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Influence of Planting Date on the Incidence and Severity of Leaf Spot Disease in *Telfairia occidentalis* Hook f.

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Abstract

Telfairia occidentalis Hook f. is attacked by a destructive fungal pathogen *Epicoccum sorghinum* which causes leaf spot disease in the field. In Cameroon, this critically important seed and leaf vegetable is predominantly cultivated under natural environmental conditions. An experiment was conducted in 2019 and 2020 during the long and short rainy seasons in Santchou to determine the influence of planting dates between seasons on the incidence and severity of leaf spot disease. The design used was a 2 by 4 factorial randomized complete block design with three replications and four sowing dates. Data for disease incidence and severity documented fortnightly, were submitted to analysis of variance using SPSS version 23, and the means were separated by Duncan's multiple range test (DMRT) at a 95% confidence interval. Statistical analysis revealed that the long rainy season registered a significantly ($p < 0.05$) lower leaf spot disease incidence and severity than the short rainy season. The initial three planting dates during the long rainy season recorded significantly low ($p < 0.05$) disease incidences and severities to other planting dates investigated. We established that the first three planting dates in the long rainy season could be a management practice to reduce disease prevalence.

Keywords

Leaf Spot, Planting Date, Season, *Telfairia occidentalis*

1. Introduction

Fluted pumpkin (*Telfairia occidentalis* Hook f.) is an important leafy vegetable delicacy in most households in Cameroon. The cultivation of the perennial vine

has greatly sustained the livelihood of the local cultivators because they can afford to continuously revenue from its sales throughout the production cycle. The young leaves have essential nutritional, and medicinal values with potentials to be used industrially [1].

However, sustainable production is greatly constrained by various diseases each year. The production and quality of fluted pumpkin is seriously constrained by leaf spot diseases caused by the pathogenic fungus *Epicoccum sorghinum* (formerly *Phoma sorghina*) [2].

Under field conditions, symptoms of the disease begin to appear and continue to proliferate about three weeks after emergence. The leaf spot pathogen, *Epicoccum sorghinum*, is a necrotrophic pathogen which obtains nutrients from living cells in the leaves of the crop and maintains a lengthy and deep interaction with the host plant. The pathogen secretes enzymes that kill host tissues, extract nutrients from the cells and then live in the dead tissue. As the parasite continues to feed on the leaf tissues, the translucent white spots further enlarge, turn brown and shatter, leaving the leaves with perforations. The parasitic fungi thus produce localized lesions of dead or collapsed cells with the result that leaf lamina is reduced. In critical conditions of attack by the pathogen, the leaf dies completely. In effect, crop production becomes limited with cultivators facing regrettable economic down trends. [3] reported that the cultivation of *T. occidentalis* contributes greatly to the economy of the producing areas because it is an important source of revenue. Attack of fluted pumpkin by the parasitic fungus is known to also significantly reduce the nutrient content [3].

However, very limited options are available for the poor resource-based farmers who are a majority of cultivators to exploit in the management of the devastating *Telfairia occidentalis* leaf spot disease. The use of synthetic chemicals has been used in the management of the disease. [4] reported that fortnightly sprays with synthetic fungicides significantly reduced that prevalence of the disease in the field. However, the use of these chemicals is said to be beyond the financial means of the local cultivators [5]. The farmers are also ignorant of how to use these chemicals coupled with lack of accessories [3]. Furthermore, [6] reported that improper use of synthetic chemicals has led to residue buildup which may rather have intoxicating effects when the vegetable is exploited for consumption as food or medicine. Moreover, the use of such chemicals endangers the health of the farmers and is a threat to the sustainability of the natural ecosystem [7]. These setbacks and the mounting desire for organically produced food devoid of synthetic chemicals also necessitate the need for alternative disease control options that can be easily adopted, cheap, safe, and environment friendly.

In Cameroon, *T. occidentalis* can be cultivated during the long and short rainy seasons. Long rainy season planting begins at the onset of the rainy season in March, while short rainy season planting is normally completed in July. With the increasing demand of the perennial vegetable owing to its nutritional and

medicinal values, there is the necessity to address the constraints to its production. Optimization of planting date is a cultural technique with potential to be channeled for the management of leaf spot disease. The main objective of this study was to investigate how season and planting dates within season impact leaf spot incidence and severity to identify optimal planting dates for *T. occidentalis* production.

2. Material and Methods

2.1. Study Area

Field studies were executed in the growing seasons of 2019 and 2020 at IRAD (Faculté d'Agronomie et des Sciences Agricoles) research and seed multiplication field during both long and short rainy seasons in Santchou. The field shares boundaries with the defunct rice production company SODERIM (Société de Développement Rizicole et Maraichères).

Santchou is located between 5˚16'N and 9˚58'E at an altitude of 786 m. The study area is characterized by an annual average temperature of 22.5˚C, with annual precipitation of 1364.4 mm. The percentage relative humidity is 92%. Being in the tropics, there are two main seasons: a short dry season which starts from mid-November and end in early March and a long rainy season [8].

2.2. Experimental Layout

The field study during the trial investigations was laid out in a 2 by 4 factorial randomized complete block design. There were three blocks with twelve (12) experimental units each. Blocks and experimental units were delineated by passage ways of 40 cm. The experimental units measured 1.5 m × 1.5 m each. Two seasons and four sowing dates were used in the trial study. Three experimental units within each block were randomly and evenly allocated to the four sowing dates. Healthy and mature fruit pods required for seeds of the same cultivar were harvested for seeds from a previous study site in the locality of Dschang [9]. The seeds, cautiously extracted manually from the pods, were air-dried for two days, cognizance that they are stubbornly resistant to storage under atmospheric conditions for longer periods, to prevent decay before planting.

2.3. Field Preparation

The experiment was laid over an area 121 m^2 that had been fallowed for over two years at the IRAD research field in Santchou and was manually cleared of weeds. Soil tillage was carried out manually and the experimental units of 1.5 m × 1.5 m were constructed. Land preparation before seed sowing involved similar field preparatory activities during both long and short rainy seasons.

2.4. Sowing of Seeds and Treatments

The hydromorphic topsoil was used as substrate for sowing. The selected seeds

were sown by direct seeding at a depth of 3 - 4 cm and covered with topsoil. Four fluted pumpkin seeds were sown on each experimental unit at planting distances were of 1 m × 1 m.

The four planting dates employed in the study were spaced out seven days apart. Long rainy season sowing commenced on 21 March (as first planting date) with the onset of first rains and, extended into early April. The second planting was on March 28th while the third and fourth plantings were executed on the 4th and 11th of April respectively throughout the field trials. Short rainy season planting started on July 4th and terminated within the same month. Seeds were sown on July 4th, 11th, 18th, and 25th for the first, second, third and fourth planting dates.

2.5. Crop Maintenance in the Field

The experimental field during the study was secured with fence. Field activities included weed removal, staking and trellis construction for appropriate disease monitoring. Biodegradable ropes were used to train the staked vines to their respective trellis.

2.6. Data Collection

2.6.1. Leaf Spot Disease Assessment

During the study, leaf spot disease incidence was established by unaided visual observations of symptoms of the disease on the leaves. Collection of information on disease parameters was initiated at three weeks after emergence when typical symptoms of the disease begin to appear. This was done once in two weeks and lasted for eight weeks.

2.6.2. Evaluation of Leaf Spot Disease Incidence

The disease incidence was evaluated within the speculated time with the aid of Microsoft excel using the following formula:

$$\text{Disease incidence} = \frac{\text{Number of leaves infected per plant}}{\text{Total number of leaves sampled per plant}} \times 100\%$$

2.6.3. Assessment of Leaf Spot Disease Severity

The leaf spot disease severity was determined, also for all plants within the treatments, based on the percentage leaf spot disease incidence using the adjusted disease severity scale of [10] (**Table 1**).

2.6.4. Data Processing and Statistical Analysis

In the study, the data collected for leaf spot disease incidence and severity were compiled in a Microsoft Excel sheet.

Data on leaf spot disease incidence and severity were submitted analysis of variance and the means separated by Duncan's Multiple Range Test (DMRT), at a 95% confidence interval ($p = 0.05$). The analyses were conducted using the Statistical Package for Social Sciences (SPSS), version 23.

Table 1. Disease severity scale of leaf spot (scored at weekly intervals).

Severity Scale	Numerical Rating	Description of symptom
0	0	No disease.
1 - 20	1	Infection of the leaves with small spot lesions.
21 - 40	2	Moderate infection of leaf with spot lesions spreading on the surface of the leaves.
41 - 60	3	Severe infection of the leaves with leaf spot lesions almost found in all the leaflets.
61 - 80	4	Very severe infection on all the leaves with spot lesions spreading in all the leaflets and coalescing.
81 - 100	5	The plant is completely infected with all leaves having leaf spot disease, some of the leaves having holes and there is leaf tearing.

3. Results

3.1. Effect of Planting Date on the Incidence and Severity of Leaf Spot Disease Incidence and Severity during the Long and Short Rainy Seasons

Regarding leaf spot disease incidence, the third planting date during the long rainy season recorded a very low leaf spot disease incidence of 9.26%, while planting date four in the study registered a very high leaf spot disease incidence compared to incidences observed in other planting dates investigated in the study during the long rainy season. With respect to disease severity, the first planting date registered the lowest severity compared to disease severities observed in the later three planting dates. In contrast, disease severity was highest at the fourth planting date.

The comparatively low leaf spot incidences recorded in the initial three planting dates at long rainy season were statistically comparable but differed significantly ($p < 0.05$) different from the disease incidences registered within all planting dates in the short rainy season including the fourth planting date in the long rainy season. Planting date three in the short rainy season registered the highest and disease incidence which was significantly ($p < 0.05$) different from all leaf spot incidences registered at planting dates during the study. Moreover, the comparatively high incidence documented at planting date one during the short rainy season differed significantly ($p < 0.05$) from leaf spot incidences observed in all planting dates in the study. Statistically similar results were obtained between the incidence at planting date two in the short rainy season and other planting dates investigated in the study (Table 2).

For the most part except for planting date four, disease severity within all planting dates during the short rainy season was depicted by the moderate infection of leaves with spot lesions spreading on the surface of the leaves. Meanwhile, the severity recorded in planting dates during the long rainy season was characterized by the infection of leaves with small spot lesions. Statistical analysis revealed that the leaf spot severities registered at planting dates one, two and three within the long rainy season were lower and differed significantly ($p < 0.05$) from other similar results recorded the trial investigation. In addition, the disease

Table 2. Effect of planting date on disease incidence and severity.

Planting dates	Season	DI ± SEM (%)	Disease severity ± SEM
One	Short rainy season	43.46 ± 1.64[b]	2.59 ± 0.09[b]
	Long rainy season	9.74 ± 1.04[f]	0.85 ± 0.06[f]
Two	Short rainy season	38.15 ± 1.72[c]	2.31 ± 0.10[c]
	Long rainy season	10.02 ± 0.83[f]	0.95 ± 0.05[f]
Three	Short rainy season	47.22 ± 1.44[a]	2.81 ± 0.08[a]
	Long rainy season	9.26 ± 0.63[f]	0.94 ± 0.04[f]
Four	Short rainy season	30.79 ± 1.88[d]	1.88 ± 0.12[d]
	Long rainy season	16.13 ± 1.00[e]	1.23 ± 0.06[e]

[a, b, c, d, e, f]Means in the same column with the same superscript are not significantly different at $p > 0.05$ (DMRT). % = percentage. SEM = Standard error of mean. DI = Disease incidence.

severities observed in the leading three planting dates investigated during the long rainy season were statistically related. The statistically high leaf spot severity recorded at planting date three investigated during the short rainy season was significantly ($p < 0.05$) different from other similar results observed in other planting dates investigated in the study (Table 2).

3.2. Leaf Spot Disease Incidence and Severity between Seasons

By and large in the study, leaf spot disease incidence and severity of fluted pumpkin were established to be higher during the long rainy season than in the short rainy season.

The disease severity during the long rainy season was characterized by the infection of leaves with small spot lesions while the severity during the short rainy season was depicted by moderate infection with leaf spot lesions spreading on the surface of leaves.

Statistical analysis revealed that the long rainy season registered a significantly ($p < 0.05$) lower disease incidence and severity than the short rainy season (Table 3).

4. Discussion

The study established the vulnerability of *T. occidentalis* to leaf spot disease under field conditions.

The first three planting dates during the long rainy season recorded significantly lower *T. occidentalis* leaf spot incidences and severities compared to the results obtained from other planting dates investigated in the study. Similar results were also reported by [11]. The authors argued that the strategic manipulation of sowing dates was effective in the management of some diseases in crop plants. The initial three planting dates during the long rainy season coincided

Table 3. Leaf spot incidence and severity between the long and short rainy seasons.

Seasonal variation	DI ± SEM (%)	Disease severity
Long rainy season	11.29 ± 0.46[b]	1.00 ± 0.03[b]
Short rainy season	39.90 ± 0.88[a]	2.40 ± 0.05[a]

[a, b]Means in the same column with the same superscript are not significantly different at $p > 0.05$ (DMRT). % = percentage. SEM = Standard error of mean. DI = Disease incidence.

with the period of moderate rainfall (134 - 268 mm) coupled with high temperatures and low humid weather, which could have been disparaging for disease development, resulting to low disease prevalence. In addition, the growing stages of fluted pumpkin in the field were less prone to infection by the pathogen resulting in the escape of the disease. Another study, however, registered contrary results compared to what was obtained in this study. [12] reported that higher disease incidences of scab were documented on early sown cowpeas, when typical rains were set in, than on later sown crops.

The comparatively high and significant leaf spot incidence and severity observed at the planting dates during the short rainy season and planting date four in the long rainy season could be ascertained by the fact that the growing stages of the stands were extremely susceptible to infection by *Epicoccum sorghinum* coupled with a favourable environmental condition. In the study, these planting dates overlapped with periods of high rainfall, low temperatures and high relative humidity, which could have been more encouraging for the sporulation, development and spread of the pathogen, resulting to significantly high disease incidences and severities.

High disease incidence and severity at planting date four within the long rainy season could be ascertained to high inoculum built up from previous planting dates within the field, higher vulnerability of the growing stages of the stands and more conducive conditions for disease development.

In the study *T. occidentalis* leaf spot incidence and severity were significantly lower during the long rainy season than in the short rainy season. This could be due to high rainfall together with high relative humidity during the short rainy season. These conditions could have been more encouraging for pathogen reproduction and infection but detrimental to the host leaves in the field, leading to higher disease incidence and severity. The leaf spot pathogen is in addition to windborne is also water borne. Therefore, rain splashes could have heightened the spread of the pathogen in the field. The results obtained in this study are in conformity with [13] who reported that an increase in the incidence and severity of angular leaf spot disease of cotton followed the pattern of the percentage relative humidity and rainfall in the study areas of Yola and Mubi, Adamawa State, Nigeria. In this study, throughout the long rainy season, precipitation was consistently low, but witnessed an increase during the short rainy season (**Table 4** and **Table 5**). Therefore, disease incidence and severity followed a pattern of

Table 4. Average monthly climatic parameters in Santchou 2019.

	January	February	March	April	May	June	July	August	September	October	November	December
Average Temperature (˚C)	28	28	28	27	26	23	22	22	23	23	23	26
Rainfall (mm)	94.9	94.9	94.9	508.63	508.63	508.63	873.1	873.1	873.1	369.97	369.97	369.97
Humidity (%)	17.7	17.7	17.7	25	25	25	28.1	28.1	28.1	24.3	24.3	24.3

Source: Meteorological station IRAD Dschang.

Table 5. Average monthly climatic parameters in Santchou 2020.

	January	February	March	April	May	June	July	August	September	October	November	December
Average Temperature (˚C)	27	28	26	25	24	22	21	21	21	22	24	25
Rainfall (mm)	194.3	194.3	194.3	614.7	614.7	614.7	874.1	874.1	874.1	386.83	874.1	874.1
Humidity (%)	21.2	21.2	21.2	27.2	27.2	27.2	28.3	28.3	28.3	26.1	26.1	26.1

Source: Meteorological station IRAD Dschang.

weather conditions. The findings in this study are consistent with previous studies by [14] who affirmed that weather conditions such as high rainfall, and high relative humidity favoured infection of crops by pathogens. These findings also agree with those of [15] who established that there was a positive correlation between environmental conditions and disease severity.

Short rainy season planting of *T. occidentalis* is usually preceded by an intervening short dry period. With the resumption of rainfall after this brief dry period, which is often more intense, together with higher temperatures, conditions could have been more encouraging for the multiplication and spread of the windborne and water borne leaf spot pathogen readily producing fresh infections. In effect, leaf spot disease incidence and severity were bound to be extremely high.

5. Conclusion

The study established that the leading three planting dates investigated during the long rainy season were crucial in reducing infection by *Epicoccum sorghinum* under field conditions. In addition, the long rainy season proved better in reducing leaf spot disease incidence and severity. The first three planting dates in the long rainy season could therefore be applied in the management of leaf spot disease of *T. occidentalis*.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

Authors' Contributions

KAK carried out the investigation, provided resources, did data curation, administered the project, and did the formal analysis and writing original draft preparation. ALA and MGA was there for conceptualization, supervision and validation; did the review and editing. All authors read and approved the manuscript.

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