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EVALUATION EFFICACY OF NEMATICIDE SEED TREATMENTS FOR THE CONTROL OF ROOT-KNOT NEMATODE, *MELOIDOGYNE JAVANICA* IN SUGARBEET PRODUCTION

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ABSTRACT: *The aim of this study was to test the effect of sugarbeet seeds treatment with Abamectin, Nemastop and Rugby nematicides on the reduction of early root penetration and damage rates of root-knot nematode, Meloidogyne javanica and sugarbeet productivity. Three approaches were done in this study, the first was to check the effectiveness of nematicide seed treatments at three soaking periods on germination ability of sugarbeet seed, the second to evaluate nematicide sugarbeet treated seeds under artificial infestation with M. javanica in greenhouse and the third was field trail in West Nubariya region under natural infestation with the same nematode species across two successive seasons 2011/2012 and 2012/2013. The study revealed that the variations in germination seeds parameters i.e. germination percentage, germination index and germination rate index are due to varying nematicide type and soaking period. The nematicide, Nemastop achieved the highest germination % (76.3%) followed by Abamectin (71.7%) then Rugby (62.0%), however, the control treatment revealed of 75.0%. All treatments of tested seeds that soaked for 90s had the best germination ability %, also, Nemastop with the assigned rate soaked for 90s gave the best germination ability (83%). Sugarbeet Plants from all of Abamectin, Nemastop and Rugby seeds were numerically differing for seedling height, seedling fresh weight; seedling dry weight, root length and root weight than plants from non-treated seeds as measured after 60 growing days under greenhouse conditions. Root galling and reproduction factor were less severe ($P < 0.05$) on sugarbeet plants from non- treated seeds. Nemastop treated seeds achieved the lowest root galling (1.7) and the lowest reproduction factor 0.39 followed by Abamectin seed treatment.*

Regarding root-galling severity in early season (28 DAS), there was no difference ($P < 0.05$) among all nematicide seed treatments or/and soil application of Nemacur. Nemastop seed treatment followed by Abamectin seed treatment pulled off the highest records for actual field emergence 89.3 and 84.3%, respectively. Regarding nematode parameters, the lowest values for gall index (1.1) and reproduction factor (0.56) were achieved by Nemastop seed treatment, whereas, the two other nematicide seed treatments (Abamectin and Rugby) came next for the same nematode parameters without significance ($P < 0.05$) between them and achieved the almost same of Nemacur soil application. Regarding qualitative reaction of sugarbeet there was no significant difference ($P < 0.05$) found among all treatments. Nemastop seed had the maximum values for T.S.S, Pol and sugar recovery % with significance ($P \leq 0.05$) for these parameters. The sugar and root yields differed with different nematicide seed treatments, but it was comparable to the highest sugar and root yields achieved under Nemastop seed treatment followed by Abamectin and Rugby. In addition, the amount of active ingredient needed to treat one seed is lower than when applying granules formulation as incorporated to the soil. The use of seed treatment is an attractive alternative for nematode control since it requires less chemical input than large scale field nematicide application, thereby reducing environmental risks, lowering the cost, reducing effects on beneficial and compatible with other IPM strategies.

Key words: *Seed treatments – sugarbeet – Nemastop- rugby- Meloidogyne – yield-nematicide-Abamectin- root- gall- reproduction factor.*

INTRODUCTION

Nematode species belonging to *Meloidygne* are pest of major food crops, vegetables, fruits and ornamental plants . It was always found in natural environments and in all parts of the world where agriculture is practiced. In Egypt, the two species, *M. javanica* and *M. incognita* are widely distributed and able to cause great losses in production and quality of sugarbeet crop (Gohar and Maareg, 2005). Chemical nematicides, due to their high availability and easy applicability, are generally preferred for their control; however, their excessive and continues use caused direct toxicity to predators, pollinators, fish and man, had adverse effects on soil health and environment and cause poor soli fertility, productivity and pesticides residues in products. The problems associated with nematicides application turned the workers view to focus on new strategies and new alternative agents for nematode management programs in sugarbeet production. Maareg and Badr (2000a) reported that addition of combination of *Asprgillus Niger*, *Trichoderma viride* (as fungi) and *Bacillus subtiles* (as bacteria) with nematicide, Oxamyl reduced the rate of nematicide application from 10 to 2.5 kg feddan^{-1} for control of *M. incognita* in sugarbeet production. Also, Maareg and Badr (2000b) in sugarbeet production, found that applying Cerealine as biofertilizer in combination with nematicide, fenemiphos at the half field rate was more effective in *M. incognita* nematode control and corresponding plant growth, quality characters and sugar yield, than applying of nematicide alone at the field rate as well as reduce quantity use of such synthetic chemical. However, Badr (2001) found that the addition of fungal filtrate, *A. niger to* each of carbofuran, fenemaphos and Oxamyl nematicides reduced reduction in their LC_{50} values by 65.38, 90.00 and 83.00%, respectively than those nematicides alone on *M. javanica* infesting sugarbeet.

In addition, the *Verticillium chlamydosporium* and *Bacillus cereus* filtrates had nearly the same effect of the nematicide, Oxamyl on root-knot nematode, *M. javanica*. Also, these biocontrol agents are ecological sound, economical viable and partial substitutes for costly and pollution causing chemical nematicides and have been successful instead of these chemical nematicides management strategy when used alone or in combination with other strategies (Maareg *et al.*, 2014). Use of treated seed can reduce chemical use by 99.4% compared to aerial applications and 88% compared to a banded in-furrow treatment (Frye, 2009). Thus, it considered among those ecofriendly root- knot nematode pest management strategies on sugarbeet. The use of seed treatment, however, is an attractive alternative for nematode control since it requires less chemical input than large scale field nematicide applications, thereby reducing environmental impact and lowering investment costs. Chemical seed treatment is only active in the rhizospheres of soil surrounding the root system of young plants and therefore reduces the risk of undesired accumulation. In addition, the amount of active ingredient needed to treat one seed is lower than when applying liquid or granules formulations as drench or incorporated to the soil. Furthermore, seed treatment is faster to handle than liquid or granular formulations, especially in areas where nematicides are incorporated into the soil and where labour is unskilled. Treating seeds directly reduces the high cost associated with all other application forms.

The aim of this study was to test the effect of sugarbeet seed treatments with Abamectin, Nemastop and Rugby nematicides on the reduction of early root penetration and damage rates of root-knot nematode, *Meloidogyne javanica* and sugarbeet productivity.

MATERIALS AND METHODS

Sugarbeet seeds

The Sugarbeet (*Beta vulgaris Saccharifera* L.) seeds of variety Beta max (multigerm) used in the germination tests with different treatments were obtained from the Sugar Crops Research Institute, Agricultural Research Center.

Nematicides used

- Abamectin as liquid formulation is a macrocyclic lactone derived from the soil bacterium *Streptomyces avermitilis* that has been shown to have nematicidal properties (Putter *et al.* 1981) and a different mode of action than the other currently available nematicides (Tuner and Schaeffer 1989). The rate of application 40 ml feddan^{-1}
- Nemastop as suspension formulation, is a natural product consist of herb extracts (thio- compounds) 8% and natural organic matter effective in fighting nematodes. The rate of application 10 L feddan^{-1}
- Rugby 20% CS (Cadusafos) is an organophosphorous - nematicide soil insecticide discovered, developed and marketed by FMC Corporation USA. The rate of application 1.5 L feddan^{-1}.
- Fenamiphos 10% G (Nemacur) is an organophosphorous. The application rate 15 kg feddan^{-1} used in this study as soil treatment at planting in the seed furrow comparable with the previous Nematicides.

Treatments of seeds

The Sugarbeet seeds soaked in the tested Nematicides, Abamectin, Nemastop and rugby at the recommended application rate for 60 , 90 and 120 seconds, for each in an Erlenmeyer flask shaken by hand, then left to dry on a paper at open fresh air, untreated sugarbeet seeds were used as controls throughout the study.

Germination experiment

The treated and untreated sugarbeet seeds were planted at 0.5 cm depth in a seed raising trays locally purchased containing organic material mixture (peat moss) and sand 1:2. Each block of 120 seeds were placed at random in a greenhouse (23 ± 5$^{\circ c}$ & 60 ± 5 RH) and they were watered daily. Each treatment was replicated four times.

Standard germination test

The germination percentage (*Grm.P*) was determined after 7, 14 and 21 days from sowing. Germination was assessed as the percentage of seeds producing normal seedlings as defined in the handbook of seedling classification (International Seed Testing Association, 1993 and 1996). Also, germination Index (*Grm.I*) and Germination Rate Index (*Grm.R.I*) were calculated. All statistical analyses were done using Mstat var. 4.

$$Grm.P = \frac{\text{Total No. of seedling that emerged in the final count}}{\text{Total No. of seeds planted}}$$

$$Grm.I = \frac{\Sigma(Nx)(DAS)}{\text{Total No. of seedling that emerged in the final count}}$$

Where, Nx is the number of seedling that emerge on day x after sowing, DAS is day after planting.

$$Grm.R.I = \frac{\text{Germination Index}}{\text{Germination Percentage } (0-1 \text{ scale})}$$

Greenhouse test:

Nematode eggs were collected from the heavily infected roots of eggplant (*Solanum melongena,* 'Black beauty') with root-knot nematode, *Meloidogyne javanica*. The eggplant plants were up-rooted and the egg masses were picked as described by Hartman and Sasser (1985). Tests were initiated on 5 June 2012 in a greenhouse. Sandy loam soil collected from sugarbeet fields of West Nubariya province was air-dried, homogenized and steam sterilized using an autoclave for 3 h at 85°C. Pots (20 cm diameter) were filled with soil (3.5 kg pot^{-1}). Two of the treated seeds (with different nematicides that soaked for 90 sacond . for each). One hour before inoculation, Nematode inoculums' of 4000 *M. incognita* eggs per pot according to Gohar and Maareg (2009) - approximately 400 eggs 250 cm^{-3} soils. Inoculum was distributed into two holes (approximately 2.5 cm deep) and covered with soil. Pots were arranged in complete block design with four replications for each and watered immediately following inoculation. The plants were then watered regularly and 15 g of compound fertilizer (15:15: 15) was added to the 3 weeks old plants.

Sixty days after sowing, the plants were up-rooted by placing the small pots in a slanting position into a big pan containing water, while being shaken gently until the soil was moved into the pan and roots were cleaned. The roots were examined and rated for galling responses on a scale; 1 = 1 – 2 galls; 2 = 3 – 10 galls; 3 = 11 – 20 galls; 4 = 31 100 galls; 5 = 101 galls and above according to Taylor and Sasser (1987). Before uprooting the plants, 250 cm3 of soil around each plant was collected up to a depth of 10 – 15 cm. From each of the soil samples using a modified Bearman's tray method as described by Barker (1985), second juvenile larvae (J2) were extracted. From 2 mL suspension of each extract, J2 were counted under a dissecting microscope and this was repeated 10 times (20 mL) to estimate its population in 250 cm^{-3} of soils. Also, the growth parameters i.e. root length, root weight, shoot height, wet weight and dry weight of seedlings were determined. Data were analyzed by analysis of variance and mean comparison by Waller-Duncan K-ratio t-test ($P < 0.5$), using Mstat statistical software.

Field trial:

The test was conducted in a sugarbeet field naturally infested with *M. javanica* at 71st km Alexandria – Cairo desert road in West Nubariya region located at 30° 43'27.61" North and 30°00'55.79" East , in 7th of September 2012 and 2013. The soil type was sandy soil containing distinctly low percentage of organic matter (0.37 %), with a pH of 8.05. The average particle size distribution was 88.2 % sand, 5.5 % fine sand, 2.0 % silt and 4.3 % clay. The field had been planted for sugarbeet for several years before initiation of this study. All crop production practices were performed by the grower, and fertilization was based on soil nutrient analysis. Treatments consisted of check (seeds were soaked in water only) and both tested nematicides (Abamectin, Nemastop and Rugby) and soil application of Fenamiphos (Nemacur) seed treatments. Nemacur was applied at sowing in the seed furrow at 1.5 kg a.i. fed^{-1} this rate was determined according to Maareg *et al.* (1999). All treatments were planted at a rate of 5 seeds m^{-1} of row. Treatments were arranged in a randomized complete block design with four replications. Experimental plot was six rows (50 cm spacing) by 3.5 m in length (3 m×3.5 m = 10.5 m^2 i.e. 1/400 Fed), Then manual sowing of seeds of sugarbeet variety were carried out on one side of the ridges keeping hill to hill distance of about 20 cm according to layout plan to obtain a rate of 40000 plants $fed.^{-1}$. Soil samples were collected on 7th September, 21st September, 5th October and 19th October and the experiment was harvested in the 1st week of March in both studied seasons.

Data regarding Actual field emergence (germination percentage): The actual field emergence (*FE*) calculates the total number of the plants emerged n_e per theoretical number of the plants (application rate) times a hundred (%).

$$FE = \frac{n_e}{n_k} \times 100\%$$

(Beckmann *et al.* 2004)
n_e: number of plants after the field emergence
n_K: number of theoretical applied seeds

Also, Actual plant density (*PD*): The actual plant density is defined as the number of the plants per feddan at harvest was determined as follows:

$$PD_p = \frac{nP \times 100}{lR} \text{ (Plants fed}^{-1}\text{)}$$

(Beckmann *et al.* 2004)
*n*P: number of plants
l: row length (m)
R: row distance (cm)

After the experimental period, plants were harvested and numbers of galls and gall index were estimated according to Taylor and Sasser (1987). The final population of second stage juvenile larvae in soil was extracted from soil according Backer (1985), also, reproduction factor calculated. Root yield and leaves yields were determined. Samples of roots (10 roots from each treatment) taken in random and sent to Nile Sugar Company Lab to determine technological characters i.e. Brix and sucrose contents (Pol %) . Then the sugar recovery (%) in different sugarbeet seeds treatments was estimated with the help of formula:

Sugar Recovery (%) = [3P/2{1-(F+5)/100}-B/2{1- (F+3)/100}] × 0.93 (Anonymous, 1970), where

P = Pol % of juice.
B = T.S.S % of juice.
F = Fibre % beet.
0.93 = Recover factor.

The data collected were subjected to statistical analysis and means were compared with LSD test (P = 0.05) as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

Germination rate as affected by nematicide seed treatments:

After 21 days of germination, the results in Table (1) indicated that the variations in germination seeds parameters are due to varying nematicide type and soaking period. As days after sowing advanced germination percentage increased. The highest seeds germination rate occurred after 21 DAS, among the nematicides, the results indicated that the nematicide, Nemastop achieved the highest germination percentage (76.3%) followed by Abamectin (71.0%) then Rugby (62.0%), however, the control treatment recorded of 75%. All treatments of tested nematicides that soaked for 90s had the best germination ability % Table (1) and it was in contrary for those seeds soaked for 60 and/or 120s. Sugarbeet seeds that were soaked in the nematicide, Nemastop with the assigned rate soaked for 90s gave the best germination ability (83%) after 21 days followed by the same nematicide but exceptionally on soaked period of 120s followed by Abamectin treated sugarbeet seed soaked for 90s (79%). The worst germination abilities % were almost noticed over abamectin treated sugarbeet seed soaked for 120s (57%) and Rugby treated sugarbeet seeds (61%) for the same soaked period.

Table1. Effect of nematicide seed treatments on germination percentage (*Grm.P*), germination index (*Grm.I*) and germination rate index (*Grm.R.I*) at 21 days after sowing.

Nematicide seed Treatments	Soaking period (seconds)	*Grm.P* 7 DAS	*Grm.P* 14 DAS	*Grm.P* 21 DAS	*Grm.I* 21 DAS	*Grm.R.I* 21DAS
Abamectin	60 s.	40	61	77 b	36.0 b	46.8 a
	90 s.	44	64	79 ab	36.5 b	46.2 a
	120 s.	22	36	57 d	26.7 d	46.8 a
Mean		35.3	53.7	71.0	33.1	46.6
Nemastop	60 s.	35	54	65 c	30.4 c	46.8 a
	90 s.	51	73	83 a	39.4 a	32.7 b
	120 s.	49	69	81 a	37.5 a	46.3 a
Mean		45.0	65.3	76.3	35.8	41.9
Rugby	60 s.	22	33	62 cd	26.3 d	46.1 a
	90 s.	37	59	63 c	30.5 c	48.4 a
	120 s.	35	54	61 cd	29.5 c	47.6 a
Mean		31.3	48.7	62.0	28.8	47.4
Control	60 s.	41	51	73 b	35.0 b	47.9 a
	90 s.	44	58	75 b	36.3 b	48.4 a
	120 s.	43	58	77 b	37.0 b	48.1 a
Mean		42.7	55.7	75.0	36.1	48.1

Means having different letters at the same column are significantly different at 5% level of significance.

From the same Table (1), Also, the nematicide, Nemastop seed treatment achieved the highest *Grm.I* value (35.8) followed by Abamectin seed (33.1) then Rugby seed (28.8) treatments, however, control treatment recorded (36.1). Also, in all nematicide seed treatments that soaked for 90s recorded the highest values of *Grm.P* and *Grm.I* in comparison with the other soaking periods (60 and 120s). Nemastop treatment with seeds soaked for 90s gave the highest *Grm.P* and *Grm.I* values followed by Abamectin and Rugby seed treatments with an average, 36.5 and 30.5 , respectively. *Grm.P* and *Grm.I* almost had significant values for all tested treatments $P \leq 0.05$'s level of significance, while, the almost absent of significance on $P \leq 0.05$'s level over all values of *Grm.R.I.*

Greenhouse trial:

Sugarbeet plants from all nematicide seed treatments were numerically differing for seedling height, seedling fresh weight; seedling dry weight, root length and root weight than plants from non-treated seeds as measured after 60 growing days under greenhouse conditions (Table, 2). Also, Root galling and reproduction factor were less severe ($P < 0.05$) on sugarbeet plants from non- treated seeds 60 DAS (Table, 3). Among the three tested nematicide seed treatments, Nemastop seed treatment was superior for all mentioned seedling parameters with an average of 28.4. 48.0, 29.8 and 73.7% increase than untreated seed for seedling root length, root weight, shoot height, seedling wet weight and dry weight, respectively (Table, 2). Beside, achieving the lowest root galling (1.7) resulted from Nemastop seed treatment and the lowest reproduction factor (0.39) followed by abamectin seed treatment with significant difference ($P < 0.05$) as shown in Table, 3.

Field Experiment:

Table. 4 showed that the initial population density of *M. javanica* second stage juveniles (j2) was almost similar at planting among all treatments (around 210 j2). Population density was lower than ($P < 0.05$) 14 days after planting in plots receiving ml Abamectin, Nemastop and Rugby seed treatment or soil application of Nemacur (Fenamiphos) than with the pots non-treated. And the density of nematode population declined gradually up to the third week (21 DAS) and turn down sharply towards mid-season (0 value 250 cm^{-3} j2 or undetectable) except for Rugby seed treatment (27 j^2 250 cm^{-3}) but it is as well considered a promising seed treatment for lowering the population density of *M. javanica* down to 86.6% at the fourth week (28 DAS). Regarding root-galling severity in early season (28 DAS), there was no difference ($P < 0.05$) among all nematicide seed treatments or/and soil application of Nemacur (Table, 4).

Under field condition, results showed in Table.5, regarding actual field emergence (germination percentage), actual plant density, Leaves weight (tons fed^{-1}), roots yield (tons fed^{-1}) and nematode parameters i.e. gall index and reproduction factor, demonstrated that Nemastop seed treatment followed by Abamectin seed treatment pulled off the highest records for actual field emergence 89.3 and 84.3%, respectively, without significance between them over ($P < 0.05$) both are followed by rugby sugarbeet seed treatment (68.5%) without significance ($P < 0.05$) among Abamectin seed treatment or/and soil application of Nemacur (Fenamiphos-10 % G) which was applied at planting in the seed furrow. Also, the same tendency can be noticed for actual plant density, Leaves weight (tons fed^{-1}) and roots yield (tons fed^{-1}), that Nemastop seed treatment in the lead followed by Abamectin seed treatment then Rugby seed treatment with no significance along with soil application of Nemacur except for Nemastop seed treatment.

From the same Table (5), regarding nematode parameters, the lowest values for gall index (1.1) and reproduction factor (0.6) were achieved by Nemastop seed treatment, whereas, the two other nematicide seed treatments (Abamectin and Rugby) came next for the same nematode parameters without significance ($P < 0.05$) between them and achieved the almost same of Nemacur soil application.

Regarding qualitative reaction of sugarbeet technological characters (Table, 6), there was no significant difference ($P < 0.05$) found among all treatments including control treatment or/and soil application of Nemacur for T.S.S, Pol and sugar recovery% except for Nemastop seed treatment which had the maximum values with significance ($P \leq 0.05$) for T.S.S%, Pol% and sugar recovery % (22.2, 20.0 and 12.7, respectively). The sugarbeet yield differed with different nematicide seed treatments, but it was comparable to the highest sugar yield achieved under Nemastop seed treatment (4.5 tons fed^{-1}) followed by Abamectin and Rugby which had similar values (3.0 and 3.0 tons fed^{-1}, respectively) on the basis of nematicide seed treatments these two nematicide sugarbeet seed treatments were so promised comparably with soil application of Nemacur 3.1 tons fed^{-1}) as shown in Table,6.

Table 2. Effect of nematicide seed treatments on growth of sugarbeet seedlings infected with root-knot nematodes, *Meloidogyne javanica* at 60 days stage in the greenhouse.

Nematicide seed Treatments / *Growth Parameters	Abamectin	Nemastop	Rugby	Control
RL (cm)	16.3^{a} b	17.2^{a}	15.3^{b}	13.4^{c}
Change (+/-) % from control	21.6	28.4	14.2	
RW (g)	3.2^{b}	3.7^{a}	2.7^{c}	2.5^{c}
Change (+/-) % from control	28.0	48.0	8.0	
SH (cm)	55.3$^{a\,b}$	57.5^{a}	49.7^{b}	44.3^{c}
Change (+/-) % from control	24.8	29.8	12.6	
WW (g)	25.8$^{b\,c}$	33.3^{a}	23.5$^{c\,d}$	21.3^{d}
Change (+/-) % from control	21.1	56.3	10.3	
DW (g)	3.0^{b}	3.3^{a}	2.7^{c}	1.9^{d}
Change (+/-) % from control	57.9	73.7	42.1	

- * Root length (RL), root weight (RW), and shoot height (SH), wet weight (WW) and dry weight (DW).

Table, 3. Effect of nematicide seed treatments on root-galling severity, and reproduction factor of root-knot *Meloidogyne javanica* on sugarbeet in the greenhouse

Nematicide seed Treatments	Root gall index	J2/250 cm^3 of Soil (Pf)	R-factor
Abamectin	2.8^{b}	203^{c}	0.51
Nemastop	1.7^{c}	155^{d}	0.39
Rugby	2.0^{b}	313^{b}	0.78
Control	5.0^{a}	1253^{a}	3.1

Reproduction factor: R= Pf/Pi, where Pi =initial population density (400 eggs/250 cm^3) and Pf= final population density.

Table 4, Effect of nematicide seed treatment on early season of root-knot nematode, *Meloidogyne javanica* population densities and root galling in Comparison with nematicide, Nemacur soil application (as combined analysis of 2011/2012 &2012/2013 seasons.

Nematicide seed Treatments	Population density Days After Sowing				Gall Rating [a]
	0 (initial) j2 250 cm^{-3} soil	14	21	28	
Abamectin	208^{a}	53^{b}	33^{cb}	0^{c}	2.1^{b}
Nemastop	205^{a}	41^{b}	21^{c}	0^{c}	1.0^{b}
Rugby	217^{a}	55^{b}	44^{b}	27^{b}	1.6^{b}
Nemacur	214^{a}	39^{cb}	17^{cd}	0^{c}	1.0^{b}
Control	206^{a}	230^{a}	256^{a}	435^{a}	3.3^{a}

Rating scale of 0–10 where 0 = no galling and 100 = 100% of root system galled.
Means within columns followed by the same letter do not significantly differ (*P* < 0.05) by Waller-Duncan K-ratio t-test.

Table.5, Effect of nematicide seed treatments on quantitative reaction of sugarbeet field infestation by root-knot nematode, *Meloidogyne Javanica* in comparison with nematicide, Nemacur soil application (as combined analysis of 2011/2012 & 2012/2013 seasons.

Nematicide seed Treatments	quantitative reaction as						
	Actual field emergence%	Actual plant density	Leaves weight (tons fed^{-1})	Roots yield (tons fed^{-1})	Gall index	Reproductive factor	Rank for beet (roots) yield
Abamectin	84.3^{a}	28.9^{b}	16.8^{a}	27.5^{b}	2.0^{c}	0.9^{b}	3
Nemastop	89.3^{a}	33.6^{a}	18.5^{a}	35.7^{a}	1.1^{e}	0.6^{c}	1
Rugby	68.5^{c}	27.3^{b}	15.9^{bc}	27.0^{b}	2.6^{b}	1.0^{b}	4
Nemacur	77.1^{b}	29.0^{b}	14.9^{c}	28.3^{b}	1.7^{d}	0.8^{bc}	2
Control	56.7^{d}	14.3^{c}	11.9^{d}	13.4^{c}	4.3^{a}	3.9^{a}	5

Average Pi for Root-knot nematode across the two studied seasons was 210 juvenile/250 cm^3 soils.

Table.6, Effect of nematicide seed treatments on qualitative reaction of sugarbeet field infestation by root-knot nematode, *Meloidogyne. Javanica* in comparison with nematicide, Nemacur soil application (as combined analysis of 2011/2012 & 2012/2013 seasons.

Nematicide seed Treatments	qualitative reaction as				
	T.S.S (%)	Pol (%)	Sugar Recovery (%)	Sugar Yield ($tfed^{-1}$)	Rank for sugar yield
Abamectin	18.8^{b}	16.4^{b}	10.8^{bc}	3.0^{b}	3
Nemastop	22.2^{a}	20.0^{a}	12.7^{a}	4.5^{a}	1
Rugby	19.4^{ab}	17.3^{ab}	11.2^{b}	3.0^{b}	3
Nemacur	19.2^{b}	16.9^{b}	11.0^{b}	3.1^{b}	2
Control	18.2^{b}	15.8^{bc}	10.2^{c}	1.4^{c}	5
LSD 0.05	1.9	1.8	1.3	0.4	

DISCUSSION

The efficiency of seed treatment was more visible under stress germination conditions. In optimum conditions washing and priming speeded up seed germination compared to control seeds. However, under the shortage and excess of water the acceleration of germination of the same seeds took place. Seeds of different sugarbeet varieties differed significantly in their germination rate Orzeszko- Rywka and Podlaski (2003). Since the current study used one sugarbeet seeds variety (Beta max), hence the variations in germination parameters are due to varying treatments i.e. nematicides and exposure periods. Although, the efficiency of seed treatment depended on initial seed quality, the worse the seed vigor, i.e. the slower the germination, the higher the efficiency of seed treatment (Draycott *et al.* 2002). But it can be said by other means from the control treatment in this study that seed vigor was good enough achieved (77% germination). Thus, the variation in germination parameters is a result mainly for the tested nematicidal seed treatments.

The potential for yield loss in sugarbeet fields due to root- knot nematodes, *Meloidogyne* spp. is relatively high in Nubariya and many other sugarbeet new reclaimed -producing areas due to its wide distribution (Gohar and Maareg, 2005). In the absence of acceptable sugarbeet cultivars with resistance to the nematode, the most effective method for root-knot management has been through annual applications of the nematicides 1,3-dichloropropene (Telone II) or aldicarb (Temik) or others. These materials are toxic, expensive, and pose considerable environmental risk. Nematicide applied as a seed treatment is an attractive approach to nematode management in crop such cotton due to its convenience and relatively low risk.

Under greenhouse Abamectin, Nemastop and Rugby applied as a seed treatment suppressed infection by *M. javanica for* 14 DAS and resulted in less severe root-galling severity early in the life of the sugarbeet plants. Nematode reproduction was also suppressed in greenhouse tests. Protection of the roots of sugarbeet seedlings from infection by *M. javanica* during the first 2 weeks after sowing may improve the development and yield of the plant (Cabrera *et al.*, 2009). However, the effects of abamectin on nematode infection and reproduction were not as evident in the field evaluations. Greenhouse trials were conducted in relatively controlled environments where the soil was steam pasteurized (greenhouse) prior to planting, which could have influenced the effect that was observed. In both of our field tests, the soil application of Nemacur , a material that has a long history of efficacy for nematode control in many crops, also had similar effect on nematode population densities or sugarbeet yield. It is possible that environmental effects on either the nematodes or the nematicides affected the efficacy of both materials in these sites. Abamectin has recently received attention as a seed treatment against nematodes in certain vegetable crops (Becker *et al.*, 2003) and appears to have considerable potential as a nematicide in this context.

The superiority of Nemastop in all trials of the this study, its efficacy on suppression of nematodes or positive effects on the growth parameters or yield components of sugarbeet need to pay more attention and it may be due to thio-compounds which implied in. Uhlenbroek and Bijloo (1958) identified an active phytochemical in *Tagetes erecta plena* as the thiophene ®-terthienyl it was nematicidal in vitro against the potato cyst nematode *Globodera rostochiensis*.

Higher plants have yielded a broad spectrum of active compounds, including polythienyls and isothiocyanate .The agricultural utilization of phytochemicals, although currently uneconomic in many situations, offers tremendous potential.

Adding Rugby toxin one week after inoculation of plant by Nematode egg and larvae caused a significant decrease in the number of egg and larvae of roots and population of larvae in soil (Soltani *et al.* 2013). The relative consistency of its effects on nematode penetration and reproduction in our greenhouse trials is compelling and merits further study. More detailed studies of the potential for this novel approach to nematode control in sugarbeet are needed across a range of field environments.

Conclusions and Recommendations:

Increasing awareness of damage caused by the root-knot nematodes, *Meloidogyne* spp. (RKN) in sugarbeet fields has prompted investigators to look at several different management strategies over the years. While crop rotation is the most effective management practice (Koenning *et al*., 1995) it is not always used due to market prices of non-host crops or poor agronomic qualities of resistant cultivars such as yield. The use of nematicides to control RKN, while, they may be effective are not registered for sugarbeet or are not economical. Due to environmental concerns and worker welfare their use is avoided when possible. Applying pesticides as a seed treatment has become a popular area of research because of the lowered risks and hazards associated with the handling and implementation associated with its use and its economic feasibility.

Use of seed treatments for control of plant-parasitic nematodes is a novel idea; however, as seen with many studies in different cropping systems there is a lot of variability and inconsistencies associated with their use. Future work should focus on the soil environment and how it affects the efficacy of these nematicide seed treatments. Possibilities are that these seed treatments may be beneficial for certain regions and soil types or under controlled conditions such as irrigated fields. Our current research suggests that host status is the most influential effect on the RKN and that the seed treatments are either short lived in the soil or are not moving with the root system. Sugarbeet nematicide seed treatments provided excellent early season protection against RKN

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تقييم معاملة البذور بالمبيدات النيماتوديه لمكافحة نيماتودا تعقد الجذور *Meloidogyne javanica* في إنتاج بنجر السكر .

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الملخص العربي

الهدف من هذه الدراسة: إختبار تأثير إستخدام ثلاثة مبيدات نيماتوديه (الأباماكتين – نيماستوب – الراجبي) لمعاملة بذور بنجر السكر بطريقة الغمر لفترات مختلفة في محاليل المبيدات بالتركيز الموصي به على خفض الإصابة المبكرة بالنيماتودا وعلي نمو النبات والمحصول.

أجريت ثلاث تجارب فى هذه الدراسة: الأولى هى إختبار تأثير معاملة البذرة بالمبيدات النيماتودية غمر لثلاث فترات (٦٠ ، ٩٠، ١٢٠ ثانية) على القدرة الإنباتية لبذور بنجر السكر, والثانية لتقييم هذه البذور المعاملة بالمبيدات النيماتودية تحت ظروف العدوى الصناعية ب *Meloidogyne javanica* فى الصوبة, والثالثة تجربة حقلية تمت فى منطقة غرب النوبارية تحت ظروف العدوى الطبيعية بنفس نوع النيماتودا وذلك خلال موسمين متتاليين ٢٠١١/٢٠١٢– ٢٠١٢/٢٠١٣ .

أظهرت الدراسة أن القدرة على الإنبات تتوقف على نوع المبيد وفترة الغمر وأفضل نسبة انبات بعد الغمر سجلت للمبيد نيماستوب (٧٦.٣%) يليه اباماكتين (٧١.٠%) ثم الراجبي (٦٢.٠%) وكانت معاملة الكنترول ٧٥.٠%. كما وجد أن كل معاملات المبيدات المختبرة والتى غمرت فيها البذور لمدة ٩٠ ثانية أعطت أحسن قدرة إنباتية عن مدتي الغمر ٦٠ و ١٢٠ ثانية وقد سجل المبيد نيماستوب أعلى نسبة انبات(٨٣.٠%) واقصى نسبة انبات كان بعد ٢١ يوماً من الزراعة. نباتات بنجر السكر من كل المعاملات إختلفت فى صفات النمو المختبرة (إرتفاع البادرة– وزن البادرة الطازج– وزن البادرة الجاف– طول الجذر– وزن الجذر) عن النباتات الغير معاملة وذلك بعد مرور فترة ٦٠ يوم من الزراعة تحت ظروف الصوبة. تعقد الجذور ومعدل التكاثر للنيماتودا كان أقل شدة (عند مستوى إحتمال أقل من ٠.٠٥%) عن نباتات بنجر السكر الناتجة من بذور غير المعاملة. البذور المعاملة بالنيماستوب حققت أقل قيمة لدليل تعقد الجذور (١.٧) ,اقل قيمة لمعامل التكاثر (٠.٣٩) يليها معاملة بذور بنجر السكر بالأبامكتين.

بالنظر الى قيم شدة تعقد الجذور فى وقت مبكر من الموسم (٢٨ يوم من الزراعة) , لم يكن هناك إختلاف (عند مستوى إحتمال أقل من ٠.٠٥%) بين كل معاملات البذرة بالمبيدات النيماتودية أومعاملة التربة بمبيد النيماكور. معاملة البذرة بمبيد النيماستوب ثم مبيد الأبامكتين سجلت أعلى القيم للإنبات الفعلى للنباتات فى الحقل (٨٩.٣%) , (٨٤.٣%) على التوالى.

وبالنسبة الى قراءات النيماتودا فقد سجلت أقل قيمة لدليل التعقد (١.١) ومعامل التكاثر (٠.٥٦) عند معاملة بذور بنجر السكر بالنيماستوب فى الحقل, بينما حققت المعاملتين الأخرتين لبذرة بنجر السكر (الأباماكتين والراجبى) المرتبة الثانية لنفس القياسات السابقة وبدون معنوية بينهما (عند مستوى إحتمال أقل من ٠.٠٥%) وحققتا نفس القيم تقريبا التى تحققت عند معاملة التربة بالنيماكور.

وبالنسبة لتأثير معاملة البذرة بالمبيدات النيماتودية على جودة بنجر السكر (نسبة المواد الصلبة الذائبة الكلية- نسبة تبلور السكر- نسبة السكر المستخلص) لم يكن هناك أى إختلافات معنوية (عند مستوى إحتمال أقل من ٠.٠٥%) بما فيهم معاملة الكنترول ماعدا معاملة البذرة بالنيماستوب التى حققت أعلى القيم لهذه القياسات السابقة. وقد إختلفت قيم محصول الجذور/ فدان الناتجة من معاملات البذرة بالمبيدات المختلفة حيث حقق مبيد النيماستوب أعلى قيمة لمحصول الجذور/ فدان.

ومما سبق نجد إن معاملة البذرة بالمبيدات سهلة التطبيق وتقلل من كمية المادة الفعالة للمبيد وبالتالي تقلل من تلوث البيئة واتكلفة والتأثيرات السلبية على الاحياء النافعة في التربة ولا تؤثر على نسبة إنبات البذور وتقلل من الإصابة المبكرة بالنيماتودا ولذا فهي تحسن من المحصول والجودة ولذا يمكن استخدامها كطريقة آمنة صديقة للبيئة لمكافحة النيماتودا في المحاصيل الغذائية أو استخدامها كعنصر من عناصر المكافحة المتكاملة مع غيرها من الطرق الاخرى.