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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (1): 44-46, 2000

Integrated Control of Root-Knot Nematodes, *Meloidogyne* spp. Infecting Sunflower and Tomato

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Abstract: Castor (*Ricinus communis*), the nematode - trapping fungus, *A. oligospora* and oxamyl were evaluated alone as well as in combination on *Meloidogyne* spp. infecting sunflower and tomato under greenhouse conditions. Results indicated that application of castor alone or in concomitant with *A. oligospora* or /and oxamyl gave better enhancement in various growth parameters such as fresh shoot length and weight whether in tomato or sunflower. Root galling was significantly suppressed in all treatments as compared with untreated plants. In sunflower, pre-planting application with castor + oxamyl gave the best results , recording a gall index of 3.50 with the highest percentage of increase in total plant fresh weight (81.9) . However, castor alone or integrated application of castor + *A. oligospora* + oxamyl or *A. oligospora* + oxamyl to the soil gave the best results in terms of suppression of galls and increased tomato plant growth. These results indicate that oxamyl as nematicide had no adverse effect on the predaceous activity of *A. oligospora*, In addition dried leaves of castor play an important role in promoting plant growth as well enhancing microorganisms in soil.

Key words: Integrated control, biological control, castor, nematicide, root-knot nematode

Introduction

The need for integrated pest management is so great nowadays that some think it is a new idea . Actually, it began developing many years ago, when combinations of biological control, cultural control, chemical control and sometimes plant resistance were used to control nematodes on a single crop (Akhtar and Alam, 1991; Zaki and Bhatti, 1990; Oduor-Owino and Waudo, 1995). The potential of nematode trapping fungus, *Arthrobotrys oligospora* Fres. as biocontrol agent against root-knot nematodes, *Meloidogyne* spp. has been studied under laboratory and greenhouse conditions (Leuprecht, 1988; Jaffee *et al.*, 1993; Duponnois, *et al.*, 1995, 1996; Mostafa, 1998). There are reports indicating that amendment of castor (*Ricinus communis* L.) used as fresh, dried leaves or oil - cake in the soil helps in suppression of population of *Meloidogyne* spp. and was found to be useful in the management of root-knot nematodes (Zaki and Bhatti, 1990; Oduor-Owino *et al.*, 1993; Sankaranarayanan and Sundarababu, 1997; Siddiqui and Alam, 1997; Nagesh *et al.*, 1998; Walia *et al.*, 1999).

Most studies on biological control have demonstrated that organisms have low efficacies, which make them unacceptable as sole agents. However, integrating biological control with other methods could make an excellent model for nematode control and achieve the desired results.

Therefore the present study was carried out to determine the impact of *A. oligospora*, integrated with castor as organic amendment as well as oxamyl in controlling *Meloidogyne* spp. infecting sunflower and tomato under greenhouse conditions.

Materials and Methods

Plastic pots 10cm-d were filled with 250 g sandy loamy soil naturally infested with root-knot nematodes (*Meloidogyne* spp.). Nematode was evaluated as 1223 second juveniles per 250 soil. Pots were supplemented with 0.5g of ground air dried leaves of castor (*R. communis* L). Fungal inoculum of *A. oligospora* 6.3 x 10^6 was used. Oxamyl as nematicide was used at recommended dose in single application and at half dose when integrated with the other components (castor and /or fungus). All pots were maintained in moist conditions for two weeks to allow decomposition of the supplements and dispersion of fungus. Then seeds of sunflower *Helianthus annus* cv. Vidoc 5 were planted in each pot. Plants were thinned to one plant per pot after 5 days. There were four replicates for each treatment. Untreated pots served as control. Pots were arranged on a greenhouse bench in a randomized complete block design, received water as needed and maintained for eight weeks.

At the end of experiment, plants were harvested . Data dealing with fresh shoot length, shoot and root weight were recorded. Root galling was rated on a scale of 0 to 5 where 0 = no galls, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, 5 = more than 100 galls per root system (Taylor and Sasser 1978).

Data were subjected to analysis of variance and the Waller-Duncan k-ratio t test was used to separate treatment (Waller and Duncan,1969).

Results and Discussion

Data presented in (Table 1) showed that the addition of castor dried leaves either individually or in concomitant with other treatments , to sunflower cv.Vidoc 5 infected with *M. incognita,* gave better performance in plant growth than did the predaceous fungus, *A. oligospora* or oxamyl. Best improvement in shoot length was recorded in pots receiving castor + oxamyl followed by those amended with castor alone then castor integrated with *A. oligospora* and oxamyl.

Moreover significant increase in shoot and root weight was recovered from pots receiving concomitant treatment as castor + oxamyl followed by castor + *A. oligospora* then castor + *A. oligospora* + oxamyl with percentage of increase 81.19, 42.81 and 23.79 respectively . Although significant difference was noticed between castor alone and castor + oxamyl for shoot weight, non significant difference was detected between *A. oligospora* alone and *A. oligospora* + oxamyl.

Further decline in the gall formation was detected when the soil treated with dried leaves of castor. Root galls were significantly suppressed on sunflower roots of all treatments with root gall indices ranged from 3.25 – 4.0 as compared with that of the control. The lowest gall index was performed in pots receiving castor alone as well as castor integrated with oxamyl + *A. oligospora*. The highest gall index was performed

Table 1: Impact of castor individually or integrated with *A. oligospora* and oxamyl on plant growth of sunflower Vidoc 5 infected with *Meloidogyne* spp. and gall formation

Treatment	Shoot length (cm)	Shoot weight (g)	Root weight (g)	Total plant fresh weight	% of increase	Root gall incidence
Castor (*R. communis*)	41.88	8.31b	8.90bc	17.21	19.02	3.25c
A. oligospora	37.50	6.65 c	8.59c	15.24	5.39	4.00b
Oxamyl	37.75	6.80c	8.78bc	15.58	7.75	3.50bc
Castor + *A. oligospora*	41.25	8.52b	12.13b	20.65	42.81	4.00b
Castor + oxamyl	43.63	10.21a	15.99a	26.20	81.19	3.50bc
A.oligospora + oxamyl	35.00	5.86c	10.27bc	16.13	11.55	3.50bc
Castor + *A.oligospora* + oxamyl	40.33	9.54ab	8.360bc	17.90	23.79	3.25c
Nematode alone	37.25	5.56c	8.90bc	14.46	-	5.00a
	NS					

Each number presented the mean of four replicates. Means in each column followed by the same letter did not differ at $P<0.05$ according to Duncan's Multiple Range test.

Table 2: Impact of *A .oligospora* singly or integrated with castor and /or oxamyl on plant growth of tomato cv. Strain B3 infected with *Meloidogyne* spp. and gall formation.

Treatment	Shoot length (cm)	Shoot weight (g)	Root weight (g)	Total plant fresh weight	% of increase	Root gall incidence
Castor (*R. communis*)	11.13	3.52	6.72a	10.24	61.20	3.50b
A. oligospora	7.80	3.39	4.19bc	7.58	19.37	3.00b
Oxamyl	10.50	3.08	4.35bc	7.43	17.00	3.00b
Castor + *A. oligospora*	11.73	3.32	4.28bc	7.60	19.69	3.25b
Castor + oxamyl	11.33	3.61	3.56c	7.17	12.91	3.25b
A . oligospora + Oxamyl	8.80	3.24	5.65b	8.89	40.00	3.25b
Castor + *A. oligospora* +oxamyl	9.80	3.44	5.85b	9.29	46.30	3.25b
Nematode alone	9.50	2.59	3.76c	6.35	-	5.00a
	NS	NS				

Each number presented the mean of four replicates. Means in each column followed by the same letter did not differ at $P<0.05$ according to Duncan's Multiple Range test.

with *A. oligospora* and *A. oligospora* + castor. Best improvement in shoot length of tomato was obtained following the application of either castor alone or integrated with *A. oligospora* or oxamyl (Table 2). Moreover, shoot and root weight showed better increase in all treatments as compared with non treated pots. Significant increase in root weight of tomato was performed in pots amended with dried leaves of castor followed by castor + *A. oligospora* + oxamyl then castor + *A. oligospora* with percentage of increase in total plant fresh weight 61.20, 46.30 and 40.00 respectively.

Root galling was significantly suppressed in all treatments as compared with control. Non significance difference was noticed between treatments. Root gall indices ranged from 3.00 – 3.50. The lowest gall index (3.00) was performed with either oxamyl or *A. oligospora* however, the highest gall index(3.50) was recorded with castor.

From the previous results it can be noticed that plant growth in terms of shoot length and weight of sunflower and tomato infected with root-knot species, *Meloidogyne* spp. showed better performance following the addition of castor singly or integrated with *A. oligospora* or /and oxamyl. Best results were obtained in concomitant treatment. Root galling was significantly suppressed in all treatments as compared with untreated inoculated plants. Treatments in sunflower infected with root-knot nematodes were effective in the order: castor + oxamyl >castor + *A. oligospora* >castor +oxamyl + *A. oligospora*. These results support the findings of Zaki & Bhatti, 1990 who reported that the integration of castor + *Paecilomyces lilacinus* was better in reducing the nematode population and increasing plant growth and yield than when used alone. On the other hand, treatments in tomato infected with root - knot nematodes were effective in the order: castor alone >castor +oxamyl + *A. oligospora* > oxamyl + *A. oligospora*. Previous results are in accordance with those reported by Rodriguez - Kabana, 1986 who reported that the addition of organic matter to soil improves soil fertility and increases crop yield. Moreover, the amendment alters the soil environment so as to favor soilborne antagonistics that destroy or weaken plant parasites (Main & Rodriguez –Kabana, 1982). Results obtained from the addition of oxamyl + castor proved that oxamyl had no adversely effect on *A. oligospora*.

We can concluded that integrated pest management of root - knot nematodes on sunflower and tomato under greenhouse conditions, using castor as organic amendment, *A. oligospora* as nematode - trapping fungus with minimum use of oxamyl as nematicide, gave promising results in suppressing root galling as well as promoting plant growth. However, more experiments are needed to be evaluated using different soil amendments as well as another microorganisms under greenhouse and field conditions.

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