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Effect of Two Organic Amendments and a Nematicide on Root-knot Nematode (*Meloidogyne incognita*) of Country Bean

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ABSTRACT

A field experiment was conducted with a view to test the efficacy of Poultry Refuse (PR), Mustard Oilcake (MOC) and chemical nematicide furadan 5G (Carbofuran) for controlling root knot nematode of country bean through which growers will be benefited. The root-knot nematode infested soils were amended with PR (3 and 5 t ha⁻¹), MOC (0.3 and 0.6 t ha⁻¹) 3 weeks before seed sowing and furadan 5G (40 kg ha⁻¹) on the day of seed sowing of country bean. All the treatments performed well in reducing root-knot infestation and increasing plant growth compared to control. The most effective treatment was PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) followed by PR alone (5 t ha⁻¹). In first year and second year, gall index values were 9.50 and 9.33 under control, respectively. The severity of root-knot disease was reduced 2.50 to 5.98 in first year and 3.93 to 6.60 in second year. Fruit yield was increased over control 21.93 to 46.37% with the maximum by PR (5 t ha⁻¹) in first year and 16.67 to 43.37% with the maximum by PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) in second year. The fruit yield of country bean was directly and linearly correlated with gall indices. Based on findings of the study PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) and PR alone (5 t ha⁻¹) were noted as effective treatment to manage root-knot disease and to maximize yield of country bean.

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

INTRODUCTION

Country bean (*Dolichos lablab*) under legume is a very popular vegetable grown all over the country. It is cultivated commercially in different areas of Bangladesh. Now a days country bean cultivation is seen significantly in Comilla, Noakhali, Sylhet, Dhaka, Kishoreganj, Tangail, Jessore and Dinajpur (BBS, 1998). In Chittagong the farmers follow intensive practices of country bean production as a commercial crop both in ails (border) of the plots or main plots (Anonymous, 2007). The crop is attacked by many pests and diseases causing marked yield loss. Among the diseases, root knot caused by *M. incognita* is highly damaging and yield reducing factor of country bean throughout the country (Anonymous, 2008). Due to only root-knot the crop suffers heavily, growth is retarded, fruit setting reduced, size and yield decreased and in serious condition, the plant die due to secondary infection with fungi and bacteria. In the late season the big size galls are easily visible at the base of the plants. However, many farmers are still unaware about the real problem or cause behind the plant mortality. A number of approaches aimed for controlling

root-knot nematodes through application of nematicides (Abd-Elgawad and Kabeil, 2010; Abd-Elgawad, 2008) organic soil amendments (Bari *et al.*, 2004a; Wani, 2006; Hasan *et al.*, 2010; Osei *et al.*, 2011), cultural management, physical methods like soil solarization (Kaskavanci, 2007), biological measures like *Trichoderma* spp., *Pacecilomyces lilacinus*, *Pasteuria penetrans* and *Pseudomonas aeruginosa* (Rao *et al.*, 1997; Reddy *et al.*, 1998; Siddiqui *et al.*, 1999; Zareen *et al.*, 2003; Sharma and Pandey, 2009) and in combination of *Gliocladium virens* with organic amendments (Ashraf and Khan, 2007). Furthermore, it has been observed that the application of organic soil amendments with nematode trapping fungi stimulates the efficacy of nematode trapping fungi and reduced the nematode population in the soil (Kumar and Singh, 2010; Niranjana and Singh, 2011; Wachira *et al.*, 2009). Country bean cultivar resistant to root-knot nematode is not available in Bangladesh. There are few nematicides which can be used effectively to control the nematodes. However, the use of only nematicides is costly, hazardous and creates residual problems. Moreover, nematicides can not be applied after fruit setting, because of the persistence in the fruit. Therefore, alternate management options against the disease are to be sought. Presently, researchers have diverted their attention to manage plant nematode through use of organic amendments (Bari *et al.*, 2004b; Wani, 2006; Hasan *et al.*, 2010; Osei *et al.*, 2011) and to develop integrated approaches against the pest because often any single approach may not be effective to manage the plant parasitic nematode efficiently.

Under these circumstances, the present study was undertaken to find out efficacy of poultry refuses, mustard oilcake and furadan 5G to manage root-knot nematode of country bean and to increase plant growth and yield of country bean.

MATERIALS AND METHODS

Management of root-knot nematode disease (*M. incognita*) of country bean with different combination and doses of two commonly available organic amendments namely Mustard Oilcake (MOC) and Poultry Refuses (PR) and a nematicide furadan 5G (Carbofuran) was studied. The experiment was conducted at Bangladesh Agricultural Research Institute (BARI), Gazipur, Bangladesh during 2007-08 and 2008-09 cropping years. A total of 8 treatments including a control viz. (1) control, (2) furadan 5G (40 kg ha⁻¹), (3) poultry refuse at 5 t ha⁻¹, (4) poultry refuse at 3 t ha⁻¹, (5) poultry refuse at 3 t ha⁻¹+furadan 5G (20 kg ha⁻¹), (6) mustard oilcake at 0.6 t ha⁻¹, (7) mustard oilcake at 0.3 t ha⁻¹, (8) mustard oilcake at 0.3 t ha⁻¹+furadan 5G (20 kg ha⁻¹) were maintained in this experiment. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications where unit plot size was 3×3 m keeping 1 m distance between plot to plot and each plot was consisted with four pits.

Standard cultivation procedures recommended by BARI were followed to grow country bean. The experimental field was well prepared with power tiller and fertilizers were added during final land preparation. Requisite quantity of fresh poultry refuse and mustard oil cake were added in the soil 3 weeks before seed sowing of country bean and allowed to decompose completely. The nematicide furadan 5G was applied to the soil before seed sowing. To ensure inocula of the nematode, tomato and lady's finger roots heavily infected with *M. incognita* were collected from sick bed and chopped into small pieces and mixed with soil at 20 g pit⁻¹. The country bean seeds variety BARI Shem-2 were sown in the pits and each pit received 10 seeds including 5 additional seeds. During crop season necessary weeding, irrigation and other intercultural operations were done as per recommendation of the crop (Anonymous 2007).

The root-knot disease severity was recorded twice i.e., one at 60 days after seed sowing and the other after final harvesting of country bean. Five additional plants in each pit were carefully uprooted after 60 days of seed sowing and cleaned the root system by washing with tap water. Data on shoot length (cm), shoot weight (g), root length (cm) and root weight (g) were recorded. The severity of root-knot disease was recorded as gall index in 0-10 scale according to Zeck (1971). The yield data were recorded on the weight of fruit plot⁻¹.

Statistical analysis: The collected data were analyzed statistically and the means were separated by DMRT at $p = 0.05$ level.

RESULTS AND DISCUSSION

Shoot growth: There existed significant effect of both organic and inorganic soil amendments on the vegetative growth of country under field condition. Average shoot length of country bean under control was 63.54 cm plant⁻¹ in first year and 49.53 cm plant⁻¹ in second year. Soil amendments with PR, MOC and furadan 5G at different doses and their combination increased the shoot growth from 77.85-121.00 cm plant⁻¹ in first year and 66.73-93.00 cm plant⁻¹ in second year compared to control. In the first year, the highest shoot length was recorded from PR (5 t ha⁻¹) treatment followed by PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹), PR (3 t ha⁻¹) and MOC (0.3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹). The lowest increase in shoot length was recorded under the treatment with furadan 5G (40 kg ha⁻¹) followed by MOC (0.3 t ha⁻¹) and MOC (0.6 t ha⁻¹). In second year, the maximum shoot length was recorded from plots treated with PR (5 t ha⁻¹). It was almost identical to the shoot length recorded from plots treated with and PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹), PR (3 t ha⁻¹), MOC (0.3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹). The least effective treatments to increase shoot length was furadan 5G (40 kg ha⁻¹) followed by, MOC (0.3 t ha⁻¹) and MOC (0.6 t ha⁻¹) (Table 1).

Similarly, the corresponding shoot weight of country bean was significantly increased due to application poultry refuse and mustard oilcake with different doses. In first year, the highest shoot weight was achieved with PR (5 t ha⁻¹) followed by PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) and they were statistically similar and differed significantly with all the rest treatments. More or less similar trend of the treatments became pronounced during second year trial. The lowest weight was recorded in control but it gave statistically insignificant with all the treatment except PR (5 t ha⁻¹) and PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹).

Root growth: Soil amendments with PR and MOC and application of furadan 5G showed positive effects on root growth of country bean as compared to control. In first year, three treatments PR alone (5 and 3 t ha⁻¹) and mixed furadan 5G (PR 3 t ha⁻¹ +furadan 5G 20 kg ha⁻¹) yielded the highest root length. The second highest root length was found in plots treated MOC (0.3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹). The least effective treatment to increase root length was furadan 5G alone (40 kg ha⁻¹) followed by MOC (0.3 t ha⁻¹) and MOC (0.6 t ha⁻¹) (Table 1). In second year, root length under control was only 14.73 cm/plant. It was increased to 19.13-21.73 cm/plant due to application of PR and MOC. On the other hand application of PR, MOC and furadan 5G did not show any significant effect on root weight of country bean during two consecutive years (Table 2).

Severity of root-knot disease: In both the years, the severity of root-knot disease of country bean was drastically reduced over control due to treatment of soil with poultry Refuse (PR) as well

Table 1: Effect of soil treatment with two organic amendments and one nematicide on shoot growth of country bean in soil inoculated with *M. incognita*

Organic amendments and furadan with dose	Shoot growth (cm plant ⁻¹)		Shoot weight (g plant ⁻¹)	
	1st year	2nd year	1st year	2nd year
Control	63.54 ^e	49.53 ^c	15.00 ^c	11.47 ^c
Furadan 5G (40 kg ha ⁻¹)	78.26 ^{de}	66.73 ^b	20.63 ^{bc}	14.73 ^{bc}
Poultry refuse (5 t ha ⁻¹)	121.00 ^a	93.00 ^a	43.75 ^a	30.25 ^a
Poultry refuse (3 t ha ⁻¹)	100.30 ^{bc}	78.33 ^{ab}	30.67 ^b	19.46 ^{bc}
Poultry refuse (3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	115.20 ^{ab}	86.00 ^a	40.83 ^a	23.75 ^{ab}
Mustard oilcake (0.6 t ha ⁻¹)	77.85 ^{de}	77.67 ^{ab}	23.06 ^{bc}	19.25 ^{bc}
Mustard oilcake (0.3 t ha ⁻¹)	78.86 ^{de}	81.00 ^{ab}	21.81 ^{bc}	18.01 ^{bc}
Mustard oilcake (0.3 t/ha) +Furadan 5G (20 kg ha ⁻¹)	92.80 ^d	86.67 ^a	25.97 ^{bc}	19.42 ^{bc}
LSD	16.39	13.86	10.08	8.764
CV (%)	11.30	7.37	8.50	18.45

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 root growth of country bean in soil inoculated with *M. incognita*

Organic amendments and furadan with dose	Root growth (cm plant ⁻¹)		Root weight (g plant ⁻¹)	
	1st year	2nd year	1st year	2nd year
Control	15.39 ^c	14.73 ^b	2.16	1.75
Furadan 5G (40 kg ha ⁻¹)	17.71 ^{bc}	19.40 ^a	2.17	1.78
Poultry refuse (5 t ha ⁻¹)	23.86 ^a	21.73 ^a	2.54	1.74
Poultry refuse (3 t ha ⁻¹)	23.97 ^a	20.00 ^a	2.11	1.35
Poultry refuse (3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	24.67 ^a	20.47 ^a	2.09	1.75
Mustard oilcake (0.6 t ha ⁻¹)	16.82 ^c	19.33 ^a	2.18	1.47
Mustard oilcake (0.3 t ha ⁻¹)	15.64 ^c	19.13 ^a	2.06	1.45
Mustard oilcake (0.3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	19.67 ^b	19.87 ^a	2.32	1.50
LSD	2.261	2.835	NS	NS
CV (%)	14.17	6.03	-	-

Values within the same column with a common letter do not differ significantly (p = 0.05), NS: Not significant

as Mustard Oilcake (MOC) and application of furadan 5G. In the first year, the highest gall index value of 9.5 was recorded in the control treatment. Lower gall index ranging from 3.52-7.00 were observed among the soil amended plots. The gall index was reduced to 2.50 to 5.98 due to treatments with two organic amendments at different doses and the furadan 5G. Higher reduction of root-knot disease severity was corroborated with higher dose of the materials and integration of lower dose of materials. The lowest severity of root-knot disease of country bean was obtained from the treatment with PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹), which was followed by PR (5 t ha⁻¹) and MOC (0.3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹). The second highest gall index value was found in plots treated with furadan 5G (40 kg ha⁻¹), which was followed by MOC (0.3 t ha⁻¹) (Table 3). In the second year, the maximum gall index value of 9.33 was recorded in control plot. The root-knot disease severity was reduced to 3.93 to 6.6 due to application of different treatments. The

Table 3: Effect of soil treatment with two organic amendments and one nematicide on the severity of root-knot disease (*M. incognita*) of country bean in two consecutive years

Organic amendments and furadan 5G with dose	Gall index at harvest (0-10 scale)		Gall index reduction over control	
	1st year	2nd year	1st year	2nd year
Control	9.50 ^a	9.33 ^a	-	-
Furadan 5G (40 kg ha ⁻¹)	7.00 ^{ab}	5.40 ^b	2.50	3.93
Poultry refuse (5 t ha ⁻¹)	3.60 ^c	2.73 ^d	5.90	6.60
Poultry refuse (3 t ha ⁻¹)	4.00 ^c	3.67 ^{cd}	5.50	5.66
Poultry refuse (3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	3.52 ^c	2.73 ^d	5.98	6.60
Mustard oilcake (0.6 t ha ⁻¹)	4.75 ^b	3.97 ^c	4.25	5.36
Mustard oilcake (0.3 t ha ⁻¹)	5.25 ^b	5.27 ^b	4.25	4.06
Mustard oilcake (0.3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	4.25 ^c	4.27 ^{bc}	5.25	5.06
LSD	2.28	1.127	-	-
CV (%)	11.47	9.92	-	-

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

Table 4: Effect of soil treatment with two organic amendments and one nematicide on fruit yield of country bean in soil inoculated with *M. incognita*

Organic amendments and furadan 5G with dose	Fruit yield plot ⁻¹ (kg)		Yield increase over control (%)	
	1st year	2nd year	1st year	2nd year
Control	6.73 ^c	8.75 ^c	-	-
Furadan 5G (40 kg ha ⁻¹)	8.62 ^{bc}	10.50 ^b	21.93	16.67
Poultry refuse (5 t ha ⁻¹)	12.55 ^a	15.20 ^a	46.37	42.43
Poultry refuse (3 t ha ⁻¹)	11.45 ^{ab}	13.35 ^{ab}	41.22	34.46
Poultry refuse (3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	12.24 ^a	15.45 ^a	45.02	43.37
Mustard oilcake (0.6 t ha ⁻¹)	10.25 ^b	11.60 ^b	34.34	24.57
Mustard oilcake (0.3 t ha ⁻¹)	9.58 ^b	11.20 ^b	29.75	21.88
Mustard oilcake (0.3 t ha ⁻¹) +Furadan 5G (20 kg ha ⁻¹)	10.06 ^b	12.20 ^b	33.23	28.28
LSD	2.56	2.99	-	-
CV (%)	13.68	20.68	-	-

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

reduction in root-knot disease severity was significant compared to control. The maximum reduction of root-knot disease severity was obtained with PR (3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) and PR (5 t ha⁻¹) followed by PR (3 t ha⁻¹) and MOC (0.3 t ha⁻¹) +furadan 5G (20 kg ha⁻¹) and MOC (0.6 t ha⁻¹). The least effective treatment to reduce root galling was furadan 5G (40 kg ha⁻¹) followed by MOC (0.3 t ha⁻¹) (Table 3).

Crop yield: Organic soil amendments with PR and MOC and furadan 5G at different doses played significant role in increasing crop yield of country bean in both years. However, yield increase was not significant under all treatments compared to control (Table 4). In first year, the lowest fruit yield of 6.73 kg plot⁻¹ was found under control. The yield was increased 8.62 to 12.55 kg plot⁻¹ due to application of different treatments with PR, MOC and furadan 5G. The maximum yield was

obtained with PR (5 t ha⁻¹) and PR (3 t ha⁻¹) +furanan 5G at 20 kg ha⁻¹ followed by PR (3 t ha⁻¹). Poultry refuse alone (5 t ha⁻¹) boosted up the fruit yield of country bean up to 46.37 as compared to control followed by PR (3 t ha⁻¹) +furanan 5G at 20 kg ha⁻¹ (45.02%) and PR (3 t ha⁻¹) (41.22%). Efficacy of three treatments to increase yield was statistically similar. Differences in fruit yield harvest from control plots and plots treated with furadan 5G at 40 kg ha⁻¹ were not significant. In 2nd year, average fruit yield was 8.75 kg plot⁻¹ under control and 10.50 to 15.45 kg plot⁻¹ under treated plots. The yield increase over control was significant under all treatments with PR, MOC and furadan 5G. The highest yield was obtained with PR (3 t ha⁻¹) +furanan 5G (20 kg ha⁻¹), which was statistically similar to PR (5 t ha⁻¹). The lowest yield increase was found under furadan 5G (40 kg ha⁻¹) followed by MOC (0.3 t ha⁻¹). The highest yield increased 43.47% over control was obtained from PR (3 t ha⁻¹) +furanan 5G (20 kg ha⁻¹) followed by PR (5 t ha⁻¹) (42.43%) and PR (3 t ha⁻¹) (34.46%).

Correlation and regression analysis was performed to find out the relationship of fruit yield, shoot and root growth with gall index values of country bean grown in soil inoculated with *M. incognita* and treated with PR, MOC and furadan 5G. Pooled data on those parameters recorded in two consecutive years were used for this analysis and found that the relationship was linear and negative for fruit yield, shoot growth and root growth with coefficient of correlations (r) 0.9309, 0.9237 and 0.8764, respectively. The relationship was significant in case of fruit yield shoot growth and root growth and influence of gall index on those two parameters may be attributed to 86.66% (R² = 0.8666) 85.33% (R² = 0.8533) and 76.81% (R² = 0.7681), respectively (Fig. 1).

Correlation and regression analysis was also performed to find out the relationship of fruit yield, shoot weight and root weight with gall index values. Results showed that the relationship was linear and negative for fruit yield and shoot weight with coefficient of correlations (r) 0.9309 and, 0.8358, respectively. The relationship was significant in case of fruit yield and shoot weight and influence of gall index on those two parameters may be attributed to 86.66% (R² = 0.8666) and 69.86% (R² = 0.6986), respectively. Relationship between root weight and gall index was not significant and may be attributed to only 0.19% (R² = 0.0019). The results indicated that organic amendments improved plant growth. It may be due to addition of plant nutrients to the soil. Their higher doses caused phytotoxicity resulting lower root weight compared to lower dose. A Lower R² value indicates that other factors are also involved in plant growth and yield increase (Fig. 2).

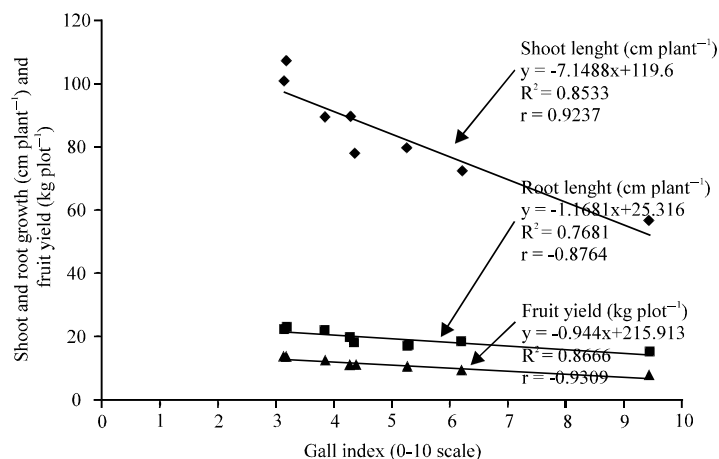


Fig. 1: Relationship of shoot length, root length and fruit yield with gall index of country bean grown in soil inoculated with *M. incognita* and treated with poultry refuse, mustard oilcake and furadan 5G

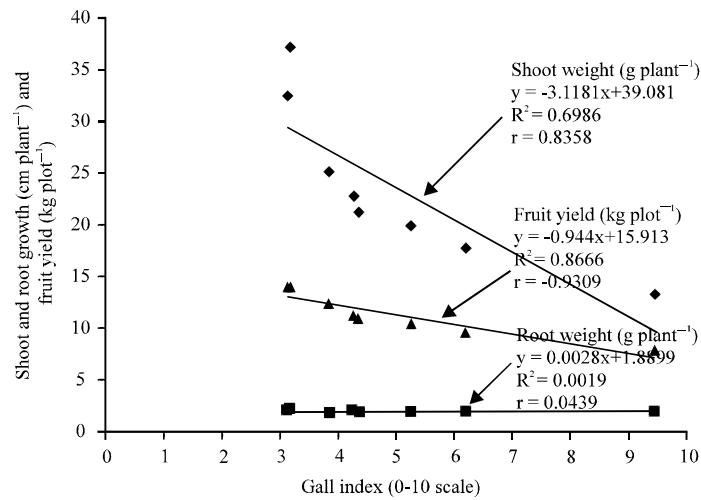


Fig. 2: Relationship of shoot weight, root weight and fruit yield with gall index of country bean grown in soil inoculated with *M. incognita* and treated with poultry refuse, mustard oi cake and furadan 5G

Results of the present study reveal that soil amendment with poultry refuse at 5 and 3 t ha⁻¹, and mustard oilcake (0.6 and 0.3 t ha⁻¹) are effective to reduce root-knot disease severity and to increase plant growth and fruit yield of country bean grown in *M. incognita* inoculated soil. Efficacy of both the amendments was corroborated with higher dose of application. However, effectiveness was improved when PR and MOC were applied at lower dose mixed with furadan 5G (20 kg ha⁻¹). Furadan 5G alone (40 kg ha⁻¹) also reduced gall index values and improved plant growth to some extent but its efficacy was not as good as PR and MOC.

Similar findings have been reported by many other researchers. Some of them reported that poultry refuse and mustard oilcake are effective in controlling root-knot nematode and enhancing plant growth and yield of tomato (Hasan *et al.*, 2010; Wahundeniya, 1991; Nahar *et al.*, 1996; Faruk *et al.*, 2001, 2002) and many other crops (Ahamad *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.*, 2004a; Ahamad *et al.*, 1987), potato (Hossain *et al.*, 1989), bottle gourd (Khan, 1996) and jute (Mishra *et al.*, 1987) which supported the results obtained from this study.

In conclusion, application of PR (3 t ha⁻¹) in combination with furadan 5G (20 kg ha⁻¹) or PR alone (5 t ha⁻¹) effectively control root-knot nematode disease and increasing plant growth as well as yield of country bean. Therefore, these two treatments poultry refuse 3 t ha⁻¹ mixed with furadan 5G (20 kg ha⁻¹) and poultry refuse (5 t ha⁻¹) may be recommended for controlling root-knot of country bean.

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