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RESPONSE OF TWO MUSKMELON HYBRID TO SEAWEED AND LICORICE ROOT EXTRACT FOLIAR FERTILIZERS

Ahmed M.T. Ahmed[1*], Abduljabbar I. Saeid[2]

[1]Amedi Technical Institute, Dohuk Polytechnic University- Iraq.
[2]College of Agricultural Engineering Sciences, University of Dohuk-Iraq.
Corresponding author: ahmed.tahir@dpu.edu.krd

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ABSTRACT:

A field experiment was conducted at Malta Dohuk government research farm in Dohuk province to investigate the impact of licorice root extract at three concentrations (0, 8, and 16 $g.L^{-1}$) and Maxi Grow at three concentrations (0, 5, and 10 $ml.L^{-1}$) on two muskmelon hybrids (ES 3111 F1 and ES 335 F1). Both hybrids received foliar sprays, and their combined effects on the growth and yield of the hybrids were examined. The experiment adhered to a randomized complete block design (RCBD) with three replicates. The results demonstrated that the influence of the muskmelon hybrids on growth and yield was not significant, except for Total Soluble Solids (TSS), which was higher in the hybrid ES 3111 F1 compared to ES 335 F1. In contrast, Maxi Grow at (10) $ml.L^{-1}$ exhibited significant positive effects on all studied traits compared to the control group. Similarly, foliar application of licorice root extract at 16 $g.L^{-1}$ significantly enhanced vegetative growth parameters (number of leaves per plant, number of branches per plant, with no effect on chlorophyll content), as well as stem diameter and yield-related traits such as the number and weight of fruits per plant. Notably, the combined interaction of licorice root extract at 16 $g.L^{-1}$ and Maxi Grow at 10 $ml.L^{-1}$ had the most favorable impact on the studied characters, particularly when applied to the ES 335 F1 hybrid. The results suggest that the use of licorice root extract and Maxi Grow is recommended for the organic production of the ES 335 F1 hybrid.

KEYWORDS: muskmelon, licorice root extract, maxi grow, foliar fertilizer

1. INTRODUCTION

Musk melon attitudes out as a significant vegetable crop globally, famous for its taste, flavor, and rich content of phytonutrients (Lester, 2008). The rapid growth and short life cycle of muskmelons necessitate a well-balanced fertilizer application to enhance both yield and quality. Reports of major and micronutrient deficiencies in melon are wide spread (Carmona *et al*., 2015).

Melon crops, especially in dry climates with moisture deficits, are particularly susceptible to nutrient deficiencies (Cabello *et al*., 2009). Among micronutrients, boron assumes a crucial role in growth and development, influencing physiological processes such as nitrogen metabolism, protein formation, cell division, and cell wall formation, translocation of carbohydrates, pollen tube germination, and fruit formation (Ahmad *et al*., 2009; Mengel and Kirkby, 1982).

Foliar fertilization emerges as an effective strategy for enhancing yield by improving crop nutrient levels during periods of high demand, particularly during flowering and fruiting stages (Lovatt, 2013). Maxigrow, an organic product primarily derived from seaweed extracts, offers substantial benefits in agriculture. Seaweed extracts, renowned as biostimulants synthesized from brown algae, exhibit the ability to stimulate crop growth, improve harvest quality, and enhance plant resilience to stress. These extracts contain essential hormones such as auxin, cytokinin, gibberellin, and various bioactive compounds like seaweed polysaccharide, sugar alcohol, betaine, and phenolic compounds, which have been widely utilized in agriculture for decades (Crouch and van Staden, 1993; Jardin, 2012; Battacharyya *et al*., 2015; Mukherjee and Patel, 2020).

Licorice extract, derived from plants within the Leguminosae family, notably Glycyrrhiza glabra, contains over 100 compounds, including triterpene saponins and phenolic compounds (Shibata, 2000; Shabani *et al*., 2009). Recent studies underscore the potential of plant extracts as safer alternatives to chemically synthesized growth regulators and fertilizers. Various research findings (Al-Ajeeli, 2005; Moses *et al*., 2002; Sabry *et al*., 2009) indicate that licorice root extract contains compounds with effects akin to growth promoters and a diverse range of minerals (Ca, K, Mg, Fe, Zn, P), along with amino acids.

Numerous studies have demonstrated the effectiveness of seaweed extracts, particularly on cucurbit crops. Al-layla and Al-Din (2011) investigated the impact of seaweed extracts, specifically Algamax and Algreen, as foliar sprays on muskmelon growth and yield. The results indicated a significant improvement in growth and yield attributes compared to the control group. Similarly, Suhail (2013) found that applying seaweed extracts and mycorrhizal fungi to cucumber plants positively influenced their growth and yield characteristics compared to a control group. Rouphael *et al*. (2017) demonstrated that foliar addition of seaweed extracts enhanced vegetative components and yield and quality traits of zucchini squash crop as matched to control.

The aim of the study is to find out the impact of licorice extracts and an organic fertilizer (Maxigrow) on organic growth and productivity of two muskmelon hybrids to produce safer crop with better harvest income and quality.

2. MATERIAL AND METHOD

The experiment was conducted on April 15th 2023 at the Malta Dohuk government research farm in Dohuk the Kurdistan

* Corresponding author

region of Iraq. Initially, seeds were planted in plastic cup within a plastic house, and animal manure was incorporated into the soil before planting. The field research utilized a factorial experiment design in a split-split plot layout within a randomized complete block design (RCBD), consisting of three factors with three replications.

In the main plot, two Muskmelon hybrids (Es3111F1 and Es 335 F1) were employed. The second factor involved the application of seaweed treatment (Maxi Grow) at concentrations of 0, 5, and 10 ml L^{-1} in the sub-plots. The third factor introduced licorice at three levels (0, 8, 16 g. L^{-1}) in the sub-sub plots, resulting in a total of 18 treatments (2*3*3=18). The first spraying occurred after the plants reached five leaves, the second spraying took place 15 days after the first, and the third spraying occurred 15 days after the second, with a three-day interval between Maxi Grow and licorice spraying.

The experimental area was divided into plots measuring 100 cm in width and 500 cm in length, with a total area of 5m² for each unit. The spacing between plants was set at 80 cm, and the distance between rows was 100 cm.

Data analysis was conducted using the SAS program (SAS, 2010), and Duncan's multiple range tests was employed to compare mean values at a significance level of 0.05 or 5%. For data collection, five randomly selected plants from each experimental group were examined for yield and its associated parameters. The cultural practices were implemented regularly such as drip irrigation, weeding, soil softening, and pathogen monitoring and control

The plant length was measured with measuring bar. The chlorophyll content was estimated by chlorophyll meter (SPAD-502, Konica Minolta). The number of leaves was enumerated and the average was calculated. The plant fresh and dry weight was measured with sensitive electric balance. The fruit weight was also measured with sensitive electric balance whereas the fruit diameter was determined with measuring bar. The number of fruits per plant was determined as total fruit number/experiment unit subdivided by plant number in each experimental unit. The TSS % was measured using the Hand Refracto-meter apparatus (A.O.A.C, 1980).

3. RESULT

Plant length (cm)

Table (1) presents data indicating the impact of muskmelon hybrid, Maxi Grow, and licorice on plant length. No significant difference was observed between the two hybrids, except for Es3111F1 (164.59 cm), which surpassed Es335F1 (163.48 cm). Regarding the influence of Maxi Grow, significant differences were noted among the applied doses, with a length of 174.66 cm at the $10g.l^{-1}$ level compared to the control's 145.27 cm. The effect of licorice also demonstrated a significant difference, particularly at the 16g/l level, where the length was 170.89 cm, compared to the 8 g. L^{-1}rate of 153.78 cm.

Examining the interaction between hybrids and Maxi Grow, a significant difference was observed in hybrid Es3111F1, reaching 176.11 cm at the 10 ml. L^{-1} level, compared to the untreated hybrid at 143.116 cm. The combination of hybrids and foliar spray with licorice exhibited a significant difference, with a length of 180.66 cm at the 16 g. L^{-1} licorice level in hybrid Es3111F1 compared to the same hybrid at the 8g.L .l rate (150.89 cm).

Additionally, the interaction between Maxi Grow and licorice extract, as shown in Table (1), indicated significant differences at the 10 ml. L^{-1} Maxi Grow and 16 g. L^{-1}licorice levels, providing a length of 198.5 cm compared to the untreated group with Maxi Grow and 16 ml. L^{-1} resulting in a length of 135.83 cm.

The triple interaction among all factors revealed a significant variation, with the highest length obtained in hybrid Es3111F1 at the 10 ml. L^{-1} Maxi Grow and 16 g. L^{-1} licorice extract, reaching a length of 203 cm, compared to hybrid Es335F1, which had a length of 194.00 cm

Table 1: Effect of foliar application by Maxi-grow and licorice on plant length (cm) of two muskmelon hybrids

Hybrids	Maxi grow ml. L^{-1}	Licorice g. L^{-1}			Hybrid * Maxigrow	Mean of Hybrids
		0.0	8.0	16.0		
Es3111F A 1	0.0	146.00^{e-g}	145.33^{e-g}	138.00^{fg}	143.11^{b}	164.59^{a}
	5	179.67^{a-d}	141.00^{e-g}	203.00^{a}	174^{a}	
	10	161.00^{d-g}	141.00^{e-g}	203.00^{a}	17 6.1^{a}	
A2 Es335 F1	0.0	162.33^{e-g}	146.33^{e-g}	133.6^{g}	147.44^{b}	163.48^{a}
	5	183.67^{a-d}	165.33^{c-g}	155.67^{d-g}	168.22^{a}	
	10	172.00^{b-e}	158.33^{d-g}	194.00^{a-c}	174.78^{a}	
Mean of licorice		167.445^{b}	153.78c	170.89^{a}	Mean of maxi grow	
Hybrid * licorice	A1	162.22^{bc}	150.89^{cd}	180.66^{a}		
	A2	172.67^{ab}	156.67^{bc}	161.1^{abc}		
Maxigrow * licorice	0.0	154.16^{bc}	145.83^{de}	135.83^{e}	0.0	145.27^{b}
	5	172.33^{cd}	165.83^{cd}	178.33 ^{bc}	5	172.17^{a}
	10	175.83 ^{de}	149.66^{de}	198.5^{a}	10	174.66^{a}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

Number of leaves

Data illustrated in table (2) shows that the Hybrid Es3111F1 was significant with 162.11 leaves/plant compared by hybrid Es335F1 provide 149.7 leaves/plant. About maxi grow effect remarked significant variance among doze applicant at level ofs10 ml. L^{-1}, was 191.38 leaves compared by 5gm/l (136.17) leaves.

Regarding the effect of licorice observer significant difference in foliar doze sprayed in rate of 16 g. L^{-1} provide 201.9 leaves compare by no treated 128.78 leaves.

Table 2: Effect of foliar application by Maxi-grow and licorice on number of leaves of two muskmelon hybrids

Hybrids	Maxi grow ml. L^{-1}	Licorice g. L^{-1}			Hybrid * maxigrow	Mean of Hybrids
		0	8	16		
A1 Es3111F1	0.0	88.00^{j}	116.67^{g-j}	205.67^{b}	136.78^{b}	162.11^{a}
	5	129.67^{e-i}	120.67^{f-i}	165.67^{cd}	138.67^{b}	
	10	162.67^{cde}	176.00^{bcd}	294.67^{a}	211.11^{a}	
A2 Es335 F1	0.0	115^{ij}	$108.33^{i\ j}$	208.00^{a}	143.77^{b}	149.7^{b}
	5	123.67^{f-i}	147.67^{d-h}	129.67^{e-i}	133.67^{bc}	
	10	152.00^{d-g}	155.00^{c-f}	208.00^{a}	171.66^{a}	
Mean of licorice		128.50^{c}	137.39^{bc}	201.9^{a}	Mean of maxi grow	
Hybrid * licorice	A1	126.78^{c}	152.78^{b}	222.78^{a}		
	A2	130.22^{bc}	137.78^{b-e}	181^{b}		
Maxigrow * licorice	0.0	101.5^{e}	112.50^{de}	206.83^{b}	0.0	140.28^{b}
	5	126.67^{d}	134.17^{c}	147.67^{c}	5	136.17^{c}
	10	157.335^{c}	165.50^{c}	251.33^{a}	10	191.38^{a}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

The interaction between hybrids and maxi grow in above table is significant difference hybrid Es3111F1 gave 211.11 leaves at level of 10 ml. L^{-1} copper by a Es335F1 hybrid provide 133.67 leaves. Concerning the combination between hybrids and licorice extract is significant difference. Hybrid Es3111F1 at level of 16g. L^{-1}

- 1- l offered 222.78 leaves/plant compared by a same hybrid 126.78 leaves no treated with licorice extract.

Regarding the interaction between Maxigrow and licorice extract observer significant variance at level of 10 ml. L^{-1} and ml. L^{-1} 251.33 leaves compare with no treated 101 leaves.

Concerning The triple interaction among all three factors remarket significant difference 294.67 leaves in hybrid Es3111F1, with concentration 16 g. L^{-1} licorice and 10 ml. L^{-1} maxi grow compare by a same hybrid no treated with foliar spraying.

Branch numbers

Result in table (3) indicated effect of maxi grow, licorice extract on branch number of two musk melon hybrids and their interaction result shows significant difference between hybrids. Hybrid Es11F1 with number of branches 4.09 overcome hybrid Es335F1 3.60 branch. About the licorice effect on number of branch observer significant among doze of licorice at level 16g. L^{-1} provide 4.03 branch compare with zero licorice 3.88 branch. Regarding effect of maxi grow remarket at rate of 10 ml. L^{-1} provide4.07 branch.

The interaction between hybrids and maxi grow on number of branches observe significant change at level of 10 g.L^{-1} in hybrid Es3111F1 provide 4.21 branch compared with hybrid Es335F1 no treated 3.33 branch. About the interaction between hybrids and licorice extract remarked] significant difference 4.40 branch at level of 16gm/l in Es3111F1 compared with level of 8gm/l in Es335F1 hybrid 3.29 branch.

Concerning the interaction between maxi grow and licorice extract on branch number at level of 16g.$^{L\text{-}1}$ licorice extract and 10 ml. L^{-1} of maxi grow was 4.26 branch compared with 3.17 l at rate of 8 g. L^{-1} licorice and zero maxi grow.

Apropos triple interaction among three factors observer significant difference, hybrid Es3111F1 at level of 16 ml. L^{-1} licorice and the rate of10 ml. L^{-1} maxi grow had the highest results 4.50 branch/plant as compare to other interactions.

Table 3: Effect of foliar application by Maxi-grow and licorice on branch number of two muskmelon hybrids

Hybrids	Maxi grow ml. L^{-1}	Licorice g. L^{-1}			Hybrid * Maxigrow	Mean of hybrid
		0	8	16		
A1 Es3111F1	0.0	4.00^{a}	3.67^{b}	4.00^{a}	3.89^{b}	4.09^{a}
	5	3.86^{b}	4.25^{a}	4.40^{a}	4.17^{a}	
	10	3.80^{b}	4.33^{a}	4.50^{a}	4.21^{a}	
A2 Es335 F1	0.0	3.67^{a}	2.67^{b}	3.67^{b}	3.33^{b}	3.60^{b}
	5	3.67^{a}	$3..33^{a}$	3.65^{c}	3.55^{ab}	
	10	3.90^{a}	3.87^{a}	4.03^{a}	$3..93^{a}$	
Mean of licorice		3.88^{ab}	4.68^{b}	4.04^{a}	Mean of Maxigrow	
Hybrid * licorice	A1	4.00^{a}	4.08^{a}	4.30^{a}		
	A2	3.75^{ab}	3.29^{c}	3.78^{b}		
Maxigrow * licorice	0.0	3.83^{b}	3.17^{c}	3.83^{b}	0.0	3.61^{c}
	5	3.76^{bc}	$3.79.00^{b}$	4.05^{a}	5	3.84^{b}
	10	$3..85^{b}$	4.1^{a}	4.26^{a}	10	4.07^{a}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

Stem diameter (cm)

The data presented in Table (4) highlights the impact of Maxi Grow, licorice extract, and their interaction on the stem diameter (cm) of two muskmelon hybrids, with no significant difference observed between the hybrids. The influence of Maxi Grow on stem diameter revealed significant variation among the applied doses. The baseline result without treatment was 3.24 cm, whereas plants sprayed with 10 ml. L $^{-1}$showed a reduced diameter of 2.98 cm.

The effect of licorice extract on stem diameter demonstrated a significant change, with plants without treatment measuring 3.16 cm, compared to 2.98 cm at the 8 g. L $^{-1}$ level. The interaction between hybrids and Maxi Grow exhibited significant variation, where hybrid Es335F1 without foliar spray showed a higher stem diameter compared to the same hybrid at the 10 ml. L $^{-1}$ Maxi Grow level.

The interaction between hybrids and licorice revealed a significant difference. In hybrid Es335F1 without treatment, the stem diameter was 3.32 cm, compared to the same hybrid at rates of 8 g. L $^{-1}$ and 16 g. L $^{-1}$, which resulted in a diameter of 2.93 cm. The combination of Maxi Grow and licorice extract, as shown in Table (4), demonstrated no significant differences among the applied doses. The baseline result without treatment was 3.53 cm that was higher than other different doses.

Regarding the triple interaction among hybrids, Maxi Grow, and licorice, there was no significant variance. Hybrid Es335F1 without treatment had a stem diameter of 4.10 cm compared to 2.90 cm with the combined application of Maxi Grow and licorice.

Table 4: Effect of foliar application by Maxi-grow and licorice on stem diameter (cm) of two muskmelon hybrids (cm)

Hybrids	Maxi grow ml. L $^{-1}$	Licorice g. L $^{-1}$			Hybrid * Maxigrow	Mean of hybrid
		0	8	16		
A1 Es3111F1	0.0	2.97^{c}	3.10^{bc}	3.40^{b}	3.16^{ab}	3.09^{a}
	5	2.90^{c}	3.07^{bc}	3.23^{bc}	3.07^{bc}	
	10	3.10^{bc}	2.93^{c}	3.07^{bc}	3.03^{bc}	
A2 Es335 F1	0.0	4.10^{a}	3.00^{c}	2.87^{c}	3.32^{b}	3.06^{a}
	5	2.90^{c}	2.90^{c}	3.03^{c}	2.94^{c}	
	10	2.97^{c}	2.90^{c}	2.90^{c}	2.92^{c}	
Mean of licorice		3.16^{a}	2.98^{b}	3.08^{ab}	mean of Maxigrow	
Hybrid * licorice	A1	2.99^{b}	3.03^{b}	3.23^{a}		
	A2	3.32^{a}	2.93^{b}	2.93^{b}		
Maxigrow * licorice	0.0	3.53^{a}	3.05^{b}	3.13^{b}	0.0	3.24^{a}
	5	2.90^{b}	2.98^{b}	3.13^{b}	5	3.01^{b}
	10	3.03^{b}	2.92^{b}	2.98^{b}	10	2.98^{b}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

Chlorophyll Content

Table (5) illustrates the impact of Maxi Grow and licorice extract on chlorophyll content in the leaves of two muskmelon hybrids. The table indicates no significant difference between hybrids regarding chlorophyll content. Regarding the influence of Maxi Grow, untreated plants exhibited a chlorophyll content of 104.88, while those treated with 5 ml. L $^{-1}$ showed a reduced content of 89.62. The impact of licorice extract resulted in a baseline content of 101.12 at the 8 g. L $^{-1}$ level.

The interaction between hybrids and Maxi Grow was significant, with hybrid Es3111F1 exhibiting a content of 106.19 without treatment, compared to the same hybrid at the 5 ml. L $^{-1}$level, which showed a content of 88.82. Concerning the interaction between hybrids and licorice extract, hybrid Es3111F1 at the 8 ml. L $^{-1}$ licorice foliar spray level showed a significant difference with a content of 101.92, compared to the same hybrid at the 16 g. L $^{-1}$ rate, which exhibited a content of 93.85.

Examining the combination of Maxi Grow and licorice extract on chlorophyll content, significant differences were observed. At the zero Maxi Grow and 8g/l licorice level, the content was 110.65, compared to the content of 86.20 at the 5 ml. L $^{-1}$ Maxi Grow and 8 g. L $^{-1}$ licorice level.

The interaction among hybrids, Maxi Grow, and licorice extract also showed significant variance. In hybrid As335F1, at the zero Maxi Grow and 8 g. L $^{-1}$licorice level, the chlorophyll content was 110.67, compared to the same hybrid and 5m.l max grow and 8 g. l licorice (85.80).

Table5: Effect of foliar application by Maxi-grow and licorice on chlorophyll content of two muskmelon hybrids

Hybrids	Maxi grow ml. L $^{-1}$	Licorice g. L $^{-1}$			Hybrid * Maxigrow	Mean of hybrid
		0	8	16		
A1 Es3111F1	0	109.87^{a}	110.63^{a}	98.07^{bcd}	106.19^{a}	99.13^{a}
	5	91.57^{de}	86.60^{de}	88.30^{de}	88.82 ^{b}	
	10	104.23^{ab}	108.53^{a}	94.40^{cde}	102.39^{a}	
A2 Es335 F1	0	103.00^{abc}	110.67^{a}	97.07^{bcd}	103.58^{a}	98.40^{a}
	5	95.17^{cde}	85.80^{e}	90.30^{de}	90.42^{b}	
	10	101.60^{abc}	104.47^{ab}	97.53^{bcd}	101.20^{a}	
Mean of licorice		100.91^{a}	101.12^{a}	94.28^{b}		

Hybrid * licorice	A1	101.89[a]	101.92[a]	93.59[b]	Mean of Maxigrow	
	A2	99.92[a]	100.31[a]	94.97[b]		
Maxigrow * licorice	0.0	106.43[ab]	110.65[a]	97.57[cd]	0.0	104.88[a]
	5	93.37[de]	86.20 [f]	89.30[ef]	5	89.62[b]
	10	102.92[bc]	106.50[ab]	95.97[d]	10	101.79[a]

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

Fruit weight (g)

Data in table (6) indicated effect of maxi grow and licorice on fruit weight of two mask melon hybrids. Hybrid Es335F1 was significant provide 1283.79 g compared with hybrid Es3111F gave 967.38g. About effect of maxi grow and licorice no difference among dose applicator on muskmelon weight.

Concerning the interaction between hybrids and maxi grow, it is significant variance at hybrid Es335 F1 no treated gave 1470.79 g weight compare by hybrid Es3111F1 gave 840.28 g. The interaction between hybrids and licorice observer significant variance hybrid Es335 F1 provide 1379.64 g at level of 16 g. L^{-1} compared with hybrid Es3111F1 gave 1066.29 g no treated. Regarding the interaction between maxi grow and licorice remarked no significant variance observed.

About the interaction among all factor observer significant difference hybrid Es335 F1 offered 1534.46 g at rate of 16 g. L^{-1} licorice and zero maxi grow, compare by hybrid Es3111F1provide 724.26 g at level of 8g/l licorice and 10 ml. L^{-1} maxi grow.

Table 6: Effect of foliar application by Maxi-grow and licorice on fruit weight (g) of two muskmelon hybrids

Hybrids	Maxi grow ml. L^{-1}	Licorice g. L^{-1}			Hybrid * Maxigrow	Mean of hybrid
		0	8	16		
A1 Es3111F1	0.0	793.36[bc]	961.05[abc]	766.44[bc]	840.28[b]	967.38[b]
	5	1258.9[abc]	1159.94[abc]	842.66[bc]	1087.18[ab]	
	10	1146.58[abc]	724.26[c]	1053.21 [abc]	974.68[b]	
A2 Es335 F1	0.0	1245.44[ab]	1.123.29[abc]	1482.65[a]	1470.79[a]	1283.79[a]
	5	1411.43[abc]	1026.54[abc]	1102.47[abc]	1180.15[ab]	
	10	842.28[bc]	1534.46 [a]	1253.80[abc]	1210.18[ab]	
Mean of licorice		1182.84[a]	1065.26[a]	1133.54[a]	mean of Maxigrow	
Hybrid * licorice	A1	1066.29[ab]	948.42[ab]	887.44 [b]		
	A2	1299.38[ab]	1182.10[ab]	1379.64[a]		
Maxigrow * licorice	0.0	1218.90[a]	973.17[a]	1274.55[a]	0.0	1155.54[a]
	5	1335.18[a]	1093.24[a]	972.57[a]	5	1133.66[a]
	10	994.43[a]	1129.36 [a]	1153.51[a]	10	1092.43[a]

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.**TSS%**

Table (7) presents the impact of licorice and Maxi Grow on TSS% (Total Soluble Solids) in two muskmelon hybrids, revealing significant differences between the hybrids. Hybrid Es1113F1 exhibited a TSS of 6.04%, surpassing Es335F1, which had a TSS of 5.56%. Regarding the effect of Maxi Grow, the results showed a substantial difference, with plants without treatment providing a TSS of 6.42% compared to other treatments. However, no significant difference was observed in the effect of licorice across the various doses.

Analyzing the interaction between hybrids and Maxi Grow, Es1113F1 was significant, yielding a TSS of 6.97%, compared to Es335F1, which obtained 5.08% when treated with Maxi Grow and licorice. The interaction between hybrids and licorice resulted in significant variance, particularly in hybrid Es1113F1 at the 16 g. L^{-1} level, providing a TSS of 6.20%, compared to Es335F1 offering 5.21% at the rate of g ml. L^{-1} result was obtained with Maxi Grow at 8ml/l and licorice at 16 g. L^{-1}, resulting in a TSS of 7.50%, compared to examining the interaction between Maxi Grow and licorice root extract, the best the control's 4.65%.

The triple interaction among all factors, particularly in hybrid Es335F1, showed a TSS of 7.37%, with significant variance. The best value was obtained at the g ml. L^{-1} licorice and 5 ml. L^{-1} Maxi Grow level, comparing favorably to the control's 5.67% TSS

Table7: Effect of foliar application by Maxi-grow and licorice on TSS% of two muskmelon hybrids

Hybrids	Maxi grow ml. L^{-1}	Licorice g. L^{-1}			Hybrid * Maxigrow	Mean of Hybrid
		0	8	16		
A1 Es1113F1	0	7.33[a]	7.10[ab]	6.47[b]	6.97[a]	6.04[a]
	5	4.70[def]	5.43[cd]	7.63[a]	5.92[b]	
	10	5.67[c]	5.50[cd]	4.50[fg]	5.22[c]	
A2	B1	6.97[ab]	6.90[ab]	3.77[g]	5.88[b]	5.56[b]

Es335F1	B2	4.60^{ef}	5.20^{c-f}	7.37 ^{a}	5.72^{b}	
	B3	5.37^{cde}	5.37^{cde}	4.50^{fg}	5.08 c	
Mean of C Licorice		5.77^{a}	5.92^{a}	5.71^{a}	Mean of maxi grow	
Hybrid * licorice	A1	5.90^{ab}	6.01^{ab}	6.20^{a}		
	A2	5.64 ^{b}	5.82^{ab}	5.21^{c}		
Maxigrow * licorice	B1	7.15^{a}	7.00^{a}	5.12^{bc}	0.0	6.42^{a}
	B2	4.65^{cd}	5.32^{b}	7.50^{a}	5	5.82^{b}
	B3	5.52^{b}	5.43 ^{b}	4.50d	10	5.15^{c}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

Number of fruits/ plants

The data presented in Table (8) reveals the impact of Maxi Grow and licorice extract on the number of fruits per plant, with significant variation observed in hybrid Es335 F1, where 4.43 fruits were recorded compared to Es335 F1, which produced 4.13 fruits. Concerning the effect of Maxi Grow, a significant difference was noted among foliar applications at the 10ml.$^{L-1}$ level, yielding 4.26 fruits compared to the untreated plants, which produced 3.91 fruits.

The effect of licorice root extract was also significant, particularly at the 16 g. L $^{-1}$ level, resulting in 4.71 fruits compared to the untreated plants, which produced 4.02 fruits. Examining the interaction between hybrids and foliar Maxi Grow spray revealed significant modifications, with hybrid Es3111F1 producing 5.04 fruits at the 10ml/l level compared to the same hybrid, which yielded 3.87 fruits.

Table8: Effect of foliar application by Maxi-grow and licorice on fruit number/plant of two muskmelon **hybrids**

A Hybrids	Maxi grow ml/l	Licorice g/l			A*B	Mean of Hybrid A
		0	8	16		
A1 Es3111F1	0.0	3.51^{b}	4.00^{b}	4.10^{b}	3.87^{b}	4.43^{a}
	5	4.22^{b}	4.42^{ab}	4.53^{ab}	4.39^{ab}	
	10	4.55^{ab}	4.63^{ab}	5.94^{a}	5.04^{a}	
A2 Es335 F1	0.0	3.81^{b}	4.37^{b}	3.50^{b}	3.89^{b}	4.13^{b}
	5	3.30^{ab}	4.27^{ab}	4.40^{ab}	3.99^{b}	
	10	4.74^{ab}	4.04^{b}	4.82^{ab}	4..53^{ab}	
Mean of licorice		4.02^{b}	4.26^{ab}	4.71^{a}	Mean of maxi grow B	
A*C	A1	3.90^{b}	4.01^{b}	5.10^{a}		
	A2	3.64^{b}	4.15^{b}	4.43^{ab}		
B*C	0.0	3.52^{b}	3.73^{ab}	4.50^{ab}	0.0	3.91^{b}
	5	3.95^{ab}	4.42^{ab}	4.47^{ab}	5	4.28^{ab}
	10	4.23^{b}	4.68^{ab}	5.45^{a}	10	4.78^{a}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

The interaction between hybrids and licorice root extract in above table result significant difference hybrid Es3111F1 at level of 16 ml. L $^{-1}$ provide 5.10 fruits compare by hybrid Es335F1 gave 3.64 fruits.

Regarding the interaction between Maxi grow and licorice root extract on number of fruits/plants were significant difference at level of 16 g. L $^{-1}$licorice and 10 m l. $^{-1}$ maxi grow provide 5.45 fruits compare by no treated plant 3.52 fruits.

About triple interaction among all remarked significant difference, hybrid Es3111F1 at rate of 16 g. L $^{-1}$ licorice root extract and 10 ml. L $^{-1}$ maxi grow provide 5.94 fruits compare by no treated 3.51 fruits in a same hybrid.

Total yield ton/ha

Table (9) presents the effects of the studied factors on total yield (t/ha), indicating no significant difference between both cultivars. Regarding the effect of Maxi Grow, a significant variance in yield was observed at the 10 ml. L $^{-1}$ level, producing 40 tons compared to the untreated plants, which yielded 37.54 tons.

The impact of licorice showed a significant difference, particularly at the 16 g. L $^{-1}$ level, resulting in a yield of 45.66 tons compared to the untreated plants, which produced 38.88 tons. The interaction between hybrids and Maxi Grow was significant, with hybrid Es335 F1 yielding 44.9 tons at the 10 ml. L $^{-1}$ level, compared to the untreated hybrid Es3111 F1, which produced 37.58 tons.

The interaction between hybrids and licorice extract also demonstrated a significant difference, where hybrid Es335 F1 provided 48.56 tons at the 16 ml. L $^{-1}$ rate, compared to hybrid Es3111 F1, which yielded 35.22 tons at the 5 ml. L $^{-1}$ level. Examining the interaction between Maxi Grow and licorice root extract at the 10 ml/l Maxi Grow and 8 g.L^{-1} licorice rate revealed a significant difference, producing 47.94 tons compared to the control (untreated).

The triple interaction of all studied factors was significant for total yield, with hybrid Es3111 F1 treated with licorice extract at a concentration of 16 ml. L $^{-1}$ and Maxi Grow at 5 ml/l showing the highest average yield of 50.74 tons/ha, compared to hybrid Es335 F1, which yielded 35.64 tons at the 8 g. L $^{-1}$ licorice root extract and untreated by Maxi Grow.

Table 9: Effect of foliar application by Maxi-grow and licorice on total yield (ton. ha^{-1}) of two muskmelon hybrids

Hybrids	Maxigrow ml. L^{-1}	Licorice g. L^{-1}/			A*B	Mean of hybrid A
		0	8	16		
A1 Es3111F1	0	37.82^{b}	35.92^{bc}	38.96^{bc}	37.56^{b}	41.76^{a}
	5	40.82^{a-c}	44.3^{a-c}	43.66^{bc}	42.92^{ab}	
	10	41.48^{c}	42.34^{a-c}	50.74^{a}	44.84^{a}	
A2 Es335 F1	0	36.4^{a-c}	35.64^{bc}	44.12^{a-c}	38.72^{b}	42.04^{a}
	5	38.12^{a-c}	41.68^{ab}	45.84^{ab}	41.88^{ab}	
	10	38.68^{a-c}	47.32^{ab}	48.72^{a}	44.9^{a}	
Mean of licorice		38.88^{b}	41.2^{ab}	45.66^{a}	Mean of maxi grow B	
A*C	A1	37.38^{b}	35.22^{b}	41.52^{b}		
	A2	45.72^{ab}	41.6^{b}	48.56^{a}		
B*C	0	34.22^{c}	39.94^{b}	38.48^{b}	0	37.54^{b}
	5	35^{c}	39.48^{b}	40.6^{b}	5	38.44^{ab}
	10	34.24^{c}	47.94^{a}	37.82^{b}	10	40.00^{a}

Letters with the means refer to Duncan's multiple range test at 5% level of confidence, with the same letter are not significantly different from each other.

4. DISCUSSION

In the previous study, the application of organic spray fertilizer, including licorice root extract and Maxi Grow, significantly enhanced the growth and yield characteristics of muskmelon. The findings from Tables (1-5) clearly demonstrate the substantial impact of the studied factors (Hybrids, Seaweed, Licorice) and their interactions on vegetative growth. Hybrid Es3111F1 consistently outperformed Hybrid Es335 F1 across various vegetative and fruit-related parameters, such as plant height, number of branches, chlorophyll levels, leaves number, fruit weight, number of fruits per plant, and Total Soluble Solids (TSS%).

The increase in plant vegetative growth and yield may attribute to the positive efficacy of seaweed extracts. This increment may refer to the effectiveness of seaweed extracts in stimulating further chlorophyll creation and efficient photosynthesis rates due to their rich content of betaine and betain-like compounds that increase chlorophyll pigment and photosynthetic rate adding to that their contribution in enhanced plant endurance to environmental negative circumstances attributed to the adequate content of effective hormones, and other bioactive compounds like seaweed polysaccharide, sugar alcohol, and phenolic compounds (Crouch and van Staden, 1993; Jardin, 2012; Battacharyya *et al*., 2015) altogether led to ameliorate foliage and harvest attributes. When sprayed to plant vegetative growth, seaweed extracts elevated root growth and its potentiality to absorb essential nutrients from soil and bettered stem thickness and foliage outgrowth of plant (Moore 2004; Gollan and Wright, 2006; Khan *et al.*, 2009).

The enhancement in studied characters under foliar spraying with licorice root extract could owe to the rich content of the licorice extract from various active compounds, some of which may have accumulated in considerable amounts, the most prominent of these compounds are phenolic compounds, organic acids, protein amino acid (asparagin), lignins, vitamins, biotin, folic acid, and polysaccharide all of which undertake a great role in bettering plant growth and hence ameliorating the yield and its quality (Rossi,1999; Arystanovaet *et al*., 2001).
This observed effect could be attributed to genetic differences between the hybrids and variations in their root systems, allowing for enhanced nutrient absorption. Licorice and Maxi Grow, being rich in organic components, may contribute to improved environmental conditions, as reported by Gad *et al*. (2012) and Karakurt et al. (2009).

The results strongly suggest that the application of licorice root extract and Maxi Grow, either separately or in combination through foliar spray, yields the best outcomes in enhancing the yield traits of muskmelon plants

CONCLUSION

The organic production of vegetable crops is a safe and sustainable method to satisfy the local demand for high quality products free from chemical contaminants that cannot harm the human health and the environment. In our study, the application of natural inputs like Maxgrow and licorice extract significantly ameliorated the growth and yield of two muskmelon hybrids. Therefore, the use of such organic products are recommended for production of vegetables in Kurdistan region with further studies be implemented on various other crops in Dohuk province.

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