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Effect of root-knot nematodes (meloidogynespp) on yield of three tomato varieties in zalingei area.

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Abstract

This study conducted at the demonstration farm of the Faculty of Agriculture University of Zalingei during the period from April to August 2013, to evaluate the effect of Root knot nematodes on the yield of three tomatoes (*Lycopersiconesculentum*) varieties (Castle rock, Strain-B and Rio Grande). Six treatments were randomly arranged in a Completely Randomized Design (CRD) with four replicates. Primary survey carried out to determine the infection of Root knot nematodes on tomato fields in the area and sampling. Parameters measured included: number of leaves per plant, plant height and rating index of root galls. Data collected subjected to statistical analysis. The results showed that: Root knot nematodes found in all tomato fields surveyed in the area (10 fields). The number of leaves on treated Rio Grande variety were significantly lower compared with the number of leaves of untreated plants at (P= 0.05). The plants from the different varieties grown in treated soil showed longer plants than untreated one, throughout the six observations. The variety Strain-B was the most susceptible to the root knot nematodes among with the other two varieties.

Keywords: Root-knot nematodes, Survey and Samples Collection, Seedlings Preparation

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Introduction

Tomato **(***Lycopersiconesculentum Mill.)* is one of the most important vegetable crops grown throughout the world for man consumption in various forms; the production of tomato affected by attack of pests and diseases, lead to acute shortage of fresh fruits production in certain periods of the year. Yield losses partly attributed to the susceptibility of tomato cultivars to pests and diseases. More than a hundred different pest species recorded worldwide on tomato crops, Including nematodes, mites, thrips, aphids, moths, whiteflies, beetles and flies. A number of viral, bacterial, fungal and nematode pathogens attack tomato and cause diseases of economic consequences [1].

Root knot nematodes (*Meloidogynespp*), and several ecto-parasitic nematodes are known to attack tomato in many different parts of the world. Tomato regarded as the most favorable host for root-knot nematodes [2]. Root-knot nematodesknown as the mostdamaging plant parasitic nematodes. They cause about 50% of yield reductions overall but individual crop losses can be much more severe damage [3].

The production of tomato is impaired by among other factors such as its infections by nematodes [4]. Reported reductions in growth and yield ranging from 28 to 68%, over sixty species of plant parasitic nematode attack tomato, but the most destructive nematodes responsible for enormous yield losses of tomato are the root-knot nematodes [5]. Due to the importance of this pest in reduction of tomato yield in different varieties, the efforts made to study the impact of root knot nematode on growth of three tomato varieties, especially with regard to

1. Evaluation of root knot nematode on tomato fields in Zalingei area
2. Evaluation of growth reduction in three tomato varieties (Castle rock, Strain-B and Rio-Grande) grown in the area due to the root-knot nematodes.

Materials and methods

Materials

Materials used in this study include, Auger for collection of samples from the soil, spade, polythene bags, and labels, polyethylene bags for soil sterilization, sensitive, balance, and mosquito net, pots, 24 sacks, tomato seeds, domestic blender, sieves, needles injector (5 ml), funnels, microscope, slides, cover slides, beakers, pipettes, Petri dishes, plastic tube, filter papers, ruler and measuring cylinders.

Methods

Survey and Samples Collection

Field survey carried out on tomato fields around (Zalingei) During April and May 2013. The survey was covered the study area. Plants with characterized symptoms of root-knot nematode collected from the field. Soil samples carefully collected with Auger from 10 different Tomato fields. Ten plants from each field (one Feddan) collected in a zigzag pattern. 100 g of infected roots and 1 kg soil from the roots and rhizosphere of each of the ten plants collected from a depth of 10 to 20 cm. Samples were kept in polythene bags with labels contains information about the host, date, place and soil type. Samples brought to the Laboratory of plant protection faculty of agriculture, University of Zalingei for nematode extraction.

Seedlings Preparation

Seeds of the three tomato varieties (Castle rock, Rio Grande

and Strain B) were planted on three separated pots (60 seeds per pot) under mosquito net, and irrigated regularly by adding equal amounts of water to each pot every two days for 35 days then transplanted to polythene bags.

Transplanting of Seedlings

After 35 days the seedlings of the three tomato varieties (Castle rock, Rio Grande and Strain B) were transplanted to 24 sack of about 23 cm diameter and 24.5 cm depth, containing 25 Kg of mixed silt soil and sands which previously sterilized by exposing to direct sun were planted on each pot and considered as experimental unit. Then the newly transplanted seedling were irrigated immediately after transplanting and after that irrigation was carried out every five days up to the end of the experiment.

Extraction of the Inoculums from Soil

Soil samples thoroughly mixed and 100-cm^3 composite sample used for nematode extraction using modified Biermann funnel techniques [6]. The nematodes collected up to 24 Hours. After one day, samples harvested and nematodes counted under the stereo-binocular microscope (Olympus SZ 61) at 3.5X magnification, to identify the population of Root-knot Nematodes in 100 cm^3 of soil.

Extraction from the Roots

The infested roots washed under tap water then chopped with a Scissors to small pieces then blended in tap water for one minute using domestic blender. The mixture of blended roots poured through 2mm sieve to remove the root tissues. Samples taken from the mixture after gentle mixing. The females were isolated under binocular Microscope [7]. The suspension homogenized by blowing air through with plastic pipette. The isolates of Nematodes from the soil and roots mixed and then homogenized again by blowing air with plastic pipette then inoculums taken in injectors 5 ml to inoculate the soil that already irrigated before the seedlings transplanted.

Seedling Inoculation

Before the transplanting, soil infestation made by mixing the first top three cm of the soil in the sack with the primary inoculums solution 5 ml (2000N) to each sack. The control sacks left without inoculation, then a healthy seedling of tomato were transplanted to each sack (three seedlings/ sack), and then the sacks were irrigated immediately. The sacks arranged in completely randomized design (CRD).

Parameters Measured

Observation of plant height, number of leaves recorded weekly for ten weeks. After ten-week plants from each sack were carefully removed and washed in running water then placed in plastic bags with labels and then taken to the laboratory and weighed, then air dried and the following parameters were measured and the averages were calculated.

The growth parameters measured include:

- Plant height
- Number of leaves
- Rating the index of galled roots

The galls rated according to [8]. Explanation of rating grades was as follows:

0. Complete and healthy root system, no infestation.
1. Very few small galls and only be detected upon close examination.
2. Small galls as in (1) but more numerous and easy to detect.
3. Numerous small galls, some grown together, functions of roots not seriously affected.
4. Numerous small galls, some big galls, majority of root still functioning.
5. 25% of root system severely galled and not functioning.
6. 50 % of root system severely galled and not functioning.
7. 75 % of root system severely galled and lost for production.
8. No healthy roots. Nourishment of plant interrupted, plant still green.
9. The completely galled root system is rotted, plant is drying.
10. Plant and root are dead.

- Digital balance with two decimals used for weighting total fresh plant weight.
- Total fresh shoot weight, total dry shoot weight, total fresh root weight and total dry root weight. In the laboratory of plant protection department.

The data recorded presented and analyzed statistically using computer package (MSTAT). The means separation carried out by least significant difference (LSD) to determine the significant difference between means.

Results

Effect of Root Knot Nematodes on (Growth Parameters)

Effect of Root Knot Nematodes on Plant Height

The results in Table 1 showed no significant difference between the means of plant heights of the three tomato varieties (Strain B, Castle rock and Rio Grande), but the variety Rio Grande was showed highest plants followed by the variety Castle rock and the least means of plant height was shown by the variety Strain B.

Table 2 showed that the treated pots were resulted in higher plants means compared with untreated plants, on first observation until the sixth observation. Whereas, the untreated plants showed longer plants after the sixth week, and the same means of plant height at last two observations.

According to the Table 3 the results indicated that there was no significant difference between the plants of different and the same variety except in first week which was showed only significant difference at P.0.05 between the means of plant height of the variety Rio Grande treated and Rio Grande untreated at the first observation.

Table 1. *Shows the effect of root knot nematode on Plant height in three tomato varieties.*

Varieties	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Rio	37.31a	40.38a	44.75a	49.00a	52.250a	53.88a	55.33a	56.38a	56.63a	56.63 a
Cas	35.70a	37.63a	41.00a	46.00a	48.88 a	50.50a	51.96a	52.38a	52.25a	53.38 a
Str	29.82a	30.88a	34.7a	40.63a	43.88 a	46.00a	46.87a	47.63a	47.88a	47.88 a
LSD	13.04	15.11	16.38	17.73	17.30	16.97	16.93	17.35	17.57	16.61
C.V	31.62	28.02	27.44	26.31	24.09	22.72	22.43	22.41	22.6	21.24
Note: Means followed by the same letter do not differ significantly from each other at p.0.05 according to least significant difference (LSD).										

Table 2. *Shows the Effect of Root Knot Nematode on Heights of treated and Untreated Plants.*

Variety	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Untreated	29.42a	34.16a	37.66a	42.66 a	46.75a	49.33 a	50.50a	52.58a	52.67a	52.67a
Treated	33.00a	38.42a	42.67a	47.750a	49.92a	50.92a	51.08a	51.66a	51.83a	52.58a
LSD	13.04	15.11	16.38	17.73	17.30	16.97	16.93	17.35	17.57	16.61
C.V	31.62	28.o2	27.44	26.31	24.09	22.72	22.43	22.41	22.63	21.24
Note: Means followed by the same letter do not differ significantly from each other at p.0.05 according to least significant difference (LSD).										

Table 3. *Shows the Effect of Root Knot Nematode on Plant Height in Three Tomato Varieties.*

Treatment	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Rio un	38.75 a	44.75 a	48.8a	57.8a	55.0a	55.8a	55.8a	56.5a	57.0a	57.0a
Rio t	34.50ab	39.00 a	43.5a	48.3a	50.3a	52.5a	54.5a	56.3a	56-3a	56.3a
Cas un	33.50ab	36.25 a	40.8a	45.3a	49.5a	51.3a	51.8a	52.5a	52.3a	54.5a
Cas t	31.50ab	36.00 a	38.5a	43.8a	47.5a	49.8a	50.0a	52.3a	52.3a	52,3a
Str un	26.75ab	31.50 a	35.8a	42.3a	44.5a	46.3a	47.0a	48.8a	48.8a	48.8a
Strt	22,25 b	30.25 a	33.8a	39.0a	43.3a	45.8a	45.8a	46.5a	47.0a	47.0a
LSD	13.04	15.11	16.38	17.73	17.30	16.97	16.93	17.35	17.57	16.61
C.V	31.62	28.02	27.44	26.31	24.09	22.72	22.43	22.41	22.63	21.24
Note: Means followed by the same letter do not differ significantly from each other at p.0.05 according to least significant difference (LSD).										

Table 4. *Shows the effect of root knot nematode on the number of leaves in three tomato varieties.*

Variety	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Rio	3.50a	5.25a	7.13a	11.88a	12.25a	14.13a	14.63a	15.00a	15.25a	15.25 a
Cas	3.25a	4.63a	5.50a	9.750a	12.38a	13.25a	13.88a	15.00a	15.13a	14.88 a
Str	3.00a	3.86a	4.36a	8.875a	11.13a	12.25a	12.75a	13.63a	13.63a	13.63 a
LSD	1.26	1.93	2,82	3.16	3.35	2.41	2.43	2.72	2.74	2.64
C.V	26.15	28,40	34.17	20.93	18.41	12.27	11.88	12.58	12.55	12.20
Note: Means followed by the same letter are not different significantly from each other at p.0.05 according to lest significant different test (LSD).										

Effect of Root Knot Nematodes on Number of Leaves

The results in Table 4 showed no significant difference between the means number of leaves of the three tested tomato varieties throughout the ten observations. However, the variety Rio Grande compared with other varieties gave highest number of leaves followed by castle rock, and Strain B is the least in number of leaves in all observations, except in the fifth observation, where the variety castle rock showed higher number of leaves per plant.

The results in Table 5 Showed that the effect of root knot nematodes on the number of leaves on untreated plants were not significant difference at all the ten observations, whereas, the treated plants showed significant difference in the last four observations.

The results presented in Table 6 showed that the treated Rio Grande plants were showed significant difference from the sixth observation to end of the experiment, while the varieties Castle rock and Strain B treated and untreated were showed significant difference from the third observation to end of the experiment.

Figure 1. *Shows the comparison between normal and infected roots of tomato plant*

Discussion

The survey conducted around Zalingei area indicated that Meloidogyne species are the most abundant in the area, therefore considered the most destructive nematodes. They cause the normal galling of the root, which leads ultimately to wilting,

Table 5. *Shows the effect of root knot nematode on the number of leaves on three tomato varieties.*

Treatment	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Untreated	3.33a	4.58a	5.75a	10.5a	13.2a	14.47a	15.08a	16.25a	16.42 a	16.33a
Treated	3.17a	4.58a	5.58 a	9.83 a	11.25a	12.00 a	12.41b	12.83b	12.92 b	12.83b
LSD	1.26	1.93	2,82	3.16	3.35	2.41	2.43	2.72	2.74	2.64
C.V	26.15	28,40	34.17	20.93	18.41	12.27	11.88	12.58	12.5	12.20
Note: Means followed by the same letter are not different significantly from each other at p.0.05 according to lest significant different test (LSD).										

Table 6. *Shows effect of root knot nematode on the number of leaves in three tomato varieties.*

Treatment	Observations									
	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Rioun	3.50a	5.50 a	7.25a	12.25a	14.00 a	15.00a	15.50a	16.75a	17.25 a	17.25 a
Riot	3.50a	5.00 a	7.00a	11.50 a	13.00 a	14.2ab	15.0ab	16.0ab	16.0ab	16.00 ab
Casun	3.25a	5.00 a	6.00ab	10.00ab	12.75ab	14.0ab	14.7ab	16.0ab	16.0ab	15.7abc
Cast	3.25a	4.25 a	5.00ab	9.75ab	12.50ab	13.3ab	13.8ab	14.0bc	14.3bc	14.00 bc
Strun	3.25a	4.00a	5.00ab	9.50ab	11.75ab	12.3bc	12.8bc	13.3cd	13.3cd	13.25 cd
strt	2.75a	3.75a	3.75b	8.00ab	9.50 b	10.50c	10.75c	11.25d	11.25 d	11.25 d
LSD	1.26	1.93	2,82	3.16	3.35	2.41	2.43	2.72	2.74	2.64
C.V	26.15	28,40	34.17	20.93	18.41	12.27	11.88	12.58	12.55	12.20
Note: Means followed by the same letter are not different significantly from each other at p.0.05 according to lest significant different test (LSD).										

stunting, and low yield of the infected crops.

The results indicated that the effect of root knot nematodes on the number of leaves tend to be significant from the sixth observation to the end of the experiment. The reduction in number of leaves (defoliation) recorded were due to the inability of the plants to absorb water and nutrient from the soil through its root, due to gall formation. This is in agreement with the findings of who reported that nematodes damage plants by feeding on the roots, weakening the plants ability to take up water and nutrient. In addition, the findings of [9] confirmed that the nematode infestation leads to wilting and stunted growth. Observation on the lack of effect on the number of leaves in this study is similar to that of [10] who observed that there was no significant difference in total number of leaves of plants treated.

Results in Table 1 and 2 showed that occurrence of taller shoots in nematode infected plants (treated plants) than in the controls (untreated plants) from the first week to the seventh week after inoculation might be plant resistant pest, its same with the findings of [11] who found the same results in their study (effect of Meloidogyne incognita (Root Knot Nematode) on the development of *Abelmoschusesculentus* (Okra). Surface feeding without actual entry of the larvae into the roots induced galls. [12] Reported that the development of lateral roots is in the region of the galls. The additional lateral roots, enhance the uptake of water and mineral salts by the treated plants and this enhancement manifested as increased shoot height in the treated plants, until the damage of root cells by the penetration of the second stage infective larva, that larvae caused deformations and damages to the roots of host plants by root-knot nematodes can lead to reduction of absorption of nutrients and impair nutrient availability in infected host plants, therefore assumed that from the eighth week to the end of the experiment when the untreated plants showed taller shoot system than the treated plants. The second stage larvae have fed on parts of the roots of the treated plants, which reduce the water and nutrients uptake and decreasing growth of the plants. On the other hand, the results presented have shown that the variety Strain-B was ranked the least in term of number of leaves, also showed least weight in total fresh plant weight, and shoot fresh weight and shoot dry weight, but showed relatively high weight in root fresh and dry weight, and gave high root gall index. From the presented results in the variety Strain-B dry roots and fresh roots weight and rating index are highest which is an indication of their higher susceptibility, and as result of the high attack the root weight and the galls were increased on this bases the heavier the fresh root weight, the higher the infestation, because the heavy weight of fresh root was due to galls induction resulted in formation of giant cells, as reported by [13]. In his thesis (Evaluation of some control methods of Root knot nematodes *Meloidogynespp* in tomato and Okra) have pointed to the tested verity that showed high rating index have relatively heavy root weight.

Heavy root weights in infected plants compared with the untreated plants due to formation of giant cells, which led to root galling. This result was similar to the findings of [14, 15]. Giant cell formation was triggered-off by enzymatic secretions from root-knot nematodes in host plants, which induce re-differentiation process that ultimately leads to the formation of multinucleated feeding cells called [16]. Giant cell formation progresses through the processes of hyperplasia and hypertrophy of surrounding cortical cells [17]. It has also been reported that the presence of nematode infection in plants induces plant hormones (indole-acetic acid, cytokinins, abscisic acid) concentrations, which can lead to acceleration of growth around the nematode feeding sites [18].

Recommendations

From the results of this work, it can be recommended that tomato growers in root knot nematode endemic areas the variety Rio Grande is preferred because it less susceptible to root knot nematodes.

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