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Sesbania species as potential hosts to root-knot nematode (*Meloidogyne javanica*) in Tanzania

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Abstract. In two glasshouse studies *Sesbania* accessions were compared with a susceptible tomato cultivar as hosts to *Meloidogyne javanica*. Inoculating the growth medium with either infective juveniles or egg masses resulted in significant differences in root galling and egg mass production. The accessions could be grouped into moderate and poor hosts. Growth of roots was also depressed by the infestation. In a field study on a nematode infested site, significant variation in root galling was observed. Infestation was lower in plants growing on ridges than those on flat land. The studies indicate that continued cultivation of *Sesbania* may lead to a build up in soil root-knot nematode populations.

Introduction

Damage from plant-parasitic nematodes is one of the principal yield limiting factors to crop and forage production in the tropics and sub-tropical regions [Whitehead, 1969]. The root-knot group (*Meloidogyne* spp.) are among the top ranked plant pathogens affecting the world's food supply [Sasser, 1980]. They are widely distributed, with extensive host ranges and are involved with fungi, bacteria and viruses in disease complexes affecting virtually all crops and forages [Baker et al., 1981]. According to Anon [1981] and Whitehead [1969] *M. javanica* is the major nematode causing yield losses of tobacco and leguminous pulses in the Tabora region of Tanzania and their population densities in crop fields are on the increase. This is partly due to growing of susceptible crops coupled with reduced durations of crop rotation with poor hosts as a means of reducing soil nematode inoculum.

Some of the *Sesbania* species currently being tested for incorporation into agroforestry systems aimed at fodder production and amelioration of soil fertility are reportedly hosts of *Meloidogyne* spp. [Evans and Rotar, 1987; Whitehead, 1969]. As the longevity of *Sesbanias* range from annuals to perennials, the introduction of such susceptible materials into crop fields could serve as sources of inoculum for the associated or subsequent crops in the farming systems and adversely influence adoption of technical packages based on the species. The objectives of these experiments were: (a) to evaluate the susceptibility of *Sesbania* species showing potential for use in agroforestry

as hosts for *M. javanica* under glasshouse conditions and (b) study infestation of *Sesbania* under field conditions.

Materials and methods

Glass house studies

Growth media

All test soil components were sieved (< 2 mm) to remove plant debris and large particles. A heat sterilized (80 °C for 30 min) 2:2:1 (volume basis) mixture of sandy clay loam, forest clay loam and sand (78% sand, 15% silt, 7% clay; pH 6.9 (1:2.5 KCl) with 1.5% organic matter, 0.1% total nitrogen and 21 ppm available phosphorus) comprised the growth media. The mixture was added to 12.5 cm diameter oven-sterilized (30 °C for 30 min) plastic pots at the rate 1 kg per pot and sown with two pre-germinated seeds each of ten *S. sesban* and one *S. macrantha* accessions (Table 1) with tomato, a good host to *M. javanica*, as the control in all experiments. Seedlings were thinned to a single plant per pot one week after germination and pots were watered twice daily to 80% soil water holding capacity.

Table 1. Effect of inoculation with infective juveniles of root-knot nematode (*M. javanica*) on galling and egg mass production by *Sesbania* species and tomato.

Host species	Acc. no.	Root gall index[a]	Egg mass index[b]	Reproductive rating (R)[c]
S. sesban	028	4.3	3.8	0.8
"	08B	4.3	3.5	0.8
"	014	2.8	2.3	0.5
"	15	2.0	2.0	0.4
"	027	2.0	1.8	0.4
"	029	6.0	4.0	0.9
"	SR19	3.3	2.8	0.6
"	T110	2.3	1.8	0.4
"	NRB1	3.8	3.0	0.7
	Ex. Tumbi	3.3	2.8	0.6
S. macrantha	017	1.5	1.0	0.2
L. esculentum		6.0	4.5	1.0
	SED	0.61	0.55	
	CV (%)	6.1	13.1	

[a] 0 = no knots on roots, 5 = 50% root infested, knoting on parts of main roots, reduced root system and 10 = all roots severely knotted, no root system, plants usually dead.

[b] 0 = no egg masses, 2 = 3–10 and 5 = 31–100 egg masses per root system.

[c] R > 1.0 = good host, 1.0 > 0.5 moderate host, < 0.5 > 0.1 poor host and < 0.1 non host.

Experiment 1: effect of inoculating with infective juveniles
Meloidogyne javanica inoculum was isolated from infected tomato (*Lycopersicon esculentum* cv. Money marker) plants; species confirmation was based on perineal patterns [Sasser and Carter, 1982]. Single egg mass cultures were increased on tomato seedlings grown in the glasshouse. Second stage *M. javanica* juveniles were extracted from 60-day-old tomato roots in 0.5% sodium hypochlorite solution and washed in water [Hussey and Baker, 1973]. Inoculum was standardized to 2000 juveniles per ml suspension. Fifteen days after seed germination, the seedlings were inoculated with 4000 juveniles. Two ml of the suspension was pipetted into six 5 cm deep holes approximately 3 cm from the collar of the seedlings and the holes were covered with soil. The experiment lasted for 50 days after inoculation. Experimental design was completely randomized with 4 replications.

Experiment 2: effect of inoculating with egg masses
The experimental procedures, growth media and plant materials were as in Experiment 1. The egg masses were extracted [Dickson and Struble, 1965] from infected tomato roots then standardized to 50 egg masses per ml suspension. Each seedling was inoculated with 100 egg masses. Design of the trial was completely randomized with 2 replications. Non-inoculated plants served as the control for estimation of effect of nematode infestation on root volumes.

Experiment 3: infestation of Sesbania *under field conditions*
The field was cropped with tobacco (*Nicotiana tabacum* cv. K51E), a good host, in the previous season (usually tobacco is grown in only one out of four seasons because of nematode build up). The soil was a sandy clay loam; 80% sand, 16% silt, 4% clay; pH 4.9 (1:2.5 KCl) with 0.7% organic matter, 0.4% total nitrogen and 8 ppm available phosphorus. Seedlings of four *S. sesban* and one of *S. macrantha* accessions were raised in the glasshouse in the heat-sterilized (80 °C for 30 min) sand contained in 10 cm deep plastic trays for 6 weeks before planting in the field. Field plots consisted of single rows of 10 plants each planted either on ridges or on flat land, two common land preparation practices found in east and southern Africa. Seedlings were planted at 10 cm depth, 75 cm apart and 1 m between rows in a randomized complete design with 2 replications. The trial period was 72 days and plots were maintained free of weeds.

Measurements

In all experiments, roots were washed free from soil and root gall indices were rated according to the method developed by Bridge and Page [1980]. In Experiments 1 and 2 egg masses were counted from three randomly selected roots per plant representing the top, mid and bottom fractions of the plant root system. Egg mass indices were assessed using the methods described by Sasser

and Carter [1982]. A reproductive rating (R) was determined by dividing the average egg mass index for each *Sesbania* accession by the average egg mass index for tomato. Based on R values, hosts were rated as good, moderate, poor and non hosts respectively [Tedford and Fortnum, 1988]. In Experiment 3 root galling was assessed on six plant per row, excluding two border plants from the end of each row. A 50 cm diameter ring was excavated around each plant, the soil carefully removed manually to ensure complete recovery of the root systems within the ring then washed in water, and transported to the laboratory in polythene bags for assessment of galling. Galling was assessed on the entire root system.

Root volumes (Experiment 2) were estimated by the displacement method. Washed roots were cut at the seedling collar, individually immersed in a 100 ml measuring cylinder containing 50 ml of clean water and the change in water volume recorded.

All data on root and egg mass indices, and root volumes were subjected to analysis of variance.

Results

Effect of inoculating with infective juveniles

Highly significant differences in root galling and egg mass production were observed between *Sesbania* accessions and tomato (Table 1). All *Sesbania* accessions sustained the development of *M. javanica* as evidence by root galling and egg mass indices. The variation in the rates of infestation between the *Sesbanias* was also significant. On the basis of R values, accessions 028, 08B, SR19, 029, NRB1, and Ex. Tumbi were moderate hosts while accessions 014, 15, 027, 017 and T110 were poor hosts.

Effect of inoculating with egg masses

Significant differences were also observed in root galls and egg mass indices between the *Sesbanias* and tomato and within *Sesbanias* (Table 2). However, egg mass inoculation resulted in either a lower or a higher rate of infestation in some *Sesbania* accessions compared to when juveniles were used (Tables 1 and 2). Galling and egg mass production declined in accession 028 and 029 but increased in 15, 027, T110 and 017. Accessions 08B, SR19, NRB1, Ex. Tumbi and 014 were, however, consistently grouped as moderate and poor hosts respectively, irrespective of the source of inoculum. Again, the variation in the rates of infestation between the *Sesbanias* was significant.

Table 3 shows mean values of root volumes. Overall there was a decrease in root volumes of all entries accredited to root infestation but significant depression in growth was only recorded in accessions 15, 029, SR19, T110, 017 and tomato.

Table 2. Effect of inoculation with egg masses of root-knot nematode (*M. javanica*) on galling and egg mass production by *Sesbania* species and tomato.

Host species	Acc. no.	Root gall index	Egg mass index	Reproductive rating (R)
S. sesban	028	2.0	2.0	0.4
"	08B	3.5	2.5	0.6
"	014	1.5	2.0	0.4
"	15	4.5	4.0	0.9
"	027	4.0	4.0	0.9
"	029	1.5	1.5	0.3
"	SR19	4.0	3.5	0.8
"	T110	5.0	4.0	0.9
"	NRB 1	6.0	3.0	0.7
"	Ex Tumbi	3.0	3.5	0.8
S. macrantha	017	3.0	2.5	0.6
L. esculentum		7.0	4.5	1.0
	SED	1.02	0.52	
	CV (%)	12.6	6.7	

Table 3. Effect of inoculation with egg masses of root-knot nematode (*M. javanica*) on seedling root volumes of *Sesbania* species and tomato.

Species	Acc. no.	Mean seedling root volumes (cm^3)	
		Inoculated	Non-inoculated
S. sesban	028	11.0	13.5
"	08B	9.7	10.5
"	014	7.5	10.2
"	15	10.2	23.5
"	027	11.2	12.5
"	029	9.1	14.5
"	SR19	14.0	19.5
"	T110	13.5	32.5
"	NRB 1	13.0	14.5
"	Ex. Tumbi	13.0	15.0
S. macrantha	017	26.0	31.5
L. esculentum		7.0	13.5
SED		2.48	
CV (%)		15.3	

Infestation under field conditions

Highly significant differences were recorded in galling between the entries and within *Sesbania* accessions. The mean infection of *S. sesban* (Table 4) accessions was lower than that of *S. macrantha*. The infection was also significantly lower in plants growing on ridges than those on flat land. The mean

Table 4. Effect of method of planting on root galling of *Sesbania* species and tomato under field conditions.

Species	Acc. no.	Method of planting	Root gall index
S. sesban	014	R[a]	1.3
"		F[b]	2.0
"	SR19	R	0.8
"		F	1.7
"	029	R	2.2
"		F	3.3
"	T110	R	2.3
"		F	4.0
S. macranta	074	R	4.0
L. esculentum		F	6.5
		R	4.8
		F	6.2
SED accession			0.41
SED method			0.24
CV (%)			2.1

[a] Hosts planted on ridges.
[b] Hosts planted on flat land.

root gall indices were 3.1 and 4.7 for *Sesbania* growing on ridges and on flat land respectively.

Discussion

Infestation of some *Sesbania* accessions varied with the source of inoculum. Since the numbers of juveniles inoculated were equal (Experiment 1), it is likely that the egg masses used as inoculum (Experiment 2) had variable numbers of infective juveniles. The observation, puts doubts on the repeatability of the results when egg masses are used as inoculum. The variation in infection under field conditions may partly be explained on the basis of the amount of inoculum present in the soil. There was a decrease in root volumes of all infected plants which is in agreement with observations by Ibrahim et al. [1987] on tomato plants. Generally the root systems of infested plants were short with fewer lateral and tertiary roots compared to those of non-infested plants. This may well explain earlier observations on the poor persistence of *Sesbania* under field conditions [Karachi et al., 1989]. Infected plants had stubby root systems and died (SR19 85%, T110 80% and 017 89%) 6 months after planting. The reasons for the consistently low infection of plants growing on ridges remains unclear. The results may, however, imply that due to the delayed infection a short lived annual crop planted on ridges is likely to escape early damage from the nematode compared to those planted on levelled land.

The studies demonstrate the potential of *Sesbania* species to support repro-

duction in *M. javanica*. Consequently, continuous cropping with *Sesbania* may result in a build up of soil root-knot nematode populations. This could limit the variety of crops or forage species that can be intercropped with *Sesbania* without damage, and therefore its potential for use in the mixed cropping systems found in eastern and southern Africa. However, the variation in host suitability exhibited suggests that resistance to attack by *M. javanica* may be found in this genus. Further collections and evaluation of germplasm from this genus is warranted.

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