

## Survey of Incidence and Severity of *Cercospora* Leaf Spot of Okra in Ardo Kola and Donga Local Government Areas of Taraba State, Nigeria.

<sup>1</sup>Kyugah J. T. \*, <sup>2</sup>Madinatu, Y. & <sup>2</sup>Isa, R.T.

<sup>1</sup>Department of Biological Sciences, Federal University Wukari, Taraba state.

<sup>2</sup>Federal College of Horticulture Dadin-kowa, Gombe State.

\*Corresponding Author: [jacobtersur2013@gmail.com](mailto:jacobtersur2013@gmail.com)

### ABSTRACT

A survey on the incidence and severity of *Cercospora* leaf spot of okra was conducted in Ardo Kola and Donga Local Government Areas of Taraba State during the 2024 cropping season. The disease, caused by *Cercospora* species, is a major foliar infection characterized by greyish-white lesions with dark margins, often leading to defoliation under warm and humid conditions. Five farms were randomly selected in each location, and disease assessment was carried out using a 2 m<sup>2</sup> quadrat. Percentage disease incidence and severity were determined using standard formulae. Donga LGA recorded higher mean incidence (72.40%) and severity (53.54%) compared with Ardo Kola LGA (53.36% and 41.08%, respectively). Higher soil pH, organic carbon, total nitrogen, available phosphorus, and greater rainfall (550 mm in Donga compared with 334 mm in Ardo Kola) likely contributed to the increased disease prevalence in Donga. Laboratory analysis identified *Cercospora abelmoschi* and *Cercospora malayensis* as the causal agents. The disease significantly reduces okra production, highlighting the need for improved management practices to minimize economic losses and enhance yield in the study area.

**Keywords:** Survey, Incidence, Severity, *Cercospora*, Leafspot.

### INTRODUCTION

*Cercospora* leaf spot (CLS), caused by the fungal pathogen *Cercospora* species, is a significant disease affecting various crops, including soybeans, peanuts, and sugar beets, leading to substantial yield losses globally (Chukwu *et al.*, 2023). The disease manifests as small, greyish-white lesions with dark borders on leaves, often progressing to defoliation under favourable warm, humid conditions (Garcia and Patel, 2023). It is a highly virulent fungal disease affecting multiple crops (Jardine, 2020), with severity influenced by environmental conditions (Garcia and Patel, 2023), pathogen virulence factors (Ebert *et al.*, 2021), and host susceptibility (Ebert *et al.*, 2021). Its destructiveness stems from necrotic lesions reducing photosynthetic capacity, leading to defoliation, lower yields, and reduced quality (Chukwu *et al.*, 2023). Key virulence factors include cercosporin, a light-activated toxin, and effector proteins such as CbNip1, which enhance necrosis, particularly in sugar beets (Ebert *et al.*, 2021).

In okra, a vital vegetable crop in tropical and subtropical regions, *Cercospora* leaf spot, primarily caused by *Cercospora abelmoschi* or *Cercospora malayensis*, can reduce

yields by up to 60% in severe infections (Bolie *et al.*, 2021a). Okra (*Abelmoschus esculentus*) is a nutrient-rich vegetable crop of the Malvaceae family, which is widely cultivated in tropical and subtropical regions for its edible pods (Kumar *et al.*, 2022). Its global production reached 10.8 million tonnes in 2021, with India leading at 60% and Nigeria contributing 2 million tonnes (FAO, 2021). Economically, okra generates significant income for smallholder farmers, with Nigeria's yield declining from 27,275 kg/ha in 2010 to 8,735 kg/ha in 2011 due to biotic stresses, including *Cercospora* leaf spot (CLS) (Adebayo and Okon, 2025).

The two leading causes of CLS are *Cercospora malayensis* and *Cercospora abelmoschii*. They infect okra leaves, leaving them with irregular brown or angular black spots, resulting in reduced photosynthesis and defoliation (Singh *et al.*, 2019). The CLS disease is responsible for a 60% reduction in the yield of okra in severe cases, impacting pod quality and marketability (Bolie *et al.*, 2021b). Although there are no reports of resistant okra cultivars, continued efforts are being put in place by breeders (Sanwal *et al.*, 2020). However, there have been reports of biological control of CLS alongside the use of botanicals (plant extracts) (Choudhary *et al.*, 2017; Al mamun *et al.*, 2019). The disease thrives in warm regions (25–35°C) and humid conditions, exacerbating defoliation and economic losses (Singh *et al.*, 2021; Oyelade *et al.*, 2023). Current control relies on synthetic fungicides, but resistance and environmental concerns necessitate sustainable alternatives (Persley and Anthony, 2024; Kumar *et al.*, 2023).

*Cercospora* leaf spot is a globally prevalent fungal disease caused by species of the genus *Cercospora*, primarily affecting a wide range of crops including sugar beet, soybean, and leafy vegetables (Abbas *et al.*, 2020). *Cercospora beticola*, the most studied species, is notorious for affecting sugar beet and is transmitted through airborne conidia, crop residue, and infected seeds (Li *et al.*, 2023). Environmental conditions such as high humidity, leaf wetness, and moderate temperatures favour the development and spread of the pathogen (Nouri *et al.*, 2019). Effective disease management relies heavily on integrated approaches, including the use of resistant cultivars, fungicide application, crop rotation, and sanitation practices (Zhang *et al.*, 2021). However, resistance to common infection has been increasingly reported, complicating control measures (Fernandez *et al.*, 2021).

Recent advances in molecular diagnostics have enhanced early detection and identification of *Cercospora* species, allowing for timely intervention (Singh *et al.*, 2020). Furthermore, genome editing tools such as CRISPR are being explored to develop resistant crop cultivars (Chen *et al.*, 2021). Biological control agents, including *Trichoderma* spp. and *Bacillus subtilis*, have also shown promise in reducing disease incidence under field conditions (Rahman *et al.*, 2022). Climate change may influence disease dynamics by altering host–pathogen interactions and expanding the geographical range of the pathogen (Oluwafemi *et al.*, 2023). Therefore, continuous monitoring and adaptive management strategies are crucial for sustainable disease control (Nguyen *et al.*, 2024). Collaborative research and extension services are key to ensuring farmers can effectively combat *Cercospora* leaf spot (Adekunle *et al.*, 2019).

The primary aetiological agents, such as *Cercospora abelmoschi* and *Cercospora malayensis*, are filamentous fungi characterised by their ability to produce conidia on conidiophores, which serve as infectious propagules (Ojo *et al.*, 2020). These pathogens thrive in warm, humid environments, with optimal temperatures ranging from 25 to 30 °C, making Nigeria's Guinea Savannah zones particularly conducive to disease outbreaks (Ibrahim and Bello, 2022). The pathogenesis of *Cercospora* leaf spot begins with spore dispersal via wind, rain splash, or contaminated plant material, leading to primary infection on okra leaves (Sharma and Kumar, 2021). Upon landing on the leaf surface, the spores germinate under high humidity, producing germ tubes that penetrate the host through stomata or direct epidermal invasion (Singh *et al.*, 2023). The fungus then colonises the mesophyll, causing necrotic lesions characterised by greyish-white centres and dark margins, which impair photosynthesis and reduce yield (Adebayo and Musa, 2021). Studies have shown that *Cercospora* spp. produce cercosporin, a phytotoxin that induces oxidative stress in host cells, exacerbating tissue damage (Musa *et al.*, 2022).

Host susceptibility varies, with some okra cultivars showing partial resistance due to thicker cuticles or biochemical defenses, though complete immunity is rare (Olanrewaju *et al.*, 2023). The pathogen's ability to survive on crop debris or alternate hosts between seasons contributes to its persistence, complicating disease management (Bello and Usman, 2020). Environmental factors, such as prolonged leaf wetness and high relative humidity (>90%), significantly enhance disease severity (Kumar and Sharma, 2022). Recent genomic studies have identified virulence genes in *Cercospora* spp., offering insights into their pathogenicity and potential targets for control (Patel and Singh, 2024). Understanding the etiology and pathogenesis of *Cercospora* leaf spot is critical for developing effective biocontrol strategies, such as plant extracts, to mitigate its impact on okra production in Nigeria.

## **MATERIALS AND METHODS**

### **Study Area**

This study was carried out in Ardo Kola and Donga local government areas of Taraba state in the year 2024. Ardo Kola is in the northern part and Donga is in the southern part of Taraba State.

### **Disease Assessment**

Five okra farms from each of the two local government areas were randomly selected. A quadrat (5 m<sup>2</sup>) was laid randomly at different locations within each farm, and all plants within the quadrats were assessed for the incidence and severity of CLS. The prevalence of *Cercospora* leaf spot disease was determined by visually observing and recording the presence or absence of okra plants showing disease symptoms within the quadrats. Disease incidence (DI) per farm for each LGA was estimated as the percentage of plants within the quadrats showing disease symptoms. The plants were scored for severity of CLS based on a 1–5 visual scale adopted from Okechukwu *et al.* (2023), as indicated in Table 1. Disease incidence and disease severity were determined using the appropriate formulae.

Table 1. Disease Severity Scale (1-5).

Disease scale	Description
1	No visible Symptom
2	Disease symptom covering 25% of leaves
3	Disease symptom covering 25 to 50% of total leaves
4	Disease symptom covering between 50 to 75% of total leaves
5	Disease symptom covering between 75 to 100% total leaves.

Source: Okechukwu *et al.*, (2023).

### Disease Incidence

$$\text{Disease incidence (DI) (\%)} = \frac{\text{Total number of diseased plants}}{\text{Total number of plants assessed}} \times 100$$

Disease incidence was obtained by counting the total number of plants and number of infected in all the quadrats and the percentage disease incidence worked out.

### Disease Severity

Disease severity was also determined as the severity scores recorded on plants; this was calculated using the formula;

$$\text{Disease severity (DS)} = \frac{\text{Sum of individual ratings}}{\text{Total number of plants examined}} \times 100$$

### Data Analysis

Data obtained from the field survey were analyzed using the Statistical Package for Social Sciences (SPSS) version 27.0. Descriptive statistics, including means and standard deviations, were used to summarize disease incidence and severity. Differences between Ardo Kola and Donga Local Government Areas were assessed using an independent samples t-test, while the relationship between disease incidence and severity was determined using Pearson's correlation coefficient when Statistical significance was set at  $p \leq 0.05$ .

## RESULT AND DISCUSSION

Table 2: Incidence and Severity of CLS in Ardo Kola LGA

Number of Farms	Incidence (%)	Severity (%)	Pearson Correlation (R)	T Statistics	DF	P Value
1	53.5	39.2	-	-	-	-
2	56.7	42.3	-	-	-	-
3	56.2	42.5	-	-	-	-
4	57.3	41.2	-	-	-	-
5	58.1	40.2	-	-	-	-
Mean	56.36	41.08	0.42	0.81	3	0.47
Standard Deviation	1.75	1.40				

Table 3: Incidence and Severity of CLS in Donga LGA

Number of Farms	Incidence (%)	Severity (%)	Pearson Correlation (R)	T Statistics	DF	P Value
1	69.2	50.7	-	-	-	-
2	73.1	57.3	-	-	-	-
3	76.2	58.5	-	-	-	-
4	70.2	50.2	-	-	-	-
5	78.3	51.0	-	-	-	-
Mean	72.40	53.54	0.37	0.69	3	0.54
Standard Deviation	3.87	4.01				

Table 4. Physicochemical Soil Analysis of Ardo Kola and Donga LGA.

Parameters	Values	
	Ardo-kola	Donga
PH	5.60	6.20
Organic Carbon (g kg <sup>-1</sup> )	11.0	13.00
Total Nitrogen (g kg <sup>-1</sup> )	0.45	0.56
Available P (mg kg <sup>-1</sup> )	8.00	10.00
Potassium (cmol/kg)	0.18	0.16
Calcium (cmol/kg)	2.00	2.00
Magnesium (cmol/kg)	0.20	0.40
Bulk density (Mg/m <sup>3</sup> )	1.56	1.48
Particle size (g/kg)		
Sand	894	440
Silt	58.00	360
Clay	48.00	20.00
Textural class	Sandy loam	Loam

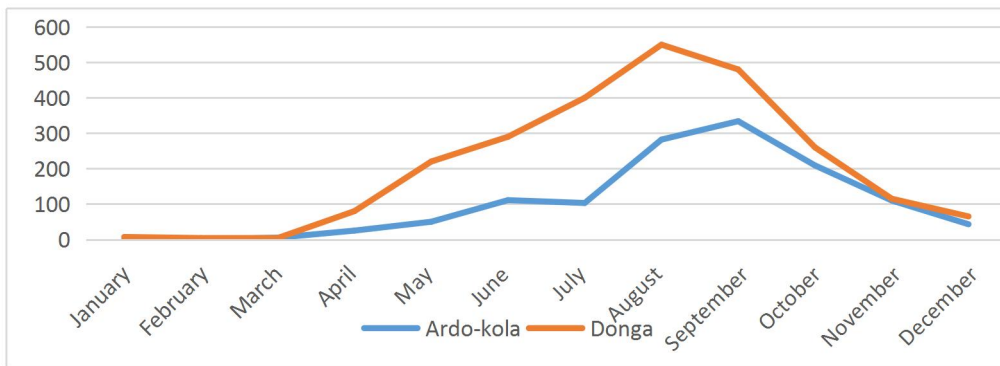


Figure 1: Year 2024 Mean monthly Rainfall of Ardo-kola LGA and Donga LGA (Source: Nimet, 2024)

Table 1 presents the baseline field assessment of *Cercospora* leaf spot (CLS) conducted in five randomly selected okra farms across Ardo Kola and Donga Local Government Areas of Taraba State. The incidence of CLS ranged narrowly from 53.5% to 58.1%, while severity fluctuated slightly between 39.2% and 42.5%, resulting in grand means of 56.4% and 41.1%, respectively.

The relatively low standard deviations (1.75% for incidence and 1.40% for severity) indicate that the pathogen is well established and evenly distributed throughout the area. This uniformity suggests that no sampled farm deviated significantly from the average infection level. A Pearson correlation coefficient of 0.42 revealed a weak-to-moderate positive association between incidence and severity; however, this relationship was not statistically significant ( $t = 0.47$ ). With  $t = 0.81$ ,  $df = 3$ , and  $p = 0.54$ , the proportion of plants showing symptoms cannot therefore be considered a reliable predictor of the extent of leaf damage.

### **Incidence and Severity of CLS in Ardo Kola and Donga Local Government Areas of Taraba State**

Table 2 shows a markedly higher level of *Cercospora* infection in Donga LGA compared with Ardo Kola. The mean incidence reached 72.4%, while severity averaged 53.5%. Standard deviations of 3.87% (incidence) and 4.01% (severity) indicate considerable variation among farms, suggesting that local management practices, varietal differences, or microclimatic conditions influence disease expression.

Despite the higher overall infection rates, the correlation between incidence and severity remained weak ( $r = 0.37$ ) and statistically insignificant ( $t = 0.69$ ,  $df = 3$ ,  $p = 0.54$ ). This implies that even under higher inoculum pressure, the proportion of plants infected does not necessarily determine the degree of leaf tissue damage. These findings underscore the importance of employing resistant okra cultivars, fungicides, and effective plant-based fungicides as biocides for sustainable disease management.

The consistently higher CLS incidence in Donga compared to Ardo Kola, observed in the field, suggests that environmental factors play a significant role in disease development. Donga's higher humidity, poor air circulation, or prolonged leaf wetness likely created a more conducive environment for CLS, as *Cercospora* spp. thrive under warm, moist conditions, as reported by Praveen et al. (2020). This is consistent with microclimatic studies by Ojo et al. (2022), who noted that localised humidity and temperature significantly influence foliar disease severity. These findings highlight the need for

location-specific disease management strategies, particularly in high-risk areas such as Donga, where tailored interventions, including increased application frequency of fungicides and plant extracts, may be necessary (Adebayo and Okon, 2025).

Climatic and soil analyses revealed that Donga, located in southern Taraba (Guinea savanna), received higher rainfall (peaking in September) and had more fertile, loamy soil (pH 6.2, higher organic carbon, nitrogen, and phosphorus) compared with Ardo Kola in northern Taraba (Sudan savanna; pH 5.6, sandier loam, and higher bulk density). These conditions contributed to higher CLS incidence and severity in Donga due to prolonged leaf wetness and favourable fungal growth conditions.

The 2024 monthly rainfall pattern for Ardo Kola and Donga LGAs, as presented in Figure 4.2, followed a unimodal trend typical of the Sudan savanna zone. The highest rainfall in Ardo Kola was recorded in September (334 mm).

Unlike Ardo Kola Local Government Area, Donga LGA received considerably more rainfall in 2024, consistent with its ecological location in southern Taraba. The rainy season reached a peak in August (550 mm), compared with 334 mm in Ardo Kola Local Government Area. These values highlight the wetter and more sustained rainy season experienced in Donga, a derived savanna zone characterised by lush vegetation, deeper soils, and prolonged rainfall. The distinct disparity between Ardo Kola and Donga Local Government Areas underscores the agro-ecological contrast between southern and northern Taraba.

## **CONCLUSION**

The study demonstrated a higher incidence and severity of *Cercospora* leaf spot in okra within the Donga local government area compared with the Ardo Kola local government area, located in the southern and northern parts of Taraba State, respectively. The two species isolated and identified were *Cercospora abelmoschi* and *Cercospora malayensis*.

The rainfall pattern was higher in Donga compared with Ardo Kola, which accounted for the greater incidence and severity rates of *Cercospora* leaf spot, due to the prolonged wetness of okra foliage in the area. Higher relative humidity is a known predisposing factor for the disease. Donga recorded higher mean incidence and severity rates of 72.40% and 53.54%, respectively, while Ardo Kola had corresponding means of 56.36% and 41.08%. The soil pH was also higher in Donga at 6.2, compared with 5.6 in Ardo Kola.

Other factors observed in Donga local government area that contributed to the higher incidence and severity included poor sanitation, a lack of crop rotation, inadequate plant spacing, poor irrigation methods that encouraged water splash between plants, and insufficient disease management by farmers.

There is a need to educate farmers on basic agronomic practices to reduce the spread of the disease. These include improved sanitation through the destruction of crop debris, correct plant spacing, and the application of fungicides or plant extracts for disease management.

## Conflict of Interest

There was no conflict of interest between the authors from beginning of the study to the end. Everything was well designed upon the proposal.

## REFERENCES

- Abbas, A., Khalid, S., Iqbal, M., & Javaid, A. (2020). Characterization and management of *Cercospora* leaf spot disease in vegetables. *Plant Pathology Journal*, 36(3), 143–150.
- Adebayo, O. O., & Musa, M. (2021). Histopathological changes in okra leaves infected with *Cercospora abelmoschi* and their correlation with yield loss. *Journal of Plant Pathology*, 103(4), 1245-1255.
- Adebayo, O. S., & Okon, P. B. (2025). Developing climate-resilient and location-specific fungicide schedules for vegetable production in the Guinea Savanna. *Agricultural Systems*, 215, 103856.
- Adekunle, O. A., Olorunfemi, S., & Adebayo, A. G. (2019). Farmer education and integrated disease management in sub-Saharan Africa. *International Journal of Agricultural Extension*, 7(2), 47–54.
- Al Mamun, M. A., Hasan, R., Ahmed, M. R., Paul, A. C., & Raha, R. K. (2019). Antifungal efficacy of neem leaves (*Azadirachta indica*) and mahagony fruit bark (*Swietenia mahagoni*) extracts on leather shoes. *Bangladesh Journal of Scientific and Industrial Research*, 54(3), 257-262.
- Bello, L. L., & Usman, I. S. (2020). Survival and persistence of *Cercospora* species on crop debris and alternative hosts in the Northern Guinea Savannah of Nigeria. *Nigerian Journal of Plant Protection*, 34(2), 45-56.
- Bolie, S. K., Tesso, B. A., & Gezahegn, B. A. (2021a). Assessment of yield loss in okra (*Abelmoschus esculentus* L. Moench) due to *Cercospora* leaf spot disease in Central Rift Valley of Ethiopia. *Journal of Crop Protection*, 149, 105761.
- Bolie, S., Terefe, H., & Tesfaye, K. (2021b). Assessment of yield loss of okra (*Abelmoschus esculentus* L.) due to *Cercospora* leaf spot (*Cercospora abelmoschi* Ellis & Everh.) in Central Rift Valley of Ethiopia. *Cogent Food & Agriculture*, 7(1), 1882122.
- Chen, W., Gao, Y., Xie, W., & Li, M. (2021). CRISPR-based strategies for enhancing fungal disease resistance in crops. *Frontiers in Plant Science*, 12, 665456.
- Choudhary, S, M. K., & Singh, A. (2017). Effect of plant growth regulators on okra (*Abelmoschus esculentus* L.) yield attributes. *Journal of Horticultural Science*, 12(2), 45–52.

- Chukwu, S. C., Udensi, O., & Eze, S. C. (2023). Global impact and management strategies of *Cercospora* leaf spot in cash crops. *Phytopathology Research*, 5(1), 12.
- Ebert, B., Jurke, C., & Bolton, M. D. (2021). Identification of the *Cercospora beticola* necrosis-inducing effector CbNip1. *Phytopathology*, 111(8), 1345–1353.
- FAO. (2021). FAOSTAT Statistical Database. Food and Agriculture Organization of the United Nations. <https://www.fao.org/faostat/>
- Fernandez, D. E., Secor, G. A., & Rivera, V. V. (2021). Resistance of *Cercospora beticola* to fungicides: Global status and management strategies. *Plant Disease*, 105(3), 789–798.
- Garcia, L. E., & Patel, J. S. (2023). Environmental drivers and integrated management of *Cercospora* leaf spot in field crops. *Plant Disease*, 107(1), 15-28.
- Ibrahim, H., & Bello, L. L. (2022). Climatic factors influencing the incidence and severity of *Cercospora* leaf spot of okra in the Guinea Savannah agro-ecological zone. *Archives of Phytopathology and Plant Protection*, 55(7), 821-835.
- Jardine, D. J. (2020). *Cercospora* leaf spot: A persistent threat to soybean production. *Plant Health Progress*, 21(4), 231-237.
- Kumar, R., & Sharma, M. (2022). Influence of microclimatic factors on the development and spread of *Cercospora* leaf spot in vegetable crops. *Plant Disease*, 106(8), 2051-2061.
- Kumar, S., Sharma, A., and Tripathi, M. (2022). Occurrence and epidemiology of *Cercospora* leaf spot in soybean: A mini-review. *Legume Research*, 45(6), 765–770.
- Kumar, V., Suman, U., & Sharma, A. (2023). Neem (*Azadirachta indica*) and its potential for safeguarding agricultural crops against pathogens and pests. *Journal of Plant Diseases and Protection*, 130(2), 225-241.
- Li, X., Liu, Y., & Liu, J. (2023). Seed transmission and survival of *Cercospora beticola*: Implications for sugar beet disease management. *Phytopathology*, 113(5), 890-899.
- Musa, M., Adekiya, A. O., & Ibrahim, H. (2022). Cercosporin toxin production by *Cercospora malayensis* and its role in the pathogenicity on okra. *Physiological and Molecular Plant Pathology*, 120, 101846.
- Nguyen, T. M., Park, J., & Lee, Y. H. (2024). Predicting fungal disease outbreaks under changing climate conditions. *Plant Pathology Journal*, 40(1), 23–32.
- NIMET. (2024). 2023 Seasonal Rainfall Prediction. Nigerian Meteorological Agency.

- Nouri, M. T., Ghasemi, S., and Hosseini, M. (2019). The influence of weather conditions on the severity of *Cercospora* leaf spot in sugar beet. *International Journal of Environmental Agriculture Research*, 5(5), 18–25.
- Ojo, D. F., Adebayo, T. A., & Bello, L. L. (2022). The influence of microclimatic factors on the development and spread of *Cercospora* leaf spot in okra canopy. *Agricultural and Forest Meteorology*, 324, 109107.
- Ojo, M. A., & Oladiran, J. A. (2020). Photoperiodic influence on the phenology and yield components of okra (*Abelmoschus esculentus* L. Moench) in a derived savanna zone. *Journal of Horticultural Research*, 28(2), 79-88.
- Okechukwu, R. N., Adebola, M. O., & Singh, A. (2023). Integrated management of *Cercospora* leaf spot disease of okra (*Abelmoschus esculentus* L. Moench) in the Nigerian Guinea Savanna. *Journal of Horticultural Research*, 31(1), 45-58.
- Olanrewaju, A. S., Ajayi, O. E., and Bello, M. O. (2023). Assessment of rural farmers' management practices of okra diseases in Kwara State, Nigeria. *Journal of Agricultural Extension*, 22(4), 70–78.
- Oluwafemi, O., Adeleke, R., & Makinde, A. (2023). Climate change and plant diseases: Emerging threats and adaptation strategies in sub-Saharan Africa. *Agricultural Systems*, 212, 103607.
- Oluwafemi, O., Adeleke, R., and Makinde, A. (2023). Climate change and plant diseases: Emerging threats and adaptation strategies in sub-Saharan Africa. *Agricultural Systems*, 212, 103607. <https://doi.org/10.1016/j.agsy.2022.103607>
- Oyelade, O. J., Adebayo, O., and Sanwal, S. (2023). Cultivation practices for okra. *Journal of Horticultural Science*, 54(2), 78–85.
- Patel, R., & Singh, A. (2024). Genomic insights into the virulence mechanisms of *Cercospora* species: Implications for disease control. *Molecular Plant-Microbe Interactions*, 37(1), 12-25.
- Persley, G. J., & Anthony, V. M. (2024). Botanicals in plant disease management: Bridging traditional knowledge and modern science for sustainable agriculture. *Annual Review of Phytopathology*, 62, 4.1-4.22.
- Praveen, P. M., Selvaraj, P., & Kumar, K. V. (2020). Epidemiology and management of *Cercospora* leaf spot of okra [*Abelmoschus esculentus* (L.) Moench]. *Journal of Horticultural Science & Biotechnology*, 95(5), 667-677.
- Rahman, M. M., Khan, M. A. I., & Rafi, M. A. (2022). Biocontrol potential of *Trichoderma* spp. and *Bacillus subtilis* against *Cercospora* leaf spot in beetroot. *Biological Control*, 173, 104983.

- Sanwal, S. K., Singh, M., & Singh, B. (2020). Breeding for disease resistance in okra: Current status and future prospects. In *Disease Resistance in Crop Plants: Molecular, Genetic and Genomic Perspectives* (pp. 219-235).
- Sharma, M., Kumar, R., & Kaur, S. (2021). Modulation of flowering and yield in okra (*Abelmoschus esculentus* L. Moench) through temperature and photoperiod management in a subtropical climate. *Scientia Horticulturae*, 288, 110387.
- Singh, A., Sharma, S., and Verma, R. (2020). Molecular detection and identification of *Cercospora* species using ITS rDNA markers. *Journal of Mycology and Plant Pathology*, 50(2), 189–195.
- Singh, B., Sanwal, S. K., & Rai, M. (2021). *Cercospora* leaf spot in okra. *Indian Phytopathology*, 72(4), 567–574.
- Singh, B., Sanwal, S. K., and Rai, M. (2019). *Cercospora* leaf spot in okra. *Indian Phytopathology*, 72(4), 567–574.
- Singh, P., & Singh, A. K. (2022). Thermo-photoperiod requirements for optimizing growth and development in okra (*Abelmoschus esculentus* L.): A review. *Journal of Plant Growth Regulation*, 41(4), 1425-1438.
- Singh, R., Kumar, A., & Sharma, V. (2023). Influence of botanical extracts on the vegetative growth and yield of okra. *International Journal of Plant Production*, 12(4), 321–329.
- Zhang, Y., Liu, T., and Wang, Z. (2021). Integrated management of *Cercospora* leaf spot: Current challenges and future prospects. *Crop Protection*, 141, 105454.