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Research article

Foliar application of low-biuret urea and humic acid influences on the growth and leaf mineral composition of Nonpareil almond seedlings under South Sinai conditions

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Abstract

A field experiment was conducted on almond seedlings (*Prunus amygdalus* B.) cv. Nonpareil to study the effect of low-biuret urea (LBU) and humic acid foliar spray on growth and leaf nutrient status at two seasons (2014 and 2015) in El Tor, South Sinai governorate, Egypt. There were nine treatments namely, T1- Control, T2- 2 g/L LBU, T3- 3 g/L LBU, T4- 2 g/L humic acid, T5- 3 g/L humic acid, T6- 2 g/L LBU +2 g/L humic acid, T7- 2 g/L LBU +3 g/L humic acid, T8- 3 g/L LBU +2 g/L humic acid and T9- 3 g/L LBU + 3 g/L humic acid with three replications under randomized complete block design, five seedlings were considered a replicate. The results indicated that the maximum stem length (127.90 and 128.28 cm), stem diameter (27.21 and 28.33 mm), leaf area (3.35 and 3.43 cm^2), shoot fresh weight (58.52 and 72.19 g) and shoot dry weight (59.06 and 61.93 g) during 2014 and 2015 season, respectively were recorded in T8 treatment. Maximum number of branches (24.21 and 29.20 / seedlings), number of leaves (335.20 and 386.20 / seedlings), leaf fresh weight (53.98 and 57.16 g) and leaf dry weight (44.98 and 47.46 g) in the first and second seasons, respectively were recorded in T9. It was found that, spraying with humic acid and urea at all concentrations significantly increased leaf macro and micro-elements. Maximum leaf nitrogen content was also recorded in T9 treatment (1.70 and 1.74 %) during two seasons, whereas the highest leaf P content (1.30 and 1.43 %), leaf K content (2.23 and 2.60 %), leaf Mg content (0.24 and 0.25 %), leaf Ca content (2.10 and 2.28 %), leaf Fe content (253.01 and 255.70 ppm), leaf Zn content (27.64 and 28.89 ppm) and leaf Mn content (64.14 and 65.91 ppm) were recorded in T8 in almond seedlings variety Nonpareil.

Key words: Almond, LBU, humic acid, growth, leaf nutrient, seedlings.

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1. Introduction

The almond (*Prunus dulcis*, syn. *Prunus amygdalus*, or *Amygdalus communis*) is a small decidious tree belonging to the subfamily, Prunoideae of the family, Rosaceae. Almonds are one of the oldest commercial nut crops of the world; from the Middle and West Asia, it has diffused to other regions and continents which include the Middle East, China, the Mediterranean region and America [1]. Almond kernels are concentrated sources of energy with a significant share of fat, protein, and fiber. Fats are primarily nonsaturated, mostly oleinic and linoleic fatty acids. Nonsaturated fatty acid is important in maintaining low cholesterol levels in the blood and significant amount of micronutrients [2].

Nitrogen is the key component in mineral fertilizers; it has more influence on tree growth, appearance and fruit production/quality than any other element [3]. In young trees, N fertilizers can favour vegetative growth and decrease flower induction [4]. Excess nitrogen application enhances vegetative tree growth and may cause groundwater contamination if leached with excess irrigation and/or rainfall [5]. However, it affects the absorption and distribution of practically all other elements [3]. Foliar N fertilization offers an opportunity to apply a significant portion of the total tree N needs in a more efficient manner than traditional flood or ground applications [6]. Low-biuret urea (LBU) is the best choice for foliar applications on high value horticultural crops. LBU sources have been applied as the foliar component of a typical N application program. Jones and Embleton [7-8] foliar application of low-biuret urea (LBU) below 0.5 % has produced its value and thus has become quite common to spray on large scale citrus plantation in the world as supplemental supply of nitrogen without any phytotoxic effects. Foliar application of LBU improves growth and leaf mineral content and yield as reported by [9].

Humic acids are the main fractions of humic substances and the most active components (65-70 %) of soil and compost organic matter. Humic acids have been shown to stimulate plant growth and consequently yield by acting on mechanisms involved in: cell respiration, photosynthesis, protein synthesis, water and nutrient uptake, enzyme activities [10]. Humic acid is particularly used to decrease the negative effects of chemical fertilizers and could have beneficial effect on the nutrition of the plant [11]. The commercial humic acids were found to improve growth, yield production, quality and increased significantly in the accumulation of N, P, K, Ca, Mg, Fe, Zn and Mn in tissues of some crops [12-15].

Therefore, the present investigation aimed to increase growth and improving nutrient status of almond seedlings by fertilization with low-biuret urea and humic acid in El Tor, South Sinai governorate, Egypt.

2. Materials and Methods

The experiment was conducted during two successive seasons of 2014 and 2015 in a private orchard at El Tor, South Sinai governorate, Egypt on two year old almond seedlings (*Prunus amygdalus* B.) cv. Nonpareil budded on bitter almond rootstock and grown in sandy soil (soil chemical properties are shown in Table 1). The almond orchard was planted at 5X5 meters apart (168 seedlings / fed) under drip irrigation system (well water analysis is shown in Table 2). The normal horticultural practices were adopted. Eight treatments were designed and treatments were arranged in randomized complete block design with three replicates for each treatment and each replicate was represented by five seedlings.

The following treatments were carried out:
T1- Control (spraying with water).
T2- 2 g/L LBU.
T3- 3 g/L LBU.
T4- 2 g/L Humic acid.
T5- 3 g/L Humic acid.
T6- 2 g/L LBU + 2 g/L Humic acid.
T7- 2 g/L LBU + 3 g/L Humic acid.
T8- 3 g/L LBU + 2 g/L Humic acid.
T9- 3 g/L LBU + 3 g/L Humic acid.
The treatments were sprayed twice at the end of April and two weeks later in each season. At the end of August, stem length (cm) and diameter (mm), leaves and branches numbers/seedling; leaves fresh and dry weights (g) and shoot fresh and dry weights (g) were determined. Leaf area (cm^2) was measured by using Cl-202 portable laser leaf area meter. Leaf chlorophyll content was measured in the field by using chlorophyll meter model SPAD- 502. Leaves samples were picked from each treatment washed and dried at 70°C till a constant weight for determination of the following nutrient elements (percentage as dry weight) N, P, K, Mg, Fe, Mn and Zn according to [16].
All data were subjected to analysis of variance (ANOVA) as described by [17] and the least significant differences (L.S.D) was used to compare between treatment means separated using Duncan's Multiple Range Test (DMRT) at probability of 5%.

Table 1. Chemical properties of the experimental soil

Soil depths (cm)	pH (1:2.5)	EC(1:5) dSm^{-1}	Soluble cations (meq/L)				Soluble anions (meq/L)			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{--}
0-30	9.4	0.34	1.5	0.5	1.2	0.25	-	0.6	1.25	1
30-60	8.5	1.5	11.5	2.5	0.8	0.39	-	4.5	1.6	9.69

Table 2. Chemical analysis of water irrigation

pH (1:2.5)	EC(1:5) dSm^{-1}	Cations (meq/L)				Anions (meq/L)			
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
8.15	0.7	2	1	3	0.2	-	1	4	2.2

3. Results and Discussion

Vegetative Growth: Data presented in Tables 3 and 4 show the effect of foliar with LBU and humic acid and their interaction on vegetative growth measurements of Nonpareil almond seedlings. Data illustrated that all aspects of vegetative growth were affected by different treatments under study.

Stem Length: Regarding LBU treatment, 3 g / L gave the highest significant value (117.96 and 120.74 cm) in 2014 and 2015 season respectively. Concerning humic acid treatment, 3 g/L gave the highest significant value (118.64 and 125.51 cm) in both seasons respectively. The interaction between the two studied factors, revealed that treatment of 3 g/L LBU plus 2g/L humic acid attained the highest significant value (127.90 and 128.28 cm) in the first and second seasons respectively.

Stem Diameter: Data in Table 3 revealed that different treatments increased stem diameter of Nonpareil cv., regarding LBU treatment, 3 g/L gave the highest significant value (23.19 and 24.33 mm) during 2014 and 2015 season respectively. Concerning humic acid treatment, 3 g/L gave the highest significant value (25.68 and 26.07 mm) in both seasons respectively. The interaction between the two studied factors cleared that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (27.21 and 28.33 mm) in the first and second seasons respectively.

Number of Branches / seedling:
Obtained data in Table 3 show that, LBU 3 g/L gave the highest significant value (21.43 and 24.20 / seedlings) in both 2014 and 2015 seasons respectively. 3 g/L humic acid gave the highest significant value (22.76 and 25.53 / seedlings) during 2014 and 2015 seasons, respectively. The interaction between the two studied factors showed that treatment of 3 g/L LBU plus 3 g/L humic acid gave the highest significant value (24.21 and 29.20 / seedlings) in the first and second seasons respectively.

Number of Leaves / seedling: Regarding LBU treatment, 2 g/L gave the highest significant value (328.11 / seedlings) in the first. In the second season 3 g/L LBU gave the highest significant increment in leaf number/ seedlings (329.09 / seedlings). Concerning humic acid treatment, 3 g/L gave the highest significant increment in leaf number/ seedlings (307.33 and 360.93 / seedlings) in the first and second seasons respectively. The interaction between the two studied factors, revealed that treatment of 3 g/L LBU plus 3 g/L humic acid attained the highest significant value (335.20 and 386.20 / seedlings) in the first and second seasons respectively (Table 3).

Leaf Area: Results in Table 3 indicated that, LBU 3 g/L gave the highest significant value (2.67 and 2.84 cm^2) in both 2014 and 2015 seasons respectively 3 g/L. Humic acid gave the highest significant value (2.82 and 2.93 cm^2) during 2014 and 2015 seasons respectively. The interaction between the two studied factors showed that treatment of 3 g/L LBU plus 2 g/L humic acid gave the highest significant value (3.35 and 3.43 cm^2) in the first and second seasons respectively.

Total Chlorophyll: From Table 4 it can be noticed that LBU 3 g/L gave the highest significant value (29.78 and 35.43) in both 2014 and 2015 seasons respectively. Humic acid 3 g/L gave the highest significant value (42.36 and 42.59) during 2014 and 2015 seasons respectively. The interaction between the two studied factors showed that treatment of 3 g/L LBU plus 3 g/L humic acid gave the highest significant value (43.78) in the first. In the second season 2 g/L humic acid plus 3 g/L urea gave the highest significant value (43.89).

Leaf Fresh Weight (LFW): Regarding LBU treatment, 3 g/L gave the highest significant value (43.97 and 38.99 g) during 2014 and 2015 seasons, respectively. Concerning humic acid treatment, 3 g/L gave the highest significant increment in leaf fresh weight (48.56 and 44.9 g) in the first and second seasons respectively (Table 4). The interaction between the two studied factors, revealed that treatment of 3 g/L LBU plus 3 g/L humic acid attained the highest significant value (53.98 and 57.16 g) in the first and the second seasons respectively.

Leaf Dry Weight (LDW): Concerning LBU treatment, 3 g/L gave the highest significant value (43.97 and 38.99 g) during 2014 and 2015 seasons respectively. Regarding humic acid treatment, 3 g/L gave the highest significant increment in leaf dry weight (37.96 and 37.90 g) in the first and second seasons respectively. The interaction between the two studied factors, revealed that treatment of 3 g/L LBU plus 3 g/L humic acid attained the highest significant value (44.98 and 47.46 g) in the first and second seasons respectively (Table 4).

Shoot Fresh Weight (SFW): Regarding LBU treatment, 3 g/L gave the highest significant value (42.26 and 51.18 g) during 2014 and 2015 seasons respectively. Concerning humic acid treatment, 3 g/L gave the highest significant increment in shoot fresh weight (49.51 and 53.45 g) in the first and second seasons, respectively. The interaction between the two studied factors, revealed that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (58.52 and 72.19 g) in the first and second seasons respectively (Table 4).

Shoot Dry Weight (SDW): Obtained data in Table 4 show that, LBU 3 g/L gave the highest significant value (42.41 and 45.95 g) in both 2014 and 2015 seasons, respectively. Humic acid 3 g/L gave the highest significant value (50.33 and 50.53 g) during 2014 and 2015 seasons respectively. The interaction between the two studied factors showed that treatment of 3 g/L LBU plus 2 g/L humic acid gave the highest significant value (59.06 and 61.93 g) in the first and second seasons respectively.

These results are in harmony with those obtained by [13,15,18] who reported that foliar application of humic acid resulted in increment of plant height, lateral shoot number per plant, leaves number per plant, stem diameter, leaf area and total leaf chlorophyll content, also it increased leaves dry weight % comparing with the control.

The enhancement in all aspects of vegetative growth may be attributed to its effects of application with humic acid and urea in stimulating biosynthesis of organic materials especially carbohydrates and the role of nitrogen as a constituent of amino-acids and proteins, protoplasm, enzymes and organic compounds as nucleoproteins as well as its important role in encouraging cell division and the development of meristematic tissues and can give an explanation for N action on growth characteristics. Also, the effect of nitrogen as a constituent of pyrimidine which plays an important role in chlorophyll synthesis is suggested on acceptable explanations for the increase leaf chlorophyll content with increasing the concentration of urea [19]. Moreover, increasing total leaf chlorophyll content led to increase in the photosynthesis and respiration rates, which regulates various growth processes in plant. On the other hand, the least growth in the control was probably due to N deficiency which could probably reduce number of functional leaves and subsequently the photosynthetic efficiency. Okwuowulu [20] had also reported that unfertilized plants had lower leaf area and this was due to less number of leaves. The number of leaves per plant was dependent on fertilizer rate as it increased with increasing fertilizer rate. This observation is in agreement with the findings of [21] who reported that increasing level of

Table 3. Effect of foliar with LBU and humic acid on stem length, stem diameter, number of branches, number of leaves/seedling and leaf area of Nonpareil almond seedlings during 2014 and 2015 seasons

Treatments	Stem Length (cm)		Stem Diameter (mm)		No. of branches/seedling		No. of leaves/seedling		Leaf area (cm^2)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1- Control	114.52	119.10	20.97	21.41	18.69	18.82	250.84	230.46	2.56	2.68
T2- 2 g/L LBU	114.58	119.55	22.52	22.66	19.69	23.20	328.11	306.11	2.64	2.80
T3- 3 g/L LBU	117.96	120.74	23.19	24.33	21.43	24.20	312.16	329.09	2.67	2.84
T4- 2 g/L Humic	118.10	124.12	24.97	25.00	22.69	22.82	275.35	349.12	2.76	2.87
T5- 3 g/L Humic	118.64	125.51	25.68	26.07	22.76	25.53	307.33	360.93	2.82	2.93
T6- 2 g/L LBU + 2 g/L Humic	118.51	125.76	25.85	26.53	23.19	25.48	286.89	325.25	3.01	3.13
T7- 2 g/L LBU + 3 g/L Humic	120.00	119.37	25.09	26.74	23.68	24.25	279.12	280.99	3.00	3.25
T8- 3 g/L LBU + 2 g/L Humic	127.90	128.28	27.21	28.33	24.03	26.53	275.28	337.74	3.35	3.43
T9- 3 g/L LBU + 3 g/L Humic	121.24	126.33	26.19	26.66	24.21	29.20	335.20	386.20	3.07	3.23
LSD value at 0.05	13.46	6.02	6.19	4.68	6.71	6.17	114.3	71.51	0.05	0.08

Table 4. Effect of foliar with LBU and humic acid on total chlorophyll, leaf fresh weight, leaf dry weight, shoot fresh weight and shoot dry weight of Nonpareil almond seedlings during 2014 and 2015 seasons

Treatments	Total chlorophyll		L.F.W (g)		L.D.W (g)		S.F.W (g)		S.D.W (g)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T1- Control	28.31	28.35	23.07	27.70	18.24	24.07	34.39	46.99	35.57	39.48
T2- 2 g/L LBU	28.85	30.08	36.28	35.07	27.14	29.83	36.44	50.82	35.92	39.69
T3- 3 g/L LBU	29.78	35.43	43.97	38.99	30.02	32.65	42.26	51.18	42.41	45.95
T4- 2 g/L Humic	36.01	40.28	35.36	41.99	32.30	37.32	45.35	52.91	44.00	49.35
T5- 3 g/L Humic	42.36	42.59	48.56	44.90	37.96	37.90	49.51	53.45	50.33	50.53
T6- 2 g/L LBU + 2 g/L Humic	44.16	43.02	43.72	45.77	38.22	39.36	55.24	53.81	51.56	51.35
T7- 2 g/L LBU + 3 g/L Humic	43.69	43.71	50.54	54.04	40.88	45.67	55.67	65.98	50.31	52.38
T8- 3 g/L LBU + 2 g/L Humic	44.28	43.89	51.47	55.50	43.55	47.34	58.52	72.19	59.06	61.93
T9- 3 g/L LBU + 3 g/L Humic	43.78	43.75	53.98	57.16	44.98	47.46	53.95	61.31	53.71	59.73
LSD value at 0.05	3.99	3.70	8.56	6.81	7.77	7.04	8.17	12.70	8.31	10.19

fertilizer application was observed to increase growth and excessive leaves.

Nutrition Status: Data in Tables 5 and 6 show the effect of spraying with LBU and humic acid on nutrition status of seedlings almond Nonpareil cv. in 2014 and 2015 seasons. It is obvious from the obtained data that single or combined application of LBU and humic acid significantly improved nutrition status.

Leaf Macro-Elements

Leaf Nitrogen (N) Content: Obtained data in Table 5 indicated that LBU alone and humic acid alone increased N percentage in leaves compared with control. Moreover, the combined application of LBU at 3 g/L plus humic acid at 3 g/L gave the highest significant value (1.70 and 1.74 %) in the first and second seasons respectively.

Leaf Phosphorus (P) Content: Regarding LBU treatment, 3 g/L gave the highest significant value (0.96 and 1.08 %) during 2014 and 2015 seasons respectively. Concerning humic acid treatment, 3 g/L gave the highest significant increment leaf P content (0.98 and 1.12 %) in the first and second seasons respectively. The interaction between the two studied factors revealed that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (1.30 and 1.43 %) in the first and second seasons respectively.

Leaf Potassium (K) Content: Data in Table 5 indicated that foliar application of Nonpareil almond seedlings with LBU and humic acid alone or combined led to obvious significant increase in the leaf potassium content. The highest significant values were obtained by combined treatment of 3 g/L LBU plus 2 g/L humic acid (2.23 and 2.60 %) in the first and second seasons respectively.

Leaf Magnesium (Mg) Content: From data in Table 5, it is noticed that highest significant values were obtained by combined treatment of 3 g/L LBU plus 2 g/L humic acid (0.24 and 0.25 %) in the first and second seasons respectively. Moreover, results showed no significant between different concentrations of LBU or humic acid alone in both seasons.

Leaf Micro-Elements:

Leaf Calcium (Ca) Content: Concerning LBU treatment, 2 g/L gave the highest significant value (1.90 %) in the first. In the second season 3 g/L gave the highest significant value (2.02 %). Regarding humic acid treatment, results showed no significance between different concentrations of humic acid alone in both seasons. The interaction between the two studied factors revealed that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (2.10 and 2.28 %) in the first and second seasons respectively (Table 6).

Leaf Iron (Fe) Content: Regarding LBU treatment, 3 g/L gave the highest significant value (206.72 and 209.40 ppm) during 2014 and 2015 seasons respectively. Concerning humic acid treatment, 3 g/L gave the highest significant increment leaf iron content (246.53 and 249.10 ppm) in the first and second seasons respectively. The interaction between the two studied factors revealed that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (253.01 and 255.70 ppm) in the first and second seasons respectively (Table 6).

Leaf Zinc (Zn) Content: Regarding LBU treatment, 3 g/L gave the highest significant value (17.46 and 18.64 ppm) during 2014 and 2015 seasons respectively (Table 6). Concerning humic acid treatment, 3 g/L gave the highest significant increment leaf zinc content (18.36 and 19.54 ppm) in the first and second seasons respectively. The interaction between the two studied factors revealed that treatment of 3 g/L LBU plus 2 g/L humic acid attained the highest significant value (27.64 and 28.89 ppm) in the first and second seasons respectively.

Leaf Manganese (Mn) Content: Data in Table 6 indicated that the combined treatment (3 g/L LBU plus 2 g/L humic acid) showed the highest significant values (64.14 and 65.91 ppm) in the first and second seasons respectively than other treatments. Regarding humic acid treatment, 3 g/L gave the highest significant increment leaf manganese content (46.73 and 48.50 ppm) in the first and second seasons, respectively. Concerning LBU treatment, 3 g/L gave the highest significant value (40.70 and 44.59 ppm) during 2014 and 2015 seasons respectively.

The stimulative effect of humic acid on nutrients concentrations might be explained by [22] who indicated that humic acid enhanced cell permeability, which in turn made more rapid entry of minerals into root cells and so resulted in higher uptake of plant nutrients. Furthermore, promotion in nutrients uptake with the addition of humic acid had been reported by various researchers [23-24] they found that humic acid as an organic fertilizer is very beneficial in increasing plant nutrition and promoted the accumulation of N, P, K, Mg and Ca in leaves.

According to that, the effects of humic acid on increasing Fe and Zn concentrations in the shoots might be due to their effect on the reduction of $Fe3^{+}$ to $Fe2^{+}$, making iron chelates are readily available to the plants [25]. Moreover, humic acid might prevent the formation of insoluble complexes of zinc and facilitated their uptake by plants. The obtained results of humic acid on micro elements concentrations of almond seedlings were in conformity with those obtained by [14] working on olive, who found that addition of humic acid increased Fe, Zn and Mn uptake.

The present results regarding the influence of LBU application on leaf mineral contents are in accordance with those found by [26] who reported that foliar application of LBU significantly increased the leaf N, P and K levels of Kinnow mandarin trees compared to control. Smith [27] reported that the increase in leaf N content might occurred due to the fact that nitrogen is highly mobile. Its efficient translocation and nutrient supply from root to tree leaves could add to its enhancing accumulation in leaves. The increase in leaf calcium content occurred because of the direct positive relationship (synergism) between leaf nitrogen and leaf calcium [28]. Thus, the foliar sprays of LBU might increase the calcium mobility sufficiently during senescence, thereby increasing its calcium level later on. Under nitrogen application, the great availability of manganese might lead to greater uptake of manganese. This might be because of the fact that higher absorption, translocation and utilization of nutrients takes place in the plants which resulted in increased plant growth. Basharat [9,26,29] reported that leaf nitrogen concentration increased after the

Table 5. Effect of foliar with LBU and humic acid on leaf macro-elements of Nonpareil almond seedlings during 2014 and 2015 seasons

Treatments	N%		P%		K%		Mg%	
	2014	2015	2014	2015	2014	2015	2014	2015
T1- Control	1.03	1.08	0.71	0.84	1.23	1.60	0.14	0.16
T2- 2 g/L LBU	1.51	1.20	0.95	1.08	1.58	1.80	0.15	0.16
T3- 3 g/L LBU	1.52	1.41	0.96	1.08	1.63	1.95	0.15	0.18
T4- 2 g/L Humic	1.36	1.52	0.97	1.10	1.45	1.99	0.16	0.18
T5- 3 g/L Humic	1.47	1.56	0.98	1.12	1.64	2.01	0.16	0.18
T6- 2 g/L LBU + 2 g/L Humic	1.66	1.57	0.99	1.12	1.65	2.02	0.17	0.18
T7- 2 g/L LBU + 3 g/L Humic	1.11	1.15	1.01	1.22	1.95	2.00	0.21	0.23
T8- 3 g/L LBU + 2 g/L Humic	1.15	1.71	1.30	1.43	2.23	2.60	0.24	0.25
T9- 3 g/L LBU + 3 g/L Humic	1.70	1.74	1.09	1.22	1.81	2.18	0.17	0.20
LSD value at 0.05	0.14	0.14	0.29	0.31	0.05	0.05	0.09	0.08

Table 6. Effect of foliar with LBU and humic acid on leaf micro-elements of Nonpareil almond seedlings during 2014 and 2015 seasons

Treatments	Ca%		Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2014	2015	2014	2015	2014	2015	2014	2015
T1- Control	1.76	1.94	159.20	161.90	14.76	17.58	24.25	26.10
T2- 2 g/L LBU	1.90	1.96	193.18	196.15	17.30	18.27	33.22	34.71
T3- 3 g/L LBU	1.78	2.02	206.72	209.40	17.46	18.64	40.70	44.59
T4- 2 g/L Humic	1.84	2.02	243.77	245.92	17.66	18.90	45.27	47.03
T5- 3 g/L Humic	1.84	2.05	246.53	249.10	18.36	19.54	46.73	48.50
T6- 2 g/L LBU + 2 g/L Humic	1.90	2.08	248.28	250.19	22.88	24.06	46.76	48.52
T7- 2 g/L LBU + 3 g/L Humic	2.00	2.25	250.18	254.98	20.16	23.73	59.43	60.68
T8- 3 g/L LBU + 2 g/L Humic	2.10	2.28	253.01	255.70	27.64	28.89	64.14	65.91
T9- 3 g/L LBU + 3 g/L Humic	2.00	2.21	249.44	253.11	24.17	25.34	55.68	57.53
LSD value at 0.05	0.19	0.20	5.53	5.62	3.71	3.37	17.22	17.99

foliar application of LBU. Increase in leaf P content is in conformity with the findings of [30] who also reported increased leaf phosphorus content with nitrogen application.

Conclusion

Finally, under El Tor conditions of this experiment it could be concluded that using 3 g/L LBU + 2 g/L humic acid or 3 g/L LBU + 3 g/L humic acid twice at the end of April and two weeks later as a foliar application resulted in improving growth and nutritional status of Nonpareil almond seedlings.

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