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Investigating the effect of humic acid-based fertilizers (three fertilizers available in the market) on the growth characteristics, absorption of elements and the percentage of essential oil of peppermint (Mentha piperita L.)

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Abstract
In order to investigate the effect of humic acid on various aspects of the growth of the medicinal plant peppermint (Mentha piperita L.) in areas with alkaline soil, this research was conducted in Rafsanjan. This research is a randomized complete block design with four treatments (1- control (without using any fertilizer) 2- humic acid 50% (brand name bishumic) per hectare, 1000 kg (100 grams) per plot with dimensions of 1 m x 1 m) 3- Humic acid 40% (with the brand name Humi Green) along with 5% nitrogen, 2% phosphorus, 2% potash per hectare 1000 kg (100 grams per plot with dimensions of 1 m x 1 m) 4- 40% humic acid (with the brand name Humic Plus) along with 5% nitrogen, 5% phosphorus, 2% iron and 0.25% copper per hectare 1000 kg (100 grams per plot with dimensions 1 m x 1 m)) in four repetitions, a total of 16 experimental plots were performed. After determining the location of each treatment, except for the control treatment, half of the determined amount of fertilizer was added to each plot (50 grams for each plot), then one irrigation was done and the seedlings were planted. The results showed that the amount of essential oil in the humic plus fertilizer treatment increased due to the increase in plant growth and the subsequent increase in dry matter. The amount of absorption of micronutrient elements such as iron, copper, zinc and manganese also increased.

Keywords: Mint, Humic Acid, Essential Oil, Micronutrients

Introduction

Peppermint is one of the most important medicinal plants belonging to the Lamiaceae family, including medicinal and aromatic plants, whose essential oil has medicinal, food, cosmetic and health uses (Lebaschy & Sharifi Ashourabadi, 2013). It is believed that by using different fertilizers, including humic acid, it is possible to increase the amount of peppermint plant production and increase the amount of its effective substance in the conditions of drought stress. Since the global approach in the production of medicinal plants is towards the use of sustainable agricultural systems and the use of their

management methods such as the use of biofertilizers in order to improve the quantitative and qualitative performance of medicinal plants, the use of humic acid in the correct management is necessary in addition to providing nutrients Environmental aspects of plant needs should also be taken into consideration (Yazdani et al., 2004). Therefore, the use of a natural and organic substance such as humic acid, which is specific to alkaline soils, is of particular importance for the production of medicinal plants in our country, and no research has been done in this regard so far. Therefore, despite humic acid being organic, its specificity for alkaline soils is very important. In addition to the role of soil amendment, changing soil acidity, root development, water absorption and management, humic acid has a claturing role in the field of nutrition, that is, it has the ability to make its accompanying or adjacent materials available to the plant in a usable way. Paying attention to this article and developing its use can be an important step towards creating employment and proper productivity of agricultural land. Considering the importance of fertilizer in yield and the amount of essential oil production in this plant and the high need of this product for chemical fertilizers and on the other hand the importance of humic fertilizers, the investigation of fertilizers containing humic acid in the production and yield of mint plant was done.

Materials and methods

This experiment was conducted in order to investigate the effect of fertilizers containing humic acid on the amount of essential oil, available elements and yield of peppermint medicinal plant. The field where the experiment was conducted was located in Rafsanjan. This research is a randomized complete block design with four treatments (1- control (without using any fertilizer) 2- humic acid 40% per hectare 1000 kg (100 grams per plot with dimensions of 1 meter by 1 meter) 3- 30% humic acid with 5% nitrogen, 5% phosphorus, 1000 kg per hectare (100 grams per plot with dimensions of 1 meter by 1 meter) 4- Humic acid 30% with 5% nitrogen, 5 % of phosphorus, 2% of iron and 0.25% of copper per hectare, 1000 kg (100 grams per plot with dimensions of 1 meter by 1 meter) in four repetitions, a total of 16 plots were tested. After determining the location of each treatment Except for the control treatment, half of the determined amount of fertilizer was added to each of the plots (50 grams for each plot), then a round of irrigation was done. Three days later, some mint seedlings were prepared and inside each plot, 5 furrows with a distance of 20 cm and depth About 5 cm was created and it was tried to plant seedlings almost uniformly in all the plots. After planting, irrigation was done again. At the end of the experiment, samples were taken from the leaves of the plants in each experimental plot and the amount of zinc, iron, magnesium, calcium and manganese were measured by atomic absorption device, phosphorus by optical spectrometry method, potassium and by flame meter device. Analysis of the obtained data was done using MSTATC and EXCEL software.

Results and Discussion

The results showed that the fertilizer treatments were significant on some traits and not significant on some others, which we will investigate here. The effect of fertilizer treatments on the wet weight of the plant was significant. The highest fresh weight was observed in humic plus fertilizer treatment. Other treatments had no significant difference with each other (Fig 1).

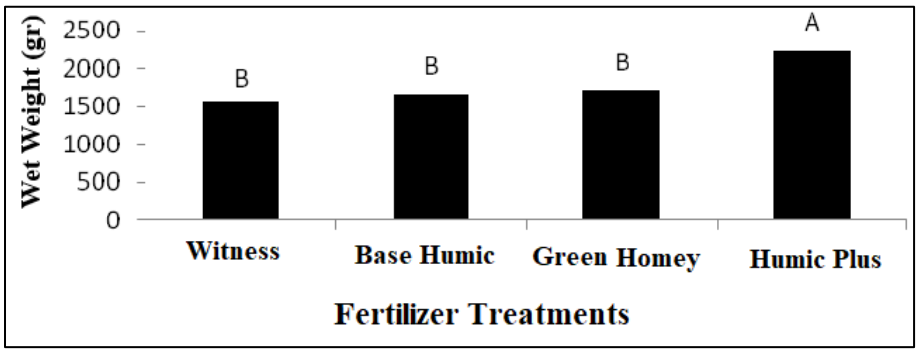

Fig1- Effect of fertilizer type on plant fresh weight. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of fertilizer treatments on plant dry weight was significant. The highest amount of plant dry weight was obtained from humic plus fertilizer treatment, which was not significantly different from humic green and base humic treatments. The lowest amount of dry weight was observed in the control treatment (Fig 2).

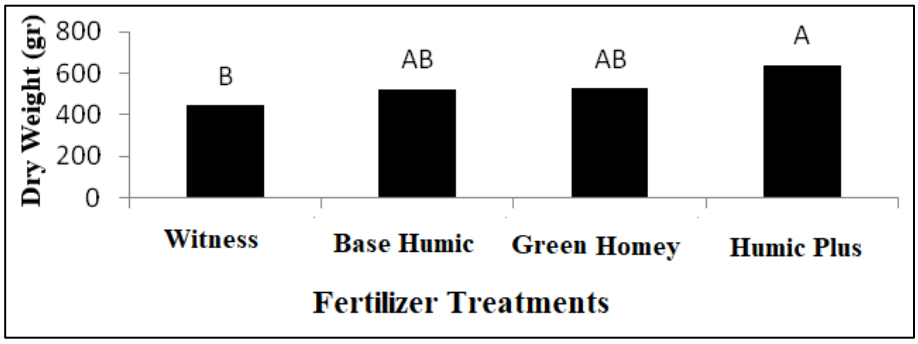

Fig 2- Effect of fertilizer type on plant dry weight. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of fertilizer treatments on potassium concentration in peppermint plants was significant at the 5% probability level and fertilizers containing humic acid increased its amount. Different fertilizer treatments did not show significant differences with each other. The lowest concentration of potassium was observed in the control treatment (Fig 3).

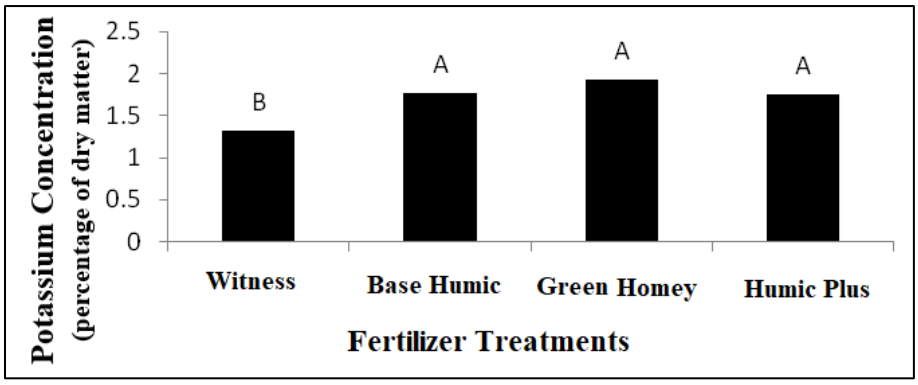

Fig 3- Effect of fertilizer type on leaf potassium concentration. Different letters on the column indicate that the difference between the means is significant at the 5% probability level

The effect of fertilizer treatments on plant manganese was significant. The use of fertilizers containing humic acid increased the amount of manganese in the plant. Fertilizer treatments had no significant differences with each other. The lowest amount of manganese was observed in the control fertilizer treatment (Fig 4).

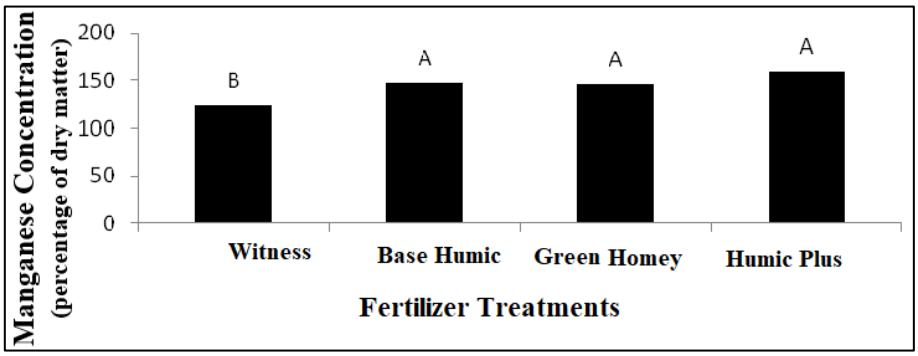

Fig 4- Effect of fertilizer type on leaf manganese concentration. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of fertilizer treatments on the amount of zinc in the plant was significant. The highest amount of zinc was observed in humic plus fertilizer treatment, which was not significantly different from the control treatment. There was no significant difference between humic green and humic base treatments (Fig 5).

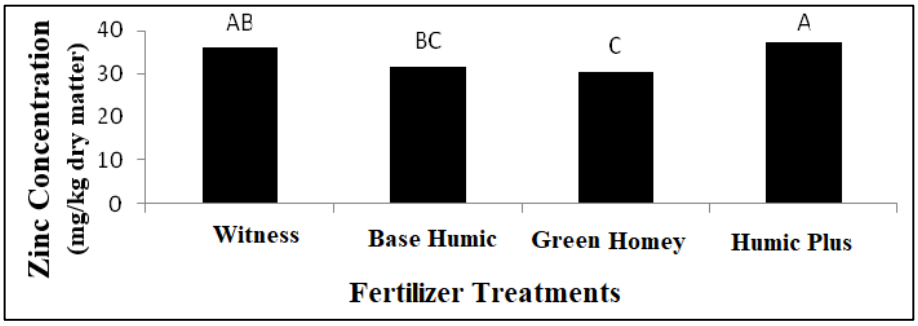

Fig 5- Effect of fertilizer type on leaf zinc concentration. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of fertilizer treatments on plant iron was significant. The application of fertilizers containing humic acid increased the amount of iron in the plant. The amount of iron in the plant was higher in the humic plus fertilizer treatment, which was not significantly different from the humic green treatment. The lowest amount of iron was observed in the control fertilizer treatment, which was not significantly different from the humic base treatment (Fig 6).

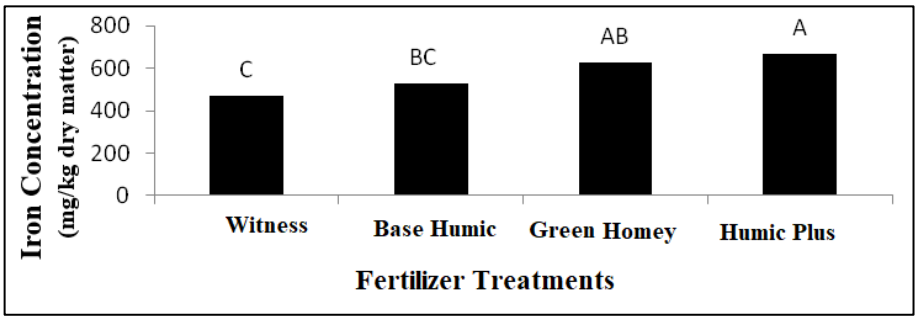

Fig 6- Effect of fertilizer type on leaf iron concentration. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of humic fertilizers on copper concentration was significant at the probability level of 5%. The highest concentration of copper was observed in the humic plus treatment and the lowest in the humic base fertilizer treatment (Fig 7).

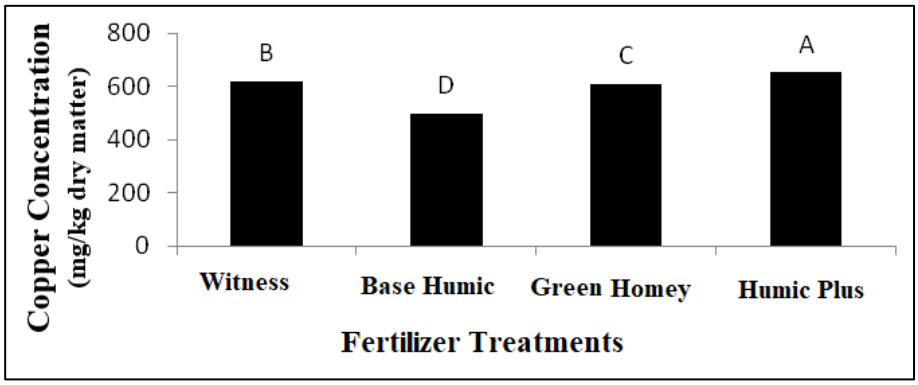

Fig 7- Effect of fertilizer type on leaf copper concentration. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

The effect of treatments on the amount of essential oil was significant at the 5% probability level. The humic plus treatment increased the percentage of essential oil, which was not significantly different from the control and humic plus treatments. Humi Green treatment reduced the percentage of essential oil. (Fig 8).

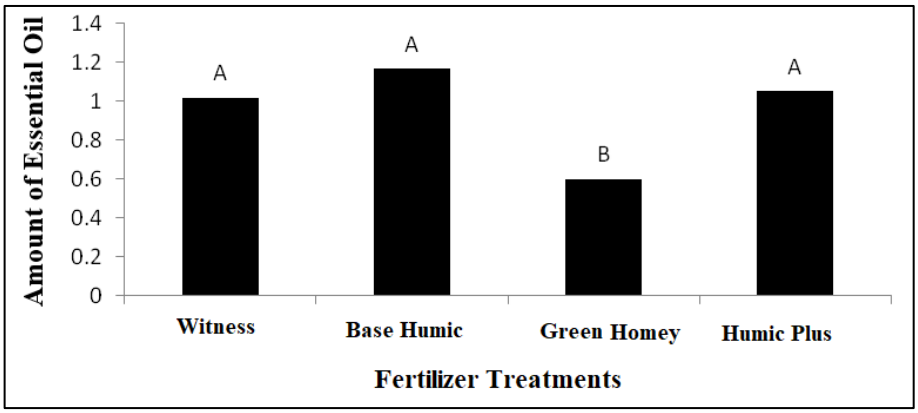

Fig 8- The effect of fertilizer type on the percentage of plant essential oil. Different letters on the column indicate that the difference between the means is significant at the 5% probability level.

Conclusion

The results of this research showed that humic plus fertilizer increased dry weight and wet weight compared to other treatments. The growth of the aerial part and root of the plant is stimulated by humic acid, but its effect is more prominent on the root and it increases the volume of the root and causes the effectiveness of the root system, which is probably the reason for increasing the growth of the aerial part of the plant (Hartwigson & Evans 2000). Experiments conducted on different products have shown that humic acid increases plant growth directly and indirectly. Humic acid can stimulate plant growth with the presence of vitamins, amino acids, gibberellin and auxin (such as growth-inducing substances in organic materials). It increases the permeability of the cell

membrane, which results in an increase in the absorption of water and other nutrients (Genevini *et al.*, 1998). The concentration of iron, zinc, copper and manganese elements increased by using humic fertilizers (Figures 4, 5, 6, 7). It should be noted that only the presence of elements in the soil is a guarantee for They are not absorbed. In fact, many minerals such as oxides, carbonates and sulfides are absolutely not absorbable by plants. The most important mineral absorbable compound for plants is the sulfate of metal elements. Therefore, humic acid directly and indirectly contributes to the release and better extraction of elements. The results of this research also showed that humic acid has a great effect on plant growth and absorption of elements. It is recommended to repeat the experiment in other places suitable for cultivation.

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