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GROWTH AND YIELD RESPONSE OF THREE BASIL (*OCIMUM BASILICUM*) VARIETIES TO DIFFERENT NITROGEN SOURCES

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Abstract

The study was conducted during the 2018 growing season in a field belong to Horticulture and Forestry Division/Iraqi Ministry of Agriculture/Al-Najaf Agricultural Directorate. Three varieties of basil, *Ocimum basilicum* Var basilicum (sweet basil), Var purple (red basil), and var. citriodorum (lemon basil) for their response (growth parameters and total yield) to nitrogen fertilizers from three different sources, including chemical (Urea $CO(NH_2)_2$), organic (plus Optimus) and biological (soil applied *Azotobacter chroococcum*) compared to spraying with distilled water (control). The Results showed the superiority of the red basil variety regarding plant height 62.97 cm, the percentage of dry weight 13.36%, and yield 3.19 kg m^{-2}. Lemon basil cultivar gave the largest leaf area (10.61 cm^2) and the number of leaves per plant (61.9). All sources of nitrogen fertilizer resulted in significant increase in plant height compared with control treatment. Organic nitrogen recorded the highest plant height (54.81cm) followed by biological fertilizer (54.49 cm). Highest value of leaf area was recorded in spraying of urea and organic fertilizer. Whereas, both organic and biological fertilizer resulted in significantly highest number of branches and plant dry weight while highest productivity (3.03kg m^{-2}) was yielded from organic nitrogen fertilizer.

Keywords: organic urea, bio-fertilizer, basil, vegetative growth.

Introduction

Basil *Ocimum* spp. L. is one of the important leafy vegetable plants is the Lamiaceae family, which includes many aromatic plants that are spread all over the world, especially in the countries of East Asia, the Mediterranean basin and Africa (Ewakil, 2018). Basil is involved in several fields, including food, therapeutic and industrial, and lies in the nutritional importance of the types of basil rich in vitamins, minerals, proteins and flavonoids (Boras *et al.*, 2006). 56 mg, potassium 295 mg, in addition to proteins, carbohydrates, clicosides, soaps and tannins (Purushothaman *et al.*, 2018) Fresh and dry green basil leaves, as well as their content of volatile oils and their various kinds, are used in the fields of medicine, preventive and complementary therapies and pharmaceuticals due to their biologic effectiveness and fewer side effects compared to chemically manufactured drugs (Al-Nouri *et al.*, 2009). Dry basil leaves are also used as spices or strong flavorings in food preparation.

Nitrogen is a key determinant of the growth of most field crops. Therefore, farmers use nitrogen fertilizers and chemical fertilizers abundantly to enhance yields of the resulting crops, leading to the problem of accumulation of high levels of nitrates in the cells of leafy vegetable plants, which has become a current problem threatening health around the world (Chowdhury and Das, 2015) because of its ability to oxidize hemoclobin Blood and thus the occurrence of cyanosis Methemoglobinemia and increase the chances of disease as well as causing other health problems for humans (Ramachandran *et al.*, 2005). Studies have shown that the adoption of food with a high content of nitrates and accumulation in the human body lead to the formation of the compound Nitrosamine, which is the primary carcinogenic substance, as this compound is the first nucleus to turn the normal cells to cancer and the development of fetal abnormalities and genetic mutations (Park *et al.*, 2018). Therefore, this study aimed to improve growth traits and yield in different basil varieties by using diversity of nitrogen fertilization, and study the interaction effect of these factors on yield quantity and quality.

Materials and Methods

The experiment was carried out during the 2018 growing season in a field belongs to Horticulture and Forestry Division/Directorate of Agriculture, province of Najaf. The field soil was prepared by tilling twice, softening and leveling. Before panting, a representative soil sample of ten randomly taken soil samples was subjected for soil analysis test (Table 1) in the soil laboratory in Department of Soil and Water Resources/ Faculty of Agriculture-University of Kufa.

The field was divided into three main plots with one meter apart and each plot was also divided into 12e experimental unit, so that the number of experimental units will be 36 pilot units The field was irrigated two days before planting using a drip irrigation system, after which the seeds were planted 10 cm apart on lines of 10 cm between each two lines. The planting was on 2/3/2018 and all crop service operations were carried out, including irrigation and manual weeding during the growing season (Mohammadi, 2017). The experiment was conducted to study the response of three basil plant varieties including sweet basil (V1), red basil (V2) and lemon basil (V3) to nitrogen fertilization from three different source; urea CO $(NH_2)_2$ containing 46% nitrogen (N1) sprayed on plant shoot at concentration of 400 mm, spraying 5% Nano-organic nitrogen liquid plus Optimus (N2) at concentration of 4 ml.L^{-1} and The biological nitrogen source (N3), *Azotobacter chroococccun* as one soil application during the growing season

Table 1 : Some Physical, Chemical and Biological Characteristics of Soil Experiment During Planting Season

NO	Type of analysis	Unit		Value
1	pH	-----		7.3
2	EC	Siemens		2.59
3	N	$Mg.L^{-1}$		0.72
4	P	$Mg.L^{-1}$		0.32
5	^{+}K	$Mmol.L^{-1}$		0.75
6	N^{+}	$Mmol.L^{-1}$		1.32
7	Ca^{+}	$Mmol.L^{-1}$		3.75
8	Mg^{+}	$Mmol.L^{-1}$		2.71
9	SO_4	$Mmol.L^{-1}$		2.62
10	Cl^{-}	$Mmol.L^{-1}$		4.39
11	HCO_3	$Mmol.L^{-1}$		0.32
12	CO_3	$Mmol.L^{-1}$		Nil
13	Organic matter	%		1.25
14	Texture	Clay	72	Mix sand
		Sand	718	
		Silt	210	

(Deshumukh *et al*., 2007), in addition to the control treatment (spraying with distilled water).

The experiment was factorial 3×4 based on Randomized Complete Block Design (RCBD) with three replicates of 12 experimental units for each factor (Al-rawy and Khalaf Allah, 2000). At the end of the experiment data (measurements) were collected including plant height (cm), Total number of leaves, number of branches (branch plant $^{-1}$), leaf area (cm) as average of three fully expanded leaves from each plant (Zaidi, 2016), dry matter (%) and vegetative yield per unit area (kg m^{-2}).

Results and Discussion

Relative to plant height, results showed that basil varieties differed between each other in their plant's height (Table 2). The highest plant height was (63.33 cm) was recorded in red basil treated with Nano-organic nitrogen (N2). It was also shown from the same table that all treatments with nitrogen fertilization were significantly higher than the control treatment. The height of the plants that were not treated with a nitrogen source (control treatment) was 51.59 cm.

In case of number of leaf/plant, the results in table (2) showed that the lemon basil variety had significantly higher number of leaves (61.9 leaf plant^{-1}) compared to 55.1 and 44.3 leaf plant^{-1} for the two varieties of red basil and sweet basil, respectively. The spray treatments N1 and N2 were also superior reaching 55.7 and 55.6 leaf plant^{-1} and significantly differed from the control treatment N0 of 51.0 leaf plant^{-1}.

Regarding the number of main branches/plant, there was no significant differences among the tested basil cultivars, as the number of branches reached 9.38, 9.19 and 9.07 branch plant¹ for both red and lemon basil and sweet, respectively. While it was noticeable that the two treatments with organic nitrogen plus Optimus N2 and the biological fertilizer treatment were significantly higher in the number of branches, reaching 9.32 and 9.29 branches plant^{-1}, respectively. The highest number of branches was recorded in the interaction treatments of V1N1 (9.44), V2N3 (10.23) and V3N1 (9.68).

The results in Table (2) showed that leaf area was also affected by plant variety. Lemon basil V3 recorded the largest leaf area of 10.61 cm and was significantly higher than the leaf area average of red basil V2 (9.65cm) and sweet basil V1 (8.38 cm). Nitrogen source diversity also had a significant effect in this plant trait. Although the three fertilizer types did not differed among each other in increasing plant leaf area, all of them resulted in significant increase in leaf area compared to the control sprayed with distilled water.

In case of shoot dry weight, basil varieties significantly differed among each other regardless type of nitrogen fertilizer (Table2). The red basil plants resulted in the highest dry weight followed by lemon basil and sweet basil, respectively. The results showed a significant increase in dry weight by treatments of organic nitrogen and bio-fertilization compared to conventional urea and the control treatments. Similarly, interaction between plant variety and nitrogen source type showed significant effect on plant dry weight. V2N2 and V1N2 resulted in significantly higher dry weight of 14.44% and 14.30%, respectively, compared to 11.66% for the control.

Regarding the total vegetative yield, results showed that different variety performed in different way (Table2). Regardless nitrogen source, the red basil showed the higher vegetative yield of 3.16 kg^{-2} compared with the production of lemon basil and sweet basil which yielded 2.82 kg m^{-2} and 2.75 kg m^{-2}, respectively. All the fertilizers types were effective in increasing the vegetative yield with regard to basil variety (Table2). The bio-fertilizer was the most effective when interacted with red and sweet basil resulting the highest yield of 3.33 kg m-2 and 2.85 kg m^{-2}, respectively, while the Nano-organic nitrogen was more effective when interacted with lemon basil and resulted in total vegetative yield of 3.35 kg m^{-2} which significantly differed from the control treatments of all basil varieties.

Table 2 : Effect of plant variety, source of nitrogen and their interactions on vegetative growth traits and total yield in basil *Ocimum basilicum*

Variety	Nitrogen source	Characteristics					
		Plant height (cm)	No. of leaf (leaf. plant^{-1})	No. of main branches	Leaf area cm^2	Dry weight %	Production k.m^2
Sweet basil	N0	44.53	42.2	9.33	7.04	11.66	2.53
	N1	46.82	44.4	9.44	9.01	11,83	2.60
	N2	47.30	48.4	8.98	8.01	14.30	2.70
	N3	49.22	42.5	8.54	9.45	12.57	2.85
Red basil	N0	59.84	49.9	8.30	8.72	12.80	3.27
	N1	62.73	60.8	9.41	9.26	12.53	3.11
	N2	66.84	52.5	9.46	10.10	14.44	3.04
	N3	63.94	56.9	10.23	10.53	13.69	3.33
Lemon basil	N0	50.39	60.9	9.28	9.00	11.84	2.54
	N1	51.82	62.0	9.68	11.14	11.85	3.08
	N2	50.28	65.7	9.52	11.56	12.46	3.35
	N3	50.31	58.9	9.00	10.73	13.67	2.66
L.S.D.$_{(P \leq 0.05)}$		4.104	11.95	4.10	1.131	0.960	0.960
mean Variety	Sweet basil	46.97	44.3	9.07	8.38	12.59	2.67
	Red basil	62.97	**55.1**	9.38	9.65	13.36	3.19
	Lemon basil	50.42	**61.9**	9.19	10.61	12.46	2.90
L.S.D.$_{(P \leq 0.05)}$		3.309	**11.99**	1.37	0.620	0.326	0.326
mean nitrogen source	N0	50.52	51.0	8.97	7.91	12.10	2.78
	N1	53.79	55.7	9.27	9.79	12.07	2.93
	N2	54.81	55.6	9.32	9.89	13.73	3.03
	N3	54.49	52.8	9.29	10.24	13.31	2.94
L.S.D.$_{(P \leq 0.05)}$		**2.16**	**3.97**	0.678	0.696	0.624	0.624

Discussion

It is noted from the above tables that both spraying with organic fertilizer Optmus and bio-fertilization in the characteristics of vegetative growth represented by plant height, number of branches, percentage of dry matter and amount of vegetative production per unit area . This is mostly due to organic fertilizers richness in water-soluble compounds, which directly or indirectly contribute to the growth of plants by enzymatic and/or hormonal actions (Ibrahem, 2017). The importance of liquid organic fertilizers is to improve the qualities of vegetative growth as it contains nutrients including nitrogen, carbon, organic acids and various amino acids. This will increase transforming simple elementary molecules by successive enzymatic reactions into biomolecules including RNA, DNA, proteins, and carbohydrates that are important to the living cell activities (Citak and Sonmez, 2010). It promotes cell division operations and building Plant tissues lead to increase leaf area (Walch *et al.*, 2000) and encourage lateral branching (Jackson, 1993), as well as stimulate the production of auxins, which elongate cells through increasing protein synthesis by activating mRNA activity or by increasing cell size (Asadi and Alkhani 2019). Such activities will be reflected in higher plant growth, which positively affects the increase in number and size of leaf cells resulting in an increase in the growth and size of total vegetative growth represented by plant height and leafy area (Mattsson and Schjoerring, 1997)

These results agreed with the findings of former studies (Amin, 2010; Khalid *et al.*, 2006; Salman, 2015; Abdul Amin, 2017) When spraying plants with minerals and humic fertilizer types and super humic 'Humus' resulted in significant increase in basil total growth and yield**.**

The superiority of bio-fertilizer treatment in vegetative growth, dry weight and vegetable yields may be attributed to the fact that the addition of bio-fertilizer *Azotobacter* has supply the nutrient needs of the plant element of nitrogen by working to fixation atmospheric nitrogen in the soil. This is important in influencing many physiological and biological processes within the plant. On the other hand, the bio-proven nitrogen is available in the form of ammonium is directly absorbed by the plant without the exchange of bio-energy, and transmitted in the form of amino acids leading to total bioactivity improvement (Taiz and Zeiger, 2006; Chiconato *et al.*, 2014; Mahmood and Salman, 2017)

Conclusion

The red basil cultivar was distinguished by the characteristics of the plant height and the percentage of dry matter and the greenery, whereas the lemon basil cultivar was distinguished by the number of leaves and the leafy area. The addition of *Azotobacter chroococccun* and organic fertilizer spraying had positive effects on most indicators of vegetative growth, dry weight and vegetative yield.

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