USING METHODS OF SOLARIZATION, BIO-FUMIGATION, BURNING AND KEEP DRYING SOIL CONTROL ROOT- KNOT NEMATODES ON LETTUCES, IN LAM DONG

Van Ngoc Thuy[a], Le Ba Le[a], Tran Thi Minh Loan[a*]

[a]*The Faculty of Agriculture and Forestry, Dalat University, Lamdong, Vietnam*

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Abstract

Root-knot nematodes (Meloidogyne sp.) are an important plant – parasitc group on green lollo lettuce. Experiments, included solarizion, bio-fumigation, burning and keep drying soil were carried out to control root-knot nematades on lettuces in Lamdong province. The results showed that burning method was the most effective (in soil) with only 28 juveniles/100g of soil and 96.75% after treating compared to the control with 1312 nematodes/100g of soil. The infection proportion of root-knot nematodes (1.433) and the number of juveniles of root-knot nematoses (201 juveniles/5g of root) in the burning were the lowest. Therefore, the height and the yield of crop treated with this method were the highest, proved by 25.99 cm and 30.25 tons/ha, respestively. In contrast, the root infection proportion in the control was the highest, acounting for 5.733 while the figures for the height (18.8 cm) and the yield of crop (15.93 tons/ha) were the lowest.

Keywords: Bio-smoking; Burning; Drying; Lettuces; Root-knot nematodes; Solariza-tion.

1. INTRODUCTION

Green Lollo variety *(Lactuca sativa)* which is an annual plant of the Chrysanthemum family (Asteraceae), is easy to grow but it is host appropriately for root knot nematodes such as *Meloidogyne incognita*, *M. javanica*, *M. arenaria*, and *M. hapla* (Westerdahl, Ploeg & Kodira, 2016).

There are many methods to prevent nematodes. Same as other diseases, many methods such as biology, physiology, chemical, crop rotation (Ciancio & Mukerji, 2008) and bio-fumigation (Khan & Khan, 1994) have been used.

In addition, there have been many researches to control nematodes. These researches had been assessed the impact of the fungus and cultivation methods to

* Corresponding author: Email: loanttm@dlu.edu.vn

production of nematodes. Besides, study on using *Chlamydosporia pochonia* control eggs of *Meloidogyne* sp. for double crops (lettuces and tomatoes) in greenhouse conditions with controlling the temperature (Verdejo-Lucas, Sorribas, Ornat & Galeano, 2003) also achieved high efficiency.

In Vietnam, there are also basic researches on lettuces. One of typical research was using chemical to control plant parasitic nematodes on lettuces (Tu & Bui, 2000).

Lamdong province has natural conditions and climate to produce lettuces such as green lollo, yellow lollo, rose lollo, curon and other varieties all the year round. Lollo green variety has been grown popularly. However, studying of plant parasitic nematode on these crops has not been focused. Therefore, it is necessary to evaluate the effectiveness of various methods to control root knot nematodes on lettuces.

2. MATERIALS AND METHOD

2.1. Study site

The experimenst were conducted on green lollo variety in rainy season, in Donduong district, Lamdong province, Vietnam.

2.2. Research methodology

The experiment was arranged by the randomized complete block design (RCBD) with one factor and three replications.

These treatments included:

- Controls: Soil was not treated before planting. Then lettuces were planted after three weeks fallowing.
- Solarization: Soil was ploughed as deeply as possible, irrigated and covered with clear plastic, filled the border, kept this for three weeks.
- Bio-fumigation: Waste of broccoli was chopped. After tilling, this waste was spread on the land, irrigated and covered up by clear plastic and incubated for three weeks.

- Burning: Rice husks were spread on the surface with a layer of approximately 10 cm then burned and kept for three weeks.

- Keep drying soil: The soil was kept in the dry conditions by ploughing every three days for three weeks.

Soil sampling: Soil samples were taken before treating, 15 days after treating and at the time of harvest. Soil samples were collected, taken from 10 separate points with the depth of 15-20 cm throughout the area. Samples were put into bags and then sieved with a 2mm sieve.

Roots sampling: The root samples were collected to determine the infection ratio of roots. The roots were taken in the morning, 10 random plants in block. Using shovels carefully dug and kept the roots to the minimum damage. Samples were then preserved in cool conditions.

Samples test: Juveniles of root-knot nematodes from soil and roots were extracted by modified Baermann method (Michel et al., 2005; Perry et al., 2009). Juveniles were counted on microscope with 4X magnification.

Effective treatment: Effective treatment (corrected efficacy) were assessed by formula of Henderson – Tilton.

Infection of roots: Root system gall was determined by Zeck (1971).

Height of lettuces: Lettuces height was measured at the time of 7, 14, 21, 28 days after planting.

Yield of lettuces: Lettuces were harvested after 28 days planting. The yield of lettuces was determined by the average weight multiplied with density per hectare (ton/hectare).

3. RESULTS AND DISCUSSION

3.1. The number of juveniles of root-knot nematodes in the soil before and after treating the soil and the effective treatment

Data from Table 1 show that, the number of juveniles of root-knot nematodes on each treatment was over 1000 juveniles per 100 grams of soil. This population caused

remarkably damage on the root, while the number of parasitic plant nematodes of threshold just fluctuated about 200 juveniles to 400 juveniles per 100g soil (Seinhorst, 1965). Green lollo is an Asteracea family, levels of root-knot nematodes (*Meloidogyne* sp.) had been strong (Ciancio & Mukerji, 2008; Mehrotra & Ashok, 2003). Moreover, these species are suitable in tropical conditions and wide host. In addition, the seasons of the year also has affected the density of nematodes in the soil. In Lamdong province, there are two seasons, dry season and rainy season, therefore nematodes density in the rainy season was higher than that in the dry season. The reason is that in the rainy season, root-knot nematodes can move easily and suit to the living conditions better than in the dry season. After harvesting, farmers used to fallow a few weeks before planting a new crop that make density of root-knot nematodes decreased.

The results show that the density of root-knot nematodes of the burning method reduced drastically, from 1,036 juveniles to 28 juveniles per 100 gram of soil. This could explain that rice husks were burned, temperature creased drastically which affected directly and killed nematodes. As a result, number of root-knot nematodes decreased quickly.

Table 1. Number of juveniles of root knot nematodes before and after treating and the effective treatment

Treatments	Before treating (juveniles/100g soil)	After treating (juveniles/100g soil)	Effective treatment (%)
Control	1576 ^{a}	1312 ^{a}	---
Solarization	1316 ^{ab}	592 ^{c}	45.96 ^{e}
Bio-fumigation	1000 ^{b}	368 ^{c}	55.79 ^{d}
Burning	1036 ^{b}	28 ^{f}	96.75 ^{a}
Keep drying	1272 ^{ab}	556 ^{c}	47.49 ^{e}

Note: The various letters in the same column were significative statistic with $P \leq 0.05$

Bio-fumigation method was killed and controlled the number of root-knot nematodes in soil. This method used anaerobic fermentation to create biogas and increase soil temperature and biochemical reactions of microorganisms in order to control root-knot nematodes in the soil. This method was also applied successfully in India when using compost to create toxic gases that inhibited root knot nematodes on eggplant (Khan & Khan, 1994; Koen, 1966). On the other hand, the bio-fumigation

method also increased organic matter in the soil, which could balance soil ecosystem and be effective to control nematodes in soil (Crow & Dunn, 1994). Solarization and keep drying soil methods were slowly effective. The number of juveniles of root-knot nematodes of control treatment remained unchanged before treating and after treating.

The efficacy of the burning treatment was the highest, illustrated by 96.75%, which was also suitable for the number of root knot nematodes. This following figure was bio-fumigation method, proved by 55.79%. This result was consistent with the research about "smoke population and the effects of root-knot nematodes on eggpkant" (Khan & Khan, 1994).

3.2. Effect of treatment on the level of infection and the number of root-knot nematodes

It is evident from Table 2 that the burning method dominated over of the total for controlling root-knot nematodes. Level of root infection in the control treatment was the highest, proved by 5.733. This figure was not significant difference with the solarization and the bio-fumigation, while there was an enormous difference in the keep drying and the burning.

Table 2. The level of infection and the number of nematodes on roots

Treatments	Level of infection	Number of juveniles of root –knot nematodes (juveniles/5g root)
Control	5.733 [a]	1031[a]
Solarization	5.267 [ab]	927[ab]
Bio-fumigation	4.800 [ab]	869[b]
Burning	1.433 [c]	201[d]
Keep drying	4.437 [b]	685[c]

Note: The various letters in the same column were significative statistic with $P \leq 0.05$

As the same pattern, the number of juveniles of root-knot nematodes of the control held a share of the top position, illustrated by 1031 juveniles per 5 grams of roots while the number of juveniles of root-knot nematodes of the burning was the lowest, proved by 201 juveniles per 5 gram of roots. Interestingly, the number of juveniles of root-knot nematodes of the solarization was not significant different from that with the bio-fumation and the control.

Eventually, the burning method was the most effective to control root-knot nematodes followed by the method of keeping the soil dry. In this study, solarization was not effective to control root-knot nematodes on green lollo in Lamdong.

3.3. Effect of treatment on the height of the lettuces

Table 3 showed that there were not significant differences in the height of lettuces planted at the beginning, 7 days, and 14 days, while there were manifest difference between treatments after 21 and 28 days after planting. At the time, juvenlies of root-knot nematodes infected into roots; therefore, the height of lettuces was different between treatments. This may be explained that after 14 days of planting, juveniles infected into root but that was not clear symptom. Therefore, the roots could absorb nutrients and the height of plants was same between treatments. The growth the plant has not been shown to the outside 21- 28 days after planting, roots were damaged, lettuces were able to absorb nutrients and affect metabolism of plants. Plant parasitic nematodes infecting into roots affected water uptake, the transport and absorption of nutrients and chlorophyll content of plant (Haddish, 2004). For that reason, the effects of plant parasitic nematodes on plant growth is common symptom at this time. The height of lettuces treated with burning treatment was the highest, the level of infection was the lowest. In contrast, the height of other methods was lower than that of the burning method. This demonstrated that burning method is the most effective in controlling root-knot nematodes and in increasing the height of lettuces.

Table 3. Effect of treatment on the height of plant

Treatments \ Date after plating	7	14	21	28
Control	10.79 ^{ns}	12.46 ^{ns}	13.94 ^{b}	18.83 ^{b}
Solarization	10.16	12.04	14.24 ^{b}	19.57 ^{b}
Bio-fumigation	10.15	12.29	14.99 ^{b}	21.20 ^{b}
Burning	10.01	12.75	17.60 ^{a}	25.99 ^{a}
Keep drying	9.46	12.79	14.86 ^{b}	20.01 ^{b}

Note: The various letters in the same column were significative statistic with $P \leq 0.05$;
ns: Non Signification

Meloidogyne sp., which is wide distribution is popular in the world (Ravichandra, 2014). There are four common *Meloidogyne* species such as *Meloidogyne*

incognita, M. javanica, M. arenaria and M. hapla (Perry et al., 2009). The second-stage juveniles (J2) of root-knot nematodes infected into root, behind root tip and moved through the root for initiating and developing to feed. The juveniles fed on protoxylem and protophloem cells to specialize nurse cells which are called giant cells. Under suitable conditions, the two-stage moult to the third-stage juvenile (J3) after approximately 14 days, then to the fourth-stage juvenile (J4) after 4 – 6 days, finally to adult stage (Perry et al., 2009; Ravichandra, 2014). Therefore, plants were not supported nutrients from the root system 14 days after planting. *Meloidogyne* sp. which infected, declined yield approximately 50% (Perry et al., 2009), reduced quality (Pérez, Navas-Cortés, Pascual-Villalobos & Castillo, 2003). Root-knot nematodes continued developing until root died.

3.4. Effect of treatments on yield of lettuces

Table 1 and Table 4 show that the relationship between ratio of infection, number of juveniles of root-knot nematodes and yield of crops. Table 4 shows that the burning method was the most effective treatment as well as also the highest yield. According to Haddish (2004), there was a close correlation between crop yield with the degree of ratio infection. High temperatures killed the grass seeding and other pathogenic in soil also limited the harmful fungi and weeds. This brought advantages for plants to absorb nutrients to grow and develop.

Table 4. Yield of green Lollo (tons/ha)

Treatments	Average value (tons/ha)
Control	13.89 ^{c}
Solarization	18.00 ^{bc}
Bio-fumigation	20.27 ^{b}
Burning	30.25 ^{a}
Keep drying	16.71 ^{bc}

Note: The various letters in the same column were significative statistic with $P \leq 0.05$

Generally, the yield of lettuces treated with burning is the highest, following to the bio-fumigaton. In contrast, keep drying and solarization were not effect on the yield of the lettuces.

4. CONCLUSION

In conclusion, the burning method was the most effects, according to the bio-fumigation method.

- The number of juveniles of root-knot nematodes before treating achieved high (≥1000 juveniles per 100g of soil) and decreased dramatically to 600 juveniles per 100g of soil after treating.

- The effective treatment of root-knot nematodes were the highest in the burning method, reaching 96.75%, following by the Bio-fumigation (55.79%).

- The figures of infection ratio and the number of juveniles of root-knot nematodes in the burning revealed the lowest, proved by 1.433 and 201 juveniles per 5g of roots, respectively. These figures of the solarization and the control were balanced.

- The height of lettuces of the burning was the highest, illustrated by 25.99cm.

- The yield of the burning was the highest (30.25 tons/ha), following by the bio-fumigation (20.27 tons/ha).

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KHẢO SÁT CÁC BIỆN PHÁP PHƠI NẮNG, XÔNG HƠI SINH HỌC, ĐỐT ĐẤT VÀ GIỮ CHO ĐẤT KHÔ ĐẾN HIỆU LỰC PHÒNG TRỪ TUYẾN TRÙNG NỐT SƯNG (*Meloidogyne* sp.) HẠI XÀ LÁCH TẠI LÂM ĐỒNG

Văn Ngọc Thủy[a], Lê Bá Lê[a], Trần Thị Minh Loan[a*]

[a]Khoa Nông Lâm, Trường Đại học Đà Lạt, Lâm Đồng, Việt Nam
**Tác giả liên hệ: Email: loanttm@dlu.edu.vn*

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Tóm tắt

Tuyến trùng nốt sưng Meloidogyne sp. *là nhóm tuyến trùng ký sinh chủ yếu gây bệnh sưng rễ trên xà lách lollo xanh. Sử dụng biện pháp phơi nắng, xông hơi sinh học, đất đốt và giữ cho đất khô để khảo sát hiệu lực phòng trừ tuyến trùng nốt sưng trên cây xà lách Lollo xanh tại Lâm Đồng. Kết quả cho thấy biện pháp đốt đất có hiệu quả xử lý tuyến trùng cao nhất, chỉ còn 28 con/100g đất và hiệu lực đạt 96,75% sau khi xử lý so với nghiệm thức đối chứng là 1312 con/100g đất. Tỉ lệ xâm nhiễm của tuyến trùng nốt sưng trong rễ ở nghiệm thức đốt đất là 1,433 và số lượng tuyến trùng tuổi 2 trong rễ (201 con/5 g rễ) ở mức thất nhất và đồng thời có chiều cao cây (26,0 cm) và năng suất cao nhất (30,25 tấn/ha). Ngược lại, đối chứng có tỷ lệ xâm nhiễm của tuyến trùng là cao nhất đạt 5,733, chiều cao cây và năng suất trung bình thấp nhất, chỉ số lần lượt là 18,8 cm và 15,93 tấn/ha.*

Từ khóa: Đốt đất; Giữ cho đất khô; Phơi nắng; Tuyến trùng nốt sưng; Xà lách lollo xanh; Xông hơi sinh học.