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المجلة العراقية لبحوث السوق
وحماية المستهلك

THE ROLE OF FOLIAR APPLICATION AND LIGHT INTENSITY ON THE FRESH AND DRY LEAVS YIELD OF PEPPERMINT

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ABSTRACT

A field experiment was conducted in a research station affiliated to the College of Agricultural Engineering Sciences - University of Baghdad, from March to Juley 2021. The study's objective was to investigate the effect of foliar application of the urea, nano-amino acids, and yeast extract, under two different lighting intensities on the growth and yield of leaves. The experiment included two factors: the environment type, involving an open field (100% lighting) and 50% shadow (50% lighting). The second factor included foliar spray of the yeast extract 5 and 7.5 g L^{-1}, 1000 and 2000 mg L^{-1} (as urea), and nano-amino acids 1 and 1.5 ml L^{-1} with half the amount of nitrogen and the entire recommended amount of N, P, K and treatment (full amount of N,P,K fertilizers). The experiment was conducted using the Randomized Complete Block Design (RCBD) according to the Nested system with three replicates. the results observed that cultivation under shade achieved a significant increase in plant height, number of branches, leaf area, and total chlorophyll (83.6 cm, 10.63 branch $plant^{-1}$ and 15.45 dm^2, 1.05 mg g^{-1} respectively), while the result was reversed in The fresh and dry yield of the leaves reached the highest at 100% lighting (1902.6 and 877.6 kg ha^{-1}, respectively),the concentration of N,P,K leaves. Results showed that all foliar spray treatments increased significantly compared to the control. The highest significant increase was from the two spray treatments, urea of 2000mgN L^{-1} and nano-amino acids of 1.5ml L^{-1} at the shadow plants for the traits, the plant height, number of branches, leaf area, and total chlorophyll content, while in the open field environment, recorded the highest fresh and dry yield of leaves(2007.8, and 995.2; 1955.1 and 957.7 kg ha^{-1} for the two treatments, respectively).

Keywords: peppermint, Foliar spray, Fresh leaves, Dry leaves, lighting intensity.

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دور الرش الورقي وشدة الإضاءة في النعناع الفلفلي وحاصل الأوراق الطري والجاف

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الخلاصة

أجريت تجربة حقلية على نبات النعناع الفلفلي في أحدى المحطات البحثية لكلية علوم الهندسة الزراعية- جامعة بغداد – للمدة من آذار- تموز ٢٠٢١ بهدف دراسة دور الرش الورقي لليوريا والأحماض الأمينية النانوية ومستخلص الخميرة تحت شدتي إضاءة مختلفة في النمو وحاصل الأوراق. تتكون التجربة من عاملين، الأول يمثل نوع البيئة: الحقل المفتوح (١٠٠٪ إضاءة) ، (٥٠٪ ظل ٥٠٪إضاءة) وتضمن العامل الثاني الرش الورقي مع إضافة الموصى به من التسميد الأرضي من الفسفور والبوتاسيوم ونصف الكمية من النتروجين مقارنة مع معاملة القياس اما معاملات الرش الاخرى فهي رش مستخلص الخميرة ٥ و ٧,٥غم لتر$^{-١}$ ، نتروجين ١٠٠٠و ٢٠٠٠ ملغم N لتر$^{-١}$ (بهيأة يوريا)، أحماض امينية نانوية ١ و ١,٥ مل لتر$^{-١}$. نفذت التجربة باستعمال تصميم القطاعات العشوائية الكاملة(RCBD) وفق نظام Nested بثلاثة مكررات. اظهرت النتائج أن الزراعة تحت الظل (٥٠٪إضاءة) حققت زيادة معنوية في ارتفاع النبات وعدد الأفرع والمساحة الورقية والكلوروفيل الكلي (٨٣,٦ سم و١٠,٦٣ فرع نبات$^{-١}$ و١٥,٤٥ دسم^{٢} ، ١,٠٥ ملغم غم$^{-١}$ بالتتابع) بينما ظهر العكس في الحاصل الطري والجاف للأوراق وبلغ أعلاه عند ١٠٠٪ اضاءة (١٩٠٢,٦ ، ٨٧٧,٦ كغم هـ$^{-١}$بالتتابع) وكذلك تراكيز مغذيات (N,P,K). لوحظ زيادة معنوية في معاملات الرش الورقي مقارنة بمعاملة القياس عند معاملتي الرش باليوريا(٢٠٠٠ ملغم N لتر$^{-١}$) والأحماض الامينية النانوية(١,٥ مل لتر$^{-١}$) في نباتات الظل لارتفاع النبات وعدد الأفرع والمساحة الورقية والكلوروفيل الكلي ، وفي بيئة الحقل المفتوح لحاصل الأوراق الطري والجاف(٢٠٠٧,٨، ٩٩٥,٢ و ١٩٥٥,١، ٩٥٧,٧ كغم هـ$^{-١}$ للمعاملتين بالتتابع).

الكلمات المفتاحية: النعناع الفلفي,الرش الورقي، الوزن الطري للاوراق، الوزن الجاف للاوراق، شدة الاضاءة.

INTRODUCTION

Medicinal plants are the primer source and basis for treating various diseases, directly as herbs or indirectly, through their involvement in manufacturing medicines used in traditional pharmacies or as a guide for constructing chemical compounds similar to that found in plants in terms of physiological and pharmacological effects. Among the medicinal plants that are characterized by many therapeutic and industrial benefits is peppermint (*Mentha piperita* L.), which belongs to the family, *Labiatae*. It is a perennial evergreen herbaceous plant, and the nature of its growth is creeper or erect. The Mediterranean basin is the original home of the plant, especially the southern part of the European continent and the northern part of the continent of African continent. The essential part of the plant is leaves, the main source of aromatic oil, which is medically industrially necessary, as the plant participates in medicines for colds and coughs. The aromatic oil is useful in expelling gases because it is rich in a menthol compound and industry, it is used in the preparation of perfumes, soaps, and some food products, such as sweets, to give them taste and flavor **(Halabo *et al*.,1995 ; Franz *et al* 2007)**.Because of the oil content of other compounds such as limonene, cineole, and others, it is added to medicines that cause diarrhea to prevent colic, and one of the most prominent industries that the plant is famous for is kinds of toothpaste for its anti-inflammatory effect on throat and pharynx infections**(Heikal, & Omar, 2012).**

Because of the importance of medicinal plants, it became necessary to develop the plant performance and its production under different light intensity conditions for its relation to the process of photosynthesis. Determining the optimal light intensity level is necessary because each plant grows ideally in light limits that differ from others. A high level of light intensity leads to a decrease in net photosynthesis, so shading is used **(Berenschot & Quecini, 2014)**. On the other hand, exposing plants to the low intensity of lighting leads to a decrease in the efficiency of photosynthesis and metabolism **(Wang *et elle*, 2013)**. Based on the aforementioned, several studies were conducted on this. At growing mint (*Mentha spicata* L.) under shade and sun, the plants grown under shade showed significant superiority in the percentage of chlorophyll a and b, total chlorophyll and carotenoids (0.89, 0.40, and 1.29 mg g^{-1}, respectively) compared to the plants grown in the sun, amounted to 0.80, 0.31, and 0.25 mg g^{-1}, respectively **(Patra *et al*., 2003). Ade-Ademilua *et al*. (2013)** noticed in their experiment when growing African basil (*Ocimum gratissimum* L.) under full sunlight and shade (44.2-26.7% of sunlight), that plants grown under shade and sun did not show significant differences in the plant height or leaf area, while the plants grown under the sun were significantly superior in increasing the fresh and dry weight of the plant, reaching 37 and 10.4 g plant^{-1} respectively, compared to the plants grown under shade (24 and 4.5 g plant^{-1}, respectively).

Chemical fertilization is one of the necessary treatments for increasing leafy crops production, but the increased use of chemical fertilizers has become a source of environmental pollution, especially when they are overused, in particular, the leafy crops fertilized with nitrogen, so it is necessary to ration the quantities with preserving the yield in quantity and quality, for achieving this aim, several studies were conducted using nutrients and stimulants as a foliar spray in limited quantities leading to encouraging results. **Mahmoodabad *et al*. (2014)** observed in their experiment on mint (*Mentha spicata* L) through foliar spraying with different concentrations of urea (1, 2, and 3%) that the 3% concentration had a significant superiority in the highest value of stem diameter (3.65 mm) compared to the control (2.7 mm), while the 2% concentration recorded a significant increase in the traits of leaf area and fresh plant weight (88.60 cm^2 and 942 g.m^{-2} respectively) compared to the control plants (77.3 cm^2 and 570 g. m^{-2} respectively).

The results obtained by **Al-Amrani *et al*., (2018)** confirmed the existence of significant differences between the peppermint plants (*Mentha piperita* L) treated with urea (1000 and 2000 mg L^{-1}) and the plants fertilized with whole soil fertilization (N, P, K), the plants treated with spraying 2000 mg.L^{-1} nitrogen plus whole soil P, K, and ¼ N were significantly superior in the plant height and number of branches per plant (46.50cm and 20.86 branches.plant^{-1}, respectively) compared with the control (44.39 cm and 20.39 branch.plant^{-1} respectively), while the treatment of spraying the concentration 1000 mg L^{-1} nitrogen plus soil P,k recorded

the highest average in leaf area, and dry weight (15.19 dm^2 and 15.2 gm $plant^{-1}$, respectively) compared to the control treatment (10.03 dm^2 and 12.95 g $plant^{-1}$, respectively).
Matter & ElSayed (2015), in their experiment on caraway plants (*Carum carvi*L.) sprayed with dry yeast extract (2 and 4 g L^{-1}), observed the plants with a concentration of 4 g L^{-1} were significantly superior in the plant height, number of branches, fresh and dry weight compared to control treatment. Hamed (2018) showed, in his experiment on mint (*Mentha spicata*L.Siwa), when spraying the plants with dry yeast extract (*Saccharomyces cerevisiae*) at different concentrations (0, 2, 4, and 6 g L^{-1}) that the plants sprayed with the highest concentration (6 gm L^{-1}) were significantly superior in the fresh and dry weight of plants (491.08, 390.77, 231.13 and 189.47 gm $Plant^{-1}$) and (127.60, 109.13, 71.05 and 56.80 gm $Plant^{-1}$) respectively for the first and second seasons of four cuts compared to the control treatment. (84.45, 103.33, 202.06, and 317.46 gm $Plant^{-1}$) and (25.04, 32.10, 56.08, and 82.04 gm $Plant^{-1}$), respectively. **Ostadi *et al*. (2020)** found a response of the mint plant (*Mentha piperita* L.) to spraying with nano-amino acids. they obtained a significant superiority in the plant height and number of leaves and branches (46.4 cm, 588 leaves $plant^{-1}$ and 19.3 branches $plant^{-1}$, respectively) compared to control plants. (40.3 cm, 440 leaves $plant^{-1}$, and 16 branches $plant^{-1}$, respectively). When spraying the Vinca plant (*Catharanthu srosus*) with two concentrations of amino acids (1 and 1.5 g L^{-1}), **Fetouh *et al*. (2016)** found that the concentrations 1.5 g L^{-1} recorded the highest average of the plant height and fresh and dry weight respectively compared to the control.
To increase the qualitative and quantitative yield of the peppermint plant with reducing the use of chemical fertilizers added to the soil, the study aimed to:
1- Find out the optimum light intensity for the growth of peppermint under the conditions of the central region of the country.
2- Increasing the quantitative and qualitative production through foliar spraying of urea, yeast and nano-amino acids in limited quantities with reducing soil nitrogen fertilizer by half to reduce environmental pollution and economic costs.

MATERIALS AND METHODS

The study was conducted at an agricultural station in College of Agricultural Engineering Sciences - University of Baghdad, during the period, from March to July 2021,In which environmental conditions were recorded (Table 1).The cuttings(semi-soft) were prepared prior to planting within plots, after successful growth of cuttings selected according to the homogeneity in length and root size, they were planted in the corridor (1 m width) with a distance of 40 cm between plants getting to 8 plants per the experimental unit . The field soil was analyzed to determine the chemical and physical characteristics (Table 2). Available nitrogen in the soil was determind to be subtracted from the fertilizer recommendation(243 kg N, 121 kg P, 60 kg K per hectare) according to the recommendation mentioned by Abu Zeid

(1992), Having the nitrogen amount modified, the whole amount of the adjusted nitrogen with phosphorus and potassium was added to the plants of the control treatments, and half of the amount of nitrogen (after modification) with the whole amount of phosphorus and potassium for foliar spray treatments.The experiment was factorial of two factors (14 treatments) conducted based on the Randomized Complete Block Design (RCBD) according to the Nested system with three replicates. The first factor (symbolized by E) was planting in two environments of lighting intensity: E1, planting in an open field (100% lighting), and E2 planting under shade (50% lighting); the second factor was the foliar spray of nitrogen (as urea), 1000 (U1) mg L^{-1} and 2000 (U2) mg L^{-1}, yeast extract 5 (Y1) g $L^{-1}$and 7.5 (Y2) g L^{-1}, nano-amino acids 1 (Am1) ml L^{-1} and 1.5 (Am2) ml L^{-1}, with adding the recommended amount of soil fertilization of whole of P and K and half amount of nitrogen compared to the control (full soil fertilization of NPK). The plants were sprayed accompanied with a Surfactants agent in the early morning (4 times) during the vegetative growth period (10 days between one spray and another), reaching the harvest (beginning of flowering). Soil nitrogen fertilizer was added to the soil in two batches, the first with P and K after planting the seedlings and the second 21 days after the first one.

Bread yeast was prepared by dissolving 5 and 7.5 g in a liter of distilled water at 32^{o}C (for the two concentrations of the experiment) with 1g of sucrose to increase the yeast activity , then kept in an incubator at 25 ^{o}C for two hours before spraying. Urea solution was prepared by dissolving 2.14 g of urea in 1 L of water to prepare 1000 mg N L^{-1} and the double quantity of urea (4.34 g) in 1 L of water to prepare 2000 mg N L^{-1}. Nano-amino acids (produced by the Commercial Agricultural Sciences Company Izmir - Turkey) were prepared by adding 1 ml to 1 liter of water to prepare the first concentration and adding 1.5 ml to 1 liter of water to prepare the second concentration.

The following parameters were measured: plant height (cm), number of branches (branch plant $^{-1}$), leaf area (dm^2. plants^{-1}), total chlorophyll (mg .g^{-1} fresh weight), N, P, K concentration in leaves, Fresh and dry leaf yield (kg ha^{-1}).

Table (1). Environmental conditions of the experiment field

Sun					Shade			
Month	Mean of 10 days	Maximum temperature ^{o}C	Minimum temperature ^{o}C	Solar illumination hours QF	Month	Mean of 10 days	Maximum temperature ^{o}C	Minimum temperature ^{o}C
March	1-10	24.9	9.24	8	March	1-10	23.1	8.21
	11-20	25.13	12.42			11-20	24.7	10.20
	21-31	26.01	12.61			21-31	24.1	10.31
April	1-10	30.6	14.01	9	April	1-10	29.6	13.11
	11-20	31.78	14.97			11-20	29.63	13.43
	21-30	38.76	21.22			21-30	37.38	20.10
May	1-10	38.29	21.24	11.3	May	1-10	36.14	20.12
	11-20	42.01	22.9			11-20	39.55	20.45
	21-31	41.72	23.06			21-31	39.37	22.01
June	1-10	42.15	22.9	12.1	June	1-10	41.7	21.3
	11-20	40.6	24.65			11-20	38.3	22.33
	21-30	46.51	25.12			21-30	44.26	24.01

Table (2): Chemical and physical properties of field soil

Measure Characteristics	Value	Measruing unit
Electrical Conductivity (EC)	2.23	ds m^{-1}
pH1:1	7.20	----------
Available nitrogen	40	mg kg^{-1}
Available phosphorous	20.7	
Available Potassium	73	
Organic matter O.M.	3.67	gm kg^{-1}
Mineral carbonate $CaCO_3$	79.5	g Kg^{-1}
Dissolved Calcium Ca^{-2}	12.8	meq L^{-1}
Dissolved MagnesiumMg^{+2}	6.7	
Dissolved SodiumNa^{+}	3.75	
Bicarbonate	1.45	
Dissolvedchlorine	16.02	
dissolved potassiumK	0.87	
Sand	740.8	Soil g kg^{-1}
Clay	135.0	
Silt	124.2	
Texture	sandy loam	-------------

RESULTS AND DISCUSSION

Results in Table 3 refer to the prominent significant role of the study factors in the, plant height, number of branches, and leaf area. The plants grown under 50% lighting (E2) recorded the highest values of plant height, number of branches and leaf area (83.67 cm, 10.63 branches. $plant^{-1}$, and 15.45 dm^2, respectively) compared to the open field E1 (50.10 cm, 9.10 branches.$plant^{-1}$, and 10.63 dm^2, respectively).

As for the foliar spray treatments, there were significant differences among them. The highest values of the traits above were from the two treatments, urea (U2) and nano-amino acids Am2 (76.08 and 72.81 cm; 10.48 and 10.22 branches.$plant^{-1}$; 13.63 and 13.42 dm^2, respectively) compared to the lowest values of the plant height and number of branches was recorded at the control (58.77 cm and 9.22 branches.$plant^{-1}$, respectively) and the leaf area recorded by control treatmentsand the yeast (Y1) (12.6 and 12.58 dm^2, respectively).

The significant differences among the treatments of lighting intensity and foliar spray led to a significant effect of the interaction on the studied traits. The highest values of the plant height, number of branches and leaf area were recorded from the interaction of each of urea (U2) and nano-amino acids (Am2) with the shadow E2 (94.65 and 89.58 cm; 11.6 and 10.91 branches. $plant^{-1}$; 16.22 and 15.96 dm^2, respectively) compared to the lowest values obtained from the two of control and yeast (Y2).

Table (3): Effect of the environment type and spraying with yeast extract, urea and nano-amino acids on the plant height, number of branches and leaf area of *Mentha piperita* L.

Trait	**Plant height (cm)**			**Number of branches (branches. plant^{-1})**			**Leaf area (dm^2)**		
Foliar spray	**Environment type**		**Mean**	**Environment type**		**Mean**	**Environment type**		**Mean**
	E1	E2		E1	E2		E1	E2	
Control	٤٥,٠٧	72.48	٧٧.٥٨	8.23	21.10	9.22	10.66	14.66	12.66
Y1	٤٥,٢٢	75.33	٢٨.٦٠	٨.63	10.35	9.49	10.19	14.98	12.58
Y2	٥٥,٦١	84.42	٧٠,٠٢	٩.16	10.64	9.90	10.58	15.40	12.99
U1	٤٥,٨٠	86.90	66.35	9.35	10.78	10.06	10.72	15.78	13.25
U2	٥٧,٥٩	94.56	76.08	٩.89	11.06	10.48	10.05	16.22	13.63
Am1	٤٥,٤١	82.39	63.90	8.90	10.49	9.69	10.32	15.14	12.73
Am2	٥٦,٠٣	89.58	72.81	9.53	10.91	10.22	10.88	15.96	13.42
L.S.D	5.96			0.04			0.26		
Mean	٥٠,١٠	٨٣.67		9.10	10.63		10.63	15.45	
L.S. D	5.14		3.35	0.02		0.07	0.15		0.18

Among the traits studied in our research correlated to the foliar spray treatments was the variance in nutrient elements (N, P and K) percentage. Results in Table 4 show that nutrient elements percentage were affected by the lighting intensity as the plants grown under the sun (open field E1) recorded the highest percentage of them, reaching 1.73, 0.38, and 2.69%, respectively, compared to the shadow plants (1.47, 0.30 and 2.49 %, respectively).

Concerning the foliar spray treatments, the highest of N, P, K was recorded at the treatment of spraying urea U2 (1.71, 0.45 and 2.72%, respectively) followed by the nano-amino acid (Am2) (1.67, 0.42 and 2.69%, respectively).

Regarding the interaction treatments, the plants grown in the open field (E1) treated with urea (U2) recorded the highest percentage of the elements (1.84, 0.49 and 2.83 %, respectively) followed by the plants treated with the nano-amino acids (Am2) at the same environment (1.80, 0.45, and 2.78% respectively) while, the lowest percentages of them were recorded in the control plants grown in the shadow environment E2 (1.34, 0.19 and 2.35 %, respectively)

Table (4). Effect of the environment type and spraying with yeast extract, urea, and nano-amino acids on the percentage of nitrogen, phosphorus, and potassium in the leaves of *Mentha piperita* L.

Trait	**Nitrogen (%)**			**Phosphorus (%)**			**Potassium (%)**		
Foliar spray	**Environment type**		**Mean**	**Environment type**		**Mean**	**Environment type**		**Mean**
	E1	E2		E1	E2		E1	E2	
Control	1.62	1.34	1.48	0.26	0.19	0.23	2.55	2.35	2.45
Y1	1.66	1.39	1.53	0.31	0.22	0.27	2.59	2.38	2.49
Y2	1.73	1.47	1.60	0.38	0.31	0.35	2.68	2.59	2.59
U1	1.76	1.51	1.63	0.42	0.34	0.38	2.72	2.63	2.63
U2	1.84	1.58	1.71	0.49	0.41	0.45	2.83	2.74	2.74
Am1	1.70	1.42	1.56	0.35	0.26	0.31	2.64	2.53	2.53
Am2	1.80	1.54	1.67	0.45	0.38	0.42	2.78	2.69	2.69
L.S.D	0.015			N.S			0.014		
Mean	1.73	1.47		٠.38	0.30		2.69	2.49	
L.S.D	0.012		0.009	0.009		0.009	0.011		0.008

It is clear from the results in Table 5 that the plants grown under 50% shade (E2) had the highest content of total chlorophyll (1.05 mg. g^{-1}) compared to the plants grown in the open field (E1) recording 0.68 mg. g^{-1} .On the contrary, in the yield of fresh and dry leaves, the open field plants(E1) recorded a significant superiority reached 1902.6 and 877.6 kg ha^{-1} compared to the plants of shade 50% (E2) that recorded 1650.9 and 639.3 kg ha^{-1}.

Regarding the foliar spray treatments, there were obvious significant differences. Urea spray treatment (U2) recorded the highest total chlorophyll content, fresh and dry yield of leaves (1.11 g.mg^{-1}, 1879.3 kg.ha^{-1} and 857.0 kg.ha^{-1} respectively) followed by the spraying nano-amino acids Am2 (1.03mg.g^{-1}, 1809.7kg.ha^{-1}, and 820.1kg.ha^{-1} respectively).

Results of the same table refer to the superiority of the foliar spray treatments at various environmental conditions (lighting intensity). The plants in 50% shadow (E2) recorded the highest chlorophyll content at the two foliar spray treatments, spraying urea (U2) and nano-amino acids Am2 (1.31 and 1.22 g.mg^{-1} respectively). The highest values of the fresh and dry yield of leaves were recorded at the interaction of the plants grown in the open field (E1) with urea spraying U2 (2007.8 and 995.2 kg.ha^{-1} respectively) and with Am2 (1955.1 and 957.7

kg.ha^{-1} respectively), while the lowest values of the fresh and dry leaf weight were at the control in the shadow environment E2 (1559.5 and 522.0 kg ha^{-1} respectively) .

Table (5): Effect of the environment type and spraying with yeast extract, urea, and nano-amino acids on the total chlorophyll content the fresh and dry weight of leaves of *Menthapiperita* L.

Trait	**Total chlorophyll**			**fresh Leaf weight (kg.ha^{-1})**			**dry Leaf weight (kg.ha^{-1})**		
Foliar spray	**Environment type**		**Mean**	**Environment type**		**Mean**	**Environment type**		**Mean**
	E1	E2		E1	E2		E1	E2	
Control	0.41	0.77	0.59	1814.2	1559.5	1686.9	749.3	522.0	635.7
Y1	0.54	0.85	0.69	1835.0	1621.8	1728.4	811.2	602.1	706.7
Y2	0.69	1.05	0.87	1921.2	1636.8	1779.0	910.6	632.3	771.5
U1	0.76	1.14	0.95	1886.5	1674.4	1780.5	863.3	662.2	762.8
U2	0.91	1.31	1.11	2007.8	1750.8	1879.3	995.2	718.7	857.0
Am1	0.61	0.98	0.79	1898.4	1648.7	1773.5	856.0	655.0	755.5
Am2	0.85	1.22	1.03	1955.1	1664.2	1809.7	957.7	682.5	820.1
L.S.D	0.019			47.2			32.1		
Mean	٠.68	١.05		1902.6	1650.9		877.6	639.3	
L.S.D	0.007		0.014	36.9		29.2	18.5		22.4

From the aforementioned, we notice that plants in the shade (50%) were superior in plant height, which occurred due to the phytochrome, which participates in the photosynthesis process, as a form of phytochrome red(pr) at a light and when there is a lack of light or shading, it turns into phytochrome over red cytochrome(pfr) affecting the growth of plants so that their stems elongate and reach the more light to perform the rest plant functions in food synthesis **(Taiz & Zeiger, 2010)** accompanied by an increase in the number of branches and the leaf area affected by shadow may be due to the increase in the leaf cell size, which in its turn affects through increasing the leaf tissue area to expand the area leaves intercepting the light to increase photosynthesis and also to compensate for the deficiency in the photosynthesis products**(Deraman *et al*, 2019)** .. Also, the increase in the chlorophyll content in the plants grown in shadow is due to the increase in substances that are directed to synthesize chlorophyll in a low-light environment to use the available light to the maximum extent, so that the plants' absorption for light is improved by increasing the pigment density per leaf area unit as physiological responses at the level of leaves and chloroplasts **(Wittmann *et al*, 2001).** The situation was reverse in the fresh and dry yield of the leaves, as it increased in the open field plants (100%), which may be due to the higher net metabolism due to the greater light abundance and the appropriate environmental conditions to increase the fresh and dry yield (Table 1).

From the previous results, we notice that all foliar spray treatments were superior in the studied traits tables (3,4,5), except for the leaf area that decreased in the yeast treatment (Y1). The increase in these traits at treated with urea (especially U2) may be attributed to the role of nitrogen in structure chlorophyll using four N atoms with an Mg atom, leading to an increase in chlorophyll content (chlorophyll association with photosynthesis) and reflecting on the traits of vegetative growth as well as the N participating in structure cell membranes and vitamins such as vitamin B, which contributes to increasing the leaf area and the number of lateral branches **(Ghareeb, 2019)**. Among the physiological effects of nitrogen which involvement in Synthesis nucleic acids RNA and DNA, organic compounds such as amino acids, stimulation of enzymatic systems, as well as cell division and elongation**(Al-Amrani *et al*., 2018; Burhan & AL-Hassan ٢٠١٩)**,which are essential for the development of vegetative traits, including leaf areas associated with photosynthesis, especially at the increase of chlorophyll content, leading to increasing the plant height and number of branches. The N importance comes from its involvement in synthesizing growth hormones, auxins, and cytokinin's, as well as proteins, as they are essential in regulating tissue building and the development of vegetative growth through cell division and elongation which increases growth **(Al-Khafaji, 2014)** represented by plant height, number of branches, leaf area, and fresh and dry weight of the plant. Spraying urea also has a role in increasing the nutrient elements by providing the leaves with nitrogen directly through leaves because urea is characterized by its small molecule size, high solubility, non-polarity, and high nitrogen content **(Taleb &Al-Amiry, 2017**), or indirectly by increasing the vegetative growth resulting in increasing the need for absorbing more amounts of nutrient elements to build the plant tissues and increasing the percentage of N, P, and K .

In amino acid treatments, the increase in growth traits may be due to their role in protein and enzymes synthesis **(Faraj & Shaker, 2011)**.and preserving metabolism products from degradation, Glycine (an amino acid), for instance, inhibits photorespiration in C3 plants (including mint), asparagine and glutamine are essential in linking the two metabolic cycles in plants (carbon and nitrogen), they affect both sugars and proteins **(Taiz & Zeiger, 2010).**

Amino acids also improve the absorption of plant nutrients, stimulate plant growth, regulate biological processes, as well as enhance enzymatic activity, and increase metabolism **(Talaat *et al*. 2014, Al-asadi & Al-jebory, 2020)**, which reflects on increasing the content of elements (N, P, K) and vegetative growth traits, especially the fresh and dry yield of leaves, as well as the indirect effect of participating amino acids in providing nitrogen and constructing proteins necessary for the construction of plant hormones and their role in plant growth and development **(Mohamed *et al*., 2020).**

Regarding the effect of yeast, especially the second concentration, Y2 (7.5 gm L^{-1}), the reason behind the increase in the study traits may be attributed to the yeast content of hormones, in particular cytokines, vitamins, enzymes and amino acids, as well as the content of minerals (P, K, Mg, Ca, and Fe) and their role with other compounds in synthesizing proteins and in cell division and elongation and chlorophyll formation **(Shehata *et al*., 2012; Bevilaqua *et al* 2008; Abdul-Qader & Rabie,٢٠١٩)**, which leads to increasing growth and developing the vegetative traits and plant yield of leaves. Because of the yeast content of gibberellin, which, along with cytokinins, plays a prominent role in cell division and elongation, resulting in an increase in plant height; moreover, the yeast contains the enzyme Trehalose-6-phosphate, which manufactures Trehalose, which is necessary for plant growth **(Marzauk *et al* 2014; Ateah *et al*., 2010)**.Concerning the increase in the accumulation of elements affected by yeast, it may be due to the elements that the yeast supplies in addition to growth hormones, which work to attract nutrients and increase photosynthesis, which reflects in improving the growth characteristics **(Al-Badri, 2019).**

CONCLUSION

Determining the lighting intensity is necessary for obtaining the best plant production, especially leafy crops, as it is closely related to the photosynthesis process, furthermore foliar spraying, according to our study, can compensate for soil fertilization by 50% with an encouraging increase in yield, as well as reducing environmental pollution and economic costs.

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