Der Tropenlandwirt, Beiträge zur tropischen Landwirtschaft und Veterinärmedizin,
101. Jahrgang, April 2000, S. 91 - 97.

Effects of *Meloidogyne javanica* javanica and *Rhizoctonia solani* alone and in combination on Soybean in Ferrallitic Soils of Eastern Nigeria

Agu, C. M. and R.O. Ogbuji

Abstract

Soybean cultivar, Samsoy-1 was exposed to *Rhizoctonia solani*. and *Meloidogyyne javanica* alone and in combination in three ferrallitic soils: Nsukka, Aba and Awka soils of eastern Nigeria. Separate effects of these two pathogens on the soybean were stronger in Nsukka than in Aba and Awka soils. In concomitant infection, the effect of *R. solani* on the soybean was increased in all the soils. Fresh root weights of soybean plants infected with *M. javanica* alone was greater than those infected with *R. solani* alone and *R. solani* plus *M. javanica* and the uninoculated control. The least fresh shoot and pod weights and plant height occurred in plants which had concomitant infection.

1 Introduction

Soybean is more highly appreciated now in Nigeria than many other crops (ASHAYE AND AFOLABI, 1988). On cost per kilogram basis, it is the cheapest source of dietary protein (JUDE, 1970). Perman (1982) reported that this crop produces the highest yield of protein per unit land area and, at the same time, produces calories. Soybean has the ability to succeed on nearly all soils (NORMAN, 1963) and hence the reason for the steadily increase in the acerage devoted to the crop. According to Akem (1991), as the growing area for soybean expanded, its pests and diseases increased in number and severity. *Meloidogyne javanica* and *Rhizoctonia solani* are among the important soybean pathogens (SINCLAIR, 1981). Soil which is the natural medium for plant growth constitutes an environment which plays a decisive role for infection to occur or not. Wallace (1963) stated that the influence of soils on disease occurrence is a highly complex one because the physical and chemical factors vary so much between localities even where the textural composition of the soils is more or less similar. The objective of this study therefore included determining the pathogenicity of *M. javanica* and *R. solani* alone and in combination on susceptible soybean in three ferrallitic soils of eastern Nigeria.

* Department of Crop Science, University of Nigeria, Nsukka, Nigeria

2 Materials and Methods

This study was carried out in the greenhouse of University of Nigeria, Nsukka, located on 52' north; longitude 07°24' east and at an altitude of 447 metres above mean sea level. Three ferrallitic soils of eastern Nigeria described by Jungerius (1964) were used. These included:

- Deep porous red soil derived from sandy deposits (Nsukka soil);
- Deep porous brown soil derived from sandy deposits (Abs soil); and
- Red and brown soils derived from sandstones and shales (Awka soil).

Representative samples of these soils were taken at 0-15cm depth and steam-sterilized for three hours. Their physical and chemical properties were analysed and are shown in Table 1. Two kilograms of each soil was potted in twenty clay pots (16cm diameter) and the pots arranged in a completely randomised design (CRD).

The soybean cultivar Samsoy-1, known to be highly susceptible to *Meloidogyne javanica* (AWOLOLA, 1987 unpublished), was used as the test crop. Seeds of this soybean cultivar were surface sterilized by soaking for three minutes in a solution of 10% concentration of commercial sodium hypochlorite (NaOCl) and rinsed three times in tap water. The seeds were placed on moist filter papers in sterilized petri-dishes to germinate. Two germinated seeds were planted per pot but after seven days were thinned down to one seedling per pot.

The inoculum source for *M. javanica* was a *Meloidogyne javanica* population which had been maintained on tomato plants (*Lycopersicon esculentum* cultivar Roma) in pot cultures. Infected tomato plants with characteristic root galls were removed and the roots washed in tap water. The galled roots were chopped into smaller pieces, placed in water and blended into a slurry. In order to avoid inactivating the infective nematode larvae, the waring blender was run for three seconds only for each blend. The slurry was made up to 3000ml by adding more water. Thirty millilitres of this diluted slurry was taken and poured into a counting dish. The number of active larvae was counted using a stereomicroscope.

The mean number of larvae in three counts approximated 1000. The inoculum source for *Rhizoczonia solani* was a plate culture of *R. solani* known to have previously attacked the soybean in the field and maintained on potato dextrose agar (PDA) medium. The PDA medium on which the fungus was growing was put into a waring blender and blended into a slurry. The ratio of water to the PDA plus *R. solani* was 2:1 by volume (OGOSHI AND BASSETT, 1990).

At three weeks old the soybean plants were inoculated using the following inoculation treatments:

- 30m1 slurry (containing about 1,000 larvae) of *M. javanica*/plant
- 30m1 slurry of PDA plus *R. solani*/plant
- 30m1 slurry (containing about 1,000 larvae) of *M. javanica* plus 30m1 slurry of PDA plus *R. solani* plant; and
- uninoculated control.

The inoculum procedure was undertaken by pouring the inoculant at the root base of the plant. Each inoculation treatment was replicated five times. At twelve weeks old the soybean roots were assessed for infection. Plants exposed to *M. javanica* alone or *M. javanica* plus *R. solani* were scored for root galls according to Ogbuji (1981) in which:

Zero = no infection (no galls present);
1 = very scanty infection (1c3 galls present);
2 = light infection (4c10 galls present);
3 = moderate infection (11c30 galls present); and
4 = severe infection (>30 galls present).

Plants exposed to *R. solani* alone or *R. solani* plus *M. javanica* were scored for root rot according to Grey et al. (1990) in which:

1 = no infection (no root rot);
2 = a light infection (fine roots destroyed);
3 = moderate infection (1 or more distinct lesions on tap root);
4 = severe infection (one fourth to one-half of tap root destroyed); and
5 = very severe infection (plant death or all roots rotted).

Data collected on mean plant height, fresh weights of root; shoot and pod were analysed using a statistical method developed by Steel and Torrie (1980). Fisher's least significant difference (F-LSP) was used to detect difference. between treatment means at P = 0.05

3 Results

Soybean plants exposed to *Meloidogyne javanica* alone had severe root galls in Nsukka soil and moderate galls in Awka and Aba soils. Root rot caused by *Rhizoctonia solani* alone was moderate in Nsukka soil and slight in Aba and Awka soils. Galling incidence at concomitant infection by the two pathogens was not different from that caused by *M. javanica* alone in any of the soils (Tables 2-4). Increased root rot was, however, obtained when *M. javanica* and *R. solani* infected the soybean concomitantly (Tables 2-4). In all the soils, plants infected by *M. javanica* alone had a mean fresh root weight that was significantly (P = 0.05) higher than those of the uninoculated control; *R. solani* alone and *R. javanica* plus *R. salani* (Tables 2-4). The least mean fresh root weight was

obtained on plants infected with *R. solani* alone. Mean fresh shoot and pod weights of the uninoculated controls were significantly (P = 0.05) higher than those infected by *M. javanica* alone; *R. solani* alone and *M. javanica* plus R. solani in Aba and Nsukka soils only. Plants that were concomitantly infected had the least mean fresh shoot and pod weights and plant height in all the soils (Tables 2-4).

Table 1: Physical and Chemical Properties of Nsukka, Aba and Awka Soils

Analysed Properties	Soils		
	Nsukka	Aba	Awka
% Coarse Sand (50μm-2mm)	56	42	28
% fine Sand (20μm-50μm)	30	34	46
% silt (2μm-20μm)	4	10	6
% clay (< 1 μm)	10	14	20
Particle Density (g/cm^{-3})	2.54	2.56	2.29
% water-holding capacity	27.3	29.7	38.7
% carbon	1.48	1.04	0.72
% nitrogen	0.13	6.08	6.06
% base saturation	99	76	61
% organic matter content	1.24	12.55	11.79
Cation exchange capacity	9.5	14.5	9.0
Exchangeable bases (in meq/100g)			
Sodium (Na)	0.18	0.38	0.39
Potassium (K)	0.24	0.33	0.16
Magnesium (Mg)	3.40	1.60	1.40
Calcium (Ca)	19.8	15.6	13.5
Phosphorus (P) (in PPM)	56	787	420
Soil pH value	6.48	5.40	5.70

Table 2: Effects of single and concomitant inoculations with *M. javanica* and *R. solani* on root infection, fresh weights (gm) of shoot, root, pod and plant heights (cm) of soybean (Samsoy-1) in Awka soil

Inoculation treatment	Mean root infections		Mean fresh weight			Mean plant height
	Rot Index	Gall index	Shoot	Root	Pod	
Uninoculated control	—	—	9.14	3.87	10.14	39.60
M. javanica	—	3	6.64	5.24	6.41	30.20
R. solani	2	—	5.26	1.72	4.48	32.40
R. solani + M. javanica	3	3	2.22	3.24	2.05	19.20
$LSD_{0.05}$			2.57	1.93	2.40	9.80

Table 3: Effects of single and concomitant inoculations with *M. javanica* and *R. solani* root infection, fresh weights (gm) of shoot, root, pod and plant heights (cm) of soybean (Samsoy-1) in Aba soil

Inoculation treatment	Mean root infections		Mean fresh weight			Mean plant height
	Rot Index	Gall index	Shoot	Root	Pod	
Uninoculated control	—	—	14.20	5.38	10.25	34.40
M. javanica	—	3	3.90	13.51	3.90	30.20
R. solani	2	—	3.52	1.24	3.66	32.20
R. solani + *M. javanica*	3	3	1.09	4.52	1.19	17.00
$LSD_{0.05}$			2.18	5.68	1.99	5.05

Table 4: Effects of single and concomitant inoculations with *M. javanica* and *R. solani* on root infection, fresh weight fresh weights (gm) of shoot, root, pod and plant heights (cm) of soybean (Samsoy-1) in Nsukka soil

Inoculation treatment	Mean root infections		Mean fresh weight			Mean plant height
	Rot Index	Gall index	Shoot	Root	Pod	
Uninoculated control	—	—	3.58	3.02	3.54	26.20
M. javanica	—	4	2.46	4.50	2.65	15.80
R. solani	3	—	1.96	0.41	1.21	21.00
R. solani + *M. javanica*	4	4	0.67	1.88	0.01	8.12
$LSD_{0.05}$			0.80	1.24	0.61	4.47

4 Discussion

Results of this study show that *M. javanica* pathogenicity on soybean varied in the different ferrallitic soils. The same was true of *R. solani*. Soil texture appeared to have influenced the nematode activity on the soybean. This was indicated by higher galling incidence in Nsukka soil which had a greater percentage of coarse sand than Awka and Aba soils. This observation agrees with O'Bannon and Reynolds (1961) who stated that soil particle size is an important determinant of the activity of *Meloidogyne* spp. on host plant. The activity (root rot) of *R. solani* being more pronounced in Nsukka than in Aba and Awka soils could be due to the marked differences in the soils' chemical properties. Nsukka soil had a higher pH value (6.48); higher percentage base saturation (99%) and higher amounts of basic cations, especially calcium. These chemical properties, according to Meyer and Shew (1991) favour R. solani in the soil. Although infection initiation

by either *M. javanica* or *R. solani* was noticed to be independent of each other there was however increased *R. solani* activity (root rot) when the two pathogens concomitantly infected the plant. This could be due to further predisposition of *M. javanica* infected roots through physiological alterations.

Nutrient exudates emanating from such roots have also been reported to contribute nutritionally to the ability of *R. solani* to overcome the natural plant resistance (VAN GUNDY et al 1976; WANG ET AL 1975).

Fresh root weights of soybean plants infected by *M. javanica* alone was greater than those of the uninoculated control and those infected by *R. solani* alone. This was because the nematode caused galling on the roots which added to the weight of the roots. Plant roots infected by *M. javanica* plus *R. solani* weighed less than those infected by *M. javanica* alone because the weight gained through *M. javanica* activity (root galling) was lost to R. solani. through root-rot and sloughing off. Of the four inoculation treatments, *M. javanica* plus *R. solani*. treatment gave the least fresh weights of shoot and pod and plant height. Observations similar to this have been reported by Carter (1975), and Elizabeth et al. (1957) and was attributed to synergistic effect of combined infection.

5 References

1 AKEM, C. N. (1991). Soybean diseases, Biology, identification, control and management. IITA Research Guide 40

2 ASHAYE, T. I. AND N. O. AFOLABI (1988). The effect of pedoclimatic factors and agronomic practices on soybean performance in the western states of Nigeria. International Agriculture Publications INTSOY Series No. 6, 102C1 06

3 AWOLOLA, T. A. (1987). Studies on elite soybean cultivars to nematode infection and on nodulation potentials. 3. Agric. Project Report; (unpublished). Department of Crop Science, University of Nigeria, Nsukka.

4 CARTER, W. W. (1975). Effects of soil temperature and inoculum levels of *Meloidogyne incognita* and *Rhizoctonia solani* on seedling disease of cotton J. Nematol. 7 (3): 229-233.

5 ELISABETH; M. J. G. C. LOOTS, W.J. JOOSTE AND D. DE WAELE (198?). Effects of root lesion nematodes (*Pratylenchus brechyurus* and *P. zeae*) and *Fusarium moniliforme* or in combination, on maize. Nematologics 33: 213C219

6 GRAY, F. A., G. P. GRIFFIN, D.A. JOHNSON, J. W. ECKERT AND T. E. KAZIMIR (1990). Interrelationships between *Meloidogyne hapla* and *Phytophthora megasperma* f. sp. *Medicaginis* in seedling damping-off and root infection of alfalfa. 80: 228C232

7 JUDD, R. W. (1970). Cost of protein. Soybean News. 21: 6

8 JUNGERIUS, P.D. 1964). The soils of eastern Nigeria. Publications Service Geologigue du-Luxemberg 14: 185-198.

9 MEYER J.R. AND H.P. SHEW (1991). Soils suppressive to black root-rot of burley tobacco. Phytopathology 81: 946-954.

10 Norman, A.G. (1963). A Textbook on Soybean Genetics, Breeding Physiology Nutrition and management Academic Press, New York London.

11 O'Bannon, J. M. and L. W. Reynolds *(1961)*. Root-knot Nematodes damage and cotton yield in relation to certain soil properties. Soil Sci. 92: 384-386

12 Ogbuji, R. O. (1981). Infectivity of three *Meloidogyne* spp. on soybean in Nigeria. Jahrgang 5: 143-152

13 Ogoshi, R. O. and E. B. Bassett (1990). *Rhizoctonia* species and anastomosis groups causing root-rot or wheat and barley in the Pacific Northwest. Phytopathology 80: 784C788.

14 Perman, G. E. (1982). Soybean research - more food for more people. In: D. I. Whigham (ed.). Soybean Production. Protection and Utilization. INTSOY series No. 6. Univ. of Illinois, Urbana-Champaign, U.S.A.

15 Sinclair, J. B. (1981). Compendium of soybean diseases. Amer. Phytopathology Soc. St. Paul M. N. U.S.A.

16 Steel, R. G. D. and J. H. Torrie (1961). Principles and Procedures of Statistics (2nd edition). McGraw-Hill Book Company Inc. N.Y. xxi + 633pp.

17 Van Gundy, S. D., J.D. Kirkpatrick and J. Golden (1976). The nature and role of metabolic leakage from rootCknow galls and infection by *Rhizoctonia solani* J. Nematol. 9(2): *113C121.*

18 Wallace, I. R. (1963). The Biology of Plant parasitic Nematode. Edward Arnold Ltd. London. 280pp.