INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

EFFICACY OF BIOAGENTS, NEEM CAKE, MULCHING, SOLARIZATION, TRAP CROP, AND NEMATICIDE ON GROWTH PARAMETERS AND REPRODUCTIVE FACTOR OF *MELOIDOGYNE INCOGNITA* INFECTING OKRA

Kedarnath, Ravichandra, N.G., Pavithra, B.S., Pavithra, R.S. & Reddy, B.M.R.
Department of Plant Pathology, UAS, GKVK, BENGALURU-560065

ABSTRACT
Field experiment was conducted to evaluate various management practices for their efficacy against *Meloidogyne incognita* on okra by examining the population levels of the nematodes in roots as well as on growth and development of okra plant. In general, all the treatments recorded significantly higher plant height and more number of leaves over untreated check (55.87 cm and 14.87 leaves, respectively). However, maximum plant height and more number of leaves were observed in carbofuran 3G (111.00 cm and 26.47 leaves respectively) and among treatments, maximum plant height and more number of leaves were observed in case of *Paecilomyces lilacinus* (105.73 cm and 23.67 leaves respectively) followed by *P. fluorescens* (99.87 cm and 21.87 leaves respectively), solarization (93.33 cm and 20.27 leaves respectively), marigold (84.20 cm and 20.27 leaves respectively), neem cake (77.73 cm and 18.33 leaves respectively) and mulching (72.80 cm and 17.53 leaves) respectively. The dry weight of shoot was more in case of carbofuran 3G (32.60 g) followed by *P. lilacinus* (31.50 g), *P. fluorescens* (29.40 g), solarization (28.20 g), marigold (27.6 g), neem cake (26.20 g) and mulching (24.30 g). Better root growth was recorded in plants treated with *P. lilacinus* with highest root length (25.40 cm) and root weight of 17.17 g and 05.90 g fresh and dry weight respectively. The okra plants treated with *P. lilacinus* (02.76 Kg/plot) recorded higher yield followed by *P. fluorescens* (02.50 Kg/plot) and solarization (02.25 Kg/plot) then compared to untreated check. The minimum number of galls (24.50 galls/root system) and egg masses (12.30) were observed in plants treated with *P. lilacinus* compared to untreated check which recorded higher number of galls (91.90 galls/root system) and egg masses (58.60 egg masses/root system).

KEY WORDS: Okra, *Meloidogyne incognita*, Galls, Egg masses and *Paecilomyces lilacinus.*

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the important vegetable crops of the world and popular in many tropical and subtropical countries (Singh, 2012). It is mostly cultivated for its young tender fruits, used in curry and soups after cooking. It is a good source of vitamins A and B, protein and minerals. It is also an excellent source of iodine and is useful for the treatment of goiter. The roots and stems of okra are used for clarification of sugarcane juice for preparation of jaggary and also for industrial use as fiber (Alegbejo *et al*., 2008). It occupies fifth position, next to tomato, in area under vegetables in the country with a production of 63.50 lakh metric tonnes from an area of 2.31 lakh hectares (Anon, 2013). Pests and diseases are the most damaging factors for okra production. Of all the pathogens, root-knot nematodes (*Meloidogyne* spp.) are the most serious (Hussain *et al*., 2011a; Mukhtar *et al*., 2013a). Root-knot nematodes are considered among the top five major plant pathogens and the first among the ten most important genera of plant parasitic nematodes in the world (Kayani *et al*., 2013). The annual yield losses caused by *Meloidogyne* spp. have been estimated up to 16.9% (Bhatti and Jain, 1977; Sasser, 1979; Agrios, 2005). Root-knot nematodes cause severe growth reductions and formation of galls on okra. Sikora and Fernandez (2005) reported severe attack of root-knot disease caused by *Meloidogyne* spp. on okra and yieldlosses up to 27%. Nematode management has been achieved by adopting various methods either singly or in combination. Chemicals are used to control nematodes but due to their high cost and hazardous effects, nematicides are not always attractive to farmers. Ecofriendly management practices like use of bioagents, organic soil amendments, soil solarization, mulching and intercrop with marry gold are economical and eco-friendly management option that can constitute an important component of the integrated management of root-knot nematodes. The main aim of this study was to evaluate the efficacy of different treatments on root-knot nematode and growth and development of okra under field condition.

MATERIALS & METHODS

Field experiment was conducted in the sick plot of AICRP (Nematodes) section, Department of Plant Pathology, University of Agricultural Sciences, GKVK campus, Bengaluru-65 to evaluate various management practices for their efficacy against *Meloidogyne incognita* on okra.

Treatment details

T_1= *Pseudomonas fluorescens* @15g/m^2 ($1x10^6$ cfu/g of powder)
T_2= *Paecillomyces lilacinus* @15g/m^2 ($2x10^8$ cfu/g of powder)
T_3= Neemcake @ 100g/ m^2
T_4= Mulching
T_5= Solarization
T_6= Marigold
T_7= Carbofuran 3G (standard check) @ 15g/m^2
T_8= Untreated control

Field preparation and sowing

The plot was thoroughly ploughed to a fine tilth, harrowed and leveled. All the normal package of practices like FYM and fertilizers were applied to the plot. Seeds of okra were selected for sowing. After germination the seedlings were thinned off to maintain one seedling per spot. The plots were watered regularly whenever required. Three replications were maintained for each treatment with fifteen plants in each replication.

Imposition of treatments

At the time of sowing *Pseudomonas fluorescense*, *Paecilomyces lilacinus*, neem cake, and carbofuran 3G were applied. Marigold was planted eight days before and soil solarization was done six weeks before sowing of okra seeds. Mulching was done after the establishment of okra plants.

Termination of the experiment

The experiment was terminated by uprooting of plants from the sick plots. The observations were recorded at 30, 60, 90 days after sowing and at harvest.

Observations recorded

Growth parameters of the host

1) Plant height (cm): Recorded from the base to the tip of the leaf at 30, 60, 90 days after sowing and at harvest in centimeter.
2) Shoot weight (g): Fresh and dry shoot weight was recorded at harvest.
3) Number of leaves: were counted at 30, 60, 90 DAS and at harvest
4) Root length (cm): Recorded from base of the stem to the tip of the roots, at harvest in centimeter.
5) Root weight (g): Fresh and dry root weights were recorded at the time of harvest. After uprooting the plants, the root and portion of the plants were cut and dried in an oven at 60ºC till the constant weight was reached and the dry weight was noted down.
6) Fruit yield (Kg): was recorded at the time of harvest.

On the nematode

1) Number of galls per root system: Recorded at the time of harvest by counting number of galls per root system.
2) Number of egg masses per root system: Recorded at the time of harvest. The number of egg masses of *M .incognita* per root system was counted after exposing the infected roots to 0.25 per cent tryphan blue for 3 minutes.

RESULT & DISCUSSION

Present study was taken up to evaluate the efficacy of different treatments against growth parameters and *Meloidogyne incognita* on okra under field condition.

Plant parameters

Plant height

Effects of treatments on the plant height of okra under field conditions was recorded at different intervals *viz.,* 30, 60, 90 days after sowing and at harvest stage. The results are presented in Table 1 and Fig. 1.

TABLE 1: Effect of different treatments on plant height of okra infested with *M. incognita*

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
T1: *Pseudomonas fluorescens* @15g/m^2	35.67	63.00	80.33	99.87
T2: *Paecilomyces lilacinus* @15g/m^2	39.83	67.67	84.33	105.73
T3: Neemcake @ 100g/ m^2	27.00	49.00	63.33	77.73
T4: Mulching	25.00	44.33	59.33	72.80
T5: Solarization	42.00	62.00	75.67	93.33
T6: Marigold	29.87	54.67	68.73	84.20
T7: Carbofuran 3G @ 15g/m^2	42.53	73.67	90.67	111.00
T8: Control (Untreated)	19.73	35.33	47.00	55.87
S. Em ±	0.98	1.70	2.07	2.55
C.D. at 5%	2.97	5.15	6.27	7.73

Initial nematode population (INP): 403/200 cc soil, DAS: Days after sowing

At 30 days after sowing, all the treatments recorded significantly higher plant height over untreated check (19.73 cm). However maximum plant height was observed in carbofuran 3G (42.53 cm) when compared to untreated check (19.73 cm). Among the treatments, the maximum plant height of 42.00 cm was recorded in solarization treated plot compared to *P. lilacinus* (39.83 cm), *P. fluorescens* (35.67 cm), marigold (29.87 cm), neem cake (27.00 cm) and mulching with green gram plant (25.00 cm) respectively. The lowest plant height was recorded in case of untreated

check (19.73 cm). Similarly at 60 days after sowing, there was a significant variation in plant height among the treatments compared to untreated check. Maximum plant height was observed in carbofuran 3G (73.67 cm), followed by *P. lilacinus* (67.67 cm) *P. fluorescens* (63.00 cm), solarization (62.00 cm), marigold (54.67 cm), neem cake (49.00 cm) and mulching (44.33 cm) compared to untreated check (35.33 cm). Even at 90 days after sowing, plant height among the treatments was significantly higher than untreated check. Maximum plant height was observed in carbofuran 3G (90.67 cm) followed by *P. lilacinus* (84.33 cm), *P. fluorescens* (80.33 cm), solarization (75.67 cm), marigold (68.73 cm), neem cake (63.33 cm) and mulching (59.33 cm) compared to untreated check (47.00 cm). At the time of harvest, significant difference was noticed with respect to plant height among the treated and untreated check. Similarly, maximum plant height was observed in carbofuran 3G (111.00 cm) compared to untreated check (55.87 cm). Among all the treatments, carbofuran 3G and *P. lilacinus*; *P. lilacinus* and *P. fluorescens*; *P. fluorescens* and solarization; marigold and neem cake; neem cake and mulching, were all on par with one another but significantly superior over untreated check. Among the treatments, the maximum plant height was observed in *P. lilacinus* (105.73 cm) followed by *P. fluorescens* (99.87 cm), solarization (93.33 cm), marigold (84.20 cm), neem cake (77.73 cm) and mulching (72.80 cm) respectively.

Number of leaves

The effects of treatments on the production of number of leaves per plant were recorded at 30, 60, 90 days and at harvest stage. The data on number of leaves presented in Table 2. At 30 days after sowing, there was a significant difference among the treatments on the production of number of leaves. The number of leaves per plant ranged from 05.20 to 12.00. More numbers of leaves were recorded in case of carbofuran 3G (12.00) and least was recorded in untreated check (05.20). Among the treatments, more number of leaves were observed in *P. lilacinus* (09.27) followed by solarization (09.00), *P. fluorescens* (07.80), neem cake (07.53), marigold (06.93) and mulching (6.60) respectively. At 60 days after sowing, all the treatments recorded significantly more number of leaves over the untreated check (07.93). More number of leaves was recorded in case of carbofuran 3G (15.33) and least recorded in untreated check (07.93). Among the treatments, more numbers of leaves were recorded in *P. lilacinus* (13.87) followed by *P. fluorescens* (11.30), marigold (11.00), solarization (10.83), neem cake (10.00) and mulching (09.47) respectively. Among these treatments marigold, solarization and neem cake were on par with each other. Similarly 90 days after sowing, all the treatments recorded significantly more number of leaves per plant compared to untreated check. More number of leaves were recorded in case of carbofuran 3G (21.53) and least numbers of leaves were recorded in case of untreated check (9.33). Among the treatments, more number of leaves were recorded in *P. lilacinus* (18.67) followed by *P. fluorescens* (16.33), solarization (16.07), marigold (14.40), neem cake (12.80) and mulching (12.00) respectively. However, *P. fluorescens* and solarization; neem cake and mulching were on par with each other. At the time of harvest, all the treatments recorded significantly more number of leaves over untreated check (14.87). More numbers of leaves were recorded in case of carbofuran 3G (26.47) and least numbers of leaves were recorded in case of untreated check (14.87). Among the treatments, more numbers of leaves were recorded in *P. lilacinus* (23.67) followed by *P. fluorescens* (21.87), solarization (20.27), marigold (19.93), neem cake (18.33) and mulching (17.53) respectively. However, *P. fluorescens* and solarization; solarization and marigold; marigold and neem cake; neem cake and mulching; were on par with each other respectively.

TABLE 2: Effect of different treatments on production of number of leaves on okra infested with *M. incognita*

Treatments	Number of leaves			
	30 DAS	60DAS	90DAS	AT harvest
T1: *Pseudomonas fluorescens* @15g/m^2	07.80	11.30	16.33	21.87
T2: *Paecilomyces lilacinus* @15g/m^2	09.27	13.87	18.67	23.67
T3: Neemcake @ 100g/ m^2	07.53	10.00	12.80	18.33
T4: Mulching	06.60	09.47	12.00	17.53
T5: Solarization	09.00	10.83	16.07	20.27
T6: Marigold	06.93	11.00	14.40	19.93
T7: Carbofuran 3G @ 15g/m^2	12.00	15.33	21.53	26.47
T8: Control (Untreated)	05.20	07.93	09.33	14.87
S. Em ±	0.36	0.47	0.52	0.59
C.D. at 5%	1.09	1.41	1.56	1.80

Initial nematode population (INP): 403/200 cc soil
DAS: Days after sowing

Shoot weight

The observations on fresh and dry shoot weight were recorded at harvest and presented in Table 3. Fresh shoot weight of okra was recorded at the time of harvest and it was significantly higher in all the treatments compared to untreated check (46.67 g). Maximum fresh shoot weight was recorded in carbofuran 3G (96.33 g) and lowest was recorded in untreated check (46.67 g). Among the

treatments, the maximum fresh shoot weight was recorded in *P. lilacinus* (93.33 g) followed by *P. fluorescens* (87.20 g), solarization (83.67 g), marigold (81.87 g), neem cake (77.00 g) and mulching (71.67 g) respectively. All the treatments were significantly found superior over untreated check. However, treatment carbofuran 3G and *P. lilacinus* were superior over all the treatments respectively. The dry weight of shoot varied from 15.70 to 32.60 g per plant. The maximum dry weight of shoot was recorded in carbofuran 3G (32.60 g) followed by *P. lilacinus* (31.5g), *P. fluorescens* (29.40 g), solarization (28.2 g), marigold (27.6 g), neem cake (26.2 g) and mulching (24.3 g) respectively. The minimum dry weight of shoot was recorded in case of untreated check (15.57 g). All the treatments were significantly superior over untreated check. However, carbofuran 3G and *P. lilacinus* were significantly superior over all other treatments.

TABLE 3: Effect of different treatments on shoot weight, growth and development of root of okra plants infested by *M. incognita* at harvest

Treatments	Shoot weight		Root length (cm)	Root weight	
	Fresh (g)	Dry (g)		Roots weight (g)	Roots weight (g)
T1: *Pseudomonas fluorescens* @15g/m^2	87.20	29.40	23.70	Fresh	Fresh
T2: *Paecilomyces lilacinus* @15g/m^2	93.33	31.50	25.40	15.33	15.33
T3: Neemcake @ 100g/ m^2	77.00	26.20	20.17	17.17	17.17
T4: Mulching	71.67	24.30	18.00	13.10	13.10
T5: Solarization	83.67	28.20	22.73	11.43	11.43
T6: Marigold	81.87	27.60	22.07	14.40	14.40
T7: Carbofuran 3G @ 15g/m^2	96.33	32.60	27.33	13.50	13.50
T8: Control (Untreated)	46.67	15.70	14.20	19.17	19.17
S. Em ±	2.31	0.78	0.63	8.83	8.83
CD at 5%	7.00	2.36	1.91	0.50	0.50

Initial nematode population (INP): 403/200 cc soil

Root length

Effect of treatments on the root length of okra plants recorded at harvest is presented in Table 3; Plate 1. At harvest, all the treatments recorded significantly better root length over untreated check (14.20 cm). However, *P. lilacinus* and *P. fluorescens*; *P. fluorescens* and solarization*;* solarization and marigold were on par with each other. Among the treatments, maximum root length was observed in carbofuran 3G (27.33 cm) followed by *P. lilacinus* (cm 25.40 cm), *P. fluorescens* (23.70 cm), solarization (22.73 cm), marigold (22.07), neem cake(20.17 cm) and mulching (18.00 cm) respectively. In general, *P. lilacinus* treated plants were recorded significantly higher root length compared to other treatments. However, the carbofuran 3G and *P. lilacinus* were superior over all the treatments respectively.

Fresh root weight

The effect of treatments on the fresh root weight of okra plant recorded at harvest is presented in Table 3. Root weight of okra was recorded at the time of harvest and root weight was significantly higher in all the treatments compared to untreated check (08.83 g). Among all the treatments carbofuran 3G and *Paecilomyces lilacinus*; *P. lilacinus* and *Pseudomonas fluorescens; Pseudomonas fluorescens,* solarization and marigold; marigold and neem cake; neem cake and mulching were on par with each other. The maximum fresh root weight was recorded in carbofuran 3G (19.17g) followed by *P. lilacinus* (17.17 g), *P. fluorescens* (15.33 g), solarization (14.40 g), marigold (13.10 g) and mulching (11.43 g) respectively.

Dry root weight

Effect of treatments on the dry root weight of okra plants was recorded at the time of harvest and data presented in

Table 3. Dry weight of root was recorded at the time of harvest and was significantly higher in all the treatments compared to untreated check (02.80g). Among all the treatments, maximum dry root weight was recorded in carbofuran 3G (6.43 g) followed by *P. lilacinus* (05.90 g), *P. fluorescens* (05.14 g), solarization (04.67 g), marigold (04.43 g), neem cake (04.23 g) and mulching (03.68 g) respectively. Among these treatments, *P. fluorescens* and solarization; solarization and marigold; marigold and neem cake were on par with each other respectively. In general, carbofuran and *P. lilacinus* treated plants recorded significantly higher dry root weight compared to other treatments. However, carbofuran 3G and *P. lilacinus* were superior over all the treatments respectively.

Fruit yield per plot

Effects of treatments on the yield of okra were recorded at the time of harvest and data are presented in Table 4; Fig 2. Among the treatments, maximum fruit yield per plot was recorded in plants treated with Carbofuran 3G (2.85 kg) followed by *P. lilacinus* (2.76 Kg), *P. fluorescens* (2.50 Kg), solarization (2.25 Kg), marigold (2.13 Kg), neem cake (1.98 Kg) and mulching (1.86 Kg) and least fruit yield was recorded in untreated check (1.47 kg). Carbofuran 3G and *P. lilacinus*; *P. lilacinus* and *P. fluorescens*; *P. fluorescens* and solarization; solarization and marigold; marigold and neem cake; neem cake were on par with each other. Similar results

were observed by Amer-Zareen (2001), who reported that by seed/soil drench with *P. lilacinus*, *T. harzianum* and *T. flavus* recorded higher plant growth compared with control and also Dhawan *et al*. (2004) reported that *P. lilacinus* treated plant recorded higher plant growth over the control. Nabanita *et al*. (2005) who reported that the *Paecilomyces lilacinus*, carbofuran (as seed treatment), poultry manure and FYM alone and in combination recorded maximum increase in growth parameters *viz*., plant height, root length, fresh and dry weight of shoot and root including yield were noticed. Kannan and Veeravel (2008) reported that *P. lilacinus* against *M. incognita* in tomato recorded maximum enhancement in shoot/root length and shoot weight.

TABLE 4: Effect of different treatments on yield of okra infested by *M. incognita*

Treatments	Yield (Kg/plot)	Per cent Increase Over Control	Yield (Q/ha)
T1: *Pseudomonas fluorescens* @15g/m^2	02.50	70.06	62.50
T2: *Paecilomyces lilacinus* @15g/m^2	02.71	84.35	67.75
T3: Neemcake @ 100g/ m^2	01.98	34.69	49.50
T4: Mulching	01.86	26.53	46.50
T5: Solarization	02.25	53.06	56.25
T6: Marigold	02.13	44.89	53.25
T7: Carbofuran 3G @ 15g/m^2	02.81	91.15	70.25
T8: Control (Untreated)	01.47	-	36.75
S. Em ±	0.08	-	1.99
C.D. at 5%	0.24	-	6.03

Initial nematode population (INP): 403/200 cc soil

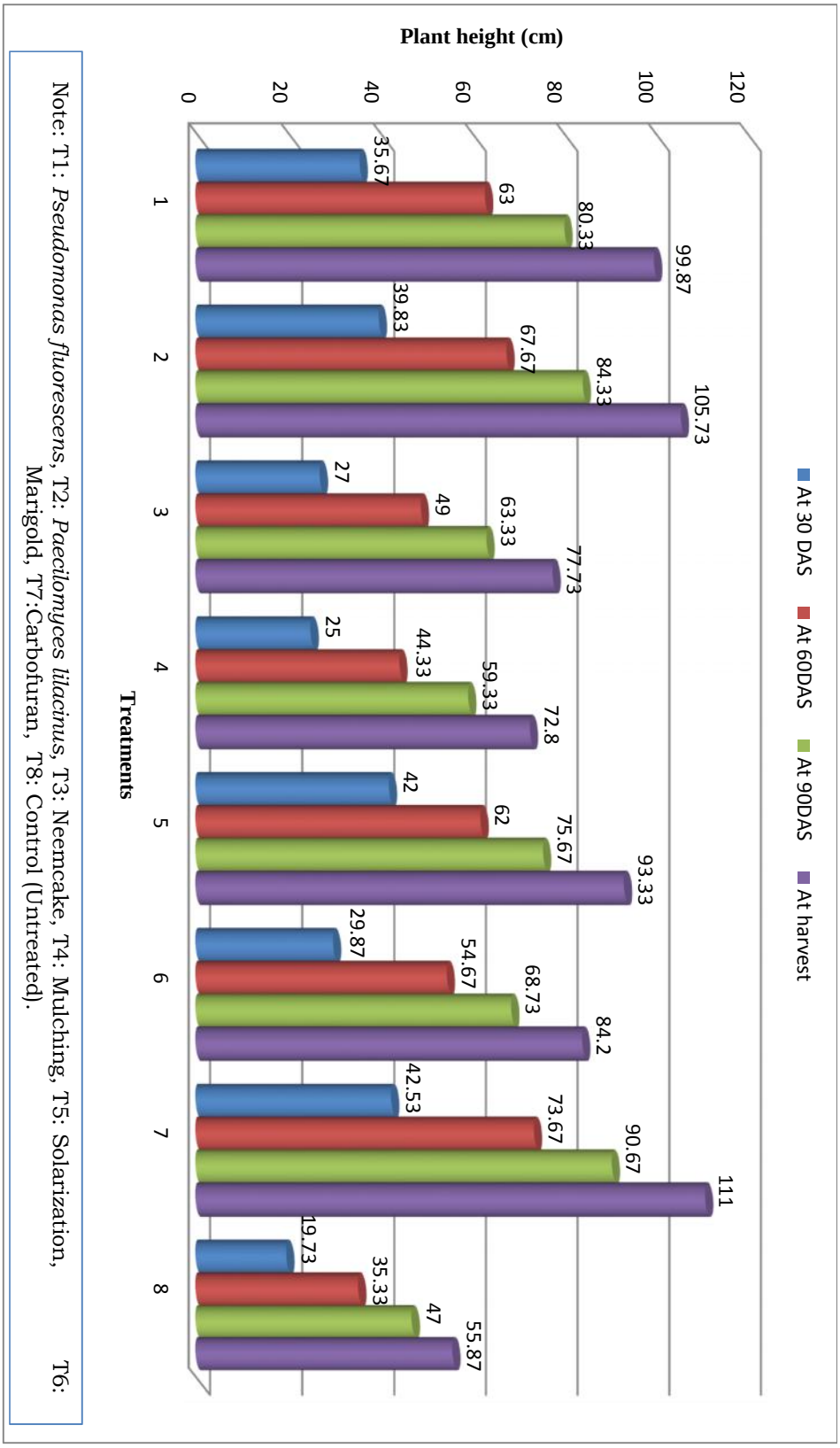
Nematode parameters

Minimum number of galls was recorded in carbofuran 3G (18.90 galls/root system) with reduction over control of 79.43 per cent as against untreated check (91.9 galls/root system), followed by *P. lilacinus* 24.50 (73.30 %), *P. fluorescens* 26.60 (71.05 %), solarization 28.90 (68.50 %), marigold 30 (67.35 %), neem cake 34.80 (62.13 %) and mulching 45.00 (51.03 %) respectively and data are depicted in table 5 and fig 3. Carbofuran 3G recorded minimum number of egg masses 09.70 (83.44 %) followed by *P. lilacinus* 12.30 (79.01 %), solarization 15.4 (73.72 %), marigold 16.60 (71.67 %), neem cake 21.10 (63.99 %) and mulching 23.60 (59.72 %), respectively. The above results with respect to *P. lilacinus* in reducing the nematode population are in conformity with the findings of Amer-Zareen (2001) reported that maximum suppression in gall formation (at $p<0.011$) and egg mass production (at $p<0.0011$) was obtained in okra plants treated with *P. lilacinus*. Nabadita *et al.* (2005) who reported that *P. lilacinus* and carbofuran alone and in combination treated plants recoded decreased in the number of galls, egg masses per root system. Similarly, Sharma *et al.* (2007) who reported that *P. lilacinus* treated okra plots recorded reduced number of galls, eggs per egg mass by 32 per cent each and soil population by 77 %. They also observed that *P. lilacinus* along with addition of neem cake reduced number of galls, eggs per egg mass by 64 % each and soil population by 77 %. Haroon *et al.* (2011) reported that mulching with *Vicia faba* (L.) and *Lupinus termis* (L.) treated plot recorded lower nematodes population. Rao *et al.* (1997) who reported seed treatment with *P. lilacinus*, recorded lowest root-knot index, final population of *M. incognita* and increasing the fruit yield of okra.

TABLE 5: Effect of different treatments on reproduction of *M. incognita* infesting okra

Treatments	Number of galls per root system	Per cent reduction over control	Number of Egg masses /root system	Per cent reduction over control
T1: *Pseudomonas fluorescens* @15g/m^2	26.60	71.05	13.90	76.27
T2: *Paecilomyces lilacinus* @15g/m^2	24.50	73.30	12.30	79.01
T3: Neemcake @ 100g/ m^2	34.80	62.13	21.10	63.99
T4: Mulching	45.00	51.03	23.60	59.72
T5: Solarization	28.90	68.55	15.40	73.72
T6: Marigold	30.00	67.35	16.60	71.67
T7: Carbofuran 3G @ 15g/m^2	18.90	79.43	09.70	83.44
T8: Control (Untreated)	91.90	-	58.60	-
S. Em ±	1.10	-	0.63	-
C.D. at 5%	3.32	-	1.92	-

Initial nematodes population (INP): 403/200 cc soil



Note: T1: *Pseudomonas fluorescens*, T2: *Paecilomyces lilacinus*, T3: Neemcake, T4: Mulching, T5: Solarization, T6: Marigold, T7:Carbofuran, T8: Control (Untreated).

FIGURE 1: Plant height in different treatments of okra infested by *M. incognita*

ISSN 2229 – 6441

PLATE 1: Effect of different treatments on growth and development of roots

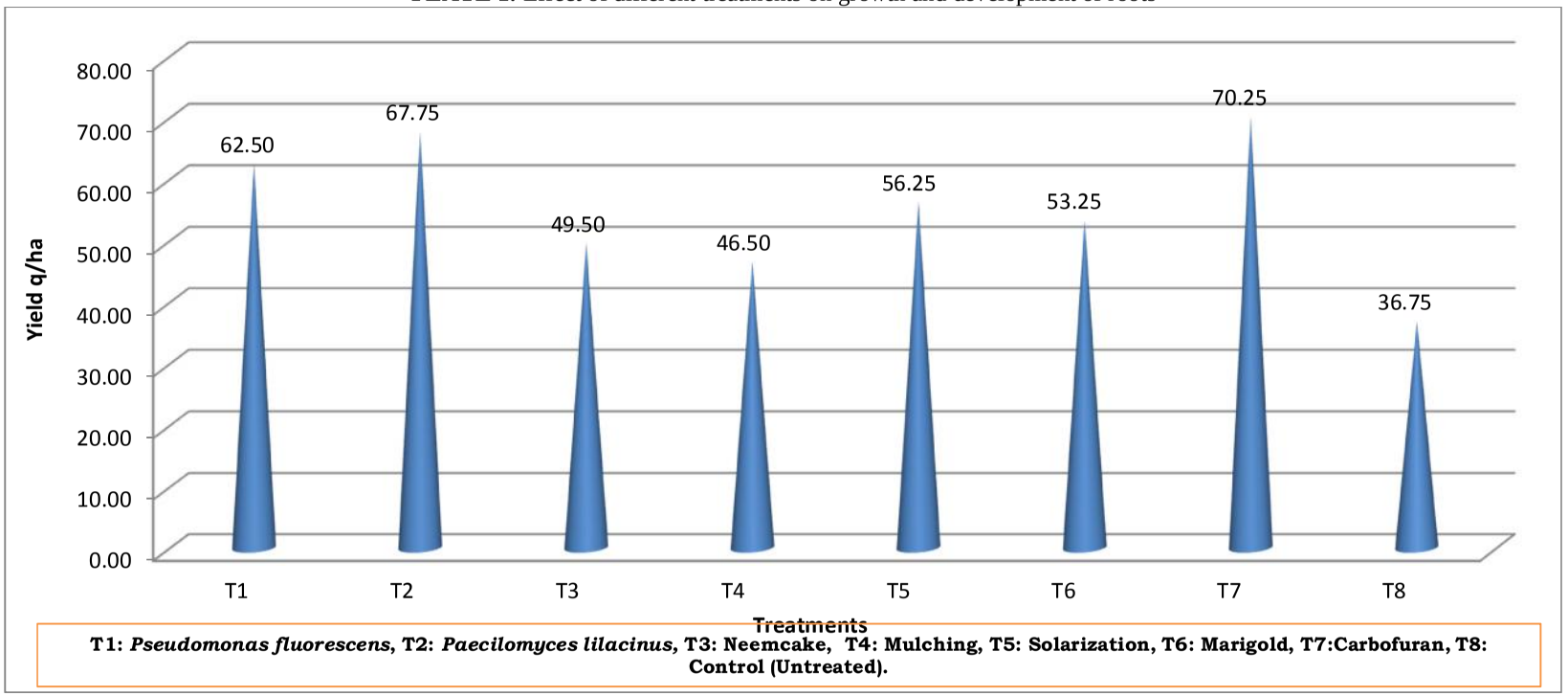


FIGURE 2: Effect of different treatments on yield of okra infested by *M. incognita*

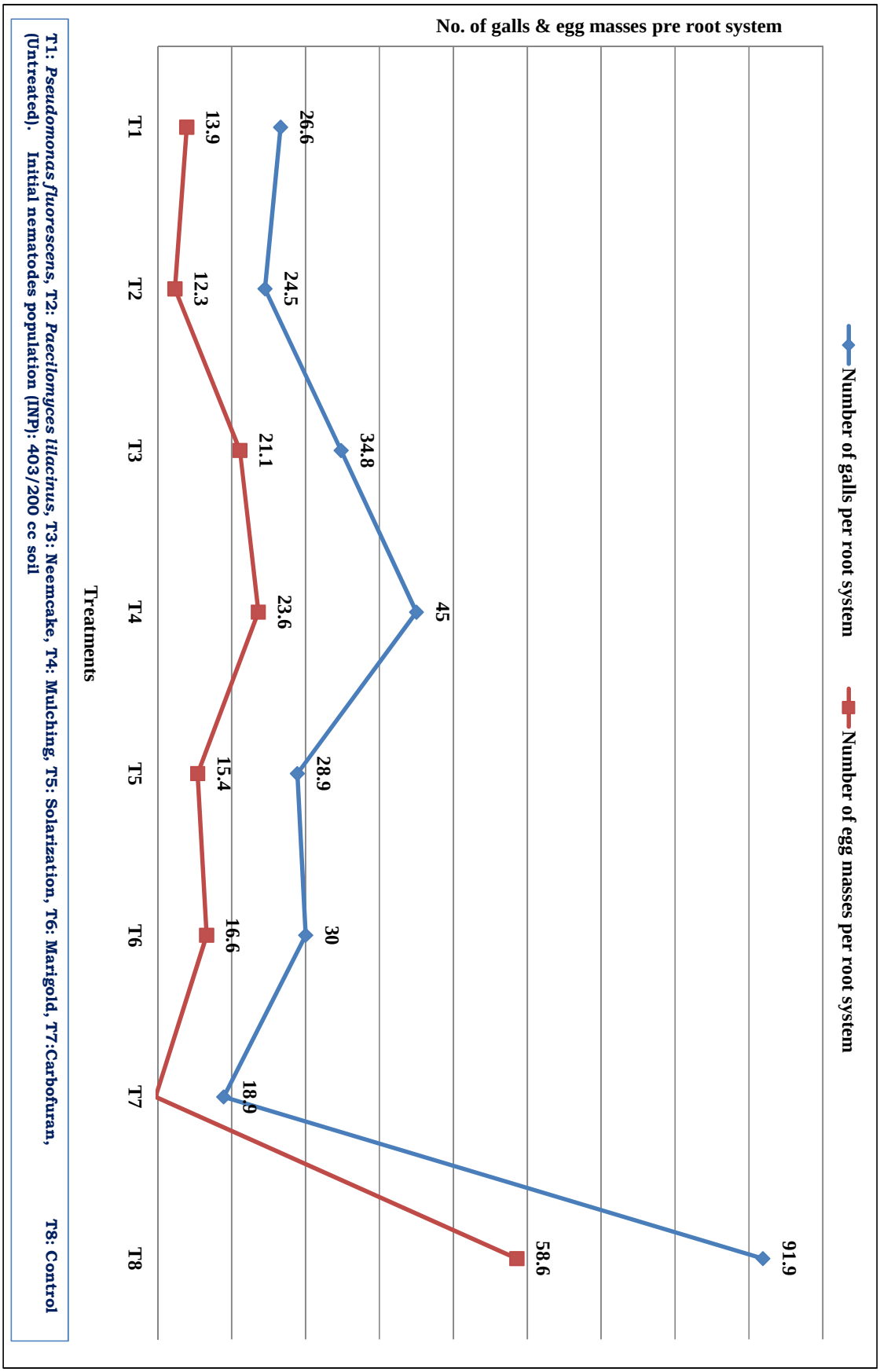


FIGURE 3: Effect of different treatments on reproduction of *M. incognita* infesting okra

ACKNOWELDGEMENT
Authors are thankful to the AICRP (Nematodes), Department of Plant Pathology, University of Agricultural Sciences, GKVK campus, Bengaluru, for the facilities provided during this study

REFERENCES

Agrios, G.N. (2005) Plant Pathology, fifth ed. Elsevier Academic Press.

Alegbejo, M., Ogunlana, M. and Banwo, O. (2008) Survey for incidence of okra mosaic virus in northern Nigeria and evidence for its transmission by beetles. *Span. J. Agric. Res.*, 6: 408-411.

Amer-Zareen, Nargis Jamil Khan, and Javed Zaki, M. (2001) Biological control of *Meloidogyne javanica* (Treub) Chitwood, root-knot nematode of okra (*Abelmoschus esculentus* L.). *Pakistan J. Biol. Sci.*, 4(8): 990-994.

Anonymous (2013) National Horticulture Board, ministry of agriculture, government of India, Eds. Rajendra Kumar tiwari, N.C. Mistry; B. Singh, C.P. Gandhi, Aristo Printing Press, New Delhi, Indian horticulture database-2013.

Bhatti, D.S. & Jain, R.K. (1997) Estimation of losses in okra, tomato and eggplant yield due to *Meloidogyne incognita*. Indian J. Nematol., 7: 37-41.

Dhawan, S.C., Narayana, R. and Babu, N.P. (2004) Bio-management of root-knot nematode, *Meloidogyne incognita* in okra by *Paecilomyces lilacinus*. *Ann. Plant. Protect. Sci.*, 12 (2): 356-359.

Haroon, S.A., Osman, E. and Zaher Awad, M. (2011) The effect of certain legume on the population level of root-knot nematode, *Meloidogyne incognita* in tomato field. *Acta Horticulturae.*, 914**:** 251-256.

Hussain, M.A., Mukhtar, T. & Kayani, M.Z. (2011a) Assessment of the damage caused by *Meloidogyne incognita* on okra (*Abelmoschus esculentus*). *J. Anim. Plant Sci.*, 21**:** 857-861.

Kannan, R. and Veeravel, R. (2008) Effect of an oviparasitic fungus *Paecilomyces lilacinus* Samson on *Meloidogyne incognita* in tomato. *Ann. Pl. Protect. Sci.*, 16(2): 466-470.

Kayani, M. Z., Mukhtar, T., Hussain, M. A. and Haque, M. I. (2013) Infestation assessment of root-knot nematodes (Meloidogyne spp.) associated with cucumber in the Pothowar region of Pakistan. *Crop Prot*., 47: 49-54

Mukhtar, T., Arshad, I., Kayani, M.Z., Hussain, M.A., Kayani, S.B., Rahoo, A.M. and Ashfaq, M. (2013a) Estimation of damage to okra (*Abelmoschus esculentus*) by root-knot disease incited by *Meloidogyne incognita*. *Pak. J. Bot.*, 45: 1023-1027.

Nabanita, D. & Sinha, A.K. (2005) Reaction of okra varieties to root-knot nematode (*Meloidogyne incognita*). *Indian J. Nematol.*, 35(2): 214.

Rao, M. S., Reddy, P. P. and Nagesh, M. (1997) Integrated management of *Meloidogyne incognita* on okra [*Abelmoschus esculentus*] by castor cake suspension and *Paecilomyces lilancinus*. *Nematologia Mediterranea*., 25: 17-19.

Sasser, J.N. (1997) Economic importance of *Meloidogyne* in tropical countries. In: Lamberti, F., Taylor, C.E. (Eds.): Root-knot Nematodes (Meloidogyne spp.): Systematics, Biology and Control. Academic Press, New York, pp. 359-374.

Sharma, H. K., Singh, S. and Pankaj (2007) Management of *Meloidogyne incognita* with *Paecilomyces lilacinus* and neem cake on Okra. *Pesticide Research J*., 19: 166-168.

Sikora, R.A. & Fernandez, E. (2005) Nematode parasites of vegetables. In: Luc, M., Sikora, R.A., Bridge, J. (Eds.).: Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CABI Publishing, London, UK, pp. 319-392.

Singh, D. (2012) Genetic control of aluminium tolerance in okra (*Abelmoschus esculentus* L. Moench). Sci. Hortic-Amsterdam., 138: 134-137.