate of photosynthesis. Plant quality and growth are significantly influenced by the light's wavelength, intensity, and exposure. The study's goal was to examine "the Effects of UV Irradiation on the growth and yield of Sorghum (Sorghum bicolor)" growth, photomorphogenesis, and stress tolerance. The study used the CRD technique of analysis because of its useful findings from pre-planting UV-light exposure of the seeds and subsequent monitoring of their germination and growth. It is common knowledge that UV radiation alters plant architecture, having a considerable impact on attractive crops and increasing their market value. Abiotic stress caused by UV exposure has two effects: it boosts resistance to pests and pathogens and lessens postharvest quality degradation. This study will aid academics and businesses in their understanding of how UV radiation affects the biological output of grains.*

KEYWORDS: Ultraviolet Light, Irradiation, Photomorphogenesis, UV wavelengths, CRD, Photogradation.

INTRODUCTION

Ultraviolet radiation is a type of light that has a longer wavelength than x-radiation but a shorter wavelength (higher frequency) than visible light. Its wavelength ranges from 100 nm to 400 nm. Because it is invisible to the human eye, ultraviolet radiation is occasionally referred to as "black light." The definition of "ultraviolet" is beyond violet. Johann Wilhelm Ritter, a German physicist, made the discovery of ultraviolet radiation in 1801. Beyond the violet region of the visible spectrum, Ritter discovered that invisible light discolored silver chloride-treated paper more quickly than violet light. His description of the intangible light as oxidizing rays alludes to its chemical activity. Until the end of the 19th century, most people referred to chemical rays as heat rays, while chemical rays were referred to as ultraviolet radiation (Hunt *et al.*, 2009). Any energy that moves from one location to another or that moves through space as a wave or particle is referred to as radiation. The frequency and wavelength of the electromagnetic radiation that the Sun emits are typically used to describe it. The fact that most people cannot see UV light does not necessarily mean that the human retina is unable to do so. Many people lack the color receptor needed to perceive color, and the eye's lens filters out UVB and higher frequencies. However, those who are without a lens (aphakia) or who have had a lens changed (as in cataract surgery) may be able to sense some UV wavelengths (Sinclair *et al.*, 2010). Children and young adults are more likely to perceive UV than older adults. It is described as a blue-white or violet-white color by those who can see UV. Near-UV light is visible to some animals, birds, and insects. Because they have a fourth color receptor to detect UV light, birds have true UV vision (Pieterse *et al.*, 2012). An example of a mammal that can see UV light is a reindeer. Utilizing the snow, they can see arctic bears. Other mammals follow urine tracks left by their prey using UV light. UV radiation is a non-ionizing radiation whose spectrum (140-400 nm) includes wavelengths between 250 and 280 nm. Since most proteins contain aromatic amino acids and can absorb light of this wavelength, it can be used as a germicide. Because exposure to UV radiation causes the synthesis of vitamin D, which is essential for healthy development, UV lamps have long been used for both air sanitation and the late-winter skin care of newborns and young children (Ouzounis *et al.*, 2015).

Cereals, sometimes known as grains, are plants in the Poaceae (grass) family that are grown largely for their starchy dry fruits. Wheat, rye, oats, barley, sorghum, and millets are examples of cereal grains. Cereals such as Sorghum and others self-fertilize. The pistil (stigma and ovary) of a specific flower becomes impregnated with pollen transported by the stamen, allowing the variety to reproduce faithfully. Because they produce a range of secondary metabolites, including flavonoids and anthocyanins, some plants are more tolerant to UV radiation than others. These substances frequently gather in the leaf epidermis cells on the upper surface and efficiently absorb UV radiation, shielding the leaf mesophyll cells from its penetration. Although UV radiation can be used to sterilize surfaces and air spaces, its application is constrained by the fact that it has a low penetration capability and that its energy diminishes quadratically with increasing distance from the light source. It is advised to take caution when applying it because it can damage the eyes and, when used in high quantities, can even result in skin cancer (Forney *et al.*, 2004).

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Statement of research problem

Premature aging and skin cancer are side consequences of continuous UV exposure; UV radiation overexposure can cause major health problems, including cancer. High amounts of UV are known to harm production and quality standards. High amounts of UV are known to harm grain quality and output. Both plants and animals are affected by ultraviolet rays. Almost all green plants have their growth processes slowed down by too much UV-B radiation.

Most of the sun's scorching ultraviolet (UV) rays are absorbed by the ozone layer, which serves as a natural filter. There are worries that the loss of plant species and decreased global food supply could result from ozone depletion. An increase in UV-B that reaches the earth's surface because of stratospheric ozone loss can disrupt biological processes and harm a variety of materials. The fact that these effects of UV-B radiation on people have existed for a long time should not be overlooked. Given the interconnectedness of all life, any alteration in the equilibrium of plant species could have negative consequences. In addition to serving as the foundation of the food chain, plants also serve as a major source of oxygen, a major sink (or repository) for carbon dioxide, and a major barrier against soil erosion and water loss. Animals cannot be artificially shielded against UV-B on a broad scale, even though most of them have superior UV-B protection due to their thick coats and skin pigmentation. The most vulnerable areas are the eyes and unprotected body regions (Fina *et al.*, 2017).

Only synthetic UV radiation is employed in place of sunlight. The germination and intensity of seeds that have been exposed to ultraviolet light benefit from the activation of plants buried in biological reserves. Numerous methods can be used, but only in place of the light, to stimulate the growth of seeds.

Justification of the Study

The study of the effects of UV radiation on the selected cereal (*Sorghum bicolor)* is warranted due to their significance to food security, environmental issues, scientific knowledge, economic ramifications and the possibility of reducing adverse effects on agriculture. Millions of people worldwide depend on sorghum as their primary crop. Any detrimental impact of UV radiation on this crop could have a considerable impact on both farmers' livelihoods and food security. As a result, insights from this study can be used to build breeding programs to create UV-tolerant varieties or useful agronomic techniques to protect Sorghum from UV radiation and how plants respond to environmental stress.

Aims and objectives

Aim

The aim of the study was to determine the effects of UV-Irradiation on the germination and early development of sorghum (Sorghum bicolor).

Objectives

The specific objectives of the present study were

i. To examine the effects of ultraviolet radiation on seed germination of two accessions of sorghum; and

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ii. To monitor the germination rates and seed growth of the two selected accessions of sorghum.

Ultraviolet Radiation (UV)

Electromagnetic radiation or light, with a wavelength more than 100 nm but less than 400 nm is referred to as ultraviolet radiation. It is often referred to as UV light, UV radiation, or just UV. Ultraviolet radiation is a type of non-ionizing radiation that is emitted by artificial sources, including tanning beds and the sun. While it can produce vitamin D, which is good for people, there are also potential health hazards. (Cronin *et al.*, 2016).

The wavelength of ultraviolet radiation is shorter than that of visible light but longer than that of x-rays. Despite having enough energy to dissolve some chemical bonds, ultraviolet light is not typically regarded as an ionizing radiation. The energy absorbed by molecules can act as the initiating energy for chemical reactions and result in the fluorescence or phosphorescence of some materials (Erickson *et al.,* 2015). Before UVB exposure, prokaryotes were unable to exist on the surface of the Earth because UVB radiation caused neighboring thymine base pairs to bond together or produce thymine dimers. Because it changed the reading frame required for genetic material replication and protein production, this disruption proved lethal to the cell. Prokaryotes that got away from the aquatic life's defenses created enzymes to fix thymine dimers. These repair enzymes are still present even though the ozone layer eventually developed and shielded cells from the most harmful solar UV radiation (Hockberger, 2002).

Ultraviolet Radiation (UV) Sources

UV radiation makes up about 10% of the Sun's total light output. About 50% of the sunlight that reaches the Earth's atmosphere is infrared radiation, 40% is visible light, and 10% is ultraviolet radiation. However, the atmosphere absorbs most solar UV light at shorter wavelengths, blocking around 77% of it. About 53% of the infrared, 44% of the visible, and 3% of the UV light that reaches Earth's surface (Bolton *et al.*, 2008).

Man-made UV radiation sources include:

i. Lighting made of mercury vapor (common in gymnasiums and stadiums)

ii. Several incandescent, fluorescent, and halogen lights.

iii. Tanning beds.

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MATERIALS AND METHODS

Description of Experimental Site

The experiment was carried out in the botanical garden located in the University of Ilorin, with a latitude lying between 8º30'N and longitude 4º33'E) Ilorin, Nigeria. Ilorin is a city located in Kwara state and the capital of the state, lying in between a latitude of 8º31'N and 8º52'W having an area of 100km square (Kwara state Diary, 2007). The city of Ilorin is situated in a tropical part of the country with a mean annual rainfall of about 1130mm, with an average annual temperature of 30.15ºC (Udo, 2000).

Collection of Materials

Two sorghums (R960 and H46) were obtained from the International Institute of Tropical Agriculture, Ibadan. A set of perforated polythene bags where the seeds will be planted was purchased from Ipata market in Ilorin. The soil used was topsoil, sieved, homogenized and steam sterilized to a temperature of 80°C for 30minutes, followed by an 8-minute resting period, resulting in 100% killing of weeds and soil pathogens (van Loenen et al., 2003). The soil was then potted into polythene perforated bags of 5-liter capacity prior to the sowing of the previously irradiated seeds. Other materials used include Ultraviolet light from the model UVGL-55 Handheld UV lamp located in the Central Research Laboratory of the University of Ilorin.

Viability Test

A seed viability test was carried out using four transparent plastics for each accession with tissue paper placed in it and the tissue paper was made wet by adding water and the seeds were put in. After 3 days, germination was observed in most of the seeds and this indicated that the majority of the seeds were viable.

Planting

42 perforated polythene pots were filled with the already steam-sterilized soil and some vermiculite was added to the soil to aid the growth of our seeds. 20 seeds were planted in each bag; the bags were labelled based on accession and the kind of treatment applied. Each accession was exposed to UV light for the following duration: 10 minutes, 15 minutes and 20 minutes and was planted in 2 replicates. A controlled experiment was conducted for each accession of Sorghum by using distilled water without exposure to Ultraviolet light. The Polythene pots were arranged 15cm to one another, with the seeds with the same level of exposure planted on the same row for easy and appropriate management/identification. The layout was in a randomized blocked Pattern.

Germination Experiment

The bags were well covered with plastic wrap to maintain high humidity and then placed in a growth chamber in the vicinity of the botanical garden with controlled temperature and light conditions.

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Germination Assessment

The germination rate of the cereals planted was monitored daily and the number of germinated seeds for each pot was recorded. Continuous monitoring of the seedlings was done until their leafy stage, and at this point the germination rate was calculated as a percentage of the total number of seeds germinated/total seeds planted X 100.

Data Collection and Analysis

Different data was collected on germination rate, plant height, and leaf length for each treatment using an appropriate statistical method (ANOVA) to analyze the data and determine the effects of Ultraviolet radiation and the duration of exposure.

Morphological growth characteristics

Agronomic data were collected at 3, 4, 5 and 6 weeks after planting (WAP).

Plumule length (cm): This was determined by placing a ruler vertically from the base of each plant to the apical region.

Number of leaves (cm): The number of leaves on each plant was manually counted and recorded.

Leaf length (cm): This was measured by placing a ruler on the leaf and taking an appropriate reading.

Radicle length: This was determined by placing a ruler vertically from the base of each plant to the apical region.

Leaf color: This was visually observed.

Watering: Since the experiment was carried out during the season of harmattan and drought, daily watering was done every morning so that the germinated seeds would not dry off.

Thinning: This is the artificial removal of excess seedlings per petri dish. In each petri dish, 20 seeds were planted; the seedlings were thinned to 10 to avoid competition for water.

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RESULTS FOR TREATMENT IN POLYTHENE BAGS

PLUMULE LENGTH

Table 2: Plumule (cm) of H-46 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	1.20 ± 0.05[ab]	2.15 ± 0.00[a]	2.10 ± 1.00[a]	4.12 ± 0.10[b]	4.20 ± 0.03[a]
15 MIN	3.15 ± 0.03[d]	5.10 ± 0.00[d]	4.12 ± 0.05[b]	6.02 ± 0.07[d]	8.03 ± 0.02[c]
20 MIN	1.25 ± 0.02[bc]	2.85 ± 0.01[c]	4.10 ± 0.03[b]	4.23 ± 0.12[bc]	4.23 ± 0.01[a]
CONTROL	1.15 ± 0.11[a]	2.20 ± 0.03 [ab]	4.34 ±0.10[c]	3.32 ± 0.00[a]	4.42 ± 0.10[b]

Table 3: Plumule (cm) of R960 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	2.30 ± 0.12[b]	5.20 ± 0.05[d]	3.12 ± 0.10[a]	7.23 ± 0.31[c]	8.01 ± 0.04[d]
15 MIN	2.25 ± 0.03[b]	4.12 ± 0.05[c]	3.12 ± 0.04[a]	4.23 ± 0.04[ab]	5.21 ± 0.04[c]
20 MIN	1.21 ± 0.06[a]	2.90 ± 0.03[a]	4.01 ± 0.00[b]	4.16 ± 0.21[a]	4.40 ± 0.04[a]
CONTROL	1.22 ± 0.05[a]	3.15 ± 0.05 [b]	5.21 ± 0.23[c]	4.23 ± 0.15[ab]	4.76 ± 0.04[b]

RADICLE LENGTH

Table 4: Radicle (cm) of H-46 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	2.30 ± 0.07[a]	5.15 ± 0.45[b]	5.21 ± 0.02[a]	7.10 ± 0.03[a]	8.45 ± 0.43[b]
15 MIN	3.20 ± 0.10c	7.12 ± 0.44[d]	7.10 ± 1.03[b]	8.15 ± 0.56[b]	9.23 ± 0.12[c]
20 MIN	3.30 ± 0.23[c]	6.10 ± 0.67[c]	7.10 ± 0.86[b]	8.32 ± 0.34[c]	7.45 ± 0.34[a]
CONTROL	2.93 ± 0.42[b]	4.21 ± 0.34[a]	7.32 ± 0.24[c]	8.20 ± 0.34[b]	9.23 ± 0.33[c]

Table 5: Radicle (cm) of R960 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	3.20 ± 0.03[bc]	5.90 ± 0.98[b]	6.10 ± 0.43[b]	7.10 ± 0.56[a]	8.45 ± 0.14[b]
15 MIN	3.30 ± 0.05[bc]	7.15 ± 0.54[d]	7.10 ± 0.54[c]	9.12 ± 0.45[b]	9.23 ± 0.09[c]
20 MIN	2.21 ± 0.08[a]	4.20 ± 0.88[a]	3.12 ± 0.06[a]	7.12 ± 0.34[a]	7.45 ± 0.17[a]
CONTROL	3.10 ± 0.09[bc]	6.12 ± 0.54[bc]	8.02 ± 0.68[d]	9.13 ± 0.54[b]	9.23 ± 0.23[c]

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ADVENTITIOUS ROOTS

Table 6: Adventitious Roots of H-46 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	1.67 ± 0.01^{c}	2.67 ± 0.05^{c}	2.33 ± 0.04^{c}	2.00 ± 0.05^{c}	2.33 ± 0.00^{c}
15 MIN	1.33 ± 0.00^{b}	1.67 ± 0.02^{b}	1.33 ± 0.02^{b}	1.67 ± 0.05^{b}	1.67 ± 0.00^{b}
20 MIN	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}
CONTROL	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}

Table 7: Adventitious Roots of R960 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	1.67 ± 0.01^{c}	2.00 ± 0.05^{c}	2.33 ± 0.04^{c}	2.00 ± 0.00^{b}	2.33 ± 0.00^{b}
15 MIN	1.33 ± 0.00^{b}	1.33 ± 0.01^{b}	2.33 ± 0.02c	2.33 ± 0.05^{c}	2.33 ± 0.00^{b}
20 MIN	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}
CONTROL	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}	1.00 ± 0.00^{a}

GERMINATED SEEDS

Table 8: Number of Germinated Seeds of H-46 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	9.00 ± 0.21^{a}	12.67 ± 0.58^{b}	14.33 ± 1.00^{a}	13.00 ± 0.34^{a}	15.00 ± 0.45^{a}
15 MIN	12.67 ± 0.30^{c}	13.00 ± 0.49^{bc}	16.33 ± 1.28^{b}	17.00± 0.56^{b}	16.33 ± 1.14^{b}
20 MIN	12.33 ± 0.12^{b}	12.00 ± 0.99^{a}	17.00 ± 1.08^{c}	18.35 ± 2.91^{cd}	17.00 ± 1.20^{c}
CONTROL	15.00 ± 1.23^{d}	18.00 ± 2.09^{d}	20.00 ± 1.56^{d}	18.00 ± 1.78^{c}	18.00 ± 1.28^{d}

Table 9: Number of Germinated Seeds of R960 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	10.67 ± 0.45^{a}	14.66 ± 0.34^{b}	16.00 ± 0.12^{c}	16.33 ± 0.09^{b}	16.67 ± 0.47^{a}
15 MIN	12.67 ± 0.34^{b}	14.00 ± 0.93^{a}	16.33 ± 0.34^{cd}	17.67 ± 0.29^{c}	17.00 ± 0.49^{b}
20 MIN	12.67 ± 0.12^{b}	14.00 ± 0.74^{a}	15.00 ± 0.29^{b}	15.00 ± 0.80^{a}	16.67 ± 0.74^{a}
CONTROL	15.00 ± 1.01^{c}	20.00 ± 2.14^{c}	12.00 ± 0.24^{a}	20.00 ± 1.45^{d}	20.00 ± 1.63^{c}

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NON-GERMINATED SEEDS

Table 10: Number of Non-Germinated Seeds of H-46 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	11.00 ± 1.25^{d}	6.67 ± 0.40^{c}	5.67 ± 0.15^{d}	7.00 ± 0.52^{d}	5.00 ± 0.45^{d}
15 MIN	7.33 ± 0.54^{b}	7.00 ± 0.39^{d}	3.67 ± 0.12^{c}	3.00 ± 0.31^{c}	1.67 ± 0.03^{b}
20 MIN	7.67 ± 0.33^{bc}	5.00 ± 0.10^{b}	3.00 ± 0.05^{b}	1.67 ± 0.16^{a}	1.00 ± 0.01^{a}
CONTROL	5.00 ± 0.00^{a}	2.00 ± 0.02^{a}	2.00 ± 0.02^{a}	2.00 ± 0.00^{ab}	2.00 ± 0.00^{bc}

Table 11: Number of Non-Germinated Seeds of R960 Treatments and Control

TREATMENTS	1 DAP	2 DAP	3 DAP	4 DAP	5 DAP
10 MIN	9.33 ± 1.27^{c}	4.67 ± 0.30^{b}	4.00 ± 0.25^{c}	3.67 ± 0.35^{c}	7.00 ± 0.61^{d}
15 MIN	7.33 ± 2.23^{b}	6.00 ± 0.61^{c}	3.67 ± 0.12^{b}	2.33 ± 0.10^{b}	3.00 ± 0.25^{b}
20 MIN	7.33 ± 1.90^{b}	6.00 ± 0.50^{c}	5.00 ± 0.28^{d}	5.00 ± 0.35^{d}	3.33 ± 0.05^{c}
CONTROL	5.00 ± 1.23^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}

DISCUSSIONS

Plumule Length

H46

For the H46 millet seeds, the highest plumule length was observed in the 15 minutes treatment (exposure of the plant to UV light for 15 minutes) with a plumule length of 3.15cm, 5.10cm, 4.12cm, 6.02cm and 8.03cm respectively across the five planting days. This is followed by the 20 minutes treatment which has the next highest plumule length, with plumule lengths of 1.25cm, 2.85cm, 4.10cm, 4.23cm and 4.23cm respectively across the five planting days. The least plumule length among the three treatments and the control for all the planting days was observed in the 10 minutes treatment with a plumule length of 1.20cm, 2.15cm, 2.10cm, 4.12cm and 4.20cm. The plumule length for the treatments and control could be arranged in decreasing order as 15 minutes treatment > 20 minutes treatment > control > 10 minutes treatment.

R960

For the R960 sorghum seeds, the highest plumule length was observed in the 10 minutes treatment (exposure of the plant to UV light for 10 minutes) with a plumule length of 2.30cm, 5.20cm, 3.12cm, 7.23cm and 8.01cm respectively across the five planting days (except for 3DAP were the plumule). This is followed by the 15 minutes treatment which has the next highest plumule length, with plumule lengths of 2.25cm, 4.12cm, 3.12cm, 4.23cm and 5.21cm respectively across the five planting days. The least plumule length among the three treatments

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and the control for all the planting days was observed in the 20 minutes treatment with a plumule length of 1.21cm, 2.90cm, 4.01cm, 4.16cm and 4.40cm. The plumule length for the treatments and control could be arranged in decreasing order as 10 minutes treatment > 15 minutes treatment > control > 20 minutes treatment.

Radicle Length

H46

For the H46 sorghum seeds, the highest radicle length was observed in the 15 minutes treatment (exposure of the plant to UV light for 15 minutes) for 1-DAP, 2-DAP and 5-DAP with a radicle length of 3.30cm, 7.12cm and 9.23cm respectively; the second highest radicle length at 1-DAP is observed in the control while the least was observed in the 10-minute treatment; the second highest at 2-DAP was observed in the 5-minute treatment, wh while the least was the control; and lastly, at 5-DAP, the second highest radicle length at 1-DAP is observed in the 10-minute treatment while the least was observed in the 20-minute treatment

At 3-DAP and 4-DAP, the highest radicle length was observed in the control treatment, with a radicle length of 7.32cm and 8.32cm respectively; followed by the 20-minute treatment, with a radicle length of a 7.10cm and 8.20cm respectively while the least was observed in the 10-minute treatment, with a radicle length of 5.10cm and 7.10cm.

R960

For the R960 sorghum seeds, the highest radicle length was observed in the 15 minutes treatment (exposure of the plant to UV light for 15 minutes) for 1-DAP, 2-DAP, 4-DAP and 5-DAP with a radicle length of 3.30cm, 7.15cm, 9.13cm and 9.23cm respectively; the second highest radicle length at 2-DAP, 4-DAP and 5-DAP is observed in the control experiment while the least was observed in the 20-minute treatment. The 15-minute treatment and control produced the highest radicle length at 4-DAP and 5-DAP.

At 3-DAP, the highest radicle length was observed in the control with a radicle length of 8.02cm followed by the 15-minutes treatment with a radicle length of 7.10cm while the 20-minute treatment has the least.

Adventitious Roots

H46 AND R960

The highest number of adventitious roots across the five planting days for the two accessions of sorghum was observed in the 10-minutes treatment followed by the 15-minute treatment while the control has the least, i.e., 10-minutes > 15-minutes > 20-minutes > control treatment. For the two accessions, there are significant differences between the number of adventitious roots observed in the 10-minute and 20-minutes treatments while the number of accessions in both the 20-minute treatments and the control are statistically the same (1.00cm). In addition, there was no increase in the number of adventitious roots for the 20-minute treatments and the control across the five planting days.

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Germinated Seeds

H46

The highest number of germinated seeds for the H46 sorghum accession was observed in the control treatment across the five planting days with 15.00, 18.00, 20.00, 18.00, and 18.00 respectively while the 10-minutes treated produced the least number of germinated seeds. However, for 1-DAP and 2-DAP, the highest number of germinated seeds was observed in the 15-minutes treatment while the 20-minutes treatment produced the highest number of seeds from 3-DAP to 5-DAP. This implies that for the highest number of germinated seeds, the H46 sorghum accession is planted without exposure to UV light followed by exposure time of 15-minutes and 20-minutes. Furthermore, there are significant differences between the number of germinated seeds produced by each treatment across the five planting days. In addition, the number of germinated seeds increased progressively from 1-DAP to 5-DAP for the four treatments evaluated in the study.

R960

The highest number of germinated seeds for the R960 sorghum accession was observed in the control treatment across all the planting days with 15.00, 20.00, 20.00, 20.00, and 20.00 seeds respectively, followed by the 15-minute treatment while the 10-minutes treated produced the least number of germinated seeds i.e. control > 15-minute > 20-minute > 10-minute. This implies that for the highest number of germinated seeds, the H46 sorghum accession is planted without exposure to UV light followed by an exposure time of 15-minutes.

Non-Germinated Seeds

H46

The highest number of non-germinated seeds for the H46 sorghum accession was observed in the 10minute treatment across the five planting days with 11.00, 6.67, 5.67, 7.00, and 5.00 seeds respectively followed by the 15-minute treatment while the control treatment has the least number of non-germinated seeds i.e. 10-minute > 15-minute > 20-minute > control. Furthermore, there are significant differences between the number of non-germinated seeds produced by each treatment across the five planting days.

R960

The highest number of non-germinated seeds for the R960 sorghum accession was observed in the 10-minute treatment across the five planting days with 9.33, 4.67, 4.00, 3.67, and 3.00 seeds, respectively, followed by the 20-minute treatment, while the control treatment has the least number of non-germinated seeds, i.e., 10-minute > 20-minute > 15-minute > control. Furthermore, there are significant differences between the number of non-germinated seeds produced by each treatment across the five planting days.

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SUMMARY

Seeds of 2 accessions of sorghum were exposed to varying durations of UV radiation (10, 15, and 20 minutes), and key growth parameters such as plumule and radicle lengths, adventitious root formation, number of leaves, and germination rates were assessed in both polythene bag and petri dish experiments. The results showed that prolonged exposure (20 minutes) generally reduced seedling vigor, germination rates, and growth across both accessions, indicating the threshold beyond which UV radiation becomes detrimental. Sorghum accessions showed variable responses, with R960 benefiting from shorter UV exposure (10 minutes), while H46 performed better in control (unexposed) conditions.

CONCLUSION

From the findings of this study, we can conclude that UV radiation has both stimulatory and inhibitory effects on cereal germination and early growth, with responses varying between crop accessions. Sorghum responses were accession-dependent, with some accessions favoring no exposure and others responding positively to moderate UV treatment. Germination rates were mostly highest in control treatments, emphasizing the sensitivity of seeds to UV stress. It was also observed that adventitious root formation and leaf development were influenced by UV exposure, but the control and 15-minute treatments generally supported better growth. Overall, short-term UV exposure may induce beneficial stress responses, but prolonged exposure adversely affects germination and seedling vigor.
These results highlight the importance of understanding accession-dependent responses to abiotic stresses like UV radiation, particularly in the context of climate change, where UV fluctuations may impact crop production.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are proposed:

1. Farmers and breeders should avoid prolonged UV exposure during seed storage or early planting stages, as excessive UV radiation reduces germination and seedling vigor.
2. Selection and breeding efforts should focus on identifying and developing UV-resilient accessions, particularly for environments prone to high UV radiation.
3. Future agricultural practices in UV-exposed environments should incorporate protective measures (e.g., mulching, shading) during sensitive stages of crop establishment.

FUTURE RESEARCH DIRECTIONS

This study opens several pathways for future research:

1. Molecular analysis of UV stress response genes (e.g., antioxidant enzymes, DNA repair pathways) should be conducted to uncover the underlying mechanisms of observed physiological changes.

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2. Further studies should assess the long-term effects of UV exposure on crop yield, reproductive success, and metabolic processes beyond early development.

3. Additional work is needed to evaluate other abiotic stresses in combination with UV radiation (e.g., drought, salinity) to simulate more realistic environmental conditions.

4. Broader trials involving a wider range of cereal species and accessions will help generalize the applicability of these findings.

5. Precision agriculture tools, such as UV sensors and remote monitoring, could be integrated into crop management to optimize exposure levels in open-field farming.

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