International Journal of
Agriculture, Forestry and Life Science, 2 (2) 2018, 56-61

e-ISSN: 2602-4381 Received: 26.09.2018 Accepted: 10.10.2018 Published (online): 10.10.2018

ORIGINAL PAPER

RESEARCHS ON THE EFFECTS OF THE MARIGOLD (*Tagetes* spp.) ON THE MANAGEMENT OF ROOT-KNOT NEMATODES (*Meloidogyne incognita*) IN NURSERIES

Neriman KURT[1], M. Atilla AŞKIN[2*]

[1]Süleyman Demirel University, Graduate School Natural and Applied Sciences, Isparta, Turkey
[2]European University of Lefke, Faculty of Agricultural Sciences and Technologies, Lefke, Northern Cyprus, via Mersin 10 Turkey

*Corresponding author email: maskin@eul.edu.tr

Abstract

This study aimed to determine the effects of marigold (Tagetes spp.) on the root-knot nematode, which are causing high damages in nurseries. In present study, different varieties and species of marigold were tested at different plant intensity. Totally 11 varieties of marigold were used in the present study, five from Tagetes erecta (Marvel Yellow, Marvel Orange, Taishan Gold, Taishan Orange and Taishan Yellow) and six from Tagetes patula (Bonanza Bee, Bonanza Yellow, Durango Bolero, Durango Flame, Durango Red and Durango Tangerine). Each treatment was tested with 10 replications and the experiments were designed with the completely randomized block design. Results showed that plant density has a significant effect on the galls index of root-knot nematodes. The highest gall index was determined from the marigold applications with only flowers and the lowest (no) gall index was noted from the marigold applications with green parts of the plants. It can be concluded from the results that using of marigold in crop rotation may significantly reduce the damages caused by the root-knot nematodes.

Key words: nurseries, biological control, nematode management, plant parts, green fertilizer

INTRODUCTION

Fruit production starts with the production of fruit transplants and is one of the important parts of agricultural activities both in the world and Turkey. It is very important to produce the seedlings in a short time with the new, true-to-type, high quality varieties; as healthy, with high quality characteristics to improve fruit sector, not only in Turkey, but in all over the world (Güleryüz, 1991; Okatan, 2017). Transplants exhibit great importance in the fruit sector in Turkey, thus the nurseries' sector is developed (Yapıcı, 1992). Total number of certified fruit transplants were around 4 million in 2002 which reached 238 million in 2017 (GTHB, 2018). Human population in the world is increasing day-by-day where the total land which is devoted for fruit production is declining due to some environmental problems, i.e. soil salinity, decrease in water quality and quantity, increase in pests and diseases and etc. One of the most important diseases causing huge losses in fruit production in Turkey, like in rest of world, is root-knot nematodes (*Meloidogyne* spp.). It is an endoparasitic poly-fag with a broad host range, which is distributed throughout the world, and is causing huge economic losses due to losses in quality and quantity of perennial fruits (Netscher and Sikora, 1990; Whitehead, 1998). Root-knot nematodes characterized by the formation of large-to-small galls in the roots of cultivated plants and is constitute one of the important groups in pathogenic nematodes. It was reported that there are about 90 different species of nematodes in the world (Hunt and Handoo, 2009). Johson and Fassuliotis (1984) conducted a study in 75 different countries about the root-knot nematode species and they reported that around 52% of the nematodes are belonging to the *M. incognita* species, 30% to *M. javanica*, 8% to *M. arenaria*, 8% to *M. hapla* and rest 2% to other species.

It was also reported that the species of *Meloidogyne* are damaging almost all plants which include vascular delivery system, and the number of host plants is more than 2000 throughout the world (Jones et al., 2013). Many of the nematicide used to control nematodes are reported to cause damages to human and environment, and are dangerous for groundwater; and are banned in Turkey, some European Countries and in some USA states (Braon and Supkoff, 1994). Furthermore, researchers are paying more attention the alternative control methods of the root-knot nematodes in all over the world. Among these alternative methods, some plants are known to have nematicidal effects in various ways.

These plants are grown together with cultivated crops, used as green fertilizer, or extracts obtained from these plants are applied directly to the cultivated crops as a protectant against root-knot nematodes.

Today in Europe, most of the nurseries use *Tagetes* spp. varieties for the control of root-knot nematodes. Seeds of *Tagetes* spp. are being planted at the planting area and are being mixed into the soil by tripping during the flowering period. Present study aimed to:

- Determine the effects of different species and varieties of *Tagetes* against *Meloidogyne incognita*;
- Determine the effects of different densities of *Tagetes* spp. on the *M. incognita*;
- Determine the effects of different parts of *Tagetes* spp. as green fertilizer on the *M. incognita*.

MATERIALS AND METHODS

This study was conducted during 2015-2017 at the research area of Isparta Municipality, Directorate of Parks and Gardens. Totally 11 varieties of marigold were used in the present study, five from *Tagetes erecta* (Marvel Yellow, Marvel Orange, Taishan Gold, Taishan Orange and Taishan Yellow) and six from *Tagetes patula* (Bonanza Bee, Bonanza Yellow, Durango Bolero, Durango Flame, Durango Red and Durango Tangerine) (see Figure 1.). Seeds of these plant materials were purchased from Tasaco company located in Antalya, Turkey.

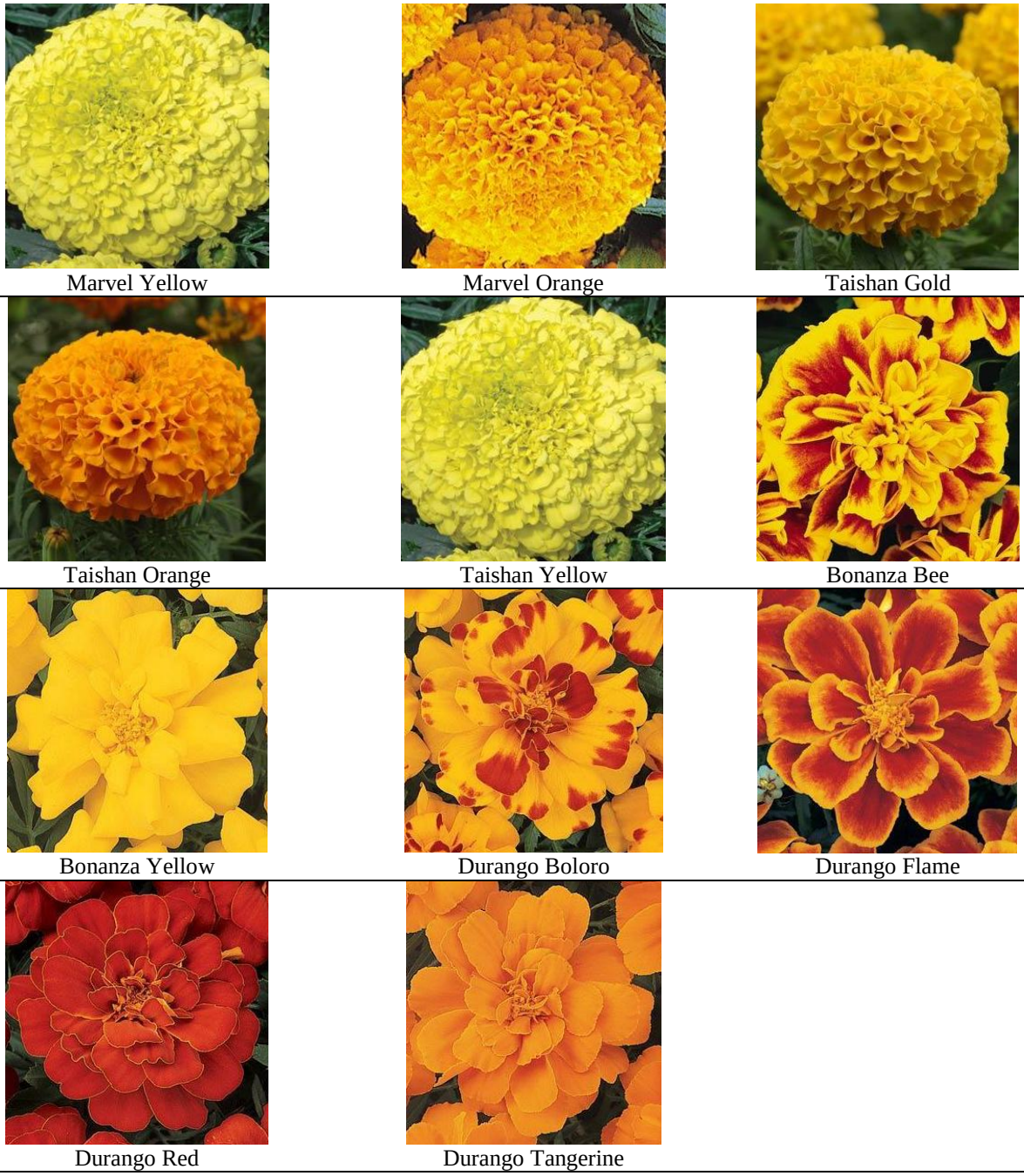

Figure 1. Flowers of the different species and varieties of *Tagetes* spp.

Root-knot nematode (*Meloidogyne incognita*) of present study was isolated from samples collected from a pepper plant in Aksu, Antalya which isolated at the Nematology laboratory of Faculty of Agriculture of Suleyman Demirel University. Rio Grande tomato hybrid was used in present study as host plant which is known as susceptible to root-knot nematode. Studies were conducted in three stages:

Determining the effects of different species and varieties of *Tagetes* against *Meloidogyne incognita*:

Each treatment was tested with 10 replications and the experiments were designed with the completely randomized block design. 10 egg packages of *M. incognita* isolates were sown with the marigolds to assess the effects of marigolds on the root-knot nematodes (Figure 2.). Plants were grown about six weeks by using standard irrigation and fertigation; and then they were harvested to determine galls numbers, egg numbers and galls indexes of roots for each variety. Inoculation of the root-knot nematodes are shown in Figure 3.

Figure 2. Planting stages of the *Tagetes* spp. plants.

Determining the effects of different densities of *Tagetes* spp. on the *M. incognita*:

All varieties of *Tagetes* spp. were found to be effective against *M. incognita* in the first experiments. Thus, *Tagetes erecta* 'Taishan Orange' were selected for the next experiments and the plants were planted with different density for 7 weeks and then incorporated into the soil the determine their effects on the root-knot nematode affecting tomato production. The experiment was prepared using 39 dm³ of soil (sandy soil structure) in a 37 x 53 area cask. Nematodes from mass-produced populations were randomly infected with approximately 4000 M. incognita eggs for each plant, as in the case of *Tagetes erecta* 'Taishan Orange'. The densities of *Tagetes erecta* was tested at three different levels: 30 units/m², 40 units/m² and 50 units/m². Plants were grown about six weeks by using standard irrigation and fertigation; and then they were harvested to determine galls numbers, egg numbers and galls indexes of roots for each variety.

Figure 3. Inoculation of root-knot nematodes.

Determing the effects of different parts of *Tagetes* spp. as green fertilizer on the *M. incognita*:

An experiment was carried out to determine the effects of nematicide on different plant parts in infested soil with *M. incognita*, a kind of *Tagetes* ssp. which is effective in the experiment. The experiment was carried out according to the Completely Randomized Block Design with 4 replications containing sandy soil (approximately 39 dm3 in volume). The seeds of T. erecta 'Taishan Orange' were planted in viols and grown until 4-5 true-leaf stages for 7 weeks. Then the different parts of the 40 marigold plants were incorporated into the soil. The tested plant parts are:

a) only roots of *Tagetes* spp.
b) only green parts;

c) only flowers;
d) all plant parts (by dividing into 0.5-1 cm parts);

Then tomato plants with four replications were planted onto the infested soils according to the Completely Randomized Block Design. Following control treatments were also tested:

a) control-1 (infested with *M. incognita*, without *Tagetes* spp. plant)
b) control-2 (without infestation of *M. incognita*)
c) control-3 (planting *Tagetes* spp. to the infested soil)

Plants were grown for 8 weeks and then they were harvested to determine galls numbers, egg numbers and galls indexes of roots for each variety.

RESULTS AND DISCUSSIONS

Results about the effects of different species and varieties of *Tagetes* against *Meloidogyne incognita*:

The galls index of the *Tagetes* varieties were recorded according to the 0-5 scale and the index numbers up to 2 were accepted as resistance against *Meloidogyne incognita*. Results of present study showed that number of galls and galls indexes for all tested *Tagetes* spp. species and varieties were zero (0) for 30 *Tagetes* spp. Plants incorporated into uninfected soil. Findings of present study were found to be in agreement with the findings of Ploeg et al. (2000). When the same number of plants were incorporated into infested soil, different number of galls were observed on the tomato plants (see Table 1.). Increase in the number of soil incorporated *Tagetes* spp. plants were found to decrease the number of galls on tomato plants, while at the same time increase in the number of tomato plants (the density) were found to decrease the gall index.

Table 1. Effects of different densities of *Tagetes* spp. on the *M. incognita*

# of tomato plants m^{-2}	30 *Tagetes* spp. plants incorporated into UNinfested soil with 30 tomato plants		30 *Tagetes* spp. plants incorporated into infested soil with 30 tomato plants		40 *Tagetes* spp. plants incorporated into infested soil with 40 tomato plants		50 *Tagetes* spp. plants incorporated into infested soil with 50 tomato plants	
	# of galls	gall index	# of galls	gall index	# of galls	gall index	# of galls	gall index
1	0	0	0	0	5	2	3	2
2	0	0	3	2	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0	0	4	2	2	1	1	1
5	0	0	2	1	0	0	1	1
6	0	0	0	0	1	1	0	0
7	0	0	1	1	0	0	0	0
8	0	0	3	2	2	1	0	0
9	N/A	N/A	N/A	N/A	1	0	1	1
10	N/A	N/A	N/A	N/A	1	0	0	0
11	N/A	N/A	N/A	N/A	N/A	N/A	0	0
12	N/A	N/A	N/A	N/A	N/A	N/A	0	0
13	N/A	N/A	N/A	N/A	N/A	N/A	0	0

Results about the effects of different densities of *Tagetes* spp. on the *M. incognita*:

Results on the effects of different densities of *Tagetes* spp. on the *M. incognita* were listed in Table 1. It was concluded from the results that the increase in the number of *Tagetes* spp. in the area (increase in the density), decreases the number of galls and galls index of the *M. incognita*. Similarly, Çetintaş and Kara (2016) reported that the extracts of marigold plants might be used for the management of some nematodes.

Results about the effects of different parts of *Tagetes* spp. as green fertilizer on the *M. incognita*:

Results about the effects different parts of *Tagetes* spp. as green fertilizer on the M. incognita were given in Table 2. It is clear from the results that the highest number of galls and galls index were determined from the treatment of control-1 (infested with *M. incognita*, without marigold plant). On the other hand, the lowest number of galls (0) and gall index (0) were obtained from the treatments where only green parts of *Tagetes* spp. were incorporated into the soil. Results suggested that the incorporating of the green parts of the *Tagetes* into the soil is highly effective in preventing the formation of galls of the *M. incognita* root-knot nematodes. Furthermore, roots of the *Tagetes* spp. were also found to be effective in controlling the nematodes, while the flowers of the marigold plants were noted as ineffective.

CONCLUSIONS

Results of present study showed that plant number, density and plant parts of *Tagetes* spp. have significant effect on the galls index of root-knot nematodes (*M. incognita*). The highest galls index was determined from the marigold applications with only flowers and the lowest (no) galls index was noted from the marigold applications with green parts of the plants. Summary of the results indicated that using of marigold in crop rotation may significantly reduce the damages caused by the root-knot nematodes in tomato and the density of tomato also might have significant effect on the root-knot nematodes.

Table 2. Effects of different parts of *Tagetes* spp. as green fertilizer on the *M. incognita*

Treatments	# of tomato plants m-2	# of galls	gall index
Only roots of *Tagetes* spp. were incorporated	1	0	0
	2	0	0
	3	3	2
	4	2	1
Only green parts of *Tagetes* spp. were incorporated	1	0	0
	2	0	0
	3	0	0
	4	0	0
Only flowers of *Tagetes* spp. were incorporated	1	2	1
	2	8	2
	3	10	2
	4	4	2
All parts of *Tagetes* spp. were incorporated	1	0	0
	2	0	0
	3	0	0
	4	1	1
control-1 (infested with M. incognita, without *Tagetes* spp. plant)	1	15	3
	2	10	2
	3	20	3
	4	12	3
control-2 (without infestation of M. incognita)	1	0	0
	2	0	0
	3	0	0
	4	0	0
control-3 (planting Tagetes spp. to the infested soil)	1	0	0
	2	0	0
	3	0	0
	4	0	0

ACKNOWLEDGEMENTS

This study was carried out as a master thesis at the Süleyman Demirel University, Graduate School Natural and Applied Sciences. Authors would like to tank to the lecturers at the Department of Plant Protection, Süleyman Demirel University for their kind helps and to the Isparta Municipality, Directorate of Parks and Gardens due to the opportunities they provided us during the studies.

REFERENCES

Braun, A.L. and Supkoff, D. M. 1994. Options to methyl bromide for the control of soil borne diseases and pests in California with reference to the Netherland. Pest management analysıs and planning program. PM 94-02.

Çetintas, R. and Kara, H., 2016. Arthrobacter (ROA) ve Kadife Çiçeği (*Tagetes patula*) Ekstraktlarının Meloidogyne incognita (Kofoid & White) Populasyonuna Karşı Etkinliği. KSÜ Doğa Bilimleri Dergisi, 19 (2): 221-226.

GTHB, 2018. Bitkisel Üretim Verileri. Erişim Tarihi: 01.06.2018. https://www.tarim.gov.tr/sgb /Belgeler/SagMenuVeriler/BUGEM.pdf

Güleryüz, M., 1991. Ülkemizde Meyve Fidancılığında Anaç Sorunu ve Dünyada Anaç Islahı ile İlgili Çalışmalar. Türkiye 1. Fidancılık Sempozyumu. Bildiri Kitabı s. 273-280. T. C. Tarım ve Köyişleri Bakanlığı, Ankara.

Hunt, D. and Handoo, Z., 2009. Taxonomy, Identification and Principal Species, 55-88. In Root- Knot Nematodes, (Eds. R. N. Perry, M. Moens & J. L. Starr). CABI, London, 488 pp.

Johnson, A. V. and Fassuliotis, G., 1984. "Nematode Parasites of Vegetable Crops, 323-372". Plant and Insect Nematodes (Ed. W.R. Nickle). Marcel Deccer Inc., New York and Basel, 713 pp.

Jones, J.T., Haegeman, A., Danchin, E.G.J., Gaur, H.S., Helder, J., Jones, M.G.K., Kikuchi, T., Manzanilla-López, R., Palomares-Rius, J.E., Wesemael, W.M.L. and Perry, R.N. 2013. Top 10 plant-parasitic nematodes in molecular plant pathology. Molecular Plant Pathology, 14(9): 946-961.

Netscher, C. and Sikora, R. A., 1990. Nematode Parasites on Vegetables. In: M., Luc, R.A., Sikora, andJ., Bridge, (eds). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. C.A.B. International, 231-283 pp.

Okatan, V. (2017). GA3 Uygulamalarının Malta Eriği (Eriobotrya japonica) Tohumlarının Çimlenmesi ve Çöğür Gelişimi Üzerine Etkileri. GÜFBED/GUSTIJ (2017), 7(2), 309-313.

Ploeg, A. T. 2000. Effects of amending soil with Tagetes patula cv. Single Gold on Meloidogyne incognita infestation on tomato. Nematology 2, 489-493.

Whitehead, A. G., 1998. Plant Nematode Control. CAB International, New York, USA. 384 pp.

Yapıcı, M. 1992. Meyve Fidanı Üretim Tekniği (Kışın Yaprağını Döken Türler), T.C. Gıda Tarım ve Hayvancılık Bakanlığı Yayın Dairesi Başkanlığı, Ankara.