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# Host-suitability of maize varieties to root knot nematode *meloidogyne incognita*

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**Abstract**

A study was carried out under plant house condition to assess the reaction of three maize varieties to *M. incognita* parasitism between May and July 2017. A pot experiment was carried out in a Completely Randomized Design with five replications. *Meloidogyne incognita* eggs @ 2000 eggs were applied per plant. Mamaba, Obaatanpa and Abeleehi maize varieties exhibited resistance potential by suppressing reproduction, development and establishment of the obligate parasite. Gall index, stem girth, plant height and shoot dry matter weights were not significantly affected. These maize varieties could be incorporated into well planned crop-land rotational and maize breeding systems to minimize *M. incognita* populations' build-up and damage to susceptible crops such as okra which follow maize in a crop rotation system.

**Keywords**: Cultural control, host plant resistance, okra, phyto nematodes, *Zea mays*.

**M**aize is the most important cereal crop in terms of production and utilization in Ghana. It accounts for more than 50% of total cereal production in the country annually (IFPRI, 2014).The Ghana Grains Development (1979–1997) and Food Crops Development (2000–2008) Projects made huge investments to improve maize crop productivity in Ghana (IFPRI, 2014). Rising human population, urbanization, and growing poultry and fishery sub-sectors have also contributed to an increased demand for maize products. For example, the poultry industry's demand for maize grew by nearly 10% annually between 2000 and 2009 (Hurelbrink & Boohene, 2011).

Extensive use of maize in crop-land rotational systems in Ghana necessitates information on its host status to economically important plant parasitic nematodes. Maize following okra crop or vice-versa directly or indirectly in a three or four-cycle crop-land rotational system is a common practice among okra farmers in Ghana. However, farmers often display inadequate awareness and knowledge of the relationship between maize crop and plant parasitic nematode populations' build-up and damage levels due to limited information on response of maize varieties to root-knot nematodes infestations in Ghana. In this work, host suitability of three maize varieties was investigated regarding *Meloidogyne incognita* parasitism under plant house condition.

## Materials and Methods

**Soil preparation and sterilization:** Top soil-river sand mix (3:1) was sieved through 2 mm diameter sieve to remove all plant debris and other foreign materials. Sieved soil was steam-sterilized at 102$^{o}$ C for 2 h in an electric steam sterilizer positioned at the CSIR - Crops Research Institute (CRI), Fumesua (6° 43 ′N, 1° 36 ′W) in the Ejisu Municipality of the Ashanti Region of Ghana, where the study was conducted. Sterilized soil was allowed to cool overnight before use. To determine effectiveness of the soil sterilization method employed, ten (10) samples of 100 cm$^3$of the sterilized soil were extracted for nematodes using the modified Baermann extraction protocol (Whitehead & Hemming, 1965). No nematodes were recovered which indicated that the sterilization was effective.

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**Table 1. Some characteristics of the maize varieties tested.**

| Variety | Maturity group | Days to maturity | Endosperm type[1] | MSV reaction[2] |
|---|---|---|---|---|
| Abeleehi | Intermediate | 105-110 | W, D | T |
| Mamaba | Late | 115-150 | W/D | T |
| Obaatanpa | Intermediate | 105-110 | W,D/F, QPM | T |

[1]W (White endosperm), D (Dent), F (Flint), QPM (Quality Protein Maize): [2]T (Tolerant to Maize Streak Virus - MSV)

**Source of maize varieties, experimental design and seedling:** Three maize varieties viz., Abeleehi, Mamaba and Obaatanpa were obtained from the CSIR – CRI Maize Improvement Programme for the study (Table 1).

Asontem, okra variety was used as positive control. The test was carried out in plant house between May and July, 2017. Average temperature of 25±1$^{o}$C, 12 h photoperiod and relative humidity of 87±1 % were observed in the plant house during the study period. A Completely Randomized Design experiment was mounted with five replications. Three seeds were sown per pot. All the seeds germinated within one week after sowing and seedlings thinned to one per pot. The experiment was terminated eight weeks after inoculation for *M. incognita* infestation assessment.

***Meloidogyne incognita*eggs extraction and inoculum levels:** Nematode eggs were extracted from *M. incognita* pure cultures established on okra var Asontem for eight weeks in the plant house. Methods given by Taylor & Sasser (1978) and Hussey & Barker (1973) were followed to extract *M. incognita* eggs. Infested plants were carefully uprooted; and roots were washed under running tap water to remove adhering soil and plant debris. The roots were cut to about 1 cm long pieces with a sharp pair of scissors on a wooden board. About 150 g of the cut roots was placed in a jar with 0.05 % NaOCl enough to cover the roots. The jar and its content was covered tightly and vigorously shaken by the hand for three minutes. The NaOCl solution containing *M. incognita* eggs was quickly poured through a 200 µm sieve nested over 500 µm sieve. The 200 µm sieve was gently tilted by the side so that the eggs were washed from it into the 500 µm sieve. The eggs were collected from the 500 µm sieve into a beaker (200 ml). *Meloidogyne incognita* egg counting was done three times by a tally counter and averaged was tacalculated using compound microscope (40x magnifications). *M. incognita* eggs inocula @ Zero and 2000 were applied to the rhizosphere of each plant in the pot using a pipette. Inoculation was done three weeks after seedlings emergence. Rhizosphere soil samples were collected eight weeks after inoculation and processed for *M. incognita* juveniles.

**Data collection:** Plant height, stem girth, gall index, reproduction factor and oven-dried shoot weight. Plant height (cm) was measured with a 20 m wooden measuring rule at eight weeks after inoculation (WAI). Measurement was taken from the base (soil level) of the maize plant up to the tip of the flag leaf. Okra plant was measured up to the apex. Stem girth (cm) was measured with a digital caliper. In assessing gall index of treatments; plant roots were harvested, washed gently and rated for typical galling symptoms using 0–10 rating scale (Bridge & Page, 1980) by visual observation (McLoed *et al*., 2001). Reproduction factor (Rf) was determined as the ratio of final nematode population (pf) to the initial applied (pi) after soil and root analyses for *M. incognita* juveniles. Reproduction factor was thus determined as:

$$Rf = \frac{pf}{pi}$$

Reproduction factor less than 1.0 (Rf< 1.0) indicates low reproduction; whilst reproduction factor greater than 1.0 (Rf> 1.0), indicate shigh reproduction (Oostenbrink, 1966).

Oven-dried weight per 100 g fresh shoot weight was taken after harvest. Temperature used for drying was 60ºC for 24 h. The experiment was repeated under the same conditions. Data collected were pooled together and subjected to ANOVA using GenStat statistical package 12.1. Treatment means were separated using least significant difference (LSD) at 5% probability level.

## Results and Discussion

No nematodes were extracted from the sterilized soil before setting up the experiment (Data not provided).The positive control recorded the highest gall index (8.3) and reproduction factor (1.9) (Fig. 1a) which were significantly higher than those recorded for the maize varieties (Table 2; Fig. 1b).

There were no significant differences amongst the maize varieties in stem girth at the inoculum levels tested (Table 3). Zero (0) *M. incognita* eggs on the positive control recorded 1.8 cm stem girth. This was 38.9% greater than that of the 2000 eggs inoculum level which was 1.1 cm (Fig. 2). There were no significant differences amongst the maize varieties in plant height at 0 and 2000 *M. incognita* egg inoculum levels (Table 4).

Plant height of 138 cm was recorded on the check (positive control)at2000 *M. incognita*eggs inoculum level,which was 52.9% lesser than that recorded at the 0 eggs inoculum level (Fig. 3).

**Table 2. Maize varieties gall indices and reproduction factor under 2000 *Meloidogyne incognita* eggs parasitism.**

| Treatment | Gall index (0-10) | Reproduction factor (Rf = Pf/Pi) | Reaction |
|---|---|---|---|
| Abeleehi | 1.8 | 0.5 | R |
| Mamaba | 2.3 | 0.2 | R |
| Obaatanpa | 1.5 | 0.2 | R |
| Okra Asontem (+ve control) | 8.3 | 1.9 | S |
| LSD (0.05) | 1.1 | 0.4 | - |

Each value is a mean of two pooled results of five replicates each; pi = Initial egg population, pf (nematode population per 100 $cm^3$ soil + 5 g root weight at harvest), R = Resistance, S = Susceptibility; (Rf< 1) = Low reproduction, (Rf> 1) = higher production (Oostenbrink, 1966)

**Fig. 1a.** Asontem okra plant root inoculated with 2000 *M. incognita* eggs.

**Fig. 1b.** Obaatanpa maize plant root inoculated with 2000 *M. incognita* eggs.

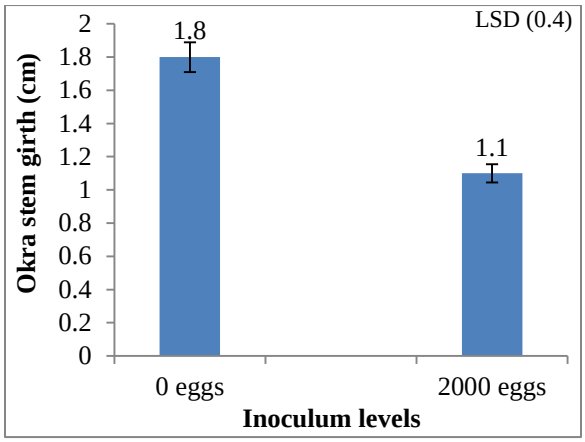


**Fig. 2.** Stem girth of Asontem okra plant under *M. incognita* parasitism; each value is a mean of two pooled results of five replicates each.

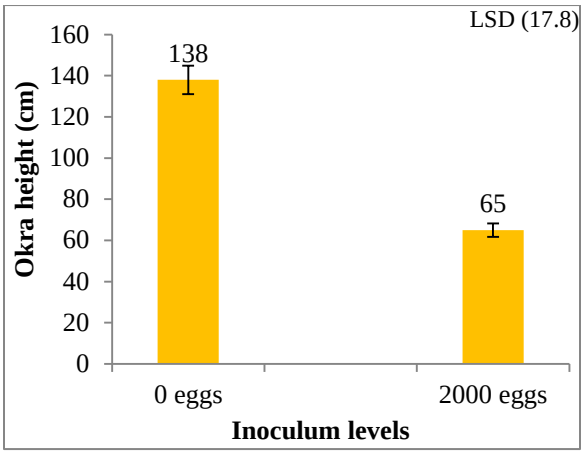


**Fig. 3.** Height of Asontem okra plant under *M. incognita* parasitism.

**Table 4. Maize varieties height under *M. incognita* parasitism.**

| Treatment | 0 eggs | 2000 eggs |
|---|---|---|
| Abeleehi | 149.9 | 149.8 |
| Mamaba | 150.0 | 149.8 |
| Obaatanpa | 150.0 | 149.7 |
| $LSD_{(0.05)}$ | 0.20.2 | |

Each value is a mean of two pooled results of five replicates each

**Table 5. Shoot dry matter weight per 100 g fresh weight of maize varieties and okra under *M. incognita* parasitism.**

| Treatment | 0 eggs | 2000 eggs |
|---|---|---|
| Abeleehi | 43.8 | 44.8 |
| Mamaba | 48.0 | 47.9 |
| Obaatanpa | 45.4 | 45.2 |
| Okra | 45.2 | 23.8 |
| $LSD_{(0.05)}$ | 6.0 | 3.1 |

Each value is a mean of two pooled results of five replicates each

**Table 3. Maize varieties stem girth under *Meloidogyne incognita* eggs parasitism.**

| Treatment | 0 eggs | 2000 eggs |
|---|---|---|
| Abeleehi | 1.8 | 1.4 |
| Mamaba | 1.0 | 1.4 |
| Obaatanpa | 1.5 | 1.4 |
| $LSD_{(0.05)}$ | 0.7 | 0.2 |

Each value is a mean of two pooled results of five replicates each

There were no significant diffrerences (P>0.05) in shoot dry matter weight amongst the maize varieties at the inoculum levels tested (Table 5). At the zero (0) *M. incognita* inoculum level, the positive control recorded 45.2 g shoot dry matter weight which was 47.3% higher than that of the 2000 eggs level (23.8 g) (Fig. 3).

High gall indices recorded on the positive control (okra) is due to okra's susceptibility to *Meloidogyne incognita* infestation. The obligate parasite did not excite visible characteristic galls on the roots of the maize varieties tested which might be due to resistance potential inherent in the maize varieties. According to the Integrated Crop

Management Newsletter (2005), root-knot symptoms of *Meloidogyne* species infestation on maize varieties are not conspicuous. Asmus *et al*., (2000) also reported no typical root-knot symptoms on some maize varieties under *Meloidogyne* species parasitism. Reproduction factor measures the relative ability of an infectious agent to multiply on a host. The current study recorded low *M. incognita* reproduction on the maize varieties.This might be due to the fibrous nature of the root architecture of maize plant which does not favour smooth entry of *Meloidogyne* species into the root system to cause infestation. Oostenbrink (1966) observed some resistant maize cultivars recording low reproduction rates, while the susceptible candidates recorded high reproduction under *Meloidogyne* species parasitism. Ngobeni *et al.*, (2011) showed that maize genotype "AFG4410" was highly susceptible under *Meloidogyne* species parasitism (Rf>1.0) at all inoculum levels applied whilst "QS-OBA" and "MP712W" were resistant.

## Conclusion

Mamaba, Obaatanpa and Abeleehi maize varieties exhibited resistance potential against *M. incognita* parasitism by suppressing reproduction, development and growth of the obligate parasite. The maize varieties will be tested against other tropical nematode species of the *Meloidogyne* genus to assess their reaction and research into okra-maize-okra crop rotations under field conditions to assess survival and infectivity of *Meloidogyne* species. Genes of the maize varieties tested in this study could be incorporated into other promising maize genotypes in maize breeding programs to evolve high yielding *M. incognita* resistant or / and tolerant maize varieties to reduce the pests' populations and damage levels in maize cropping and land rotational systems among resource poor maize farmers. Adoption of improved maize crop cultivars, sustainable agronomic practices; and pests and diseases management are a prerequisite for higher economic yields in maize cropping systems.

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