African Journal of Agricultural Research Vol. 7(25), pp. 3695-3700, 3 July, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897// AJAR11.2033
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Efficacy of two organic amendments and a nematicide for management of root-knot nematode *(Meloidogyne incognita)* of watermelon

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Accepted 13 April, 2012

A field experiment was conducted during two consecutive years for the management of root-knot nematode *(Meloidogyne incognita)* of watermelon with two organic soil amendments poultry refuse (3 and 5 t/ha), mustard oilcake (0.3 and 0.6 t/ha) and a nematicide Furadan 5G 40 kg/ha. Organic amendments were incorporated in the soil 3 weeks before and Furadan 5G on the day of seedling transplanting. PR 3 t/ha and MOC 0.3 t/ha were used alone and integrated with Furadan 5G 20 kg/ha. The soil was inoculated with galled roots of tomato at the time of treatment application. Two organic soil amendments alone or integration with Furadan 5G gave satisfactory reduction of root-knot and increase plant growth in both years. The most effective treatment was PR 5 t/ha followed by PR 3 t/ha + Furadan 5G 20 kg/ha. Efficacy of PR 3 t/ha and MOC 0.6 t/ha were also appreciable. In first and second years, gall index values were 8.13 and 5.67 under control, respectively. The severity was reduced from 3.13 to 5.80 in first year and 2.34 to 3.94 in the second year due to treatments. Based on findings of the study, PR alone 5 t/ha and PR 3 t/ha + Furadan 5G 20 kg/ha were noted as effective treatment to manage root-knot disease of watermelon.

Key words: Poultry refuse, mustard oilcake, furadan, *Meloidogyne incognita.*

INTRODUCTION

Watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai, family Cucurbitaceae) refers to both fruit and plant of a vine-like herb originated from Southern Africa and one of the most common types of melon. The watermelon fruit, loosely considered a type of melon has a smooth exterior rind and a juicy, sweet, usually red, but sometimes orange, yellow, or pink interior flesh. Watermelon is highly susceptible to many diseases caused by fungi, bacteria, viruses and nematodes (Anon. 2007). Among these, nematode diseases are also very important. Nematodes can substantially reduce the yield of watermelon. Root-knot disease caused by *Meloidogyne incognita* and *M. javanica* are very detrimental to the crop and cause galling in roots. When the susceptible variety of watermelon is severely affected, the root system is converted to the galls which drastically affects yield. A number of approaches have been reported for controlling root-knot nematodes through application of nematicides (Hossain et al., 1989), plant extracts (Ahmed and Karim, 1991), organic soil amendments (Trivedi et al., 1978; Mian and Rodrigued-Kabana 1982; Faruk et al., 2001*;* Bari et al., 2004; Wani, 2006; Faruk et al., 2011), cultural, physical (soil solarization) and biological (*Trichoderma* spp*, Paecilomyces lilacinus, Pasturia penetrans* and *Pseudomonas aeruginosa*) (Rao et al., 1997, Reddy et al., 1998, Siddiqui et al., 1999). Single approach is not adequate to control the disease and as such, integrated management is the best option which is cost effective and eco-friendly. At the present, resistant cultivar of water melon in the country is not available. Chemicals in combination with organic soil amendments have positive roles in reducing the nematode population in soil as well

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as, improving the physical properties of soil (Hussain and Khan, 1988). Presently, researchers have diverted their attention to manage plant nematode through the use of organic amendments (Mian and Rodrigued-Kabana, 1982; Faruk et al., 2001; Bali et al., 2004) and to develop integrated approaches against the plant parasitic nematode efficiently. Under the ongoing circumstances, the present study was undertaken to find out efficacy of poultry refuses, mustard oilcake and Furadan 5G for management root-knot nematode and to increase plant growth of watermelon.

MATERIALS AND METHODS

The experiment was conducted in the experimental field of Plant Pathology Division, Bangladesh Agricultural Research Institute (BARI), Gazipur in two consecutive years (2008 to 2009 and 2009 to 2010 cropping seasons). The experiment was laid out in a Randomized Completely Block Design (RCBD) with three replications. The unit plot size was 3 × 2 m. There were eight treatments including organic amendments and chemicals. The treatments were (i) control, (ii) Furadan 5G at 40 kg/ha, (iii) poultry refuse at 5 t/ha, (iv) poultry refuse at 3 t/ha, (v) poultry refuse at 3 t/ha+ Furadan 5G at 20 kg/ha, (vi) mustard oilcake at 0.6 t/ha, (vii) mustard oil cake at 0.3 t/ha, (viii) mustard oilcake at 0.3 t/ha+ Furadan 5G at 20 kg/ha.

Standard cultivation procedures recommended by BARI were followed to grow watermelon. Each experimental plot was divided into four pits. Requisite quantity of fresh poultry refuse and mustard oil cake were incorporated with the soil 3 weeks before transplanting of watermelon seedlings and allowed to decompose properly. Furadan 5G was applied at the time of seedlings transplanting. To ensure inoculum of the nematode, severely galled tomato roots infected with *M. incognita* were collected from nematode sick bed, chopped into small pieces and mixed with soil at the time treatment application at 10 g/pit. Twenty days old watermelon seedlings of variety Glory were transplanted in the pits and ten seedlings were planted in each pit. During the crop season, necessary weeding, irrigation and other intercultural operations were done as per recommendation of the crop (Anon, 2007).

The root-knot disease severity was recorded at 60 days after transplanting by uprooting five seedlings from each pit. Data on length (cm) and weight (gm) of shoot and root, and severity of root gall was recorded based on a 0 to 10 scale (Zeck, 1971). Correlation and regression analysis was performed to find out the relationship of shoot weight and root weight with gall index values of watermelon.

RESULTS AND DISCUSSION

Severity of root-knot disease

In both years, all the treatments significantly reduced the severity of root-knot of watermelon over control. In the first year (2008 to 2009 cropping season), the maximum average gall index value of 8.13 was recorded in the control plot. It was reduced to 3.13 to 5.80 due to treatments with two organic amendments at different doses and the Furadan 5G and their integration. Higher reduction of root-knot severity was resulted with higher dose of organic amendments. The lowest severity of root-knot disease was recorded by PR at 5 t/ha, which was followed by PR at 3t/ha + Furadan 5G at20 kg/ha and MOC at 0.3 t/ha + Furadan 5G at 20 kg/ha and they were statistically similar (Table 1).

In the second year (2009 to 2010 cropping season), the highest gall index value of 5.67 at harvest was found in control and the values were reduced to 2.34 to 3.94 due to application of different treatments. All the treatments significantly reduced root-knot severity compared to control at both data recording period. The maximum reduction was obtained with PR at3 t/ha + Furadan 5G at 20 kg/ha followed by PR at 5 t/ha and MOC at 0.3 t/ha + Furadan 5G at 20 kg/ha. The least effective treatment to reduce root-knot galling was Furadan 5G at 40 kg/ha followed by MOC at 0.3 t/ha and MOC at 0.6 t/ha and they showed statistically insignificant.

Shoot growth

Average shoot length of watermelon under control was 25.07 cm/plant in the first year and 31.72 cm/plant in the second year. There existed significant effect of organic soil amendments, Furadan 5G and their integration on the growth of watermelon over control. In the first year, the highest shoot length was obtained with PR at 5 t/ha which differed with all the rest treatments except PR at 3 t/ha + Furadan 5G at 20 kg/ha and MOC at 0.6 t/ha. In second year, the maximum shoot length was recorded by PR at5 t/ha which showed statistically insignificant with PR at 3 t/ha + Furadan 5G at20 kg/ha. The least effective treatments to increase shoot length was Furadan 5G at 40 kg/ha followed by MOC at 0.3 t/ha, MOC at 0.3 t/ha + Furadan 5G at 20 kg/ha and MOC at 0.6 t/ha (Table 2).

In the first year, the shoot weight of watermelon was only 16.33 g/plant in control. The highest shoot weight was achieved with PR at 3 t/ha + Furadan 5G at 20 kg/ha which was statistically similar to PR at 5 t/ha, PR at 3 t/ha, MOC at 0.6 t/ha and MOC at 3 t/ha + Furadan 5G at 20 kg/ha. In the second year, significantly higher shoot weight was obtained by PR at 5 t/ha and PR at 3 t/ha +Furadan 5G at 20 kg/ha and they differed significantly with the remaining treatments. The effect of PR at 3 t/ha, MOC at 0.6 t/ha and at 0.3 t/ha and MOC at 0.3 t/ha + Furadan 5G at 20 kg/ha on shoot weight was insignificant. These four treatments gave significantly higher shoot weight as compared to control and Furadan 5G at 40 kg/ha (Table 2).

Root growth

Soil amendment with PR and MOC and application of Furadan 5G showed significant effects on growth of watermelon roots as compared to control. In the first year, the minimum root length of 6.07 cm/plant was recorded under control. Three treatments, PR alone at 5 t/ha, Furadan 5G at 40 kg/ha and PR at 3 t/ha + Furadan

Table 1. Effect of soil treatment with two organic amendments and one nematicide on the severity of root -knot disease *(Meloidogyne incognita)* of water melon in two consecutive years.

Organic amendments and furadan 5G with dose	Gall index at 60 days of seed sowing (0-10 scale)		Gall index at harvest (0-10 scale)		Gall index reduced over control (at harvest)	
	1st year	2nd year	1st year	2nd year	1st year	2nd year
Control	5.87[a]	4.33[a]	8.13[a]	5.67[a]	-	-
Furadan 5G at 40 kg/ha	3.40[b]	2.73[b]	5.00[b]	3.33[b]	3.13	2.34
Poultry refuse at 5 t/ha	1.67[cd]	1.17[e]	2.33[e]	1.80[c]	5.80	3.87
Poultry refuse at 3 t/ha	1.93[cd]	1.80[c]	3.20[cd]	2.21[c]	4.93	3.46
Poultry refuse at 3t/ha + furadan at 20kg/ha	1.27[d]	1.33[de]	2.40[e]	1.73[c]	5.73	3.94
Mustard oilcake at 0.6 t/ha	2.23[c]	1.77[c]	3.47[c]	2.33b[c]	4.66	3.34
Mustard oilcake at 0.3 t/ha	2.20[c]	2.00[c]	4.50b	2.67b[c]	3.63	3.00
MOC 3t/ha + furadan at 20 kg/ha	1.73[cd]	1.73[cd]	2.73[de]	1.93[c]	5.40	3.74
LSD	5.87[a]	0.4069	0.6430	0.989	-	-
CV (%)	3.40[b]	11.04	6.62	10.71	-	-

Values within the same column with a common letter do not differ significantly (P=0.05)

Table 2. Effect of soil treatment with two organic amendments and one nematicide on shoot growth of watermelon in soil inoculated with *Meloidogyne incognita.*

Organic amendments and furadan with dose	Shoot length (cm/plant)		Shoot weight (gm/plant)	
	1st year	2nd year	1st year	2nd year
Control	25.07[e]	31.72[e]	16.33[d]	19.00[c]
Furadan 5G at40 kg/ha	33.20[d]	45.40[d]	23.87[cd]	22.00[c]
Poultry refuse at 5 t/ha	50.13[a]	59.70[a]	42.33[a]	46.00[a]
Poultry refuse at 3 t/ha	42.80[bc]	53.67[bc]	35.67[ab]	35.67[b]
Poultry refuse at 3 t/ha+ furadan 5G at 20 kg/ha	47.27a[b]	56.20[ab]	42.80[a]	45.67[a]
Mustard oilcake at 0.6 t/ha	47.73[ab]	50.73[cd]	37.33[ab]	35.67[b]
Mustard oil cake at 0.3 t/ha	39.73[c]	46.00[d]	30.33[bc]	31.33[b]
Mustard oilcake at 0.3 t/ha+ furadan 5G at 20 kg/ha	43.93[bc]	49.20[cd]	33.53[abc]	35.00[b]
LSD	5.307	5.152	9.778	6.979
CV (%)	5.30	5.99	12.27	10.39

Values within the same column with a common letter do not differ significantly (P=0.05).

5G at 20 kg/ha yielded the highest root length ranging from 13.80 to 14.67 cm/plant. Other four treatments also increased root length over control within the range of 9.13 to 13.40 cm/plant. In the second year, root length under control was only 8.53 cm/plant. It was increased from 12.87 to

Table 3. Effect of soil treatment with two organic amendments and one nematicide on root growth of watermelon in soil inoculated with *Meloidogyne incognita.*

Organic amendments and furadan with dose	Root length (cm/plant)		Root weight (g/plant)	
	1st year	2nd year	1st year	2nd year
Control	6.07^{c}	8.53^{d}	5.33^{b}	5.33^{c}
Furadan 5G at 40 kg/ha	14.67^{a}	12.87^{c}	6.34^{ab}	5.50^{c}
Poultry refuse at 5 t/ha	14.53^{a}	17.73^{ab}	7.94^{a}	8.67^{a}
Poultry refuse at 3 t/ha	13.40^{ab}	15.20^{abc}	7.26^{ab}	6.00^{c}
Poultry refuse at 3 t/ha+ furadan 5G at 20 kg/ha	13.80^{a}	18.67^{a}	6.19^{ab}	8.00^{ab}
Mustard oilcake at 0.6 t/ha	12.27^{ab}	16.40^{ab}	5.78^{ab}	6.33^{bc}
Mustard oil cake at 0.3 t/ha	9.13^{bc}	14.80^{bc}	6.37^{ab}	5.67^{c}
Mustard oilcake at 0.3 t/ha+ furadan 5 g at 20 kg/ha	13.20^{ab}	17.47^{ab}	5.12^{b}	6.67^{bc}
LSD	4.18	3.191	2.233	1.842
CV(%)	14.17	15.77	14.60	15.37

Values within the same column with a common letter do not differ significantly (P=0.05).

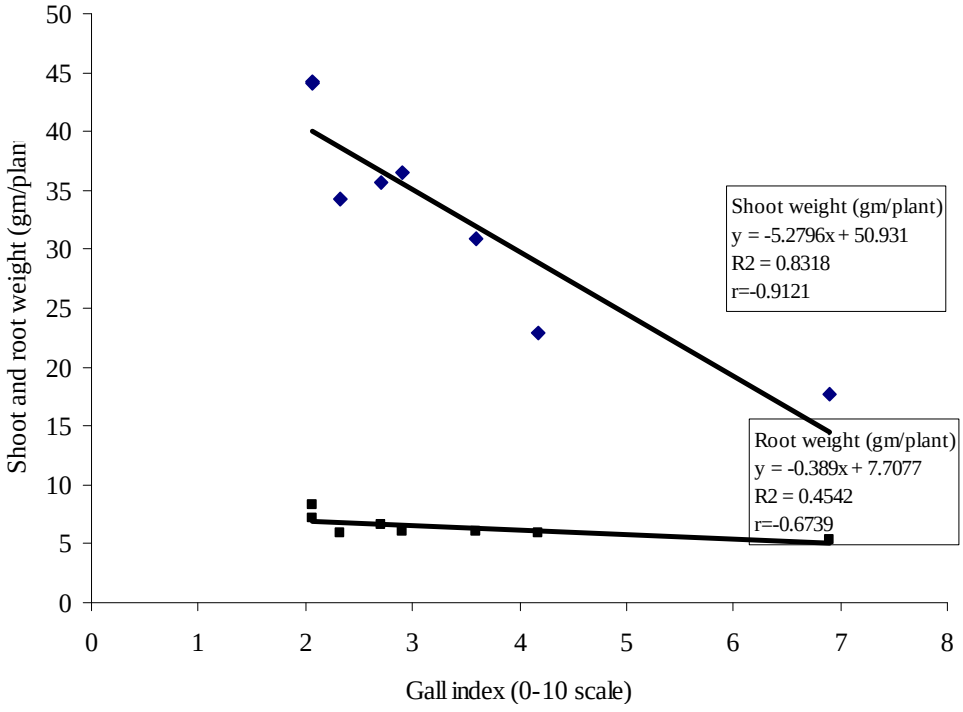

Figure 1. Relationship of shoot weight and root weight with gall index of watermelon grown in soil inoculated with *Meloidogyne incognita* and treated with poultry refuse, mustard oil cake and Furadan 5G.

18.67 cm/plant due to the application of individual treatment and their integration. The highest root length of 18.67 cm was achieved with PR at 3t/ha + Furadan5G at 20 kg/ha followed by the PR at 5 t/ha, MOC at 0.3 t/ha + Furadan 5G at 20 kg/ha and MOC at 0.6 t/ha. In the first year, the highest root weight of 7.94 cm was achieved with PR at 5 t/ha treatment followed by PR at 3t/ha, MOC at 0.3 t/ha, Furadan 5G 40 kg/ha, PR at 3t/ha + Furadan5G at 20 kg/ha and MOC at 0.6 t/ha and they are statistically similar. However, in the second year, root weight per plant ranged from 5.33 to 8.67 cm. Significantly higher root weight was recorded by PR 5 t/ha and it differed with all the rest treatments except PR at3t/ha + Furadan5G at20 kg/ha. The treatment MOC at 0.3 t/ha+ Furadan 5G at 20 kg/ha ranked next to PR at 3t/ha + Furadan5G at 20 kg/ha but this was statistically insignificant with same treatment in addition to MOC 0.6 t/ha for increasing higher root weight (Table 3).

Pooled data on shoot weight and root weight with gall index values recorded in two consecutive years were used for correlation and regression analysis and found that the relationship was linear and negative for shoot weight and root weight with coefficient of correlations (r) 0.9121 and 0.6739, respectively (Figure 1). The relationship was significant in the case of shoot and root weight and influence of gall index on those two parameters may be attributed to 83.18% (R^2 = 0.8318) and 45.42% (R^2 = 0.4542), respectively. The results indicated that organic amendments improved plant growth. It may be due to the addition of plant nutrients to the soil. A Lower R^2 value indicates that other factors are also involved in plant growth and yield increase.

The effectiveness of organic soil amendments in the suppression of plant disease is well documented (Hoitink and Fahy, 1996). For plant parasitic nematodes, effectiveness of suppression varies depending upon nematode species and types of organic soil amendments (Akhtar and Alam, 1993). The present study was taken to determine the potential of two available organic soil amendments, poultry refuse and mustard oilcake in the suppression of root-knot nematode, *M. incognita* in the field condition. Our results demonstrated that soil amendment with poultry refuse at 5 and 3 t/ha, and mustard oilcake at 0.6 and 0.3 t/ha are effective in reducing root-knot severity and increasing plant growth of watermelon grown in *M. incognita* inoculated soil. The suppression of root-knot disease severity was improved when PR and MOC applied at lower dose with chemical nematicide Furadan 5G at 20 kg/ha. Furadan 5G at 40 kg/ha reduced gall index values and also improved plant growth to some extent.

The present results are in agreement with those reported by Hasan et al. (2010) who found that organic waste materials were effective against root-knot nematode attacking tomato under field condition and significantly reduced root gall indices, nematodes and egg masses as compared to control. Faruk et al. (2011) found that poultry refuse and oil cake significantly reduced nematode disease severity and enhanced plant growth parameters of tomato. Wani (2006) indicated that soil amendments with oil cakes and leaves of different plants significantly reduced root-knot disease of okra and lentil. Also, many other investigators indicated that poultry refuse and mustard oilcake are effective in controlling root-knot nematode and enhancing plant growth of tomato (Wahundcniya, 1991; Nahar et al., 1996; Faruk et al., 2001, 2002) and many other crops (Ahmad et al., 1987; Mishra et al., 1987; Hossain et al., 1989; Bari et al., 1999; 2004a, b). Soil amendment with poultry refuse has also been reported to be effective against root-knot nematode of okra (Bari et al., 1999*),* brinjal (Bari et al., 2004; Ahmad et al., 1987), potato (Hossain et al., 1989), bottle gourd (Khan, 1996) and jute (Mishra et al., 1987). Finally, it could be concluded that the results from this study indicated that poultry refuse and mustard oilcake singly or combined with chemical nematicide Furadan 5G is highly effective against root-knot nematode and in addition gave increasing in plant growth. Among the treatments tested in the present study, the most effective one was poultry refuse at 5 t/ha followed by poultry refuse 3 t/ha mixed with Furadan 5G at 20 kg/ha. Based on findings of the present investigation, these two treatments may be recommended for controlling root-knot of watermelon.

ACKNOWLEDGMENTS

This work was supported in part by the Plant Pathology Division, Bangladesh Agricultural Research Institute. The authors are grateful to Dr. Rustom Ali and Dr. Md. Delowar Hossain for the valuable suggestion during this study.

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