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Biological Performance of Certain Bio-Agents, Fluopyram and Fosthiazate against *Meloidogyne* spp. on Guava Trees (*Psidium guajava* L.)

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ABSTRACT

In this study, the potential of some bio-agents, fluopyram and fosthiazate were investigated against root-knot nematodes (*Meloidogyne* spp.) on guava trees under field conditions for two successive seasons (2020 & 2021). The examined bio-agents were; Bio-Nematon® (*Paecilomyces lilacinus*), Bio Cure-F® (*Trichoderma viridi*), Bio Cure-B® (*Pseudomonas fluorescens*) and BIOTECT® (*Bacillus thuringiensis* var. *kurstaki*). The infection parameters of root-knot nematodes (*Meloidogyne* spp.) were recorded at 35 and 70 days after treatment. Results indicated that all the applied treatments suppressed the soil population density (J_2/250g soil) at range of 68.75 to 88.85% during the 1st season, and from 57.72 to 92.92% during the 2nd season. Besides, the numbers of root galls were decreased at range of 60.22 to 77.11% and from 57.90 to 70.90% during 1st and 2nd seasons, respectively. Also, the number of isolated eggs from roots was decreased at range of 67.13 to 94.61% and from 51.37 to 88.45% during 1st and 2nd seasons, respectively. However, the content of total N, P and K (%) in leaves of guava trees was fluctuated during both seasons.

Key words: *Meloidogyne* spp., *Paecilomyces lilacinus*, *Trichoderma viride*, *Pseudomonas fluorescens*, *Bacillus thuringiensis*, fluopyram.

INTRODUCTION

In Egypt, Guava (*Psidium guajava*) has been given a considerable priority in the commercial cultivation. Guava fruits are main source of lycopene, betacarotene, protein, fat, carbohydrate, fibers, minerals, vitamin A, B & C (Atawia *et al*., 2017).

Guava trees are attacked by numerous devastating pests that cause great economic losses. The most famous pest which attacking guava in Egypt, is the plant parasitic nematodes especially the root-knot nematodes (*Meloidogyne* spp.). The root- knot nematodes (*Meloidogyne* spp.) are the most famous genera around the world, which responsible for at least 90% of all damage caused by PPNs (Khalil and Darwesh, 2018).

Using of fumigant or non-fumigant nematicides are the major choice for most farmers to manage PPN, due to their prompt efficacy, easy in application and the relatively low cost (Khalil and Darwesh, 2018 and Abd El-Aziz and Khalil, 2020). In Egypt, synthetic nematicides are the common solution for the problem of Phytonematodes. However, there are certain alternative approaches which is safe and eco-friendly manner such as the biocontrol agents (e.g. fungi, & bacteria), neem products, plant extracts, resistant plant varieties, soil solarization and soil amendments (Radwan *et al*., 2012; Renčo *et al*., 2014 and Khalil and Darwesh, 2018).

Several microbes are produced as commercial products to control different pests including the root-knot nematodes in varied crops. Many authors reported that *Paecilomyces lilacinus* is capable of parasitize on nematode eggs, juveniles and females of root-knot and cyst nematodes resulting in reduced soil density of PPNs (Jatala, 1986; Atkins *et al*., 2005 and Kiewnick and Sikora, 2006). Furthermore, *Trichoderma* species are common fungi in the soil and root ecosystems, which have nematicidal activity towards root-knot nematodes (Izuogu and Abiri, 2015 and Mukhtar, 2018).

Also, *Pseudomonas fluorescens* is one of the most commonly used biocontrol agents against plant parasitic nematodes, in addition to be considered a powerful phosphate solubilizing bacterium and activate the defense mechanisms in plants (Khan *et al*., 2009; Saad *et al*., 2010; Akhtar *et al*., 2012 and Rahanandeh and Moshaiedy, 2014). Moreover, *Bacillus thuringiensis* (Bt), is a soil bacterium that possessing nematicidal

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crystal proteins, is being used widely to control PPNs (Ramalakshmi *et al*., 2020).

Fluopyram is belongs to pyridinyl-ethyl-benzamide class which discovered and produced by Bayer Crop Science as a broad-spectrum fungicide (Rieck and Coqueron, 2012). Globally, fluopyram ia a new member at nematicides family and was introduced in 2013 under the trade name Verango® in Honduras (McDougall, 2014). Recently, fluopyram was registered in Egypt as a nematicide and became available at the end of 2020. Therefore, the present study aimed to investigate the effectiveness of some bio-control agents (*Paecilomyces lilacinus, Trichoderma viride*, *Pseudomonas fluorescens* and *Bacillus thuringiensis* var. *kurstaki*) and a new registered nematicide (Fluopyram) against the incidence of root-knot nematodes (*Meloidogyne* spp.) and on the levels of N, P, K in leaves of guava trees.

MATERIALS AND METHODS

The present investigation was carried out in a private orchard located at EL-Bossaily area, Rashid region, Behera governorate, Egypt during 2020 and 2021 seasons on guava trees (*Psidium guajava* L.) of five years old grown in sandy soil. Mature twenty-four guava trees (Banaty cv.) were used in this study, the selected trees were nearly identical in vigor and size, and spaced at 3 X 3 m apart (175 trees / Fed.), and received the same cultural practices usually adopted for this area according to the recommendation of Ministry of Agriculture, Egypt.

The soil samples were collected according to Barker (1985). Three sub-samples were collected from 10 to 35 cm depth of each replicate to form a composite sample of approximately 2 kg, which was then thoroughly mixed. The soil samples were collected directly before application and after applying the treatments of each replicate. Also, for galls and eggs in roots the samples were collected from each replicate before and after treatments. All treatments were applied as soil drenches, except fosthiazate was mixed with soil in the rhizosphere zone.

The tested products were applied to evaluate their activity on root-knot nematodes *(Meloidogyne* spp.), as well as, the mineral composition (N, P, K) in leaves of guava trees. The examined products were utilized as follow: -

1. Nemathorin® (Fosthiazate 10% G) applied at the recommended dose of 12.5 Kg/feddan.
2. Velum prime® (Fluopyram 40% SC) applied at the recommended dose of 500 ml/feddan.
3. Bio-Nematon® containing 1×10^9 cfu/g of the fungus *Paecilomyces lilacinus,* applied at the recommended dose of 4 kg/ feddan.
4. Bio Cure-F® contains 1×10^8cfu/g of the fungus *Trichoderma viridi*, applied at the recommended dose of 1.2 kg/ feddan.
5. Bio Cure-B® contains 1×10^9 cell/g of the bacterium *Pseudomonas fluorescens,* applied at the recommended dose of 1.2 kg/ feddan.
6. BIOTECT® 9.4% WP (equally 32000× 10^6 iu) of the bacterium *Bacillus thuringiensis* var. *kurstaki,* applied at the suggested doses of 5 and 10 kg/ feddan.

The second stage juveniles (J2) of *Meloidogyne* spp. were extracted from a 250g sub-sample soil of each replicate, using the sieving and Baermann plates' technique (Ayoub, 1980), and counted under a stereomicroscope. The reduction (%) in the soil population density, galls/5g roots and eggs/5g roots were calculated after 35 and 70 days of application during both seasons (2020&2021) according to Henderson and Tilton's equation (1955) as follow:

$$\mathbf{Red.}\,(\%) = \{\,\mathbf{1} - \left(\frac{\mathbf{a}}{\mathbf{b}} \times \frac{\mathbf{c}}{\mathbf{d}}\right)\} \times \mathbf{100}$$

Where:

a = Population density in treatment after application

b = Population density in treatment before application

c =Population density in check untreated (control) before application

d =Population density in check untreated after application

Statistical Analysis

The gained data of the present study were subjected to the analysis of variance (ANOVA) as complete randomized design (CRD) using the computer program CoStat 6.303 (2005). Means were separated using the least significant difference (LSD) method at $P \leq 0.05$.

RESULTS AND DISCUSSION

Using of bio-control agents namely; Bio-Nematon® (*Paecilomyces lilacinus*), Bio Cure-F® (*Trichoderma viridi*), Bio Cure-B® (*Pseudomonas fluorescens*) and BIOTECT® (*Bacillus thuringiensis* var. *kurstaki*), in addition to Nemathorin® (fosthiazate) and Velum prime® (Fluopyram) were significantly effective in control of root-knot nematodes (*Meloidogyne* spp.) on guava trees at 35 and 70 days after treatments (DAT) in comparison with the untreated check (Table 1). During the 1st season, *B. thuringiensis* 2 (10 kg/fed.) was the most effective treatment which recorded suppression in soil population density (J_2/ 250g soil) by 88.85% as general mean reduction of both intervals at 35 and 70 days, while *P. lilacinus* was the least effective treatment with 68.75%, the rest treatments recorded reductions ranged from 82.95 to 73.61%. In the 2nd season, *P. lilacinus* was the superior treatment which reduced soil

Table 1. Effect of some biological control agents, fluopyram and fosthiazate on soil population of *Meloidogyne* spp. on guava trees during two successive seasons of 2020&2021

Treatments	Juveniles / 250g soil during the 1st season 2020					
	Pi	Pf (35 days)	Reduction (%)	Pf (70 days)	Reduction (%)	GMR (%)
	Mean	Mean		Mean		
Trichoderma viride	280.33abc	153.33bc	63.01	106.00b	84.21	73.61
Paecilomyces lilacinus	146.00c	90.33cd	57.93	71.00b	79.58	68.75
Pseudomonas fluorescens	250.67abc	94.33cd	74.41	63.67b	89.33	81.87
Bacillus thuringiensis 1	379.67a	188.67b	66.21	133.67b	85.21	75.71
Bacillus thuringiensis 2	227.00bc	53.67d	83.92	33.67b	93.77	88.85
Fluopyram	154.00c	68.00cd	69.97	52.33b	85.73	77.85
Fosthiazate	325.67ab	115.33bcd	75.92	77.67b	89.98	82.95
Untreated check	220.00bc	325.33a	-----	526.67a	-----	-----
	Juveniles / 250g soil during the 2nd season 2021					
Trichoderma viride	97.33b	66.00bc	74.06	97.00bc	46.61	60.34
Paecilomyces lilacinus	165.00ab	25.00c	94.24	25.67d	91.60	92.92
Pseudomonas fluorescens	137.67ab	115.00b	68.26	134.67ab	47.18	57.72
Bacillus thuringiensis 1	178.33ab	112.00b	76.13	106.67ab	67.70	71.92
Bacillus thuringiensis 2	137.33ab	106.67b	70.49	83.00bc	67.36	68.92
Fluopyram	204.67a	225.67a	58.10	55.33cd	85.40	71.75
Fosthiazate	174.00ab	41.00bc	91.05	121.33ab	62.34	76.70
Untreated check	95.00b	248.33a	-----	177.33a	-----	-----

Within a column, numbers followed by different letter(s) are significantly different using LSD at p = 0.05

Means are the average of three replicates, Pi = Initial populations, Pf = Final populations, *Bacillus thuringiensis* 1= used at 5 kg / feddan (175 trees), *Bacillus thuringiensis* 2= used at 10 kg / feddan (175 trees), GMR (%) = General mean reduction of 35 &70 days.

population density by 92.92%, whilst *P. fluorescens* gave the at most less efficacy 57.72%, and the remained treatments gave reductions ranged from 76.70 to 60.34%.The obtained results are in agreement with those reported by Radwan, (2007), Khalil, (2013) and Khalil and Abd El-Naby, (2018) who found that *Bacillus thuringiensis* have the ability for managing *Meloidogyne* spp.. Meanwhile, Radwan, (2007) indicated that application of Dipel 2x®, Delfin®, Ecotech Bio®, Turex® and Xentari® (commercial products of *B. thuringiensis*) against root-knot nematode caused significant decrease in galls (49.3 to 78.2%) and the second stage juveniles in soil (63.7 to 76.7%).

Mohammed *et al.*, (2008) elucidated the use of vegetative and crystal toxins produced by *Bacillus thuringiensis* (Bt) gave the highest mortality of soil population at a range of 86-100%. Also, Using of *B. thuringiensis* var. *kurstaki*. (Dipel® 54% DF) against *M. incognita* as soil application at doses of 5 and 10 g / kg soil suppressed the soil population at rates ranged from 68.57 to 78.88% and galls from 70.63 to 78.42% in tomato plants (Khalil and Abd El-Naby, 2018).

In the same context, some selected isolates of *B. thuringiensis* indicated nematicidal activity against the final population comprised in soil (68.96 to 73.15%), egg masses (66.66-79.35%), eggs/ egg mass (43.85-50.00%), root galls (30.71-61.66%) and adult females (52.72-68.14%) of *M. incognita* (Ramalakshmi *et al*., 2020). Certain reports were showing that the produced Cry proteins by *B. thuringiensis* such as Cry5, Cry6, Cry12, Cry13, Cry14, Cry21; Cry55 have nematicidal activity (Wei *et al*., 2003 and Iatsenko *et al*., 2014). The toxic effect of crystal proteins on the nematodes was found to be caused by the extensive damage to their gut and the decrease in their fertility followed by death (Abd El-Moneim and Massoud, 2009). Also, Sikora *et al.*, (1993) suggested that *B. thuringiensis* produce metabolites which reduce hatch and attraction and/or degradation of specific root exudates which control nematode behavior.

The efficacy of each of applied treatments on root galls as also recorded during both seasons 2020 and 2021, as general mean reduction (Table 2) *B. thuringiensis* 1 (5 kg/fed.) during the 1st season was the superior treatment with 77.11% reduction, while *P. lilacinus* gave the least reduction with 60.22%. The rest treatments recorded decreasing ranged from 75.89 to 60.92%. Furthermore, *B. thuringiensis* 2 recorded the highest reduction in galls numbers by 70.90% during the 2nd season. Whereas, fluopyram was the less effective treatment with57.90%, all the other treatments gave reductions ranged from 69.59 to 60.79%. No significant differences were noticed between the most performed treatments at 35 and 70 DAT during both seasons.

Kiewnick and Sikora, (2006) recorded that the fungal biocontrol agent, *P. lilacinus* strain 251 (PL251) was potential to control the root-knot nematode *M. incognita* on tomato. The pre-planting soil treatment reduced root galling by 66% and number of egg masses by 74%. *P. lilacinus* was effective against the root knot nematode and significantly reduced the galls number, egg masses and eggs per egg mass. Moreover, the activity of *P. lilacinus* attributed to ability to infect eggs, juveniles and females of *M. javanica* by direct hyphal penetration (Khan *et al*., 2006). Besides, *P. lilacinus* produce lipases, proteases and chitinases which play an important role in the degradation of the egg shell (Gine and Sorribas, 2017 and Khan *et al*., 2004).

Regarding, *P. fluorescence* was found to be decrease the soil population of root-knot nematode (*M. incognita*) on tomato under greenhouse conditions at rate ranged from 81.10 to 92.70%, while root galls was minimized by 39.10% (Saad *et al*., 2010). Kavitha *et al.,* (2007) indicated that *P. fluorescens, B. subtilis* and *T. viride* were suppressed the nematode population significantly. Also, Sharma *et al.,* (2008) found that *P. fluorescens* decreased nematode penetration and galling by 54 and 70%, respectively. It was found also that the productionof fluorescent by *Pseudomonas* have inhibited the egg hatching and juveniles' penetration on pigeon pea roots colonization (Siddiqui *et al.,* 2005). The possible actions of antagonistic *P. fluorescence* against plant parasitic nematodes may be due to; altering root exudates which effect on nematodes behaviors, competition with pathogens for nutrients and production of hydrogen cyanide (HCN) as secondary metabolites (Saad *et al*., 2010 and Imran *et al.,* 2006).

Table 2. Efficacy of some biological control agents, fluopyram and fosthiazate on root galling of *Meloidogyne* spp. on guava trees during two successive seasons of 2020&2021

Treatments	Pi Mean	Pf (35 days) Mean	Reduction (%)	Pf (70 days) Mean	Reduction (%)	GMR (%)
	Galls / 5g roots during the 1st season 2020					
Trichoderma viride	82.67ab	68.33ab	52.64	21.67b	84.98	68.81
Paecilomyces lilacinus	48.00b	42.67b	49.33	24.33b	71.10	60.22
Pseudomonas fluorescens	114.67a	66.67ab	66.86	30.33b	84.92	75.89
Bacillus thuringiensis 1	86.33ab	38.00b	74.91	31.33b	79.31	77.11
Bacillus thuringiensis 2	67.33b	50.67b	57.11	41.67b	64.73	60.92
Fluopyram	60.33b	43.67b	58.75	35.00b	66.93	62.84
Fosthiazate	59.00b	37.33b	63.93	18.67b	81.97	72.95
Untreated check	53.67b	93.67a	-----	143.00a	-----	-----
	Galls / 5g roots during the 2nd season 2021					
Trichoderma viride	55.33ab	28.67bc	81.22	37.67a	50.96	66.09
Paecilomyces lilacinus	73.00ab	46.67bc	76.99	38.33a	62.19	69.59
Pseudomonas fluorescens	69.33ab	22.67c	88.23	47.33a	50.85	69.54
Bacillus thuringiensis 1	86.00a	57.00b	76.14	55.33a	53.67	64.91
Bacillus thuringiensis 2	68.67ab	36.33bc	80.95	37.33a	60.85	70.90
Fluopyram	60.00ab	29.00bc	82.60	55.67a	33.20	57.90
Fosthiazate	52.33ab	29.33bc	79.82	42.33a	41.76	60.79
Untreated check	38.67b	106.67a	-----	53.67a	-----	-----

Within a column, numbers followed by different letter(s) are significantly different using LSD at p = 0.05

Means are the average of three replicates, Pi = Initial populations, Pf = Final populations, *Bacillus thuringiensis* 1= used at 5 kg / feddan (175 trees), *Bacillus thuringiensis* 2= used at 10 kg / feddan (175 trees), GMR (%) = General mean reduction of 35 &70 days.

Trichoderma strains showed efficacy as plant growth promoter and *M. incognita* control agent on pepper (Herrera-Parra *et al*., 2017). Approximately, 22 to 35% reductions in galling index were reported in pots treated with *T. atroviride*, *T. virens*, and *T. harzianum*-C2. In addition, *T. atroviride* reduced the nematode egg production by 63% and the number of females by 14.36%. Also, Kiriga *et al*., (2018) studied the effect of *Trichoderma* spp. and *P. lilacinum* on *M. javanica* in production of commercial pineapple. Action mechanism of *Trichoderma* spp. may reduce RKN infections through triggering host defense. A group of researchers investigated whether *Trichoderma* modulates the hormone signaling network in the host to induce resistance to nematodes (Martınez-Medina *et al*., 2017). Using *M. incognita*, they found that root colonization by *Trichoderma* prevented nematode performance both locally and systemically at multiple stages such as invasion, gall formation and reproduction. First, *Trichoderma* primed SA-regulated defenses, limiting nematode root invasion. Then, it enhanced jasmonic acid (JA) regulated defenses, thereby antagonizing the deregulation of JA-dependent immunity by the nematodes, compromising galling and fecundity.

The potential of applied treatments was inspected against eggs formation/5g roots during both seasons (Table 3). Results showed that *P. fluorescens* was the most effective treatment with 94.61% (GMR), while fluopyram gave the least efficacy on egg formation by 67.13% during the 1st season. The rest treatments recorded reductions ranged from 92.76 to 74.03%. In contrast, during the 2nd season, fluopyram gave the highest reduction by 88.49%, whereas *P. fluorescens* gave the less reduction by 51.37%. The remain treatments recorded reduction values ranged from 71.69 to 52.65%.

It was found that the granular formulation of fosthiazate minimized the population soil density of *M. incognita* on tomato by 96.45% and root galls by 97.52% (Radwan *et al.*, 2012). Also, Saad *et al*., (2017) reported that fosthiazate suppressed the second stage juveniles, galls and eggs/ root system by 90.31,63.81 and 24.15%, respectively. The toxic effect of fosthiazate which is belonging to organophosphate group was acted by the inhibition of acetylcholinesterase (AChE) at cholinergic synapses in the nematode nervous system (Saad *et al*., 2017).

Table 3. Impact of some biological control agents, fluopyram and fosthiazate on egg formation of *Meloidogyne* spp. on guava trees during two successive seasons of 2020&2021

Treatments	Eggs/ 5g roots during the 1st season 2020					
	Pi	Pf (35 days)	Reduction (%)	Pf (70 days)	Reduction (%)	GMR (%)
	Mean	Mean		Mean		
Trichoderma viride	2718.00b	1390.00bc	78.23	572.67cd	92.06	85.14
Paecilomyces lilacinus	6736.67a	2160.00ab	86.21	445.00d	97.49	91.85
Pseudomonas fluorescens	5780.00a	883.33c	93.43	640.00bcd	95.79	94.61
Bacillus thuringiensis 1	6251.67a	1808.00b	87.56	335.00d	97.96	92.76
Bacillus thuringiensis 2	2185.67b	1680.00b	66.95	1086.33bc	81.11	74.03
Fluopyram	1626.67b	1386.33bc	63.35	1245.00b	70.92	67.13
Fosthiazate	2734.67b	866.67c	86.37	196.00d	97.28	91.82
Untreated check	1190.00b	2795.00a	-----	3157.00a	-----	-----
	Eggs/ 5g roots during the 2nd season 2021					
Trichoderma viride	2709.00abc	910.50b	87.42	1942.00bc	48.77	69.29
Paecilomyces lilacinus	1414.00cd	1614.00b	57.77	937.67cd	52.92	52.65
Pseudomonas fluorescens	792.67d	1381.50b	35.51	621.67d	44.32	51.37
Bacillus thuringiensis 1	1593.00bcd	782.00b	81.84	625.00d	72.14	62.60
Bacillus thuringiensis 2	3364.00a	1787.50b	80.34	2745.00ab	42.06	71.21
Fluopyram	2709.00abc	1090.00b	85.06	590.00d	84.49	88.45
Fosthiazate	1517.50bcd	850.00b	79.28	550.00d	74.27	71.69
Untreated check	2740.00abc	7319.67ab	-----	3834.00a	-----	-----

Within a column, numbers followed by different letter(s) are significantly different using LSD at p = 0.05

Means are the average of three replicates, Pi = Initial populations, Pf = Final populations, *Bacillus thuringiensis* 1= used at 5 kg / feddan (175 trees), *Bacillus thuringiensis* 2= used at 10 kg / feddan (175 trees), GMR (%) = General mean reduction of 35 &70 days.

The chemical nematicide; fluopyram protected the plants from *M. incognita* by reducing the population soil density of nematode at planting and protecting the plantlets against the initial penetration and significant root damage (Dahlin *et al.*, 2019). Also, the *In vitro* study proved that a very low dose (1.0 μg/mL) of fluopyram is able to paralyse juveniles of *M. incognita* when exposed to it for 2 h and protected tomato roots (Faske and Hurd, 2015). According to Rieck and Coqueron, (2012) fluopyram is a new subclass of complex II respiration inhibitors (FRAC, group7), which belongs to succinate dehydrogenase inhibitors (SDHI). In nematodes the compound has been described to inhibit mitochondrial respiration quinone-dependent succinate reductase (complex II – SQR inhibition), which leads to a fast and severe depletion of the nematode's cellular energy (adenosine triphosphate, ATP) (Broeksma *et al*., 2014 and Luemmen *et al.*, 2014).

In the termination of the experiments the levels of N, P, and K (%) were estimated in leaves of guava trees, during both seasons 2020 and 2021 (Table 4). In respect to, the level of N, P and K during the 1st season, results showed that the estimated values ranged from (0.22 to 0.73%), (0.12 to 0.89%) and (1.20 to 2.10%), respectively before treatment. While After treatment the values of N, P and K were ranged from (0.46 to 1.03%), (0.20 to 0.66%) and |(1.30 to 2.90%), respectively.

Regarding, the 2nd season, results showed that before treatment, the values of N, P and K were ranged from (1.00 to 1.60%), (0.1 to 0.9%) and (1.20 to 2.10%), respectively. Moreover, after treatment, the values of N, P and K were ranged from (1.10 to 1.70%), (0.10 to 0.20%) and (0.4 to 1.00%), consecutively. In general, it was noticed that the ranges of N, P, and k (%) were higher in the second season than the first one (without control values), which may be attributed to the impact of applied treatments, except total K (%).

The measured fluctuating values of inspected macro elements in the leaves of the treated guava trees, throughout both the following seasons of 2020 and 2021, to a more or a less extent, effect yield quantity and quality of growing fruits; that needs further investigations.

Table 4. Effect of infestation with *Meloidogyne* spp and some biological control agents, fluopyram and fosthiazate on the levels of N, P and K (%) in leaves of guava trees during two successive seasons of 2020&2021

Treatments	Macro elements in guava leaves' during 1st season 2020					
	Before			After		
	Total N (%)	Total P (%)	Total K (%)	Total N (%)	Total P (%)	Total K (%)
Trichoderma viride	0.22	0.47	1.30	0.56	0.20	2.30
Paecilomyces lilacinus	0.49	0.38	2.10	0.78	0.66	2.90
Pseudomonas fluorescens	0.25	0.12	1.70	0.67	0.42	1.60
Bacillus thuringiensis 1	0.38	0.48	1.10	1.03	0.27	1.45
Bacillus thuringiensis 2	0.48	0.39	1.20	0.73	0.48	1.30
Fluopyram	0.29	0.18	1.60	0.46	0.30	1.30
Fosthiazate	0.73	0.89	1.30	0.48	0.50	2.10
Untreated check	0.35	0.66	1.50	0.84	1.16	2.35
	Macro elements in guava leaves' during 2nd season 2021					
Trichoderma viride	1.10	0.50	1.30	1.60	0.10	1.00
Paecilomyces lilacinus	1.20	0.40	2.10	1.30	0.20	0.50
Pseudomonas fluorescens	1.20	0.10	1.70	1.70	0.10	0.80
Bacillus thuringiensis 1	1.10	0.50	1.10	1.60	0.10	0.40
Bacillus thuringiensis 2	1.00	0.40	1.20	1.50	0.20	0.60
Fluopyram	1.10	0.20	1.60	1.10	0.20	0.80
Fosthiazate	1.60	0.90	1.30	1.30	0.20	0.40
Untreated check	1.10	0.60	1.50	1.50	0.60	0.70

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الملخص العربي

الأداء البيولوچي لبعض العوامل الحيوية، الفلوبيرام والفوزثيازيت ضد نيماتودا تعقد الجذور علي اشجار الجوافة

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تم اختبار فاعلية بعض العوامل الحيوية، ومركبي الفلوبيرام والفوزثيازيت ضد نيماتودا تعقد الجذور علي اشجار الجوافة تحت الظروف الحقلية وذلك لموسمين متتاليين(٢٠٢٠ و ٢٠٢١). وكانت العوامل الحيوية المختبرة هي مركب بيونيماتون® (باسيلومايسيس ليلاسينس)، بيوكيور – أف® (تريكودرما فيردي)، بيوكيور –بي® (سيدموناس فلوريسينس) ومركب البيوتكت ® (باسيلس ثيورنجنسيس). وتم أخذ القياسات الخاصة بنيماتودا تعقد الجذور واللتي تشمل (عدد اليرقات/ ٢٥٠ جرام تربة، عدد العقد/ ٥ جرام جذور وتعداد البيض/ ٥ جرام جذور) وذلك بعد ٣٥ و ٧٠ يوم من المعاملة. بينت النتائج المتحصل عليها أن كلا من المعاملات اللتي تم تطبيقها أدت لإنخفاض تعداد العشيرة في التربة في مدي من ٦٨,٧٥ إلي ٨٨,٨٥% خلال الموسم الأول، وفي مدي من ٥٧,٧٢ إلي ٩٢,٩٢%خلال الموسم الثاني.

من ناحية أخري، ادت المعاملات الي انخفاض ملحوظ في تعداد التعقدات الجذرية في مدي يتراوح من ٦٠,٢٢ اي ٧٧,١١% وفي مدي من ٥٧,٩٥ الي ٧٠,٩٠% خلال الموسم الأول والثاني علي التوالي. أيضا أدت المعاملات ألي أنخفاض في تعداد البيض المعزول من الجذر في مدي يتراوح من ٦٧,١٣ الي ٩٤,٦١% وفي مدي من ٥١,٣٧ الي ٨٨,٤٥% خلال الموسم الأول والثاني علي التوالي. علاوة علي ذلك، أدت المعاملات المستخدمة الي أختلافات واضحة فى مستويات كلا من العناصر الكبري وهي النيتروجين، الفسفور والبوتاسيوم (%) في اوراق اشجار الجوافة خلال موسمي الزراعة.

كلمات مفتاحية: نيماتودا تعقد الجذور، فطر البسيلوميسس ليلاسينس، فطر التريكودرما فيردي، بكتريا سيدوموناس فلوريسنس، بكتريا باسيلس ثيورنجنسيس، فلوبيرام