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The effect of different fertilizer applications on stem and bulb nematode, *Ditylenchus dipsaci* (Kühn 1857) (Tylenchida: Anguinidae) on onion[1]

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ABSTRACT

Stem and bulb nematode, *Ditylenchus dipsaci* (Kühn 1857) is an important constraint of onion. The application of chemical control methodologies due to the environmental and economical concerns is restricted and needed to develop new control strategies to keep the nematode population under damage threshold. Considering the effects on plant development and soil biodiversity, it is aimed to investigate control option for the stem and bulb nematode using different fertilizer combinations. The *D. dipsaci* susceptible onion variety Beyaz Bilek was planted onto fresh field soil in 3x13 cm plastic tubes as one plant per tube being 8 replications for each fertilizer application and the negative control. Fertilizer applications were 5 fertilizer applications of organic, synthetic, worm fertilizer and humic acid and sea algae. Fertilizers were applied 4 times with 2 weeks intervals starting in sowing. *Ditylenchus dipsaci* was inoculated to all plants as 200 nematodes per plant after 4 weeks planting. Plants were harvested 4 weeks later nematode inoculation. At harvest time, the most frequent soil nematodes were *Cephalobus* and *Eucephalobus* genera. Humic acit, vorm fertilizer and synthetic fertilizer increased the plant development significantly. Stem and bulb nematode population significantly decreased in fertilizer applications, the most lower one were organic fertilizer and humic acid application.

Key words: control, *Ditylenchus dipsaci*, fertilizer, onion, stem and bulb nematode, humic acid

INTRODUCTION

Onion is one of the economically important products in Turkey. Total dry and green onion was produced 1 938 255 ton in 69 429 ha area in 2014 (12). Turkey takes 7th place in onion production after China, India, USA, Iran, the Russian Federation and Egypt in the world (6). Onion is produced in almost all provinces being mostly in Black Sea, Aegean, Trace and Central Anatolian Plateau, East Mediterranean Regions in Turkey (12). Fungal diseases, onion fly and stem and bulb nematode are the most important constraints affecting onion production in Turkey (2). Stem and Bulb Nematode *Ditylenchus dipsaci* (Kühn 1857) (Tylenchida: Anguinidae) reported from Central Anatolia, Trace, Black Sea and Aegean Regions on onion in Turkey (21, 15, 14, 2, 18). Recently, yield losses up to 41.5% were shown on onion due to the nematode in Karaman province (19).

Integrated control methodology should be developed for control of the diseases and pest on onion in a production area. Currently, chemical control agents are used widely and intensively for disease and pest management under field conditions. Considering concerns on effects of chemicals on environment and human health, alternative control options should be incorporated into management systems. One of the alternative control options for nematode, pest and disease damage is the use of the rotational crops, green manure and organic amendments (1, 13, 17). Organic amendments and compost products was also shown to be a promising alternative to chemical fertilizers in terms of yield and quality characteristics of different plant species (4, 8, 9, 16, 5, 11, 3). The mechanism of the organic amendments on plant growth and disease suppression is slow mobilization of plant nutrients and depending formation of biological succession in the soil food web. The population of inhabitant beneficial microorganisms increases in respond to organic enrichment and pathogens cannot compete for food and place resulting disease suppression. The organic amendments can also release toxic metabolites against soil pathogens (11). Nematodes have an important role in soil health. The population of bacterivorous and fungivorous nematodes changes in respond to organic enrichment in soil depending on increase in bacteria and fungus biomass. Opportunistic bacterial feeder nematode species quickly respond to bacteria population changes in soil and population levels increases with organic enrichment while basal nematode fauna of fungal feeders and slowly growing bacterial feeders grows later in soil succession (10; 7). Nutrient mobilization status in soil could be followed by nematode succession in soil.

Therefore, to determine the effect of different organic and synthetic fertilizers on soil nematode composition and stem and bulb nematode damage on onion growth was aimed in current study.

MATERIALS AND METHODS

Experimental design

Experiment was carried out in growth room at 20 °C and 90% humidity for 16 hours light and 8 hours dark conditions for two months. Stem and bulb nematode susceptible green onion variety; Beyaz Bilek was planted into field soil in 3x13 cm dimensions cylinder plastic tubes as one seed per tube. Experiment with five fertilizer application and a negative control treatment without any application with 8 replications was set up using completely randomized block design in containers. Field soil used in the experiment contained 40% sand, 38% clay and 22% silt classified as clay loamy soil texture. pH of soil was 7.8. Organic matter, phosphor and $CaCO_3$ content were 1.11%, 25.9% and 0.46 kg/ da, respectively. The soil used in the experiment contained *Cephalobus*, *Acrobeloides* and *Eucephalobus* genera bacterivorous nematodes, *Aphelenchus* and *Aphelenchoides* genera fugivorous nematodes and dorilaimida order nematodes and *Ditylenchus* and *Tylenchus* genera plant parasitic nematodes at the beginning of the experiment.

Fertilizer application

Liquid fertilizer treatments (table 1) were applied 4 times during experiment at 200 ml/ da in 100 lt water concentration. Each plant took 10 ml of fertilizer solution. First application was at planting and there after two weeks intervals.

Table 1. Fertilizer treatments and their mineral contents

Treatment number	**Fertilizer application name**	**Mineral content**
1	Negative control	
2	Syntetic fertilizer	N: P: K (10: 8: 5%)
3	Beet molasses originated organic fertilizer	N: P: K (7: 7: 7%)
4	Organic worm fertilizer	
5	Leonardit originated humic acit	humik fulvik acit: K: organic matter (17: 3: 16%)
6	Sea algae	Alginic acit: K: organic matter (0,4: 3: 9%)

Nematode inoculation and harvest

Stem and Bulb nematode (*Ditylenchus dipsaci)* was inoculated onto plant leaves as 200 nematodes/ plant in 10 µl CMC (carbocsimetilcellulose, 1%) solution after 4 weeks planting. Plants were grown for 4 weeks after nematode inoculation and harvested. Fresh whole plant weight, number of nematodes in plant and soil for each tube was evaluated.

Statistical analysis

Fresh whole plant weight and nematode population data were analyzed using ANOVA to determine statistically significant differences among fertilizer treatments. Correlations between nematode numbers and plant weight in the fertilizer treatments were investigated using multivariate correlation analysis. Jump 5.0.1a program was used for the statistical analyses.

RESULTS

There were statistically significant difference among fertilizer treatments for whole plant weight, number of *D. dipcasi,* number of *Cephalobus* spp. and total number of bacterivorous nematodes. Other nematode data were not found significantly different by ANOVA test. Effect of fertilizer applications on onion plant growth was evaluated after two months after planting. Whole plant weight is used to express the effect of fertilizer applications on plant growth. Leonardit originated humic acid, organic worm fertilizer and synthetic fertilizer applications significantly increased plant weight compared to negative check treatment (P<0,05). The most effective fertilizer treatment on plant growth was leonardit originated humic acid application, followed by organic worm fertilizer and synthetic fertilizer applications. Plant weight in sea algae and beet molasses originated organic fertilizer treatments were lower (Figure 1).

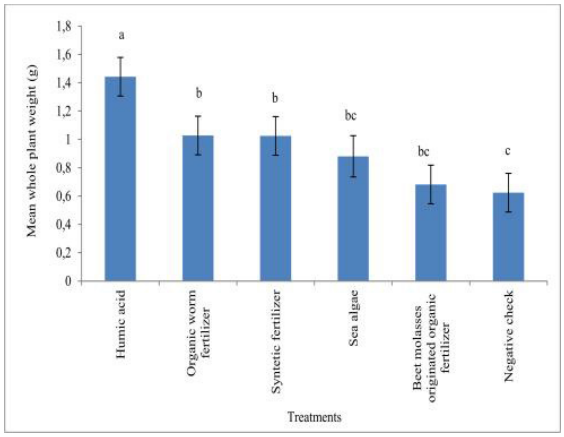


Figure 1. Effect of fertilizer treatments on onion plant growth after 2 months planting.

Total number of *D. dipsaci* per tube both from plant and soil was significantly decreased in all fertilizer treatments (P<0,05; Figure 2). Number of stem and bulb nematode in negative check treatment was 467 nematodes/ tube, it was 122-42 nematodes/ tube in fertilizer treatments. Number of *D. dipsaci* was higher in sea algae and beet molasses originated organic fertilizer treatments; 122 and 115 nematodes per tube, respectively. Average number of *D. dipsaci* in synthetic fertilizer, organic worm fertilizer and humic acid treatments were between 60-42 nematodes/ tube.

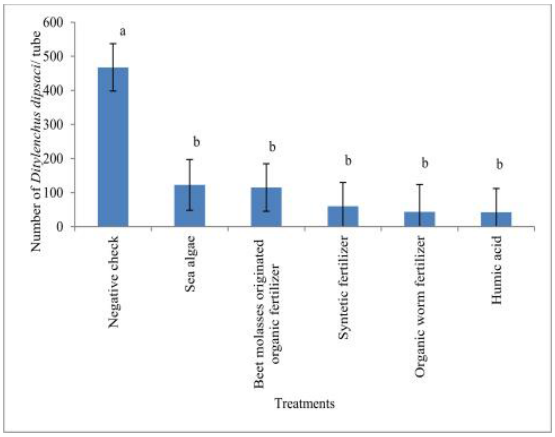


Figure 2. Number of *D. dipsaci* per tube in different fertilizer treatments.

Bacterivorous nematodes were in high incidence in sy-

nthetic fertilizer and organic worm fertilizer treatments (57 and 47 nematodes/ tube, respectively), while negative check, humic acid, sea algae and molasses originated organic fertilizer treatments had low nematode numbers (15-32 nematodes/ tube) (Figure 3). The results were similar for *Cephalobus* genus of bacterivorous nematodes. *Eucephalobus* spp. were found in all treatments.

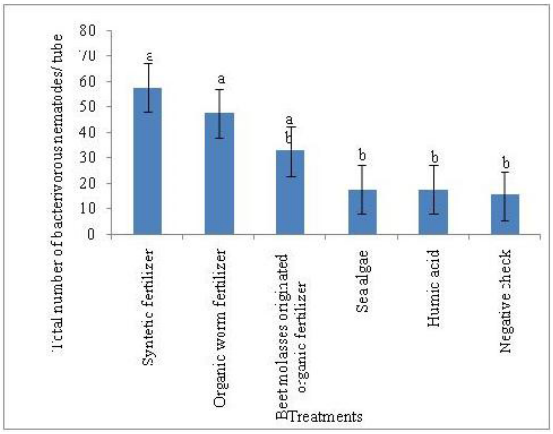


Figure 3. Total number of bacterivorous nematodes per tube in different fertilizer treatments.

Plant weight slightly had positive relationship with total number of bacterivorous nematodes in organic worm fertilizer and with number of *Cephalobus* spp. in humic acid treatment (Figure 4 and 5). Conversely plant weight had statistically significant negative relationship with total number of bacterivorous nematodes in sea algae treatment (P<0,05) (Figure 6).

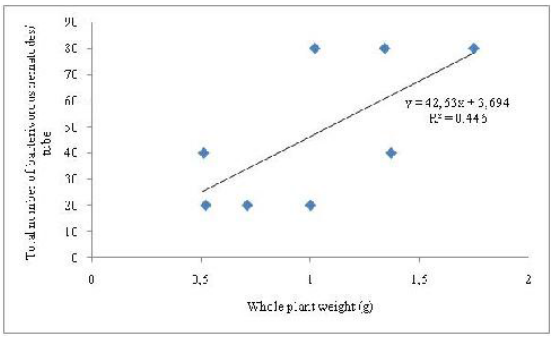


Figure 4. Positive relationship between whole plant weight and total number of bacterivorous nematodes/ tube in organic worm fertilizer treatment.

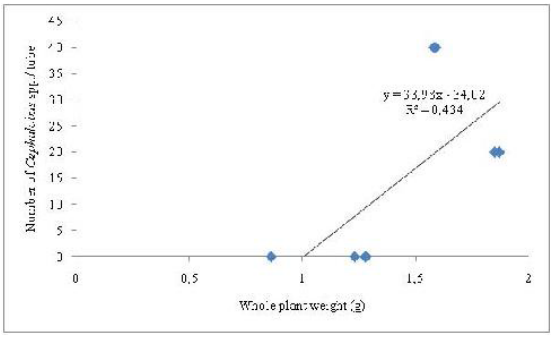


Figure 5. Positive relationship between whole plant weight and total number of *Cephalobus* spp./ tube in humic acid treatment.

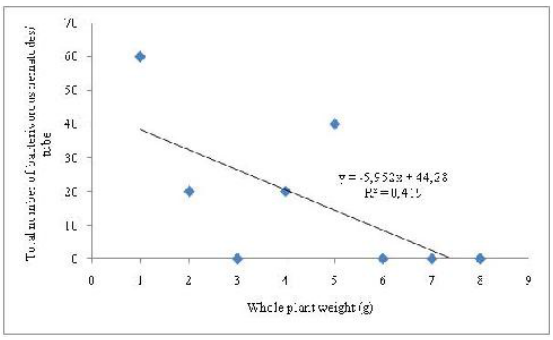


Figure 6. Negative relationship between whole plant weight and total number of bacterivorous nematodes/ tube in sea algae treatment.

DISCUSSION

The results clearly indicated that humic acid, organic worm fertilizer and synthetic fertilizer significantly increased the plant growth. The positive effect of humic acid and worm fertilizer on root development of plants is well known and suggested to growers in practice (20). Organic fertilizers are also useful for constructing soil biodiversity for long term usage (17, 8, 11). Soil saprophytic bacteria and fungi mineralize the organic matter slowly dependingly soil succession develops. Soil free living nematode fauna is indicator of soil mineralization level. Quickly developing bacterial feeders are increased in respond to soil organic matter enrichment and then slowly growing bacterial feeders and fungal feeders are increase (7). The number of bacterial feeder basal fauna nematodes of *Cephalobus* spp. and *Eucephalobus* spp. are found in high incidence in fertilizer treatments, especially in humic acid and worm fertilizer treatments. However long therm field trials are best way of showing effect of organic fertilizers on soil nematode succession. Healthy plant development contribute to disease suppression (11). This effect clearly shown in experiment with lower *D. dipsaci* numbers in fertilizer treated tubes.

As a result, organic based fertilizers are a good alternative to chemicals for pest management for long term sustainability of soil ecosystem and producing high yield.

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