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New approaches for sucker selection in greenhouse banana to reduce nematode number in subtropics

Adem Özarslandan*

Applied Technology and Management School of Silifke, Mersin University, Mersin, Turkey

ABSTRACT

Banana is grown in both tropical and subtropical regions of the world. It is also grown in the Mediterranean coastal region of Turkey. Many pests including plant parasitic nematodes cause damages to banana. The nematodes may both limit the growth of suckers from which reproduction of banana is achieved, and reduce fruit quality and quantity. The effect of nematodes on suckers based on distance to mother plant has not been fully understood. Therefore, this study was aimed to determine effect of the distance of sucker plants from mother plants to the nematode population, stem diameters, plant growth and yield. Nematode extraction was performed by a modified Baermann funnel method and nematodes were identified under the microscope. Results revealed that *Helicotylenchus multicincitus* was the most abundant one followed by *Meloidogyne javanica* and *M. incognita*, respectively. The yield of new seedlings obtained from the first sucker of the mother plant were 51, 46 and 48 kg / plant, while it was 32, 30 and 31 kg / plant in the control plots (sucker plants next to the mother plant). Overall, a positive correlation was determined about distance of sucker plant from mother plants and yield. Yield increases were observed as 59%, 53% and 55% in three greenhouses, respectively. In addition, yield and quality were enhanced because of lower nematode population. The suckers next to the mother plants were unable to grow due to the higher nematode density. It can be concluded that the efficiency of this application increases when used with integrated pest management strategies.

Keywords: *Musa* sp., spiral nematode, root knot nematode, propagation.

INTRODUCTION

The bananas have great economic significance in tropical and subtropical climates around the world. Based on 2016 data for Mediterranean region in Turkey, banana production was 305, 926 MT with 6225 hectare of cultivation (Antalya 2550, Mersin 3634.7, Hatay 36.6 and Adana 2.7 hectare). Plant parasitic nematodes cause economic crop losses in banana fields. Several studies reported important plant parasitic nematodes such as *Radopholus similis*, *Helicotylenchus multicinctus, Pratylenchus* spp. and *Meloidogyne* spp. in banana fields (Mant and Hinai, 11). The nematodes attack the roots of the banana plant and destroy the plant root functions, preventing water and nutrient intake. Therefore, it leads to significant yield losses due to thinning of the trunk, leaf yellowing, decrease in leaf count and size, late flowering, prolongation of product cycle, decrease in fruit weight and size (Fogain and Gowen, 7).It was reported that as the roots detached from the soil, the banana plants could bend over due to their increased weight with fruits or strong winds. The nematode-induced mean banana crop loss is 19.7% worldwide (Sasser and Freckman, 15), and 75-80% in South Africa (Sarah, 14). Davide (6) reported that Burrowing (*Radopholus similis*) and spiral nematodes (*Helicotylenchus multicinctus*) create problems in banana cultivation fields around the world, resulting a yield loss of 30-50% in Costa Rica and Panama,40% in Africa, and 30-60% in India. Studies conducted in major banana cultivation sites in the Nadu region demonstrated that root-knot nematode and spiral nematode led to 30-60% yield loss (Jonathan, 9). Analysis of nematode data plays an important role in enforcing control measures before the nematodes reach the economic threshold. Nematodes infected plants also exhibit chlorosis, dwarfing, reduction in pseudostem girth, yellowing and drying of leaves with small bunches (Gowen & Quénéhervé, 8). Screening of Musa hybrids for resistance to Pratylenchus coffeae (Das *et al.*, 5). Resistant varieties are desirable to prevent economic losses of R. similis in banana (Das *et al.*, 4). They tested 129 bananas against Radopholus similis. In the study, 9 types were resistant, 8 types were moderately resistant and others were found to be sensitive to different degrees (Reddy, 13). *H. multicinctus, H. dihystera*, *M. incognita* and *M. javanica* were detected in banana fields in Turkey . It was found that *H. multicincus* populations in banana greenhouses were higher when compared to *Meloidogyne incognita* and

*Corresponding Authors' Email: ozarslandan2001@yahoo.com

M. javanica (Kasapoğlu *et al.*, 10: Özarslandan and Dinçer, 12). The results demonstrated that *Helicotylenchu*s spp. and *Meloidogyne* spp. were present in banana fields. Both the percentage of infected land and *Helicotylenchus* spp. population density was higher when compared to *Meloidogyne* spp. The total nematode presence (*Helicotylenchus* spp. + *Meloidogyne* spp.) in August was higher than in May. 62% of the root samples collected in August included more than 2500 nematodes per 100 g soil (Özarslandan and Dinçer, 12).

As monoculture banana cultivation is conducted in Turkey, yield and quality decrease due to nematode damage, leaves concentrate on the top and banana cluster weight decrease. Continuous banana cultivation is conducted in same locations either on land or in greenhouses. Spiral and root knot nematodes populations in the mother plant prevent sucker root development, which is the basis of the next generation fruit. The present study aimed to investigate the effect of nematode population on yield quality and quantity using suckers that are remote from the root of the mother plant. The nematode count and percentage effects on the yield were obtained with the analysis of the soil on the suckers that were at a 1 meter distance from the mother plant.

MATERIALS AND METHODS

The experiment were conducted in a banana (Grand Naine) grown under greenhouse in Anamur, Turkey during 2015 and 2016. Experiments were conducted in different greenhouses that included seedling and control lots. Five plants were selected for each replication, and each application was conducted on 15 banana plants. Banana yield, distance from the mother plant and diameter of each plant were measured. A rhizome emerged in April and it was allowed to grow (Fig. 1) and others were removed. The seedlings were cut flat and carved on July 15, 2015. The rhizomes were left next to the mother plant for banana sucker development for the following year. The farmer applications were evaluated as control plot. The seedling diameter was measured in January, 2016. In November 2015, soil samples were collected at 0-20, 20-40, 40-60, 60-80 and 80-100 cm distances and 0-30 cm soil depth for each application. Two kg samples were collected in to plastic bags (Mant and Hinai, 11). Samples were transferred to the nematology lab and 100 g soil obtained from these samples were placed into petri dishes and modified Baermann funnel method was used to extract the nematodes (Southey, 16). The percentage effect of treatments

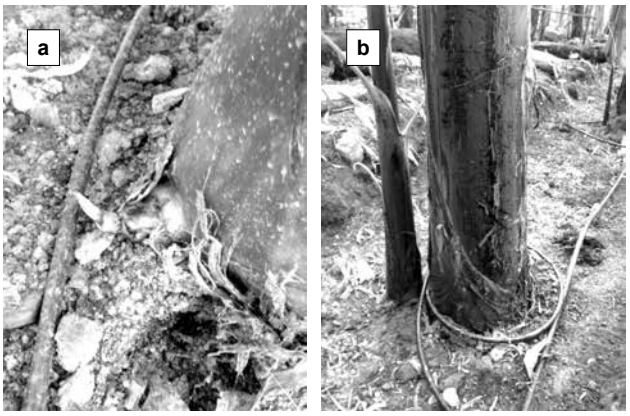

Fig. 1. One of the rhizomes near soil surface was left in April (Fig. a, b).

on yield was determined with the Abbott formula. The data analysis was conducted with SPSS software (SPSS Inc., Chicago, IL, USA), the mean values were compared with t-test (multiple range) test, and 95% ($P < 0.05$) confidence level was accepted as statistically significant.

RESULTS AND DISCUSSION

The nematode count decreased in the soil samples obtained on November 2015 since they moved away from the main plant. While there were 765-1440/100 g nematodes within0-20 cm of the mother plant, the count declined to 150-268/100 g nematodes within a distance of 40-60 cm. Since the plants in the control parcel are adjacent to the main plant, they are exposed to high the nematode population at 0-40cm. Therefore, their yield and quality decrease. As the plants in the application are more than 40 cm away from the main plant, they are exposed to a low nematod population. Therefore, plant growth, yield and quality increase. (Table 1). It was determined that suckers that would fruit the following year had a better chance when located at 47-51 cm from the mother plant and grow healthier roots due to the lower nematode count (Table 2). The total number of nematodes was taken into account, root nematodes and spiral nematodes were counted together due to nematode development control strategy. In soil analyses, 0-220 root-knot nematodes were counted. In general, it was determined that when the spiral nematode count was high, the root knot-nematode count was very low in soil samples. Thus, spiral nematodes out competed the root knot-nematode in the soil where bananas were cultivated. The reason for the presence of nematodes in all greenhouses was due to the high number of weeds, which also hosted the nematodes. The trunk diameters of the cutting seedlings were 68,

Table 1. Total nematode populations (Spiral nematode (*Helicotylenchus multicinctus*) and Root knot nematode (*Meloidogyne incognita* and *M. javanica*) in 100 g soil obtained at a meter distance from the trunk of the mother banana plant.

Greenhouses	Applications	The distance of the nematode population from the mother plant (0-1m)				
		0-20cm	20-40cm	40-60cm	60-80cm	80-100cm
Greenhouse 1	Application	765±136	435±81	210±34	215±37	130±22
	Control	1028±299	655±213	188±49	100±16	53±18
Greenhouse 2	Application	1086±283	708±190	333±71	175±27	84±19
	Control	680±316	470±121	150±12	105±20	140±
Greenhouse 3	Application	1442±208	710±134	268±44	157±10	68±10
	Control	1185±183	705±129	190±34	175±20	100±10

Table 2. The trunk diameter, the distance from the main plant, the yield per tree and the percentage impact obtained in the cut-off seedlings left in May.

Greenhouses	Applications	Trunk diameter (cm)	Distance from the trunk (cm)	Yield/tree kg	Effect (%)
Greenhouses 1	Application	68,8±2,4	47,2±1,6	51± 1,5	58,9
	Control	50,3±0,8	Adjacent to mother plant	32,1±1,3	
Greenhouses 2	Application	71,8±4,8	51,2±2,2	46,9±1,4	56,3
	Control	50,8±1,6	Adjacent to mother plant	30±0,9	
Greenhouses 3	Application	64,3±2,5	48,7±1,7	48,8±0,9	57,4
	Control	41,5±2,5	Adjacent to mother plant	31±0,9	

71 and 64 in greenhouses, respectively, while the trunk diameters of the seedlings left adjacent to the mother plant in May were much smaller and 50, 50 and 41 cm (Table 2). Yield per plant was 51, 46 and 48 kg/plant in different greenhouses, respectively, and yields obtained for the seedlings in the control lot were 32, 30 and 31 kg/plant (Table 2). It was found that the seedling yields of the seedlings obtained from the main plant in May were higher in Middle-July and the yields of the seedlings that remained in end-July were higher.

As the distance between the seedlings and the main plant increased, the stem diameter and plant growth improved. Since the first seedlings were next to the main plant, the nematode population infested the new seedlings after the mother plant was cut. Nematodes decreased root mass by preventing new root growth, hence reducing the yield and quality. The seedlings farthest to the mother plant were allowed to grow (Fig. 1-3). It was observed that the cut-off seedlings exhibited better root development and produced a higher yield in the following year. The cut-off seedlings were highly homogeneous since they all emerged around the same time. Furthermore, harvest times for the cut-off seedlings were close to each other and harvest was completed between October and December. Although the seedlings emerged in end July, they had better plant

Fig. 2. In mid-July, suckers were cut to obtain new sucker (c, d).

Fig. 3. Suckers sharing the same quality and size (e, f).

height, yield, and quality when compared to the seedlings left in the main plant in May. Furthermore, the seedlings that were left next to the main plant did not develop well due to nematode damage; leading to a weak plant formation, light clusters small and poor quality banana fruits.

It was demonstrated that spiral nematodes inhibit the development and reproduction of root-knot nematodes due to their ability to cause plant diseases (Araya and Moens, 1). Although the banana roots could develop up to 1 m, it is known that the roots that grow around 0-40 cm could maintain the plant (Belalcazar *et al.,* 2).Nematodes could also lead to a late harvest of up to 12 months. The nematode damage reduces the market value of the product. The nematode population is low in suckers that are far from the mother plant (Gowen and Queneherve, 8). It is known that any minor nematode infection could lead to a serious long-term problem. Banana cultivation is monoculture, nematode population continues to increase and there is a continuous source of nematode inoculation in the soil. Even low nematode population during winter affects the development of seedlings. However, most producers are not aware of the fact that yield losses in banana production are due to nematode damage (Brooks 3).As a result, spiral and root-knot nematodes attack plant roots and tissues and disrupt the functions of the plant root, preventing water and nutrient intake. They decrease the root mass and the yield. It is, therefore, necessary to develop control strategies against nematodes by considering the damage caused by total nematode population (Araya and Moens, 1). In the present study, we allowed the suckers that emerged in April 2015 to grow and then cut them in July 2015 to allow the growth of new suckers far from the mother plants. It was found that since the new plant was obtained far from the mother plant, the nematode damage declined and the yield increased. It was suggested that this application could be a part of an integrated pest management strategy against nematodes to increase productivity in banana fields. This application does not require the use of nematicides or nematicide administration could be reduced. When the bunches harvest time is extended in the control parcel, this application is harvested earlier in the areas where the application is made. With this application the producers have become more wide spread practice in the fast way for harvesting more quality and more products. On the contrary, in the control parcels where there is nematode damage, the harvest time is extended and the yield and fruit quality decrease. Control parcels significant reduction in plant size, bunch weight, number of harvested bunches and total harvest. In addition to the reduction in the average plant size and bunch weight. The plant where in application parcel were more quality fruits and yield. In additions to earlier harvested time. Future studies should be conducted on flowering and yield by cutting suckers indifferent thickness and in different months.

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