



Effects Of Seasonal Disparity on Crop Susceptibility to Injuries of Phyto-Parasitic Nematodes



Ogenetega Emeriewen^{1*} & Emmanuel Green Ekine²

^{1&2}Department of Biology, Federal University Otuoke, Bayelsa State, Nigeria

* Corresponding Author Email: ekineeg@fuotuoike.edu.ng

ABSTRACT

Seasonal discrepancies can display effects on the sequence of events in the soil ecosystem and impact on the biotic and abiotic elements, exposing crop plants to conditions relatively requiring resilient for survival and prompt parasites to intensify mechanisms to stay alive. This scenario increases vulnerability of host plants to infections of parasitic pathogens in soil. This study tested the effects of seasonal disparity as it influences crop susceptibility to injuries of plant parasitic nematodes and established that nematode penetration on plant tissue and population richness in soil is seasonal reliance. Soil and root sampling were done during dry and wet seasons using a modified soil auger and hand trowel. Determination of gall index to access crop injury was done on a scale of 0-4 where 0 represent no infection, 1-10 (light infection), 11-20 (moderate infection and 21 and above represent severe infection. The study adopted the modified Bearman's extraction technique for nematode extraction. Nematode population in soil was high at wet season (75.9%) when compare with the observation during the dry season (24.1%). However, nematode population was higher in the root tissue of bell pepper during the dry season (73.6%) compared to wet was 26.4%. In this study, crop injuries were relatively severe at dry season. This observation is evidence that crop plants are relatively susceptible to infections of parasitic agents in soil during dry season.

Keywords:

Disparity,
Dry season,
Susceptibility,
Wet season

INTRODUCTION

The productivity of crop plants is largely dependent on its viability to withstand stress and diseases, provided the soil is fecund. A viable crop in a fertile soil free from parasitic agents can guarantee food security and promote sustainable economy. Unfortunately, phyto-parasitic nematodes incumbent in the Nigerian soil presents a serious threat to crop performance and yield, putting food security at risk. The survival mechanism of plant parasitic nematodes obstructs the developmental sequence of crop plants, impair yield and can prompt food insecurity in a very severe case (Ekine & Ezenwaka, 2024; Coyne et al., 2018). However, the actual instance of plants parasitic nematodes in the soil ecosystem is dynamic, under the control of edaphic factors on the influence of seasonal disparity. According to Yandom et al., (2025) and Mohanty et al., (2020), Crop farming is significant for global security and economic development. Nevertheless, diseases emanating from parasitic agents remain a critical setback for improve yield globally (Yandom et al., 2025).

Seasonal variance usually noticed due to change in temperature and soil water content form a key determinant for crop susceptibility to injuries of plants parasitic nematodes (Ekine and Ezenwaka, 2024; Chen et al., 2021). These elements influence the functions of host plants (Alotaibi, 2023), impact on the developmental sequence of the parasites and also facilitate or inhibits interactions between the parasite and the crop host plants (Da Silva et al., 2017). Certain species of plants parasitic nematodes are most active in specific season and increases crop vulnerability as population richness is influenced by season. The population dynamics of plants parasitic nematodes and crop susceptibility waves with regards to seasonal discrepancy (Hassan et al., 2009) and could depict strong effects on crop yield and vulnerability to parasitic agents. In some cases, the vulnerability of crop plants to injuries of phyto-parasitic nematodes can be very severe with respect to season leading to decline in yield and food supply.

The activities of nematodes in soil can many a times be regulated and predicted by ecological elements such as temperature, soil pH and soil water content in favour or against crop survival due to seasonal variations (Devi, 2025; Mola *et al.*, 2025; Ekine and Ezenwaka, 2024; Shokohi *et al.*, 2019; Cerevkova and Ludovit, 2012; Renco *et al.*, 2010).

Observation has shown that during wet season, much nutrient is made available in soil which increases interactions of soil organisms including nematodes (Ekine and Eenwaka, 2024; Chen *et al.*, 2021; Ankrom *et al.*, 2020) and can relief plant of parasitic attacks. The availability of these nutrient keeps the plants parasitic nematodes away from disturbing plant tissues and rather concentrate more on the available nutrient within the root rhizosphere. Dry season pose a harsh atmosphere for phyto-parasitic nematodes in soil, a condition which increases crop susceptibility to infections particularly of plant parasitic nematodes.

Agricultural practice that are seasoned based like ploughing and harvesting, can sometimes constitute a factor increasing crop vulnerability to infections of phyto-parasitic nematodes due to environmental influence (Devi, 2025; Shokohi *et al.*, 2019). The susceptibility of crop plants to parasitic infections can be affected by their growth sequence in specific season (Pokhrel, 2021; Nilusumas *et al.*, 2020). The flowering or seedling stage of crop plants are prone to parasitic injuries (Da silva *et al.*, 2017; Cui *et al.*, 2022). When these growth sequence correspond with parasite favourable season, damages on the crop plant become intense. There is a growing concern on food security and sustainable farming system due to a possible shift in parasite richness and crop vulnerability due to the impact of climate change on seasonal cycle. Therefore, adequate knowledge on the effects of seasonal disparity on crop susceptibility to damages of phyto-parasitic nematodes can inform the farmer on the optimum season of preference to certain crop as to reduce infection, maximized yield and enhance food security. Be that as it may, this study is aimed at investigating the association between seasonal variance and crop susceptibility to infections of plants parasitic nematodes.

MATERIALS AND METHODS

Study Area: This study was carried in Abua. Abua is an ethnic nationality in Rivers State, Nigeria with the geographical coordinates: 4.956° N (Latitude) and Longitude 6.634°E It is regarded as the food basket of Rivers State due to its agricultural activities. The area experience two seasons which are wet and dry seasons and crop cultivation is done all through the year not minding season. The residents of Abua are mostly farmers.

Figure 1: Map of Abua



Sampling: The study sampled soil and roots of bell pepper. The sampling was done in November, 2023-February, 2024 and June- September, 2024 for dry and wet seasons respectively.

Collection of soil and roots: Soil was collected at the root rhizosphere at 0-30 cm core depth. At the time and period, the roots of the bell pepper where soil was collected was also collected to test symptoms relating to infections of parasitic nematodes of crop plants.

Determination gall index: A scale of 0-4 was adopted for gall index analysis where 0 represent no infection, 1-10 (light infection), 11-20 (moderate infection and 21 and above represent severe infection. During each sampling period, the bell pepper was physically examined for other evidence relating to infections of plant parasitic nematodes such as die back, necrosis, stubby root tip, wilting etc.

Nematode extract Procedure: The study adopted the modified Bearman's extraction technique as documented in Ezenwaka and Ekine (2024).

The soil samples were carefully screened and stones removed and were raped in tissue paper placed on a mesh on aw plastic rubber plats with water. The water in the rubber plats set as such that the soil rap was wet but not immerse and allow undisturbed at room temperature for two days. At the expiration of two days, the soil raps were discarded and suspensions poured into specimen bottles, fixed in four drops of 20% formalin for microscopic examination. The liquor was then examined for phyto-parasitic nematodes using the x4, x10 and x40 of electronic microscope. The roots of bell pepper were washed in sachet water to free it from soil particles and were ponded in plastic mortar. Raps were made with tissue paper and the extraction procedure as for the soil was also followed.

Identification of nematodes: The identification and counting of nematodes was done to genera level using pictorial keys according to Mekete et al. (2012).

Data Analysis

The result was presented in tables using simple percentages ($n \times 100/N$). The test for significance on crop susceptibility in relation to season was done in the special package for social science version 23 using t-test at 95 % significance. Shannon Winner diversity index analysis was done using $\sum p_i \times \ln p_i$ and evenness was displayed using $H/H_{\max}$

RESULTS AND DISCUSSION

Soil nematode richness in relation to seasonal disparity

The total population richness of plant parasitic nematodes in soil was 1281 with 971 (75.9%) occurring during the wet season and 310 (24.1%) at dry season respectively. The nematode genera reported were *Meloidogyne*, *Pratylenchus*, *Ditylenchus*, *Scutellonema*, *Paratylenchus*, *Tylenchus*, *Hoplolaimus*, *Heterodera*, *Radopholus*, *Helicotylenchus*, *Hemicyclophora*, *Tylenchorhynchus*

Table 1: Soil nematode richness in dry and wet seasons

Nematode genera	Seasonal	Occurrence	
	Dry season (%)	Wet season (%)	Total (%)
<i>Meloidogyne</i>	27 (8.7)	117 (12.0)	144 (11.2)
<i>Hoplolaimus</i>	10 (3.2)	47 (4.8)	57 (4.40)
<i>Tylenchus</i>	27 (8.7)	68 (7.0)	95 (7.4)
<i>Paratylenchus</i>	0	73 (7.5)	73 (5.7)
<i>Scutellonema</i>	46 (14.8)	90 (9.3)	136 (10.6)
<i>Ditylenchus</i>	29 (9.4)	56 (5.8)	85 (6.6)
<i>Heterodera</i>	57 (18.4)	102 (10.5)	159 (12.4)
<i>Radopholus</i>	35 (11.3)	91 (9.4)	126 (9.8)

<i>Hemicyclophora</i>	0	34 (3.5)	34 (2.7)
<i>Helicotylenchus</i>	28 (9.0)	68 (7.0)	96 (7.5)
<i>Tylenchorhynchus</i>	0	117 (12.0)	117 (9.1)
<i>Pratylenchus</i>	51 (16.5)	108 (11.1)	159 (12.4)
Total	310 (100)	971 (100)	1281 (100)

Population Assemblage of root nematodes in relation to seasonal variance

From the roots of bell pepper, a total of 817 plant feeding nematodes were recovered. Among the 970 plants parasitic nematodes reports from the roots of bell pepper, 601 (73.6%) were reportedly found during the dry season and 216 (26.4) occurred at wet season respectively.

Table :2 Assemblage of root nematodes of bell pepper in relation to season

Nematode genera	Seasonal	Occurrence	
	Dry season (%)	Wet season (%)	Total (%)
<i>Meloidogyne</i>	81 (13.5)	27 (12.5)	108 (13.2)
<i>Hoplolaimus</i>	42 (7.0)	17 (7.9)	59 (7.2)
<i>Tylenchus</i>	47 (7.8)	28 (13.0)	75 (9.2)
<i>Paratylenchus</i>	39 (6.5)	3 (1.4)	42 (5.1)
<i>Scutellonema</i>	51 (8.4)	0	51 (6.2)
<i>Ditylenchus</i>	37 (6.2)	16 (7.4)	53 (6.5)
<i>Radopholus</i>	124 (20.6)	31 (14.4)	155 (19.0)
<i>Hemicyclophora</i>	19 (3.2)	0	19 (2.3)
<i>Helicotylenchus</i>	28 (4.6)	38 (17.6)	66 (8.0)
<i>Tylenchorhynchus</i>	24 (4.0)	25 (11.6)	49 (6.00)
<i>Pratylenchus</i>	97 (16.1)	31 (14.4)	128 (15.6)
<i>Xiphinema</i>	12 (2.0)	0	12 (1.5)
Total	601 (100)	216(100)	817 (100)

Nematode dynamics in relation to seasonal disparity

The study displays a total nematode population of 2098 with an uneven distribution across season. Nematode

occurrence at dry season was 914 (46.0%) and the wet season had 1133 (54.0%) nematodes.

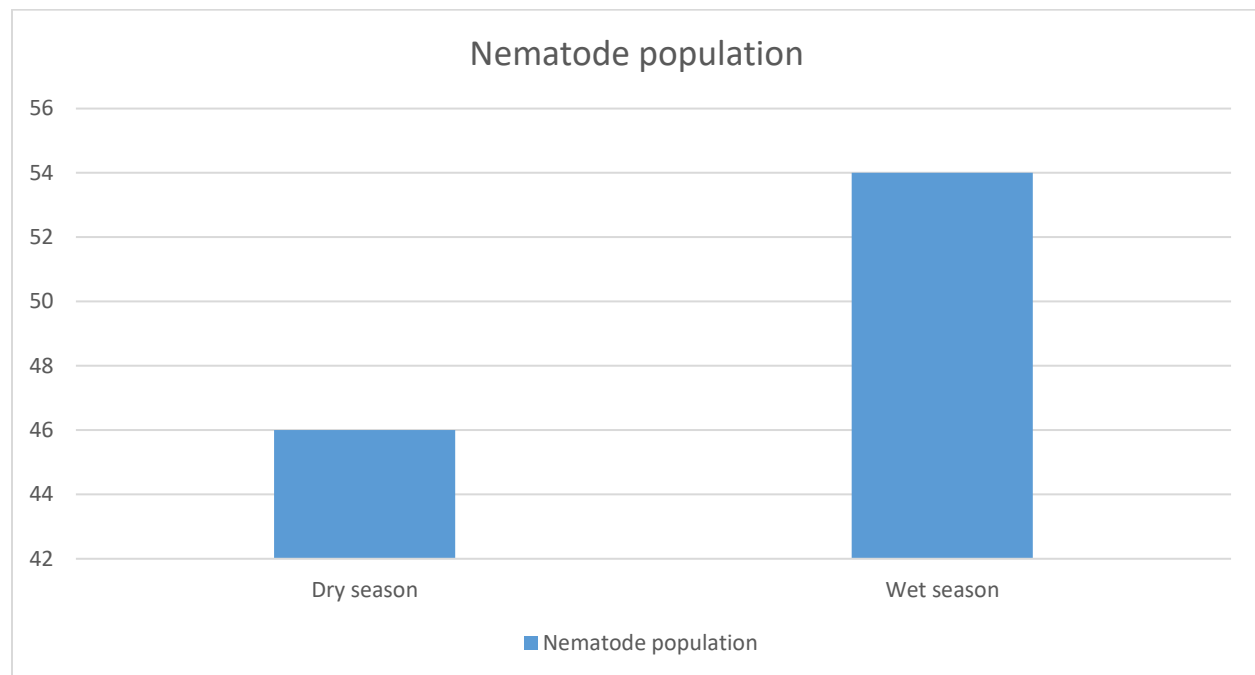


Figure 2: Nematode dynamics in dry and wet seasons

Evidence of crop susceptibility in relation egg mass and seasonal variance

The average egg mass observed in study during the wet season was 4.5 representing light infection, and the dry season had an average egg mass of 17.2 respectively. Other evidence of susceptibility observed were die back and stubby root tip respectively.

Table 3: Evidence of crop susceptibility in relation to egg mass and seasonal variance

Season	Egg mass	Interpretation
Dry	4.5	Light in
Wet	12.7	severe

Table 4: Symptoms of nematode infectivity in relation to season

Season	die back	stubby root tip
Dry	y	y
Wet	x	y

Key: Y = yes
X = No

It is obvious that climate change impact on natural sequence of events. It presents unstable atmospheres, altering biotic and abiotic elements of the ecosystem and exposing living things to harsh conditions requiring resilient for survival. Such conditions prompt parasites to

intensify mechanisms to stay alive on the host and increases host vulnerability to parasitic injuries. This study tested the effects of seasonal disparity as it influences crop susceptibility to injuries of plant parasitic nematodes and established that nematode penetration on plant tissues and population richness in soil is seasonal based.

Nematode population in soil was high at wet season (75.9%) when compare with the observation during the dry season (24.1%). This observation suggests that the improved soil water content during wet season due to frequent rainfall encourages nematode proliferation and increases survival. This observation concurs with Andrea and Ludovit (2012) and Ekine and Ezenwaka (2024) who reported that wet season supports nematode development and improves their population in soil ecosystem. Shearer and Ezenwa (2020) and Chen et al. (2021) reports that rainfall due to seasonal variance constitute a prominent influence in parasitism of nematodes, affecting population and leaving structure intact. The continuous availability of water in soil during the wet season present optimum temperature for juvenile survival and aid rapid sedentary motion and nutrient consumption. However, the decline in nematode richness as observed during the dry season in soil can be attributed to increased temperature due to harsh weather which may have prompt limited nutrient to support nematode survival. Ekine et al. (2018) reports that nematodes flourish under conducive atmosphere and diminishes in an unfavourable

ecosystem. This result further concurs with Kumkum (2024) who reports that seasonal variations can display significant impact on nematode populations. Kumkum (2024) further reports that fluctuations in soil water contents due to disparity in season can also promote or restrain the populations of plant feeding nematodes in soil.

On the contrary, the population of nematodes was higher in the root tissue of bell pepper during the dry season (73.6%) and the observation during the wet was 26.4%. This observation implied that, increase in temperature as notice during the dry season stressed the crop plants and weaken resistant mechanisms in favour of nematode penetration. It also suggests that dry season impacted on abiotic factors not restricted to temperature and water content in soil which in turn influences physiological susceptibility of the crop and ease nematode entering into the plant tissues. Ekine and Ezenwaka (2024) report that dry season is usually accompanied with intense temperature and compels nematodes to adopt borrowing into root tissue as a strategy for survival. The limited number of nematodes notice in the roots of bell pepper crop during the wet season suggests that plant protection mechanism was adequate and conferred the required rigidity or immunity and deny nematode entry. This result is consistent with Daramola *et al* (2021). Renco *et al.* (2010) and Cui *et al.* (2022) reports that nematodes are most active in soil environment with optimum water content which is likely to be seen during wet season. The result here further suggest that edaphic features enhanced above or reduced below the most favourable level in soil ecosystem can batten damage potential of phyto-parasitic nematodes, deplete plants defence system and prompt food insecurity.

Although combined nematode richness in soil and root tissues was higher during the wet season, yet crop injuries were relatively severe at dry season. This observation is evidence that crop plants are relatively susceptible to infections of parasitic nematodes in soil during dry season than in wet season. The calculated Shannon Winener diversity index support the deduction with a proportional stable evenness, suggesting crop stress due to seasonal variations. The presence of nematodes above 40% during wet and dry seasons as seen in figure 1 suggests that phyto-parasitic nematodes are adequately adapted for survival in soil ecosystem, collectively upholding ecological persistent across season by switching feeding mechanism on seasonal basis. During the wet season, phyto-parasitic nematodes concentrated in soil due to improved nutrient and during the dry season they adopt root colonisation as shelter against desiccation stress and source of nutrient for life sustenance. Ankrom *et al.* (2020) reports that increased precipitation influences nematode population in all ecological system.

It is obvious that the absence of sufficient water in soil due to change in season influences nematode behaviour and choice of feeding at dry season. The switch in nematode feeding mechanism as observed in this study relating to season indicates its ecological dexterity to continuously inflict injuries on crops in every season of the year. This observation is significant and portrays severe implications on crop protection, farmers income and food security. The assessment of crop susceptibility through gall index analysis and observable root symptoms suggests high crop susceptibility at dry season with severe infection and improved crop protection during wet season with limited susceptibility and light infection. Elsewhere, Pokhrel (2021) reports that alterations in abiotic elements in soil not limited to temperature and moisture due to seasonal variance can activate response in nematodes and disease severity in crop plants. Although, crop roots sampled at both seasons displays visible root injuries relating to plant parasitic nematodes such as stubby root tip and excessive root branching and die back. Nevertheless, it was relatively severe during the dry season. This observation implies that crop plants are most susceptible to infections of plant parasitic nematodes at dry season.

CONCLUSION

Crop susceptibility to nematode injuries is amplified by ecological conditions under the impact of seasonal variation. Nematode richness and survival pattern is influenced by nutrient availability underscoring the predictability of populations in soil and roots tissues of crop plants with regards to seasonal variance. Nematode control strategy or intervention can propel result if employed at all seasons. The result in this study highlights that nematode management technique be seasoned based, suggesting that the target at wet season be adjusted toward population reduction since nematodes can quickly shift feeding pattern to aid survival due to seasonal disparity and cause damage on crop. It further established that during the dry season, nematodes management strategy should target enhancing plants cuticular tissues to boost protection and reduce penetration of parasitic nematodes as to reduce the chances of injuries and support crop production.

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