

Nematode as a Potential Threat to Food Security in North East Nigeria and the Way Forward.

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Abstract

The contribution of agriculture to the growth and development of a nation cannot be undervalued. However, the production of food crops in Nigeria is seriously threatened by ongoing conflicts between farmers and herders, banditry, kidnapping, Boko haram insurgency, inflation, climate change, and biotic factors, particularly in the northeastern part of the country. Plant Parasitic Nematode (PPN), a soil microorganism is considered to be one of the most devastating factors threatening agricultural production in the region. The impact of damage caused by PPN is estimated to be about at 8.8 – 14 % annually, which is responsible for crop losses estimated to be in excess of 173 billion USD worldwide. This figure will most likely increase if appropriate management and control measures are not taken. Therefore, it is expedient that farmers within the northeastern region of Nigeria take precautionary management measures before, during and sometime after each farming season in order to curtail the problem of damage cause by PPN.

Key words: Nematode, *Meloidogyne*, Northeast , Threat, Plant Parasitic Nematode (PPN)

1 Introduction

Adamawa, Bauchi, Borno, Gombe, Taraba, and Yobe are the six states that make up the North East, one of Nigeria's largest geopolitical zones. It occupies over one-third of the country's total territory and is both a political and geographic region (Akinyemi *et al.*, 2022). These states are recognized for their agricultural and livestock rearing practices, which have a significant positive economic impact on both the local economy and the nation as a whole (Food and Agriculture Organization FAO, 2021). However, boko haram insurgency, banditry, kidnapping, farmers' herders conflict, inflation, impact of climate and biotic factors continue to threatening agricultural production in the region leading to an increase hunger crisis in Nigeria at large, with 26.5 million people across the country projected to serious hunger (FAO, 2021). Sub-Saharan Africa (SSA) is experiencing an increase in food insecurity, hunger, and malnutrition these are the three of the world's most pressing issues according to Alao *et al.* (2020). The world's progress toward reaching Sustainable Development Goal-2 zero hunger by 2030 has slowed down due to a number of main issues, including economic recessions, conflicts resulting from climatic variability, and biotic variables (Agbibo, 2015). The fundamental factors of growing inequality and poverty increase the frequency and intensity of these drivers (FAO, 2021).

About 4.4 million people in Borno, Adamawa, and Yobe states are food insecure due to conflict that has caused 2.2 million people to be relocated in the Northeast (Alao *et al.*, 2020). According to D'Amato (2018), three million of them reside in Borno State, the insurgency's epicenter. Nigeria experiences frequent floods and droughts, which have a negative effect on agricultural productivity and make people more vulnerable, particularly in rural regions (Devereaux and Edwards, 2019). More so, soil microorganism such as Plant Parasitic Nematode (PPN) has a profound impact on the agricultural food

production which has led to massive crop loss, estimated at 8.8- 14% annual crop loss at an estimated cost of approximately 173 billion (Ahuja and somyanshi, 2021).

2 Economic effect of Plant Parasitic Nematode

Plant parasitic nematodes, particularly the root knot nematodes (*Meloidogyne*), are widely recognized as a major obstacle to increasing crop production, especially in developing countries like Nigeria (Aghale, 2017). One of the major issue with root knot nematodes infestation on agricultural crops in tropical and sub-tropical region of the world is how quickly the problem escalates (Aghale, 2017). However, accurate statistics on crop losses caused by *Meloidogyne* spp are hard to come by. Estimated crop losses due to nematodes in various crops, such as cowpea, cotton, okra, tomato, tobacco, banana, maize, etc., vary from 20-100% in different parts of the world (Fawole, 2018). The extent of crop losses ranges from minor, less than 1%, to complete destruction, and the level of damage depends on the population density of nematodes, crop susceptibility, and environmental conditions such as fertility, moisture, and the presence of other pathogenic organisms that may interact with nematodes (Fawole, 2018). Furthermore, it was revealed that the 20 life-sustaining crops that are the main sources of human nutrition had an estimated yearly production loss of 10.7%, and the projected annual yield loss of the world's key crops owing to damage by plant parasitic nematodes was 12.3%.it Additionally, it was reported that the expected annual production loss of plant parasitic damage to the world's major crops Cassava (8.4%), citrus (14.2%), cocoa (10.5%), maize (10.2%), cotton (10.7%), groundnut 12%, potato (12.2%), rice (10.0%), sorghum (6.9%), soy beans (10.6%), sugar cane (15.3%), wheat (7.0%), tobacco (14.7%), and sweet potato (10.2%) are the crops that have yield losses (FAO, 2016). For the majority of crops in Nigeria and other nations, reliable statistics on yield losses are not easily accessible (Adesiyan *et al.*, 2017). Plant parasitic nematodes have been found to reduce yields in studies on tomato, maize, and cowpea by 28–64%, underscoring their impact on food security (Adesiyan, *et al.*, 2017). According to Aghale (2017), the root knot nematode damages a variety of agricultural crops, causing delayed maturation, decreased yield and crop quality, higher production costs, and income loss. Nematode attacks can lead to significant losses of 20 – 30% in crops like maize, cowpea, sorghum, sugar cane, citrus, and vegetables Aghale (2017). More so, disfiguration in root and tuber crops not only decreases market value but also leads to consumer rejection (Aghale, 2017). For example, galled yam tubers experience a 39-52% reduction in price and lose more weight during storage compared to healthy tubers (Nwauzor and Fawole 2015). Nematode damage significantly affects yam quality, yield, and overall losses both in the field and during storage (Nwauzor and Fawole 2015). In Nigeria's irrigated areas, a 40% crop loss has been reported, with tomato experiencing losses ranging from 10 – 89% (Nwauzor *et al.*, 2019). Nematode infections cause more severe crop losses in warmer climates and areas with less access to food and fiber. Plants impacted by nematodes show signs of nutrient stress and dryness, which frequently results in incorrect diagnoses (Aghale, 2017). Nematode damage reduces root effectiveness in *Musa* spp. (bananas and plantains) and can cause root necrosis and death in crops, which can collapse plants and result in the complete loss of immature fruit (Gowen *et al.* 2015). Across the world, areas where maize is grown have reported harmful populations of a number of root knot nematode species, including *M. incognita* and *M. javanica* in India (McDonald and Nicol 2017). And in Pakistan, as well as in the USA, according to multiple writers (McDonald and Nicol 2017). Leaf chlorosis, uneven growth, and stunting are signs that are visible above ground. Large or little, terminal or sub-terminal, or completely missing, are possible characteristics of root galls. Because of this, maize has frequently been incorrectly believed to be a poor or non-host for nematodes known to cause knots in roots (McDonald and Nicol 2017).). *Pratylenchus brachyurus* has been linked to a 28.5% yield drop in Nigeria, according to reports, and this reduction is coupled with a 50% rise in nematode density (Egunjobi 2019). According to Adesiyan *et al.* (2017), it has been challenging to estimate the precise amount of economic losses brought on by root-knot nematodes, particularly in underdeveloped nations where crops are rarely farmed as sole crops. Adesiyan *et al.* (2017). Furthermore, many populations of plant-parasitic nematodes can be found in the soil, often feeding on the same plants as other diseases such fungi, bacteria, and viruses (Adesiyan *et al.* (2017).

3 Management /Control Measures

Numerous methods have been considered for managing and or controlling plant parasitic nematodes, with the preferred immediate solution being the use of nematicides, despite the environmental concerns

and pesticide residues (Aghale, 2017). The use of resistant plant types, integrated pest management, cultural and land management techniques, and the more recent usage of ethno medicinal plants (botanicals) are some other means of control. Nigerian farmers have found success with cultural control techniques such crop rotation, bush fallow, mulching, dry season plowing, trap crops, and flooding of farm lands (Aghale, 2017). Crop rotation, which involves switching sensitive crops with non-host crops, poor hosts, or crops resistant to or tolerant of root-knot nematodes, is the most successful cultural technique for controlling nematode pests among these (Aghale, 2017). The crops employed in rotation sequences were identified by Atu & Okuji (2019) as *Amaranthus* spp., *Citrullus laratus*, *Zea mays*, *Manihot* spp., and the extremely resistant *Mucuna pruriens*. Farmers haven't, however, implemented any cropping plans that include plants that inhibit nematodes known to cause knotting in roots (Aghale, 2017). The introduction of nematodes through contaminated plant materials on uninfected soil has created a vicious circle, resulting in infestations of new plants and soil. The introduction of resistant plant cultivars is another low-cost cultural strategy for nematode control (Aghale, 2017). Many crops have notable yield gains as a result of cultivars that have been engineered to be resistant to nematode pests or that are naturally resistant to them. It is clear, though, that these cultivars are resistant to a relatively small range of worm taxa. There are not many known resistant yam variants, and those that exist are primarily cultivars and species with little consumer demand (Onyenobi, 2017). Another cultural control strategy used by smallholder farmers is intercropping (Onyenobi, 2017). Most traditional intercrops such as *Hibiscus esculentum*, *Corchorus litorus*, and *Cucurbita pepo* are highly susceptible to root knot nematodes, and mixed cropping with other host crops of *Meloidogyne* spp alongside yam plants is likely to increase nematode populations and damage severity (Atu, 2019). Most effective means of control in crop production (Onyenobi, 2017). Onyenobi (2017) successfully pre-treated seed yams with oxamyl to control bio deterioration prior to Growing different crops on the same piece of land in a random fashion results in minimal damage to a very susceptible the crop (Atu, 2019). Peasant farmers in Nigeria therefore experience less nematode issues than those in areas where modern agriculture is practiced as sole cropping. Chemical control, which involves the use synthetic nematicides to control nematodes, is an efficient way to manage nematodes. Nonetheless, these compounds' established environmental risks have resulted in their deregistration (Aghale, 2017).). Given the speed at which target species gain resistance to chemical nematicides and the accompanying issues of high cost and application expertise, there is a growing body of questioning surrounding these chemicals (Aghale, 2017). The usage of nematicides has been linked to an increase in sterility and birth malformations in South East Asia, as reported by Yaradua (2017), raising concerns about potential health risks. The humus layer in particular is where these pesticides are frequently absorbed into the soil, where they may have an indirect or direct effect on the microbiota of the soil, changing the rate at which organic matter breaks down and the flow of nutrients. Earthworms and other soil organisms are very hazardous when exposed to chemical nematicides, as Yaradua (2017) has observed. Fifty thousand hectares of Costa Rican banana plantations were irreversibly destroyed by chemical control of *Radophilus* nematodes. Plant parasitic nematodes have been thought to be controlled by botanical methods. This strategy is motivated by the fact that traditional nematodes are unavailable to farmers with limited resources, and plants such as neem are effective at controlling nematodes; these results are consistent with farmers' preference for Integrated Pest Management Techniques. The neem tree, *Azadirachta indica*, has been utilized more frequently as a cheap source of nematicide; its nematicidal qualities have been examined (Jacobson, 2017).). Plant extracts are preferred over chemical nematicides due to the additional benefit of environmental safety; other plants, like *Crotalaria* and *Piper nigrum*, are presently under evaluation. Farmers, especially those with limited resources, have found success using botanicals to protect crops from pests and diseases while they are in storage or in the field. According to Salako (2015), botanical

pesticides are reasonably priced and comprise a complex mixture of active components that operate on different stages of the nematode lifecycle, thus making it difficult for nematodes to build resistance. Yaradua (2017) asserts that botanical insecticides are safe for the environment, simple to make, and renewable locally. According to Egunjobi (2014), a number of plants have been identified as having nematostatic or nematicidal qualities in their leaves, barks, seeds, fruits, and seeds. Root extracts from *Chromolaena odorata*, *Ricinus communis*, *Lycopersicon esculentum*, and *Vigna unguiculata* were successfully employed by Amosu (2018) against *Meloidogyne spp* in vitro. Salawu (2016) discovered that *Heterodera sachari* eggs could not hatch when *Azadirachta indica*, *Chromolaena odorata*, and *Amnora muricata* were used against them. According to Triantaphyllou (2017) and Eisenback (2017), *A. indica* and *P. nigrum* are both beneficial substitutes for synthetic pesticides in the production and storage of yams, and they are both employed locally in ethnomedical practices without leaving any toxicological residues.

4 Conclusion

One cannot underestimate the contribution of agriculture to national economic growth and development. The abundance of plant parasitic nematodes in the soil of northeastern Nigeria poses a threat to food crop production and food security, about 89 metric tons of root knot nematode infestations occurred in 2008 in Nigeria, affecting root and tuber crops, which make up the majority of the country's agricultural output. It is essential to educate farmers about the problems caused by plant parasitic nematodes and how to handle them. Nematodes can impede productivity and the benefits that come with it if they are not properly control, particularly in this period of rapidly increasing population. Farmers must be able to identify nematode problems in their regions in order to understand the significance of control efforts. But because of widespread illiteracy and a dearth of technical knowledge in nematode research, accomplishing this goal has been challenging. Due to their high costs and small profit margins, resource-poor farmers are forced to rely more on traditional techniques of pest management. These less expensive techniques that don't require specific knowledge of nematode control should be prioritized in the future

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