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INFLUENCE OF FOLIAR APPLICATION OF NPK ON GROWTH, ESSENTIAL OIL AND SEED YIELD OF BASIL (*OCIMUM BASILICUM* L. CV DOLLY)

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Abstract

Basil (*Ocimum basilicum* L.) is an important plant belonging to the Lamiaceae family. Basil is grown in different countries as a medicinal and aromatic plant. Basil production can be influenced by abiotic and biotic stresses including plant nutrition deficiency. Thus, a field experiment was conducted in a completely randomized design during summer 2019 to investigate the effect of foliar application of NPK fertilizer (0.0, 0.5, 1.0, 1.5, 2.0 and 2.5 g/L) on growth, essential oil and seed yield of basil. Applying moderate levels of NPK fertilizer is proposed to be sufficient for high vegetative growth traits and essential oil production. The highest non-reproductive biomass yield was recorded at a dose of 1.0 to 2.0 g/L. The highest amount of essential oil was determined in plants fertilized with NPK dose of 1.5 g/L. Applying NPK fertilizer (1.5 to 2.0 g/L) produced the highest seed yield. Generally, NPK application as foliar fertilizer contributed to the increase of most plant traits compared to control (0 g/L) in basil.

***Key words*: Basil, NPK fertilizer, foliar application, essential oil and dolly.

Introduction

Basil (*Ocimum basilicum* L.) is an annual and perennial herb and belongs to the Lamiaceae family. Moreover, basil is cultivated as an aromatic and medicinal plant in tropical and subtropical regions in the world. Basil crop is known as annual and perennial herbs (Nayak *et al*., 2008; Ekren *et al*., 2012). Basil herb is utilized for cooking, cosmetic, and culinary purposes; moreover, basil is used for folk medicine (Daneshian *et al*., 2009). Basil herb contains up to 1.5% of essential oil, tannins, saponins, glycosides, flavonoids, enzymes and organic acids. Basil's oil components, such as linalool, eugenol, 1,8-cineole, estragole, geranial, neral, methyl chavicol, caryophyllene oxide and methyl cinnamate are known to be biologically active (Ekren *et al*., 2012; Dzida, 2010; Daneshian *et al*., 2009). Moreover, these oil components are used as an antioxidant, antimicrobe, a fungistatic agent and anti-mutagenic activity (Nurzynska-Wierdak *et al*., 2011). The essential oil concentration and oil components in medicinal and aromatic plants are influenced by genotypes, environment, soil conditions, irrigation, growing techniques, as well as fertilization (Daneshian *et al*., 2009; Nayak *et al*., 2008).

Basil herb requires nitrogen, phosphorus, and potassium in high amounts for growth and development. These nutrients are known as macronutrients that are required for creating chlorophyll, protein, enzyme, nucleic acids and cell membranes. Moreover, these nutrients play important roles in photosynthesis, transpiration, respiration, and osmotic regulation (Eleiwa *et al*., 2012). Thus, applying NPK fertilizer increases plant growth and development. NPK fertilizer applied in soil showed a low effect on plant growth because these macronutrients can be lost in various ways such as fixations. Thus, foliar nutrient applied is designed to solve the above problems. Applying NPK fertilizer at different levels by foliar application is the modern method of fertilization to produce vegetative crops and medicinal plants (Chaurasia *et al*., 2005; Khalid and Shedeed, 2015). Basil (*Ocimum basilicum* L.) has been studied extensively in different research works to identify growth, yield components, essential oil ratio, and oil components under different environmental conditions; however, few studies have focused on the influence of the foliar application of NPK fertilizer at different rates. Therefore, theobjective of this study was to investigate the influence of different NPK rates (0, 0.5, 1.0, 1.5, 2.0, and 2.5 g/L) applied as foliar fertilizer on growth, oil yield and composition of essential oil of basil.

Materials and Methods

A field study was conducted with basil (*Ocimum basilicum* L.) at the station of field research, Al-Diwaniyah city, Al-Qadisiyah, Iraq in the summer of 2019. Dolly cultivar

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was used by sowing seeds in plastic seedling trays filled with peatmoss. After 5 weeks of growth, a uniform seedling of cultivar was selected for use in fertilizer study and transplanted to a field. The soil samples were taken from depth 0-30 cm and analyzed to show some physical and chemical characteristics in Table 1.

The complete randomized design (CRD) with three replicates was used in this experiment. Basil seedlings were cultivated in a plot (6 x 4 m^2) and other agricultural management practices (weeding, flood irrigation and pesticide application) were carried out during the growing season. Foliar application of NPK fertilizer (0, 0.5, 1.0, 1.5, 2.0, and 2.5 g/L) were applied at 30, 45, and 60 days after transplanting (DAP). Chlorophyll content was measured by using the chlorophyll meter (SPAD) at 65 days after transplanting (DAT). Plant growth traits were plant height (cm), stem diameter (mm), number of internodes per plant, number of leaves per plant and vegetative biomass yield (g m^{-2}) and measured at the flowering stage. The essential oil content was determined in 50 g of dry leave and stems through using Clevenger - type apparatus. The plant sample was distilled for 3 hours in 500 ml distillation water. Finally, seed yield (g m^{-2}) was measured at harvesting time. All the statistical analyses were conducted with CRD design with three replications. The data obtained were subjected to regression analysis using the R software system.

Results and Discussion

There were differences in plant growth, leaf traits, essential oil and seed yield by the influence of NPK concentration applied as foliar fertilizer during the summer 2019 season. The healthy and fully expanded leaves were used at 65 days after transplanting (DAT) to measure the leaf SPAD values. The leaf SPAD value was significantly increased by applying NPK foliar fertilizer with a non-linear relationship existing between the leaf SPAD value and NPK rate (Figure 1). The number of leaves per plant was significantly increased with the NPK rate, and there was a linear relationship between this trait and NPK rate (Figure 2). There was a non-linear relationship existing between the stem diameter and NPK rate (Figure 3). The plant height of basil was significantly increased through using the NPK foliar fertilizer and there was a linear relationship between plant height and NPK rate (Figure 4). The number of internodes $plant^{-1}$ was significantly increased by NPK rate at the flowering stage with a non-linear relationship existing between this trait and NPK rate (Figure 5). At the same plant stage, the vegetative biomass yield was significantly increased by applying different rates of NPK fertilizer, and there was a non-linear relationship existing between vegetative biomass yield and NPK rate (Figure 6). The F-test and regression analysis for the essential oil was significantly increased by NPK at the flowering stage. There was a non-linear (polynomial regression) relationship between the essential oil trait and NPK rate (Figure 7). The seed yield was significantly increased by applying different NPK rates at maturity time with a polynomial regression existing between seed yield and NPK rate (Figure 8).

The effect of NPK applied as foliar fertilizer on plant growth, seed yield and essential oil has been suggested as an improvement factor for plant growth of most medicinal plants (Khalid and Shedeed, 2015; Khalid, 2012; Hassan *et al*., 2015 and Abdou *et al*., 2014). The obtained results were confirmed by Abbas and Ali (2011), Hassan (2009), Khosa *et al*. (2011) and Khalid and Shedeed (2015) they reported that NPK foliar fertilizer can improve plant growth through increasing chlorophyll content, plant height, stem diameter, seed yield, and essential oil. Increasing chlorophyll content by applying NPK fertilizer has been reported by Hassan (2009) and Abbas and Ali (2011). Enhancing photosynthesis efficiency through increasing chlorophyll content may be led to an increase in different plant growth parameters (Mohamed *et al*., 2015). The improving of plant height and other plant traits has been reported by Chaurasia *et al*. (2005). In this respect, Okonwu and Mensah (2012), Kashif *et al*. (2014), Singh *et al*. (2015) and Khosa *et al*. (2011) stated that applying NPK foliar fertilizer increased plant height, stem diameter, number of leaves and dry weight of vegetative biomass yield compared to control. The lowest value of essential oil was produced by untreated plants during the summer season. This result is in close agreement with those reported by Sharafzadeh *et al*. (2011) and Mohamed *et al*. (2015). In addition, Yanchev and Ivanov (2015), Abdelkader *et al*. (2018), Abdalla and Hendi (2014), and Khalid and Shedeed (2015) showed that applying NPK fertilizer increased essential oil yield of *Ocimum basilicum* L., *Coriandrum sativum* L., *Origanum majorana* L. and *Nigella sativa* L, respectively. The seed yield was the highest when NPK foliar fertilizer was applied with different rates in this study. Similar results have been obtained by Abbas and Ali (2011), El-Sayed and El-Basuony (2017) and Mohamed *et al*. (2017), who demonstrated that the highest seed yield value was recorded in applying NPK foliar fertilizer as compared to control (untreated plants).

Conclusion

Our results demonstrated that basil can be grown in a field with foliar application of NPK fertilizer for fresh market production and essential oil. Applying 1.5 g/L of NPK fertilizer provided the most consistent results compared to other levels of NPK fertilizer. The foliar application of NPK fertilizer may have improved the growth traits of basil under field conditions. Thus, spraying NPK fertilizer on the plants can be increased essential oil and avoiding environmental pollution.

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Table 1: Soil physical and chemical properties of the study field

Soil texture	**Sandy clay loam**
Organic matter (g.kg^{-1} soil)	0.49
Electrical conductivity EC (ds.m^{-1})	1.4
pH	7.8
Sand (g.kg^{-1} soil)	203
Silt (g.kg^{-1} soil)	442
Clay (g.kg^{-1} soil)	306
Nitrogen availability (mg.kg^{-1} soil)	47
Phosphorus availability (mg.kg^{-1} soil)	12
Potassium availability (mg.kg^{-1} soil)	138

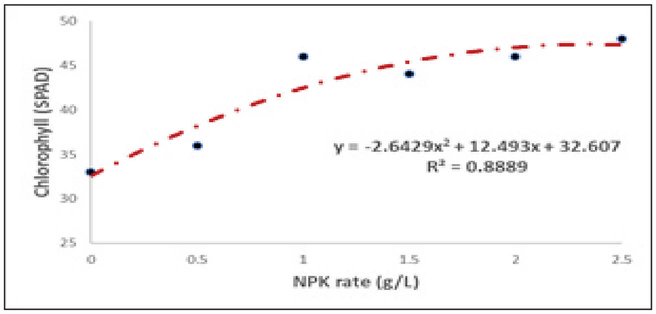

Figure 1: Effect of NPK foliar fertilizer rate on chlorophyll at 65 days after transplanting (DAT) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

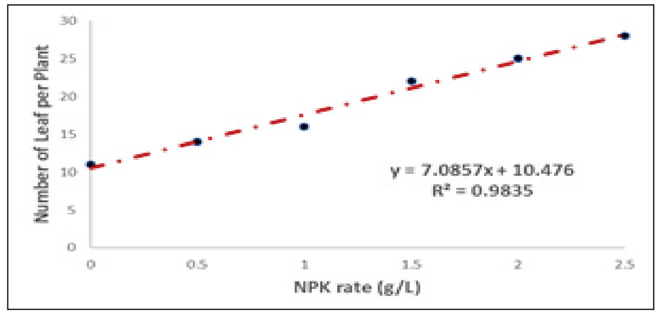

Figure 2: Effect of NPK foliar fertilizer rate on a number of leaves per plant for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

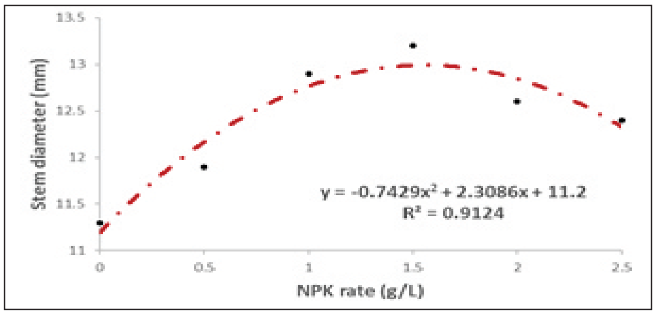

Figure 3: Effect of NPK foliar fertilizer rate on stem diameter (mm) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

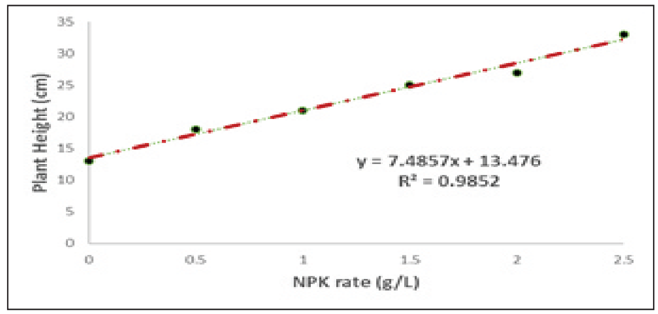

Figure 4: Effect of NPK foliar fertilizer rate on plant height (cm) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

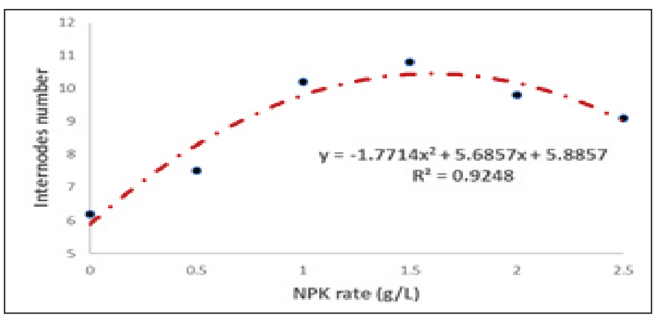

Figure 5: Effect of NPK foliar fertilizer rate on internodes number per plant for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

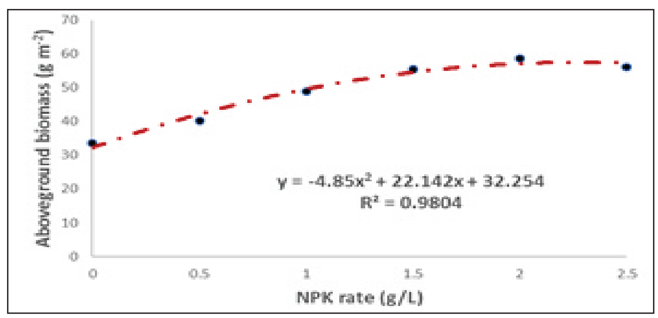

Figure 6: Effect of NPK foliar fertilizer rate on vegetative biomass yield (g m^{-2}) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

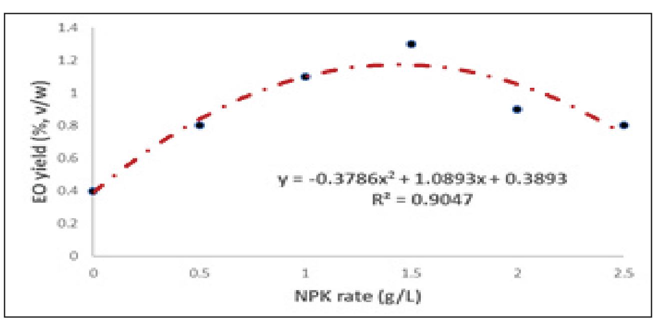

Figure 7: Effect of NPK foliar fertilizer rate on essential oil yield (%, v/w) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019

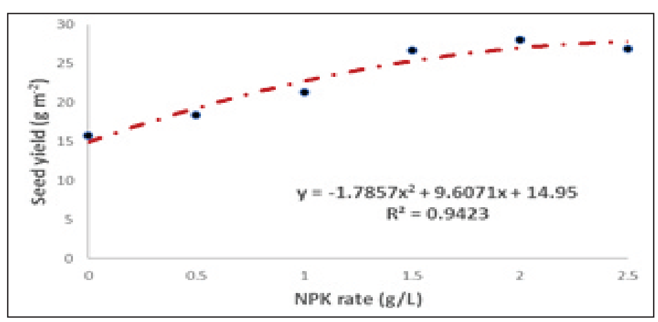

Figure 8: Effect of NPK foliar fertilizer rate on seed yield (g m^{-2}) for the cultivar Dolly basil grown in the field at Al-Diwaniyah during 2019