INFLUENCE OF AQUEOUS EXTRACT OF BARLEY SPROUTS, TREHALOSE, AND CALCIUM ON GROWTH, QUALTY AND YEILD OF CARROT

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ABSTRACT

This research was implemented at vegetable field of the College of Agricultural Engineering Sciences - University of Baghdad during fall seasons, 2018 and 2019. The experiment was conducted using factorial within Randomized Complete Block Design arrangement with three factors and replicates (3X3X2). The aqueous barley sprouts extract (B0, B1) (0, 100 $g.L^{-1}$) represented the first factor. Trehalose (T0, T1, T2) (0, 50, 75 $mmole.L^{-1}$) represented the second factor. Calcium (C0, C1, C2) (0, 1, 2 $ml.L^{-1}$) represented the third factor. The research objectives are assessing the impact of the mentioned factors and their interaction on carrot vegetative, quality, and yield traits. Results showed the effectiveness of three ways interaction treatment B1T2C1 in producing significant increases in leaves number (14, 13, total sugars in roots (8.619, 8.15$mg.100^{-1}g$) and carrot weight (161.6, 159g) for both seasons respectively.in compare with control treatment B0T0C0.

Keywords: sugars; germinated grains; TSS; sprouting; dry matter; divalent ion
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تأثير المستخلص المائي لمستنبتات الشعير والتريهالوز والكالسيوم في نمو ونوعية وحاصل نبات الجزر

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المستخلص

نفذت تجربة حقلية في حقول كلية علوم الهندسة الزراعية/جامعة بغداد للموسمين خريفي 2018 وخريفي 2019. طُبقت التجربة باستعمال تصميم القطاعات الكاملة المعشاة حسب ترتيب التجارب العاملية وبثلاث عوامل وثلاث مكررات (2X3X3)، مَثَل الرش بالمستخلص المائي للحبوب المستنبتة لنبات الشعير (0، 100 غم حبوب جافة.لتر$^{-1}$) العامل الاول والذي رُمز له (B0 وB1)، اما العامل الثاني فيتضمن الرش بسكر التريهالوز (0، 50 ، 75 ملي مول.لتر$^{-1}$) والذي رمز له (T_0 وT_1 وT_2)، ويشتمل العامل الثالث على الرش بالكالسيوم على هيئة كالسيوم مخلبي (0 و 1 مل.لتر$^{-1}$ و 2 مل.لتر$^{-1}$) والذي رمز له (C_0 وC_1 وC_2)، تتمثل أهداف البحث في اختبار تأثير العوامل المذكورة وتداخلاتها في مؤشرات النمو الخضري والنوعية والحاصل لنبات الجزر. اظهرت النتائج التفوق المعنوي لمعاملة التداخل الثلاثي B1T2C1 في زيادة عدد الاوراق (14، 13) والسكريات الكلية (7.9، 7.967 ملغم . 100غم$^{-1}$) ووزن الجزرة (161.6، 159غم) في الجذور مقارنة بمعاملة القياس B0T0C0.

الكلمات المفتاحية: سكريات، حبوب منبتة, المواد الصلبة الذائبة الكلية, برعمة , المادة الجافة، ايون ثنائي التكافؤ
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INTRODUCTION

Carrot plant that belongs to Apiaceae has elevated interest around the world in recent years. it ranks as the most 10 produced vegetables, which it's consumption increased 3 folds in the last decade in compare to the 20th century statistics (8). Importantly, carrots classified as the second most popular veggies after potato (21). It acquired this position because of its favorable crunchy and sweet taste. In addition to its health benefits such as having the edible part sufficient amount of carotenoids -the precursor of vitamin A-. Moreover, carrots have B3, B2, B1, and C vitamins. As well as sugars and amino acids (18). As a result, many studies extensively focused on how to increase its yield and yield component in order to reach a significant level of improvement to cope with people demands. Using sprouted seeds become very common in the two last decades because they have simple, absorbable and water-soluble forms including amino acids, sugars, and fatty acids (17). Furthermore, they have sufficient amount of gibberellins and low levels of ABA (22). Thus, their aqua extracts can be sprayed on plant. Trehalose is non-reduced disaccharide that forms from combining two glucose molecules (12). It has versatile functions in plant including carbon metabolism, plant protection from abiotic stress (5) and molecule signal (9). As well as, it has been proven that trehalose 6 phosphate (trehalose precursor) affects sucrose mobilization to its final destination (6; 16; 23). Shafiq et al (20) observed that foliar feeding of trehalost (50mmol.L^{-1}) increased the fresh weight of radish plant yield under drought conditions. Calcium classified as a structural element that's enters directly in the composition of the cell wall, in addition to its function as a plasma membrane stabilizer, osmotic regulator, and second messenger for many cellular and hormonal responses (22). Lee et al (14) noticed that spraying carrot plant of calcium nitrate 2% improved storage traits. Hussein (11) reported that spraying a fertilizer having 5% CaO (6ml.L^{-1}) on cauliflower plant increased the total yield. Saaseea and Al-a'amry (19) demonstrated that spraying calcium (1000 mg.L^{-1}) significantly improved tuber weight of potato plant. The objective of this study is to evaluate the impact of barley aqua sprouted grains, trehalose, and calcium on growth, yield and yield component of carrot plant.

MATERIALS AND METHODS

This experiment was conducted during two fall seasons (2018 and 2019) at researches station (A) College of Agricultural Engineering Sciences, University of Baghdad (Al-Jadiryah). Table 1 shows the chemical and physical characteristics of the soil for both seasons. The seeds of carrot were sowed on lines on terraces in 15/September for both seasons. The field was under drip irrigation system. Mineral fertilizer was added as recommended for carrot plants (120 kg.ha^{-1}, 120 K_2O_5 kg. ha^{-1}, 40 K_2O kg. ha^{-1}) to all plots before planting (1). Thinning carried out after 30 days from planting seeds for both seasons. The spacing between one plant and another for both seasons was 0.05 m. The seeds of carrot var. Nantes were purchased from Modesto Seed Company (California, U.S.A.) for the first season. The seeds of the fall 2019 season produced locally in the spring 2019 season from the stecklings of the fall season 2018. The seeds were planted in a plant density 1,000,000 plants.ha^{-1}. The entire plots harvested after 115 days of the planting day for the1st season and 85 days for the 2nd season. The experiment was implemented as factorial arrangement (2X3X3) within randomized complete block design with three replicates. Spraying barley aqueous sprouted grains extract was represented the first factor with two levels (0, 100g.L^{-1} DW) which symbolized (B_0, B_1). The second factor is spraying with three levels of trehalose (0, 50, 75 mmol.L^{-1}) which symbolized (T_0, T_1, T_2). The third factor is spraying with three levels of calcium (0, 1, 2 ml.L^{-1}) (as chelated calcium 30% Ca), which symbolized (C_0, C_1, C_2). The first spraying was after 10 days from thinning. The second spraying was after 15 days from the first spraying. The third spraying was after 15 days from the second spraying. Barley aqueous sprouted grains extract was prepared by hydroponically germinating 100 g of barley grains, var. Ebaa class 265, (until radical penetration stage). After that, the germinated grains blended in an electric blender until the ingredients were mixed well. Then the solution was filtered by whatman filter paper 42 pore size and the volume was completed to 1 liter. The extract was sprayed on the plants directly after preparation. An aqueous extract was prepared from the quiescent barley grains (for the purpose of comparison and calculating the nutritional bioavailability). Table 2 shows the chemical and physical properties and conversion ratio of barley aqueous sprouted and grains extract. The study traits were leaves number, chlorophyll concentration ($mg.100^{-1}g$ FW) (10), vegetative dry weight (g), carrot weight (g), carrot length (cm), and determination of total sugars in carrots ($mg.100^{-1}g$ FW) (13), The collected data analyzed using analyses of variance and the means were compared according to L.S.D. test under 5% probability.

Table 1. Physical and chemical characteristics of the soil for the two seasons

character	Values	
	Fall 2018	fall 2019
pH	7.44	7.41
$EC_{1:1}$ ($ds.m^{-1}$)	2.39	2.36
Total N ($mg\ kg^{-1}$)	55.0	45.6
P ($mg\ kg^{-1}$)	13.7	12.1
K ($mg\ kg^{-1}$)	170	166
Ca ($mg\ kg^{-1}$)	187	177
Mg ($mg\ kg^{-1}$)	170	130
Fe ($mg\ kg^{-1}$)	2.60	2.10
Na ($Meq\ L^{-1}$)	61.0	63.0
Cl^- ($Meq\ L^{-1}$)	51.0	55.0
SO_4^{-2} ($Meq\ L^{-1}$)	207	209
HCO_3^- ($Meq\ L^{-1}$)	477	453
O.M. (%)	10.3	9.10
Gypsum (%)	320	327
Sand (%)	12.0	15.0
Silt (%)	40.0	45.1
Clay (%)	48.0	39.9
Texture	Clay Loam	

Table 2. Physical and chemical characteristics of the aqueous extract of quiescent (Q), sprouted (S) barley grains and conversion ratio

character	Values		
	Q	S	CR
pH	7	6.9	—
$EC_{1:1}$ ($ds.m^{-1}$)	1.70	1.80	—
Total N ($g\ L^{-1}$)	1.52	2.01	1.32
P ($mg\ L^{-1}$)	219	232	1.05
K ($mg\ L^{-1}$)	278	266	0.95
Ca ($mg\ L^{-1}$)	29.5	39.1	1.32
Mg ($mg\ L^{-1}$)	76.3	88.7	1.16
Fe ($mg\ L^{-1}$)	2.50	6.00	2.40
Zn ($mg\ L^{-1}$)	2.00	4.01	2.00
Gibberellin ($\mu g\ L^{-1}$)	2	304	152

(Q) aqueous extract of quiescent barley grains
(S) aqueous extract of sprouted barley grains
(CR) conversion ratio: calculated by dividing Q/S for each nutrient

RESULTS AND DISCUSSION

Vegetative growth traits

results in table 3A show that there is a significant impact of three ways interaction treatments in the vegetative growth traits of carrot for both seasons. B1T2C1 treatment produced the highest leaves number (13, 14), chlorophyll concentration (393, 396.2mg.100g^{-1} F.W.) dried vegetative growth (5.167, 5.1g) for both seasons respectively, compared to B0T0C2.The results of Table 3 B demonstrated that there were significant differences in two ways interaction between the aqueous extract of barley sprouts and trihalose. Plants with B1T2 produced the highest leaves number (12, 11.44), chlorophyll concentration (377.7, 379.5 mg.100g^{-1} F.W.) dried vegetative growth (4.544, 4.5g) for both seasons respectively compared to B0T0. Plants with B1C1 were displayed the highest leaves number (11.33, 10.78), dried vegetative growth (4.033, 3.989g) for both seasons respectively compared to B0C0.

Table 3 A. Vegetative traits of carrot plant after treatment for three ways interaction of fall 2018 and fall 2019 seasons

traits / treatments	leaves number		chlorophyll conc. (mg.100g^{-1})		dried vegetative growth (g.)	
	2018	2019	2018	2019	2018	2019
B0T0C0	7.30	7.33	296.2	282.7	2.083	2.050
B0T0C1	7.33	7.00	298.4	285.2	2.433	2.400
B0T0C2	7.00	6.67	294.2	286.0	2.367	2.333
B0T1C0	7.67	7.67	301.6	291.7	2.717	2.667
B0T1C1	7.67	8.00	320.1	316.7	2.900	2.867
B0T1C2	7.33	7.67	299.5	298.3	2.800	2.767
B0T2C0	7.67	8.00	311.5	306.0	2.767	2.733
B0T2C1	8.67	8.33	361.1	354.6	3.300	3.267
B0T2C2	8.33	8.00	334.8	329.8	3.100	3.067
B1T0C0	7.67	7.67	298.9	286.4	2.367	2.333
B1T0C1	7.66	7.67	301.7	288.5	2.633	2.600
B1T0C2	7.50	6.60	297.2	289.6	2.532	2.500
B1T1C0	8.00	7.33	305.0	300.7	3.033	3.000
B1T1C1	12.33	11.67	368.7	369.3	4.300	4.267
B1T1C2	12.34	11.33	310.7	309.9	3.900	3.867
B1T2C0	9.00	9.33	357.0	361.9	3.867	3.833
B1T2C1	14.00	13.00	393.0	396.2	5.167	5.100
B1T2C2	13.00	12.00	382.7	380.5	4.600	4.567
LSD 0.05	1.41	1.32	17.4	19.3	0.348	0.347

The findings of two ways interaction between calcium and trehalose (Table 3B) showed the consistent differences between treatments, T2C1 treatment increased leaves number (11.33, 10.67), chlorophyll concentration (377.3, 375.4 mg.100g^{-1} F.W.) dried vegetative growth (4.233, 4.183g) for both seasons respectively compared to T0C0. The results of the statistical analysis of the individual factors showed the significant superiority of B1 in leaves number (10.19, 9.63), chlorophyll concentration (335, 331.4 mg.100g^{-1} F.W.) dried vegetative growth (3.6, 3.563g) (Table 3C) for both seasons respectively compared to the lowest percentages in B0. Plants that received foliar trehalose application (75 mmol/l^{-1}) showed higher vegetative traits for both seasons, while the lowest traits were found in T0) (Table 3C). Spraying calcium (1 ml.l^{-1}) was produced the highest vegetative traits compared to the lowest numbers in C0) (Table 3C).

Table 3 B. Vegetative traits of carrot plant after treatment for two ways interaction of fall 2018 and fall 2019 seasons

treatments	leaves number		chlorophyll conc. (mg.100g^{-1})		dried vegetative growth (g.)	
	2018	2019	2018	2019	2018	2019
			TXB			
B0T0	7.22	7.00	296.3	284.6	2.294	2.261
B0T1	7.56	7.78	307.0	302.2	2.806	2.767
B0T2	8.22	8.11	335.8	330.1	3.056	3.022
B1T0	7.66	7.33	299.3	288.2	2.511	2.478
B1T1	10.89	10.11	328.1	326.6	3.744	3.711
B1T2	12.00	11.44	377.7	379.5	4.544	4.500
LSD 0.05	0.81	0.76	10.1	11.11	0.200	0.201
			CXB			
B0C0	7.56	7.67	303.1	293.5	2.522	2.483
B0C1	7.89	7.78	326.5	318.8	2.878	2.844
B0C2	7.56	7.44	309.5	304.7	2.756	2.722
B1C0	8.22	8.11	320.3	316.3	3.089	3.056
B1C1	11.33	10.78	354.6	351.3	4.033	3.989
B1C2	11.00	10.00	330.2	326.7	3.678	3.644
LSD 0.05	0.81	0.76	N.S.	N.S.	0.200	0.201
			CXT			
T0C0	7.50	7.50	297.6	284.6	2.225	2.192
T0C1	7.50	7.33	300.1	286.9	2.533	2.500
T0C2	7.33	6.67	295.4	287.8	2.450	2.417
T1C0	7.83	7.50	303.3	296.2	2.875	2.833
T1C1	10.00	9.83	344.4	343.0	3.600	3.567
T1C2	9.83	9.50	305.1	304.1	3.350	3.317
T2C0	8.33	8.67	334.2	333.9	3.317	3.283
T2C1	11.33	10.67	377.3	375.4	4.233	4.183
T2C2	10.67	10.00	358.7	355.1	3.850	3.817
LSD 0.05	0.99	0.93	12.3	13.6	0.246	0.245

Table 3 C. Vegetative traits of carrot plant after treatment for individual factors of fall 2018 and fall 2019 seasons

treatments	leaves number		chlorophyll conc. (mg.100g^{-1})		dried vegetative growth (g.)	
	2018	2019	2018	2019	2018	2019
			B			
B0	7.67	7.63	313.4	305.7	2.719	2.683
B1	10.19	9.63	335.0	331.4	3.600	3.563
LSD 0.05	0.47	0.44	5.8	6.4	0.116	0.115
			T			
T0	7.44	7.17	297.8	311.7	2.403	2.369
T1	9.22	8.94	317.6	314.4	3.275	3.239
T2	10.11	9.78	356.7	354.8	3.800	3.761
LSD 0.05	0.57	0.54	7.1	7.9	0.142	0.141
			C			
C0	7.89	7.89	311.7	304.9	2.806	2.769
C1	9.61	9.28	340.6	335.1	3.456	3.417
C2	9.28	8.72	319.8	315.7	3.217	3.183
LSD 0.05	0.57	0.54	7.1	7.9	0.142	0.141

Yield and quality traits in roots (carrots)

The most significant increases in carrot length (21.66, 21.3 cm), carrot weight (161.6, 159 g), TSS (10.76, 10.96 %), total sugars (8.619, 8.51 mg.100^{-1}g) was observed in B1T2C1 for both seasons respectively (Table 4A). Two ways interaction between T2 and B1 had a significant impact on carrot length (19.77, 19.85 cm), carrot weight (149.6, 147.1g), TSS (9.7, 9.456 %) respectively (Table 4B). The results in the same table also showed the superiority of B1C1 by producing the highest carrot length (18.99, 18.97 cm), carrot weight (140.5, 141.7 g), TSS (9.7, 9.867 %), total sugars (7.963, 7.845 mg.100^{-1}g) in the roots for both seasons. Exogenous application of calcium and trehalose significantly enhanced antioxidant traits (Table 4B). T2C1 showed the highest numbers in carrot length (19.68, 19.5 cm), carrot weight (148.3, 145.3 g), total sugars (7.772, 7.668 mg.100^{-1}g) for both seasons respectively (Table 4B). Statistical analysis of the individual factors (Table 4C) reveals the significant results of B1, T2, C1 treated plants by producing the highest carrot length, carrot weight , TSS, total sugars.

Table 4A. Yield and quality traits of carrot plant after treatment for three ways interaction of fall 2018 and fall 2019 seasons

treatments	carrot length (cm)		carrot weight (g.)		TSS (%)		total sugars (mg.$100g^{-1}$)	
	2018	2019	2018	2019	2018	2019	2018	2019
B0T0C0	15.33	15.60	101.0	101.4	7.533	7.633	5.079	5.098
B0T0C1	15.50	16.00	105.0	104.3	8.167	8.267	6.139	5.782
B0T0C2	15.36	15.90	99.33	103.0	8.067	8.200	5.990	6.009
B0T1C0	16.10	16.20	117.3	115.6	8.333	8.233	7.151	7.040
B0T1C1	17.06	16.83	118.3	119.3	8.800	8.933	6.825	6.745
B0T1C2	16.30	16.30	113.3	115.0	8.467	8.600	6.218	6.032
B0T2C0	16.23	16.53	115.0	115.6	8.133	8.067	7.868	7.701
B0T2C1	17.70	17.70	135.0	131.6	8.733	8.867	6.925	6.825
B0T2C2	17.17	17.06	121.6	122.7	8.728	8.870	7.031	6.894
B1T0C0	15.56	15.83	101.3	107.6	7.933	8.000	6.689	6.583
B1T0C1	15.70	16.50	110.0	116.7	8.233	8.332	7.036	6.917
B1T0C2	15.70	16.36	102.6	106.6	8.133	8.233	5.670	5.524
B1T1C0	16.63	17.23	118.3	119.3	8.467	8.567	7.861	7.815
B1T1C1	19.60	19.13	150.0	149.6	10.100	10.300	8.235	8.108
B1T1C2	18.06	18.26	148.6	147.3	9.567	9.767	6.075	5.903
B1T2C0	17.80	17.76	132.3	128.3	8.200	8.333	7.984	7.846
B1T2C1	21.66	21.30	161.6	159.0	10.760	10.960	8.619	8.510
B1T2C2	19.80	20.50	155.0	154.0	10.200	10.400	6.604	6.502
LSD 0.05	0.80	0.70	9.7	9.9	0.865	0.890	0.459	0.540

Table 4 B. Yield and quality traits of carrot plant after treatment for two ways interaction of fall 2018 and fall 2019 seasons

treatments	carrot length (cm)		carrot weight (g.)		TSS (%)		total sugars (mg.$100g^{-1}$)	
	2018	2019	2018	2019	2018	2019	2018	2019
				TXB				
B0T0	15.40	15.83	101.7	102.8	7.944	8.044	5.703	5.630
B0T1	16.49	16.44	116.3	116.6	8.578	8.700	6.731	6.606
B0T2	17.03	17.10	123.9	123.3	8.556	8.689	7.275	7.140
B1T0	15.65	16.23	104.6	110.3	8.078	8.178	6.465	6.342
B1T1	18.10	18.21	139.0	138.7	9.333	9.433	7.390	7.275
B1T2	19.77	19.85	149.6	147.1	9.700	9.811	7.736	7.619
LSD 0.05	0.46	0.40	5.6	5.7	0.499	0.514	N.S.	N.S.
				CXB				
B0C0	15.89	16.11	111.1	110.8	8.067	8.100	6.705	6.613
B0C1	16.75	16.84	119.4	118.4	8.567	8.689	6.541	6.451
B0C2	16.27	16.42	111.4	113.5	8.444	8.567	6.163	5.976
B1C0	16.69	16.94	117.3	118.4	8.133	8.178	7.511	7.415
B1C1	18.99	18.97	140.5	141.7	9.700	9.867	7.963	7.845
B1C2	17.85	18.37	135.4	136.0	9.278	9.456	6.416	6.312
LSD 0.05	0.46	0.40	5.6	5.7	0.499	0.514	0.265	0.312
				CXT				
T0C0	15.45	15.71	101.1	104.5	7.733	7.817	5.893	5.841
T0C1	15.60	16.25	107.5	110.5	8.200	8.300	6.455	6.349
T0C2	15.53	16.13	101.0	104.8	8.100	8.217	5.905	5.767
T1C0	16.36	16.71	117.3	117.5	8.400	8.400	7.506	7.427
T1C1	18.33	17.98	134.1	134.5	9.450	9.617	7.530	7.428
T1C2	17.18	17.28	131.0	131.1	9.017	9.183	6.147	5.968
T2C0	17.05	17.15	123.6	122.0	8.167	8.200	7.926	7.774
T2C1	19.68	19.50	148.3	145.3	9.750	9.917	7.772	7.668
T2C2	18.48	18.78	138.3	138.3	9.467	9.633	6.817	6.698
LSD 0.05	0.56	0.49	6.9	7.0	N.S.	N.S.	0.324	0.382

Table 4 C. Yield and quality traits of carrot plant after treatment for individual factors of fall 2018 and fall 2019 seasons

treatments	carrot length (cm)		carrot weight (g.)		TSS (%)		total sugars (mg.100g^{-1})	
	2018	2019	2018	2019	2018	2019	2018	2019
				B				
B0	16.30	16.46	114.7	114.3	8.359	8.478	6.570	6.458
B1	17.84	18.10	131.1	132.0	9.037	9.141	7.197	7.079
LSD 0.05	0.27	0.23	3.2	3.3	0.288	0.297	0.153	0.180
				T				
T0	15.52	16.03	103.2	106.6	8.011	8.112	6.084	5.986
T1	17.29	17.32	127.6	127.7	8.956	9.067	7.061	6.941
T2	18.40	18.47	136.7	135.2	9.128	9.250	7.505	7.380
LSD 0.05	0.33	0.28	4.0	4.0	0.353	0.363	0.187	0.221
				B				
C0	16.28	16.52	114.2	114.7	8.100	8.139	7.108	7.014
C1	17.87	17.91	130.0	130.1	9.133	9.278	7.252	7.148
C2	17.06	17.40	123.4	125.0	8.861	9.011	6.289	6.144
LSD 0.05	0.33	0.28	4.0	4.0	0.353	0.363	0.187	0.221

Exogenous application of sprouted barley aqueous extract, trehalose, and calcium was efficiently utilized by increasing the vegetative growth, quality, and yield traits. The reason behind this could be due to the synergetic effect of each factor in triggering different activation of different cellular process. Sprouted barley aqua extract has sufficient amount of gibberellins (Table 2), which has a role in cells division and elongation. In addition to that; trehalose spray has a contribution in nitrate assimilation in leaves (15). Meristematic cells need calcium to form the spindle and enlarge the cells (4;22). As a result that's all led to optimizing vegetative, quality, and yield traits. The significant impact of T2B1 in vegetative growth, quality, and yield traits could be due to trehalose role in increasing photosynthesis and plant biomass (15), thus has an impact on chlorophyll accumulation in leaves (2). Moreover, sprouted barley aqua extract has bioavailable forms of nutrients (Table 2). The superiority of B1C1 in vegetative growth, quality, and yield traits. may be due to contributing those factors in enhancing plant structure by their impact on cell walls i.e. calcium is a main component of cell walls and gibberellins (in sprouted barley aqua extract Table 2) have a role in cell wall extensibility, which led to form strong cell walls and highly organized cells with better aqueous relationships. In fact, that's all reflecting the improvement of plant growth and dry matter accumulation and yield (22). The significant impact of T2C1 in vegetative growth, quality, and yield traits is due to the work of both of calcium and trehalose in preserving cell membranes. In fact, trehalose contributes in cells membranes stability and homeostasis by forming hydrogen bonds between its hydroxyl groups and hydrogen bonds of membranes phospholipids (3). Calcium maintains plasma membranes by increasing its activity by constantly opening or closing Ca^{+2} channels in response to a specific signal, which leads to better functioning of membranes. This means better control over the biological processes in the plant, better diagnosis and reception of signals and stimuli from outside the cell, and better connection between cells and their biological pathways (4; 22). As a result, better efficiency and homeostasis of the plant tissues and improving the growth and development in the plant. The significant influence of all individual treatments is due to their impact on plant metabolism from different angles, which leads to improving plant fitness and increasing its growth, development and responses to external signals and enhances its absorption and assimilation of the elements, i. e. The richness of aqueous extract of barley sprouts in gibberellin and bioavailable nutrients (Table 2) and the effect of trehalose in increasing photosynthesis rates and plant biomass (15). Besides, trehalose role in regulation nitrate assimilation enzymes (15) Finally, calcium effect in building plant structure as a major component of plant cell walls as well as being a cellular and osmotic regulator and co-enzymatic for several biological processes in plants (4; 7;22). In conclusion; two seasons of field and laboratory studies authenticate that aqueous extract of barley sprouts, trehalose, and moderate level of calcium had a profound role in enhancing vegetative, quality, and yield traits in carrots.

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