

## EFFECT OF SOME SPICE POWDERS ON ROOT KNOT NEMATODE (*MELOIDOGYNE* SPECIES) INFECTIONS ON SOYBEAN(*GLYCINE MAX* MERR.) IN ISHIAGU, NIGERIA.

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### ABSTRACT

This research was carried out at the Research and Training Farm of Federal College of Agriculture Ishiagu, Ebonyi State to evaluate the effect of spice powders on *Meloidogyne* species infections on soybean in 2017 and 2018. The experimental sites were laid out in a Randomized Complete Block Design (RCBD) with four treatments replicated three times. The treatments used were ginger powder at 2.5 tons/ha, garlic powder at 2.5 tons/ha and chili pepper powder at 2.5 tons/ha. Plots not treated with any of the powders served as control. Data were collected on plant height, number of leaves, number of pods, weight of pods at harvest, number of galled roots and gall index at harvest, nematode population density/ 100g of soil after harvest. The data collected were subjected to analysis of variance (ANOVA) and correlation analysis was performed with the average of the two years data. Results showed that application of the spice powders significantly ( $P < 0.05$ ) increased all the growth and yield parameters and decreased significantly ( $P < 0.05$ ) on the number of galled roots, gall index and nematode population/100g soil. Garlic powder performed better than the other spice powders in the control of root knot nematode and increased the growth and yield of soybean. The control plots (with no amendments) recorded the highest number of galled roots and gall index. Therefore, farmers should adopt the use of spice powders in the control of *Meloidogyne* species infection on soybean.

**Key words:** Spice, powders, growth and yield, root knot nematode, soybean

### INTRODUCTION

Soybean (*Glycine max* L.) is a leguminous vegetable of the pea family; Leguminosae, that grows in tropical, sub-tropical and temperate climates (Gibson *et al.*, 2005). Soybean is among the major industrial and food crops grown in every continent. The crop can be successfully grown in many states in Nigeria using low agricultural input (Uphold and Olechowski, 2000). Gai, *et al.*, (2000) stated that it is an important cash crop in the legume family giving relatively high returns for a limited land area and is well adapted to the hot semi-arid conditions characterizing many of the regions where it is grown.

Soybean (*Glycine max* L.) ranks as the third most important oil food grain legumes after cowpea and groundnut in the developing countries especially in the tropical northern parts and to a limited extent in the southern parts of Nigeria, where it is mainly grown both at the subsistence and commercial levels. Soybean requires few inputs for its production and it increases soil fertility by fixing nitrogen (that is, legume feature), making it an approximate choice in the low input agricultural systems that are prevalent among many small-scale farmers in Africa (FAO, 2009). Similarly, soybean, an East Asian crop, is an important cash crop in the legume family giving relatively high returns for a limited land area and is well adapted to the hot semi-arid conditions characterizing many of the regions where it is grown. Soybean plant especially in Nigeria is classified as an oilseed rather than a pulse (FAO, 2009). It is rich in

nutrients, and it is regarded as a nutrient storage. Also, soybean is not only seen as an oil plant but also used for various purposes (that is, it is also found as a dual purpose grain legume plant), native to East Asia that is grown for oil and protein around the world (Gai, *et al.*, 2000). Among grain legumes, soybean is an economically important crop that is grown in diverse environments throughout the world. Soybean fruits are known as rich source of protein, high level of vitamins B, E and K and also account for about 56 % of the global oil seed production (FAO, 2009). Soybean is vulnerable to damages by pests and diseases. Ogwulumba *et al.*, (2010) reported that the major problems of soybean are pests and diseases which do not only cause low yield but also discourage most farmers from cultivating the crop. One of the major limiting factors to the profitable soybean production is the damage caused by plant-parasitic nematodes especially *Meloidogyne* species (Ogwulumba *et al.*, 2009). The most predominant species of root knot nematodes are *M. javanica*, *Meloidogyne incognita* and *M. arenaria*. *Meloidogyne* species are notoriously difficult to control because of their wide host range and high rates of reproduction (Khan *et al.*, 2008). *M. javanica* causes severe yield losses of more than 90% in high population (Muthukrishnan *et al.*, 2003). The extent of damage is influenced by the cultivar, nematode species, level of soil infestation and environment. Root-knot nematodes infect roots of soybean plants resulting in considerable yield losses,

which are usually associated with conspicuous galls that disrupt water and nutrient uptake (Cavensis, 2000).

The objective of this research was to assess the effect of spice powders as soil amendments on nematode infection on soybean.

## MATERIALS AND METHODS

### Location of Experimental Site

The experiment was conducted at the students' research and teaching farm of Federal College of Agriculture, Ishiagu, Ebonyi State during the 2017 and 2018 cropping seasons. The study area lies within latitude 05° 56'N and longitude 07° 4'E in the derided savannah zone of the South Eastern Nigeria.

### Experimental Materials and Sources

Soybean (*Glycinemax*) seed: var. T9X1951-3F was obtained from International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria. While ginger, garlic and chili pepper seeds were obtained from Ogbete Main Market in Enugu State.

### Treatment Preparation

The seeds of ginger, garlic and chili pepper were sun-dried for two weeks. The dried seed samples were then ground to powder using electronic blender two days before application. These powdery samples (ginger, garlic and chili pepper) were separately stored in clean plastic containers and kept in the room.

### Experimental Design and Layout

The experimental design was randomized complete block design (RCBD) with three treatments of soil amendment including the control replicated three

times. The organic soil amendments used were: Ginger, Garlic and Chili pepper powdery extracts, with no amendment as control. The experimental area in each year measured 10m x 10.50 m (105m<sup>2</sup>) with the help of measuring tape. Three blocks comprising twelve (12) plots measuring 2m x 2m, with 1m spacing between blocks and 0.5m spacing between plots were used for the experiments.

### Treatments Allocation

The spice powders used as soil amendments were: Ginger, Garlic, Chili pepper powders at 2.5 t/ha each and Control (No soil amendment). The spice powdery extracts were randomly allocated to the plots at equivalent rate of 2.5 t/ha and incorporated into the soil with garden fork.

### Sowing

The soybean seeds were sown directly into the plots three days after amendments application, at a spacing of 50cm by 50cm at the rate of two seeds per hole and were thinned down to one, two weeks after germination. This gave sixteen (16) stands per plot and a projected plant population of 40,000 stands /ha.

### Weeding

Regular weeding was carried out manually with weeding hoe. No herbicide was applied throughout the period of the experiment.

### Data Collection

Data were collected on plant height and number of leaves at 3,6,9 and 12 weeks after planting. Number of pods, weight (kg) of pods, number of galled roots and gall index were evaluated at harvest. The gall index was scaled according to Ogwulumba and Okonta, (2015) below:

### Nematode gall index scale/ rating

Rating	Number of galls	Infection level
0	No galls	No infection
1	1-10	Mild
2	11-20	Moderate
3	21-30	Moderately high
4	31-40	High
5	41-50	Very high
6	>-50	Highly infected

### Statistical Analysis

The data collected were averaged over the two years and subjected to analysis of variance (ANOVA). Significant treatment means were separated using Fisher's least significant difference (F-LSD) at 5% level of probability as stated by Obi (2002). Correlation analysis was performed to evaluate the relationships among the data collected using SPSS 21.0.

## RESULTS

### Effect of spice powders on the plant height (cm) at 3, 6, 9 and 12 weeks after Planting (WAP).

In Table 1, the result obtained showed that at 3, 6 and 12 weeks after planting, the amendments significantly ( $P < 0.05$ ) increased the plant heights.

While at 9 weeks after planting, the result showed that there was no significant ( $P > 0.05$ ) effect on the plant height.

However, it was observed that at 3 weeks after planting, plots treated with chili pepper powder recorded the highest plant height (18.73cm and 18.88 cm) while the control plot recorded the lowest plant height (5.7cm and 6.02 cm) in both years.

Similarly, the results obtained showed that at 6 and 12 weeks after planting, plots treated with garlic recorded the highest plant height (35.67cm and 37.23 cm) and (67.54cm and 70.03 cm) respectively while the control plot recorded the lowest plant height (9.06cm and 10.01 cm) and (16.33cm and 18.04 cm) in both years respectively.

**Effects of spice Powder on the Number of leaves at 3, 6, 9, and 12 Weeks after Planting (WAP).**

In Table 2, the results obtained showed that the amendments significantly ( $P < 0.05$ ) influenced the number of leaves produced at 3, 6, 9 and 12 weeks after planting. Meanwhile, plots treated with garlic powder recorded the highest number of leaves (8.17

and 8.23), (15.37 and 15.93), (31.9 and 32.08) and (50.11 and 51.20) at 3, 6, 9 and 12 weeks in 2017 and 2018 respectively, while the lowest number of leaves was obtained from the control plots (4.43 and 5.01), (6.37 and 6.92), (9.6 and 9.85) and (18.0 and 19.02) in both years respectively.

**Table 1: Effects of spice Powders on Plant Height at 3, 6, 9 and 12 Weeks After Planting (WAP).**

Treatments(tons/ha)	3WAP		6 WAP		9WAP		12WAP	
	2017	2018	2017	2018	2017	2018	2017	2018
Ginger 2.5 t/ha	10.33	11.21	19.37	20.11	24.10	24.32	40.9	43.19
Garlic 2.5 t/ha	11.43	12.32	35.67	37.23	52.98	54.89	67.54	70.03
Chili pepper 2.5 t/ha	18.73	18.88	21.93	27.08	29.77	29.85	49.07	49.83
Control	5.76	0.02	9.06	10.01	14.00	14.97	16.33	18.04
F-LSD <sub>(0.05)</sub>	2.84	2.86	10.02	10.05	10.03	10.21	29.04	29.67

F-LSD Fisher's least significant difference. WAP = weeks after planting, NS = Not Significant.

**Table 2: Effects of spice Powders on the Number of Leaves at 3, 6, 9 and 12 Weeks after Planting (WAP).**

Treatments/(Tons/ha)	3WAP		6WAP		9WAP		12 WAP	
	2017	2018	2017	2018	2017	2018	2017	2018
Ginger 2.5 t/ha	6.68	6.93	11.13	11.97	15.28	15.35	30.17	32.02
Garlic 2.5 t/ha	8.17	8.23	15.37	15.93	31.90	32.08	50.11	51.21
Chili pepper 2.5 t/ha	5.8	6.34	11.73	11.94	19.33	19.74	31.32	33.02
Control	4.43	5.01	6.37	6.92	9.6	9.85	18.04	19.02
F-LSD <sub>(0.05)</sub>	1.99	2.01	3.58	3.61	8.91	9.03	11.57	11.62

**Effect of spice Powders on the Number and Weight of Pods (kg) at Harvest.**

In Table 3, the results obtained showed significant ( $P < 0.05$ ) effect of the amendments on the number of pods produced by the plants in 2017 and 2018 respectively. However, the plots treated with garlic powder recorded the highest number of pod (100.08 and 111.23), followed by chili pepper powder which recorded (79.67 and 79.98), while the plot with control recorded the lowest number of pods (36.77 and 38.03) of soybean at harvest. However, plots treated with garlic powder recorded the highest weight (1.23kg and 1.42 kg) while the control plots recorded the lowest weight of pod (0.21 kg and 0.73 kg).

**The Effect of spice Powders on the Number of Galled Roots and Gall Index at Harvest.**

The results obtained in Table 4 showed that there was significant ( $P < 0.05$ ) effect on the number of galled roots per plant of soybean at harvest. Meanwhile, it was observed that the control plots recorded the highest mean (30.01 and 33.12) on the number of galled root while the plots treated with garlic and chili pepper powder recorded the lowest mean (5.33 and 5.54) and (6.67 and 7.02) respectively on the number of galled root per plant of soybean at harvest.

The result also revealed that there was significant ( $P < 0.05$ ) effect on the gall index at harvest. The highest mean (3.67 and 3.92) of gall index was obtained from the plot with control, while the lowest mean (1.00 and 1.01) and (1.00 and 1.03) of gall indices were obtained from the plots treated with garlic and chili pepper in 2017 and 2018 respectively.

**Table 3: Effect of spice Powders on the Number and Weight of Pods (kg) of Soybean at Harvest.**

Treatments	Number of pods		Weight of pods (kg)	
	2017	2018	2017	2018
Ginger 2.5 t/ha	69.67	70.34	0.97	1.03
Garlic 2.5 t/ha	100.08	111.23	1.23	1.42
Chili pepper 2.5 t/ha	79.67	79.98	1.00	1.14
Control	36.77	38.03	0.21	0.73
F-LSD <sub>(0.05)</sub>	22.41	22.52	0.44	0.51

F-LSD Fisher's least significant difference.

**Table 4: Effect of spice powders on the number of galled root and gall index at harvest.**

Treatments (tons/ha)	Number of galled roots		Gall index	
	2017	2018	2017	2018
Ginger 2.5 t/ha	7.12	8.00	1.33	1.43
Garlic 2.5 t/ha	5.33	5.54	1.00	1.01
Chilipepper 2.5 t/ha	6.67	7.02	1.00	1.03
Control	30.01	33.12	3.67	3.92
F-LSD <sub>(0.05)</sub>	8.528.78		0.94 1.01	

F-LSD Fisher's least significant difference.

#### Correlation analysis of Nematode Population/ 100g Soil with the Growth and Yield Parameters of Soybean

In Table 5, the result showed that nematode population/ 100g soil correlated positively with number of galled roots ( $r = .911$ ), gall index (.911) and (.869) respectively and correlated negatively with plant height, number of leaves, number of pods and weight of pods with correlation coefficients ( $r$ ) as (-.707), (-.703), (-.755) and (-.894) respectively. Number of galled roots correlated positively and significantly ( $P < 0.01$ ) with gall index. Also number of galled roots correlated negatively and significantly ( $P < 0.05$ ) with weight of pods at harvest. Gall index correlated positively and significantly ( $P < 0.01$ ) with number of galled roots and it also correlated negatively and significant ( $P < 0.05$ ) with weight of pods.

Plant height correlated positively and significantly ( $P < 0.05$ ) with number of leaves. Meanwhile, plant height correlated positively and significantly ( $P < 0.01$ ) with number of pods.

Number of leaves correlated positively and significantly ( $P < 0.05$ ) with plant height (.982\*) and number of pods at harvest (.983\*).

Number of pods correlated positively and significantly ( $P < 0.01$ ) with plant height (.997\*\*). Also number of pods correlated positively and significantly ( $P < 0.05$ ) with number of leaves (.983\*). Weight of pods at harvest correlated negatively and significantly ( $P < 0.05$ ) with number of galled roots (-.980\*) and gall index (-.977\*) respectively. Meanwhile weight of pod correlated positively with plant height (.926), number of leaves (.884) and number of pod (.946) and it also correlated negatively with nematode population/ 100g soil.

**Table 5: Correlation analysis of Nematode Population/ 100g Soil on the Growth and Yield Parameters of Soybean**

	Nematode population/ 100g soil	No of galled roots	Gall index	Plant height	Number of leaves	Number of pods	Weight (kg) of pods
Nematode population /100g soil	1	.911	.869	-.707	-.703	-.755	-.894
No of galled roots		-1	.996**	-.838	-.772	-.865	-.980*
Gall index			1	-.853	-.775	-.874	-.977*
Plant height				1	.982*	.997**	.926
Number of leaves					1	.983*	.884
Number of pods						1	.946
Weight (kg) of pods							1

\*\* . Correlation is significant at the 0.01 level (2-tailed).

\* . Correlation is significant at the 0.05 level (2-tailed).

#### DISCUSSION

The growth and yield parameters of the test crop were significantly enhanced at the plots treated with the spice powders when compared with the control. This was attributed to either the nematicidal or nematostatic effects of the organic powders on the root knot nematodes attacking the plant in the treated plots which created conducive environment for the thrive of the plants. Schmutterer, (2010) reported that plant products, as natural resources, possess properties that drive away pests. Siam weed has some phyto-chemicals which protect plants from nematode infection (Ogwulumba et al., 2008).

Powdery leaf extract of *J. curcas* significantly increased the height of soybean plant by decreasing the effect of nematode on the soil as reported by Ogwulumba et al. (2011). Hassan et al. (2001) also reported that extracts of ginger plant reduced root knot nematode population in the soil with corresponding increase in plant height, leaf and fruit yield. The effects of these powders underscores the importance of using plant extracts in pest and disease management in agriculture. These extracts are biodegradable and possess no deleterious effects on the crops and environment. These organic powders are easily affordable by resource poor farmers.

The plots treated with garlic powder recorded the highest height than those obtained from the control plots, this can be attributed to its natural chemicals with pesticidal and biocidal properties which prevented the pests from attacking the plants in the treated plots thereby allowing the plants to absorb maximally the available nutrients necessary for growth in their micro environment. This is in agreement with Schmutterer, (2000), who reported that most part of the garlic plant especially the bulbs prepared as powder repels insects attack in tomato, okra, and soybean plant.

However, the number of galled roots and gall index decreased drastically in the plots treated with organic powders (ginger, garlic, chili pepper) while the control plots increased drastically. This further demonstrated the potency of these extracts due to their high nematicidal efficacies. This is in agreement with Okoro (2009), who reported that capsaicin in pepper is also used to deter pests, such as soil borne Pest (root-knot nematode) and mammalian pests.

Nematode population /100g soil correlated positively with number of galled roots, gall index, and correlated negatively with plant height, number of leaves, number of pods and weight of pods. This means that the higher the nematode population/ 100g soil the higher the number of galled roots and gall index and the lower the plant height, number of leaves, number of pods and weight of pod at harvest. This was corroborated by the data obtained in the parameters evaluated. Nematode population has direct relationship with the gall parameters but showed inverse relationship with the growth and yield parameters which are the main trust of agricultural production thus showcasing the importance of preventive and curative measures in disease management. Naterajan *et al.*, (2006) and Ogwulumba *et al.*, (2010) reported that the major problem of soybean is pests and diseases which do not only cause low yield but also discourage most farmers from cultivating the crop. This was further corroborated with the data obtained in the correlation analysis between the nematode population and plant parameters evaluated.

This means that the higher the growth parameters the higher the yield parameters and the lower the nematode population/ 100g soil, number of galled roots and gall index. Meanwhile the higher the nematode population/ 100g soil, the lower the growth and yield parameters and the higher the number of galled roots and gall index. This is in agreement with (Ogwulumba, 2009 *et al.*,) who reported that one of the major limiting factors to the profitable soybean production is the damage caused by plant-parasitic nematodes especially *Meloidogynes* species.

#### CONCLUSION

The ability of the spice powders to reduce nematode effects on the crops with concomitant increase in the growth and yield parameters of the

crops in the treated plots further demonstrated their abilities to control nematodes. This research had revealed that apart from using these spices as food condiments, they could also be applied as pesticides. It is therefore recommended that these spice powders could be employed in the control of root knot nematodes to increase and sustain the productivity of soybean.

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