

Comparative Efficacy of Biotic and Abiotic Agro-Commercial Products Against *Rotylenchulus reniformis* Under Field Conditions

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Abstract

In a field experiment, twelve commercial agro-products were applied as soil drench and 14 as foliar spray as recommended method of application and dose. The results indicated that Biofertile product was the best which had the highest suppressive effects followed by Algeferet and Perfect applied as a soil drench compared to nematode check. The most effective one of products applied as a foliar spray was Indole buteric acid then Feedchem and Amino strong with no significant differences. The experiments indicated that the SAR commercial materials (Nemakill, Indole-3 butyric acid, Gibirilic acid, Indole-acetic acid, Salicylic acid, Citric acid and Glutamic acid) applied as foliar spray reduced nematode counts and reproduction under all conditions. The Mega NPK recorded the best improvement in plant fresh and dry weights and yield criteria. Our results concerning plant growth and yield were highly significant in foliar application treatments more than soil application and the compounds used to induce systemic acquired resistance exhibited more enhancements in plant growth criteria and yield.

Key words: *R. reniformis*, Cowpea, commercial products.

Introduction

The reniform nematode *Rotylenchulus reniformis* is an obligate sedentary semi-endo devastating nematode parasite attacks over 300 plant species belonging to 46 families grown in the tropical, sub-tropical and warm- temperate regions of the world (**Robinson et al., 1997**).

Rotylenchulus reniformis, based on its scientific and economic importance was rated as one of the top ten nematodes in plant pathology (**Jones et al. ,2013**). In Egypt, it is found through the areas with heavier soil such as sandy loam, sandy clay and clay loam soils. Reasons of *Rotylenchulus reniformis* huge losses include the lack of available commercial host plant resistance, the ability to survive under adverse environmental conditions in the absence of the host (**Robinson et al., 2005**). Moreover, *Rotylenchulus reniformis* has short life cycle, wide host range (no host specificity) and unique parasitic habit.

In recent years, there has been tremendous increase in public awareness on environment pollution and climate change associated with pesticides toxicity and residues. This resulted in the shift in pest management strategies from chemical era in the late 1980s. Since then, the search for novel environmentally friendly alternatives with which to manage plant-parasitic nematode populations has therefore increasingly important. Several national and international companies have developed and produced numerous agro-biological, chemical eco-friendly compounds, claiming that these commercial materials have nematicidal and plant growth promoting properties. Such materials are natural products, biocides (**Montasser et al., 2012; Patil and Sharma, 2016**), bio-fertilizers (**Youssef and Eissa, 2014; Dar and Reshi, 2017**), botanical extracts (**Abid et al., 2005; El-Nagdi and Youssef, 2013**), organic (**Aktar and Malik, 2000; Zeeshan et al., 2016**) and inorganic fertilizers (**Bationo et al., 2006; Mahfoud, 2015**), plant growth promoters and systemic acquired resistance inducers (**Youssef and Lashein, 2014; Luangkhot, 2016**).

Extensive research is needed before they could be used reliably for management of plant-parasitic nematodes. Hence this is an attempt to evolve suitable bio, abio-management approaches through the present study for the control of *Rotylenchulus reniformis*.

Materials and Methods

This trial was carried out to design some regimes able to control the reniform nematode and enhance acquired resistance in the infected cowpea plants under field conditions. Experiment was conducted in summer 2016 at experimental area of Nematology Division, Zoology and Agric. Nematology Dept. The experimental plan was a randomized complete block design. The experimental field area was (8×3.7 m) solarly sterilized, plowed, harrowed, rowed and the seeds of cowpea cv. Kareem7 were planted on the prepared field by hand. The seeds were not treated with pesticides. Weeds were controlled manually at 4 and 8 weeks after planting.

Each treatment was replicated 3 times, each replicate had 3 plants and each plot size was three rows (2m length). Distance between plants was 60cm×30cm. After the seeds germinated, plants were thinned to one per site. One week after germination each plant at the experimental site was infected with 2000 un-swollen females of *R. reniformis*. After one week from infection, infected plants were treated with the commercial agro-products (biotic and abiotic) according to their recommended method of application and dose. (table 1, 2). Three months after planting, plants were taken off and data of nematode counts in 250gm soil and on 2gm roots were enumerated and plant growth criteria (plant fresh and shoot dry weight) and yield (number of pods, fresh and dry weight and number of seeds) were recorded.

Table (1): Soil drench treatments and doses of the field experiment.

Treatment	Dose /plant as soil drench
Biofertile (Mixed bacterial solution)	5 ml/ plant
<i>Pseudomonas fluorescens</i>	5 ml/ plant
<i>Serratiamarcescens</i>	5 ml/ plant
Mycorrhiza (vesicular arbuscular mycorrhiza)	3 gm/ plant
Algeferet (Marine algae extract +Amino acids+ plant growth regulator + Macro and micro elements)	2 ml/plant
Nemastop (Plant extracts from <i>Alliums</i> spp. + Titrasulphide Tri- Di- Mono)	2 ml/ plant
Nile compost (plant residues)	5 gm/plant
Nema clean (Amino acids)	0.5 ml/plant
Decka (Humic acid+ Fulvic acid+ Amino acids+ macro and micro elements)	1ml/ plant
Mega N/P/K (N19/P19/K19 + Mg 1%)	5 gm/ liter (25ml/plant)
Perfect (Oxamyl 24%+ Metalaxyl-M4%+ Tetramethrin 2%)	0.4 ml/ plant

Table (2): Foliar spray treatments and doses of the field experiment.

Treatment	Dose/ plant as foliar spray
Cal mix (Calcium and Boron carried on organic and amino acids)	0.4 ml/ plant
Humo plus 40 (Humic acid + macro and micro elements)	0.4 ml/ plant
Amino strong (Amino and organic acids + Fe+ Mn+ Zn)	0.4 ml/ plant
Feed chem. (Macro and micro elements)	8 gm/ liter
UniBor (Boron carried with vitamins + Gibirilic acid)	0.5 ml/ liter
Biogibb (Gibirilic acid + Ca+ B+ cytokinin)	0.25 gm/liter
Kenzo (cytokinine+ 6-Benzylaminopurine)	0.2 ml/liter
Glutamic acid	1gm/ liter
Citric acid	2 gm/ liter
Nemakill (Indolybutric acid 0.002%)	0.2 ml/liter
Indole-3 butyric acid	0.1 gm /liter
Indole-acetic acid	0.2 gm /liter
Gibirilic acid	0.2 gm /liter
Salicylic acid	1gm/ liter

Results

1. Effect on nematode population

a. Soil drench treatments

Data presented in table (3) reveal that remarkable significant reductions were apparent in root, soil and final population among most treatments compared to check. The microbial treatments demolished significantly root, soil, final populations and the subsequent build up.

Biofertile was the uppermost with significant differences in reducing nematode soil and root populations and build up among bio-agents and other treatments as well. Transparent significant reductions in nematode criteria were visible in *Serratia marcescens*, *Pseudomonas fluorescens* and Mycorrhiza, respectively.

Concerning plant extracts, Algeferet was in the lead and raised steadily its efficacy in reducing the nematode population up to 64.59% in the field. Meanwhile, Nemastop and Nile compost behaved the same with no significant differences.

In view of amino and organic acids, Nemaclean and Decka, they were not significantly different in action. Decka behaved unsatisfactory achieving 41.91% nematode reduction in the field. Mega NPK recaptured its potency in the field by achieving 50% reduction in nematode population. Perfect sustained its normal nematicidal action in the field which was around 70%.

b. Foliar sprays treatments

Data shown in table (4) infer that differences in all abiotic treatments (except Humo plus 40) were significant in reducing root, soil, final population and multiplication rates of *R. reniformis* as compared to check, however some of them showed no significance with each other. IBA was the most efficacious treatment, yet Kenzo was the lowest, Humo plus 40 had no effect at all, in the contrary improved the nematode development and reproduction recording values more than that of the nematode check.

Amino strong elevated its omnipotence to 67.74% in the field. Cal mix action was inconsistent. It encountered significantly the nematode criteria in the field as compared to check with improper reduction rate.

Feed chem was active achieving 67.98% in the field, meanwhile UniBor was not, achieving only 18.71% of reduction.

The plant growth regulator Biogibb beard resemblance to Gibirillic acid treatment in the field obtaining almost the same efficacious rates. Kenzo was not satisfactory effective. Glutamic acid increased its percentages of reductions to more than 50% in the field. Similar pattern was seen with citric acid treatment which reached its maximum potency in the field.

Table (3): Reproductivity of *Rotylenchulus reniformis* as influenced by biotic and abiotic commercial products treated as soil drench under field condition

Treatment	Dose/ plant	Nematode counts			Pf/Pi	%change of Final population
		Root pop./ 2gm root	soil pop./ 250 gm soil	Final population		
Biofertile (Mixed bacterial solution)	5 ml/ plant	400.67 cd	1656.00 d	2056.67 h	1.03 h	-72.69
<i>Pseudomonas fluorescens</i>	5 ml/ plant	224.67 de	3646.00 bc	3870.67 ef	1.94 ef	-48.59
<i>Serratiamarcescens</i>	5 ml/ plant	406.00 cd	2940.00 c	3346.00 fg	1.67 fg	-55.56
Mycorrhiza (vesicular arbuscular mycorrhiza)	3 gm/ plant	179.00 de	4071.00 b	4250.00 e	2.12 e	-43.6
Algeferet (Marine algae extract +Amino acids+ plant growth regulator + Macro and micro elements)	2 ml/plant	625.00 bc	2041.33 d	2666.33 gh	1.33 gh	-64.59
Nemastop (Plant extracts from <i>Alliums</i> spp. +Titr sulphide Tri- Di- Mono)	2 ml/ plant	117.00 e	5628.00 a	5745.00 bc	2.87 bc	-23.7
Nile compost (plant residues)	5 gm/plant	754.00 b	5461.67 a	6215.67 b	3.11 b	-17.45
Nema clean (Amino acids)	0.5 ml/plant	837.67 b	4259.67 b	5097.33 cd	2.55 cd	-32.3
Decka (Humic acid+ Fulvic acid+ Amino acids+ macro and micro elements)	1ml/ plant	436.67 cd	3937.67 b	4374.33 de	2.19 de	-41.91
Mega N/P/K (N19/P19/K19 + Mg 1%)	5 gm/ liter (25ml/plant)	637.30 bc	3032.00 c	3669.30 ef	1.83 ef	-51.27
Perfect (Oxamyl 24%+ Metalaxyl-M4%+ Tetramethrin 2%)	0.4 ml/ plant	215.30 de	2094.33 d	2309.63 h	1.15 h	-69.33
Nematode only		1281.67 a	6248.00 a	7529.67 a	3.76 a	0

In each column, values followed by the same letter(s) are not significantly different ($P \leq 0.05$).

Table (4): Reproductivity of *Rotylenchulus reniformis* as influenced by abiotic commercial products treated as foliar sprays under field condition.

Treatment	Dose/ plant	Nematode counts			Pf/Pi	%change of Final population
		Root pop./ 2gm root	soil pop./ 250 gm soil	Final pop.		
Cal mix (Calcium and Boron carried on organic and amino acids)	0.4 ml/ plant	960.00 bc	5400.00 bc	6360.00 b	3.18 b	-15.53
Humo plus 40 (Humic acid + macro and micro elements)	0.4 ml/ plant	806.00 cde	7076.00 a	7882.00 a	3.94 a	4.68
Amino strong (Amino and organic acids + Fe+ Mn+ Zn)	0.4 ml/ plant	600.00 efg	1829.00 efg	2429.00 de	1.21 de	-67.74
Feed chem. (Macro and micro elements)	8 gm/ liter	369.00 hi	2042.00 efg	2411.00 de	1.21 de	-67.98
UniBor (Boron carried with vitamins + Gibirilic acid)	0.5 ml/ liter	1123.00 ab	4998.00 c	6121.00 b	3.06 b	-18.71
Biogibb (Gibirilic acid + Ca+ B+ cytokinin)	0.25 gm/liter	555.67 fgh	2780.00 def	3335.67 cd	1.67 cd	-55.7
Kenzo (cytokinine+ 6-Benzylaminopurine)	0.2 ml/liter	832.00 cd	5601.67 bc	6433.67 b	3.22 b	-14.56
Glutamic acid	1gm/ liter	253.00 i	3488.00 d	3741.00 c	1.87 c	-50.32
Citric acid	2 gm/ liter	565.67 fgh	1771.00 fg	2336.67 de	1.17 de	-68.97
Nemakill (Indolybutric acid 0.002%)	0.2 ml/liter	925.50 bc	5268.00 bc	6193.50 b	3.10 b	-17.75
Indole-3 butyric acid	0.1 gm /liter	356.00 hi	1410.00 g	1766.00 e	0.88 e	-76.55
Indole-acetic acid	0.2 gm /liter	664.00 defg	3166.67 d	3830.67 c	1.92 c	-49.13
Gibirilic acid	0.2 gm /liter	497.00 gh	2812.00 de	3309.00 cd	1.65 cd	-56.05
Salicylic acid	1gm/ liter	739.00 cdef	2514.00 def	3253.00 cd	1.63 cd	-56.8
Nematode only		1281.67 a	6248.00 ab	7529.67 a	3.76 a	0

In each column, values followed by the same letter(s) are not significantly different ($P \leq 0.05$).

Our results reveal that the inducing systemic resistance materials are more constant in reducing the reniform population in the field than any material used, recording the most efficacious rates.

Indole- butyric acid was the highest (76.55%) reduction and Indole- acetic acid was the lowest. Salicylic acid recorded more than 50% reduction in the field.

2. Plant growth response

Soil drench treatments applied in the experiment (Table 5) indicated to wide variability in plant growth and yield due to commercial agro-products treatment. Generally, significant differences were recorded in yield characters more than growth parameters. Also, differences were significant in some not all criteria within materials in each group and among groups. *R. reniformis* alone inhibited significantly all growth parameters and yield criteria when compared to healthy check.

In case of microbial agents, *Serratia marcescens* ameliorated significantly shoot fresh weight, number of pods, their fresh and dry weights and number of seeds. But insignificant increase was found in shoot dry weight. No significant enhancement but disorder in some cases (Mycorrhiza and *Pseudomonas* treatments) when compared with nematode check. In case of Biofertile no significant improvement but disorder in plant fresh and dry weights, but significant increase in yield criteria was found in number of pods, pods dry weight and number of seeds when compared with the nematode check.

Differences between the plant extracts (Nemastop and Nile compost) were significant in improving cowpea yield characters but not shoot parameters, though no significance was found when compared to each other. NPK significantly promoted pods dry weight and number of seeds but not in number of pods and their fresh weight. The nemacide Perfect improved shoot fresh and dry weights but disordered yield characters significantly.

In the amino and organic acids compounds, NemaClean achieved the highest yield in terms of number of pods, fresh and dry weights of pods and number of seeds and overmatched even healthy check. Decka was the second, which improved significantly shoot parameters, pods dry weights and number of seeds.

Results of foliar sprays of the abiotic treatments in the field (Table 6) indicate to proportional relations between plant growth, yield parameters and the capabilities of commercial materials in reducing nematode population in many cases especially those inducing systemic acquired resistance materials.

No significant improve was observed in Cal mix and Humo plus 40 treatments but disorder in the former treatment. Meanwhile, Amino strong which was highly efficient in hampering *R. reniformis* population, enhanced significantly all parameters, and yield in particular. Feed chem. and UniBor exhibited significant increase in pod dry weight and number of seeds as compared to nematode check with no significance between them.

Table (5): Cowpea growth and yield as influenced by *Rotylenchulus reniformis* infection and biotic and abiotic soil drench treatments under field conditions.

Treatment	Dose/ plant	Plant parameters						Yield criteria					
		plant fresh weight (gm)	% Change	shoot dry weight (gm)	% Change	no. pods	% Change	pods fresh weight (gm)	% Change	pods dry weight (gm)	% Change	no. seeds/ pods	% Change
Biofertile (Mixed bacterial solution)	5 ml	135.7 f	-7.8	25.7 e	-16.7	4.4 de	88.8	6.9 e	11.4	4.9 c	206.3	43.8bcd	188.5
<i>Pseudomonas fluorescens</i>	5 ml	167.3 ef	13.7	25.9 e	-16.0	2.0 fg	-14.2	4.2 f	-31.9	1.1 d	-31.3	11.0 f	-27.5
<i>Serratiamarcescens</i>	5 ml	242.4 bode	64.7	40.9 bcd	32.7	6.5 ab	179.0	15.4 b	149.6	8.5 a	431.3	60.5 a	298.8
Mycorrhiza (vesicular arbuscular mycorrhiza)	3 gm	186.6 def	26.8	40.3 bcd	30.8	1.0 g	-57.1	3.0 f	-51.4	1.0 d	-37.5	8.0 f	-47.3
Algeferet (Marine algae extract +Amino acids+ plant growth regulator + Macro and micro elements)	2 ml	167.7 ef	13.9	29.9 de	-3.0	4.0 e	71.7	11.0 c	78.3	4.5 c	181.3	38.5 d	153.8
Nemastop (Plant extracts from <i>Alliums</i> spp. + Titrasulphide Tri- Di- Mono)	2 ml	260.1 bcd	76.7	35.0 cde	13.6	6.0 abc	157.5	9.3 d	50.7	8.1 ab	406.3	50.0 b	229.6
Nile compost (plant residues)	5 gm	133.2 f	-9.5	27.4 de	-11.0	5.3bcd	128.8	9.7 cd	57.2	7.0 b	337.5	48.3 bc	218.6
Decka (Humic acid+ Fulvic acid+ Amino acids+ macro and micro elements)	1ml	361.9 a	145.9	57.7 a	87.3	4.9 cde	109.0	7.4 e	19.5	4.8 c	200.0	41.9 cd	176.0
Nema clean (Amino acids)	0.5 ml	216.2 cdef	46.9	36.8 cde	19.4	7.0 a	200.4	21.1 a	241.5	8.4 ab	425.0	60.0 a	295.5
Mega N/P/K (N19/P19/K19 + Mg 1%)	5 gm/ liter (25ml/plant)	199.6 def	35.6	56.5 a	83.3	2.3 f	-2.6	7.0 e	13.5	4.3 c	166.9	28.9 e	90.7
Perfect (Oxamyl 24%+ Metalaxyl-M4%+ Tetramethrin 2%)	0.4 ml	300.2 abc	104.0	52.5 ab	70.5	1.0 g	-57.1	4.0 f	-35.1	1.0 d	-35.6	9.0 f	-40.7
Nematode only		147.2 f	0.0	30.8 de	0.0	2.3 f	0.0	6.2 e	0.0	1.6 d	0.0	15.2 f	0.0
Healthy plant		315.8 ab	114.6	47.1 abc	52.9	5.5 bcd	136.1	9.7 cd	56.7	7.3 ab	356.3	40.0 d	163.7

In each column, values followed by the same letter(s) are not significantly different ($P \leq 0.05$).

Table (6): Cowpea growth and yield as influenced by *Rotylenchulus reniformis* infection and abiotic foliar spray treatments under field conditions.

Treatment	Dose /plant	Plant parameters						Yield criteria					
		plant fresh weight (gm)	% Change	shoot dry weight (gm)	% Change	no. pods	% Change	pods fresh weight (gm)	% Change	pods dry weight (gm)	% Change	no.seeds/ pods	% Change
Cal mix (Calcium and Boron carried on organic and amino acids)	0.4 ml/ plant	77.2 e	-47.6	13.4 g	-56.5	2.0 f	-14.2	5.8 f	-6.0	2.2 cde	37.5	20.0 fg	31.8
Humo plus 40 (Humic acid + macro and micro elements)	0.4 ml/ plant	170.3 cd	15.7	28.2 def	-8.4	2.3 f	0.0	6.3 f	2.1	1.7 e	6.3	13.0 g	-14.3
Amino strong (Amino and organic acids + Fe+ Mn+ Zn)	0.4 ml/ plant	347.1 ab	135.9	54.6 ab	77.2	5.2 cde	124.5	14.6 cd	136.6	7.2 b	350.0	46.2 c	204.8
Feed chem. (Macro and micro elements)	8 gm/ liter	145.1 cde	-1.4	24.6 efg	-20.2	2.8 ef	18.9	5.4 f	-12.5	3.1 cde	93.8	19.5 fg	28.5
UniBor (Boron carried with vitamins + Gibirilic acid)	0.5 ml/ liter	91.4 de	-37.9	17.1 fg	-44.5	3.1 def	33.1	8.9 ef	43.8	4.1 cd	154.4	35.0 cde	130.7
Biogibb (Gibirilic acid + Ca+ B+ cytokinin)	0.25 gm/liter	342.1 ab	132.4	54.6 ab	77.2	4.5 cdef	93.1	11.9 de	92.4	4.4 c	176.9	19.5 fg	28.5
Kenzo (cytokinine+ 6-Benzylaminopurine)	0.2 ml/liter	203.6 c	38.3	30.0 def	-2.6	3.0 def	28.8	5.8 f	-6.0	3.1 cde	93.8	7.0 g	-53.9
Glutamic acid	1gm/ liter	399.9 a	171.7	63.7 a	106.8	6.0 bc	157.5	18.8 b	204.7	7.8 b	387.5	61.0 b	302.1
Citric acid	2 gm/ liter	332.8 ab	126.1	61.7 a	100.3	3.2 def	36.1	9.7 ef	56.7	4.4 c	175.0	29.2 def	92.3
Indole-3 butyric acid	0.1 gm /liter	178.5 c	21.3	31.4 de	1.9	9.5 a	307.7	12.6 cde	104.2	11.2 a	600.0	60.0 b	295.5
Nemakill (Indolylbutric acid 0.002%)	0.2 ml/liter	308.3 b	109.4	48.3 bc	56.8	10.0 a	329.2	28.8 a	366.8	10.6 a	562.5	75.0 a	394.4
Indole-acetic acid	0.2 gm /liter	166.1 cd	12.8	30.7 de	-0.3	3.0 def	28.8	9.5 ef	53.5	2.1 de	29.4	21.8 efg	43.5
Gibirilic acid	0.2 gm /liter	223.1 c	51.6	38.8 cd	25.9	2.5 f	7.3	6.8 f	9.7	2.1 cde	33.1	15.5 fg	2.2
Salicylic acid	1gm/ liter	169.6 cd	15.2	30.4 def	-1.4	8.0 ab	243.4	16.1 bc	160.9	10.8 a	575.0	77.5 a	410.9
Nematode only		147.2 cde	0.0	30.8 de	0.0	2.3 f	0.0	6.2 f	0.0	1.6 e	0.0	15.2 fg	0.0
Healthy plant		315.8 b	114.6	47.1 bc	52.9	5.5 cd	136.1	9.7 ef	56.7	7.3 b	356.3	40.0 cd	163.7

In each column, values followed by the same letter(s) are not significantly different (P≤0.05).

Kenzo, Biogibb and Gibirilic acid improvements were not significantly different with the nematode check in all growth and yield criteria, however Biogibb improved fresh and dry weights of either shoot and pods. The SAR treatments differed in their significance in shoot parameters as compared with the check, improve was significant in yield criteria especially pods numbers, pods dry weights and number of seeds. Glutamic, NemaKill and salicylic acid were the most conspicuous.

Discussion

In field experiment, the microbial agents, however they are rhizoorganisms varied in their effectiveness against *R. reniformis*. (Biofertile & Algeferet) were highly effective, others achieved less than 50% efficacy (*Pseudomonas fluorescence* and Mycorrhiza). Biofertile was rated as the best in the field as it accomplished the highest suppressive effects. The fluctuating malignant actions of microbial products in field impose the importance of different environmental factors that affect their activities in plant rhizosphere (Stirling, 1991 and Zuckerman *et al.*, 1993). Biofertile and *Serratia marcescens* could be recommended as candidates for *R. reniformis* integrated management programs.

There were no direct proportional effects between capability of microbes to reduce nematode reproduction and improvement of growth criteria.

Commercial compounds composed of microbes are now available in the Egyptian market and acceptable as an alternative for nematicides but they can not stand alone as a control procedure, but it should be involved as an element of complementary program for nematode management.

The addition of products containing amino and organic acids as soil drench are dependent on the compound nature, Decka efficacy ended with 41.91% in the field, meanwhile, NemaClean was lower. Amino strong was more efficient in the field than any other mineral compound. Humo plus 40 was not effective at all.

Generally, the foliar spray of abiotic compound was more effective in reducing nematode population than that used as soil drench.

Nemastop followed by Nile compost achieved unsatisfactory reductions. While up word in Algeferet efficacy was recorded to reach highest reduction among all botanicals. Several factors such as nematode host status of the candidate plants, timing of incorporation into the soil, phytotoxicity to crop, stability of nematicidal compounds in the soil and soil type affect plant extracts efficacy. Nematode control by plant preparations containing nematicidal compounds seems to be more effective in light soils such as sandy than heavy soils, because in the later, active compounds may be absorbed by the clay and inactivated (Oka, 2010).

In some experiments composts showed activity against root knot and root lesion nematodes (**LaMondia et al., 1999 & Everts et al., 2006**) but in others, composts affected nematodes only slightly, if at all (**McSorley and Gallaher 1995, 1996**). In a long term experiment, application of compost increased total yield of potato and grain yields. Certain microorganisms in composts are thought to play a suppressive role to nematodes (**Sharon et al., 2001; Kokalis- Burelle et al., 2003; Mekete et al., 2009**). Other studies indicated that nitrogenous compounds rather than microorganisms contribute to nematode **suppression (Oka and Yermiyahu, 2002 & Raviv et al., 2005)**.

Ammonia released from organic materials during microbial decomposition plays an important role in nematode control. Anhydrous and aqueous ammonia, urea and other ammonium compounds have been used for nematode control (**Eno et al., 1955 & Walker, 1971**). The nematicidal activity of ammonia greatly depends on soil pH, humidity and temperature.

McSorley (2011) summarized reasons for variability in organic amendments performance and boasting tolerance of plants to infection in usage of many different materials, results may differ vary with nematodes and environmental factors, most organic amendments are fertilizers, greenhouse results may differ from field conditions, amendments effects not limited to plant parasitic nematodes. Several authors (**Csizinszky, 1999 and Noling, 1997**) observed that composts on mulches did not suppress root-knot nematodes. However despite lack of nematode control, tomato yield in compost- amended plots was 196% of the yield in control plots.

The systemic acquired resistance commercial materials applied on foliage activated nematode reductions. The exogenous application of IAA or IBA as well as amino acid containing formulations may restrict nematode biology which ultimately acquire some resistance to treated cowpea against *R. reniformis*. Our results are supported with those of **Yu and Zhena (2007)**. **Khare and Arora (2010)** attributed the biocontrol activity of the fluorescent *Pseudomonas* to their ability to produce IAA.

IAA and IBA are considered pesticide derivatives (**Omar and Muneer, 2005**). They reported that IBA has been classified as a biocontrol pesticide because it is similar in structure and function to the naturally occurring plant growth Indol-3-acetic acid. Also, B amino-butyric acid is known as chemical plant defense activator and has been used successfully to induce resistance against a wide spectrum of pathogens (**Sahebani et al., 2011**).

Concerning the commercial inorganic fertilizers (**Mega NPK, Feed chem, UniBor**) were highly fluctuating in their action in the field. However, they were significantly effective in reducing the nematode counts. UniBor was the lowest in the field. Feed chem controverted Uni Bor. Efficacy of NPK achieved more than 50% efficacy in the field. Despite that they all succeeded significantly in minimizing the

nematode population. Concerning NPK, reports of **Waceke and Waudu (1993)**, **Bamelet et al. (2003)**, **Coyne et al. (2004)**, **Kheir et al. (2009)** and **Farahat et al. (2010)** are congenial with our findings.

It is interesting to notice that Cal mix disordered plants in all experiment and Mega NPK recorded best improvement in plant fresh, dry weights and yield criteria, however reduction in nematode population was the lowest. **Sharma and Khan (1995)** reported that tomato given potassium alone were heavily infested with *M. incognita* also high levels of P could not overcome the deleterious effects of *R. reniformis* on cotton yield and there was no interaction between levels of potassium and *R. reniformis* on cotton growth. In contrast, in cowpea field study, NPK decreased the population of *M. incognita* root galling and in soil (**Egunjobi and Olaitan 1986**). Similar results were obtained by **Ahmed et al. (1991)** and **Olowe (2012)**. The latter reported that *M. incognita* galling in the field was reduced by 53% by NPK and the fertilizer has a nematicidal effect. NPK has been observed to boost tolerance of plants to diseases, cause nematode mortality (**Melaka Barhan et al., 1997**).

Our results concerning cowpea growth could be summarized as follows, the applications of biotic and abiotic commercial agro-products resulted in differences in their performance. Foliar application treatments achieved stimulatory effects on plant growth more than soil application and growth parameters were ameliorated.

There were direct proportion effects between potency of different sprayed materials in reducing nematode population and growth response in many cases, but was to some extent in soil. The compounds used to induce systemic acquired resistance exhibited more enhancements in plant growth criteria and were more consistent in reducing the nematode population. Biofertile and Algeferet were the eminent soil treatments applied in the field, simultaneously IBA and Amino strong as foliar.

The relation between the material efficacy and its cost-effectiveness should be considered in any nematode management program whereby applying more than one material together may express their potentiality to surpass any chemical nematicide, achieve ultimate performance of plants and transcend environmental hazards.

This research recommend that under comprehensive nematode management programs, the best available alternative lies in the complimentary use of biofertilizers and organic /inorganic materials in suitable combinations with SAR material which together surpass the nemacide effects on nematode reduction. This ensures high productivity and at the same time yields good soil health.

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مقارنة كفاءة المنتجات التجارية الزراعية الحيوية وغير الحيوية ضد الـنيماتودا

الكلوية تحت ظروف الحقل

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في تجربة حقلية تم اختبار اثني عشر منتجًا زراعيًا عوملت في التربة، وأربعة عشر مركبًا آخر عوملت رشًا تبعًا لطريقة التطبيق والجرعة الموصى بها ضد الـنيماتودا الكلوية التي تصيب محصول اللوبيا. وقد أظهرت النتائج أن المركب الحيوي Biofertile عندما استخدم في التربة كان أفضلهم في التأثير على أعداد الـنيماتودا وتبعه مركبي Perfect وAlgeferet عندما استخدم أيضًا "رشًا" في التربة وذلك بالمقارنة بالـنيماتودا. وكان أفضل المركبات المعاملة "رشًا" وبمعنوية عالية IBA يتلوه Amino Strong وFeed Chem دون فروق معنوية بينهم. وأوضحت التجربة أن المواد التجارية المستخدمة كمستحضات للمقاومة عندما استخدمت رشًا أدت إلى خفض أعداد ومعدلات تكاثر الـنيماتودا، وفي حالة تأثير هذه المركبات المستخدمة "رشًا" أو "رشًا" على نمو نباتات اللوبيا ومحصولها قد سجل مركب Mega NPK أفضل النتائج، وبصفة عامة فإن المركبات المعاملة "رشًا" كانت أعلى معنويًا سواء في خفض أعداد الـنيماتودا أو في زيادة نمو النبات وإنتاجيته إذا ما قورنت بالـنيماتودا وخاصة تلك المركبات المستخدمة كمستحضات للمقاومة الجهازية للنبات عن المركبات المستخدمة في التربة.