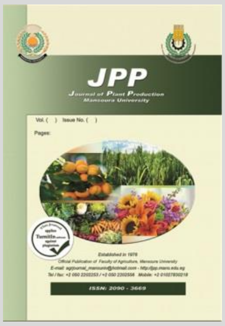
Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www.jpp.journals.ekb.eg

Induction of Sunflower Plants Resistance to *Meloidogyne incognita* Infection by Seed Priming Technique

Gad, S. B.[1*]; W. A. E. Abido[2]; El-Shimaa A. M. Abo-El-Kheer[3]; Ágnes Hadhazy[4] and Csaba Juhász[4]

[1] Agricultural Zoology, Faculty of Agriculture, Mansoura University, Egypt.
[2] Agronomy Department, Faculty of Agriculture, Mansoura University, Egypt.
[3] Agricultural Botany Department, Faculty of Agriculture, Mansoura University, Egypt.
[4] Research Institute of Nyiregyhaza, Institutes for Agricultural Research and Educational Farm, University of Debrecen, Hungary.



ABSTRACT

A greenhouse experiment was conducted during the summer seasons 2019 and 2020 to evaluate the effect of sunflower grains priming in different concentrations of salicylic, ascorbic acids, hydrogen peroxide, thiamine, nitric oxide and Oxamyl growth parameters of sunflower plants under the stress of nematode infection. The best effect was reach by the seed soaking of Nitric oxide at 100 ppm(stem height 66.4 cm; root length 81.96 cm;shoot fresh weight 414.2 g;root fresh weight 201.86 g; shoot dry weight 65.76 g).Meanwhile,the less efficiency was reach with the seed soaking of hydrogen peroxide at 50 ppm (stem height 47.66 cm; root length 53.36 cm; shoot fresh weight 263.6 g; root fresh weight 126.28 g; shoot dry weight 49.52 g). Nematicide Oxamyl (stem height 34.3 cm; root length 32.94 cm;shoot fresh weight 156.0 g; root fresh weight 72.3 g; shoot dry weight 37.94 g) followed by control non soaked the best effect was reached over both season by the seed soaking of hydrogen peroxide at 100 ppm (N: 7.32%; P: 0.78%; K: 6.5%; phenol: 117.1; POX: 1.4; Chlorophyll a: 1.1; Chlorophyll b: 0.7; Total Chlorophyll: 1.74; and Carotene: 1.28). Seed priming in nitric oxide (100 ppm), chitosan(50 ppm)and chitosan(100 ppm), consequently produced the highest averages of seedling growth parameters as compared with the other treatments over both seasons. On the other hand, seed priming in H_2O_2 at 100 ppm, thiamine at 50 ppm, thiamine at 100 ppm and nitric oxide at 50 ppm resulted the highest values of chemical parameters over both seasons.

Keywords: Sunflower; Priming; Nematode; Ascorbic acid; Salicylic acid; Hydrogen peroxide

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the most important oil crops, grown on over 56.11 million feddan all over the world, with total production of 56.07 million tones. While, in Egypt the harvested area reached 16660 feddan with production quantity 21000 (FAO, 2020). Sunflower seeds have 39 to 49% oil content with high percent of unsaturated fatty acids. Sunflower productivity maybe decreased due to occasional unfavorable climatic conditions, non-availability of enhanced seed and infected by a lot of diseases and pests. Sunflower infected by more than 90 diseases such as fungi, bacteria and nematodes which minimized the seed yield and its quality (Bai *et al.*, 1985; Amin and Youssef, 1997). Among the various pests and diseases attacking sunflower, plant-parasitic nematodes form an integral part of the complex (Bolton *et al.*, 1989; Keetch and Buckley 1984; Kleynhans *et al.*, 1996; Bakker *et al.*, 2007; Fourie *et al.*, 2010). Sunflower has a wide scope of plant-parasitic nematodes. Early reports about the effect of nematode bothers on neighborhood sunflower creation showed that root-hitch nematodes, specifically *M. incognita*, *M. arenaria* and *M. javanica*, are the transcendent parasites that harmed the yield (Van der Linde *et al.*, 1959), while *M. hapla* has additionally been recorded in relationship with sunflower (Keetch and Buckley 1984; Kleynhans *et al.*, 1996). The root-gall nematode, Meloidogyne species attack more than 2000 species of plants. A gall on host plant can reveal all structural modifications which the plant has potential to produce. (Dropkin, 1955). When susceptible plants are infected at seedling stages, losses are very severe and may result in complete destruction of the crop. Nematodes cause significant losses in the sunflower yield. Amongst nematodes, *Meloidogyne incognita* has also been shown to be a danger to sunflower plants and decreased the seed yield by 16.44 (Singh, 2006). Among various control measures screening of resistant varieties is the most economical mean and economical component of IPM package for controlling plant parasitic nematodes. Priming pant seeds is a simple technique which can enhance seedling and crop performing (Ashraf and Foolad, 2005; Farooq *et al.*, 2006), reduce abiotic stresses through germination stage in plants (Abdulrahmani *et al.*, 2007; Akbarimoghaddam *et al.*, 2011). Pre-sowing chemicals seed treatments such as salicylic acid, ascorbic acid, hydrogen peroxide, nitric oxide, thiamine and chitosan could stimulate the sunflower seedling characters and increased sunflower stress tolerance leading to healthy sunflower growth (Xu and Zhao, 2003). Ascorbic acid is assessed as an organic antioxidant composite accumulated in plants tissues and plays a vital role in reduction of damage under routine and stress

*** Corresponding author.**
E-mail address: samirborham@mans.edu.eg
DOI: 10.21608/jpp.2021.207289

conditions (Smirnoff, 2005; Chen and Gallie, 2004). Salicylic acid is considered one of most of plant growth regulating germination processing, vegetative growth, organized ions uptake and transport and protected plants opposed to abiotic stresses, membrane permeability, inhibition of ethylene biosynthesis and water relations (Harper and Balke, 1981; Barkosky and Einhellig, 1993), regulator of biogenesis chloroplasts, activity of photosynthesis and other processes (Uzunova and Popova, 2012, Fariduddin *et al.*, 2003). Hydrogen peroxides are helped to promote in plants at biotic and abiotic stresses. The highest levels of Hydrogen peroxides result in toxicity to cellular membrane as well as damages plant cells (Kathiresan *et al.*, 2006). Nitric oxide enhancing antioxidant plant defense under stress conditions (Palavan-Unsal and Arisan, 2009; Kopyra *et al.*, 2006; Xu *et al.*, 2010). Content of corn seedling from thiamine expanded when presented to dry spell, salt, and oxidative burdens and that reflects digestion of thiamine under such ecological anxieties (Rapala-Kozik *et al*., 2008).

Chitosan is a bountiful and similarly modest natural compound. It is an enormous cationic polysaccharide fundamentally got from squander materials from fish handling. Chitosan treatment of wheat seeds prompted protection from specific sickness and further developed seed quality (Reddy *et al*., 1999). Seed drenched with chitosan expanded the energy of germination, germination rate, lipase action, and gibberellic corrosive (GA3) and indole acidic corrosive (IAA) levels in nut (Zhou *et al*., 2002). Seed covered with chitosan may speed up seed germination and work on the resistance to push state of mixture rice seedlings (Ruan *et al*., 2002) and control the development and propagation of sclerotinia decay in carrot. Seed preparing with two unique acidic chitosan arrangements worked on the life of maize seedlings (Shao *et al*., 2005). Subsequently, it appears to be that chitosan is a promising material for seed medicines. In the current review, the impacts of seed preparing with various groupings of chitosan arrangements were researched. For better understanding the outcomes, chilling-open minded and chilling-touchy maize ingrained lines were utilized to decide germination and the seedling development corresponding to physiological changes under low temperature stress after the seed preparing.

Priming of seed is an effective tool for increasing seedlings characters and parameters of sunflower in Egypt. Thus, this study was undertaken to estimate the effect of seed priming in differing concentrations of chemicals (salicylic, ascorbic acids) and signaling molecules such as hydrogen peroxide, thiamine and nitric oxide on sunflower plant growth criteria under phytonematode infection.

MATERIALS AND METHODS

Experimental location:

This study was carried out at greenhouse of (NRU) Faculty of Agriculture, Mansoura University, Egypt, during the summer seasons 2019 and 2020.

Preparation of nematode inoculation:

The root hitch nematode, *M. incognita* from recognized culture was gathered from contaminated root frameworks with exceptionally substantial root-knot nematode egg masses of *Coleus blumei* (Kofoid& White) plants. These roots were washed by regular water, then, at that point, absorbed 1.0% NaOCl and physically shaken for 60 s. From that point forward, it was straightforwardly passed however sifters (500 lattice); the eggs were gathered cautiously subsequent to washing with regular water (Hussey and Barker, 1973). At long last, the quantities of egg were counted and utilized for vaccinating tomato seedlings in the accompanying investigation.

Plant material and chemicals:

Seed materials:

Seeds of Sunflower (*Helianthus annuus* L.) cv Giza 102 acquired from Agriculture Research Center Egypt that was utilized and preserved with fungicide before planting.

Nematicide:

Oxamyl (Vydate 24%) Methyl-N-N-dimethyl-(N-(methyl) carbomycocyl)-1-Thioxamidate was used in the current investigation as a positive control for the following treatments.

Priming Chemicals:

The tested priming chemicals (ascorbic, salicylic acids, Hydrogen peroxide, nitric oxide, Thiamine and chitosan) were obtained from El- Gomhouria Chemical Company Mansoura, Egypt.

Sunflower Seeds priming:

Sunflower cv Giza 102 seeds were put in a dish containing a limited quantity of drops of cleaning up fluid in water for 5 min then, at that point, washed a few times by refined water. This is followed cleaned seeds by 1% business blanch arrangement (15 min), then, at that point, washed with refined water and parched on a channel paper. Seeds were absorbed 50 and 100 ppm of ascorbic, salicylic acids, Hydrogen peroxide, nitric oxide, Thiamine and chitosan for 24 h while one more seed absorbed refined water and passed on others without drenching to fill in as controls. Then again, one more gathering of sunflower seeds were preparing at oxamyl (nematicide) for a similar time.

Experimental design:

Eighty five plastic pots (10-cm-d) filled with 1000 gm sterilized sandy loam soil (1:1) (v:v) were used in this trial. The experiment was carried as randomized complete block design with five replications represented 17 treatments. Two weeks after germination, nematode inoculate (1000 eggs) of *M. incognita* were introduced according to the design of the experiment. Pots were arranged in a randomized complete block design on a bench of a partly controlled greenhouse at 28±3°C. Plants were watered regularly and treated as recommended. Pots were watered as needed then plants were harvested after 60 days from nematode inoculation.

Assessment parameters:

All plants allied to each treatment were uprooted and both vegetative and root systems were utilized as fresh and dried tissues for the following efficacy estimate analyses.

Plant growth parameters: Sunflower plant morphology boundaries including plant length (shoot and root); new shoot and root loads; and shoot dry weight were recorded and recorded. Then again, plant roots were stained with corrosive fuchsin in lactic corrosive and counted for females and egg masses. (A.O.A.C., 2005).

Determination of nematode reproduction:

Nematodes were extracted from 250g soil using sieving and modified Baermann technique from sunflower plant roots (Goodey, 1957). The nematode suspensions were assessed in a Hawksely counting slide by a microscope to calculate the numbers of nematode juveniles. Roots were stained at acid fuchsin in lactic acid and counted for females and egg-masses (Byrd *et al.*, 1983).

Biochemical analysis:

Chlorophyll contents at sunflower fresh leaves were determined in each replicate/treatment according to Goodwine methodology (1965). Sunflower dried leaves were ground and wet digested for determination of nitrogen, phosphorus, potassium contents, according to Kjeldahl methods described by Pregl (1945) and Jackson (1967) and John (1970). The total phenol contents were extracted and calculated at 520 nm via spectrophotometer by chatichole as standard (Simons and Ross, 1971).

Statistical analysis:

Statistically results analyzed using ANOVA (Gomez and Gomez, 1984) then means were compared according to Duncan multiple range tests (Duncan, 1955).

RESULTS AND DISCUSSION

Results

Plant growth parameters:

The best effect was reach by the seed soaking of nitric oxide at 100 ppm (plant length 66.4 cm; root length 81.96 cm; shoot fresh weight 414.2 g; root fresh weight 201.86 g; shoot dry weight 65.76 g;) (Table 1). Followed by chitosan at 50 ppm (stem length 63.74 cm; root length 77.88 cm; shoot fresh weight 392.7 g; root fresh weight 191.06 g; shoot dry weight 63.44 g;) and chitosan at 100 ppm (stem length 61.06 cm; root length 73.8 cm; shoot fresh weight 371.2 g; root fresh weight 180.26 g; shoot dry weight 61.12 g;). The trend following by ascorbic acid at 50 ppm (stem length 58.36 cm; root length 67.7 cm; shoot fresh weight 349.7 g; root fresh weight 169.48 g; shoot dry weight 58.8 g) and ascorbic acid 100 ppm (stem length 55.7 cm; root length 65.62 cm; shoot fresh weight 328.2 g; root fresh weight 158.68 g; shoot dry weight 56.48 g) and salicylic acid at 50 ppm (stem length 53.04 cm; root length 61.54 cm; shoot fresh weight 306.62 g; root fresh weight 147.88 g; shoot dry weight 54.16 g) and salicylic acid at 100 ppm (stem length 50.34 cm; root length 57.44 cm; shoot fresh weight 285.1 g; root fresh weight 137.08 g; shoot dry weight 51.81 g).

Table 1. Averages of stem height and root length, total seedling length, shoot and root fresh weight, total of fresh weight, shoot and total dry weight as affected by seed priming in salicylic acid, ascorbic acid, hydrogen peroxide, thiamine, nitric oxide, chitosan and nematicide as averages over both seasons.

Treatments	Stem height (cm)	Root length (cm)	Total length (cm)	stem fresh weight (g)	Root fresh weight (g)	Total fresh weight (g)	stem dry weight (g)	Total Dry wt. (g)
SA (50 ppm)	58.36 d	69.7 d	128.08 d	349.7 d	169.48 d	519.16 d	58.8 d	81.56 d
SA (100 ppm)	55.7 e	65.62 e	121.32 e	328.2 e	158.68 e	486.84 e	56.48 e	77.78 e
ASA (50 ppm)	53.04 f	61.54 f	114.58 f	306.62 f	147.88 f	454.52 f	54.16 f	73.98 f
ASA 100 ppm)	50.34 g	57.44 g	107.78 g	285.1 g	137.08 g	422.2 g	51.84 g	70.2 g
H_2O_2 (50 ppm)	47.66 h	53.36 h	101.02 h	263.6 h	126.28 h	389.9 h	49.52 h	66.4 h
H_2O_2 (100 ppm)	45.0 i	49.28 i	94.28 i	242.1 i	115.48 i	357.56 i	47.2 i	62.62 i
Thiamine (50 ppm)	42.32 j	45.2 j	87.52 j	220.6 j	104.68 j	325.26 j	44.88 j	58.82 j
Thiamine (100 ppm)	39.64 k	41.1 k	80.74 k	199.06 k	93.88 k	292.94 k	42.56 k	55.04 k
Nitric oxide (50 ppm)	36.96 l	37.02 l	73.98 l	177.5 l	83.1 l	260.64 l	40.24 l	51.26 l
Nitric oxide (100 ppm)	66.4 a	81.96 a	148.38 a	414.2 a	201.86 a	616.1 a	65.76 a	92.92 a
Chitosan (50 ppm)	63.74 b	77.88 b	141.62 b	392.7 b	191.06 b	583.78 b	63.44 b	89.14 b
Chitosan (100 ppm)	61.06 c	73.8 c	134.84 c	371.2 c	180.26 c	551.46 c	61.12 c	85.36 c
Nematocides	34.3 m	32.94 m	67.22 m	156.0 m	72.3 m	228.3 m	37.94 m	47.46 m
control non-soaked	31.9 n	29.88 n	61.8 n	137.8 n	63.34 n	201.12 n	35.98 n	44.28 n
control water soaked	28.04 o	22.74 o	50.78 o	104.66 o	46.48 o	151.14 o	32.38o	38.44 o
Nematodes non-soaked	27.52 o	22.7 o	50.22 o	101.66 o	44.74 o	146.4 o	32.02o	37.84 o
Nematodes water soaked	22.92 p	15.56 p	38.48 p	64.76 p	26.72 p	91.44 p	28.1 p	31.42 p
F. test	611.4	776.2	722.5	653.49	664.86	656.80	663.08	651.42

N = 1000 eggs of *M. incognita*

***Each value is a mean of five replicates. Mean values in each column followed by the same letter(s) did not differ at $P< 0.05$ according to Duncan's multiple- range test.**

The less efficiency were reach with the seed soaking of hydrogen peroxide at 50 ppm (stem length 47.66 cm; root length 53.36 cm; shoot fresh weight 263.6 g; root fresh weight 126.28 g; shoot dry weight 49.52 g) and the hydrogen peroxide at 100 ppm (stem length 45.01 cm; root length 49.28 cm; shoot fresh weight 242.1 g; root fresh weight 115.48 g; shoot dry weight 47.2 g) that followed the thiamine at 50 ppm (stem length 42.32 cm; root length 45.2 cm; shoot fresh weight 220.6 g; root fresh weight 104.68 g; shoot dry weight 44.88 g) and the thiamine at 100 ppm (stem length 39.64 cm; root length 41.1 cm; shoot fresh weight 199.06 g; root fresh weight 93.88 g; shoot dry weight 42.56 g) and the nitric oxide (stem length 36.96 cm; root length 37.02 cm; shoot fresh weight 177.5 g; root fresh weight 83.1 g; shoot dry weight 40.24 g). On the other hands the least effective were resulted from the next materials: Nematicides 1 (plant length 34.3 cm; root length 32.94 cm; shoot fresh weight 156.0 g; root fresh weight 72.3 g; shoot dry weight 37.94 g) followed by control non soaked (plant length 31.9 cm; root length 29.88 cm; shoot fresh weight 137.8 g; root fresh weight 63.34 g; shoot dry weight 35.98 g) followed by control water soaked (plant length 28.04 cm; root length 22.74 cm; shoot fresh weight 104.66 g; root fresh weight

46.48 g; shoot dry weight 32.38 g) and Nematodes non-soaked (plant length 27.52 cm; root length 22.7 cm; shoot fresh weight 101.66 g; root fresh weight 44.74 g; shoot dry weight 32.02 g) and Nematodes water soaked (plant length 22.92 cm; root length 15.56 cm; shoot fresh weight 64.76 g; root fresh weight 26.72 g; shoot dry weight 28.1g).

Plant biochemical analysis' results:

According to statistical analysis of growth parameters, the results clearly shows that all chemical materials under studies were significantly affected on botanical morphological characters. The statistical analysis of biochemical characters, the best effect on was reached both of season by the seed soaking of hydrogen peroxide 2 (N: 7.32%; P: 0.78%; K: 6.5%; phenol: 117.1; POX: 1.4; chlorophyll a: 1.1; chlorophyll b: 0.7; total Chlorophyll: 1.74 and carotene: 1.28) (*Table 2.*). The effect on thiamine t the rate of 50 and 100 ppm and nitric oxide at the first rate were the same or nearly similar to hydrogen peroxide (N%: 6.96; 6.64; 6.5; P%: 0.7; 0.7; 0.68; K%: 6.22; 5.94; 5.68; phenol: 115.38; 114.32; 100.32; POX: 1.3; 1.3; 1.22; chlorophyll a: 1.0; 1.0; 1.0; chlorophyll b: 0.7; 0.64; 0.6; total chlorophyll: 0.7; 0.66; 0.6; carotene: 0.2; 0.2; 0.1). The third effective chemical materials were the ascorbic acid at 50 and 100 ppm, the salicylic acid at 50 and 100 ppm, the hydrogen peroxide at 50 ppm and the nitric oxide at 100 ppm. The lower values were measured by the application of the chitosan at 50 ppm (3.9; 0.4; 3.72; 61.0;0.92; 0.8; 0.5, 1.3;0.8) and the chitosan at 100 ppm (3.56; 0.4; 3.44; 55.0; 0.9; 0.7; 0.5; 1.2; 0.8), the Nematicide 1 (3.24; 0.36; 3.18; 49.0; 0.84; 0.7; 0.5; 1.2; 0.7), the control non-soaked (2.94; 0.3; 2.94; 43.06; 0.8; 0.7; 0.46; 1.1; 0.7), the control water soaked (2.4; 0.28; 2.5; 37.1; 0.74; 0.64; 0.4; 1.06; 0.64), the nematodes non soaked (2.34; 0.28; 2.46; 31.1; 0.74; 0.62; 0.4; 1.06; 0.6), and the Nematodes water soaked (1.78; 0.2; 1.98; 25.1; 0.66; 0.6; 0.4; 0.98, 0.52). As to our statistical analysis of chemical or biochemical characters the results clearly shows that all chemical materials under studies were significantly affected on the chemical and biochemical characters of sunflower.

Table 2. Averages of nitrogen content (N%), phosphorous (P%), potassium (K%), Phenol content, Polyphenol oxidase (POX), chlorophyll a,b, total chlorophyll, carotene content as affected by seed priming in salicylic acid, ascorbic acid, hydrogen peroxide, thiamine, nitric oxide, chitosan and nematicide as averages over both seasons.

Treatments	N %	P%	K%	phenol	POX	Chloyll a	Chloyll b	Total chl.	Carotene
SA (50 ppm)	5.6 f	0.6 c	5.12 f	90.86 cd	1.16 d	0.9 d	0.6 c	1.5 d	1.02 d
SA (100 ppm)	5.26 g	0.56 d	4.82 g	84.9 cde	1.1 e	0.9 d	0.6 c	1.48 d	1.0 d
ASA (50 ppm)	4.94 h	0.5 e	4.56 h	78.9 def	1.08 e	0.88 d	0.58 c	1.4 e	0.96 e
ASA 100 ppm)	4.58 i	0.5 e	4.28 i	72.9 efg	1.0 f	0.8 e	0.5 d	1.38 e	0.9 f
H_2O_2 (50 ppm)	4.24 j	0.46 f	4.0 j	66.96 fgh	1.0 f	0.8 e	0.5 d	1.3 f	0.88 f
H_2O_2 (100 ppm)	7.32 a	0.78 a	6.5 a	117.1 a	1.4 a	1.1 a	0.7 a	1.74 a	1.28 a
Thiamine (50 ppm)	6.96 b	0.7 b	6.22 b	115.38 a	1.3 b	1.0 b	0.7 a	1.7 ab	1.2 b
Thiamine (100 ppm)	6.64 c	0.7 b	5.94 c	114.32ab	1.3 b	1.0 b	0.64 b	1.66 b	1.2 b
Nitric oxide (50 ppm)	6.5 d	0.68 b	5.68 d	100.32 abc	1.22 c	1.0 b	0.6 c	1.6 c	1.1 c
Nitric oxide (100 ppm)	5.96 e	0.6 c	5.38 e	96.8 bc	1.2 cd	0.94 c	0.6 c	1.56 c	1.1 c
Chitosan (50 ppm)	3.9 k	0.4 g	3.72 k	61.0 ghi	0.92 g	0.8 e	0.5 d	1.3 f	0.8 g
Chitosan (100 ppm)	3.56 l	0.4 g	3.44 l	55.0 hij	0.9 g	0.7 f	0.5 d	1.2 g	0.8 g
Nematocides	3.24 m	0.36 h	3.18 m	49 .0 ijk	0.84 h	0.7 f	0.5 d	1.2 g	0.7 h
control non-soaked	2.94 n	0.3 i	2.94 n	43.06 jkl	0.8 h	0.7 f	0.46 e	1.1 h	0.7 h
control water soaked	2.4 o	0.28 i	2.5 o	37.1 klm	0.74 i	0.64 g	0.4 f	1.06 h	0.64 i
Nematodes non-soaked	2.34 o	0.28 i	2.46 o	31.1 lm	0.74 i	0.62 gh	0.4 f	1.06 h	0.6 j
Nematodes water soaked	1.78 p	0.2 j	1.98 p	25.1 m	0.66 j	0.6 h	0.4 f	0.98 i	0.52 k
F. test	630.9	150.0	650.00	23.4	201.2	196.8	99.87	236.1	316.5

N = 1000 eggs of *M.*

***Each value is a mean of five replicates. Mean values in each column followed by the same letter(s) did not differ at P< 0.05 according to Duncan's multiple- range test.**

Nematode reproduction:

According to eggmass (EI) index which scale between 0-5 the lowest value was in nematodes water soaked while the highest value show which treated by hydrogen peroxid (H_2O_2 .1). The least significant difference was 0.37. In this case to the P. value was zero. The F. value was 72.9. Consequently, in the eggmass column results correlates the (El) results. The least significant difference value was 1.72. The F. value result was 471.09. The correlation is also visible if we follow the gall results. Which seeds soaked in hydrogen peroxid (H_2O_2.) at 50 ppm bring the highest value. In contrast the lowest value come from nematodes which soaked water.

Nematode reproduction:

According to *Table 3.* eggmass (EI) index which scale between 0-5 the lowest value was in nematodes water soaked while the highest value show which treated by hydrogen peroxid (H_2O_2 .1). The least significant difference was 0.37. In this case to the P. value was zero. The F. value was 72.9. Consequently, in the eggmass column results correlates the (El) results. The least significant difference value was 1.72. The F. value result was 471.09. The correlation is also visible if we follow the gall results. Which seeds soaked in hydrogen peroxid (H_2O_2.) at 50 ppm bring the highest value. In contrast the lowest value come from nematodes which soaked water.

Table 3. Development and reproduction of *Meloidogyne incognita* infecting sunflower plants as affected by seed priming in salicylic acid, ascorbic acid, hydrogen peroxide, thiamine, nitric oxide, chitosan and nematicide as averages over both seasons.

Treatments	N soil	Females	D.S.	Total N	Rf	Galls	RGI	Egg mass	EI
SA (50 ppm)	11468.74 h	32.5 h	27.76 h	11464.0 h	5.74 h	30.7 h	1.7 efgh	25.18 h	3.24 gh
SA (100 ppm)	10281.56 i	27.42 i	24.86 i	10279.0 i	5.14 i	27.88 i	1.64 fghi	22.56 i	3.02 hi
ASA (50 ppm)	9094.4 j	22.4 j	21.96 j	9094.0 j	4.54 j	25.08 j	1.58 ghij	19.94 j	2.8 ij
ASA 100 ppm)	7907.24 k	17.3 k	19.06 k	7909.0 k	3.96 k	22.26 k	1.5 hijk	17.32 k	2.58 jk
H_2O_2 (50 ppm)	19778.9 a	67.9 a	48.06 a	19759.1 a	9.88 a	50.36 a	2.24 a	43.56 a	4.82 a
H_2O_2 (100 ppm)	18591.74 b	62.84 b	45.16 b	18574.1 b	9.3 b	47.54 b	2.16 ab	40.94 b	4.6 ab
Thiamine (50 ppm)	17404.56 c	57.8 c	42.26 c	17389.1 c	8.7 c	44.74 c	2.1 abc	38.32 c	4.38 bc
Thiamine (100 ppm)	16217.4 d	52.7 d	39.36 d	16204.04 d	8.1 d	41.94 d	2 .0 abcd	35.68 d	4.14 cd
Nitric oxide (50 ppm)	15030.24 e	47.68 e	36.46 e	15019.0 e	7.5 e	39.12 e	1.94 bcde	33.06 e	3.92 de
Nitric oxide (100 ppm)	13843.06 f	42.6 f	33.56 f	13834.0 f	6.92 f	36.32 f	1.88 cdef	30.44 f	3.7 ef
Chitosan (50 ppm)	12655.9 g	37.52 g	30.66 g	12649.0 g	6.32 g	33.5 g	1.8 defg	27.82 g	3.48 fg
Chitosan (100 ppm)	6720.06 l	13.1 l	16.16 l	6724.0 l	3.36 l	19.46 l	1.4 ijkl	14.68 l	2.34 kl
Nematocides	5532.9 m	12.26 l	13.26 m	5539.0 m	2.78 m	16.66 m	1.34 jklm	12.06 m	2.12 lm
control non-soaked	4345.74 n	7.92 m	10.36 n	4354.0 n	2.18 n	13.84 n	1.28 klmn	9.44 n	1.9 mn
control water soaked	3158.56 o	7.2 m	7.46 o	3169.0 o	1.58 o	11.04 o	1.2 lmn	6.82 o	1.68 no
Nematodes non-soaked	1891.66 p	2.9 n	4.32 p	1903.9 p	0.94 p	8.0 p	1.1 mn	3.9 p	1.36 op
Nematodes water soaked	864.0 q	2.14 n	1.9 q	879.0 q	0.44 q	5.66 q	1.04 n	1.84 q	1.3 p
F. test	659.62	737.7	617.75	655.98	654.8	330.71	18.49	471.09	72.9

N = 1000 eggs of *M. incognita* **D.S.= Developmental stages.**

***Each value is a mean of five replicates.**

Discussion:

From present examinations, it is very certain that sunflower grains preparing sunflower grains in differing groupings of salicylic corrosive, ascorbic corrosive, hydrogen peroxide and nitric oxide on germination on the sunflower plant development boundaries under the pressure of nematode contamination ended up being powerful in initiating pressure resistance at the phase of seed germination in sunflower plants. These outcomes were in concurrence with those of Afzal *et al*., (2006) who expressed that wheat seed absorbed salicylic corrosive prior to planting was compelling in diminishing the pressure impact. The outcomes identified with germination rate can measure up to prior finding in which (El-Tayeb, 2005) found an improvement in germination of these seeds pretreated with NO, H2O2, AsA or SA arrangement than those of hydropriming or un-treated grains. Preparing with or ASA ended up being the best treatment by mitigating the unfriendly impacts of weight on development of the seeds (Ashraf and Khan, 2008). Seeds development rate expanded by prepared with salicylic corrosive as it upgraded oxygen take-up and the productivity of activating supplements from the cotyledons to the early stage hub under saline conditions (Kathiresan *et al*., 1984). The beneficial outcomes of preparing with SA on seedling development are likewise affirmed by the perception of Katembe *et al*., (1998) explored the impact of seed preparing as a strategy to further develop seedling development of two Atriplex species under salt pressure. Besides, Rajasekaran *et al*., (2002) and Shakirova *et al*., (2003), which showed apromotion in seed germination with SA application. These outcomes are like those detailed by (Kaydan *et al*., 2007) and (Afzal *et al*., 2005) who observed that dry weight was decreased by salt pressure in wheat. Dry loads of seedling were diminished because of saltiness stress yet seedlings raised from seeds prepared with SA, worked on dry load of seedlings when contrasted with non-SA treated under non saltiness and saltiness conditions. This might show that, treatment of seedling with SA displayed a critical expansion in salt resilience. This outcome was like the investigations of (El-Tayeb, 2005) announced that SA pretreatment expanded dry load in the focused on grain seedlings; expanded the new and dry load of shoot and foundations of salt focused on maize plants and (Ghoulam and Fares, 2001). The outcomes unmistakably showed that grains preparing had impact on seedling development may be because of prepared grains have better water assimilation from the developing media that empowered quicker metabolic exercises in seeds and prompts prior radicle and plumule appearance and speeding up imbibition, which worked with the duplication of radicle cells and prompted a previous rise and upgrading K+ focus in the two seeds and seedlings, prompting improved α-amylase action and the centralization of diminishing sugars with amylase movement. Comparative discoveries were accounted for by Kaya *et al*., (2006). Prepared seeds would be advised to effectiveness for water ingestion from developing media that is the reason metabolic exercises in seed during germination process start significantly sooner than radicle and plumule appearance (Hopper *et al*., 1979). By and large, it very well may be reasoned that all tried synthetic substances utilized and hydropriming effectsly affected germination and seedling development. In this manner, preparing might be chosen to further develop seedling development in field condition since it is less expensive. In addition, these preparing methods or different medicines ought to be contemplated in farming cultivars under field condition to get more great outcomes for the impacts of preparing on seedling development and yield boundaries.

CONCLUSION

In conclusion, seed priming in nitric oxide (100 ppm), chitosan (50 ppm) and chitosan (100 ppm), consequently produced the highest averages of seedling growth parameters as compared with the other treatments over both seasons. On the other hand, seed priming in H_2O_2 at 100 ppm, thiamine at 50 ppm, thiamine at 100 ppm and nitric oxide at 50 ppm resulted the highest values of chemical parameters over both seasons.

REFERENCES

A.O.A.C. (2005). Association of official Agriculture Chemist, official methods of Analysis. 13th ed. Washington, D.C.

Abdulrahmani, B., Ghassemi-Golezani, K., Valizadeh, M. and Feizi-Asl, V. (2007). Seed priming and seedling establishment of barley (*Hordeum voulgare* L.). J. of Food Agric. Environ. 5:179-184.

Afzal, I. S., Basra, M. A. and Hameed, A. (2006). Physiological enhancement for alleviation of salt sress in wheat. Pakistan. J. Bot., 1649-1659.

Afzal, I. S., Basra, M. A., Ahmad, N. and Farooq M. (2005). Optimization of hormonal priming techniques for alleviation of salinity stress in wheat (*Triticum aestivum* L.). Caderno de Pesquisa Série Biologia, 17(1): 95-109.

Akbarimoghaddam, H., Galavi, M., Ghanbari, A. and Panjehkeh, N. (2011). Salinity effects on seed germination and seedling growth of bread wheat cultivars. Trakia J. of Scie., 9(1): 43-50.

Amin, A. W. and Youssef, M.M.A. (1997). Efficiency of certain plant leaves for controlling Meloidogyne javancia and Rotylenchulus reniformis infecting sunflower in Egypt. Int. J. Nematol., 7: 198- 200.

Ashraf, M. and Foolad, M. R. (2005). Pre-sowing seed treatment-A shotgun approach to improve germination growth and crop yield under saline and none-saline conditions. Adv. Agron., 88: 223-267.

Ashraf, M. S. and Khan, T. A. (2008). Biomanagement of reniform Nematode, *Rotylenchulus reniformis* by fruit wastes and *Paecilomyces lilacinus* on chickpea. World J. Agric. Sci., 4(4): 492-494.

Bai, R., Liu, W. and Zheng, H. (1985). Problems of sunflower disease in china. Second sunflower Conference Decemer 12-16, 1985. Baichen2, Agricultural institute, Jilin, China. p.14.

Barker, K. R., Schmitt, D. P. and Campos, V. P. (1982). Response of peanut, corn, tobacco and soyabean to Criconemella ornata. J. Nematol., 4: 576-581.

Barkosky, R. R. and Einhellig, F. A. (1993). Effects of salicylic acid on plant-water relationships. J. Chem. Ecol. 19:237–247.

Bolton, C.; De Waele, D.; Leuven, K. U. and Loots, G.C. (1989). Plant-parasitic nematodes on field crops in South Africa: 3. Sunflower. Revue Nématol. 12 (1): 69-76.

Byrd, D. W., Kirkpatrick, T. and Barker, K. (1983). An improved technique for clearing and staining plant tissues for detection nematodes. J. Nematol., 15 (3): 142-143.

Chen, Z. and Gallie, D. R. (2004). The ascorbic acid redox state controls guard cell signaling and stomatal movement. Plant Cell, 6(5):1143-62.

Dropkin, V. H. (1955). The relations between nematodes and plants. Exp. Parasitol., 4(3): 282-322.

Duncan, D. B. (1955). Multiple range and multiple, F-test. Biometrics, 11: 1-42.

El-Tayeb, M. A. (2005). Response of barley grains to the interactive effect of salinity and salicylic acid. Plant Growth Regul., 45:215–224.

FAOSTAT, ProdSTAT (2020): The FAOSTAT ProdSTAT module on crops contains detailed agricultural Production data. Cited from: http://faostat.fao. org/site/PageID=567.

Fariduddin, Q., Hayat, S. and Ahmed, A. (2003). Salicylic acid influences net photosynthetic rate, carboxylation efficiency, nitrate reductase activity, and seed yield in Brassica juncea, Photosynthetica, 41(2):281-284.

Farooq, M.; Basra, S. M. A. and Rehman, H. (2006): Seed Priming enhances emergence, yield, and quality of direct-seeded rice. Crop Manag & physiol., 3:42-44.35: 15-29.

Fourie, H., Mienie, C. M. and Waele, D. D (2010). Relationships between initial population densities of Meloidogyne incognita race 2 and nematode population development in terms of variable soybean resistance. J. Nematol., 42(1): 55-61.

Ghoulam, C. and Fares, K. (2001). Effect of salinity on seed germination and early seedling growth of sugar beet. Seed Sci. and Technol., 29: 357-364.

Gomez, K. A. and Gomez, A. A. (1984). Statistical procedures for Agricultural Research. 2nd Ed., John Wiley &Sons: Inc., New York.

Goodey, J. B. (1957). Laboratory methods for work with plant and soil nematodes. Tech. Bull. No. 2. Min. Agric. Fish Ed. London, 47 pp.

Goodwine, T. W. (1965). Countative analysis of the chloroplast, Pigmnts. Acadmic press, London and New York.

Harper, J. R. and Balke N. E. (1981): Characterization of the inhibition of K+ absorption in oats roots by salicylic acid. Plant Physiol., 68: 1349-1353.

Hopper, N. W., Overholt, J. R. and Martin, J. R. (1979). Effect of cultivar, temperature and seed size on the germination and emergence of soybeans (*Glycine max* (L.) Merr.). Ann. Bot., 44: 301-308.

Hussey, R. S. and Baker, K. R. (1973). A comparison of methods of collecting inocula of *Meloidogyne* spp. Including a new technique. Pl. Dis. Repte., 57: 1025-1028.

Jakson, M. L. (1967). Soil chemical analysis. Prentice. Hall of India, New Delhi.498 pp.

John, M. K. (1970). Colorimetric determination of phosphorus in soil and plant material with ascorbic acid. Soil Sci., 109: 214-220.

Katembe, W. J.; Ungar, I. A. and Mitchell, J. P. (1998). Effect of salinity on germination and seedling growth of two Atriplex species (Chenopodiaceae). Ann. Bot., 82: 167-175.

Kathiresan, A., Lafitte, H. R., Chen, J., Mansueto, L., Bruskiewich, R and Bennett, J. (2006). Gene expression microarrays and their application in drought stress research. Field Crops Res. 97: 101-110.

Kathiresan, K., Kalyani, V. and Gnanarethium, J. L. (1984): Effect of seed treatments on field emergence, early growth and some physiological processes of sunflower (*Helianthus annus* L.). Field Crops Res., 9: 255-259.

Kaya, M. D., Okçu, G., Atak, M., Çıkılı, Y. and Kolsarıcı, Ö. (2006). Seed treatments to overcome salt and drought stress during germination in sunflower (*Helianthus annuus* L.). Eur. J. Agron., 24: 291-295.

Kaydan, D., Yagmur, M. and Okut, N. (2007). Effects of Salicylic acid on the growth and some physiological characters in salt stressed wheat (*Triticum aestivum* L.). TarimBilimleri Dergisi, 13 (2): 114–119.

Keetch, D. P. and Buckley, N. H. (1984). A checklist of the plant-parasitic nematodes of South Africa. Techno. Comm. Dep. Agric., Repub. S. Afr. No. 195, 213 p.

Kleynhans, K. P. N., Van den Berg, E., Swart, A., Marais, M. and Buckley, N. H. (1996). Plant nematodes in South Africa. Plant Protection Research Institute Handbook no. 8, Plant Protection Research Institute, Pretoria.

Kopyra, M., Stachoñ-Wilk, M. and Gwóÿdÿ, E. A. (2006) Effects of exogenous nitric oxide on the anti-oxidant capacity of cadmium-treated soybean cell suspension. Acta Physiol. Plant, 28, 525–536.

Palavan-Unsal, N. and Arisan, D. (2009). Nitric oxide sinalling in plats. Bot. Rev., 75: 203-229.

Pregl, E. (1945). Quantative organic micro-analysis 4th Ed. J. Chundril. London.

Rajasekaran, L. R., Stiles, A. and Caldwell, C. D. (2002): Stand establishment in rocessing carrots: Effects of various temperature regimes on germination and the role of salicylates in promoting germination at low temperatures. Canadian J. of Plant Sci., 82: 443–50.

Rapala-Kozik, M., Kowalska, E. and Ostrowska, K. (2008). Modulation of thiamine metabolism in Zea mays seedlings under conditions of abiotic stress, J. Exp. Bot., 59(15): 4133–4143, https://doi.org/ 10.1093/ jxb/ ern253.

Reddy, M. V. B., Arul, J., Angers, P. and Couture, L. (1999). Chitosan treatment of wheat seeds induces resistance to Fusarium graminearum and improves seed quality. J. Agric. Food Chem., 47(3):1208-1216. doi: 10.1021/jf981225k.

Ruan, S., Xu, Q. and Salkowski, K. (2002). The influence of priming on germination of rice Oryza *sativa* L. seeds and seedling emergence and performance in flooded soil. Seed Sci. Technol., 30: 61–67.

Shakirova, F. M., Sakhabutdinova, A. R., Bezrukova, M. V., Fathutdinova, R. A. and Fathutdinova, D. R. (2003): Changes in hormonal status of wheat seedlings induced by salicylic acid and salinity. Plant Sci., 164: 317-22.

Shao, C. X., Hu, J., Song, W. J. and Hu, W. M. (2005). Effects of seed priming with chitosan solutions of different acidity on seed germination and physiological characteristics of maize seedling. J. of Zhejiang Univ. (Agric. and Life Sci.), 31(6):705–708.

Simons, T. J. and Ross, A. F. (1971). Changes in metabolism associated with enclosed systemic resistance to tobacco. Phytopathol., 61:1261-1265.

Singh, V. K. (2006). Management of root-knot nematode, *Meloidogyne javanica* infecting tomato. Indian J. Nematol., 36: (1) 126-127.

Smirnoff, N. (2005): Ascorbate, tocopherol and carotenoids: metabolism, pathway engineering and functions. In: Smirnoff N, (ed) Antioxidants and Reactive Oxygen Species in Plants. Blackwell Publishing Ltd., Oxford.

Smirnoff, N. and Wheeler, G. L. (2000): Ascorbic acid in plants: biosynthesis and function. Crit. Rev. Plant Sci. 19:267-290.

Taylor, A. L. and Sasser, J. N. (1978). Biology identification and control of root-knot nematode (*Meloidogyne* spp.) Raleigh: North Carolina state Univ. Graphics. Raleigh, NC. 111 pp.

Uzunova, A. N. and Popova, L. P. (2012). Effect of salicylic acid on leaf anatomy and chloroplast ultrastructure of barley plants, Photosynthetica 38(2):243-250.

Van Der Linde, W. J., Clemitson, J. G. and Crous, M. E. (1959). Host-parasite relationships of South-African root-knot eelworm (*Meloidogyne spp*.). Dep. Agric. Techn. Seru. Repub. S. AJE, Ent. Ser., 44: 3-16.

Xu, H. C.., Xu, J. H., Zhang, L. Q. and Lin, H. P. (2010). Nematicidal activity of *Bacillus thuringiensis* to *Bursaphelenchus xylophilus*. Chinese J. Biol. Control. 26: 1, 85-89.

Xu, Y. C. and Zhao, B. L. (2003): The main origin of endogenous NO in higher nonleguminous plants. Plant Physiol. Biochem., 41: 833-838.

Zhou, Y. G., Yang, Y. D., Qi, Y. G., Zhang, Z. M., Wang, X. J. and Hu, X. J. (2002). Effects of chitosan on some physiological activity in germinating seed of peanut. J. Peanut. Sci., 31(1): 22–25.

استحثاث مقاومة عباد الشمس للاصابة بنيماتودا *Meloidogyne incognita* بتقنية نقع البذور

سمير برهام جاد[1]، وليد أحمد المعداوى عبيدو[2]، الشيماء عبدالله محمد أبو الخير[3]، أجنش هاديهازى[4] وإتشابا يوهاذا[4]

[1] قسم علم الحيوان الزراعي، كلية الزراعة، جامعة المنصورة، مصر.

[2] قسم المحاصيل، كلية الزراعة، جامعة المنصورة، مصر.

[3] قسم النبات الزراعى، كلية الزراعة، جامعة المنصورة، مصر.

[4] معهد البحوث الزراعية والمزرعة التعليمية ، جامعة ديبرتسين نيريغيهازا، المجر.

أجريت تجربة بصوبة وحدة بحوث النيماتولوجيا ، قسم علم الحيوان الزراعي ، كلية الزراعة ، جامعة المنصورة ، مصر ، خلال موسمى 2019 و 2020 لتقييم تأثير نقع بذورنبات عباد الشمس في حمض الساليسيليك وحمض الأسكوربيك وبيروكسيد الهيدروجين والثيامين وأكسيد النيتريك والشيتوزان بتركيزات مختلفة وتأثير ذلك علي إنبات ونمو نباتات عباد الشمس تحت ظروف الاصابة بنيماتودا تعقد الجذور. أظهرت النتائج أن نقع البذورفي أكسيد النيتريك عند 100 جزء في المليون سجل أفضل القيم (ارتفاع النبات 66.4 سم ؛ طول الجذر 81.96 سم ؛ الوزن الرطب للساق 414.2 جم ؛ الوزن الرطب للجذور 201.86 جم ؛ الوزن الجاف للساق 65.76 جم) . وفي الوقت نفسه تم تسجيل أقل كفاءة في المعاملات المختبرة في حالة نقع البذور في بيروكسيد الهيدروجين عند 50 جزء في المليون (طول النبات 47.66 سم ؛ طول الجذر 53.36 سم ؛ الوزن الرطب 263.6 جم ؛ الوزن الرطب للجذور 126.28 جم ؛ الوزن الجاف للمجموع الخضري 49.52 جم). وسجلت معاملة المبيد النيماتودي أوكساميل قيم (ارتفاع النبات 34.3 سم ، طول الجذر 32.94 سم ، الوزن الرطب للساق 156.0 جم ، الوزن الرطب للجذور 72.3 جم ، الوزن الجاف للمجموع الخضرى37.94 جم ،) مقارنة بغير المعامل. وسجلت معاملة النقع للبذور في ببيروكسيد الهيدروجين عند 100 جزء في المليون افضل القيم (النيتروجين 7.32% ، الفوسفور 0.78% والبوتاسيوم 6.5% والفينول 117.1% وبولي فينول اوكسيديز 1.4% ؛ الكلوروفيل أ: 1.1 ؛ الكلوروفيل ب: 0.7 ؛ إجمالي الكلوروفيل: 1.74 ؛ و كاروتين: 1.28). أدى نقع بذور نباتات عباد الشمس فى أكسيد النيتريك (100 جزء في المليون) والشيتوزان (50 جزء في المليون) والشيتوزان (100 جزء في المليون) إلى إنتاج أعلى القيم لمعظم الصفات تحت الدراسة مقارنة بالمعاملات الأخرى خلال الموسمين. من ناحية أخرى ، أدى نقع البذور في بيروكسيد الهيدروجين بتركيز 100 جزء في المليون ، والثيامين عند 50 جزء في المليون ، والثيامين عند 100 جزء في المليون ، وأكسيد النيتريك عند 50 جزء في المليون إلى أعلى القيم لصفات الكيميائية.