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Effects of Intercropping on Root-Gall Nematode Disease on Soybean (*Glycine max* (L.) *Merril*)

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Abstract: Six intercrops (maize, melon, okra, *Telfairia*, *Amaranthus* and pepper) were tested for control of root-gall nematode disease on soybean in a loamy sand soil naturally infested with *Meloidogyne javanica*. The experiment was laid out in a randomized complete block design replicated four times. Results based on root-gall indices and number of Juveniles (J_2) recovered from roots and rhizospheric soil showed that intercropping soybean with *Telfairia*, pepper and *Amaranthus* effectively suppressed infection on soybean roots. Okra, maize and melon intercropped with the soybean aggravated root-gall damage and caused yield reductions.

Key words: Disease, intercrop, nematode, root-gall, soybean, Owerri, Imo State, Nigeria

INTRODUCTION

Soybean is the cheapest source of dietary plant protein (Judd, 1970). It produces the highest yield of protein per unit land area and has the ability to succeed on nearly all soils (Perman, 1982). The crop is usually grown sole and suffers a great deal of nematode damage which has led to some farmlands being abandoned to some parasitic nematodes (Lehman, 1978). Total crop failure in soils heavily infested with root-gall nematode (*Meloidogyne* sp.) has also been reported (Agu, 2006). A number of control methods and practices have however, been developed. These included: Inclusion of non-hosts in rotation sequence (Adesiyan *et al*., 2000), introduction of resistant varieties (Odihirin, 1981); heat and chemical treatments (Adesiyan *et al*., 2000); use of biological control agents (Adesiyan, 1985) and the use of organic manures (Egunjobi and Onayemi, 1981 and Amosu, 1981). The success and adoption of any one of these methods however depends mainly on the level of expertise and socio-economic conditions of the farmers.

In Nigeria, root crops, cereals, legumes and vegetables are grown together in mixtures in various combinations. Besides yield advantages (Wahua *et al*., 1981) mixed cropping systems also provide an effective strategy in controlling nematode pests of agricultural crops (Idowu and Fawole, 1991). This is by intercropping a susceptible crop with non-host crops. Information on crop mixtures for effective control of soybean root-gall nematode is lacking. This study was therefore, concerned with the evaluation of different soybean based intercrops for effective control of root-gall nematode disease on soybean.

MATERIALS AND METHODS

The study was conducted at the Teaching and Research Farm of Federal University of Technology, Owerri, located between latitudes 5° 20'N and 5° 27'N and longitude 7° 00'E. The soil was loamy sand (84.08% sand; 12.56% clay and 3.36% silt) and naturally infested with root-gall nematode, *Meloidogyne javanica*. By sieving and Bearmann's funnel technique (Viglierchio and Schmitt, 1983) the nematode population density in the soil was estimated.

Before planting, the land was cleared and made into mounds (2×1 m) according to farmers' practice and laid out in a randomized complete block design with 4 replications on a 20×25 m plot size. Soybean cv. TGX 813-6D, moderately susceptible to *M. javanica* (Awolola, 1987); Okra cv. Awgu early; melon cv Red Queen, *Telfairia occidentalis*, maize cv. FARZ 7; pepper cv. Nsukka yellow and *Amaranthus cruentus* were combined as follows: Soybean/melon/maize/okra; soybean/ maize/ okra/*Amaranthus*;soybean/pepper/*Telfairia*/*Amaranthus*;soybean/melon/*Amaranthus*/pepper; soybean /*Telfairia*/maize/melon; soybean/pepper/*Telfairia*/okra and interplanted the same day on the mounds using the sole populations of each (soybean, 240,000, okra, 37,037, melon, 10,000; *Telfairia*, 10,000, maize, 20,000; pepper, 17,778 and *Amaranthus*, 222,222/ha (Unanma *et al*., 1991). In each crop mixture, soybean was sown 2 seeds/hole on crest and the intercrops planted 15 cm away from soybean and in alternate arrangement. Mounds planted with sole soybean served as control.

Compound fertilizer NPK 15:15:15 at 400 kg ha^{-1} was applied after first hoe-weeding (i.e. 3 weeks after planting)

and second weeding done 10 weeks after planting. Twelve weeks after planting the crops were carefully lifted from soil and the crops separately washed free. The roots were examined and rated for galls on a scale of 0-4 according to Ogubji (1981) in which 0 = no infection (no galls present); 1 = rare infection (1-3 galls present); 2 = light infection (4-10 galls present); 3 = moderate infection (11-30 galls present) and 4 = severe infection (= 30 galls present). Juveniles second stage (J_2)/2 g of plant root system were extracted by the jar incubation method (Ayoub, 1977). Juveniles/120 cm^3 of soil were also extracted using a modified Bearman funnel technique (Tray method) (Hooper, 1969). The nematodes from roots and soil were counted using a dissecting microscope.

Data collected on soybean also included: Number of harvested pods/plant, number of grains/pod; shoot weights (fresh and dry); grain yield/ha and root dry weights. These data were subjected to analysis of variance (Steel and Torrie, 1981) and significant differences between means separated by Fisher's least significant difference method (Fisher, 1948) at p = 0.05.

RESULTS AND DISCUSSION

Crops roots rated for galls showed that the intercrops differed in host status to *M. javanica* (Table 1) and can be grouped as follows: Highly susceptible: Okra; moderately susceptible: Maize and melon; resistant: *Telfairia* and highly resistant: Pepper and *Amaranthus*. The intercrops influenced root-galling on soybean (Table 2). Severe root-galls occurred on soybean plants intercropped with okra, maize and melon; also with *Telfairia*, melon and maize as well as with maize, okra and *Amaranthus*. Moderate root-galls occurred on the soybean when intercropped with melon, *Amaranthus* and pepper. Pepper, *Amaranthus* and *Telfairia* intercrops suppressed gall formation on the soybean.

These results showed that okra, maize and melon are not good crop associates with soybean in *M. javanica* infested soils. This observation agrees with Bridge (1978) who noted that planting susceptible crops alongside yam plants could increase nematode population density and the severity of damage by root-gall nematode (*M. incognita*) on yam plants. Atu and Ogbuji (1986) also reported that susceptible intercrops planted on yam mounds resulted in greater root-gall damage on the harvested tubers.

Rare root-galls on soybean caused by resistant pepper, *Amaranthus* and *Telfairia* intercrops was because these intercrops prevented nematode population increase around the soybean plants (Table 2). Fawole and Mai (1979) reported that gall indices corresponded with nematode population density.

Soybean yields varied with galling responses at different crop mixtures (Table 3). Significantly higher number of pods/plant were produced by soybean plants intercropped with pepper, *Amaranthus* and *Telfairia* with low gall index. Grain yield (tons/ha), fresh shoot weight and number of grains/pod consistently decreased with increases in galling response at the various crop mixtures. These decreases were significant on soybean plants intercropped with two or more of the intercrops susceptible to the root-gall nematode (*M. javanica*). This was due to significant increases in galling response at significantly increased nematode population attacking the soybean (Table 2). Galls are known to decrease the uptake of minerals, especially, N, P and K (Trudgill, 1987) and also do not translocate adequate water and nutrients to vegetative organs for photosynthesis (Otiefa and Elgindi, 1962).

Soybean root dry weights increased as galling response increased with increasing number of intercrops susceptible to the root-gall nematode (Table 3). This was because of the weight gain on the main roots caused by galls. Agu (2002) found that galled roots represented most of the total weight of the root system.

From this study, it is obvious that root-gall nematode disease on soybean can be effectively controlled and good grain yields obtained in *M. javanica* infested soils

Table 1: Host status of intercrops collected from around *M. javanica* infected soybean

Intercrop	Mean root-gall indices (0-4)	Host status to *M. javanica*
Okra cv. Awgu early	4.00	Highly susceptible
Melon cv. Red Queen	3.10	Moderately susceptible
Telfairia occidentalis	0.20	Resistant
Maize cv. FARZ 7	2.90	Moderately susceptible
Pepper cv. Nsukka yellow	0.00	Highly resistant
Amaranthus sp.	0.00	Highly resistant
$LSD_{0.05}$	1.00	

Table 2: Root-gall indices, number of *M. javanica juvenile* (J_2) recovered from roots and rhizospheric soil of soybean alone and in association with other intercrops

Crop mixture	Soybean root-gall indices (0-4)	Juvenile (J_2) population /2g root system	Juvenile (J_2) population /200 cm3 soil
S/P/T/A	0.40	0.00	44.00
S/P/T/O	2.20	48.00	66.00
S/Me/A/P	3.20	188.00	148.00
S/T/M/Me	4.00	296.00	338.00
S/M/O/A	4.00	322.00	336.00
S/Me/M/O	4.00	350.00	402.00
Soybean sole (control)	3.00	174.00	152.00
$LSD_{0.05}$	1.20	56.02	69.31

S = Soybean; P = Pepper; T = Telfairia; A = Amaranthus; O = Okra, Me = Melon; M = Maize

Table 3: Soybean yields as affected by intercrops and root-gall nematode infection

Crop mixture	Mean soybean root-gall indices (0-4)	Mean soybean yields: Number of Pods/plant	Number of Seeds/pod	Shoot weights (gm) Fresh	Shoot weights (gm) Dry	Grain yield (ton ha^{-1})	Root dry weights (gm)
S/P/T/A	0.40	21.39	3.64	10.10	3.02	3.80	9.18
S/P/T/O	2.20	15.37	3.75	10.00	3.85	3.00	10.20
S/Me/A/P	3.20	13.61	2.99	9.30	3.60	2.60	13.87
S/T/M/Me	4.00	10.80	2.23	8.80	4.63	2.10	16.14
S/M/O/A	4.00	9.73	2.80	8.60	4.70	1.90	15.92
S/Me/M/O	4.00	10.75	1.39	8.70	6.99	1.20	18.32
$LSD_{0.05}$	1.20	3.94	1.61	0.50	2.08	1.00	3.47

S = Soybean; P = Pepper; T = Telfairia; A = Amaranthus; O = Okra, Me = Melon; M = Maize

if *Telfairia*, pepper and *Amaranthus* were used as intercrops. *Telfairia*, pepper and *Amaranthus* are therefore, recommended as intercrops for effective control of soybean root-gall nematode disease in soils infested with *M. javanica*.

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