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REACTION OF SOME SELECTED SOYBEAN VARIETIES (*Glycine max* (L) Merril) TO ROOT – KNOT NEMATODE INFECTION

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Abstract

Two-year screen-house studies to evaluate the reaction of five soybean varieties (TGX – 1987 – 34F, TGX -1987 – 38F, TGX – 1987 – 95F, TGX – 1986 -3F, TGX – 1985 – 8F) to root – knot nematode, Meloidogyne incognita, were conducted in the Faculty of Agriculture, University of Ilorin. Forty experimental pots containing pasteurized soil were used. Twenty pots were inoculated each with approximately 3,000 eggs of M. incognita while the other twenty which did not receive any treatment served as control. The experimental set up was a completely randomized design having each treatment replicated four times. Results showed that all the varieties were susceptible to M. incognita at varying degrees. While plant height of nematode inoculated varieties were significantly (P=0.05) lower than the un-inoculated plants, among the same varieties, there were significant differences in the number of branches of inoculated and non inoculated plants between different and among the same varieties. There were varietal differences in terms of seed weight which represented actual yield. Generally, the un-innoculated plants gave significantly higher yield than inoculated ones. Root gall infestation rated the same level for all the five varieties. However, variety TGX-1985 – 8F exhibited superior characteristics over the other four varieties because it showed higher level of tolerance to nematode infestation judging from its performance and yield. From the study, it can be deduced that the use of nematode resistant/tolerant Soybean varieties be adopted in the management of root- knot nematode infestation. It is one of the cheapest and safest control methods that pose no form of hazard to man and the environment. In nematode endemic ecological zones, TGX-1985 – 8F is therefore recommended as it proved to contain some specialized genes that conferred a higher level of tolerance against root- knot nematode, Meloidogyne incognita.

Key Words: *Glycine max, root – knot nematode, Dominant loci, Mi – 1.2, leucine zipper and R genes.*

Introduction

Soybeans and soya beans are common names for an annual leguminous crop belonging to the family Fabacea and genus, Glycine. Soybean has been one of the five main plant foods of China along with rice, barley, wheat and millet (Lance and Garren, 2005). Over the years, it has become one of the most economically versatile crops cultivated worldwide. In Nigeria, soybean cultivation has expanded as a result of its nutritional, economic and diverse domestic usage. Dugje *et al*. (2009) enumerated some benefits derived from growing soybean to include; source of good food soymilk, soy cheese, tom bran (infant

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weaning food). It is a source of excellent vegetable oil. It improves soil fertility and controls parasitic weed *Striga hermontheca*. Soybean cake is an excellent livestock feed especially for poultry. The haulms provide good feed for sheep and goat. It is used in industry.

According to Stallings and Lupo (2009), soybean also has the potential to decrease photo aging of the skin and prevent skin cancers through the oestrogen type and the antioxidant effects of its metabolites. Soybean flour is becoming increasingly important as an ingredient of foodstuffs and baker products such as bread, biscuits and cakes. Because of its low starch content, the flour forms an ideal ingredient of food for diabetic patients all over the world (Kochlar, 2009). Soybean diet is a low fat diet that can generate positive impulse in the atherosclerosis and formations of artery blocking blood clots are reduced (Shidhaye *et al.*, 2009). Being a plant protein, soybean is free from both steroids and antibiotics animal protein content.

As agriculturists try to feed the fast growing world, production of soybeans has been faced with a lot of challenges which result in yield losses or reduction in yield. The reasons attributable to such production constraints range from physiological and growth factors to diseases and pests (Sikora *et al.*, 2005). Many pathogenic organisms are responsible for disease manifestations which in turn result in yield loss. They include nematodes, fungi, viruses and bacteria (George, 2004; Singh, 2009; IITA 2009).

Plant parasitic nematodes from several genera including both the economically important cyst and root knot nematodes modify plant cells into feeding sites able to support sedentary females. The most characteristic symptom is the appearance of brownish or dark swellings (galls) all over the root system (Gangawane and Khilare, 2008). The degree of root galling generally depends on three factors: nematode population density, nematode specie and host plant cultivar (Mitkowski and Abawi, 2003).

Root knot nematodes are silent killers that cause high rate of losses in the aggregate and are yield limiting. Hence much attention should be given to nematode control. In view of the hazards associated with the use of chemical nematicides, management strategies which are eco – friendly, effective and sustainable are sought after. The potential of soybean tolerance or resistance was investigated in these trials. The main objective of the study was to evaluate some selected soybean cultivars for nematode tolerance and susceptibility resistance.

Materials and Methods

A screen-house experiment was conducted at the Faculty of Agriculture, University of Ilorin for two years. Five soybean varieties were obtained from the International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. The varieties of soybean include TGX – 1987 – 34F, TGX -1987 – 38F, TGX –1987 – 95F, TGX – 1986 -3F, TGX – 1985 – 8F.

Seven and half kg each of pasteurized soil was weighed into 40 perforated plastic buckets. Two seeds sown at 5cm depth per pot and each variety was replicated four times for the infected and for the un-inoculated control. The pots were placed on blocks to avoid reintroduction of microorganisms from the soil. One week after germination, seedlings were thinned down to one vigorous plant per pot. Following the method described by Southey (1986), root – knot nematode eggs were extracted from galled root of *Celosia argentea* (L). The eggs suspension was standardized to contain 300 eggs per ml.

For each variety of the soybean, four buckets were inoculated with 10ml of nematode egg suspension whereas the remaining four pots served as control. The whole set up was a factorial experiment fitted into a randomized complete block design.

Data Collection and Observation

The plant parameters measured are as follows: number of leaves, plant height, number of pods, weight of pods and visual physical conditions of the plants. At harvest, roots were assessed for galling using the rating scale described by Taylor and Sasser (1978).

Table 1: Root Gall Rating

Rating	Number of galls	Host reaction
0	0	Immune
1	1 – 12	Resistant
2	3 – 10	Moderately resistant
3	11 – 30	Susceptible
4	31 and above	Highly susceptible

Taylor and Sasser (1978)

Result and Discussion

Results of the growth parameters measured on the effect of treatment on plant height and number of leaves followed almost the same trend in the two-year trials. No significant difference was observed between the nematode inoculated and un-inoculated plants of the same variety from week one to week four but significant differences were observed among the different varieties. However, at week five, there were significant differences only in the height of inoculated and un-inoculated plants of the same variety while the number of branches and leaves of inoculated and control plants were not only significantly different among the same variety but also between different varieties (Tables 2, 3 and 4).

Table 5 shows the root – knot nematode effect on the number of pods, pod weight, root galls and seed weight, shoot weight and root weight. No significant differences (p= 0.05) were observed in the number of pods from inoculated and control plants of the same variety but there were significant differences in the number of pods produced by different varieties. Significant differences were recorded in the weight of pods within the same and different varieties. However, variety TGX – 1985 – 8F recorded the highest pod weights of 49.09g and 43.81g in both un-inoculated and inoculated respectively. Variety TGX – 1987 – 95F recorded the lowest pod weight for un-inoculated and inoculated control plants; 32.18g and 27.73g respectively. There were significant differences in the root and shoot weights of treated and control pots within and among varieties.

The root weights of nematode – inoculated plants were significantly lower compared to their un-inoculated counterpart in all the varieties. Shoot weight also followed the same trend. There were significant differences in the weight of seeds produced by all the varieties. Generally, the seed weights of the control plants were significantly higher than those obtained from the nematode inoculated pots. There were no significant differences in the mean number of galls among all the *Meloidogyne* inoculated varieties while the control plants had no root galls on any of them. Although all the varieties were susceptible to root – knot nematode but the level of response to the pathogen varied from one variety to another. TGX – 1985 – 8F recorded the highest pod and seed weights followed by TGX – 1987 – 3F, TGX -1987 – 38F, TGX – 1987 – 34F and finally TGX – 1986 -95F.

Chlorosis was observed at varying degrees across all the inoculated plants at the termination of the experiment. Galls were present in all the inoculated varieties and ranged between eleven (11) and thirty on their roots.

From the results obtained, all the five varieties of soybean screened were susceptible to root – knot nematode infection. This was informed by the fact that all the nematode inoculated plants performed significantly lower when compared with their uninoculated counterparts in terms of growth, yield parameters and galling of roots. Apparently, the nematode population of the soil was high to cause damage and reduce yield. As a result of nematode feeding, galls of varying sizes and numbers were formed around the root systems of the infected plants. It is believed that upon perception of food signal, parasitic nematodes (including the root – knot nematode, *Meloidogyne spp*.) penetrate the root cell, establish a feeding site, induce cellular modification in root tissues, leading to formation of galls (Bird and Kaloshian, 2003). Plant nutrients are diverted to the galls, invariably leading to reduced translocation of food to other parts of the plant thereby translating to poor growth and low yield. Studies have shown that root – knot nematode infestation on host crops results in root galling, stunted growth and general low productivity (Pandey and Kalra, 2003; Mitkowski and Abawi, 2003). The significantly higher yield produced by TGX – 1985 – 8F shows that the variety is more tolerant to nematode infection. This variety therefore, could be cultivated in nematode infested soils when a selection is to be made from the five varieties evaluated. However, identifying the genes responsible for the resistance would help breeders facilitate their search for the resistant varieties. It had been reported that dominant loci conferring resistance to root – knot nematode have been identified in a number of plants (Bird and Kolashian, 2003). The best studied nematode – resistance gene is *Mi* – 1.2, which has been cloned and found to be a member of the leucine zipper, nucleotide binding, leucine – rich repeat family of plant R genes (Millligan *et al*., 1998). This constitutively – expressed gene (Martinez de Ilarduya and Kaloshian, 2001) confers resistance to *Meloidogyne incognita*, *M. javanica* and *M. arenaria*, but not to *M. Hapla*, even though these four species are present sympatrically. Recently, Science News line (2012) reported that scientists have identified three neighbouring genes that make soybeans resistant to the most damaging nematode disease (cyst nematode) of soybean. They explained that the genes exist side by side on a stretch of chromosomes, but only give resistance when the stretch is duplicated several times. Since all the tested varieties were susceptible to root- knot nematodes with just one variety showing higher tolerance to *M. incognita*, one could infer that the three neighbouring genes on a stretch of chromosomes may have duplicated minimally but more in TGX – 1985- 8F to allow a level of tolerance developed, making it superior to other varieties in terms of response to nematodes infection and yield. High yield recorded was not dependent on vegetative growth as taller varieties gave lower yield.

The present study has therefore broadened our knowledge on the interactions between some soybean varieties and root–knot nematode, *M. incognita*. However there is need to understand the exact genes responsible for *M. incognita* resistance or tolerance in soybeans. This will help breeders focus on the development of soybean varieties that are not only resistant to root – knot nematode but are also high yielding. According to Wall (2012), understanding this interaction will lead to the development of new novel strategies to enhance the nematode resistance of soybean. Moreso, resistant plant varieties are generally cheap and safe to use as they pose no environmental hazards.

Table 2: Effect of treatment on plant height in cm (mean of 4 replicates)

Variety	Treatment	Week1	Week2	Week3	Week4	Week5	Week6	Week7
TGX –	Inoculated	18.3a	24.0a	29.5a	37.8bc	37.8bc	42.3c	45.5c
1987-34F	Un-inoculated	17.8a	24.0	29.5	41.5a	52.8a	55.0ab	57.0ab
TGX –	Inoculated	13.0c	19.0ab	25.5ab	38.0ab	39.3bc	40.8cd	41.8cd
1985-8F	Un-inoculated	14.5bc	19.5ab	25.5ab	36.5ab	40.8ab	42.8c	43.88c
TGX –	Inoculated	12.3c	16.8d	21.0bc	31.3bc	37.3bc	38.3cd	39.5cd
1987- 38F	Un-inoculated	12.3c	17.3b	20.3bc	31.5bc	40.8bc	44.5c	43.3c
TGX –	Inoculated	12.8c	16.0b	18.3c	27.5c	31.8c	34.0d	35.3d
1986-3F	Un-inoculated	12.5c	18.5ab	24.5abc	34.5abc	39.3bc	38.0cd	40.5cd
TGX –	Inoculated	14.0c	19.5ab	24.0abc	37.0ab	47.5ab	52.0b	58.8ab
1987-95F	Un-inoculated	12.8c	21.3ab	25.5ab	41.0a	52.5a	60.8a	65.5a
S.E		1.2	1.8	2.1	2.3	3.2	2.3	2.4

Mean values with different letters (a, b, c, d) in the same column are significantly different at p= 0.05 using Duncan's Multiple Range Test.

Table 3: Effect of treatment on the number of Branches (mean of 4 replicates)

Variety	Treatment	Week1	Week2	Week3	Week4	Week5	Week6	Week7
TGX –	Inoculated	2.0a	3.0a	3.3ab	4.0b	4.0b	4.0d	4.8c
1987-34F	Un-inoculated	2.0a	3.0a	3.0b	4.5ab	5.5a	5.8ab	6.5a
TGX –	Inoculated	2.0a	3.0a	3.3a	4.0b	4.5ab	5.0bcd	5c
1985-8F	Un-inoculated	2.0a	3.0a	3.3a	4.5ab	4.8ab	5.8ab	6.3ab
TGX –	Inoculated	2.0a	3.3a	3.3a	4.3ab	4.3b	4.8bcd	5.0c
1987- 38F	Un-inoculated	2.0a	3.0a	3.0a	31.5bc	40.8bc	44.5c	43.3c
TGX –	Inoculated	2.0a	3.0a	3.3ab	4.8a	4.5ab	5.3bc	5.3bc
1986-3F	Un-inoculated	2.3a	3.3a	3.8a	5.0a	5.5a	6.5a	6.5a
TGX –	Inoculated	2.0a	3.0a	3.0b	4.3ab	4.3ab	4.5cd	5.0c
1987-95F	Un-inoculated	2.0a	3.0a	3.3ab	4.5ab	4.8ab	5.8ab	5.8abc
S.E		0.2	0.1	0.2	0.3	0.3	0.4	0.3

Mean values with different letters (a, b, c) in the same column are significantly different at p= 0.05 using Duncan's Multiple Range Test.

Table 4: Effect of treatment on the number of leaves (mean of 4 replicates)

Variety	Treatment	Week1	Week2	Week3	Week4	Week5	Week6	Week7	Week8
TGX –	Inoculated	16.ab	30.8bc	46.8cde	56.8ef	89.0c	104.0bc	115.3c	122.8cd
1987-34F	Un-inoculated	16.5ab	30.0bc	48.3cd	60.3ef	111.8a	114.5a	175.5a	183.5a
TGX –	Inoculated	14.8b	34.5ab	66.8ab	80.3bc	90.3bc	96.3c	102.8c	106.0d
1985-8F	Un-inoculated	15.3b	35.3ab	66.5ab	87.5ab	97.8abc	110.8bc	117.8bc	122.0cd
TGX –	Inoculated	17.5ab	36.5a	53.0a	65.0de	92.8bc	101.8c	107.0c	114.5c
1987- 38F	Un-inoculated	19.4a	37.3a	56.3bc	73.8cd	107.5ab	126.5ab	144.3b	156.5ab
TGX –	Inoculated	14.3b	33.3ab	65.0ab	93.8a	102.5a	105.0bc	106.0c	107.5cd
1986-3F	Un-inoculated	15.3b	33.5ab	73.0a	99.5a	106.0abc	117.0bc	122.5bc	131.5bcd
TGX –	Inoculated	16.3ab	25.5c	32.0e	50.3f	97.5ab	112.5ab	122.5bc	129.5bcd
1987-95F	Un-inoculated	16.0b	25.0c	37.3de	59.5ef	112.8a	118.8bc	130.0bc	138.8bc
S.E		1.1	1.8	5.0	4.2	5.4	7.4	8.7	9.5

Mean values with different letters (a, b, c, d, e, f) in the same column are not significantly different according to Duncan's Multiple Range Test.

Table 5: Effect of treatment on the number of pods, number of galls, pod weight (g), seed weight (g), root weight (g) (mean of four replicates)

Variety	Treatment	Number of pod	Pod weight	Number of galls (g)	Seed weight (g)	Root weight (g)
TGX –	Inoculated	79.3c	29.8ef	17.5c	22.9e	41.8c
1987-34F	Un-inoculated	82.5c	36.3d	0a	30.5c	49.ab
TGX –	Inoculated	88.5c	43.8b	15.5bc	35.9b	43.3c
1985-8F	Un-inoculated	94a	49.1a	0a	41.5a	54.9a
TGX –	Inoculated	80c	32.6e	16.75bc	26.5d	40.6c
1987-38F	Un-inoculated	82c	40.1c	0a	34.7b	43.0c
TGX –	Inoculated	81.8c	41.8bc	16.25bc	29.6c	44.7bc
1986-3F	Un-inoculated	81.5c	41.8bc	0a	34.2b	54.4a
TGX –	Inoculated	60d	27.7f	13.25d	20.8e	51.2ab
198 7-95F	Un-inoculated	62d	32.2e	0c	25.9d	54.3a
S.E		1.6	1.1	1.2	1.0	2.2

Mean values with different letters (a, b, c, d e, f) in the same column are significantly different at p= 0.05 using Duncan's Multiple Range Test.

Table 6: Root gall ratings

Variety	Degree of infestation	Host reaction
TGX – 1987 – 34F	3	Susceptible
TGX – 1985 – 8F	3	Susceptible
TGX – 1987 – 38F	3	Susceptible
TGX – 1986 – 3F	3	Susceptible
TGX – 1987 – 95F	3	Susceptible

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