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Early screening of cassava for resistance to root knot nematodes

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Abstract

Two node cuttings of 18 cassava varieties were planted in 20 cm diameter non-disposable plastic pipes filled with sawdust with the objective of establishing their resistance to root knot nematodes (*Meloidogyne* spp.). The cassava plants were left to grow for one month after which they were inoculated with 1000 eggs of *Meloidogyne* spp. Plants were left to grow for another two months after inoculation before assessment. The trial was repeated three times and data pooled for analysis. Greater resistance to root knot nematodes was observed in the cultivars TME 12, Migyera, Nase 10 and TME 5. Cultivars Nase 1, TME 12, 192/0232, Abbey and TME 4 had moderate resistance. These varieties were characterised by low galling index, high plant heights and high fresh root weights. Cultivars TME 14 and P.D.B showed tolerance to root knot nematodes. Varieties, MH 95/0414, 95/SE00087, MM96/0245, 94/SE00036 and MM96/0561, respectively had more than 50% roots galled coupled with low fresh root weights or rotten roots hence, highly susceptible to root knot nematodes. Though varieties 192/0427 and 191/0057 exhibited low galling index, their fresh root weights remained low hence highly susceptible. *Meloidogyne* spp. populations did not significantly differ across varieties probably because of the short time duration.

Key words: Cassava, root knot nematodes, *Meloidogyne* spp.

Introduction

A number of plant parasitic nematode species are known to be associated with cassava, of which root-knot nematodes (*Meloidogyne* spp.) are recognised as the most important (Jatala and Bridge, 1990). In Uganda *Meloidogyne* spp. have been identified as a substantial threat to cassava production (Coyne and Namaganda, 1996; Coyne and Talwana, 2000). The nematodes attack the cassava feeder roots causing disruption in normal translocation of water and nutrients and causing galling damage to the roots (Gapasin, 1980). Talwana *et al*. (1996), using drum oils, reported significant cassava plant height and root fresh weight reduction as a result of *Meloidogyne* spp. infection in Uganda. Caveness (1982) however reported almost total cassava storage root loss as under high levels of *Meloidogyne* spp. in West Africa. On a global basis, *Meloidogyne* spp. are among the major obstacles to food production in many developing countries (CAB International, 2002).

The extent of damage by *Meloidogyne* spp. has been observed to be directly proportional to the *Meloidogyne* spp. population densities occurring on a susceptible cultivar (Caveness, 1980). Caveness (1992) further reported that susceptible cassava cultivars become heavily affected by *Meloidogyne* spp. within six months from date of infestation. This is partly attributable to their short life cycle (23 – 30 days) (Eisenback and Triantaphyllou, 1991). Mcsorley *et al*. (1983) reported that cultivars can respond to the same *Meloidogyne* species differently or to different populations levels of the same species. Resistant or tolerant cultivars therefore are suggested as an effective management option for *Meloidogyne* spp. The current study was undertaken to establish the reaction of newly developed cassava cultivars and existing germplasm at the International Institute of Tropical Agriculture to *Meloidogyne* spp. in pot experiments, following a revision of the protocol of Talwana *et al*. (1997).

Materials and methods

Two-node cassava cuttings were planted in 20 cm diameter non-disposable plastic pipes, split lengthwise and filled with steam-sterilized sawdust. Each cutting was separated from each other within the half-pipe using plastic spacers. Each cutting occupied 20 cm. cm of pipe. The pipes were arranged in a randomised complete block design using 18 cultivars (cv) with three replications each. One month after planting

(MAP), plants were each inoculated with 1000 eggs of *Meloidogyne* spp. in 8 ml water suspension, delivered to the root zone using a pipette. Nematode cultures were maintained on tomato plants, and eggs extracted using the NaOCl method shortly before inoculation (Hussey and Barker, 1973). At three MAP height, root fresh weight, galling index, root rot (root condition), *Meloidogyne* spp. populations and egg populations per 1 g root samples were assessed. Galling index was assessed according to the extent of galling on the root system after Gapasin (1980): 1 = no galls observed, feeder roots intact; 2 = at least one gall observed; 3 = numerous galls, about 50% roots affected, 4 = numerous galls, most roots affected; 5 = heavy galling on most roots, with necrosis and feeder roots heavily affected or absent. Root condition was assessed using scores with 'score 0' for dead roots and 'score 1' for live roots. The experiment was conducted three times in total and data pooled for analysis. Cultivars screened included: Nase 1, 192/0427, TME 5, 191/0057, TME 12, Migyera, 192/0232, Abbey, TME 4, Nase 10, P.D.B, MH95/0414, 95/SE00087, MM96/0245, TME14 and 94/SE00036 and MM96/0561.

Nematode population data was sqrt (x+0.5) transformed to normalize the data set (homogeneous variance among treatments) prior to analysis of variance (Gomez and Gomez, 1984). Differences between means were compared using Tukey's studentized range test (HSD) (SAS Institute, 1999). The correlation between between root fresh weight and galling index was assessed with linear regression analysis. Root condition was analyzed using chi-square in a logistic regression model.

Results

Plant height (P= 0.001) and root fresh weight (P= 0.004) and galling index (P= 0.025) differed between cv.s. *Meloidogyne* spp. populations at two months after inoculation were not, however, influenced by cultivar (P≤ 0.05). The cv.s Nase 1, 192/0427, TME 5, 191/0057, TME 12, Migyera, 192/0232, Abbey, TME 4 and Nase 10 recorded the lowest galling index, with at least 1 gall observed (Table 1). These cultivars were also characterised by high (P≤ 0.05) root fresh weights except for 192/0427 and 191/0057. Highest (P≤ 0.05) galling index was recovered on the cv.s P.D.B, MH 95/0414, 95/SE00087, MM96/0245, TME14 and 94/SE00036, with each having more than 50% of roots with galling damage. However, among these cv.s, TME 14 and P.D.B had high (P≤ 0.05) root fresh weights suggesting some tolerance to *Meloidogyne* spp.. Among the cv.s with low galling, plant height was high (P≤ 0.05) in TME 12, Migyera, Nase 10 and TME 5. The level of root survival differed across cv.s (P = 0.003) with cv MM96/0561 having particularly high (P≤ 0.05) levels of root rot at harvest.There was a positive correlation observed between root fresh weight and galling index for cv.s: Nase 1 (r = 0.99), 192/0427 (r = 0.99), 191/0057 (r = 0.48), TME 12 (r = 0.95), Migyera (r = 0.07), 192/0232 (r = 0.31), TME 4 (0.91) and Nase 10 (r = 0.30), while negative correlations were observed for cv.s 94/SE00036 (r = -0.732), 95/SE00087 (r = -0.42), Abbey (r = -0.40), I91/0067 (r = -0.44), TME 5 (r = -0.08) and MM96/0245 (r = 0.26). Cultivars, which exhibited negative correlations (94/SE00036, 95/SE00087, Abbey, I91/0067 and MM96/0245) were also characterized by very low values of fresh root weight (Table 2).

Discussion

Resistance was observed in the cultivars Nase 1, 192/0427, TME 5, 191/0057, TME 12, Migyera, 192/0232, Abbey, TME 4 and Nase 10 as suggested by the low galling damage to roots, high fresh root weights and no or few *Meloidogyne* spp. present at harvest. Coyne and Talwana (2000) reported that high galling index is likely to translate into yield losses. Observations on the variability of cassava cultivar reaction to *Meloidogyne* spp. has been made in several reports (e.g. Mcsorley *et al.*, 1983; Bridge *et al.*, 1991; Coyne and Talwana, 2000). Significantly taller plants in cv.s TME 12, Migyera, Nase 10 and TME 5, in addition to low galling damage, suggests that these cultivars were those most resistant to the *Meloidogyne* spp. within the study, and therefore most suitable for use in high *Meloidogyne* spp. pressure areas. Hussey (1985), Talwana *et al.* (1996) and Starr *et al.* (1989) reported that plants infested with *Meloidogyne* spp. tend to show stunted growth in form of reduced plant height. Although the cultivar P.D.B. is inedible, it appears tolerant to *Meloidogyne* spp. and may therefore have potential in breeding for *Meloidogyne* spp. resistance in cassava. The cultivars, MH95/0414, 95/SE00087, MM96/0245 and 94/SE00036 all had over 50% root galling damage albeit non-significant and low root fresh weights, suggesting *Meloidogyne* spp. susceptibility. The cultivar MM96/0561 also had substantial root rotting suggesting a different reaction to *Meloidogyne* spp. by this cultivar to the others. Bridge *et al.* (1991) and Talwana *et al.* (1997) attributed the presence of rotten and dry roots or dead plants to early infections by *Meloidogyne* spp. and subsequent infections by rot causing organisms. Although galling was evident, *Meloidogyne* spp. populations were in general low and did not differ across cultivars. McSorley *et al.* (1983) reported similar observations when cassava plants were sampled for nematodes at 3 months old, although Talwana *et al.* (1997) establsished a rapid screening method with similar durations, using soil not sawdust however.

The positive correlation observed between galling index and root fresh weights were essentially for cultivars, which exhibited low galling, whereas those with negative correlations exhibited higher galling and low fresh root weights, or the more susceptible cultivars. Care is therefore required when interpreting data of this nature, and quite possibly needs to be assessed on an individual cultivar basis. The current study indicates that the cultivars TME 12,

Table 1. Reaction of 18 cassava cultivars to inoculation with 1000 *Meloidogyne* spp. eggs 1 months after planting and harvested at 3 months after planting

Varieties	Height (cm)		Root fresh Wt (g)		Galling index[1]		*Meloidogyne* spp.[2]	
TME12	7.28	a	2.97	a	1.80	a	3.9(35.6)	a
TME14	5.70	ab	2.65	ab	2.71	a	1.9(7.7)	a
Migyera	5.53	ab	1.91	abc	2.12	a	1.0(0.9)	a
Nase10	5.09	ab	1.51	abc	2.33	a	1.1(2.1)	a
PDB	4.68	ab	1.84	abc	3.0	a	2.5(27.0)	a
MM96/0245	4.6	ab	1.01	abc	2.83	a	0.7(0.0)	a
TME5	4.01	ab	1.30	abc	1.66	a	1.0(1.0)	a
95/SE00087	3.84	ab	1.65	abc	2.75	a	1.6(7.0)	a
192/0232	3.6	ab	1.34	abc	2.23	a	2.6(27.7)	a
MH95/0414	3.54	ab	1.49	abc	2.85	a	1.7(5.2)	a
Abbey	3.0	ab	1.56	abc	2.20	a	0.7(0.0)	a
TME4	2.96	ab	1.29	abc	2.20	a	2.6(20.2)	a
94/SE00036	2.67	ab	0.84	abc	2.60	a	0.7(0.0)	a
MM96/0561	2.03	ab	1.17	abc	2.00	a	0.7(0.0)	a
I91/0057	1.77	b	0.49	bc	1.83	a	3.1(21.2)	a
Nase1	1.0	b	0.20	c	1.50	a	0.7(0.0)	a
I92/0427	0.86	b	0.53	bc	1.66	a	0.7(0.0)	a
I91/0067	0.79	b	0.11	c	1.25	a	0.7(0.0)	a

Means followed by the same letter are not significantly different at 0.05 significant level using tukey's studentized range test.
[1] based on a scale of 1-5, 1=no galls and 5 = severe galling. [2] Analysis undertaken on sqrt(x+0.5) transformed *Meloidogyne* spp. data with actual nematode counts in parenthesis.

Table 2. Linear regression equations ($P \leq 0.05$) **between cassava root fresh weight and *Meloidogyne* spp. galling index for cultivars with significant correlations**

Variety	Regression equation	R^2
94/SE00036	Fwt = 2.58 – 0.634 x GI	0.54
95/SE00087	Fwt = 3.89 – 0.812 x GI	0.17
Abbey	Fwt = 3.60 – 0.93 x GI	0.16

Fwt = Root fresh weight, GI = Galling index.

Migyera, Nase 10 and TME 5, offer some resistance against *Meloidogyne* spp. However, their response to higher nematode population densities and validation of resistance against individual species of nematode is required.

On-going and future prospects

Pot trial studies are on going to establish the most important *Meloidogyne* spp. among *Meloidogyne incognita*, *M. javanica* and a mixture on different cassava cultivars.

Studies to establish a rapid routine resistance screening method for cassava against *Meloidogyne* spp. is also on going.

Field studies to determine the effect of different initial populations of *Meloidogyne* spp. on cassava are also being conducted.

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