Effect of Intercropping Sesame plants with Eggplant on the Suppression of Root-Knot Nematodes (Meloidogyne sp(.

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Abstract

This study was conducted to evaluate the effectiveness of sesame root extract at three concentrations (20%, 40%, and 60%) and three concentrations of nematicide (Velum Prime) (40, 80, and 120 ppm) against root-knot nematodes in vitro and the effect of intercropping sesame with eggplant and Velum Prime application in the field against this pest. The results showed the effectiveness of the extract concentrations in reducing the rate of egg hatching and increasing the juveniles' mortality with significant differences, and the 60% concentration achieved the highest reduction in the rate of hatching and increase in juveniles' mortality by 35.8% and 57%, respectively. The sesame intercropping with the eggplant showed an increase in the vegetative growth of eggplant and a decrease in infection severity compared to the control treatment, where the infection severity was 0.28 compared to 0.43 in the control treatment. The results also showed that the nematicide Velum Prime was significantly superior in giving the lowest hatching rate and the highest mortality rate of juveniles in the laboratory, as well as significantly superior in the vegetative growth characteristics of eggplant .

Keywords. Sesame, Eggplant, Meloidogyne sp, Velum prime.

Introduction

Nematodes are one of the most important pests that cause severe damage to the root system of plants and lead to the failure of roots in performing their functions in absorbing water and nutrients for the plants and make the roots susceptible to infection by other disease-causing agents such as fungi, bacteria, viruses, and others. Vegetable crops are more susceptible to this pest, where economic losses in the productivity of these crops due to infection with this pest reach about 10% of the total global production, half of these damages are due to infection with root-knot nematodes Meloidogyne spp. alone [18]. In Iraq, root-knot nematodes are one of the most widespread species and cause severe damage to many crops, and four main species spread in Iraq have been diagnosed, namely M.javanica, M incognita, M arenaria, M hapla [4]. Eggplant (Solanum melongena L.), which belongs to the family Solanaceae, is one of the important vegetable crops in Iraq, where it is cultivated in two ways, open-field cultivation and protected cultivation, and the area cultivated with it in 2021 was (51,056) dunums, producing 215,687 tons. With a production rate of 4224.5 kg/dunum [16] It is low in calories and fats. Eggplant is affected by a number of pests that threaten its cultivation, and one of the most dangerous of these pests is the root-knot nematode (RKN) of the genus Meloidogyne sp., which is difficult to control due to its high reproductive efficiency and wide host range [12]. Several methods have been used to control root-knot nematodes, including chemical methods, which have shown high efficiency in controlling them, but their high cost,

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environmental and human health damage, long persistence, and toxicity to non-target organisms have contributed to the reduction of their use [9]. In recent years, there has been increased interest in biological control factors based on natural biological products. These factors are characterized by not being dangerous to humans and animals, having a selective mode of action, and preventing the development of pest resistance to these products [14]. Among the vital factors that gave good results in this field is the use of antagonistic plants that inhibit or limit the spread of nematodes. It has been proven that introducing sesame (Sesamum indicum) into the agricultural cycle reduces the levels of root-knot nematodes [6]. The anti-nematode effect of sesame is attributed to its containing lignans sesamin and sesamolin, which are natural antioxidants found only in this crop [3,5,6]. This study aimed to evaluate the effects of intercropping sesame with eggplant, along with sesame root extract and the nematicide Velum Prime, on the suppression of root-knot nematodes (Meloidogyne sp.(.

Materials and Methods

Preparation of sesame root extract

Sesame root extract was prepared by taking 25 g of sesame roots, drying them in the shade for a week, grinding them with an electric mixer, adding 100 ml of distilled water and then leaving the mixture for 24 hours and then filtering with whatman No. 1 filter paper to obtain a concentrated extract and then concentrations of 20%, 40% and 60% were prepared [2.[

Preparation of nematicide concentrations

Three concentrations of Velum Prime (40, 80, and 120 ppm) were prepared for the in vitro experiment.

Preparation of nematode egg suspension

The method described by [11] was followed. The roots of infected eggplant plants were washed with water to remove dust, then cut into pieces 1–2 cm in length and placed in an electric mixer. A 200 ml solution of sodium hypochlorite (0.5% concentration) was added, prepared by mixing 1 ml of sodium hypochlorite with 199 ml of distilled water. The mixer was run for 25–30 seconds and restarted twice. After homogenizing the sample, the mixture was passed through 200 and 500 mesh sieves, respectively; the first sieve removed impurities, while the second collected the nematode eggs. The sieve containing the eggs was rinsed under a stream of water for 3 minutes to remove sodium hypochlorite residues. The contents of the sieve were then transferred by placing it diagonally over a glass beaker and directing a stream of water to collect the eggs. Finally, the number of eggs was adjusted to 50 ± 2 eggs/ml using a counting slide, following the method described in [7.[

Preparation of Juvenile Suspension of J2 Root-Knot Nematodes

The [21] method, also called the soaking method, was used to extract second-phase juveniles from infected roots. Where I took a sample of the infected roots and was washed by a stream of water and then cut by scissors into small pieces with a length of 1-2 cm and then took 20 g of them and placed in an electric mixer with the addition of 200 ml distilled water and the mixer was turned on for 5-10 seconds and then poured the mixture on a concave sieve lined with paper napkins and put under the sieve a container with water so that the surface of the water touches the sieve and does not immerse it and then left at a temperature of 27 ºC. Then a quantity of water is taken under the sieve containing the young of the second generation J2 for nematodes and

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the water is completed when needed so that it is in contact with the sieve.

Testing of nematode egg hatching in vitro

Petri dishes with a diameter of 6 cm were used and 1 ml of nematode eggs containing 50 ± 2 eggs / ml were placed in each dish, then 2 ml of concentrations of sesame roots extract and nematicide were added to each dish, with three dishes per treatment and three replicates, along with a control treatment to which 2 ml distilled water was added. Then all the dishes were incubated at a degree of 30 m, which is the appropriate degree for hatching eggs and the number of hatched eggs was calculated after three days and then calculated the corrected percentage of hatching eggs according to the equation [17.[

Corrected hatching ratio = number of hatching eggs in treatment / number of hatching eggs in control × 100

The experiment was carried out according to the complete random design (CRD(with three repeaters.

Testing of corrected mortality ratio of juvenile nematodes in vitro

A suspension of second-stage juveniles was prepared and adjusted to 50 ± 2 juveniles/ml. The concentrations of sesame roots extract and nematicide were added as described in the previous section, and the dishes were incubated at 27°C. Readings were taken after 72 hours, and the corrected mortality rate was calculated according to equation [1.[

Corrected mortality ratio = 100 - (number of live juveniles in treatment / number of live juveniles in control)× 100

Field experiment

The field experiment was conducted in Qarah Tappa District, Diyala Governorate, on a 500 m² plot of land that was plowed, leveled, and divided into three lines, each 18 meters in length and spaced 3 meters apart. Each line was subdivided into four experimental units, each 3 meters long and containing 10 plants, with a spacing of 2 meters between units. A drip irrigation system was installed, after which the soil was sterilized using formalin and covered with nylon sheets for three days. The cover was then removed, and the soil was left exposed for one week to allow the evaporation of residual formalin. Eggplant seedlings of the 'Hauser' variety were transplanted into the field, planted on both sides of the drip irrigation lines with a spacing of 40 cm between plants. A suspension of second-stage juveniles (J2) of nematodes was prepared and adjusted to a concentration of 50 ± 5 larvae/ml. The suspension was applied at a rate of 400 juveniles per planting hole, and the seedlings were planted directly into these inoculated holes. Sesame seeds were then sown between the eggplant plants. When the sesame plants reached the five-leaf stage, thinning was performed to leave one sesame plant between every two eggplant plants. One month after transplanting the eggplant seedlings, the nematicide Velum Prime was applied at a concentration of 120 ppm to the relevant treatment group. The experiment was conducted using a randomized complete block design (RCBD) with three replicates. The treatments included nematode + sesame plants, nematode + velum prime, a positive control (nematode only), and a negative control (no nematode.(

The five-degree root-knot index was used to assess infection severity, where:

=1no nodes on roots,

=2nodes on 25% of the roots,

=3nodes on 50% of the roots,

=4nodes on 75% of the roots,

=5nodes on 100% of the roots.

To calculate infection severity, the following equation [13] was used:

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Infection severity = (Number of plants infected × Infection grade 1 + ... + Number of plants infected × Infection grade 5) / (Total number of plants × 5) × 100

Results and Discussion

Effect of sesame root extract and nematicide (velum prime) on egg hatching and mortality rate of nematode juveniles in vitro

The results of Table 1 indicated that sesame root extract at a concentration of 60% was the most effective in reducing egg hatching to 35.8%, followed by the concentrations of 40% and 20%, which recorded 66.5% and 72.3%, respectively, compared to the control, which showed the highest egg hatching percentage (96.1%). Similarly, the concentration of 60% was also the most effective in increasing the corrected mortality ratio to 57.0%, followed by the concentrations of 40% and 20%, which recorded 33.1% and 23.0%, respectively, compared to the control, which had the lowest rate, 2.4%.

The results of Table 2 showed that velum prime at a concentration of 120 ppm was the most effective in reducing egg hatching to 1.3%, followed by the concentrations of 80 ppm and 40 ppm, which recorded 2.2% and 4.4%, respectively, compared to the control, which showed the highest egg hatching percentage (96.1%). Similarly, the concentration of 120 ppm was also the most effective in increasing the corrected mortality ratio to 98.4%, followed by the concentrations of 80 ppm and 40 ppm, which recorded 90.9% and 84.7%, respectively, compared to the control, which had the lowest rate, 2.4%.

These findings are consistent with [19]; they confirmed that the cultivation of sesame root tissue in artificial environments led to the inhibition of nematode egg hatching and the death of larvae of the genus Meloidogyne incognita and may be due to the presence of aspartic acid, glutamic acid, glycine, and leucine in sesame root secretions or extracts [20]. The chemical nematicide (velum prim) on hatching eggs and larval death is consistent with [10], which found the hatching rate was 4.4%. [15] also pointed out that the chemical nematicide (velum prim) can penetrate the egg and stop the development of the embryo or kill the juveniles of the first phase J1, which is inside the egg, or kill the young women of the second phase J2, and the reason may be attributed to the fact that it contains a triple fluorine atom that enables it to penetrate the egg membrane and then kill the embryos.

Effect of intercropping sesame with eggplant and nematicide (Velum Prime) on nematode infection severity and some vegetative traits of eggplant

The results of Table 3 showed that Velum Prime was the most effective in reducing infection severity to 0.12%, followed by the sesame plants, which recorded 0.28, compared to the control, which showed the highest infection severity (0.43%.(

The results of Table 4 revealed that the Velum Prime significantly improved plant height to 61.00 cm and plant weight to 511.6 g, with lower loss ratios of 8.5% and 16.8%, respectively, followed by sesame plant treatment, which enhanced plant height to 52.00 cm and plant weight to 341.6 g, with lower loss ratios of 22.0% and 44.4%, respectively, compared to the positive control group, which recorded the lowest plant height (48.33 cm) and weight (333.3 g), with the highest loss ratios (27.5% and 45.8%, respectively). The negative control (no nematode) showed the highest growth (66.66 cm, 615.0 g, respectively), confirming the damaging effect of nematodes and the

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protective role of both treatments, especially Velum Prime.

The positive control recorded the highest fresh root and dry weight (54.0 and 13.25 g, respectively) and the highest loss ratios (67.1% and 65.6%, respectively), indicating severe damage. Treatment with Velum Prime recorded lower fresh and dry root weights (35.3 and 8.8 g, respectively) with minimal loss ratios (9.2% and 10.0%, respectively), while the sesame plant treatment recorded 40.7 and 10.25 g, with loss ratios of 26.0% and 28.1%, respectively. The negative control had the lowest fresh and dry weights (32.3 g and 8.0, respectively). These results suggest that Velum Prime was more effective than sesame plants in minimizing nematode-induced root biomass loss.

Conclusion

Both sesame root extract and Velum Prime effectively reduced root-knot nematode activity in eggplants; they showed superior performance by significantly reducing egg hatching, increasing corrected mortality ratio, minimizing infection severity, and improving plant growth and root biomass, and sesame intercropping provided good protection, suggesting its potential as an eco-friendly alternative in integrated nematode management.

Table 1. Effect of sesame root extract on corrected egg hatching rate and corrected Juvenile mortality rate of Root-Knot Nematode

Sesame root extract	Corrected hatching ratio	Corrected mortality ratio
20%	72.3 b	23.0 c
40%	66.5 c	33.1 b
60%	35.8 d	57.0 a
Control	96.1 a	2.4 d

Table 2. Effect of velum prime on corrected egg hatching rate and corrected Juvenile mortality rate of Root-Knot Nematode

Velum prime	Corrected hatching ratio	Corrected mortality ratio
40 ppm	4.4 b	84.7 c
80 ppm	2.2 c	90.9 b
120 ppm	1.3 c	98.4 a
Control	96.1 a	2.4 d

Table 3. Effect of sesame plants and velum prime on infection severity caused by Root-Knot Nematode in eggplant roots

Treatments	Infection severity
Nematode + sesame plants	0.28 b
Nematode + velum prime	0.12 c
positive control	0.43 a

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Table 4. Effect of sesame plants and velum prime on some vegetative traits of eggplant infected with Root-Knot Nematode

Treatments	Plant height cm		Plant weight g		Fresh root weight g		Dry root weight g	
	Height	Loss ratio	Weight	Loss ratio	Weight	Loss ratio	Weight	Loss ratio
Nematode + sesame plants	52 c	22	341.6 c	44.4	40.7 b	26	10.25 b	28.1
Nematode + velum prime	61 b	8.5	511.6 b	16.8	35.3 c	9.2	8.8 c	10
positive control	48.33 d	27.5	333.3 d	45.8	54.0 a	67.1	13.25 a	65.6
Negative control	66.66 a	0.0	615 a	0.0	32.3 c	0.0	8.0 c	0.0

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