Pathogenicity of Different Inoculum Levels of *Meloidogyne Javanica* on Indigenous and Exotic *Solanum Lycopersicum* Varieties; Derica and F1 Cobra 26

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***Abstract*: - The effects of different inoculum levels (0, 500, 1000, 1500 egg mass/juveniles) of *Meloidogyne javanica* on indigenous (Derica) and exotic (F1 Cobra 26) *Solanum lycopersicum* varieties were studied with the zero (0) group serving as the control. There were 3 replicates of each treatment, laid out in a complete randomized block design. Plants were grown in a screened house using perforated bags. The reproduction rate of the nematodes was monitored at 30 and 60 days after inoculation (DAI). The result obtained from the study showed that there was a significant difference ($p<0.05$) in the population of *M. javanica* at 30 and 60 DAI respectively in both cultivars. Both cultivars showed high increase in endophytic nematode population in the 1500 inoculum level (il) 60 DAI. At 60 DAI, F1 Cobra 26 had 400 (44.9%) root nematodes in 1ml of aliquot while the Derica had 370(41.6%) endophytic nematodes. No nematodes were recovered from the roots and soil samples of the control groups 60 DAI. The study also revealed a significant difference ($p<0.05$) in the root weight of both cultivars as inoculum increased within the 60 day interval. The root weight of Derica cultivar declined as inoculum levels increased from 0 il (14.4g) to 1500 il (13.9g) while the root weight of F1 Cobra 26 increased as inoculum level increased from 0 il (14.2g) to 1500 il (14.6g). There was a significant difference ($p<0.05$) in the apical growth of both cultivars. At 60 DAI, F1 Cobra 26 cultivar showed more apical competence (90.7cm) than the Derica cultivar (89.8cm) at the treatment groups. The control groups showed the Derica cultivar to have more apical competence than F1 Cobra 26 cultivar 60 DAI.**

Keywords: **Pathogenicity, Derica, F1 Cobra 26, *Meloidogyne javanica*, inoculum levels**

I. INTRODUCTION

According to Nzeako *et al.*, (2013), parasitic infestation by plant parasitic nematodes is one of the most important biological factors limiting crop production all over the world .One major constraint associated with the assessment of nematode impact is that the harm caused by nematode infection is usually not as obvious as that caused by many other pest and diseases (Nicole *et al*., 2011). Endoparasitic nematodes are more harmful to plants and has more agricultural importance than the ectoparasitic species (Safiuddin and Shweta, 2011). Among the plant parasitic nematodes that greatly depreciate crop yield is the *Meloidogyne* species, also referred to as the root knot nematodes (Fourie *et al*., 2014). Moens *et al*., (2009) described root knot nematodes as important constraint to plants' yield.

Meloidogyne is a genus in plant parasitic nematodes commonly referred to as root knot nematodes. Almost 100 species of *Meloidogyne* spp. have been identified and 22 of these species have been reportedly present in Africa (Onkendi *et al*., 2014). Approximately 2000 plants are susceptible to *Meloidogyne* spp. infection which results to about 5% of world wide agricultural losses (Sasser and Carter, 1985). Moens *et al*., (2009) described root knot nematodes as important constraint to plants' yield.

Tomatoes, *Solanum lycopersicum*, is a fleshy vegetable fruit that can be grown as a garden fruit or in large commercial quantities. Tomato is a constant ingredient for the preparation of multiple meals in Nigeria. The importance and values attached to tomatoes had made them become widely grown all over the world (Adepoju, 2014; Tsado, 2014). Its malleability when frozen has played a very great role in the fast and general adoption of the vegetable plant as an important feed commodity (Tsado, 2014). Vegetable crops such as tomato has been greatly impacted by pathogens such as the root knot nematodes which negatively affects the quality and quantity of marketable yields (Nzeako and Imafidor, 2008). Tomato is one of the world's largest vegetable crops in terms of production also found to be cultivated in 85% of farms in Nigeria (Olaniyi *et al*., 2010; Nzeako *et al*., 2013). Nigeria ranks as the second highest producer of tomatoes in Africa, 13th in the world (FAO, 2011) but Nigeria is not on the list of officially exporting countries of tomato or tomato products. The low tomato production can be attributed to the impact of pests and diseases especially in the southern part of the country (Abiodun *et al*., 2018).

However, three major species of *Meloidogyne* that affects tomatoes include; *M. arenaria*, *M. incognita* and *M. javanica* (Nzeako and Imafidor, 2008). To a lot of growers, commercial

production of tomato is a great means for income generation but the root knot nematode reduces annual yield by about 28-68% (Adesiyan, *et al*., 1990; Nzeako and Imafidor, 2008).

The study compares the Pathogenicity of *M. javanica* on two tomato cultivars; Derica and F1 Cobra 26. This will help tomato growers to be able to make a better choice when selecting cultivars for planting. The green house will also serve to protect the plants against intruding pathogens like insects and arthropods as well as prevent the excessive rainfall which is somewhat not good for tomato growth. With a greenhouse, a tomato grower in the southern Nigeria can harvest tomato all year round irrespective of seasonal variations.

The objectives of study include to determine the;

1. Pathogenicity of *M. javanica* on the indegenious *L. solanium* variety, Derica.
2. Pathogenicity of *M. javanica* on the exotic *L. solanium* variety, F1 Cobra 26.
3. Effect of *M. javanica* infection on the growth parameters (Height, Girth, root weight) of both tomato cultivars.

II. MATERIALS AND METHODS

The Randomized Complete Block Design was adopted for this work. The cultivars were cultivated in 10cm wide bags in three (3) replicates. Plants were cultivated in steam sterilized loamy and sandy soil misture (1:1). The sterilized soil were stored in a cool, dry environment for 3 months to enhance soil nematode disintegration (Nzeako *et al*., 2013).

Preparation of nematode inoculum and inoculation of plants

Meloidogyne javanica juveniles (J2 and eggmass) were extracted from tobacco plants sourced from reliable tobacco farms in Oyo state, Nigeria using Cobb's sieving method (Hartman and Sasser, 1985). Inocula were standardized using Nzeako *et al*. (2013). Plants were inoculated inundatively at 0 inoculum level (il), 500 il, 1000 il and 1500 il with the zero (0) il as the control in three (3) replicates. Two weeks old seedlings of Derica and F1 Cobra 26 (respectively sourced from the Eleme junction market and Agritropics in oil mill junction, both in Port Harcourt, Rivers state) planted in sterilized soil were transplanted to the potted soil and inoculation followed 24 hours later. The cultivars were monitored at 30 days interval for 60 days. Growth parameters such as plant height, girth and root weight were studied.

Destructive assay to determine the rhizosphere and endophytic population of *M. javanica* was carried out every 30 days interval using the Bearmann's Technique for soil nematodes and the Cobb's Sieving Technique for tissue-dwelling nematodes (Imafidor and Nzeakor, 2010).

III. RESULTS

At 30 DAI of the cultivars, the height of the varieties, Derica and F1 Cobra 26, for the control groups were 40.5cm and 45.1cm respectively. However, the heights of the plants inoculated with 500 il, 1000 il and 1500 il were recorded as (37.8cm and 37.4cm), (36.7cm and 37.1cm), (33.3cm and 36.8cm) for Derica and F1 Cobra 26 respectively. The root weights for the control groups were recorded as 3.2g for Derica and 3.1g for F1 Cobra 26. Those of the treatments for both cultivars respectively were as follows; 500 il (3.0g and 3.2g), 1000 il (2.9g and 3.2g), 1500 il (2.9g and 3.6g). The plant girth for all inoculum levels were as follows for Derica and F1 Cobra 26 respectively; 0 il (2.39mm and 2.53mm), 500 il (2.02mm and 2.49mm), 1000 il (2.04mm and 2.31mm), 1500 il (1.97mm and 2.31mm) respectively (Table 1).

At 60 DAI, the tomato cultivars, Derica and F1 Cobra 26, revealed plant heights for the control groups as 100.8cm and 98.8cm respectively. However, the heights of the plants inoculated with 500 il, 1000 il and 1500 il were recorded as (97.1cm and 97.5cm), (95.4cm and 97.1cm), (89.8cm and 90.7cm) for Derica and F1 Cobra 26 respectively. The root weights for the control groups were recorded as 14.4g for Derica and 14.2g for F1 Cobra 26. Those of the treatments for both cultivars respectively were as follows; 500 il (14.0g and 14.2g), 1000 il (13.9g and 14.3g), 1500 il (13.9g and 14.6g). The plant girth for all inoculum levels were as follows for Derica and F1 Cobra 26; 0 il (6.30mm and 6.40mm), 500 il (6.26mm and 6.31mm), 1000 il (6.14mm and 6.28mm), 1500 il (6.19mm and 6.18mm) respectively (Table 1).

Table 1. Effect of *M. javanica* on the growth parameters of the tomato cultivars, 60 days after inoculation (DAI)

DAI	Inoculum level (il)	Height (cm)		Girth (mm)		Root weight (g)	
		D	C	D	C	D	C
30	**0**	40.5	45.1	2.39	2.53	3.2	3.1
	500	37.8	37.4	2.02	2.49	3.0	3.2
	1000	36.7	37.1	2.04	2.31	2.9	3.2
	1500	33.3	36.8	1.97	2.31	2.9	3.6
60	**0**	100.8	98.8	6.30	6.40	14.4	14.2
	500	97.1	97.5	6.26	6.31	14.0	14.2
	1000	95.4	97.1	6.14	6.28	13.9	14.3
	1500	89.8	90.7	6.19	6.18	13.9	14.6

At 30 DAI, the tomato cultivars, Derica and F1 Cobra 26, the average soil nematodes recorded for the control groups was 0(0%) for both Derica and F1 Cobra 26 while the nematodes for the other treatments were recorded as 110(42.3%) for Derica and 90(36.0%) for F1 Cobra 26, 80(30.8%) for Derica and 80(32.0%) for F1 Cobra 26, 70(26.9%) for Derica and 80(32.0%) for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively. The average endophytic nematodes recorded for the control groups was 0(0%) for both Derica and F1 Cobra 26 while the nematodes for the treatments were recorded as 160(23.2%) for Derica and 130(21.0%) for F1 Cobra 26, 210(30.4%) for Derica and 190(30.6%) for F1 Cobra 26, 320(46.4%) for Derica and 300(48.4%) for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively (Table 2).

At 60 DAI, the tomato cultivars, Derica and F1 Cobra 26, the average soil nematodes recorded for the control groups was 0(0%) for both Derica and F1 Cobra 26 while the nematodes for the other treatments were recorded as 80(38.1%) for Derica and 80(36.4%) for F1 Cobra 26, 70(33.3%) for Derica and 80(36.4%) for F1 Cobra 26, 60(28.6%) for Derica and 60(27.2%) for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively. The average endophytic nematodes recorded for the control groups was 0(0%) for both Derica and F1 Cobra 26 while the nematodes for the treatments were recorded as 220(24.7%) for Derica and 200(22.5%) for F1 Cobra 26, 300(33.7%) for Derica and 290(32.6%) for F1 Cobra 26, 370(41.6%) for Derica and 400(44.9%) for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively (Table 2).

Table 2. Population dynamics of *M. javanica* at different inoculum levels in both cultivars; Derica and F1 Cobra 26, 60 days after inoculation (DAI)

DAI	Inoculum level (il)	Root Nematode Population in 1ml of aliquot (%)		Soil Nematode Population in 1ml of aliquot (%)	
		D	C	D	C
30	**0**	0(0)	0(0)	0(0)	0(0)
	500	160(23.2)	130(21.0)	110(42.3)	90(36.0)
	1000	210(30.4)	190(30.6)	80(30.8)	80(32.0)
	1500	320(46.4)	300(48.4)	70(26.9)	80(32.0)
60	**0**	0(0)	0(0)	0(0)	0(0)
	500	220(24.7)	200(22.5)	80(38.1)	80(36.4)
	1000	300(33.7)	290(32.6)	70(33.3)	80(36.4)
	1500	370(41.6)	400(44.9)	60(28.6)	60(27.2)

Reproductive factor (R)=Pf/Pi, Pf is the final population of root nematode while Pi is the initial population of root nematodes.

At 30 DAI, the reproductive factor (R) recorded for the control groups was 0(0) for Derica and F1 Cobra 26 cultivars. The reproductive factor (R) of the treatments were recorded as 0.32 for Derica and 0.26 for F1 Cobra 26, 0.21 for Derica and 0.19 for F1 Cobra 26, 0.21 for Derica and 0.20 for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively (Table 3).

At 60 DAI, the reproductive factor (R) recorded for the control groups was 0(0) for Derica and F1 Cobra 26 cultivars while the reproductive factor (R) of the treatments were recorded as 0.44 for Derica and 0.40 for F1 Cobra 26, 0.30 for Derica and 0.29 for F1 Cobra 26, 0.25 for Derica and 0.27 for F1 Cobra 26 for the 500, 1000 and 1500 inoculum levels respectively (Table 3).

Table 3. Reproductive factors of endophytic *M. javanica* in both cultivars; Derica and F1 Cobra 26, 60 DAI

DAI	Inoculum levels (il)	Endophytic Nematodes	
		Derica	**F1 Cobra 26**
30	**0**	0	0
	500	0.32	0.26
	1000	0.21	0.19
	1500	0.21	0.20
60	**0**	0	0
	500	0.44	0.40
	1000	0.30	0.29
	1500	0.25	0.27

Table 4 shows the gall index in both Derica and F1 Cobra 26 at various inoculum levels with *M. javanica*, 60 DAI.

At 30 DAI, the gall index for Derica and F1 Cobra 26 were both recorded as 0, 3, 4 and 4 for the control (0 il), 500il, 1000 il and 1500 il respectively.

At 60 DAI, the gall index for the Derica and F1 Cobra 26 were both recorded as 0, 4, 5 and 5 for the control (0 il), 500il, 1000 il and 1500 il respectively.

Table 4. Gall index in both tomato cultivars, Derica and F1 Cobra 26, at different inoculum levels of *M. javanica*, 60 DAI

Days After Inoculation (DAI)	Inoculum levels	Gall index	
		Derica	F1 Cobra 26
30	0	0	0
	500	3	3
	1000	4	4
	1500	4	4
60	0	0	0
	500	4	4
	1000	5	5
	1500	5	5

IV. DISCUSSIONS

The Response of Tomato Cultivar, Derica, to different inocula levels of M. javanica, 60 DAI

The control group of the Derica cultivar showed more apical competence than the treatment groups. There was a significant different ($p<0.05$) between the plant heights of the control group and the experimental groups (Table 1). Also the apical growth of Derica cultivar decreased with increase in inoculum levels 60 DAI. This did not support Nzeako and Imafidor (2008) who reported that *M. javanica* stimulated apical growth in Derica cultivar when compared with the control groups at 60 DAI. The decrease in plant height as inoculum level increased supports Moens (1978) who asserted that galled root tissues are capable of absorbing many nutrients and water, making it difficult for the root to adequately transport nutrients and water to the above ground parts of the plant. This subsequently leads to a reduced growth in the infected plant. There was a significant difference ($p<0.05$) in the height of the Derica cultivars 60 DAI (Table 1). Therefore, the distinction in height between the control groups and the treatment group was because of the presence of root galls which made the flow of nutrients to the apical plant parts difficult (Moens *et al*., 1978; Ogwulumba and Ugwuoke, 2013).

Galls in the root increased as inoculum levels increased which supports the record by Jaiteh *et al* (2012). The control group of the Derica cultivars had no sign of galls 60 DAI because they were not inoculated with *M. javanica*. Therefore, there was a significant difference between the control groups and the treatment groups. There was a significant difference ($p<0.005$) between the gall index of the root as inoculum levels increased from 500 to 1000 but there were no significant differences in the gall index ($p>0.05$) as inoculum level increased from 1000 to 1500, 60 DAI (Table 4). This is because the reproductive factor reduced as inoculum level increased; which means that the endophytic population of *M. javanica* at 1500 il was high, leading to more competition amongst the nematodes which slowed down the population growth at 60 DAI (Table 3) (Jaiteh *et al*., 2012).

Stem girth also decreased with increase in inoculum levels at 30 and 60 DAI. There was a significant difference ($p<0.05$) in girth size between the control group and the treatment groups. The control group had bigger girth size (6.30mm) when compared to the experimental groups at 60 DAI (Table 1). This could be as a result of decreased transportation of nutrients and water to the above ground parts due to the galling of roots (Moens, 1978; Ogwulumba and Ugwuoke, 2013).

The root weight also decreased as inoculum levels increased at 30 and 60 DAI which did not support the study by Imafidor and Nzeako (2007), Nzeako and Imafidor (2008) and Jaiteh *et al*. (2012) who recorded that the nematodes stimulated increase in root weight. There was a significant difference ($p<0.05$) in root weight as inoculum levels increased. The control groups had more weight (14.4g) than the experimental groups at 60 DAI (Table 1). This reduction in root weight could be as a result of root depletion by the *M. javanica* in the process of feeding. This depletion must have contributed in making the nutrients at the above ground parts to be insufficient for plant growth, leading to slower plant growth in the treatment groups when compared to the control groups.

There was a significant difference ($p<0.05$) between the population of the endophytic nematodes and the nematodes in the rhizosphere 60 DAI. At 30 DAI, the population of nematodes in the rhizosphere decreased while that of the roots increased due to the effective penetration of larvae and securing of feeding sites which supports the study of Imafidor and Nzeako (2007) and Nzeako and Imafidor (2008) (Table 2). Such increase in the population of *M. javanica* in the root also supports the study of Sorribas and Verdejo (1994) who reported that in the presence of the tomato host, there is a rapid vertical migration of the *Meloidogyne* spp. from the rhizosphere to the root. The population of nematodes in the root continued to increase at 60 DAI, which also increased as inoculum levels increased. This is in line with Imafidor and Nzeako (2007), Nzeako and Imafidor (2008) and Jaiteh *et al*. (2012). This trend could be attributed to increased active penetration of juveniles and reproduction within the root while rhizosphere nematodes continued to die due to lack of suitable tissues owing to the degradation of the plant cells at 60 DAI. The control group of Derica showed no signs of *M. javanica* infection 60 DAI which showed that the sterilization procedures was effective (Table 2).

Response of Tomato Cultivar, F1 Cobra 26, to Different Inoculum Levels of M. javanica, 60 DAI

The plant height decreased as inoculum level increased, ($p<0.05$) (Table 1). Apical growth decreased with increase in inoculum levels in the F1 Cobra 26 at 30 and 60 DAI. This study is in line with Moens (1978) and Stanton (2001) who

attributed such decrease in height to increased gall formation. The control groups showed more apical competence than the treatment groups because there was no gall to hinder plant growth (Table 1). The presence of the galls prevented adequate supply of nutrients and water to the above ground parts resulting in reduced growth in the 500 il, 1000 il and 1500 il respectively compared to the control group (Table 4) (Moens, 1978).

The gall in the root of F1 Cobra 26 increased as the inoculum level increased which supports the study by Jaiteh *et al* (2012). This was significantly different ($p<0.05$) from 0 il to 500 il and from 500 il to 1000 il but was not significantly different ($p>0.05$) as inoculum level increased from 1000 il to 1500 il (Table 4). This could be because the *M. javanica* population was higher than the carrying-capacity of the root. This led to increased competition, low penetration and reproduction of the endophytic nematodes at 1500 il (Nzeako and Imafidor, 2008).

The root weight of the F1 Cobra 26 increased as the inoculum levels increased (Table 1). This was in line with Imafidor and Nzeako (2007), Nzeako and Imafidor (2008) and Jaiteh *et al*. (2012). There was a significant difference ($p<0.05$) between the 1500 il and the rest of the experimental groups as the control showed the least root weight. The trend of increase in root weight did not stop at 30 DAI but continued to 60 DAI. This could be attributed to the increasing population of nematodes in the root as inoculum level increased from 0 il to 1500 il. There was also the possibility that there was no depletion of root in the F1 Cobra 26 variety of tomato (Table 1).

The girth of the F1 Cobra 26 decreased as the inoculum levels increased at 30 and 60 DAI ($p<0.05$) (Table 1). Also, the girth of the control group was more than that of the experimental groups at all inoculum levels (Table 1). This could be due to reduced uptake of nutrients as suggested by Moens *et al*. (1978) who recorded that gall formation reduced nutrient and water uptake in plants.

There was a significant difference ($p<0.05$) between the endophytic and rhizosphere nematode population (Table 2). This was due to the rapid decrease in *M. javanica* population in the rhizosphere and a resultant increase in endophytic *M. javanica* population. This supports the study of Moens (1978), Imafidor and Nzeako (2007) and Nzeako and Imafidor (2008) who recorded that nematode population increased with increase in inoculum level. The rapid migration from the rhizosphere to the root of the host plant, F1 Cobra 26, supported the study by Sorribas and Verdejo (1994) who studied *Meloidogyne* spp. of tomato plants and the rate in which their population increased from an undetectable level in the soil to a high level in the root of the tomato plants. This increase in endophytic nematode population could be attributed to the active migration of juveniles to the root of F1 Cobra 26 and subsequent death of the rhizosphere nematodes that were unable to secure feeding sites. There was no migration of juveniles in the control groups 90 DAI which showed that the sterilization procedure was effective (Table 2).

Comparative effect of M. javanica on the heights of Derica and F1 Cobra 26, 60 DAI

The variation in height among both cultivars was not significantly different ($p>0.05$) at 60 DAI. The presence of *M. javanica* inhibited the apical competence of both cultivars as endophytic population of the nematode increased, ($p<0.05$). The control group of the cultivar, F1 Cobra 26 demonstrated a higher apical growth than the control of Derica cultivar at 30 DAI (Table 1). At 60 DAI, Derica cultivar exhibited more apical competence than the F1 Cobra 26 in relation to the controls (Table 1). However, the experimental groups of F1 Cobra 26 were taller in relation to the experimental groups of the Derica cultivar. This could be because of the depletion of the roots during nematode migration as seen in the Derica cultivar. Such root depletion must have led to reduced nutrient uptake and subsequently slowed the growth rate of the Derica plant (Moens, 1978). The root of the F1 Cobra 26 was not depleted by the actions of the endophytic nematodes because of the possibility that the roots tissues were more adapted to *Meloidogyne* species infestation. Both cultivars manifested above ground symptoms including stunting, crinkled foliage and chlorosis.

Comparative effect of M. javanica on the root weights of both cultivars, Derica and F1 Cobra 26, 60 DAI

The root weight variations was significantly different ($p<0.05$) among both cultivars and within inoculum levels. The presence of giant cells, high endophytic population and tumor tissue formation must have influenced this variation in the root weights (Nzeako and Imafidor, 2008) of the plants. Increase in root weight as inoculum levels increased was associated with the F1 Cobra 26 while Derica demonstrated a reduction in root weight as the inoculum level increased. This reverse trend in root weights between both cultivars could be attributed to the depletion of the Derica root as the nematodes fed. Comparatively, the control groups of both tomato varieties showed the Derica cultivar to exhibit higher root weight 60 DAI (Table 1).

Overall population of M. javanica in the rhizosphere of both tomato cultivars, Derica and F1 Cobra 26, 60 DAI

The soil nematode population showed great variation from the endophytic nematode population at 30 DAI in both cultivars. This indicated an effective hatching and active penetration of *M.javanica* eggs (Sorribas and Verdejo, 1994; Imafidor and Nzeako, 2007; Nzeako and Imafidor, 2008). This showed host specificity in both cultivars. There was no significant difference ($p>0.05$) between the population of the soil nematodes in both cultivars and within corresponding inoculum levels. Both cultivars demonstrated a reduction in *M. javanica* population in the rhizosphere as inoculum level increased which indicated a decline in the nutrients, which led to the death of the ectophytic juveniles. Both tomato cultivars recorded no nematodes in the soil of their control groups

which shows that the sterilization technique was effective against the nematodes (Table 2).

The overall population of M. javanica in the root of both cultivars, Derica and F1 Cobra 26, 60 DAI

The results of both cultivars showed variability in the population of the endophytic *M. javanica* 60 DAI. F1 Cobra 26 showed more increase in endophytic nematode population at 1500 il than the corresponding Derica, 60 DAI. Deterioration of the root as a result of the feeding activities of *M. javanica* must have hampered the multiplication of the nematodes, 60 DAI in the Derica variety. There was a significant difference ($p<0.05$) between the inoculum levels and population of *M. javanica*. Never the less, endophytic population of *M. javanica* increased with increased inoculum levels in both cultivars. There was no significant difference ($p>0.05$) in the control groups of both cultivars as no nematodes were recovered from their respective roots (Table 2).

V. CONCLUSION

The tomato cultivars; Derica and F1 Cobra 26 were susceptible to *M. javanica* infestation with little variations in their levels of tolerance. The apical competence demonstrated by both cultivars made the pathogenic dynamics of the disease difficult to be detected at 30 DAI but gradually became auspicious 60 days after inoculation. The underground symptoms of galls or tumour cells manifested greatly in both cultivars of the *S. lycopersicum* which is indicative of *M. javanica* infestation.

REFERENCES

[1]. Abiodun, O. C., Luqman, A. A., Abiodun, A. O., Olapeju, A., Rasheed, O. A., Christopher, O. I., Pamela, A. I., Olajumoke, Y. A., Olajumoke, O. F. and Adefoyeke, O. A. M. (2018). Sustainable tomato production amongst smallholder farmers in Nigeria through resistance, rapid multiplication and use of biopesticides. Retrieved online on 2nd January, 2018 from http://uirf.ui.edu.ng/sustainable-tomato-production-amongst-smallholder-farmers-nigeria-through-resistance-rapid

[2]. Adepoju, A. O. (2014). Post-harvest losses and welfare of tomato farmers in Ogbomosho, Osun state, Nigeria. *Journal of stored products and postharvest research*. Vol.5(2) , pp. 8-13. doi: 10.5897/jsppr2014.0160. ISSN 2141-6567.

[3]. Adesiyan, S. O., Caveness, F. E., Adeniyi, M. O. and Fawole, B. (1990). Nematode pests of tropical crops. Heinemann Education Book (Nigeria) Limited. 114 Pp.

[4]. FAO (2011). Global food losses and food waste. Food and Agriculture Organization of the United Nations, Rome, 2011.

[5]. Fourie, H., Van, A., Venter, C. and Tiedt, L.R. (2014). The effects of cropguard® on the motility, ultrastructure, and respiration of two *Meloidogyne* species. *Nematropica*. 44:85-92.

[6]. Hartman, K. M. and Sasser, J. N. (1985). Identification of *Meloidogyne* species on the basis of differential host tests and perineal pattern morphology. 69-77. In: An advanced treatise on Meloidogyne. Vol. 2. Methodology, K. R. Barker, C. C. Carter and J. N. Sasser, eds. North Carolina State University Graphics. Raleigh.

[7]. Imafidor, H. O. and Nzeako, S. O. (2007). The effect of *Meloidogyne javanica* on the growth of the tomato cultivar, UC82B. Afr. J. Appl. Zoology and Envi. Bio. 9:1-4.

[8]. Imafidor, H. O. and Nzeako, S. O. (2010). Effects of different rhizosphere population of *Meloidogyne javanica* on the growth of tomato cultivar "Gboko". *Afr. J. Appl. Zool. Environ. Biol*. 12(1): 76-81.

[9]. Jaiteh, F., Kwoseh, C. and Akromah, R. (2012). Evaluation of Tomato Genotypes for Resistance of Root knot Nematode. *African Crop Science Journal*. 20: 41-49

[10]. Moens, M., Perry, R. N. and Starr, J. L.(2009). *Meloidogyne* species – a diverse group of novel and important plant parasites. Pp. 1-17 in R. N Perry, M. Moens, and J. L. Starr (eds.). Root-knot nematodes. Wallingford, UK: CAB International.

[11]. Moens, S., Wallace, H. R. and Fisher, J. M. (1978). Water Relations of Tomato (*Lycopersicum esculentum* mill cv, Early Dwarf Red) infected with *Meloidogyne javanica* (Treub), Chitwood (in press)

[12]. Nicole, J. M., Turner, S. J., Coyne, L. D., den Nijs, L., Hockland, S. and TahnaMaafi, Z. (2011). Current Nematode Threats to World Agriculture. J. Jones et al. (eds.), Genomics and Molecular Genetics of Plant-Nematode Interactions, DOI 10.1007/978-94-007-0434-3_2, © Springer Science+Business Media B.V. 2011.

[13]. Nzeako, S. O. and Imafidor, H. O. (2008). Pathogenicity of Meloidogyne javanica on growth of tomato (Lycopersicum esculentum) cv. Derica: Effect on fruit yield. Nigerian Journal of Parasitology. 29(2). 121-124

[14]. Nzeako, S. O., Yessoufou, K., van der Bank, M and Imafidor, H. O. (2013). Testing impacts of endoparasitic nematode *Meloidogyne javanica* on crop productivity, using tomato cultivar "Gboko" as a case study in Nigeria. International Journal of Plant Breeding and Crop Science Research. 1(1): 1-9.

[15]. Ogwulumba, S. I. and Ugwuoke, K. I. (2013). Coefficient and path analysis of the impact of root galls caused by *Meloidogyne javanica* on some growth and yield parameters of tomato (Solanium lycopersicum). *International Journal of Plant and Soil Science*. 2(2): 222-229.

[16]. Olaniyi, J. O. Akanbi, W. B., Adejumo, T. A. and Akande O. G. (2010). Growth, fruit yield and nutritional quality of tomato Varieties. *Afr. J. Food Sci*., 4: 398-402.

[17]. Onkendi, E. M., Kanuki, G. M. and Marais, M. (2014). The threat of root-knot nematodes (*Meloidogyne* spp.) in Africa: A review. *Plant pathology.* 63: 727-737

[18]. Safiuddin, S. S. and Shweta, S. (2011). Pathogenicity of root-knot nematode (*Meloidogyne incognita*) and root-knot fungus, Rhizoctonia solani on okra (*Abelmoshcus esculentus L*.). e-Journal of Science and Technology. 3: 97-102

[19]. Sasser, J. N, Carter, C. C. (1985). *Overview of the international Meloidogyne project* 1975–1984. In an advanced treatise on *Meloidogyne*. Edited by: Sasser J. N, Carter, C. C. Raleigh: North Carolina state University Graphics; 1985:19-24.

[20]. Sorribas J. F. and Verdejo-Lucas, S. (1994). Survey of *Meloidogyra* spp in tomato field of the Baix Llobregat County, Spain. *Journal of Nematology*. 26(45): 731-736

[21]. Stanton, J. (2001). *Tomato root knot nematodes.* Biology and control. G. Stirling note on biological crop protection. Department of primary industries and fisheries. Queen land government. USA. http://www.dpiqld.goo.aau/horticulture/4855.html

[22]. Tsado, E. K. (2014). The best source of compost for tomato production- a study of tomato production in Niger state, Nigeria. *European Journal of Agriculture and Forestry* Research Vol. 2 (4),pp.1-11.