**Biological and Environmental Sciences Journal for the Tropics**
Volume 21, Number 2, August 2024. Pp 37 - 45
https://dx.doi.org/10.4314/bestj.v21i2.5

***Research article***

# Effect of radiation on the incidence and severity of bacterial blight disease induced by *Xanthomonas axonopodis pv. Vignicola* on some varieties of cowpea (*Vigna unguiculata* L. Walp)

[1]Zafar, S., [2]Mai-Abba, A. I., [2]Kutama*, A.S. and [2]Auyo, M.I.

[1]Department of Biological of Sciences, Yusuf Maitama Sule University, Kano
[2]Department of Plant Biology, Federal University Dutse.

*Corresponding Author: *kutamasak@yahoo.com*

*Submission: 02/04/2024*
*Accepted: 02/07/2024*

**Abstract**

Cowpea (*Vigna unguiculata* L.), is a legume that holds great importance in Africa. Around 70% of cowpea production worldwide comes from the arid regions of sub-Saharan Africa, specifically the Savanna and Sahelian areas, where it is primarily cultivated. Nevertheless, this vital crop faces multiple challenges posed by pests and diseases, including a bacterial infection called cowpea bacterial blight (CoBB). It is important to identify resistant sources to develop cowpea varieties that can withstand CoBB, as it has a detrimental effect on cowpea production. The objective of this study was to examine the impact of different radiation treatments on the incidence and severity of the disease. The experiment consisted of eight levels of radiations X-Ray-0Secs ($X_0$), X-Ray-5Secs ($X_1$), X-Ray-10Secs ($X_2$), X-Ray-20Secs ($X3_4$), UV-Rays-0Mins ($UV_0$), UV-Rays-15Mins ($UV_1$), UV-Rays-30Mins ($UV_2$) and UV-Rays-60Mins ($UV_3$)), two cowpea varieties (IT97K-819-118 and Dan'ila) and two levels of bacterial blight inoculum (full inoculum (I1) and no inoculum (I0)) combined factorially and laid out in Randomized Complete Block Design with three replications. Disease incidence was determined by assessing the proportion of symptomatic plants as a percentage of the total number of plants per pot, while severity was evaluated using a severity rating scale. The results revealed that disease incidence was highest in the absence of radiation, Danila cultivar, the disease incidence at 0 seconds of X-ray exposure was 82.63%. Similarly, for IT97K-819-118, the disease incidence was 79.33% whereas longer durations of X-ray and UV-ray exposures, particularly 60 minutes of UV-ray exposure, were associated with lower mean values, Danila had a disease incidence of 18.56% (a decrease of 64.07%). IT97K-819-118 exhibited the lowest disease incidence of 28.03% (a decrease of 50.52%). Additionally, IT97K-819-118 demonstrated generally lower severity mean values compared to Danila, when no X-ray radiation was applied, the disease severity for IT97K-819-118 was recorded as 2, indicating slight infection. The study concluded that both X-ray and UV-ray radiation show potential as suppressive agents against cowpea bacterial blight; however, the effectiveness vary depending on the cultivar and the duration of exposure.

**Keywords:** Cowpea, Radiation Levels, Bacterial Blight, Disease Incidence, Severity

## Introduction

Cowpea (*Vigna unguiculata* L.) is a significant legume indigenous to Africa, cultivated in the drier Savanna and Sahelian regions of sub-Saharan Africa (SSA), which contribute approximately 70% of the global cowpea production (Boukar *et al.*, 2018). Besides Africa, cowpea is also grown extensively in Latin America, Southeast Asia, and the Southern United States (FAO, 2016). Globally, cowpea is cultivated on over 12 million hectares, yielding more than 6.9 million tons of grain annually. Nigeria, Niger, and Brazil are the largest producers of cowpea (FAO, 2016). The grains, leaves, and haulms of cowpea are highly valued for their nutritional content for both humans and livestock, the grains contain approximately 25%

protein, as well as essential macro and micronutrients and the leaves and haulms are primarily used as fodder for livestock and also possess valuable nutrients (Singh, 2006). Despite its adaptability to various regions in SSA, cowpea faces threats from several pests and diseases, including cowpea bacterial blight (CoBB),the first report of this disease dates back to the mid-20th century in the United States (Nandini, 2012). CoBB has since been reported in most countries where cowpea is grown (Bastas and Sahin, 2017; Moretti *et al*., 2007; Nandini and Kulkarni, 2016). Among the biotic stresses affecting cowpea production in SSA, bacterial diseases such as CoBB and bacterial pustules are particularly severe, leading to significant crop damage (Agbicodo*et al.* and Adegbite *et al*., 2010).

Improving the sustainability of agriculture while minimizing its environmental impact has become a crucial challenge for humanity in meeting the food demands of a growing global population (Edmondson *et al.*, 2014). The concept of agricultural sustainability involves the development of technologies and practices that do not harm the environment while enhancing food productivity (Pretty *et al.*, 2006). Although chemical compounds are widely use in modern agriculture, the utilization of physical factors presents a promising alternative to increase agricultural yield, improve plant protection, and enhance storage (Aladjadjiyan, 2012). Potential approaches include the application of electromagnetic waves (EWs), magnetic fields (MFs), ultrasound (US), and ionizing radiation (IR). Ionizing Radiation, in particular, has been extensively studied for its ability to enhance the microbiological safety and storability of food, given the concerns regarding food supply safety (Farkas and Mohácsi-Farkas, 2011). The findings from this study will contribute to the identification of effective radiation treatments that can be integrated into breeding programs to develop cowpea cultivars resistant to CoBB and other desirable traits.

## Materials and Methods

### Experimental Site

The experiment was conducted in the screen house of the International Institute of Tropical Agriculture (IITA) experimental research station Kano. Kano is located in the Sudan Savanna Agro-ecological zone, latitude 12$^o$ 03'N and longitude 08$^o$ 31'E and an altitude of 1500 m above sea level (Kowal and Knabe, 1972).

### Pot Preparation and Seed Sowing

The sizes of pot for this experiment were 17 cm length and 17 cm breadth plastic pots. The pots were filled with sand mixture after creating a hole at the bottom of the pot to allow passage of water so as not to create a water-logged soil. The pots were then watered and allowed to stand for a day before planting (Kutama *et al.,* 2014). A small hole of 3 cm was dug in each pot and 4 seeds per hole were sown and buried under the soil. Irrigation was used as mode of water supply to the plants for establishment and growth (Kutama *et al.,* 2014).

### Exposure of Seeds to Radiation

Seeds of cowpea (Local Dan'ila, and IT97K-819-118) were exposed to radiations (X and UV radiation) at different time periods following the protocols prepared by (Michael and Paul, 2010).Each batch of seeds was placed inside an air and water permeable seed envelope and labelled accordingly. The parked seeds were kept in a desiccator over glycerol (60% by volume) and kept at room temperature for 7 days. This equilibrates the seeds moisture content to 12 to 4%, the ideal moisture condition for achieving efficient induction of mutation.The seeds were then packed into appropriate size petri-dishes and the samples were immobilized by packing with tissue papers. The prepared seeds were then taking to Radiology Department of Rasheed Shekoni Teaching Hospita,l Dutse, for exposure to irradiation source where the seeds were exposed to X-rays at time periods of 5, 10 and 20 secs. and UV radiation at time periods of 15, 30 and 60 mins., respectively, taking care to observe all safety precautions (Michael and Paul, 2010).

### Treatment Combinations and Experimental Design

The experiment was conducted using eight levels of radiations X-Ray-0Secs ($X_0$), X-Ray-5Secs ($X_1$), X-Ray-10Secs ($X_2$), X-Ray-20Secs ($X3_4$), UV-Rays-0Mins ($UV_0$), UV-Rays-15Mins ($UV_1$), UV-Rays-30Mins ($UV_2$) and UV-Rays-60Mins ($UV_3$)), two cowpea varieties (IT97K-819-118 and Dan'ila) and two levels of bacterial blight inoculum (full inoculum ($I_1$) and no inoculum ($I_0$)) combined factorially giving a total of (8×2×2=32) 32 treatments combination and laid out in Randomized Complete Block Design with three replications (Zar, 2010).

**Inoculum Sample Collection**

The technique of (Moretti *et al*., 2007) was adopted with little modification for inoculum sample collection. Diseased leaf samples of Cowpea showing symptoms of common bacterial blight disease was collected from a farm considered as a ‘hot spot’ for many years in the International Institute of Tropical Agriculture (IITA) cowpea research farm at Minjibir, Kano State. The leaves were then kept in plastic bags and taken to the Centre for dry land Agriculture, Bayero University Kano.

**Isolation and Identification of the Inoculum**

The leaves were surface sterilized with 0.5% NaOCl, rinsed three times with sterile distilled water and dried under shade for 7 days. A portion of leaf (1–2 mm) with bacterial infection was placed on nutrient agar (NA). The plates were then incubated at 28°C for 48 to 2 hours. Sub- culturing was performed to obtain pure cultures. The isolate was then stored on NA slants for further use (Duche *et al*., 2015).

Gram test of the isolates following the Gram staining procedure of Schaad, (2001) was done to determine the morphological characteristics. Culturally, yellow colony indicates the presence of the bacteria (*Xanthomonas campestris* pv. *Vignicola*) and microscopically gram-negative rod shaped confirms the presence of the bacteria (Tika and Sundar, 2009).

**Preparation and Application of Inoculum**

Inoculum suspensions were prepared by harvesting bacterial cells from petri-dishes into sterilized deionized distilled water. Suspensions were adjusted turbidimetrically using McFarland standards. McFarland standards was used as a reference to adjust the turbidity of the bacterial suspension so that the number of bacteria will be within a given range to standardize the approximate number of the bacteria in a liquid suspension by visually comparing the turbidity of the harvested test suspension with that of a McFarland standard. Six hours prior to the inoculation plants were misted with tap water from 10 a.m. to 4 p.m. to create a favorable environment for disease development, plants were inoculated 14 days after planting (dap). In the screen house, the average temperature was 24.0 °C and 25.5 °C for the experiment. The average relative humidity in the screen house was 88%. The isolated bacterial suspensions were used to inoculate the growing seedlings using spray pump. The inoculum was poured into the spray pump and was introduced to the leaves by spraying the leaves until it dried out, after inoculation, plants were covered with polyethene bags for 48hrs to increase humidity in plant canopy to enhance the establishment infection (Agbicodo *et al.*, 2010).

**Pathogenicity Test**

Pathogenicity test was conducted in a screen house using Koch’s postulate. Steam-sterilized soil in plastic containers, a total number of eight plastic containers was used: six plastic containers for the tested organism, *Xanthomonas*, and two plastic containers for the control. Five 5kg of soil was placed in each of the plastic containers. Three (3) seeds of the cowpea were planted in each container. Two weeks after planting, inoculum prepared from the isolate were sprayed on young, healthy cowpea seedlings at the upper and lower surfaces of the leaves till run-off, covered with a polythene for 48hrs. The presence or absence of characteristic symptoms was observed.

**Data Collection**

**Determination of Disease Incidence**

The incidence of the bacterial blight disease was recorded by establishing the proportion of plants showing the symptoms and expressing the result as percentage of total number of plants per pot as suggested by Kutama *et al*. (2013a) and Fagwalawa *et al*. (2013).

$$\text{Disease Incidence} = \frac{Number\ of\ infected\ plants}{Total\ number\ of\ plants\ visited} \quad X\ 100$$

**Determination of Disease Severity**

The severity was scored at two (2) weeks after inoculation. The severity percentage was calculated using the formula below and then the severity was scored on the infected plant using the severity rating scale as follows:

$$\text{Disease severity (\%)} = \frac{\text{Area of affected leaf}}{\text{Total leaf area}} \times 100$$

0-0% 0 = No infection

1-10% 1 = very slight infection (very few spots on the leaves and a few leaves affected)

11-20% 2 = Slight infection (few spots on the leaves and more visible)

21- 40% 3 = moderate infection (up to four spots per plant and general light spotting i.e appears clearly).

41- 60% 4 = Severe infection (Nearly every leaf with lesions, plant still remaining normal form)

61 – 100% 5 = Lead to death (only few leaves left green, most leaves are dead) (Kutama *et al*., 2011).

**Statistical Analysis**

Data collected were subjected to Analysis of Variance (ANOVA) using augmented RCBD R package version 0.1.5.9000 and significantly different means were separated using LSD post hoc test ($P \leq 0.05$).

**Results and Discussion**

**Pathogenicity Test**

The results showed initial appearance of water-soaked spots on leaves, which enlarge to irregular brown necrotic lesions surrounded by yellow haloes, and adjacent lesions frequently coalesced. This has tallied with the report Kutama *et al*. (2018) on the symptoms of bacterial blight in cowpea. The re-isolated pathogen from inoculated plants was found to be identical to the isolate used for inoculation and the same bacteria species (*Xanthomonas axonopodis)* was identified. Control plants did not show any symptom of common bacterial blight disease (Kutama *et al*. 2018).

Table 1: Pathogenicity Test Result for Bacterial Blight Pathogen of (Danila and IT97K-819-118) Cowpea varieties

| S/No | Bacterial Isolate | Pathogenecity |
|---|---|---|
| 1. | *Xanthomonas axonopodis* | Positive (+) |

**Effects of Different Radiations on the Disease Incidence (%) of *Danila* and IT97K-819-118 Cowpea (*Vigna Unguiculata*) Cultivars.**

Table 2 presents the effects of different radiation exposures on the disease incidence in two cowpea cultivars, Danila and IT97K-819-118. The results from Analysis of variance (ANOVA) indicated that the differential effect of eight levels of radiations was highly significant ($P<0.05$) in diseases incidence.

The results of this study demonstrate that different radiation treatments have varying effects on disease incidences and disease severity of the two cowpea cultivars: Danila and IT97K-819-118. The disease incidence decreased significantly with increasing durations of X-ray exposure for both cultivars. The Danila cultivar had a higher baseline disease incidence compared to IT97K-819-118. However, both cultivars exhibited a decreasing trend in disease incidence with longer exposure times. UV-ray exposure: Similar to X-ray exposure, disease incidence decreased significantly with increasing durations of UV-ray exposure for both cultivars. The baseline disease incidence was higher in Danila compared to IT97K-819-118.

Table 2: Effects of Different Radiations on the Disease Incidence (%) on *Danila* and IT97K-819-118 Cowpea (*Vigna Unguiculata*) Cultivars.

| | Varieties | |
|---|---|---|
| Radiations | Dan'ila | IT97K-819-118 |
| X-RAY-0Secs | 82.63±0.8[a] | 79.33±0.8[a] |
| X-RAY-5Secs | 74.30±0.4[a] | 53.33±0.8[b] |
| X-RAY-10Secs | 33.16±0.2[c] | 33.27±1.6[c,g] |
| X-RAY-20Secs | 30.72±0.8[b,c] | 33.17±1.4[d,c] |
| UV-RAY-0Mins | 76.30±0.8[a] | 56.60±0.7[e] |
| UV-RAY-15Mins | 57.14±1.6[d] | 40.11±0.0[b,c] |
| UV-RAY-30Mins | 39.80±0.8[e,c] | 26.30±0.4[g] |
| UV-RAY-60Mins | 18. 56±0.8[f] | 28.03±0.7[h,d] |
| P-Value =0.000 | | |

Means followed by the same letters in the column are not significantly different at P<0.05 alpha level.

**Effects of Different Radiations on the Cowpea Blight Disease Severity (%) on *Danila* and IT97K-819-118 Cowpea (*Vigna Unguiculata*) Cultivars.**

Table 3 presents the severity of the disease recorded for each cultivar under different radiation durations. In the case of the Danila cultivar, exposure to X-ray radiation for different durations showed a consistent pattern. When no radiation (0 secs) was applied, the disease severity was recorded as 2, indicating slight infection. However, with an increase in radiation duration to 5 secs, 10 secs, and 20 secs, the disease severity decreased to 1, indicating very slight infection. Regarding UV-ray radiation, the Danila cultivar displayed similar trends.

Effects of Different Radiations on Disease Severity: X-ray exposure: Disease severity showed a consistent pattern of decrease with increasing durations of X-ray exposure for both cultivars. The severity decreased from slight infection to very slight infection for all exposure durations. UV-ray exposure: Disease severity also decreased with longer durations of UV-ray exposure. However, an interesting observation was made for IT97K-819-118, where the disease severity decreased to no infection at 30 minutes of exposure but reverted to very slight infection at 60 minutes.

Comparing the two cultivars, IT97K-819-118 generally exhibited lower disease incidences and lower disease severities than Danila, indicating a higher level of disease resistance. Overall, the results demonstrate that both X-ray and UV-ray radiations had a significant impact on reducing disease incidences and severities values for cowpea blight in both cultivars. Longer exposure durations generally resulted in greater reductions in disease parameters. The differences observed between the two cultivars suggest variations in their responses to radiation and potential differences in disease resistance.

Table 3: Effects of Different Radiations on the Disease Severity (%) of Cowpea Blight on *Danila* and IT97K-819-118 Cultivars.

| | Varieties | |
|---|---|---|
| Radiations | Dan'ila | IT97K-819-118 |
| X-RAY-0Secs | 2.00 | 2.00 |
| X-RAY-5Secs | 1.00 | 1.00 |
| X-RAY-10Secs | 1.00 | 1.00 |
| X-RAY-20Secs | 0.00 | 1.00 |
| UV-RAY-0Mins | 2.00 | 1.00 |
| UV-RAY-15Mins | 1.00 | 1.00 |
| UV-RAY-30Mins | 1.00 | 0.00 |
| UV-RAY-60Mins | 1.00 | 1.00 |

Key: 0= No Infection, 1= Very slight Infection (1-10%), 2= Slight Infection (11-20%)

**The interaction effect of Varieties, Radiation Levels and Inoculum on Disease Incidence and Disease Severity.**

Table 4 provides information on the effects of different treatment combinations of varieties, radiations, and inoculum on mean values of Disease Incidence and Disease Severity. The disease incidence means are presented as percentages, with lower percentages indicating a lower incidence of the disease. Upon examining the data, it becomes apparent that the disease incidence means vary across the treatment combinations. The highest disease incidence means of 100.00% were observed in the following combinations: Danila: $UV_0$:$I_1$, Danila: $X_0$:$I_1$, and IT97K-819-118: $X_0$:$I_1$. These combinations indicate a high susceptibility to the disease, as they had the highest disease incidence means. On the other hand, some treatment combinations demonstrated significantly lower disease incidence means. For example, combinations such as IT97K-819-118: $UV_2$:$I_1$, Danila: $UV_3$:$I_1$, and Danila: $X_3$:$I_1$ exhibited disease incidence means of 16.50%, 33.50%, and 33.50%, respectively. These combinations suggest a relatively effective resistance to the disease.

Additionally, there are treatment combinations that showed intermediate disease incidence means, falling between the highest and lowest values. Combinations like Danila: $X_2$:$I_1$, Danila: $UV_1$:$I_1$, and IT97K-819-118: $UV_1$:$I_1$ had disease incidence means of 83.50%, 66.50%, and 66.50%, respectively. These combinations indicate a moderate level of disease incidence. The interaction effect of varieties, radiation levels, and inoculum on disease incidence and disease severity is shown in Table 4. Disease Incidence: The disease incidence means vary across the treatment combinations. Combinations such as Danila: $UV_0$:$I_1$, Danila: $X_0$:$I_1$, and IT97K-819-118: $X_0$:$I_1$ had the highest disease incidence means (100.00%), indicating high susceptibility to the disease. Combinations like IT97K-819-118: $UV_2$:$I_1$, Danila: $UV_3$:$I_1$, and Danila: $X_3$:$I_1$ exhibited lower disease incidence means (16.50%, 33.50%, and 33.50% respectively), suggesting effective resistance to the disease. Combinations like Danila: $X_2$:$I_1$, Danila: $UV_1$:$I_1$, and IT97K-819-118: $UV_1$:$I_1$ had intermediate disease incidence means (83.50%, 66.50%, and 66.50% respectively), indicating a moderate level of disease incidence. The treatment combination IT97K-819-118: $UV_2$:$I_1$ performed the best in terms of disease incidence means, with the lowest value of 16.50%, suggesting effective resistance against the disease.

Disease Severity: The severity means of different treatment combinations are grouped. Combinations like IT97K-819-118: $X_0$:$I_1$, Danila: $X_0$:$I_1$, and IT97K-819-118: $UV_0$:$I_1$ demonstrated relatively higher disease severity. Combinations like Danila: $UV_0$:$I_1$, Danila: $X_1$:$I_1$, IT97K-819-118: $UV_1$:$I_1$, and IT97K-819-118: $X_1$:$I_1$ showed decreasing disease severity means, indicating increasing effectiveness of the treatments. Combinations like Danila: $X_3$:$I_1$ exhibited the lowest disease severity among all combinations. Combinations involving Danila and different inoculum levels tended to show better performance in terms of disease severity. Combinations including IT97K-819-118 and various radiation levels also exhibited favourable results.

Therefore, the radiations are playing a big role on the progress of the disease, where it suppresses the inoculum performance. In general, longer exposure times to X-ray radiation resulted in decreased disease severity in both cultivars. This suggests that X-ray radiation may have a suppressive effect on the progression of cowpea blight disease. However, it's important to note that the effect of X-ray radiation on disease severity may be cultivar-specific, as the IT97K-819-118 cultivar consistently exhibited lower values than Danila across all X-ray radiation treatments. The effects of UV-ray radiation on disease severity were more complex. For both cultivars, increasing exposure times to UV-ray radiation generally led to a decrease in disease severity. This indicates that UV-ray radiation may have a suppressive effect on cowpea blight disease. However, the longest exposure time of 60 minutes (UV-RAY-60Mins) resulted in an increase in values compared to the previous treatment for both cultivars. This unexpected result suggests that prolonged exposure to UV-ray radiation may have a detrimental effect on disease severity in certain circumstances. Our results were supported by Ikram *et al.,* (2015) that there was complete suppression of root rot fungi when seeds were treated with x-rays for 5, 10 and 20 sec.

Table 4: The interaction effect of Varieties, Radiation Levels and Inoculum on Disease Incidence, Disease Severity and Area under Disease Progress Curve of *Danila* and IT97K-819-118 Cowpea (*Vigna unguiculata*) Cultivars.

| Treatments Combination | DI (%) | DS (%) |
|---|---|---|
| IT97K-819-118: $X_0$:$I_1$ | 100.00$^{a}$ | 3.67$^{a}$ |
| Danila: $X_0$:$I_1$ | 100.00$^{a}$ | 3.33$^{ab}$ |
| IT97K-819-118: $UV_0$:$I_1$ | 100.00$^{a}$ | 3.33$^{ab}$ |
| Danila: $UV_0$:$I_1$ | 83.00$^{ab}$ | 3.00$^{abc}$ |
| Danila: $X_1$:$I_1$ | 66.50$^{abc}$ | 2.33$^{bcd}$ |
| IT97K-819-118: $UV_1$:$I_1$ | 66.50$^{abc}$ | 2.33$^{bcd}$ |
| IT97K-819-118: $X_1$:$I_1$ | 66.50$^{abc}$ | 2.33$^{bcd}$ |
| IT97K-819-118: $UV_3$:$I_1$ | 66.50$^{abc}$ | 2.00$^{cde}$ |
| Danila: $UV_2$:$I_1$ | 66.50$^{abc}$ | 1.67$^{de}$ |
| Danila: $X_2$:$I_1$ | 66.50$^{abc}$ | 1.67$^{de}$ |
| Danila: $UV_1$:$I_1$ | 66.50$^{abc}$ | 1.00$^{ef}$ |
| Danila: $UV_3$:$I_1$ | 50.00$^{bcd}$ | 1.00$^{ef}$ |
| IT97K-819-118: $UV_2$:$I_1$ | 50.00$^{bcd}$ | 1.00$^{ef}$ |
| IT97K-819-118: $X_2$:$I_1$ | 33.00$^{cde}$ | 1.00$^{ef}$ |
| IT97K-819-118: $X_3$:$I_1$ | 33.00$^{cde}$ | 1.00$^{ef}$ |
| Danila: $X_3$:$I_1$ | 16.50$^{de}$ | 0.33$^{f}$ |
| Danila: $UV_0$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $UV_1$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $UV_2$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $UV_3$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $X_0$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $X_1$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $X_2$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| Danila: $X_3$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $UV_0$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $UV_1$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $UV_2$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $UV_3$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $X_0$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $X_1$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $X_2$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| IT97K-819-118: $X_3$:$I_0$ | 0.00$^{e}$ | 0.00$^{f}$ |
| LSD | 0.80 | 1.00 |

Means followed by the same letters in the column are not significantlydifferent at P<0.05 alpha level.

Brown *et al.* (2001) also reported that seed treatments with low doses of UV were used to elicit host resistance to black rot in cabbage (*Brassica oleracea* L.). It is important to note that the combinations involving Danila and different inoculum levels tend to show relatively better performance in terms of disease severity. Additionally, the combinations including IT97K-819-118 and various radiation levels also exhibit favourable results.

**Conclusion**

The research revealed that, the significant impact of radiation treatments on reducing disease parameters in cowpea blight. Both X-ray and UV-ray radiation show potential as suppressive agents against the disease. However, the effects may vary depending on the cultivar and the duration of exposure.

## REFERENCES


Adegbite, A.A. and Amusa, N.A. (2010). The major economic field diseases of cowpea in the humid agro-ecologies of south-western Nigeria. *Phytopathology Plant Protection* 43: 1608–1618.

Agbicodo, E., Fatokun, C., Bandyopadhyay, R., Wydra, K., Diop, N., Muchero, W., Ehlers, J., Roberts, P., Close, T. and Visser, R., (2010). Identification of markers associated with bacterial blight resistance loci in cowpea [*Vigna unguiculata* (L.) Walp.]. *Euphytica*,175: 215–226.

Aladjadjiyan, A. (2012). The use of physical methods for plant growing stimulation in Bulgaria. *Journal of European Agriculture*,8(3): 369-380.

Bhaskara Reddy, M.V., Raghavan, G.S.V., Kushalappa, A.C. and Paulitz, T.C. (2008). Effect of microwave treatment on quality of wheat seeds infected with Fusa-riumgraminearum. *Journal of Agricultural Engineering Research*, 71(2): 113-117.

Boukar, O., Belko, N., Chamarthi, S., Togola, A., Batieno, J. and Owusu, E. (2018). Cowpea (*Vigna unguiculata*). *Journal of Genetic and Genomics, Plant Breeding*. 1–10.

Brown, J. E., Lu, T. Y., Stevens, C., Khan, V. A. and Wilson, C. L., (2001). The effect of low dose ultraviolet light-C seed treatment on induced resistance in cabbage to black rot (*Xanthomonas campestris pv. campestris*). *Crop Protection*, 20: 873–883.

Duche, T. R., Iheukwumere, C.C. and Omoigui, L. (2015). Evaluation of Selected Cowpea Genotypes for Resistance to Bacterial Blight. *International Journal of Current Microbiology and Applied Sciences*, 4(6), 257-270.

Edmondson, J. L., Davies, Z. G., Gaston, K. J., and Leake, J. R. (2014). Urban cultivation in allotments maintains soil qualities adversely affected by conventional agriculture. *Journal of Applied Ecology*,51: 880–889.

Fagwalawa, L.D., M.T. Yakasai and Kutama, A.S (2013): Growth and Yield parameters of sorghum genotypes as affected by artificial inoculation techniques for screening against head smut in Nigeria. *Bayero Journal of Pure and Applied Sciences*,6(1):144-151.

FAO. Climate Change and Food Security: Risks and Responses; FAO: Rome, Italy, 2016.

Farkas, J., and Mohácsi-Farkas, C. (2011). History and future of food irradiation. *Trends Food Science Technology*,22: 121–126.

Flavel, R. J., Guppy, C. N., Tighe, M., Watt, M., and McNeill, A. (2012). Non-destructive quantification of cereal roots in soil using high-resolution X-ray tomography. *Journal of Experimental Botany*: Online present.

Gupta, P.R.K. and Chaturvedi, G.S. (2007). Effect of pre germination exposure of ultraviolet radiation on forage seeds. *Seed research*, 15(2): 143-148.

Hamid, N. and Jawaid, F. (2011). Influence of seed pre-treatment by UV-A and UV-C radiation on germination and growth of Mung beans. *Pakistan Journal Chemistry*,1: 164–167.

Harwalker, M.R., Donger, T.K. and Padwal-Desai, S.R. (2005). Radiation disinfestations of spice and spice products. I. Radiation sensitivity of developmental stages of *Lasiodermaserricorne* and *Stegobiumpanicium*. *Journal of Food Science Technology*, 32: 249-251.

Hollósy, F. (2002). Effects of ultraviolet radiation on plant cells. *Micron*,33: 179–197.

Hyun-pa, S., Kim D. H., Jo, C., Lee, C. H., Kim, K. S. and Byun, M. W. (2006). Effect of gamma irradiation on the microbiological quality and antioxidant activity of fresh vegetable juice. *Food Microbiology*,23(4): 372-378.

Ikram, N., Dawar, S., and Imtiaz, F. (2015). X Rays Exposure on Leguminous Seeds in Combination with *Aerva javanica* Parts Powder for The Promotion of Growth and Management of Root Rot Fungal Pathogens. *European Journal of Botany Plant Sciences and Pathology*, *2*(2): 1-10.

Ivanov, A. S., Ovchinnikov, V. P., Svinin, M. P., Tolstun, N. G. and Bogart, S. L. (2001). 4 MeV high voltage accelerator with 500 kW electron beam for radiation sterilization. *Vacuum*,62: 225- 231.

Kowal. J. M. and Knabe, D. J. (1972). An Agroclimatiological Atlas of the northern states of Nigeria with explanatory notes. *Ahmadu Bello University Zaria. Nigeria. ABU Press*, pp 128.

Kravchenko, A., Falconer R. E., Grinev, D., and Otten, W. (2011). Fungal colonization in soils with different management histories: modelling growth in three-dimensional pore volumes. *Ecological Applications*,21: 1202–1210.

Kutama, A.S., Emechebe, A.M., and Aliyu, B.S. (2011). Field evaluation of some inoculation techniques on the incidence and severity of sorghum head smut (*Sporisoriumreilianum*) in Nigerian Sudan savanna. *Biological and Environmental Sciences Journal for the Tropics*, 8(3):292-296.

Kutama, A.S., Hayatu, M., Binta, U.B. and Abdullahi, I.K. (2014). Screening for some Physiological Mechanisms in some Drought Tolerant Genotypes of Cowpea (Vignaunguiculata (L.) Walp). *Standard Research Journal of Agricultural Sciences*,2(1):007-011.

McFarland, J. (1907). Nephelometer: an instrument for estimating the number of bacteria in suspensions used for calculating the opsonic index and for vaccines. *The Journal of the American Medical Association*, 14(16): 1176-1178.

Moretti, C., Mondjana, A, M., Zazzerini, A. and Buonaurio, R. (2007). Occurrence of leaf Spot on cowpea (*Vigna unguiculata*) caused by *Xanthomonas axonopodisPv. Vignicola* in Mozambique, 11-13.

Munkholm, L. J., Heck, R. J. and Deen, B. (2012). Soil pore characteristics assessed from X-ray micro-CT derived images and correlations to soil friability. *Geoderma*,181: 22–29.

Nagy, J., Rathos, J. and Toth, O. (2005). Effect of ultrasonic irradiation and vacuum infiltration combined with fungicides on fungi-infected sunflower seeds. *Acta Agronomicahungarica*,43: 93-102.

Nandini, R. and Kulkarni, S. (2016). Evaluation of botanicals for the suppression of cowpea bacterial blight disease. *Journal of Indian Botanical Society*, 95: 165–168.

Pretty, J. N., Noble, A. D., Bossio, D., Dixon, J., Hine, R. E. and Penning De Vries, F. W. T.(2006). Resource-conserving agriculture increases yields in developing countries. *Environmental Science and Technology*,40: 1114–1119.

Sameh, A. S., Kumar, A. P., Rao B. S. and Singh, R. P. (2006). Biodegradation of γ-sterilised biomedical polyolefins under composting and fungal culture environments. *Poly Degrade Stab*,91: 1105-1116.

Singh, B., 2006. Recent progress in cowpea genetics and breeding, I international conference on indigenous vegetables and legumes. In: Prospectus for Fighting Poverty, Hunger and Malnutrition 752, Conference Publication Ed. Leuven, Belgium.*International Society for Horticultural Science*, 69–76.

Sitton, J.W., Borsa, J., Schultz, T.R. and Maguire, J.O. (2005). Electron beam irradiation effects on wheat quality, seed vigor and viability and pathogenicity of telio spores of *Tilletiacontroversa* and *T. tritici*. *Plant disease*, 79(6): 586-589.

Spadaro, D, and Gullino M. L. (2005). Improving the efficacy of biocontrol agents against soilborne pathogens. *Crop Protection*,24: 601-613.

Stephenson, M.M., Kushalappa, A.C. and Raghavan, G.S.V. (2006). Effect of selected combinations of microwave treatment factors on inactivation of *Ustilago nuda* from barley seed. *Seed Science and Technology*, 24(3): 557-510.

Tekalign, T. (2009). Soil, Plant, Water, Fertilizer, Animal Manure and Compost Analysis. *International Livestock Research Center*, 13.

Therdetskaya, T.N. and Levashenko, G.I. (2006). Pre-sowing disinfestations of cucumber seed by bactericidal rays. *Zashchitai. KarantinRastenii*, 4: 43.

Zar, J.H. (2010). Biostatistical Analysis. *Prentice-Hall, Saddle River, New Jarsey, USA*: p. 947.