Plant Archives Vol. 20, Supplement 2, 2020 pp. 2959-2962 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF DIFFERENT NPK NANO-FERTILIZER RATES ON AGRONOMIC TRAITS, ESSENTIAL OIL, AND SEED YIELD OF BASIL (*OCIMUM BASILICUM* L. CV DOLLY) GROWN UNDER FIELD CONDITIONS

Ali Sabah Alhasan
Department of Horticulture Science and Landscape Architecture, Faculty of Agriculture, University of Al-Qadisiyah, Iraq
E-mail: ali.alhasan@qu.edu.iq

Abstract

Basil herb (*Ocimum basilicum* L.) is an aromatic plant that cultivated for essential oil production, utilizing in culinary, cosmetics, biopesticides, and pharmaceutical productions. The production of essential oil influenced by different biotic and abiotic stress. However, nutrients deficiency is a major problem for basil growth and production in alkaline soil. Thus, this field study was preformed to evaluate applying different rates of NPK nano-fertilizer (0, 2.5, 5.0, 7.5, 10.0, 12.5, and 15.0 ml/10L) on agronomic traits, essential oil, and seed production. Utilizing a moderate rate of NPK nano-fertilizer is proposed to be sufficient for leaf SPAD trait. However, increasing the nano-fertilizer rate showed a positive response to most agronomic traits. There was a linear-relationship between plant traits and NPK nano-fertilizer rate. Moreover, results highlighted the using NPK nano-fertilizer as a sufficient way in increasing plant growth, essential oil, and seed production under high soil pH conditions.
***Keywords*:** Basil, aromatic plants, medicinal plants, nanotechnology, and NPK nano-fertilizer.

Introduction

Basil plant (*Ocimum basilicum* L.) is a native plant in tropical and subtropical regions and belongs to the Lamiaceae family (Esetili *et al*., 2016; Dzida, 2010). Nowadays, basil herb is planted as medicinal or aromatic plants in the United States, Iran, Egypt, Greek, France, and other countries (Ekren *et al*., 2012). Esetili *et al*., (2016) state that basil herb is utilized in culinary and traditional medicines. Basil is also used in biopesticides and pharmaceutical productions; moreover, basil herb is utilized in the cosmetic industry (Bufalo *et al*., 2015). Basil herb contains up to 1.5% of essential oil, containing different concentration of terpenoids and phenylpropanoids (Esetili *et al*., 2016), linalool and eugenol (Dzida, 2010), and estragole, methyl cinnamate, methyl chavicol, 1,8-cineole, neral, geranial, and caryophyllene oxide (Ekren *et al*., 2012). The essential oil rate in the basil plant influenced by environmental factors, genetic factor and soil conditions such as nutrition deficiency (Esetili *et al*., 2016; Dzida, 2010). Thus, the differences in compounds of essential oil determine the flavors and specific aroma for each basil species, cultivar, and genotype (Bufalo *et al*., 2015). A nanotechnology is a tool for increasing the value of essential oil and vegetative production. Moreover, applying nano-fertilizer can also reduce environmental pollution when traditional chemical fertilizers applied with high rates (El-Labban *et al*., 2016). Kottegoda *et al*., (2011) stated that using nano-fertilizer and nano-pesticide can reduce environmental pollution by reducing release fertilizer. Thus, nanotechnology has an important role in agricultural science in recent years (Elshamy *et al*., 2019). There is a strong interest in cultivating medicinal and aromatic plants in an effort to increase essential oil production. The vegetative biomass production and essential oil yield can be increased by using nano-fertilizers: magnetite nano-fertilizer on sweet basil *Ocimum basilicum* L. (Elfeky *et al*., 2013), iron, zinc, and potassium nano-fertilizer on peppermint *Mentha piperita* L. (Hassani and Tajali, 2014), zinc nano-fertilizer on basil (El-Kereti *et al*., 2013), potassium nano-fertilizer on chamomile *Matricaria chamomilla* L. (Ibrahim, 2019), nano-iron chelate on basil (Nazari *et al*., 2012), nano-fertilizer on black cumin *Nigella sativa* L. (Safaei *et al*., 2014) and nano-fertilizer on Saffron *Crocus sativus* L. (Amirnia *et al*., 2014) as well as, application of potassium nano-fertilizer on sweet basil (Najafian and Zahedifar, 2018). This study aims to evaluate the influence of the foliar application of the NPK nano-fertilizer on growth traits and essential oil yield as well as seed yield in basil (Dolly cultivar) grown in the field conditions at Al-Diwaniyah governorate, Iraq.

Material and Methods

A field experiment was carried out during the summer season of 2019 at Al-Diwaniyah Station for Crop Cultivation and Development, Al-Diwaniyah city, Al-Qadisiyah Province, Iraq, to investigate the response of basil (Dolly cultivar) to foliar application of NPK nano-fertilizer. Seeds of Dolly cultivar was obtained from the Johnny's Selected Seeds company (USA), and seeds were sown in the plastic seedling trays, which were filled with peat moss. Seedlings were transferred to the field after 35 days after planting (DAP). Treatments consisted of seven rates of the fertilizer; 0, 2.5, 5.0, 7.5, 10.0, 12.5, and 15.0 ml L^{-10} distilled water. Soil samples were taken from a field location to do the soil analysis, and all samples were taken from depth 0 to 30 cm. The soil physical and chemical characteristics were shown in Table 1.

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

Soil texture	Silt clay loam
Organic matter (g.kg^{-1} soil)	0.49
Electrical conductivity EC (ds.m^{-1})	1.4
pH	8.6
Nitrogen availability (mg.kg^{-1} soil)	18
Phosphorus availability (mg.kg^{-1} soil)	11
Potassium availability (mg.kg^{-1} soil)	157

Basil seedlings were transferred to the plots (6 ×4 m^2), which laid out in the completely randomized design (CRD) with three replicates. Plants treated with foliar application of NPK nano-fertilizer in different rates (0, 2.5, 5, 7.5, 10, 12.5, and 15 ml/10L) at 30, 45, and 60 days after transplanting (DAT). Different agricultural management such as controlling weeds and application pesticides were applied at the growing season. Moreover, hand irrigation was used to water plants at the seedling stage, while the flood irrigation system was utilized to avoid drought stress during the growing season in the field.

At 65 days after transplanting (DAT), chlorophyll was measured by using the SPAD-502 meter. Basil plants were harvested by cutting at 10 cm above the soil surface and most plant traits (plant height, stem diameter, number of leaves per plant, and vegetative biomass yield) were measured. Basil plants (leaves and shoots) were air-dried until constant weight for three days, and dried samples were taken to measure essential oil. The essential oil was extracted from the whole plant (leaves and shoots) and was determined by using the hydro-distillation method (Clevanger). Moreover, the plant samples (50 g for each sample) were distilled for three hours in 500 ml of distillation water. Finally, basil plants were harvested at the end of the experiment (last week in October 2019) to account for the seed yield. The R software system was used for doing the statistical analysis, which was carried out through using the regression analysis.

Results and Discussion

Growth parameters were taken to determine if the NPK nano-fertilizer rates influence plant development and production. Chlorophyll content was measured by using the healthy and fully expanded leaves, and SPAD-502 meter was used to measure the chlorophyll content at 65 days after transplanting (DAT). Applying NPK nano-fertilizer at different rates showed significantly increased the chlorophyll trait compared to untreated basil plants. There is a polynomial relationship between the leaf SPAD value and NPK nano-fertilizer rate (Fig.1). The plant height trait was significantly increased by applying different rates of NPK nano-fertilizer, and there was a linear relationship between plant height and NPK nano-fertilizer rate (Fig. 2). At the flowering stage, applying different rates of nano-fertilizer increased the number of leaves per plant, and stem diameter. There is a linear relationship between the leaves number per plant and NPK nano-fertilizer rate (Fig. 3), while the relationship between stem diameter and the NPK nano-fertilizer rate was a polynomial (Fig. 4). The vegetative biomass yield (g m^{-2}) was significantly increased through applying the NPK nano-fertilizer compared to untreated plants (control) at the flowering stage, and there was a linear relationship between this trait and NPK nano-fertilizer rate (Fig. 5). The essential oil of basil was significantly increased by using different rates of NPK nano-fertilizer compared to control when plant samples were harvested at the flowering stage. There was a non-linear (polynomial) relationship between the essential oil of basil (%, v/w) and NPK nano-fertilizer rate (Fig. 6). Finally, the F-test and regression analysis were significant for the seed yield trait, and a linear relationship between the seed yield (g m^{-2}) and NPK nano-fertilizer rate existed (Fig. 7).

Influence of NPK nano-fertilizer applied as foliar spraying on plant growth, vegetative biomass yield, seed yield, and essential oil production has been suggested as an important way for increasing plant growth of different crops without impact on our environment (Al-Juthery *et al.*, 2018; Abdel-Aziz *et al.*, 2016; Ekinci *et al.*, 2014; Drostkar *et al.*, 2016; and Jameel and Al-Tai, 2017). Al-Juthery *et al.*, 2018 stated that the NPK nano-fertilizer increased the chlorophyll content in wheat compared to untreated plants. Increasing chlorophyll content in plant tissues leads to increase and enhance the efficiency of photosynthesis, which leads to increase the plant growth parameters such as plant height, leaf area, and the number of branches (Mohamed *et al.*, 2015). Increasing plant height by applying NPK nano-fertilizer has been reported by Jameel and Al-Tai (2017), Ibrahim (2019), and Hegab *et al.*, (2018). In this respect, Hasaneen *et al.*, (2016) stated that applying NPK nano-fertilizer as foliar application increased different plant growth traits, which include root length, shoot length, and leaf area. Thus, increasing plant growth leads to an increase in the vegetative biomass yield under applying the NPK nano-fertilizer compared to normal or unfertilized treatments. The applying NPK nano-fertilizer at different rates increased the production of vegetative biomass compared to untreated plants (control). Similar results have been reported by Jameel and Al-Tai (2017) and Elshamy *et al.*, (2019). The high value of essential oil was produced by applying the NPK nano-fertilizer. Similar results have been obtained by Jameel and Al-Tai (2017) in three species of Apiaceae at field conditions and El-Labban *et al.*, (2016) in *Cuminum cyminum* L. Seed yield was increased with applying different rates of NPK nano-fertilizer. Similar results have been obtained by Burhan and Hassan, (2019) and Abdel-Aziz *et al.*, (2016) in wheat, and Safaei *et al* (2014) in black cumin (*Nigella sativa* L.).

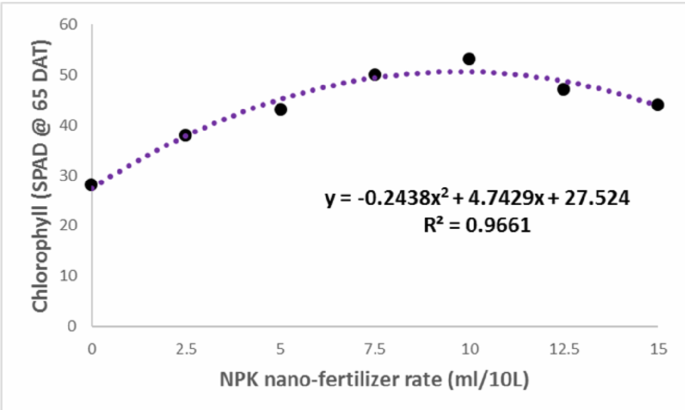

Fig. 1 : Influence of NPK nano-fertilizer rate on chlorophyll at 65 days after transplanting (DAT) for the cultivar Dolly basil.

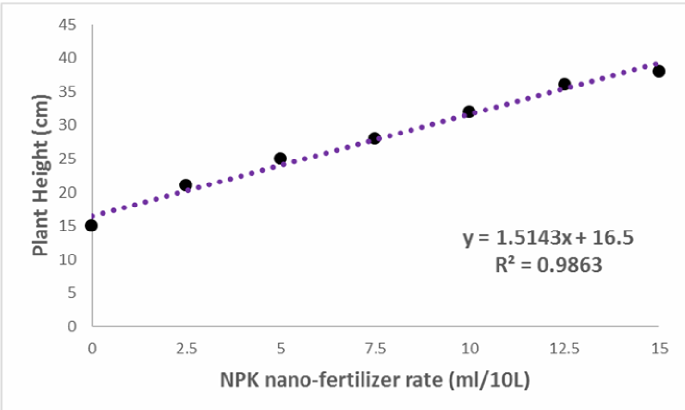

Fig. 2 : Influence of NPK nano-fertilizer rate on plant height (cm) for the cultivar Dolly basil.

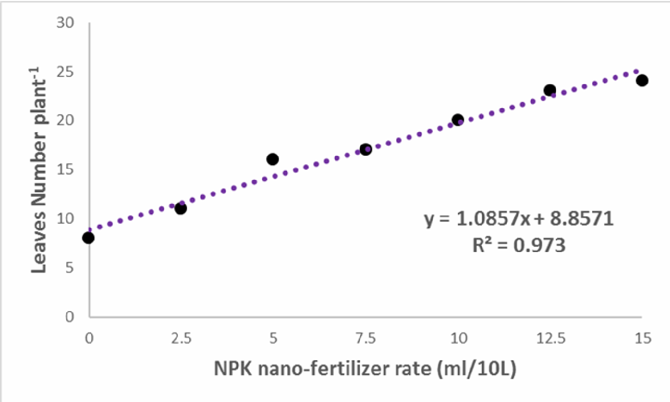

Fig. 3 : Influence of NPK nano-fertilizer rate on a number of leaves per plant for the cultivar Dolly basil.

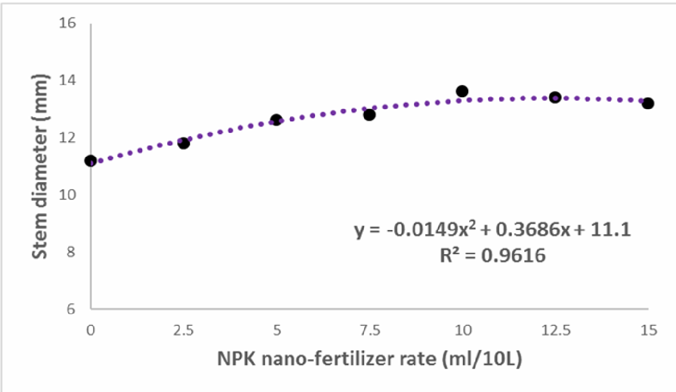

Fig. 4 : Influence of NPK nano-fertilizer rate on stem diameter (mm) for the cultivar Dolly basil.

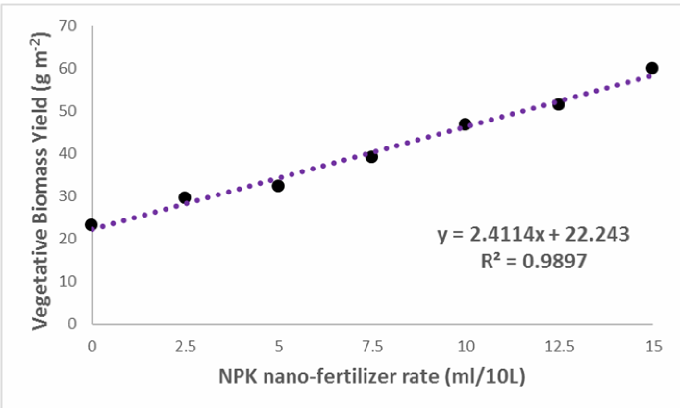

Fig. 5 : Influence of NPK nano-fertilizer rate on vegetative biomass yield (g m^{-2}) for the cultivar Dolly basil.

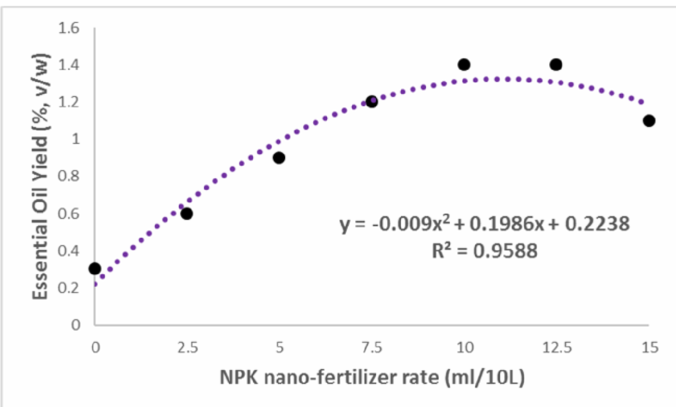

Fig. 6 : Influence of NPK nano-fertilizer rate on essential oil yield (%, v/w) for the cultivar Dolly basil.

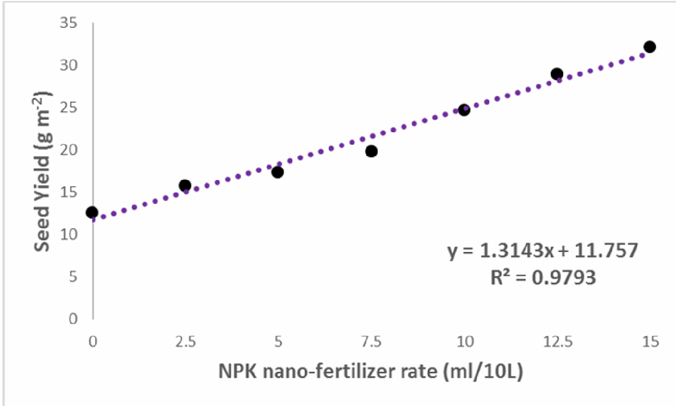

Fig. 7 : Influence of NPK nano-fertilizer rate on seed yield (g m^{-2}) for the cultivar Dolly basil.

Conclusion

According to obtained results, NPK nano-fertilizer rate has a positive influence on plant growth and essential oil production of basil by increasing chlorophyll content, leaves number, plant height, vegetative biomass yield, and seed yield of plants treated compared to untreated plants. Applying 7.5 (ml/10L) showed the highest value for some plant parameters compared to other treatments. However, most plant traits increased with increasing rates of NPK nano-fertilizer. Therefore, it can be concluded that the foliar application of NPK nano-fertilizer can be suggested as increasing the plant growth, essential oil, and vegetative biomass yield of basil without negative influences on plants and the environment.

References

Abdel-Aziz, H.M.M.; Hasaneen, M.N.A. and Omer, A.M. (2016) Nano chitosan-NPK fertilizer enhances the growth and productivity of wheat plants grown in sandy soil. Spanish Journal of Agricultural Research. 14(1): 1-9.

Al-Juthery, H.W.A.; Habeeb, K.H.; Altaee, F.J.K.; AL-Taey, D.K.A. and Al-Tawaha, A.R.M. (2018). Effect of foliar application of different sources of nano-fertilizers on growth and yield of wheat. Journal by Innovative Scientific Information & Services Network. 15(4): 3988-3997.

Amirnia, R.; Mahdi, B. and Tajbakhsh, M. (2014). Effects of nano fertilizer application and maternal corm weight on flowering of some saffron (*Crocus sativus* L.) ecotypes. Turkish Journal of Field Crop. 19 (2): 158-167.

Bufalo, J.; Cantrell, C.L.; Astatkie, T.; Zheljazkov, V.D.; Gawde, A. and Boaro, C.S.F. (2015). Organic versus conventional fertilization effects on sweet basil (*Ocimum basilicum* L.) growth in a greenhouse system. Industrial Crops and Products. 74: 249-254.

Burhan, M.G. and AL-Hassan, S.A. (2019) Impact of nano NPK fertilizers to the correlation between productivity, quality and flag leaf of some bread wheat varieties. Iraqi Journal of Agricultural Sciences. 50: 1-7.

Drostkar, E.; Talebi, R. and Kanouni, H. (2016) Foliar application of Fe, Zn and NPK nano-fertilizers on seed yield and morphological traits in chickpea under rainfed condition. Journal of Research in Ecology. 4(2): 221-228.

Dzida, K. (2010) Biological value and essential oil content in sweet basil (*Ocimum basilicum* L.) depending on calcium fertilization and cultivar. Acta Scientiarum Polonorum Hortorum Cultus. 9 (4): 153-161.

Ekinci, M.; Dursun, A.; Yildirim, E. and Parlakova, F. (2014) Effects of nanotechnology liquid fertilizers on the plant growth and yield of cucumber (*Cucumis sativus* L.). Acta science Poland Hortorum Cultus. 13(3): 135-141.

Ekren. Sıdıka., Ç; Sonmeza, Ozc, E.; Kurttas, Y.S.; Bayrama, E. and Gurgulu, H. (2012). The effect of different irrigation water levels on yield and quality characteristics of purple basil (*Ocimum basilicum* L.). Agricultural Water Management. 109: 155-161.

Elfeky, S.A., Mohammed, M.A.; Khater, M.S.; Osman, Y.A.H. and Elsherbini, E. (2013). Effect of magnetite Nano-Fertilizer on Growth and yield of *Ocimum basilicum* L. International Journal of Indigenous Medicinal Plants. 46 (3): 2051-4263.

El-Kereti, M.A.; El-feky, S.A.; Khater, M.S.; Osman, Y.A. and El-Sherbini, E.A. (2013). ZnO Nanofertilizer and He Ne Laser Irradiation for Promoting Growth and Yield of Sweet Basil Plant. Recent Patents on Food, Nutrition & Agriculture, 5 (3): 1-13.

El-Labban, H.M.; Menesy, F.; Kotb, S.A.; Fetouh, M.I. and Naga, N.M. (2016). Effect of nano fertilization, chemical and humic acid on the vegetative growth, chemical composition and oil yield of *Cuminum cyminum* L. Menoufia Journal of Plant Production. 1: 177-199.

Elshamy, M.T.; El-Khallal, S.M.; Husseiny, S.M. and Farroh, K.Y. (2019). Application of nano-chitosan NPK fertilizer on growth and productivity of potato plant. Journal of Science and Research Science. 36: 424-441.

Esetlili, B.Ç.; Öztürk, B.; Çobanoğlu, Ö. and Anaç, D. (2016). Sweet basil (*Ocimum basilicum* L.) and potassium fertilization. Journal of Plant Nutrition. 39 (1): 35-44.

Hasaneen, M.N.A.; Abdel-aziz, H.M.M. and Omer, A.M. (2016). Effect of foliar application of engineered nanomaterials: carbon nanotubes NPK and chitosan nanoparticles NPK fertilizer on the growth of French bean plant. Biochemistry and Biotechnology Research, 4(4): 68-76.

Hassani, A. and Tajali, A.A. (2015). Studying the conventional chemical fertilizers and nano-fertilizer of iron, zinc, and potassium on the quantitative yield of the medicinal plant of peppermint (*Mentha piperita* L.) in Khuzestan. International Journal of Agriculture Innovations and Research. 3(4): 1078-1082.

Hegab, R.H.; Abou Batta, W.F. and El-Shazly, M.M. (2018). Effect of mineral, nano and bio nitrogen fertilization on nitrogen content and productivity of *Salvia officinalis* L. plant. Journal of Science and Agriculture, 9(9): 393-401.

Ibrahim, F.R. (2019). Influence of potassium fertilization and nano-chitosan on growth, yield components and volatile oil production of chamomile (*Matricaria chamomilla* L.) plant. Journal of Plant Production of Mansoura University. 10 (6): 435-442.

Kottegoda, N.; Munaweer, I.; Madusanka, M. and Karunaratne, V. (2011). A green slow-release fertilizer composition based on urea-modified hydroxyapatite nanoparticles encapsulated wood. Current Science, 101(1): 73-78.

Mohamed, S.M.; El-Ghait, E.M.A.; El-Shayeb, N.S.A.; Ghatas, Y.A. and Shahin, A.A. (2015). Effect of some fertilizers on improving growth and oil productivity of basil (*Ocimum basilicum* L.) cv. Genovese plant. Egypt Journal of Applied Science. 30(6): 384-399.

Najafian, S. and Zahedifar, M. (2018). Productivity, essential oil components and herbage yield, of sweet basil as a function of biochar and potassium-nano chelate. Journal of Essential Oil Bearing Plants. 21(4): 886-894.

Nazari1, M.; Mehrafarin, A.; Badi, H.N. and Khalighi-sigaroodi, F. (2012). Morphological traits of sweet basil (*Ocimum basilium* L.) as influenced by foliar application of methanol and nano-iron chelate fertilizers. Annals of Biological Research, 3(12): 5511-5514.

Safaei, Z.; Azizi, M.; Davarynejad, G. and Aroiee, H. (2014). The effect of foliar application of humic acid and nanofertilizer (Pharmks®) on yield and yield components of black cumin (*Nigella sativa* L.). Journal of Medicinal Plants and By-products. 2: 133-140.