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Growth Performance of Bay (*Laurus nobilis* L.) Under Different Amount, Period of Watering and NPK.

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ABSTRACT

The aim of this work was to estimate the growth of *Laurus nobilis* seedlings under different levels, period of water and its interaction with NPK. Different amounts of water (150, 300 and 400) ml/polyethylene bag and irrigation intervals (two different scales are considered, once per week and once per two weeks) were used in addition to different amounts of NPK (zero (control), 500, 1000 ppm). Multi-measurements and strategy was utilized for measuring stem length, stem diameter, root length, root diameter, moisture content, stem wet weight, stem dry weight, root wet weight, root dry weight and shoot root ratio. The results showed that bay seedlings had significantly affected by water amount (150ml) as well as water period (once per two weeks). Water deficit is therefore more commonly limiting seedlings growth than NPK through growing season. Therefore, sensitivity of bay seedlings to limitation water has indicated that decreasing in stem length, stem diameter, number of leaves, root diameter, moisture content, stem wet weight, stem dry weight, root wet weight, root dry weight and root shoot ratio (12.56cm, 3.35mm, 17, 3.66mm, 3.67%, 5.42g, 5.59g, 5.96g, 4.99g, 0.05). However, seedlings with three interaction (450ml, once/week and 1000ppm) had displayed significant differences through stem length, number of leaves, root diameter, moisture content, stem wet weight, stem dry weight, and root wet weight, root dry weight and root shoot ratio (28.16cm, 29, 6.57mm, 19.33%, 11.85g, 8.35g, 8.10g, 6.26g, 1.37 respectively). It is concluded that *Laurus nobilis* seedlings could not success in this area, especially under low water availability.

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INTRODUCTION:

Laurus nobilis L. is known as bay laurel, sweet bay, true bay, Grecian laurel, and bay tree. It belongs to the family Lauraceae which comprises numerous aromatic and medicinal plants, native to the southern Mediterranean region (Conforti et al., 2006). It is an evergreen shrub usually grows to a height from 20 to 30 feet (10-12 m) flowered from April to May. The species is dioecious and it is not self-fertile. Laurel can be grown in different soil type (sandy, loamy and clay soils), but it prefers well-drained soil. This plant is widely used and its leaves can be used fresh or are reaped in the summer and dried to add flavor to food and a distinctive aroma. Their leaves could be used as a spice, to treat a variety of neuralgia, complaints and intestinal cramps and for its useful effect upon the

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digestive system (Chaudhry and Tariq, 2006). It is indicated that bay leaves can protect body from the impact of cancer-causing free radicals because it is the unique combination of antioxidants and including catechins, phytonutrients, parthenolide and linalool (Al-kalaldeh, Abu-dahab and Afifi, 2010). Furthermore, for patients who suffer diabetes, it is found that bay leaves have been directly linked with improved insulin receptor function and controlled blood sugar levels (khan, Goher and Richard, 2009). Laurus nobilis is grown in various warm regions of the world, particularly in Southern Europe and around the shores of the Mediterranean Sea (Chmit et al., 2014). Although this species is often encountered under semi-arid circumstances and hence has to cope with periods of water deficiency, it also can adapt to coastal humid environments and demands large amounts of water through the first year of seedlings development (Rhizopoulou and Mitrakos, 1990). Water stress, drought, is considered to be one of the major important environmental factors that limit plant production (Chandler and Bartels, 2003). Plant responds to water shortage and adapt to drought through several physiological and biochemical changes (Impa et al., 2005), and one of the earliest responses of plants to low water availability is to close stomata to avoid excessive losing of water; consequently, this stomatal closure does limit rate of CO_2 diffusion and thus photosynthesis (Niinemets et al., 2005). Also, cell wall extensibility of elongating cells was similarly stated to be rapidly affected by drought and both loosening and hardening processes may occur in plants exposed to water shortage depending on the considered species (Neumann, 1995 and references therein). Biochemical composition of the cell wall might affect biophysical parameters like bulk modulus of elasticity and extensibility but also the water content in cell wall and the quantities of bound water which is considered to contribute to water stress resistance in various plant species (Thompson, 2005 and Evered et al., 2007). In addition, the effect of different irrigation intervals strategies on plant water use and growth were investigated and showed reduce plant growth, lower water content, plant size and lower number of shoots (Álvarez et al., 2009). Furthermore, it is reported that mineral nutrition is one of the factors affecting plant development and water relations (Clarkson et al., 2009 and Cramer et al., 2009). For instance, nitrogen fertilization could impact either positively or negatively xylem vessel size and water use efficiency in various species and growth circumstances (Atwell et al. 2009 and Hacke et al. 2010). Also, phosphorus addition was found to increase cavitation vulnerability in dwarf mangroves (Lovelock et al. 2006) and decrease it in poplar (Harvey and van den Driessche, 1997), whereas phosphorus deficiency was decreased root hydraulic conductance in Pistacia (Trubat et al. 2006). Too, the impact of potassium availability on plant water balance was studied in link to turgor regulation of stomatal guard cells, however, the results are contradictory (Fournier et al. 2005, Benlloch-González et al. 2008). A recent review about the several benefits of sufficient potassium nutrition for plant resistance to numerous biotic and abiotic stresses has been highlighted by Römheld and Kirkby (2010). Recent findings on the effect of cations on xylem hydraulics propose a probable additional role for this nutrient in the modulation of water balance and plant hydraulic efficiency. This plant was selected since it is tree of magnificent economic and ecological interest, which has been broadly studied because of its alimentary and pharmaceutical properties. The aim of this study was to investigate the effect of water stress on Laurus nobilis in areas with water limitation whether would affect growth characters. Also, to investigate whether the effect of NPK would improve the growth of laurel seedlings to water stress.

MATERIALS AND METHODS:

Plant materials and experimental design

This study was carried out in Grdarasha research field, College of Agricultural Engineering Science, Salahaddin University-Erbil, Iraq, from October 2018 to July 2019 at an altitude 436 meters above sea level (Latitude North 36.16°, longitude East 44.03°). One-year-old samplings of *Laurus nobilis* were planted in polyethylene pots size (30*30*45) cm filled with sandy soil. The experiment was arranged in design with 54 treatments (9 treatments in each block) and three replications. Three factors were used to investigate plant growth. The first has included two periods of irrigation (irrigation once per week and once per two weeks), while the second has comprised three different levels of irrigation amounts (150ml, 300ml, and 450ml) and the third factor has included fertilizer with NPK (20:20:20) solution at three concentration of (zero, 500 and 1000) ppm modified from Demirkiran and Cengiz (2010). They were prepared by dissolving (1.250 and 2.500) mg of NPK in 500 ml of distilled water according to the treatments. NPK nutrition was added as soil medium during a time. Seedlings were protected from rainfall in the upper by polyethylene covers. The results analyzed based on factorial complete randomized design (F- CRD). Selected chemical and physical properties of studied water, which is analyzed in directory of environmental –Erbil, are shown in Table 1.

Table 1: Chemical and physical properties of studied water

Water properties	Tap water
pH	7.8
Electrical Conductivity (ms.cm-2)	360
Total Dissolved Solid (ppm)	180
Hardness (ppm)	240
Alkalinity (ppm)	162
K+ (ppm)	0.9
Na+ (ppm)	9.4
$NO3^{-}$ (ppm)	38
Cl^{-} (ppm)	55.2
Ca++ (ppm)	40

Monthly averages temperature and humidity were recorded throughout the experiments period and shown in Table 2.

Table 2: Average air temperature and relative humidity during the period of the research.

Year	Month	Average air temperature ˚C	Average air humidity %
2018	October	25.1	34.1
	November	15.6	67.2
	December	10.9	79.6
2019	January	9.1	69.2
	February	10.7	65.8
	March	12.3	68.5
	April	16.6	59.7
	May	27.4	29.6
	June	34.7	16.0
	July	36.2	15.3

Character measurements:

Measurements of stem length, stem diameter, root length and root diameter were obtained by (digital vernier caliper) in addition to account number of leaves. Fresh stems, roots and leaves were harvested and immediately measured by weighing scale with accuracy of 0.0 g, then oven dried at 105 °C, for at least 48 hours to determine the dry weight (Baninasab and Mobli, 2008). Moreover, fresh leaves have been taken to measure the moisture content. Leaves have weighed and dried in an oven, readings of the dried leaves have been taken then subtracted from the fresh leaves weight and the result gave the moisture present in the leaves. By dividing the result with dry weight, the moisture content percentage (%) on the dry basis has been obtained. Similarly, by dividing the result with fresh leaves weight, moisture content present percentage (%) in leaves on wet basis has been obtained (Rev, 2004).

MC =((W_w-W_d)/W_d)x100 (dry basis)

MC =((W_w-W_d)/W_w)x100 (wet basis)

In which:
MC= moisture content (%)
Ww= wet weight
Wd= weight after drying

In addition, root shoot ratio was measured by total dry weight for roots (g)/ dry weight for shoot (g) (Sadeghipour and Aghaei, 2013). The data were submitted to analysis of variance, the means compared by least significant differences (L.S.D.) at probability level of 5% for field. (SAS institute, 2005).

RESULTS AND DISCUSSION:

Effect of water amounts on the physical properties of Bay seedlings

Statistical analysis is indicated that significant differences were found between plants treated with (450ml) of water comparing with (150ml) of water. These differences appeared at stem length, number of leaves, stem diameter, root diameter, moisture content, stem wet weight, stem dry weight, root wet weight, root dry weight and root shoot ratio (22.77cm, 27, 3.91mm, 4.91mm, 12.61%, 9.54g, 6.68g, 7.29g, 5.84g and 0.07 respectively) Table 3. Yet, root lengths did not significantly differ among the three irrigation amounts, suggesting that roots of *Laurus nobilis* had higher tolerance of water shortage compared to others parts of plant. Researchers pointed out the increase in root growth as an indicator of plant ability to withstand water stress, as well as to screen plant for drought tolerance. It is clear from the consequences obtained in this study, that different levels of water have affected the growth of laurel seedlings differently, which references that the laurel differed in their ability to tolerate different amounts of water stress. So, water stress can be considered the major factor affects plants during growth period resulting in limiting physical properties. Similar finding was reported by Charles et al., (1994) confirming the results of current study, those seedlings were dissimilar in their response to different water stress.

Table 3: Response of seedlings growth to different amounts of water

Water (Ml)	Stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root Dry Weight (g)	Shoot Root Ratio
150	12.96	17	3.35	31.88	3.66	3.67	5.42	4.59	5.96	4.99	0.05
300	17.52	23	3.70	35.00	4.01	5.72	7.52	5.83	6.51	5.39	0.07
450	22.77	27	3.91	32.38	4.91	12.61	9.54	6.68	7.29	5.84	0.06
L.S.D.>= 0.05	4.31	6	0.54	N.S.	0.88	2.87	1.32	0.75	0.86	0.56	0.10

Effect of irrigation interval on *Laurus nobilis*

Irrigation once per two weeks resulted in a significant reduction of stem length, stem diameter, stem wet weight, stem dry weight and root wet weight (15.66cm, 3.40mm, 6.83g, 5.08g, 0.70g respectively) when compared with irrigation per week (19.84cm, 3.91mm, 8.15g, 6.32g, 6.25g respectively). However, no significant differences were found in number of leaves, root length, root diameter, moisture content, and root dry weight as shown in Table 4. These results showed that seedlings responses to irrigation intervals were dissimilar, and most parts of plant were decreased during deficit irrigation period (once per two weeks). The impact of water stress on leaf growth could be clarified as a method of adaptation to the conditions of water deficit to limit the transpiration rate, in order to preserve the water amount in the soil around plant roots to increases the chance of plant survival. Yet, others parts of plant which did not affect during deficit irrigation period might be because of partial root drying reduce water losses by transpiration without affecting plant growth. These are in consistent with the findings of Maatallah et al. (2010) as the root was not influenced by water stress, and the reduction in the total dry weight is owing to the lack of dry weight of shoot, and drought may cause significant changes in laurel plants (Petropoulos et al., 2008).

Table 4: Effect of water period on Bay seedlings

Day	Stem length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root dry Weight (g)	Shoot Root Ratio
per week	19.84	24	3.91	30.62	4.16	8.22	8.15	6.32	6.25	5.47	1.15
per two weeks	15.66	20	3.40	35.55	4.23	6.44	6.83	5.08	6.93	5.34	0.95
L.S.D.> = 0.05	3.580	N.S.	0.448	N.S.	N.S.	N.S.	1.07	0.61	0.70	N.S.	N.S.

Effect of NPK on Laurel seedlings growth

There were no obvious differences between control NPK and fertilized seedlings Table 5. This result is agree with study of Petropoulos et al., (2008) when stated that there was no significant increase in plant growth when the level of applied fertilizer increased from 150 to 300 or 450 mg kg^{-1}, additionally, increasing the N level to 300 mg kg^{-1} did not cause additional increase in the number of leaves per plant and even decrease number of leaves in comparison with 150 mg kg-^{1} level.

Table 5: Effect of fertilizer (NPK) on seedlings growth

NPK (PPM)	stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	stem Wet Weight (g)	stem Dry Weight (g)	Root Wet Weight (g)	Root dry Weight (g)	Shoot Root Ratio
0	16.30	23	3.56	34.05	4.25	6.22	7.16	5.52	6.47	5.39	1.03
500	19.13	21	3.75	33.63	4.05	8.00	7.60	5.77	6.77	5.40	1.06
1000	17.82	23	3.66	31.58	4.28	7.77	7.71	5.82	6.52	5.43	1.06
L.S.D. >= 0.05	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.

Interaction effect of amount of water and irrigation intervals on Bay growth

A significant interaction between water amount (450ml) and period of watering (once/week) was found for stem length, number of leaves, stem diameter, root diameter, moisture content, stem wet weight, stem dry weight, root wet weight, root dry weight and root shoot ratio (23.87cm, 27, 4.17mm, 5.12mm, 16.77%, 10.61g, 7.51g, 7.56g, 6.02g, 1.24 respectively). Yet, root length displayed no noticeable differences. Although water stress affected most of the plant growth, this effect depended on the length of irrigation intervals, level of water stress to which the plant is subjected to water stress of plant species. Basically, low irrigated plants supplemented with long period had lower growth than those grown under higher irrigation Table 6. This refers that water in early stage of growing is a fundamental factor to plant development. Different studies on this plant were shown considerable changes observed under water stress (Pirzad et al., 2006; Bettaieb et al., 2009), resulted in significant reduction of wet and dry matter, and nutrient content of plants (Mirsa and Srivastava 2000). De Lillis (1991) reported that although *Laurus nobilis* is a drought tolerant species, the young seedlings are vulnerable to water stress and drought condition in early stages of the development.

Table 6: Interaction effect of water amount and irrigation intervals

Water (ML)	Day	Stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root dry Weight (g)	Shoot Root Ratio
150	per week	16.11	21	3.63	31.11	3.73	2.33	5.82	5.13	5.95	5.26	0.98
	per two weeks	9.82	13	3.08	32.66	3.60	5.00	5.01	4.05	5.97	4.72	0.85
300	per week	19.54	25	4.17	32.11	4.04	5.55	8.02	6.33	5.77	5.15	1.23
	per two weeks	15.50	21	3.23	37.88	3.97	5.88	7.02	5.32	7.26	5.63	0.96
450	per week	23.87	27	3.94	28.65	4.70	16.77	10.61	7.51	7.03	6.02	1.24
	per two weeks	21.66	27	3.88	36.11	5.12	8.44	8.47	5.86	7.56	5.67	1.04
L.S.D.>= 0.05		6.01	7	0.70	N.S.	1.18	3.78	1.77	1.05	1.12	0.78	0.15

Interaction effect of water amount and NPK

All seedlings treated with amount of water (450ml) and amount of fertilizer (500, 1000 ppm) had more important differences in stem length, number of leaves, root diameter, moisture content, stem wet weight, stem dry weight, root wet weight, root dry weight and root shoot ratio (25.58cm, 28.16, 4.70mm, 13.33%, 9.81g, 6.92g, 7.57g, 6.00g, 1.20 respectively) than those suffered water stress and zero NPK (11.58cm, 17.00, 3.33mm, 2.83%, 5.45g, 4.62g, 5.59g, 4.87, 0.94 respectively). However, no significant differences were found at stem diameter and root length Table 7. According to Huxley (1992) bay plant prefers a moisture soil and fertile soil.

Table 7: Interaction effect of water amount and NPK

Water (ML)	NPK (PPM)	Stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root Dry Weight (g)	Shoot Root Ratio
150	0	11.58	17	3.26	25.66	3.33	2.83	5.45	4.62	5.59	4.87	0.94
	500	14.00	15	3.48	33.83	3.74	3.83	5.38	4.57	6.27	4.97	0.92
	1000	13.31	19	3.32	36.16	3.92	4.33	5.42	4.58	6.02	5.12	0.89
300	0	18.00	27	3.78	41.66	4.07	4.00	7.01	5.55	6.77	5.43	1.06
	500	17.81	21	3.77	36.83	3.71	7.50	7.62	5.81	6.48	5.23	1.12
	1000	16.75	22	3.55	26.50	4.24	5.66	7.93	6.13	6.30	5.52	1.11
450	0	19.31	26	3.63	34.83	5.35	11.83	9.02	6.39	7.05	5.88	1.09
	500	25.58	27	4.01	30.23	4.67	12.66	9.79	6.75	7.26	5.64	1.14
	1000	23.41	28	4.09	32.08	4.70	13.33	9.81	6.92	7.57	6.00	1.20
L.S.D.>=0.05		7.96	9.00	N.S.	N.S.	1.47	5.68	2.40	1.55	1.51	1.02	0.23

Interaction effect of irrigation intervals and NPK on Laurel plant

Irrigation intervals and NPK had marked differences in some physical properties of Laurel as shown in stem length, stem diameter, root length, stem t dry weight, root dry weight and root shoot ratio (22.72cm, 4.04mm, 41.22cm, 6.81g, 5.86g, 1.32 respectively). However, there was no significant differences in number of leaves, root diameter, moisture content, stem wet weight and root wet weight that treated with same amount of NPK Table 8. It has been pointed out laurel growth decrease under water stress, and it requires extra water in warm season (Maatallah et al., 2016).

According to Wang et al. (2003) and Wu *et al*. (2008) the growth and biomass production of two varieties of *Laurus nobilis* have been limited by permanent and cyclical stress and fertilizers resulting in reduction in average growth activities of leaves, roots and stems.

Table 8: Interaction effect of NPK and irrigation once per week and once per two weeks

Day	NPK (PPM)	Stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root Dry Weight (g)	Shoot Root Ratio
per week	0	16.43	25	3.76	33.00	3.98	6.44	7.15	5.57	5.95	5.29	1.06
	500	20.37	22	3.95	26.04	4.13	8.77	8.50	6.59	6.29	5.27	1.23
	1000	22.72	26	4.04	32.83	4.36	9.44	8.81	6.81	6.51	5.86	1.16
per two weeks	0	16.16	21	3.36	35.11	4.52	6.00	7.18	5.47	6.99	5.50	1.01
	500	17.88	20	3.56	41.22	3.97	7.22	6.71	4.94	7.25	5.52	0.89
	1000	12.93	19	3.28	30.33	4.20	6.11	6.61	4.83	6.54	5.00	0.97
L.S.D.>=0.05		6.89	N.S.	0.73	13.84	N.S.	N.S.	N.S.	1.30	N.S.	0.84	0.17

Interaction effect of amount of water, irrigation intervals and NPK

Seedlings with three interactions (450ml, 1000ppm and once per week) had great differences in stem length, number of leaves, root diameter, moisture content, stem wet weight, stem dry weight, and root wet weight, root dry weight and root shoot ratio (28.16cm, 29, 6.57mm, 19.33%, 11.85g, 8.35g, 8.10g, 6.26g, 1.37 respectively) except stem diameter and root length that showed no significant differences through all interactions Table 9. These results demonstrate that moderate water stress with increasing NPK amount slightly increase seedlings growth. Conversely, sever water stress with increasing NPK reduce laurel development. This significant reduction might be due to the decrease in the area of photosynthesis, a lower in chlorophyll production and a raise of the energy consumed by plants to absorb water and to boost the density of protoplasm (Farahani et al., 2009).

Table 9: Interaction effect of amount of water, irrigation intervals and NPK

Water (Ml)	Day	NPK (PPM)	Stem Length (cm)	Number of Leaves	Stem Diameter (mm)	Root Length (cm)	Root Diameter (mm)	Moisture %	Stem Wet Weight (g)	Stem Dry Weight (g)	Root Wet Weight (g)	Root Dry Weight (g)	Shoot Root Ratio
150	per week	0	13.33	20	3.60	25.33	3.51	1.33	5.82	4.90	5.55	5.08	0.96
		500	16.66	17	3.52	29.33	3.72	2.67	5.77	5.12	5.97	4.88	1.04
		1000	18.33	27	3.77	38.66	3.96	3.00	5.87	5.38	6.33	5.81	0.93
	per two weeks	0	9.83	14	2.93	26.00	3.15	4.33	5.09	4.35	5.63	4.67	0.93
		500	11.33	14	3.43	38.33	3.76	5.00	4.99	4.02	6.57	5.05	0.79
		1000	8.30	11	2.88	33.66	3.88	5.66	4.96	3.78	5.71	4.44	0.85
300	per week	0	19.67	28	4.33	41.00	4.31	4.33	6.76	5.52	5.45	4.60	1.20
		500	17.30	23	4.13	25.33	3.62	6.33	7.88	6.30	5.83	4.93	1.27
		1000	21.66	26	4.07	30.00	4.21	6.00	9.44	7.18	6.05	5.92	1.21
	per two weeks	0	16.33	26	3.23	42.33	3.83	3.66	7.27	5.57	8.10	6.26	0.92
		500	18.33	20	3.42	48.33	3.80	8.66	7.37	5.33	7.12	5.52	0.96
		1000	11.83	18	3.03	23.00	4.28	5.33	6.42	5.07	6.54	5.12	0.99
450	per week	0	16.30	27	3.35	32.66	4.13	13.66	8.87	6.31	6.86	6.20	1.01
		500	27.16	27	4.19	23.46	5.05	17.33	11.85	8.35	7.07	6.00	1.37
		1000	28.16	26	4.27	29.83	4.92	19.33	11.11	7.87	7.15	5.85	1.34
	per two weeks	0	22.33	25	3.91	37.00	6.57	10.00	9.17	6.48	7.24	5.57	1.16
		500	24.00	26	3.82	37.00	4.36	8.00	7.77	5.48	8.07	6.00	0.91
		1000	18.66	29	3.92	34.33	4.43	7.33	8.47	5.62	7.37	5.43	1.05
L.S.D.>=0.05			10.60	13	N.S.	N.S.	2.17	7.06	3.25	1.85	2.12	1.38	0.25

CONCLUSION:

The results that obtained in this study have shown *Laurus nobilis* significantly differed in their response to drought and hence tolerance. The degree of tolerance depended on the interactions between levels of water stress, irrigation periods and mineral fertilizers. Water deficit (150ml) has been obviously displayed in plant characters, and it had considerable effect on physical properties of seedlings (stem length, number of leaves, stem diameter, root diameter, moisture content, stem wet weight, stem dry wet, root wet weight, root dry weight and root shoot ratio). Also, irrigation periods (especially once per two weeks) had presented significant harmful impact on most parts of *Laurus nobilis*, but interaction effect of water amount and irrigation periods showed the highest growth of seedlings was within 450ml of water and once per week. Moreover, NPK had no clear effect on plants in all amounts of fertilizer, yet its interaction with water levels and irrigation intervals (1000ppm of NPK, 450ml of water, and once per week) showed important impact on plant growth. This indicates that laurel parts differed in their ability to tolerate different levels of water stress. This will assist to discover more physiological parameters and growth that might be linked to water stress sensitivity. It can be concluded that the reduction of water availability could decrease plant growth, though fertilizers have applied to plant considerably. This study illustrates that *Laurus nobilis* seedlings could not success in growing under water shortage.

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نمو شتلات الغار (*Laurus nobilis* L.) تحت تأثير كميات وفترات مختلفة من ماء الري والتسميد بـ NPK

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المستخلص

اجريت دراسة خلال الموسم الزراعي 2018−2019 لمعرفة تأثير مستويات وفترات الري والتسميد المعدني (NPK) في صفات النمو الخضري والجذري لشتلات الغار (*Laurus nobilis*). نفذت هذه التجربة بتصميم القطاعات العشوائية الكاملة بثلاث مكررات اشتملت على ثلاث عوامل، العامل الاول الري بثلاث مستويات (150, 300, 450) ملم/كيس والعامل الثاني فترات الري بمستويين (رية كل أسبوع ورية كل اسبوعين)، والعامل الثالث التسميد بسماد NPK بثلاث تراكيز (صفر, 500, 1000 جزء بالمليون). بينت النتائج تأثر صفات النمو الخضري و الجذري بكمية و فترات الري حيث اظهر المستوى 150ملم/كيس والري كل اسبوعين اقل معدل لصفات طول الساق وقطر الساق و عدد الاوراق و قطر الجذر والمحتوى الرطوبي والوزن الرطب للساق والوزن الجاف للساق والوزن الرطب للجذر و الوزن الجاف للجذر ونسبة الجذر للساق(12.56سم، 3.35ملم، 3.66ملم، 17 ، 3.67%، 5.42 غم، 5.59غم، 5.96 غم، 4.99غم، 0.05 على التوالي)، بينما سجلت اعلى القيم لمعاملة التداخل الثلاثي بين الري بمستوى 450ملم/كيس والري كل اسبوع والتسميد NPK بتركيز 1000جزء بالمليون لمعدل صفات طول الساق, عدد الاوراق, قطر الجذر, المحتوى الرطوبي, الوزن الرطب للساق, الوزن الجاف للساق, الوزن الرطب للجذر، الوزن الجاف للجذر ونسبة الجذر للساق (28.16سم, 29, 6.57ملم, 19.33%, 11.85غم, 8.35غم, 8.10غم, 6.26غم, 1.37 على التوالي). يستنتج من هذه الدراسة إلى أن شتلات *Laurus nobilis* لا يمكن أن تنجح في هذا المنطقة، لا سيما في ظل قلة توافر المياه.

الكلمات المفتاحية: شتلات الغار ، صفات النمو، كميات الماء، فترات الري، التسميد، NPK .