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Evaluation of Mycorrhizal Fungi, Vermicompost and Humic Acid on Essence Yield and Root Colonization of Fennel

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Introduction

The main objective of sustainable agriculture is to decrease the off-farm inputs such as chemical fertilizers, increased farm nutrient cycle through reduced tillage and the use of biological and organic fertilizers. Studies on medicinal plants indicates that the use of sustainable farming systems provide the best conditions for the production of these plants. Mycorrhizal fungi, vermicompost and humic acid are samples of biological and organic fertilizer that can be used, to eliminate or substantially reduce the use of chemical inputs in order to increase the quantity, quality and stability of the products. Mycorrhizal fungi are one of the most important rhizosphere microorganisms which have symbiotic relation with root of most crops. Mycorrhizal symbiosis improves the soil physical (through expansion of hyphae of fungus), chemical (through increased absorption of nutrients) and biological (the soil food web) quality. These fungus increased nutrient uptake, such as phosphorus and some micronutrients, water uptake, reducing the negative effects of environmental stress and increase resistance to pathogens and improve the quality of their host plants. Fennel (Foeniculum vulgare Mill) is one of the most important medicinal plants, as the essential oil from the seeds used in a variety of industries, pharmaceutical, food and cosmetic use. Anethole is important component of the essential oil of fennel seed.

Materials and Methods

This experiment was conducted as a factorial based on randomized complete block design in order to evaluate the effects of vermicompost application, humic acid and mycorrhizal fungi on quantitative and qualitative aspects of fennel yield at experimental farm of Shahrood University during growing season of 1391-92. This experiment includes 12 treatments and 3 applications. Vermicompost levels include: v1 (no application) v2 (4 ton ha^{-1}) v3 (8 ton ha^{-1}). Mycorrhizal fungi include: m1 (no inoculation) and m2 (inoculation) and humic acid include: h1(no application) and h2 (application). Each plot had 5 rows with row spacing of 50 cm and row length of 5 m was considered. Ten grams mycorrhizal fungi were added to the soil under each seed. Humic acid was sprayed in 3 stages (vegetative, reproductive and seed filling stage) according to the recommended dose (200 mg per liter). Sampling and measuring of traits were done at the end of the season and after removal of border rows. A 50 gram sample of each plot milled and then essence collected with Clevenger for three hours using water distillation. Percent of fungal colonization obtained with Gridline Intersect Method. Finally, for analysis of data and drawing shapes, MSTAT-C software and Microsoft Excel were used. Comparison of the least significant difference test (LSD) was conducted at the 5% level.

Results and Discussion

Results of this study showed the main effects of experimental factors on seed yield, essence percent and yield were significant. Comparison of mean results showed the highest seed yield (1119.37 kg ha^{-1}) obtained from mycorrhizal colonization. With increasing vermicompost applying, seed yield also increased. So, the greatest and lowest seed yield obtained from 8 ton ha^{-1} vermicompost and control plots (1315 and 1016 kg ha^{-1}), respectively. With humic acid foliar application, seed yield increased about 18 percent. In this experiment essence percent significantly increased due to mycorrhizal colonization. Essence percent of fennel seeds showed, the highest value of essence percent (2.83%) obtained from 8 $ton.ha^{-1}$ vermicompost and the lowest essence was obtained from control plots (2.15%). Seed essence percent significantly increased due to humic acid foliar application compared with control plots (2.6% and 2.4% respectively). Essence yield significantly increased due to mycorrhizal inoculation (31.67 kg ha^{-1}). Vermicompost application increased essence yield about 64 and 25 percent compared with control plots. Compared to control, humic acid increased essence yield by 22 percent. Mycorrhizal inoculation significantly increased root colonization compared with control plots (47.39 and 23.89 %, respectively). Application of vermicompost increased root colonization by about 6% compared to control

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plots. Combined effects of vermicompost and mycorrhiza on seed yield and essence percent were significant. Combination effects of vermicompost and mycorrhiza showed, seed yield increased about 45 percent. Moreover, combination of mycorrhiza and 8 ton.ha^{-1} vermicompost resulted in the highest seed essence yield (3.09 kg ha^{-1}) that significantly was higher than control polts (2.11 kg ha^{-1}) .The threeway interactions of factors on seed yield and essence percent was also significant. The highest essence percent of seed obtained from combination of 8 ton.ha^{-1} with humic acid and mycorrhizal inoculation (3.09 %) which significantly was higher than control plots (1.99%). In this treatment essence yield was 36% higher than control plots. In general, the highest amounts of anethole obtained from 8 ton ha^{-1} with humic acid and mycorrhizal inoculation. On the other hand, with increase in anethole the amounts of stragol, fenkon and limonene per seed essence decreased.

Conclusions

Results of this study showed that vermicompost and humic acid application and also mycorrhizal colonization, improved the quantitative and qualitative yield of fennel. So, the seed yield, essence yield and root colonization significantly affected by these factors. These factors without causing environmental damage, provide nutrients for medicinal plants, therefore improved the yield and quality.

Keywords: Anethole, Biofertilizer, Essence, Fennel, Organic manure