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Evaluation of Ultraviolet Radiation on the Root Cell Mitosis and Germination of *Corchorus olitorius*

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Abstract

Ultraviolet radiation (UVR) is a powerful ionizing mutagen capable of altering plant cell chromosomes and enhancing genetic diversity. The category of UVR used, was Ultraviolet C (UV-C) with a wavelength of 100-280 nanometers (nm). This study assessed effects of UV-C treatments on *Corchorus olitorius* (*C. olitorius*) seed germination, speed of germination, seedling vigor and mitotic cell division; of Amugbadu and Oniyaya accessions. Sourced from National Horticulture Research Institute (NIHORT) Ibadan, Nigeria. Five experiments (4 Laboratory and 1 field) were conducted at Babcock University Ilishan, Ogun state, Nigeria, consisting of five treatments. Four were exposed to UV-C radiation for 1-4 hours at 254 nm, with intensity of 54mJcm⁻² and Wet Heat Treatment, which is the control. Each treatments were replicated three times, data collected on above measured parameters, analyzed using Analysis of variance, Duncan Multiple Range Test at (1% and 5% levels of probability) and Pearson correlation coefficient. Results showed highly significant treatments effects on germination count/percentage, germination index, and seedling vigor at 1% probability level. A generally low/decline of UV-C treatments effects were observed, except for 3-hours exposure. Evident in treatments impact mean germination percentage ranging from 18.67 (1hr) to 77.33 (control). UV-C treatments led to prolonged cellular in-activities at interphase and inhibitory changes at some mitotic phases, indicating cellular stress. Despite these low and inhibitory effects, all treatments induced *C. olitorius* seed germination and break its dormancy; offering insights into crop response or resilience to UV stress and potential for genetic improvement.

Keywords: Mitotic index, seed germination, seedling vigor, roots cells microscopic views.

1. INTRODUCTION

Corchorus olitorius is an important African Leafy Vegetable (ALV), commonly cultivated and widely utilized as veg, in making diverse delicious local dishes and intercontinental cuisines. It is a highly nutritious food crop, an important cash, export and foreign exchange earning crop. A major source of natural fiber material next to cotton and used in different manufacturing sectors of the economy for making bags, carpets, papers, production of renewable films, packaging materials, electrically conductive films and information storage devices (Bilgili et al., 2018; Hossein et al., 2020; Zhong et al., 2021). Hence, *C. olitorius* is been tagged the golden fiber crop (FAO, 2012; Ministry of Textile, Government of India, 2020).

This ALV and golden fiber crop is commonly found, wildy growing and widely cultivated in both Africa and Asian continents. However, there is a widely held contention that Africa or Asia continent is *C. olitorius* center of origin (CABI, 2022; Loumerem & Alercia, 2016). Afolayan et al., (2023) and Nwangburuka and Denton (2012) in their submissions, however, asserted that, Africa is the center of origin and center of diversity of *Corchorus olitorius* because of the large number of wild *Corchorus* species and wide genetic diversity of *Corchorus olitorius* discovered on African continent. More also, a large morphological and physiological diversity existed between the various *C. olitorius* cultivars cultivated on various farm plots in Nigeria

(Nwangburuka & Denton, 2012). *Corchorus olitorius* is a dicotyledonous, tap-rooted, erect, fairly branched, herbaceous, annual to short-lived perennial, leafy vegetable plant growing to a height of 3.5 - 4 meters, with alternate leaves of finely or coarsely serrate leaf margin, which may be lanceolate or ovate in shape (Ken, 2019).

Corchorus olitorius is known and called by several vernacular and local names. Generally, it is popularly called Jute. Other common names are Jutae, Tossa jute, Golden fiber crop, Bast fire crop, Leafy vegetable, Wild jute, Jute mallow, Jew's mallow, Bush okra, Egyptian spinach, and West African sorrel (Meshack, 2021; Palada & Chang, 2003). Furthermore, jute is also called Ademe in Togo, Ayoyo in Ghana, Mrenda in Kenya, Mulukhiyah in Egypt, Lalo in Haiti, Molokhia in Middle East, Rau-day in Vietnam, and Saluyot in Philippines. In Nigeria, the Yorubas in the south-west call it Ewedu, the Igbos in south-east call it Ahihara while the Hausa in the North call it Malafiya (Tayo, 2022).

The botanical name or scientific nomenclature of Jute is *Corchorus olitorius* Linn, meaning a wild plant of uncertain identity but relating to vegetables. A name coined and given, by the great Swedish botanist, naturalist and explorer Carolus Linnaeus (1707 – 1778), popularly known as Carl Linnaeus or Carl von Linne; the father of botany (Muller-Wille, 2023). Jute plant species is under the genus *Corchorus spp.* Grouped under the Malvales order, in Tiliaceae family (Basu et al., 2016; Mukul & Akter, 2021). A family of a group of flowering plants containing approximately 244 genera and at least 4,225 plant species of herbs, shrubs and trees (Kadry et al., 2021; Liu et al., 2020). The desirable and diverse qualitative, quantitative, morphological and agronomic traits of *Corchorus olitorius* has motivated and enable researchers cum breeders all over the world and even at the National Horticulture Research Institute (NIHORT) Ibadan, Nigeria; to breed and develop varieties of desirable qualities. Varieties developed at NIHORT include NHC 03 (called Ewedu Eti Ehoru), NHC 06 (called Amugbadu or Amugbadudu or Agbadu) and NHC 09 (known as Oniyaya), (Nigeria Seed Portal Initiative [SP], 2023).

Generally, jute plant is a highly renewable and environmentally friendly plant (Basu & Roy, 2008). To which, Food Agriculture Organization [FAO], (2023) attested that, it is an agro-based, recyclable, 100% biodegradable, completely compostable, durable, a nutrient supplier to the soil, totally reusable and highly superior to synthetic fibers (Loumerem & Alercia, 2016). The environmental friendliness of jute plant, dubbed as “an ecologically friendly resource plant” is attested to; by the fact that, one hectare of jute plants consume approximately 15 metric tonnes of carbon dioxide and release 11 tonnes of oxygen to the environment (Discover Natural Fibers Initiative [DNFI], 2020; FAO, 2023). Furthermore, the leftover of roots and shoots of jute that falls to the ground are highly soil fertility enricher. The bio-materials is used in farm yard composite manure formulations for the enrichment of the soil fertility. According to Alicia (2022), jute plant cultivation requires minimal fertilizer and pesticide in comparison to cotton. Therefore, helping to reduce environmental side effects of inorganic fertilizers, pesticides, herbicides, and other agro chemicals on jute farm lands.

Adeyemo et al. (2021) stated that, the health benefits of *C. olitorius* are enormous because of the antioxidant effects of the vitamins A, B, C, alpha-tocopherol (a type of vitamin E), phenol, minerals (such as iron and calcium) and essential amino acids. These help to reduce oxidative stress, prevent heart and other chronic diseases, support brighter eye sight, ensures optimum

brain functions, contribute to mental health wellbeing, reducing inflammation in the body and support healthy aging process (Jamie, 2022). Hence, *C. olitorius* is widely used in both traditional and modern medicine for the treatment of chronic diseases such as diabetes, dysentery, typhoid and high blood pressure (Adeyemo et al., 2021; Tarm, 2021). Thus, the pharmaceutical and other health care industries had tapped into the nutritional and medicinal health benefits of *Corchorus olitorius* in the formulation and manufacturing of nutritional, health care and medicinal products of immense medical values to humanity.

Corchorus olitorius is also a multi-million dollar cash crop and a huge source of foreign exchange income. In 2022, top exporting countries of jute and other textile fiber products like Bangladesh earned foreign exchange valued at \$205 Million (M) dollar, India realized \$29.2M, Tanzania \$24.1(M), Belgium \$4.8(M) and United States of America trade value was \$2.66(M), (Sandhya, 2023; World Bank, 2022). Nigeria jute export, like most African countries was just, put, at a meager 715mts, valued at \$5.02 thousand dollars (OEC World, 2023; Volza Grow Global, 2023). Most Africa countries have not even tapped into the enormous jute production potentials, talk less of unlocking, utilizing and actualizing the full benefits embedded in

- (1) Jute crop production/large scale cultivation,
- (2) Jute business value chains/support services,
- (3) Jute's value addition (processing) sector,
- (4) Jute export trade,
- (5) Jute Commodity Exchange Trading and in establishing
- (6) An Africa International Jute Commodities Exchange Markets/Platform.

These African countries are primarily, still using *C. olitorius* for food, in preparation of local delicacies and formulation of herbal medicine. To change this narrative and enable African farmers/countries to cultivate, export jute and jute-products that meet international export standards; there is need to develop and make available to African farmers, high quality varieties of *C. olitorius* seeds, with desirable morphological and agronomic traits. To achieve these, there is need for wider domestication of more wild *Corchorus olitorius* species, ensure greater genetic diversity and preserve a large number of genetic diversity in African. The exposure of *C. olitorius* seeds and plant to UV radiation can lead to chromosomal mutation and thus development of more mutants and thus increasing genetic diversity of jute species available to breeders to develop improved varieties needed by African farmers.

Ultraviolet radiation (UVR) is part of the electromagnetic energy emitted from both natural or artificial sources, with a short wavelength of between 100 - 400nm, which are practically invisible to the naked human eye but are visible to some insects like the bumble bee. It is also a carcinogenic (causing cancer) and mutagenic (causing alteration/aberrations in plant and animal cells) agent. The sun is by far the major source of natural UVR, emitting the largest ultraviolet radiation (Diffey, 2002; World Health Organization [WHO]. 2016). There are also diverse artificial sources of UV radiation, with some emitting dangerous levels of radiation. Sources like the welder's arc light, fluorescent, mercury lights and halogen lamps used in many research laboratories, industries, offices and at homes (Centers for Disease Control and Prevention [CDC], 2021; WHO, 2016).

UVR can be grouped into three major categories, based on their wavelength emission strength, namely, Ultraviolet A (UV-A), Ultraviolet B (UV-B), and Ultraviolet C (UV-C) with a short wavelength of 100nm – 280 nanometer (nm), (Diffey, 2002). Generally, UV radiation electromagnetic has detrimental and beneficial impacts on both plants, animals, man and the environment. Among the major detrimental effect of UVR is that, it causes skin cancer, aging, wrinkles, eye damage, vision loss, cataracts, sunburns, damages the immune system, weakens plastic materials and causes fading of colors on fabrics (CDC, 2021; National Toxicology Program, 2014).

Ultraviolet radiation has also been used, since ancient times to treat various diseases. Skin exposure to early morning sun leads to synthesis of vitamin D3 needed by human body, which helps to strengthening bones and inhibit the growth of some cancers, (Egan et al., 2005; John et al., 2005). Long-term exposure to sunlight leads to reduction in cardiovascular disease (CVD), reduction in mortality risk, reduction in some forms of cancer, and non-CVD/non-cancer related diseases (Alfredson et al. 2020),. Thus, helping in the treatment of these disease conditions. Exposure to sunlight has also been linked to improved energy and elevated mood. UV radiation has successfully been used for disinfection and sterilization purposes (World Health Organization [WHO], 2020). Some insects make use of UV radiation for their navigation in flight and help some other birds, reptiles, insects and bees in their vision and to locate ripe fruits, seeds and flowers (Kelber & Warrant, 2021).

Furthermore, exposure to UV radiation causes mutation in plants and animals, which might also be beneficial or detrimental. Mutation is the chromosomal changes or alterations in cell DNA or RNA of living organism. These mutations at the DNA sequence level are the primary source of new alleles (new genetic materials) in a plant species (East Tennessee State University, 2019). Chromosomal alterations or mutations cause changes in chromosome structure. Mutation occurs when a section of a chromosome breaks off and rejoins incorrectly or does not rejoin at all; which can occur either by Deletion, Duplication, Inversion, Insertion and Translocation in DNA (Pierce, 2017). These new genetic materials are actually what researchers and plant breeders required for the development of new improved plant varieties needed by farmers for increased jute production. Hence, the need for evaluation of Ultraviolet radiation on the root cell mitosis and germination of *Corchorus olitorius*.

II. MATERIALS AND METHODS

Plant Materials:-

The major materials used, were the seeds of *Corchorus olitorius*, of Amugbadu(NHC 06) and Oniyaya (NHC 09) accessions. The seeds were developed at NIHORT (Nigeria Seed Portal [SP], 2023) and sourced from the same institution. The list of other materials, laboratory equipment and machines used are listed in appendix A.1 and A.2.

Experimental Location:-

The experiments were conducted at 3 different locations within Babcock University, which is situated in the rainforest vegetation of South Western, Nigeria; at a latitude 6.88997° and

longitude 3.72297° (Oyekale et al., 2021; Mapcarta, 2022). The experiments were conducted at: (1) Department of Biochemistry Teaching Lab. – where seeds of *C. olitorius* were exposed to UV-C radiate, (2) Department of Agriculture and Industrial Technology, Soil Science Lab., where experiments on seed germination % test, germination index/speed of germination test, seedling vigor index, mitotic index, root cells microscopic views and Micrograph-photos snap shoot of those views were taken; and (3) the University experimental farm plot – where actual sowing, cultural operations were carried out, morphological and physiological parameters measured, and data recorded.

Experimental Design and Procedures:-

A total of seven experiments were carried out, which were in two parts, six laboratory experiments and a field experiment. The six laboratory experiments are the exposure of *C. olitorius* seeds to UV-C radiation, wet heat treatment, determination of germination test/seed dormancy, speed of germination/germination index, seedling vigor index tests and preparation of slides, its viewing for cytological mitotic activities (index) of *C. olitorius* root tip under the electron light microscope at X100 and X400 magnifications, while photomicrograph of observed impacts of UV-C radiation on *C. olitorius* cell activities and aberrations snap shots were taken at X1000 magnification. The field experiment was carried out at the University farm plot, to determine the effect of UV-C radiation on the morphological and agronomy traits of jute plants.

Laboratory Experiments:-

Lab. Exp. 1:- (Seeds Exposure to UV-C Radiation). 5 sets of seed lots weighing 45g each, were scaled using a sensitive electronic scale and labeled. 4 were exposed to UV-C radiation using UV/White Light Trans-illuminator machine. At a wavelength of 254nm and intensity of 54mJcm⁻², for a period of 1 hour, 2 hours, 3 hours and 4 hours respectively (Sadeghianfar et al., 2019).

Lab. Exp. 2:- (Control - Wet Heat Treatment). The 5th seed lot which is the control was not exposed to UV light. It was immersed into Digital Water Bath machine for 2 minutes at 80°C to break the seed dormancy (Oyekale et al., 2021).

Lab. Exp. 3:- (Seed germination count, germination %, speed of germination or index and Seedling Vigor Index (SVI). The seed viability and seedling vigor index tests were carried out by counting a final representative sample of 100 seeds from each of the 5 treatments seed lot, using the Modified Halving sampling technique/method and each replicated 3 times (International Seed Testing Association [ISTA]. 2023).

- a) Germination count (GC) = No of seed germinated / No of seeds sown
- b) Germination percentage (G%) = (No of seed germinated / Total No of seeds sown) * 100%.

Lab. Exp. 4:- Germination Index, Seed Viability and Seedling Vigor Index Determination:- The 100 seeds from each of the 5 seed lots were cultured in petri dishes and replicated 3 times. Data were collated, recorded and analyzed using the formulas below:-

Germination Index (GI) or Speed of Germination (SOG) = [(Seedling number at 1st count / Day of 1st count) + (Seedling number at 2nd count / Day of 2nd count) + (Seedling number at 3rd count / Day of 3rd count) + ----- + (Seedling number at final count / Day of final count)].

Therefore, GI (SOG) = (n1/d1) + (n2/d2) + (n3/d3) + + (nz/dz)

Where n = Number of seedling emerging on each day

d = day of plant emergence, from (day 1 to day “z”)

z = day of final count

Lab. Exp. 5:- Seedling Vigor Index (SVI) = Germination % * Seedling length(mm). Note, all formula source was (International Seed Testing Association [ISTA]. 2023).

Data inferences:- Any seed lot with the highest germination percentage (G%), speed of germination (SOG), seed vigor index (SVI) is considered the most vigorous seed (Oyekale et al., 2021).

Lab. Exp. 6:- UVR impacts on *C. olitorius* root tip Mitotic Index (Cytological Behavior/Aberration).

Procedure:- Root tips of cultured seeds was harvested after 48 hours at the peak of mitotic cells division. The root tips were fixed in 1:3 glacial acetic alcohol and preserved in the refrigerator for further analysis. It was later removed and rinsed in distilled water for 2mins. Subsequently, the root tip was hydrolyzed in 1N HCl for 5mins and mounted on a clean glass slide. The milky part of the root tip was sectioned with dissecting knife and stained with Aceto-orcein stain for 15mins (Sharma & Gupta, 2023). This milky part of the root tip was later covered with cover slip and gently squashed between the glass slide and cover slip, to ensure even spread of the cells. The prepared slide was mounted and viewed under the Electron Light Microscope at X100 and X400 magnifications. Thereafter, the photomicrograph of mounted slide was taken at X1000 magnification (Jones & Smith, 2021; Wang & Cheng, 2022). Data was collected based on viewed mitotic cells activities observation.

Mitotic cells index determination was calculated using the formula

Mitotic Index (MI) = [Number of Dividing Cell/Total Number of Cells Observed] *100% (Ammeling et al., 2023; Kato & Haskins, 2023).

Farm plot/Field Experiment 7:-

The actual sowing of *C. olitorius* seeds was carried out at Babcock University farm plot within the University community; to determine the effects of the UV-radiation treatments on the morphological and agronomy traits of jute plants. Procedure involved are:- Field allocation, clearing and preparation. Experimental layouts were

arranged into 15 plots, using Completely Randomized Design (CRD), replicated 3 times. The basic agronomic practices like bush clearing, plot layout, beds making, weeding and so on were carried out before and after seed sowing/planting. Morphological and agronomy traits were measured and data collected at 8th week.

Morphological and agronomic characters measured were:- Plant Height (PH - cm), Leaf Area (LA), Number of Branches (NoBr), Number of Leaves per plant (NoL), Date of First Flowering (Do1F), Leaf Weight per Plant (LW/P - g) and Leaf Weight per Plot (LW/plot). Descriptive morphological and agronomic character also considered were Leaf shape (LS), Leaf color (LC) and Leaf Margin (LM).

Data Analysis:- Each treatments were replicated three times, parameters measured, data collected and subjected to analysis of variances (ANOVA) in characters using SAS 2000 and significant differences between mean was separated using the Duncan Multiple Range Test (DMRT) at 1% and 5% levels of probability. Pearson correlation coefficient was adopted to verify the correlation between the characters.

III. RESULTS AND DISCUSSION

Germination and Seedling Vigor:

The analysis of variance ANOVA results as showed in (Table 1) revealed a positive significant UV treatment effects on germination percentage (G %), speed of germination (SOG), and seedling vigor (SVI) at 1% probability level ($p \leq 0.01$). Summarized in Table 2 is the mean performance of the treatments, which showed significant reduction in the germination and seedling vigor of *C. olitorius* seeds exposed to UV-C radiation, as compared to the wet heat treatment (control). The control had the highest germination percentage of 77.33% and speed of germination of 117.17 and seedling vigor which were significantly higher than all UV-treatment mean results. Closely followed by the 3hr-UV radiation treatment mean results. These findings were consistent with previous studies demonstrating the inhibitory effects of UV radiation on seed germination (Qiu et al., 2007; Kazama et al., 2008).

Table 1: Analysis of Variance for Treatment Effects on Germination and Seedling Vigor

SOV	Df	G %	SOG	SVI
Treatment	4	1376.93**	3328.26**	5523522.39**
Error	10	20.27	30.47	66628.54

KEY: SOV - Sources of Variation, df - degree of freedom, G % - Germination percentage, SOG - Speed of Germination, and SVI - Seedling Vigor index. Note: * is Significant at 5% ($p \leq 0.05$) level of probability; ** is Significant at 1% ($p \leq 0.01$) level of probability.

Table 2: Mean performance of five treatments on Germination, Speed of Germination and Seedling Vigor of *C. olitorius*

Treatment	Germination	Germ index	Seedling vigor
1hr-UVR	18.67d	24.21d	1215.07d
2hr-UVR	43.00bc	66.82bc	2904.07b
3hr-UVR	46.67b	72.76b	2783.27b
4hr-UVR	35.33c	59.11c	2169.13c
Control	77.33a	117.17a	4908.00a

KEY: 1hr-UVR (1 hour UV radiation treatment), 2hr-UVR (2 hours UV radiation treatment), 3hr-UVR (3 hours UV radiation treatment), 4hr-UVR (4 hours UV radiation treatment). Note: Means with the same letter are not significantly different.

Seedling vigor, measured by the seedling vigor index means showed a similar trend like that of the germination parameters. The control treatment likewise, had the highest seedling vigor (4908.00), followed by 3 hours UV radiation treatment with (2783.27), while 1 hour UV radiation treatment resulted in the lowest seedling vigor (1215.07). These results corroborated with the submission of previous researchers on the adverse effects of UV radiation on seedling growth and development (Krizek et al., 2006; Shaukat et al., 2013; Azeemi et al., 2017).

Parameters Correlation Coefficient Analysis:

The relationships/interactions between the germination percentage, speed of germination and seedling vigor of *C. olitorius* seeds treated with UV radiation is presented in Table 3. The results showed a strongly positive relationship between germination percentage, speed of germination and seedling vigor at 1% level of probability ($p \leq 0.01$). These correlations revealed that improvements in germination count and percentage parameters were closely linked and will lead to improvement in seedling vigor. This result showed that, the influence UV-C radiation treatments on germination also influenced seedling vigor positively and vice versa.

Table 3: Correlation coefficients between the Germination percentage, Speed of Germination and Seedling vigor of *C. olitorius*.

	Speed of Germination	Seedling Vigor Index
Germination percentage	0.99**	0.99**

Speed of Germination

0.98**

Note. * is Significant at 5% ($p \leq 0.05$) level of probability; ** is Significant at 1% ($p \leq 0.01$) level of probability.

Mitotic Index and Phase Distribution:

The results of the analysis of variance (ANOVA) as indicated in Table 4, showed that UV-C treatments had strong significant effects on the interphase ($p \leq 0.01$), prophase ($p \leq 0.01$), and anaphase ($p \leq 0.05$) of the *C. olitorius* mitotic cell division cycle. These results revealed that, the UV-C radiation treatments altered the distribution of cells across different mitotic phases, most especially increasing the proportion of cells in interphase.

Table 4: Mean squares of ANOVA of Seed treatments on *C. olitorius* Mitotic index.

SOV	Df	TCC	IP	PP	MP	AP	TP	MI
TRT	4	0.00	461194.23**	6.10**	82.57	42.57*	4.50	0.00
Error	10	0.00	142369.80	0.73	46.27	11.33	4.13	0.00

KEY: SOV - Sources of variation, TRT - Treatment, df - degree of freedom, TCC - Total cell count, IP - Interphase, PP - Prophase, MP - Metaphase, AP - Anaphase, TP - Telophase, and MI - Mitotic Index. Note: * is Significant at 5% ($p \leq 0.05$) level of probability; ** is Significant at 1% ($p \leq 0.01$) level of probability.

Furthermore, treatment with UV-C radiation for different durations led to significant changes in the mitotic phase distribution as shown in Table 5. The control group had the lowest number of cells in interphase (1210.33), while 3hr-UV radiation had the highest in anaphase (16.67) and telophase (3.33), indicating normal mitotic progression. UV-treated groups showed increased interphase cells, suggesting delayed cell cycle progression and potential DNA damage. The results across all treatments showed that, there was no significant difference in total cell count. This implies that, both the control and UV radiation exposures had no substantial effect on the overall mitotic cell proliferation. There was also a relatively constant treatments impact on total numbers of cells that were actively dividing, indicating that, the number of cells undergoing mitotic division were not significantly affected by the treatments.

Furthermore, all treatments had impact on distribution of cells across specific mitotic phases. At Interphase, 4hr-UVR treatment had the highest cell count of mean value of (2118.00). Closely, followed by 3hr-UVR treatment with mean value of (1912.67), while the Wet heat treatment had the lowest value of (1210.33). This implies that, the exposure of *C. olitorius* seeds to 4hr-UV radiations might have caused delay in *C. olitorius* cell progressing into active mitotic cell

division phases inevitably, leading to delayed and low rate of seed germination and seedling vigor indexes. On the other hand, the highest cells counts at the Metaphase, Anaphase and Telophase of the mitotic cell cycle were observed in the 2-UVR, 3-UVR and 3-UVR treatments respectively (Jones & Smith, 2021; Wang & Cheng, 2022). The study indicated that, 3-UV radiation treatment, had the highest and most actively dividing cells at most of the phases, particularly at anaphase and telophase stages of the mitotic cell cycle. Thus, 3hr-UVR duration impacted significantly on the germination rate, growth and development of *C. olitorius*.

Highest counts were observed in 2hr-UVR and 4hr-UVR treatments. These elevated counts recorded in Prophase and Metaphase for 2hr-UVR and 4hr-UVR treatments could be attributed to an accumulation of cells in early mitotic phases, potentially due to cell cycle arrest or DNA damage response mechanisms.

Table 5: Mean performance of the effect of UV Radiation Exposure on *Corchorus olitorius* Mitotic Phase Distribution.

TRT	TCC	IP	PP	MP	AP	TP	MI
1hr_UVR	1188.00a	1329.00bc	1.33b	27.00ab	10.33bc	0.67a	0.03a
2hr_UVR	1188.00a	1838.67abc	4.00a	28.00a	14.00ab	0.33a	0.02ab
3hr_UVR	1188.00a	1912.67ab	2.33b	21.00ab	16.67a	3.33a	0.02ab
4hr_UVR	1188.00a	2118.00a	4.00a	20.00ab	10.00bc	0.67a	0.02b
Control	1188.00a	1210.33c	1.00b	15.33b	7.00c	1.67a	0.02ab

TRT - Treatment, TCC - Total cell count, IP - Interphase, PP - Prophase, MP - Metaphase, AP - Anaphase, TP - Telophase, MI - Mitotic Index, 1hr-UVR (1 hour UV radiation treatment), 2hr-UVR (2 hours UV radiation treatment), 3hr-UVR (3 hours UV radiation treatment), 4hr-UVR (4 hours UV radiation treatment), CTL - Control treatment. Note: Means with the same letter are not significantly different.

Correlation Matrix of Mitotic Phase Parameters

The correlation matrix (Table 6) showed significant relationships between various mitotic phases, highlighting how UV exposure affects cellular processes. Presented in table 4.6, is correlation coefficients of *Corchorus olitorius* showing the relationships between the different mitotic phases (Interphase, Anaphase, Prophase Metaphase and Telophase) and the total cell count. The interphase of the mitotic cell cycle, had a positive correlation coefficient of (0.65**) with Prophase, Metaphase (0.26), and Anaphase (0.48), but had a negative correlation with Mitotic Index (-0.48). The study revealed that, Prophase correlation coefficient is positively

related with the Metaphase (0.35) and Anaphase (0.29), but negatively related with the Telophase (-0.13) and Mitotic Index (-0.16). Furthermore, the Metaphase of the cycle is also positively correlated with the Anaphase (0.46), but had a negative association with Telophase (-0.22), and a positively correlated with Mitotic Index (0.59*). The study showed that the Anaphase is positively correlated with Telophase (0.05) and Mitotic Index (0.32), while Telophase is also positively correlated with Mitotic Index (0.04).

Table 6: Correlation coefficients of *Corchorus olitorius* Mitotic Index

	IP	PP	MP	AP	TP	MI
TOTAL CELL COUNT	-	-	-	-	-	-
INTERPHASE		0.65**	0.26	0.48	0.06	-0.48
PROPHASE			0.35	0.29	-0.13	-0.16
METAPHASE				0.46	-0.22	0.59*
ANAPHASE					0.05	0.32
TELOPHASE						0.04

KEY: IP - Interphase, PP - Prophase, MP - Metaphase, AP - Anaphase, TP - Telophase, MI - Mitotic Index. Note. * is Significant at 5% ($p \leq 0.05$) level of probability; ** is Significant at 1% ($p \leq 0.01$) level of probability is negative (-) relationship.

The table 6 above, provided an insights into the relationships between the different mitotic phases of *C. olitorius* parameters. Positive correlations between successive mitotic phases (e.g., Interphase with Prophase, Prophase with Metaphase) suggested and increase or progression in phase will automatically lead to a progression in the phase it is related with, within the cell mitotic cycle. Negative correlations between mitotic phases and the Mitotic Index may indicate reciprocal relationships, where increased time spent in one phase reduces the proportion of cells actively undergoing mitosis.

IV. CONCLUSION

UV radiation significantly affects the germination, seedling vigor, and mitotic activity of *Corchorus olitorius*. The observed decrease in germination and seedling vigor and alterations in mitotic phase distribution underscore the potential adverse impacts of increased UV exposure on this economically important plant. Future studies should explore the underlying mechanisms and potential mitigation strategies to enhance the resilience of *C. olitorius* to UV radiation.

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