Magnetic field exposure affects plant-parasitic nematode

*Meloidogyne* spp. motion behavior

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Abstract. Plant-parasitic nematodes are costly burdens of crop production. Ubiquitous in nature, phytoparasitic nematodes are associated with nearly every important agricultural crop and represent a significant constraint on global food security. This study aimed to determine the effect of magnetic field exposure on plant-parasitic nematodes, namely *Meloidogyne* sp. This research was carried out in October 2019 in the laboratory of agriculture, University of Jember. The study used a completely randomized design using four treatments, namely exposure to the N polar magnetic field, S polar magnetic field, toroidal magnetic field (N to S), and reverse toroidal magnetic field (S to N) with a magnetic strength of 1.5 Mt and the number of nematodes was 50 J2 per treatment. The results showed that the magnetic field affects the nematode's motion, which is increasingly greening the magnetic field within 60 seconds, 90 seconds, and 120 seconds. Nematodes experience the most rapid movement and move further away from the magnetic field within 60 seconds and 120 seconds in the treatment of reverse toroidal magnetic field exposure (S to N) equal to 13 mm and 24.5 mm. Hereby, this study provides new information about changes in nematode motion to exposure to magnetic fields.

1. Introduction

Plant-parasitic nematodes are one of the causes of the loss of economic value in plants. One type of nematode that is very damaging to plants is *Meloidogyne* spp. [1]. Root galls is the specific symptom of *Meloidogyne* spp [2] and it can be as a tuber and field borne pathogens [3]. Nematode control using chemicals can damage the environment and beneficial insects [4]. The use of magnetic fields to control nematodes has not been studied. Many studies are currently being conducted to examine the effects of exposure to magnetic fields on living things. Starting from the fields of agriculture, food to health. Previous studies in living organisms reported that exposure to a 0.2 mT magnetic field could increase *Bacillus* sp. protease [5]. In agriculture, the use of magnetic fields is used to accelerate growth in plants. However, no research has been done on the effect of magnetic field exposure on nematode motion behavior.

Therefore, this study aimed to determine the effect of using magnetic fields on nematodes. The barless turgreen method is carried out by taking nematode samples from the isolation of 100 grams of potato soil and roots taken from the Bromo region. The study used a completely randomized design using four treatments: exposure to the N polar magnetic field, S polar magnetic field, toroidal magnetic field (N to S), and reverse toroidal magnetic field (S to N) and one control treatment. Our
treatments will be tested on the treatment that has the highest effect on the motion behavior of the nematode *Meloidogyne* spp.

2. Material and Methods

2.1. Material

This research was conducted at the Agrotechnology Laboratory, the University of Jember, in October 2019. The material used in this study were two sets of Barless Tulgreens, Binocular Microscope, Object Glass, Deckglass, 1 ml Pipette, and Sprayer.

2.2. Methods

This study used the same sampling strategy implemented by J. van Bezooijen [6]. The materials needed are soil samples from the rice fields as much as 100 grams from each point, plant roots, and water. Meanwhile, the test uses magnetic fields U and S.

The experimental design used in this study was a completely randomized design consisting of:

1. P1 treatment: not exposed to magnetic fields and not given an inductor.
2. P2 treatment: using exposure to U pole magnetic field
3. P3 treatment: using S pole magnetic field exposure
4. P4 treatment: using a toroidal magnetic field exposure (U to S)
5. P5 treatment: using reverse toroid magnetic field exposure (S to U)

The variables observed were (1) Exposure to a U Pole Magnetic Field, (2) Exposure to S Pole Magnetic Fields, (3) Exposure to Toroidal Magnetic Fields (U to S), and (4) Exposure to Reverse Toroid Magnetic Fields (S to U). It will be tested that the treatment has the highest effect on the motion behavior of the nematode *Meloidogyne* spp and the data analyzed by descriptive statistically.

3. Results and Discussion

The results showed that exposure using a magnetic field U pole for 60 seconds could move the nematode as far as 10.5 mm from its original position. Meanwhile, for 90 and 120 seconds, it can move the nematode 14.4 mm and 20.75 mm from its original position. Exposure using a magnetic field pole S for 60 seconds can move the nematode 4 mm from its original position. Exposure using a magnetic field S for 90 and 120 seconds could move the nematode 5.8 and 8.5 mm from its original position.

**Table 1. The Effect of Magnetic Field Exposure on Nematode Motion Behavior**

| Treatments                      | 60 Seconds (in mm) | 90 Seconds (in mm) | 120 Seconds (in mm) |
|---------------------------------|--------------------|--------------------|---------------------|
| P1 Control                      | 0                  | 0                  | 0                   |
| P2 U Pole                       | 10.5               | 14.4               | 20.75               |
| P3 S Pole                       | 4                  | 5.8                | 8.5                 |
| P4 Toroidal (U to S)            | 9.5                | 13.9               | 19                  |
| P5 Reverse Toroidal (S to U)    | 13                 | 18.6               | 24.5                |

Descriptive statistically analyzed data

Exposure using a Toroidal magnetic field (U to S) for 60 seconds can move the nematode as far as 9.5 mm from its original position. Exposure using a Toroidal magnetic field (U to S) for 90 and 120 seconds can move the nematode 13.9 and 19 mm from its original position. Exposure using a Reverse Toroid magnetic field (S to U) for 60 seconds can move the nematode as far as 13 mm from its original position. Exposure using a Toroidal Reverse magnetic field (S to U) for 90 and 120 seconds can move the nematode as far as 18.6 and 24.5 mm from its original position.
As a result of this, magnetic fields affect nematode displacement. The magnetic field U has a more significant effect than the magnetic field S for moving the nematodes. With a time of 60 seconds, the smallest value for nematode displacement uses pole S and the largest value for nematode displacement is in the Toroid Reverse magnetic field (S to U). With a time of 120 seconds, the smallest value of nematode displacement uses pole S, and the largest value is the displacement of the nematode's Toroidal Reverse Magnetic Field (S to U). From Table 1, it can be understood that the longer the exposure to the magnetic field, the farther the nematode displacement is. There has been no research report on why magnetic fields can affect the movement of nematodes that are further away from the magnetic field. This is because may the electric charge on the magnet can affect the nematodes' movement [7]. This discovery is an excellent start to control the nematode Meloidogyne spp, and other types are also detrimental to cultivated plants. According to Nicol et al. [8; 9], nematodes of various types can cause losses of 80-118 billion dollars per year in damage to crops and in the Indonesia was reported in Ngablak, central of java was infection on potato up to 88,23% [10]. The magnetic field can be a new alternative to control plant-parasitic nematodes in the future, and further research is needed.

4. Conclusion
Based on the research results, it can be concluded that there is a significant effect of using magnetic fields on the movement of nematodes. The longer the magnetic exposure time, the further away from the nematodes will move from the magnetic field. The best treatment is using a reverse toroidal magnetic field that can move the nematodes as far as 13 mm in 60 seconds and 24.5 mm in 120 seconds. The smallest displacement uses a magnetic field S capable of moving 4 mm nematodes in 60 seconds and 8.5 mm in 120 seconds. It can be concluded that magnetic fields can be used as a control for nematodes in the future.

5. References
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