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A. Lado, Y. B. Daraja, K. D. Dawaki,
H. J. Jibril, A. I. Magashi,
M. A. Yawale, M. S. Fulani,
M. S. Garko

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WEED BIOLOGY AND ECOLOGY

Survey of Sedge Weeds for Root–Knot Nematode in Arable Fields in a Southern Guinea Savannah of Nigeria

*I.A. Garuba[1], J.A. Falola-Olasunkanmi[2], K. O. Affinnih[2] and F. O. Takim[2]

[1]College of Education (Technical) Lafiagi, PMB 001, Lafiagi, Kwara State, Nigeria

[2]Department of Agronomy, Faculty of Agriculture, University of Ilorin, PMB 1515, Ilorin, Nigeria.

*Email: ismail_garuba@yhaoo.com

ABSTRACT

Nematodes are plant-parasites that cause alterations in the soils and affects crop performance. This study survey selected arable field for sedges and examine the population of root-knot nematode in soil and roots of selected fields. A total of 42 weed species belonging to 34 genera within 17 families were associated with Fimbristylis littoralis (33.65%), Cyperus esculentus (36.61%) and Cyperus imbricatus (21.34%). The results showed that the proportion of nematodes in soil was positively correlated with soil pH ($r^2 = 0.80$); nitrogen ($r^2 = 0.90$), calcium ($r^2 = 0.91$), organic carbon ($r^2 = 0.96$), organic matter ($r^2 = 0.95$), magnesium and sandy textural class ($r^2 = 0.92$), however, it decreased with increasing clay, silt, sodium, potassium and available phosphorus in the soil. The study concluded, Cyperus esculentus is the major host of root-knot nematodes and its survive and proliferate well in sandy soils and positively correlated with most soil chemical properties.

Key words: Nematode, alternate host, weed

Introduction

Weeds have long been recognized as a major constraint to agricultural production, it reduces crop quality. Noxious weeds are even more competitive and persistent. The losses arising from noxious weed infestation cannot be overestimated (Gabriel et al., 2015), some weeds apart from competing with crops, also harbour plant pathogen, which subsequently cause disease for the crop planted, many weeds associated with agricultural crops have been reported as hosts of plant-parasitic nematodes (Noling and Gilreath, 2002). The problem of weed hosting plant parasitic nematodes is particularly severe in the subtropical and tropical environments where weeds grow all year round (Fatemeh et al. 2012). Bird and Kaloshian, (2003) reported that most of the crop damage by plant-parasitic nematodes is caused by a relatively small number of nematode genera, which include root-knot nematodes (Meloidogyne spp.), cyst nematodes (Globodera and Heterodera spp.) and migratory endoparasitic nematodes (Pratylenchus and Radopholus spp.).

The significance of weeds acting as reservoir hosts is being increasingly recognized and more than 226 weed species have been studied for their host suitability to different root-knot nematodes worldwide (Rich et al., 2009). Nutsedge, crabgrass, lambsquarters, and pigweed have been reported as major weed hosts of root-knot nematodes (Lisa et al., 2004). Noling and Gilreath (2002), reported that several species of crabgrass served as hosts of root-knot nematode but greenhouse report confirmed the importance of yellow and purple nutsedge as hosts of M. incognita (Lisa et al., 2004). It as being known that beneficial interactions exist among yellow nutsedge (YNS), purple nutsedge (PNS) and root-knot nematodes (RKN), which occur simultaneously in many crops grown throughout the southern region of United State (Zhining et al., 2008). The problem of these weeds competing with our crops for nutrients, water and so on, also enable plant-parasitic nematodes to survive in the absence of crops, providing a source of inoculum for the following season, in spite of the absence of the susceptible arable crops, the damage threshold population are still maintained in the next growing season, which most time leads to not attaining our optimal or potential crop yields. Studying these weeds that are always on the field, aiding nematode proliferation in the absence of susceptible arable

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crop plants is therefore vital for the attainment of the desired crop yield in this part of the country. The study was therefore designed to survey the arable field for sedges and examine the population of root-knot nematode in selected fields.

MATERIALS AND METHODS

Survey Procedure

The study was conducted at University of Ilorin Teaching Research Farm and College of Education (Technical), Farm, Lafiagi during 2017 growing season. Both sites are in the southern Guinea savanna ecological zone of Nigeria. The locations are characterized by bimodal rainfall that varies from 1200 - 1500 mm and an average temperature range of 19°-33°C and a length of growing period of about 181-270 days.

The field survey was carried out according to the quantitative survey method described by Kamal-Uddin et al. (2009). Transect lines was set to cover the research field and quadrats of size 1m x 1m was arranged 10 m apart in a grid pattern across each transect line. Each transect line was surveyed and observations was recorded from the quadrats. The weeds were identified using the third edition of the hand book of West African Weeds (Akobundu et al., 2017).

Soil and root samples was taken in the three farms using hand trowel, ball of earth comprising the soil around the rhizosphere of the nut sedge root zone was taken to the lab for extraction of root knot nematode. Nematodes were extracted from nutsedge root using Hussey and Barker (1973) method and from the soil using Whitehead and Hemming (1965) and the nematode were counted under a stereo-microscope. Roots of nutsedge were carefully uprooted and rinsed in water to dislodge soil particles. Soil samples collected from the study area were air dried in the laboratory dried and passed through 2 mm sieve which was used for the determination of organic matter, macronutrients and micronutrients content by adopting standard laboratory methods.

Data collected were on population density of members of cyperaceae and associated weed species, population of nutsedge infected with nematode, number of galls per nematode; and soil physical and chemical characteristics of infected soil. The composition of the weed flora was analysed by calculating the relative abundance (RA) of each specie within each experimental unit as follows: RA = (RD + RF) / 2, where RD (relative density) = number of a weed specie per unit area (within a quadrat) in the plot divided by the total number of weed species within the same unit area (quadrat); and RF (relative frequency) = proportion of quadrat in which the species were present per experimental unit divided by the total frequency of all species in the experimental unit (Takim & Fadayomi, 2010).

The severity of the infection was determined by estimating the number of galls. The population distribution of nematode identified was presented or describe with descriptive statistics and data were subjected to analysis of variance (ANOVA) using GenStat statistical package and significant means were separated using LSD at $p \leqslant 0.05$.

RESULTS AND DISCUSSION

Weed Species Composition

A total of 42 weed species belonging to 34 genera within 17 families were enumerated across the experimental sites. The weed spectrum consisted of 57% broadleaves, 28.6% grasses and 14.3% sedges while 66.7% were annual and 33.3% were perennials weed species (Table 1). The nutsedge population varies across sites, Fimbristylis littoralis was the most prevalent sedge (33.65%) at Lafiagi site 1, Cyperus esculentus (36.61%) dominated Lafiagi 2 while Ilorin site had Cyperus imbricatus (21.34%) as the dominant nutsedge weed.

Fimbristylis littoralis encountered at Lafiagi site I was associated with Commelina diffusa (2.73%) Cyperus esculentus (2.87%) and Cyperus rotundus (2.48%), at site II, Cyperus esculentus was highly associated with Commelina diffusa (20.18 %) and Cyperus rotundus (14.17 %) while the Ilorin site, Cyperus imbricatus was highly dominated with grasses, Paspalum vaginatum (19.97%), Pennisetum violaceum (27.53%) and Oryza longistaminata (15.46%).

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Soil Properties

Soil acidity is an important physicochemical factor in soil that influences soil biological properties, plant growth and soil biota (Kabata-Pendias, 2000). Table 2 shows that soil acidity ranged between 5.34 – 5.97 and has been reported to affect nematode populations. For example, the proportion of Meloidogyne incognita was generally decreased in either extremely acidic or alkaline soils (Amal, 2021) while Organic matter (OM) constitutes a fundamental soil component that serves as a source of carbon and energy for plants and soil organisms; however, OM also affects root infestation by nematodes. OM in this study ranged between 0.67 to 3.10% and it shows that, high OM increases soil nematode population whereas a decrease in root nematode population. Similar trend was observed with the other soil chemical properties.

Population of Root-Knot Nematode

There was a significant ($p<0.05$) variation in root-knot nematode population across the infested nutsedge weeds and soil samples enumerated (Table 3). The population of the root-knot nematode was relatively higher in Cyperus rotundus across the experimental sites, the soil samples obtained from Lafiagi sites had relatively higher root-knot nematode compared to Ilorin site. Nematodes were discovered both in the roots and the soil rhizosphere, Kaur et al. (2007) reported that weed enable plant parasite nematode to survive in the absence of susceptible crop thus providing a source of nematode inoculums for the following season which ease nematode multiplication. Thomas (1997) and Lisa et al. (2004) had similar reports in their study areas.

Table 4 shows that Na, P and K negatively correlated with nematode population. Sandy soil allows the proliferation of nematode, clay and silt soil inhibits the proliferation of the nematode. While pH, nitrogen, calcium, organic carbon and organic matter were significantly positive correlation with the nematode population (Table 5). The percentage of plant parasite nematode present in the rhizophere of the sedge can be used to indicate potential infestation. This was in line with the work done by Dabiré and Mateille (2004) who observed that, Meloidogyne spp. occurs more frequently and more abundantly in sandy soils than in clay soils and Arévalo et al. (2007) reported that in soils with more than 50% of sand, Meloidogyne spp. Present will be highly mobile and infective While Mario et al (2011) further explained that, the soil texture incidence is determined by a higher macroporosity, which produces more air circulation and a consequent acceleration of the biological processes.

CONCLUSION

This study has demonstrated the importance of sedge weed species as host and soil properties as a regulating factor on nematodes. Root-knot nematodes survive and proliferate well in sandy soils and positively correlated with most soil chemical properties. Farmers should think of adequate sedge-nematode management strategies in order to improve crop yield.

Table 1. Relative abundance of weed species encountered in the experimental sites

				Relative Abundance		
FAMILY	WEED SPECIES	MG	LC	Lafiagi I	Lafiagi II	Ilorin
Aizoaceae	Triumfetta rhombioda Jacq.	B	A	-	4.72	-
Amaranthaceae	Alternanthera sessillis (L.) Dc.	B	A	-	-	0.59
Caesalpinioideae	Chamaecrita mimosoides (L)	B	A	0.36	-	-
Cleomaceae	Cleome viscosa L.	B	A	0.58	4.53	-
Commelinaceae	Aneilema beniniense Kunth.	B	P	-	-	0.46
	Commelina benghalensis L.	B	A	-	-	0.24
	C. diffusa L.	B	P	2.73	20.18	-

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Convulvulaceae	Ipomea aquatic Forsk.	B	P	-	-	0.59
Cyperaceae	Cyperus esculentus L.	S	P	2.87	36.61	2.68
	C. imbricatus L.	S	P	-	-	21.34
	C. rotundus L.	S	P	2.48	14.17	-
	Fimbristylis littoralis Gaudich.	S	A	33.65	4.33	4.88
	Fuirena umbellata Rott.	S	P	-	-	1.22
	Kyllinga erecta Schmach Var.	S	P	-	-	0.36
Euphorbiaceae	Euphorbia heterophylla L.	B	A	-	-	0.05
	Phyllantus amarus Schum.	B	A	0.03	-	-
Fabaceae	Corchorus tridens L.	B	A	1.02	-	-
	Calopogonium mucunoides Desv.	B	P	-	-	2.22
	Tephrosia bractiolata Guill.	B	A	-	0.39	-
	T. linearis (Willd.)	B	A	0.85	-	-
	T. pedicellata Bak.	B	A	0.17	-	-
Hydrophyllaceae	Hydrolea palustris (Aubl.)	B	A	-	-	0.05
Lamiaceae	Hyptis suaveolens Poit.	B	A	-	0.39	-
	Leucas martinicensis (Jacq.)	B	A	-	0.79	-
Malvaceae	Hibiscus asper Hook.	B	A	0.22	-	-
Mimosoideae	Neptunia oleracea Lour.	B	A	-	-	0.14
Onagraceae	Ludwigia abyssinica A. Rich	B	P	-	-	0.95
	L. octovalvis Jacq.	B	A	0.17	-	0.20
Poaceae	Axonopus compresus (Sw)	G	P	0.11	-	-
	Brachiaria lata (Schumach.)	G	A	2.32	-	-
	Cenchrus biflorus Roxb.	G	A	0.33	-	-
	Digitaria ciliaris (Retz.)	G	A	0.44	6.89	-
	Echinochloa crus-pavenis Schult.	G	A	-	-	0.92
	Leptochloa caerculescens Steud.	G	A	-	2.76	-
	Oryza longistaminata A. Chev. & Roehr	G	A	-	-	15.46
	Paspalum vaginatum Sw.	G	P	-	-	19.97
	Pennisetum polystachion (L.)	G	A	0.06	-	-
	P. violaceum (Lam.)	G	A	-	-	27.53
	Seteria pumila Poir.	G	A	0.83	-	-
Rubiaceae	Diodia sarmentosa Sw.	B	P	0.30	4.13	-
	Pentodon pentandrus (Schum & Thonn.)	B	P	-	-	0.17
Tiliaceae	Corchorus tridens L.	B	A	0.50	0.10	-

A= Annuals, B= Broadleaves, G= Grasses, LC = Life cycle, MG= Morphological groups, P = perennials, S =Sedge

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Table 2: Analysis of the physico-chemical properties of the three experimental fields

Site	pH	Nitrogen	Organic Carbon	Organic matter	Calcium	Mg	Sodium	Potassium	Phosphorus	Sand	Silt	Clay
			%				$cmolkg^{-1}$		$mgkg^{-1}$		%	
Lafiagi I	5.84	0.10	0.39	0.67	1.63	0.15	0.05	0.12	2.37	81.5	10.67	7.80
Lafiagi II	5.97	0.15	0.72	1.19	2.10	0.20	0.09	0.19	2.70	77.5	11.67	10.80
Ilorin	5.34	0.22	1.67	3.10	2.43	1.00	0.19	0.25	3.87	57.5	24.00	18.50
Sed	0.02	0.34	0.12	0.14	0.15	0.06	0.02	0.04	0.35	3.04	0.79	2.51
LSD ($p \leq 0.05$	0.05**	NS	NS	0.39*	0.42*	0.16**	0.05*	NS	0.97*	8.43*	2.20**	6.97*

NS= Not significant *=significant at 5% level, **=significant at 1%level, , Mg= Magnesium

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Table 3: Population of root-knot nematode in roots of nutsedge and infected soil samples

	Lafiagi site I		Lafiagi site II		Ilorin	
Weed species(W)	Root	Soil	Root	Soil	Root	Soil
Fimbristylis littoralis	18	2	7	1	0	0
Cyperus rotundus	21	1	39	1	16	1
Cyperus esculentus	13	2	23	1	10	0
Cyperus imbricatus	0	0	0	0	11	0
Sed	10.5	0.79	6.40	0.63	5.12	0.47

Table 4: Correlation matrix of the physico-chemical properties and nematode population

	NES	NE Total	Na	K	P	Sand	Silt	Clay
	0.080	0.999**	-0.101	-0.009	-0.107	0.340	-0.387	0-.259
NES	1	0.132	-0.935**	-0.898**	-0.922**	0.921**	-0.875**	-0.914**
NE Total		1	-0.150	-0.056	-0.154	0.387	-0.431	-0.306
Na			1	0.740*	0.932**	-0.908**	0.926**	0.825**
K				1	0.723*	-0.807**	0.676*	0.912**
P					1	-0.882**	0.893**	0.808**
Sand						1	-0.975**	-0.963**
Silt							1	0.879**
Clay								1

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level
NES= Nematodes in soil, NE Total=Nematode in soil + Nematodes in root, Na=Sodium, K=Potassium, P= Phosphorus.

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Table 5: Correlation Matrix of the physico-chemical properties and nematode population in the experimental area

	NES	NETotal	pH	N	O/C	O/M	Ca	Mg
	0.080	0.999**	0.374	0.184	-0.208	-0.235	0.088	-0.333
NES	1	0.132	0.804**	0.893**	0.960**	0.950**	0.908**	0.901**
NETotal		1	0.414	0.136	-0.257	-0.284	0.040	-0.378
pH			1	-0.633	0.889**	0.918**	-0.626	0.959**
N				1	0.827**	0.806**	0.913**	0.724*
O/C			1	0.993**	0.877**	0.971**		
O/M				1	0.852**	0.980**		
Ca					1	0.750*		
Mg						1		

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level
NES= Nematodes in soil, NE Total=Nematode in soil + Nematodes in root N= Nitrogen, O/C= Organic Carbon, O/M=Organic Matter, Ca=Calcium, Mg= Magnesium

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