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Effect Of Foliar Application Of Npk Nano-Fertilizer On Some Agronomic Traits And Essential Oil Of Sweet Basil (Ocimum Basilicum L.) Grown Under The Shade-Net House Conditions

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Abstract

Smart fertilizers, such as nano-fertilizers, can reduce environmental pollution and cultivation expenses in the medicinal and aromatic plant industry. The purpose of this research was to see how NPK nano-fertilizer affected the morpho-physiological characteristics and essential oil content of sweet basil. The plants were grown in pots under the shade net house conditions, and treated with six different NPK nano-fertilizers (0.0, 0.5, 1.0, 1.5, 2.0, and 2.5 g/L). As a foliar treatment, the NPK nano-fertilizer was sprayed four times in a 30-day interval. The pot experiment, which was set up in a completely randomized design with three replications, was subjected to regression analysis. According to the findings, applying different rates of NPK nano-fertilizer had a significant influence on vegetative parameters and essential oil content. The usage of smart fertilizers was found to have a linear relationship with plant height, essential oil %, and essential oil production. Plants treated with 1.5 g/L smart fertilizer had the highest leaves number per plant, branches number per plant, and herb dry weight. Using a smart fertilizer, according to this research, can reduce pollution while also improving essential oil output.

Keywords: nano-fertilizer, smart fertilizer, vegetative biomass.

Introduction

Basil (Ocimum basilicum L.) is a herbaceous annual plant in the Lamiaceae family. Basil grows wild throughout Asia's tropical and subtropical regions, as well as Africa, Central and South America, and is widely cultivated around the world as one of the most significant medicinal and aromatic herbs. In Iraq, basil is known as Reyhan, and it is also known as the King of Herbs, and it is grown all over the world for its flavorful, medicinal, and industrial benefits (Abbasifar et al., 2020; Alhasan et al, 2020; Alhasan et al., 2020; Alhasan et al., 2021). Basil is grown and harvested for its vegetative biomass, aromatic ornamental plant, or essential oil, which is used in cosmetic and pharmaceutical industry. Basil leaves, both fresh and dried, can be used in cooking (Bufalo et al., 2015). Basil essential oil has been shown to have insecticidal, antibacterial, and insect repellent qualities, and has been used to repel houseflies and mosquitoes (Al-Ameri et al., 2020; Türkmen, 2021).

In basil, different plant parameters and essential oil content strongly influenced by different biotic and abiotic stresses including nutrient deficiency (Zahedifar and Najafian, 2017). Standardization of planting conditions and availability of plant nutrients in soil are most important factor affecting aromatic herbs in the terms of obtaining commercially better quality and quantity vegetative biomass and essential oil according to consumer demands (Abbasifar et al., 2020; Türkmen, 2021). Widespread existence of nutrient deficiency in soil has reduced in nutritional quality and overall quantity of essential oil production and significant results in great economic loss in in the sector of medicinal and aromatic plant production.

Although large amounts of chemical fertilizer can be used to increase the essential oil of medicinal and aromatic plants, this alters the mineral balance of the soil and reduces soil fertility. Furthermore, traditional chemical fertilizers have lower plant uptake efficiency (PUE) than nano-fertilizers, necessitating the use of more chemical fertilizer to achieve maximum output. Thus, nano-fertilizers are nutritional fertilizers made up of nanostructured particles that can be applied to plants, and these smart fertilizers have a high PUE, allowing for effective uptake or gradual release of active compounds (Raliya et al., 2018). Nanostructured materials have a single unit size that ranges from 1 to 100 nm, which is smaller than the size of bulk particles (Ali and Al-Juthery, 2017; Al-Juthery and Saadoun, 2018). As a result, medicinal and aromatic plants absorb nano-fertilizers in ways that bulk particles or ionic salts do not. Farmers who use smart fertilizers instead of conventional fertilizers can achieve high nutrient utilization efficiency, strong vegetative growth, increased essential oil quality and quantity, and lower environmental pollution (Benzon et al., 2015; Burhan and Al-Hassan, 2019; Jubeir and Ahmed, 2019; Alhasan et al., 2021). Numerous recent studies have discovered that using nano-fertilizers on basil has a significant impact on plant growth, flower and seed yield, as well as essential oil content and components. The application of 300 mg kg-1 soil K-nano fertilizer increased the dry weight of vegetative biomass as well as the uptake of Cu and Zn in basil (Zahedifar and Najafian, 2017). Alhasan (2020) investigated the effects of NPK-nano fertilizer concentrations ranging from 0.0 to 2.5, 5.0, 7.5, 10.0, 12.5, and 15.0 ml per 10L on basil plant growth, vegetative biomass, and essential oil. The results revealed a linear relationship between NPK-nano fertilizer use and several agronomic characteristics, but a non-linear relationship between NPK-nano fertilizer use and essential oil output. According to Elfeky et al., using nano-fertilizer significantly increased basil essential oil production (2013). When compared to traditional fertilizers used on basil plants grown in greenhouses, using Fe-urea nano-fertilizer at the optimal dosage (0.2 percent) resulted in the highest rate of rosmarinic acid and antioxidant activity (Tavallali et al., 2020). Because of the novelty of nanotechnology in medicinal and aromatic plant cultivation, as well as the scarcity of research on the use of NPK-nano fertilizer in Iraq. Due to the importance of medicinal and aromatic plants, as well as the use of nanotechnology, this study was conducted under shade-net house conditions with the goal of evaluating the use of NPK-nano fertilizer on vegetative development, biomass production, and essential oil content in basil.

Material and Methods

During the summer of 2020, an experiment was conducted in the station of crop production and development at Al-Diwaniyah city, Al-Qadisiyah, Iraq, under shade-net house circumstances. The effect of applying different rates of NPK-nano fertilizer (0.0, 0.5, 1.0, 1.5, 2.0, and 2.5 g. L^{-1}) on basil was studied using a completely randomized design (CRD) with three replications (local cultivar). During the spring of 2020, seeds were planted in plastic seedling trays. During the growing season, seedlings were transferred to plastic pots (10 kg) filled with compost and natural soil (1:1 v/v) and placed in the shade-net house system. Several soil samples were taken from the pots to generate one sample to analyze certain soil physical and chemical characteristics, and the outcome soil test was shown in table 1. Following 50 days after planting, the foliar application was completed, and NPK-nano fertilizer treatments were applied (DAP). The basil plants were watered twice time during the day to avoid drought stress by applying the hand irrigation system. The neem oil was applied to avoid problem of insects, including aphids and whitefly under the shade-net house conditions. Different agronomic traits (plant height, total number of leaves per plant, total number of branches per plant, dry weight of vegetative biomass, essential oil %, and essential oil yield) were calculated at the end of the experiment. Fresh weight of vegetative biomass was obtained by sum of stalk and leaf. Plant height was measured in centimeters using a ruler. To calculate the total number of leaves or branches per plant, three plants in each pot selected and number of leaves or branches were calculated and then averaged. To get the essential oil, dry leaves (50 g) were subjected to three hours with distilled water into the Clevenger apparatus, and the essential oils were kept under 4˚C conditions. The data of experiment were statistical analysis by using the excel program, and the linear and non-linear regression analysis were performed.

The physical and chemical parameters of the soil in the pot experiment are listed in Table 1.

Soil texture	Clay %	Silt %	Sand %	N %	Soil pH	N ppm	P ppm	K ppm	EC ds/m
Silty loam	17	25	67	0.09	7.8	54.2	38.6	49.9	0.91

Results and Discussion

For pot experiment, the linear regression analysis indicated that the mean plant height value was significantly affected by NPK nano-fertilizer rate (Fig. 1). However, the mean total number of leaves per plant and the total number of branches per plant were significantly increased by NPK nano fertilizer with a non-linear relationship existing between these plant parameter values and NPK rate (Fig. 1). At the end study, the dry weight of vegetative biomass was significantly increased by NPK nano-fertilizer rate (dry weight of vegetative biomass in g/plant = [$Y=25.521(\text{NPK Rate})^{0.0772}$]). The linear regression analysis indicated that the mean essential oil % value was significantly affected by NPK rate. Also, significant P-value was observed for the linear regression of essential oil yield as a function of NPK nano-fertilizer rate (Fig. 1).

The influences of increasing the rate of foliar-applied NPK nano-fertilizer were positive for essential oil traits (86% increase for essential oil % and 18% increase for essential oil yield). Vegetative morphological traits also increased due to NPK nano-fertilizer within pot study (65% increase for plant height and a 62% increase for DW of vegetative biomass). The high value of essential oil yield wan obtained when high rate (2.5 g/L) of NPK nano-fertilizer was applied on plants due to increasing other plant parameters such as total leaves number and dry weight of vegetative biomass, which also high correlated with essential oil yield (data not shown). Alhasan (2020) evaluated plant growth and essential oil production of basil (Dolly cultivar) grown under field conditions with different rates of NPK nano-fertilizer, finding that applying 15 ml/10L resulted in the highest plant growth and essential oil production, while using only distilled water as a control treatment resulted in the lowest vegetative growth and essential oil production. The maximum vegetative growth traits were obtained in the current investigation by increasing the rate of NPK nano-fertilizer. Mohammadhagheri and Naderi. (2017) obtained the highest biomass yield when gerbera plants treated with the nano-fertilizer compared to the control treatment, which showed the lowest value. Under field conditions, different types of nano-fertilizer (Iron, Zinc, and Potassium) have been applied on mint plants, and the highest values of different agronomic traits were obtained by applying the nano-fertilizer compared to using traditional type of chemical fertilizers (Hassani et al., 2015). Different sources of chemical fertilizers including nano-fertilizer have been applied on peppermint plants grown under field conditions, and the maximum values of plant height, chlorophyll content, biomass yield, and essential oil content of plants treated with nano-fertilizer than control (Ostadi et al., 2020). Therefore, the correct choice of fertilizer rate, cultivar, time of application, application method, and type of nano-fertilizer can be considered the most crucial factors in crop management and economic production of medicinal and aromatic plants in Iraq.

Conclusion

According to the findings, NPK nano-fertilizer increased plant height, dry weight of vegetative biomass, and essential oil production significantly. The effect of Nano-NPK level on plant height, essential oil percent, and

essential oil yield was linear, with Nano NPK (2.5 g/L) producing the highest value of essential oil production. There were, however, significant differences between vegetative characteristics and Nano-NPK levels, indicating a non-linear relationship. When Nano-NPK (1.5 g/L) was used, the total number of leaves per plant, total number of branches per plant, and dry weight of vegetative biomass all increased by 56, 55, and 62 percent, respectively. It was discovered that foliar application of Nano NPK fertilizer (1.5 g/L) during the vegetative stage increased basil dry weight and essential oil production when grown in a shade-net house.

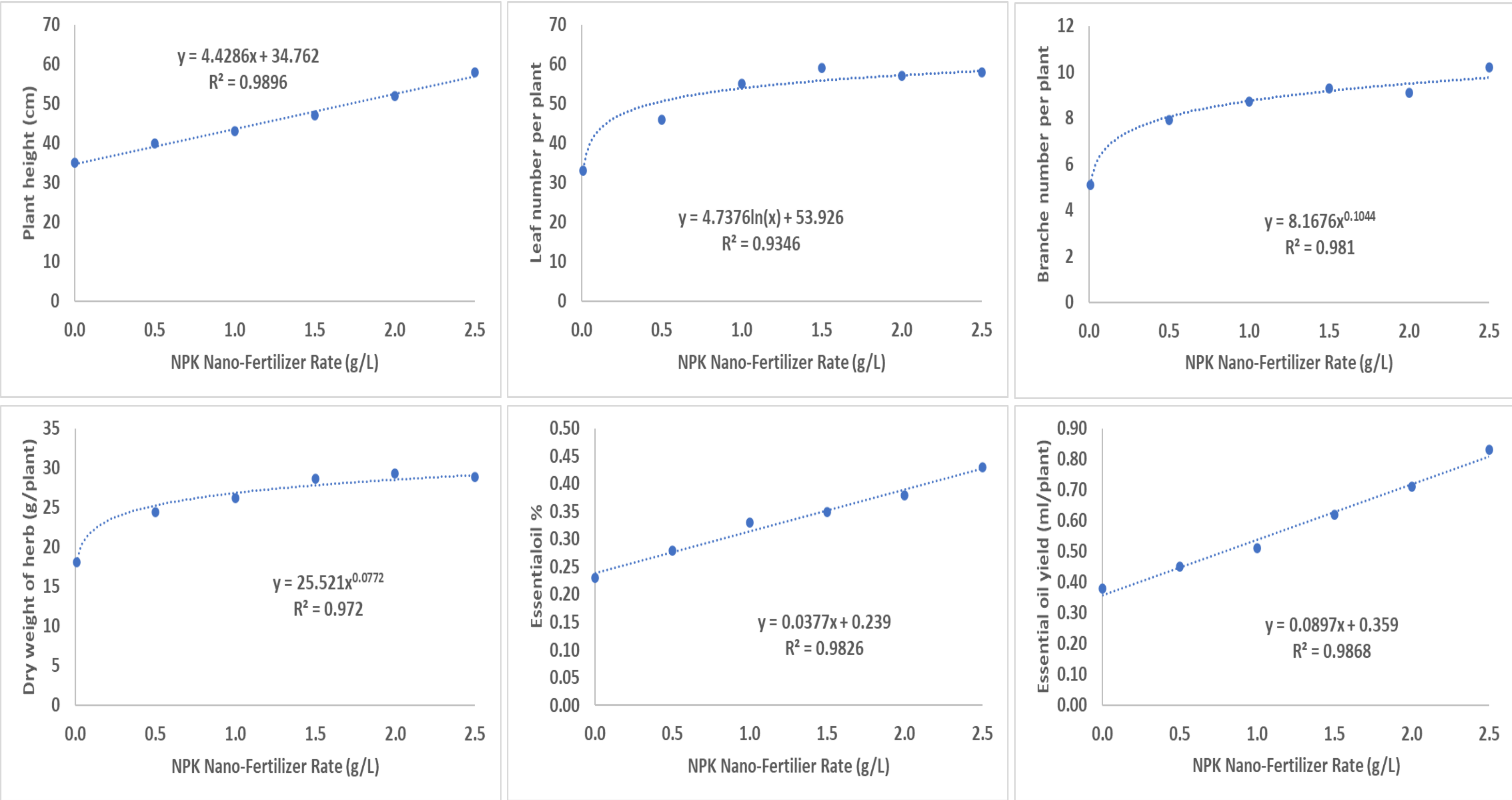

Figure 1. Influence of applying different rates of NPK nano-fertilizer on growth traits and essential oil yield of basil grown under shade-net house conditions.

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