

Use of organic waste as biofumigant for controlling root knot nematodes (*Meloidogyne* spp.) on potato

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Abstract. Root knot nematode (*Meloidogyne* spp.) is one of the important pathogens that causes big impact on potato crop yields. One of the control strategies for controlling this nematode is the use of biofumigants. Biofumigants are *volatile toxic compound* derived from plants, and have biocide properties against insects and plant pathogens. Organic waste such as *Brassicaceae*, *Leguminoceae*, and *Solanaceae* can be used as biofumigant sources. This research was conducted to determine the effectiveness of *Brassicaceae*, *Leguminoceae*, and *Solanaceae* as biofumigants against *Meloidogyne* spp. The experiment was set in a *completely randomized design* (CRD) with the treatments were organic wastes including *Brassicaceae*, *Leguminoceae*, and *Solanaceae*, both single and combinations, and 2 controls (positive and negative controls) with 3 replications. Each of the biofumigant treatments was prepared and stored for 2 weeks. Potato tubers were transplanted 15 days after germination into polybag inoculated with 1,000 *Meloidogyne* spp. J2s. The results showed that *Brassicaceae* + *Solanaceae* were effective in decreasing the number of galls in potato plants, however only *Solanaceae* improved plant growth.

1. Introduction

Potato (*Solanum tuberosum* L.) the fourth most important food crop in the world after corn, rice and wheat. Potatoes and other plants use these tubers to store sugars, called carbohydrates, as energy and nutrition sources they need to reproduce. These carbohydrates and nutrients are also beneficial to the human diet. One factor that reduce the potato production is the attack of nematodes [1], which one of them is root knot nematode (*Meloidogyne* spp.) [2]. The loss that is caused by the attack of root knot nematode could happen on the field, so it could reduce the quality and the quantity of the product. This nematode attack could decrease the crop yields around 15% on potato plants [3]. *Meloidogyne* spp. larvae infect plant roots, causing the development of root-knot galls. This condition causes the limitation of water absorption and even the essential fertilizer to the plants, hence it would harm the growth and the development of the plants and the loss could not be avoided [4].

During the last 50 years, the nematode control using chemical nematicide has been very significant role, but this control causes negative impact on living organisms and environment including polluting land and waterland causing death for non-targeted organisms, such as nematode natural enemies such as fungi and bacteria. Therefore, looking for an alternative environmental friendly control strategies is urgently needed. One of those alternative methods is the use of biofumigants.



Daulay [5] reported that the addition of the organic material such as the residue of cabbage, broccoli, mustard and radish could be made use as biofumigants to control nematodes and the other soil borne pathogens through the biofumigant process. Biofumigants are *volatile toxic compound* derived from plants, and have biocide properties against insects and plant pathogens. Horticultural biofumigant is based on the organic molecular exploitation derived from the nature that possesses ability as biocide, which the organic molecules are contained in a number of plants species such as from *Brassicaceae* [6]. There are several plant species that could be used as biofumigants [5]. The purpose of this research is to study the effectiveness of *Brassicaceae*, *Leguminosae*, and *Solanaceae* as single or combination as biofumigants to control the root knot nematode (*Meloidogyne* spp.) on potato plants.

2. Material and methods

2.1 The supply of biofumigant

The organic wastes *Leguminosae*, *Brassicaceae*, and *Solanaceae* were cleaned and cut into small pieces with the size around 1-3 cm for *Leguminosae*, *Brassicaceae* and around 5 – 7 cm for *Solanaceae*. After being cut, all organic wastes were ready to be used.

2.2 Extraction of root knot nematode

The potato roots that were infested by root knot nematode from the potato plantations in Karo District were collected and put into a plastic bag before brought to Plant Disease Laboratory, Faculty of Agriculture, Universitas Sumatera Utara. The roots were washed under the running water. The egg masses of nematode were collected under a stereo microscope. The egg masses were soaked in the sterile water, and incubated for 24 hours at 22^o C. Juvenil 2 (j2) that germinated from the eggs were used for the evaluation.

2.3 Screenhouse studies

The experiment was conducted at Balai Penelitian Tanaman Buah (BPTB), Tongkoh, Karo District. The experiment was conducted with the *Completely Randomized Design* (CRD) with 3 organic waste treatments, namely *Brassicaceae*, *Leguminosae*, and *Solanaceae*, single and combinations, and 2 controls (positive control which was nematicide with carbofuran (Furadan 3G) with the suggested dosage, and negative control which was treatment without biofumigation) with three replications. The fumigational treatment were conducted by mixing 300 g biofumigant / 3 kg soil (1 : 10) in polybags and the polybags were tightly closed for two weeks. The polybags were unbound one day before the potato tubers were planted. The 15 day old- potato seedlings of Granola G0 cultivar were planted in polybags. The nematode inoculation was conducted during the planting of potatoes. Each plant was inoculated more or less 1000 J2 nematodes.

The observation was conducted toward the plants growth such as : tuber weight (g), root length (cm), shoot fresh weight (g), shoot dryweight (g), and the nematodes growth including the number of galls, and the final nematode population.

2.4 Statistical analysis

Data were statistically analyzed according to standard analysis of variance by a one way ANOVA with SPSS software. The comparison between means was carried out by Duncan's Multiple Range Test [7] with level of 5%.

3. Results and Discussions

The results showed that the treatment of application of the agricultural waste as biofumigant gave the better influences to the plants growth such as : tuber weight, shoot fresh weight, shoot dry weight, root length and diameter of root distribution compared to the negative control plants (K0) and the application of nematicide (K8) (Table 1). On the positive control treatment (K8) and the negative control treatment (K0), seen the nematode attack that retarded the root growth. This occurs because of the ability of nematode to use the significant elements such as phosphor and carbon needed by the

plants. Nematodes transferred the elements for its importance to proceed its life cycle, therefore roots lacked of nutrition and could not grow well. According to [8] *Meloidogyne* spp. could transfer 10 % of total phosphor compound and carbon derived from shoot to the root part of the plants for the importance of nematode activities in accomplishing its life cycle.

Table 1. The impact of organic wastes *Brassicaceae*, *Leguminoceae*, and *Solanaceae* as the single and combination of biofumigant toward the parameter of potato growth infected by *Meloidogyne* spp.

Treatment	Tuber weight (g)	Shoot fresh weight (g)	Shoot dry weight (g)	Root length (cm)	Diameter of root distribution(cm)
K0	3.48 d	1.84 c	0.33 d	3.65 c	4.61 b
K1	32.42 bc	3.70 abc	1.75 abc	5.19 ab	11.1 a
K2	16.38 cd	3.24 abc	1.51 bcd	4.98 ab	9.58 a
K3	39.04 abc	5.42 a	3.30 a	5.74 a	12.3 a
K4	46.90 ab	3.95 abc	2.11 ab	5.21 ab	8.75 a
K5	43.32 ab	4.45 ab	2.13 ab	5.28 ab	10.9 a
K6	51.18 ab	4.65 a	2.72 ab	5.76 a	12.6 a
K7	56.09 a	4.83 a	2.40 ab	5.66 a	11.4 a
K8	8.80 d	2.48 bc	0.50 cd	4.47 bc	7.76 ab

Note : K0 (negative control), K1 (*Brassicaceae*), K2 (*Leguminoceae*), K3 (*Solanaceae*), K4 (*Brassicaceae*+*Leguminoceae*), K5 (*Brassicaceae*+*Solanaceae*), K6 (*Leguminoceae*+*Solanaceae*), K7 (*Brassicaceae*+*Leguminoceae*+*Solanaceae*), K8 (carbofuran = positive control)

By increasing the growth of potato that were applied by biofumigants *Brassicaceae*, *Leguminoceae*, and *Solanaceae*, these organic wastes did not only have roles as biofumigants but also had a role as biofertilizer. The application of organic waste improve the process of organic material decomposition. The addition of organic materials into the soil can improve the chemical and physical conditions of the soil and therefore can increase the microbes which can balance the natural environment underneath the soils. *Brassicaceae*, *Leguminoceae*, and *Solanaceae* contain fertilizer such as N, P, K which are important requirement for plants for their growth. Similarly, *Brassicaceae* produces nitrogen for the plant growth as well as P, K, Mg and C-Organic. This condition is also similar to the wastes *Leguminoceae* and *Solanaceae*. Besides *Brassicaceae* can reduce the nematode population, it can also improve the soil structure, increase fertilizer elements, and increase the useful microbe activities [9].

It can be seen from Table 2 that the impact of organic wastes *Brassicaceae*, *Leguminoceae*, and *Solanaceae* as the single and combinations of biofumigants toward the number of galls and the nematode population potato plants infected by *Meloidogyne* spp. showed that the application of agricultural wastes could reduce the number of galls and nematode population compared to control treatment.

The agricultural waste application as the biofumigants on potato plants infected by *Meloidogyne* spp. gave lower average of galls number, compared to the plants that were not applied by biofumigants (negative control / K0) (36 galls/10 g root) and the application of nematicides with active carbofuran material (positive control / K8) (52.33 galls/10 g root). The lowest average galls number was the treatment *Brassicaceae*+*Solanaceae* (K5), which was 9.16 galls/10 g root. The highest final nematode population from roots and from the soil was potatoes treated with carbofuran (949 nematodes) comparing to control (K0) which was 616.5 nematodes. The successful treatment of combination of *Brassicaceae* and *Solanaceae* because potato is grouped as *Solanaceae* and *Brassicaceae* waste has been proven to be able to control nematodes through biofumigant process. Brassica produces *Glukosinolat* that can be converted into the chemical material (*isothiosianat*) with biofumigant activities [8].

Table 2. The impact of organic wastes *Brassicaceae*, *Leguminoceae*, and *Solanaceae* as the single biofumigants and combinations toward the number of galls and the nematode population on potato plants infected by *Meloidogyne* spp.

Treatment	The number of galls/10 g root	Nematode population (10 g root + 100 g soil)
K0	36.00 ab	616.5 abc
K1	18.00 bc	461.0 c
K2	9.33c	507.6 bc
K3	10.16 c	853.6 ab
K4	10.50 c	542.5 bc
K5	9.16c	378.3 c
K6	15.16 bc	497.8 bc
K7	18.50 bc	510.5 bc
K8	52.33 a	949.0 a

Note : K0 (negative control), K1 (*Brassicaceae*), K2 (*Leguminoceae*), K3 (*Solanaceae*), K4 (*Brassicaceae*+*Leguminoceae*), K5 (*Brassicaceae*+*Solanaceae*), K6 (*Leguminoceae*+*Solanaceae*), K7 (*Brassicaceae*+*Leguminoceae*+*Solanaceae*), K8 (carbofuran = positive control)

4. Conclusions

The results showed that combination treatment of *Brassicaceae* + *Solanaceae* were effective in decreasing the number of galls in potato plants, however only *Solanaceae* improved plant growth.

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