EFFECT OF BIO HEALTH, TECAMIN MAX AND BENZYL ADENINE ON GROWTH CHARACTERISTICS OF SWEET ORANGE SEEDLINGS

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ABSTRACT

This investigation was aimed to study the effect of soil application of Bio health and foliar application with Tecamin max and Benzyl adenine on growth characteristic of sweet orange (*Citrus sinensis* L.) seedlings during two successive seasons (2020 and 2021). Bio health was added with three concentrations (0, 6 and 12 g.L^{-1}) to the soil and foliar application of Tecamin max with three concentration (0, 5 and 10 ml.L^{-1}), Benzyl adenine with three concentration (0, 100 and 200 mg. L^{-1}) on the sweet orange seedlings which were brought from private nursery in Duhok city and have two- years old and nearly uniform in growth vigor. The results proved that all parameters such as increases in plant high, stem diameter, branch numbers, single leaf area, total chlorophyll as soon as leaves carbohydrate and leaves dry weight in both seasons were increased significantly as compared with control, accept Tecamin max had no significant effect on leaves carbohydrates and leaves dry weight, Benzyl adenine no significant effect on leaves dry weight on both seasons, Furthermore, combination among high concentration of Bio health, Tecamin max and Benzyl adenine improved all parameters in comparison with the control.

Keyword: Bio fertilizer, Amino acid, Cytokinin, local, Citrus .
Part of Ph.D. Dissertation of the first author.

تأثير السماد الحيوي والتيكامين ماكس والبنزل ادينين في صفات النمو الخضري لشتلات البرتقال الحلو

عامرة صالح عبدالرحمن شوكت مصطفى محمد الاتروشي
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تهدف هذه التجربة الى دراسة تاثير اضافة السماد الحيوي الى التربة والرش بالتيكامين ماكس والبنزل ادينين على صفات النمو الخضري لشتلات البرتقال الحلو (*Citrus sinensis* L.) خلال موسمي النمو (2020–2021). اضيف السماد الحيوي الى التربة بثلاث تراكيز (0 و 6 و 12) غم.لتر$^{-1}$ والرش بالحامض الاميني تيكامين ماكس بثلاث تراكيز (0 و 5 و10 مل.لتر$^{-1}$ وثلاث تراكيز من البنزل ادينين (0 , 100, 200) ملغ.لتر$^{-1}$ على شتلات البرتقال الحلو التي جلبت من مشتل اهلي في مدينة دهوك، عمرها سنتين ومتماثلة تقريبا في قوة النمو. اظهرت النتائج ان اغلب الصفات مثل الزيادة في ارتفاع وقطرالنبات قطر وعدد الافرع و مساحة الورقة الواحدة والكلوروفيل الكلي وكذلك نسبة الكاربوهيدرات في الاوراق والوزن الجاف للورقة في كلا الموسمين ازدادت معنويا مقارنة بمعاملة المقارنة (الكونترول) ماعدا الرش بالحامض الاميني لم يسبب تاثير معنوي في نسة الكاربوهيدرات والوزن الجاف في الاوراق وكذلك الرش بالبنزل ادينين لم يسبب تاثير معنوي في الوزن الجاف للورقة في كلا الموسمين، اضافة الذلك فان التداخل بين التركيز العالي من السماد الحيوي والحامض الاميني والبنزل ادينين حسنت كل الصفات مقارنة بالكونترول.

الكلمات الافتتاحية: سماد حيوي، حامض اميني، سايتوكاينات، محلي، الحمضيات.
البحث جزء من اطروحة دكتوراه للباحث االاول

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INTRODUCTION

Citrus fruits are one of the most delicious fruits belonging to the family Rutaceae. All commercially important species belong to the genus citrus including sweet orange, Mandarin, lime, Lemon, Sweet lime, Grape fruit, etc. Sweet orange is originated from southern China where it has been cultivated for many years (30). But today it is grown commercially worldwide in tropical, sub-tropical and some temperate regions to become the most widely planted fruit tree in the world (21). Nutrition is an important input that determines the soil health and production as a whole, the application of nutrients to both young and maturing trees determines the vegetative development of citrus trees (27). Today, chemical fertilizers are undesirable in crops nutrition because it had adversely effects on the soil fertility, water quality, yield and quality of the products (6, 33). Therefore, uses of bio-fertilizers, amino acids and Benzyl adenine have assumed great importance for sustainable production and to improve the soil physical, chemical and biological properties. Also, they are a good alternative to reduce uses of chemical fertilizers. In this respect, several workers reviewed the significant role of bio-fertilizers in influencing the soil properties and enhancing the growth, yield and quality of citrus (17, 24, 25). Bio-fertilizers have the potential to increase the health and productivity of plant life and reduce the need to use synthetic fertilizers (7, 8). Most of bio-fertilizers consist of microbes that are involved in the decomposition of organic matter and the breakdown of minerals into a soluble form that is useful to plants. The results Al- Abbasi. (1) showed that bio-fertilizers treatment of Azospirillium and Bacillius with organic fertilization was significantly increased the height of seedling, stem diameter, number of branches, number of leaves, leaf area and shoot fresh and dry weights compared with control treatment which gave the lowest values. Amino acids are organic compounds; the key elements of an amino acid (C, (H, O and N), although other elements are found in the side chains of certain amino acids. About 500 naturally occurring amino acids are known (though only 20 appear in the genetic code) and can be classified in many ways (28). Amino acids have various prominent functions in plants. Besides their usage during protein biosynthesis, they also represent building blocks for several other biosynthesis pathways and play pivotal roles during signaling processes as well as in plant stress response. In general, pool sizes of the 20 amino acids differ strongly and change dynamically depending on the developmental and physiological state of the plant cell (19, 31). The results Al-Himdany. (3) showed that spraying of saplings with Disper chlorophyll had high significant increase in plant length -stem diameter, branch umber, leaves area, root number, root length, root branches compared to the control treatment. Benzyl adenine (BA) can be considered to be an endogenous-like compound which provides very little risk to the environment. A precondition of precocious bearing in young trees is the development of a canopy structure which has good cropping potential and this can be achieved by using BA. The efficiency of PGRs is determined by the physiological age of trees, by the environmental conditions at application and by the application methods used (12). Al-Juboori. (5) investigated the effect of three concentrations of Benzyl adenine (0, 100, 200) mg. L^{-1} and three concentrations of Gibberllic acid (0, 150, 300) mg. L^{-1} on Two citrus seedlings (*Swingle citrumelo and Troyer citrange*). The results showed superiority of *Swingle citrumelo* root stocks in C/N ratio, phosphorus and potassium leaves content for two seasons while Troyer citrange root stock showed superiority in leaves content of (Nitrogen and Protein) which. the treatment of Benzyl adenine 200 ml. L^{-1} had significant increases in all studied characteristics C/N ratio, Nitrogen, Protein, phosphorus and potassium for two seasons (10.01, 1.533%, 9.57% ,0.247% and 0.602%) for season 2013(11.22, 1.703%, 10.64%, 0.275% and 0.669%) for season 2014 respectively. This study was aimed to investigate the effect of Bio health, Tecamin max and Benzyl adenine alone or in combination on vegetative growth characteristics of sweet orange seedlings.

MATERIALS AND METHODS

This study was carried out in the lath house of the College of Agricultural Engineering Sciences, Duhok Province, Kurdistan Region,

Iraq, during two growing season (2020 -2021) to study the effect of Bio health with three concentrations (0, 6 and 12 $g.L^{-1}$), Tecamin max with three concentration (0, 5 and 10 $ml.L^{-1}$), Benzyl adenine with three concentration (0, 100 and 200 $mg.L^{-1}$) and their interaction on vegetative growth characteristics of sweet orange seedling, which were brought from private nursery at Duhok city and had two years old and nearly uniform in growth vigor. All seedlings were transferred from plastic bags to the pots with a capacity of 10 kg mixture of 1:3 organic manure and river sand. The decided concentration of Bio health was dissolved in a liter of water, and then the solution was added to the soil around the seedlings in 20 March for both seasons and was repeated one month later. The previous decided conc. of the Tecamin max and Benzyl adenine were prepared then the seedlings were sprayed as a foliar application three times per season: first, 24/3 /2020 for Tecamin max and 27 ⁄ 3 / 2020 for Benzyl adenine and was repeats three time in interval one month for the two growing seasons, the spraying was done till the runoff, Tween-20 was used to increase the surface tension of leaves, the control plants were sprayed only by distilled water with Tween-20. The experiment was arranged in a randomized complete block design with four replications and three seedlings for each experiment unit. All the results were analyzed statistically by using SAS programs (29). Duncan ‘s multiple range test (DMRT) at 5% level of portability was used to compare the treatments means according to the (5). During the study period, attention was paid to the operations of servicing seedlings, such as irrigation, control of diseases and insects, and removal of weeds. The lath house was also covered with plastic during the cold winter months, from December until March, to protecting the seedlings from frost.

RESULTS AND DISCUSSION

Plant hight: Data in Table 1 Clearly shows that soil application of Bio health at both concentrations significantly increase seedling high compared to the control, the high value (18.91 and 10.78 cm) for both seasons respectively were obtained in seedling treated with 12 g. L^{-1}, whereas the less increase in seedling high (13.09 and 6.85 cm) were obtained in untreated seedling. Data in same table indicate that spraying of amino acid (Tecamin max) at both concentrations during both seasons led to increase seedling hight. The highest value (18.72 and 10.55 cm) for both seasons respectively were show in seedling sprayed with 10 ml.L-1 of Tecamin max compared to the lowest values showed in control. For the effect of Benzyl adenine, Table (1) appears that spraying sweet orange seedling significantly increased seedling hight in both seasons, maximum increase (18.90 and 10.61 cm) for both seasons respectively were resulted in seedling sprayed with 200 mg. L^{-1} Benzyl adenine compared to minimum increase (13.45and 7.09) for both seasons respectively were obtained in control. Regarding the interaction among the a above factors same table clearly shows that the best increase (24.250 and 15.225 cm) was results for interaction among the highest concentration of Bio-health, Tecamin max and Benzyl adenine in both seasons.

Table 1. Effect of Bio health, Tecamin max and Benzyl adenine on average increase in plant hight of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health $g.L^{-1}$	Tecamin max $ml.L^{-1}$	Benzyl adenine (BA) $mg.L^{-1}$ 0	100	200	T. M × BA	Benzyl adenine (BA) $mg.L^{-1}$ 0	100	200	Bio × T.M
0	0	6.000 I	13.250 f-h	15.250 c-h	11.500 f	4.025 k	4.492 jk	6.825 f-k	5.114 e
	5	10.500 g-i	13.500 e-h	16.167 b-g	13.389 ef	5.308 i-k	5.775 h-k	8.400 d-i	6.494 de
	10	13.083 f-h	14.417 d-h	15.667 b-h	14.389 d-f	6.767 f-k	8.517 d-i	11.550 b-d	8.944 bc
6	0	8.750 hi	15.833 b-g	16.667 b-g	13.750 d-f	6.183 g-k	7.642 e-k	8.925 c-i	7.583 cd
	5	16.500 b-g	16.667 b-g	17.000 b-g	16.722 c-e	6.475 f-k	7.350 f-k	9.858 b-g	7.894 cd
	10	20.917 a-d	20.000 a-f	22.250 a-c	21.056 a	7.875 e-j	8.458 d-i	11.258 b-e	9.197 bc
12	0	13.833 d-h	17.833 a-f	20.250 a-f	17.306 b-d	5.950 h-k	7.700 e-j	11.083 b-e	8.244 cd
	5	14.250 d-h	19.250 a-f	22.667 ab	18.722 a-c	9.333 c-h	10.033 b-f	12.425 a-c	10.597 b
	10	17.250 b-g	20.667 a-e	24.250 a	20.722 ab	11.958 a-d	13.358 ab	15.225 A	13.514 a
Bio health		Bio × BA			Main Effect of Bio.	Bio × BA			Main Effect of Bio.
		0	2	4		0	2	4	
0		9.861 e	13.722 d	15.694 b-d	13.093 b	5.367 e	6.261 de	8.925 Bc	6.851 c
6		15.389 cd	17.500 b-d	18.639 bc	17.176 a	6.844 de	7.817 cd	10.014 B	8.225 b
12		15.111 cd	19.25 ab	22.389 a	18.917 a	9.081 bc	10.364 b	12.911 A	10.785 a
		T.M × BA			Main E of T.M	T.M × BA			Main E of T.M
0		9.528 d	15.639 bc	17.389 a-c	14.185 c	5.386 e	6.611 de	8.944 Bc	6.981 c
5		13.750 c	16.472 bc	18.611 ab	16.278 b	7.039 c-e	7.719 cd	10.228 B	8.329 b
10		17.083 a-c	18.361 ab	20.722 a	18.722 a	8.867 bc	10.111 b	12.678 A	10.552 a
Main effect of BA		13.454 c	16.824 b	18.907 a		7.097 c	8.147 b	10.617 A	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Stem diameter

Data in Table (2) shows that soil application of Bio health and spraying of Tecamin max and Benzyl adenine all at highest concentration ($12g.L^{-1}$,$10\ ml.L^{-1}$and $200\ mg.L^{-1}$) respectively led to increase in stem diameter of sweet orange seedling, the highest increases in stem diameter (2.00, 1.75,1.76,1.70 and 1.75,1.44 mm) for both season respectively were produced from application of highest concentration of all studies factors compared to the lowest increase (1.20, 0.79,1.46, 0.84 and 1.48, 1.12 mm) for both seasons respectively were obtained in un treated seedling. Concerning the combination effect of studies factor, the best increase in stem diameter were resulted from the interaction among the high concentrations of both Bio health, Tecamin max and Benzyl adenine compared to the less result were obtained in untreated seedling.

Table 2. Effect of Bio health, Tecamin max and Benzyl adenine on average increase in plant high of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health	Tecamin max	Benzyl adenine (BA)mg.L^{-1}			T.M × BA	Benzyl adenine (BA)mg.L^{-1}			Bio × T.M
g.L^{-1}	ml.L^{-1}	0	100	200		0	100	200	
0	0	0.833 f	1.092 Ef	1.500 b-f	1.142 e	0.365 Lm	0.458 k-m	0.647 j-m	0.490 e
	5	1.083 ef	1.167 d-f	1.167 d-f	1.139 e	0.829 g-m	0.900 g-l	1.083 f-k	0.938 d
	10	1.250 c-f	1.250 c-f	1.500 b-f	1.333 de	1.417 d-h	1.250 e-j	0.221 M	0.962 cd
6	0	1.250 ab	1.500 b-f	1.583 a-f	1.444 c-e	0.708 i-m	0.917 g-l	1.250 e-j	0.958 cd
	5	1.583 a-f	1.475 b-f	1.833 a-e	1.631 b-d	1.167 f-j	1.333 d-i	1.441 d-g	1.314 c
	10	1.667 a-e	1.750 a-e	1.917 a-d	1.778 bc	1.500 d-g	1.750 c-f	1.908 b-e	1.719 b
12	0	1.746 a-e	1.833 a-e	1.833 a-e	1.804 bc	0.750 h-m	1.083 f-k	1.400 d-h	1.078 cd
	5	1.917 a-d	2.000 a-c	2.083 ab	2.000 ab	1.417 d-h	1.625 c-f	2.167 Bc	1.736 b
	10	2.008 a-c	2.250 ab	2.333 a	2.197 a	2.000 b-d	2.417 ab	2.917 A	2.444 a
Bio health		Bio × BA			Main E of Bio	Bio × BA			Main E of Bio.
		0	2	4		0	2	4	
0		1.056 e	1.169 de	1.389 c-e	1.205 c	0.870 Ef	0.869 ef	0.650 F	0.797 c
6		1.500 b-d	1.575 bc	1.778 a-c	1.618 b	1.125 De	1.333 cd	1.533 Bc	1.330 b
12		1.890 ab	2.028 a	2.083 a	2.000 a	1.389 b-d	1.708 b	2.161 A	1.753 a
Tecamin max		T.M × BA			Main E of T.M	T.M × BA			Main E of T.M
0		1.276 c	1.475 bc	1.639 a-c	1.463 b	0.608 E	0.819 de	1.099 Cd	0.842 c
5		1.528 a-c	1.547 a-c	1.694 a-c	1.590 ab	1.138 Cd	1.286 bc	1.564 Ab	1.329 b
10		1.642 a-c	1.750 ab	1.917 a	1.769 a	1.639 A	1.806 a	1.682 A	1.709 a
Main effect of BA		1.482 b	1.591 ab	1.750 a		1.128 B	1.304 ab	1.448 A	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Branch numbers

Data in Table (3) shows that the branches number per seedling was significantly stimulatory by soil application of Bio health in different concentrations in both seasons, when compared with untreated seedlings, the highest values (15.34 and 15.22) for both seasons respectively provided when orange seedlings treated with 12 g.L^{-1} of Bio health, whereas the lowest value of branches number from (12.89 and 6.87) was recording untreated seedlings in both growing seasons respectively. The effect of Tecamin max its notice in same Table that seedling gave the highest value (15.34 and 12.79) when seedlings were treated with 10 ml.L^{-1} in the two seasons. Same Table shows that the Sweet orange seedlings treated with 200 mg.L^{-1} Benzyl adenine in both seasons produced the significant highest number of branch when compared with other treatments, which were (16.04 and 12.13) respectively in both seasons and the lowest value (11.90 and 9.13) recorded in untreated seedling in both seasons. Concerning the interaction among the three studded factors, the maximum number of branches (18.250 and 18.375) for both seasons respectively was resulted from the interaction among 12 g.L^{-1} Bio-health, 10 ml.L^{-1} Tecamin max and 200 mg.L^{-1} Benzyl adenine compared to minimum number of branches (8.167&4.833) for both season respectively was resulted in untreated seedling.

Table 3. Effect of Bio health, Tecamin max and Benzyl adenine on average increase in plant high of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health g.L^{-1}	Tecamin max ml.L^{-1}	Benzyl adenine (BA)mg.L^{-1} 0	100	200	T.M × BA	Benzyl adenine (BA)mg.L^{-1} 0	100	200	Bio × T.M
0	0	8.167 l	12.667 f-j	14.417 b-g	11.750 e	4.833 K	5.750 jk	7.750 f-k	6.111 e
	5	10.833 i-k	13.500 d-i	15.333 b-g	13.222 d	5.167 Jk	6.167 h-k	8.583 f-k	6.639 e
	10	11.417 h-k	14.000 c-h	15.750 a-e	13.722 d	7.583 f-k	7.750 f-k	8.250 f-k	7.861 de
6	0	9.167 kl	10.417 j-l	15.083 b-g	11.556 e	6.917 g-k	10.000 e-h	9.000 f-j	8.639 d
	5	12.750 f-j	13.000 e-j	16.917 ab	14.222 b-d	7.750 f-k	9.375 e-i	10.250 e-g	9.125 d
	10	13.000 e-j	16.833 a-c	17.167 ab	15.667 ab	9.750 e-h	11.125 d-f	14.000 b-d	11.625 c
12	0	12.500 g-j	14.500 b-g	15.417 b-f	14.139 cd	11.375 d-f	14.750 a-d	15.625 a-c	13.917 b
	5	14.333 b-g	15.333 b-g	16.083 a-d	15.250 a-c	13.125 c-e	14.500 b-d	17.375 Ab	15.000 ab
	10	15.000 b-g	16.667 a-c	18.250 a	16.639 a	15.750 a-c	16.125 a-c	18.375 A	16.750 a
Bio health		Bio × BA 0	2	4	Main E of Bio.	Bio × BA 0	2	4	Main E of Bio.
0		10.139 e	13.389 c	15.167 ab	12.898 c	5.861 E	6.556 de	8.194 D	6.870 c
6		11.639 d	13.417 c	16.389 a	13.815 b	8.139 D	10.167 c	11.083 C	9.796 b
12		13.944 bc	15.500 a	16.583 a	15.343 a	13.417 B	15.125 b	17.125 A	15.222 a
Tecamin max		T.M × BA			Main E of T.M	T.M × BA			Main E of T.M
0		9.944 e	12.528 d	14.972 bc	12.898 c	7.708 D	10.167 bc	10.792 B	9.556 b
5		12.639 d	13.944 cd	16.111 ab	14.231 b	8.681 Cd	10.014 bc	12.069 Ab	10.255 b
10		13.139 d	15.833 ab	17.056 a	15.343 a	11.028 B	11.667 ab	13.542 A	12.079 a
Main effect of Benzyl adenine		11.907 c	14.102 b	16.046 a		9.139 C	10.616 b	12.134 A	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Single leaf area

The results in Table (4) show significant differences in plant single leaf area maximum values (37.21 and 41.67) cm^2 respectively for the two seasons when Bio health added as soil fertilization with 12g.L^{-1}. For the foliar application of Tecamin max and Benzyl adenine data from same Table shows that the lowest value recorded in untreated seedlings in both seasons, when the seedlings treated with Tecamin max and Benzyl adenine the highest leaf area (36.24 and 41.18; 36.536 and 40.240 cm^2) revealed in seedlings treated with 10ml.L^{-1} Tecamin max and 200 mg.L^{-1} Benzyl adenine respectively for both seasons, as for the combination effect among application of the three factors, data noticed that the maximum leaf area (44.136 and 47.632 cm^2) was obtained from the interaction of 12g.L^{-1} Bio health+5ml.L^{-1} Tecamin max + 100 mg.L^{-1} Benzyl adenine in first season and from the interaction of 6g.L^{-1} + 10ml.L-1 Tecamin max + 200 mg.L^{-1}Benzyl adenine .and the minimum leaf area (25.925 and 24.553) recorded in untreated seedlings

Table 4. Effect of Bio health, Tecamin max and Benzyl adenine on single leaf area of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health $g.L^{-1}$	Tecamin max $ml.L^{-1}$	Benzyl adenine (BA) $mg.L^{-1}$ 0	100	200	T.M × BA	Benzyl adenine (BA) $mg.L^{-1}$ 0	100	200	Bio × T.M
0	0	25.925 f	32.107 d-f	35.532 b-d	31.188 C	24.553 k	29.109 Jk	30.965 h-k	28.209 f
	5	28.593 ef	33.733 c-e	33.704 c-e	32.010 Bc	30.373 i-k	33.292 f-j	36.965 b-j	33.543 e
	10	31.811 d-f	36.483 b-d	36.993 b-d	35.096 Ab	32.047 g-k	36.370 c-j	38.139 b-i	35.519 c-e
6	0	27.838 ef	34.040 c-e	35.446 b-d	32.441 Bc	30.892 h-k	35.097 d-j	38.238 b-i	34.742 de
	5	31.639 d-f	37.910 b-d	37.789 b-d	35.779 A	33.812 e-j	39.481 b-g	41.482 a-e	38.258 b-d
	10	35.436 b-d	36.420 b-d	37.009 b-d	36.288 A	41.228 a-f	43.695 a-c	47.632 A	44.185 a
12	0	31.966 d-f	35.911 b-d	41.559 ab	36.479 A	37.883 b-i	38.734 b-h	41.316 a-f	39.311 bc
	5	34.063 c-e	44.136 a	35.239 b-d	37.813 A	40.744 a-f	41.622 a-e	43.248 a-c	41.871 ab
	10	36.808 b-d	39.723 a-c	35.553 b-d	37.361 A	42.643 a-d	44.692 Ab	44.176 a-c	43.837 a
Bio health		0	Bio × BA 2	4	Main E of Bio.	0	Bio × BA 2	4	Main E of Bio.
0		28.776 d	34.108 bc	35.409 b	32.764 c	28.991 c	32.924 B	35.356 B	32.424 c
6		31.637 cd	36.123 b	36.748 ab	33.182 b	35.310 b	39.424 A	42.450 A	39.062 b
12		34.279 bc	39.923 a	37.450 ab	37.217 a	40.423 a	41.683 A	42.913 A	41.673 a
Tecamin max			T.M × BA		Main E of T.M		T.M × BA		Main E of T.M
0		28.576 d	34.019 Bc	37.512 ab	32.764 b	31.109 f	34.313 Ef	36.839 c-e	34.087 c
5		31.432 cd	38.593 A	35.578 ab	34.836 a	34.976 d-f	38.131 b-e	40.565 a-c	37.891 b
10		34.685 bc	37.542 Ab	36.518 ab	36.248 a	38.639 b-d	41.586 Ab	43.316 A	41.180 a
Main effect of Benzyl adenine		31.564 b	36.718 A	36.536 a		34.908 b	38.010 A	40.240 A	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Total chlorophyll (µg.m^{2-1})

Data in Table (5) illustrates that the positive effect of all treatments on the chlorophyll content in sweet orange seedling whether added to the soil as Bio health or foliar application as Tecamin max and Benzyl adenine in both seasons, where the highest value of chlorophyll (208.32 and 208.04) that was produced from application Bio-health to the soil at 12g.L^{-1} in both seasons. Also, the seedling had the highest value of seedling chlorophyll content when treated with Tecamin max and Benzyl adenine at 10ml.L^{-1} and 200 mg.L-1 respectively, where the values included it (207.11 and 200.6, 206.4 and 198.12) respectively in both seasons. Interaction effect among the Bio health or foliar application as Tecamin max and Benzyl adenine, highest chlorophyll content (215.384 and 216.058) was obtained from the interaction of high concentration of these factors in first season and from the interaction of 12g.L^{-1} + 0 ml.L^{-1} Tecamin max + 0 mg. L^{-1}Benzyl adenine in second season.

Table 5. Effect of Bio health, Tecamin max and Benzyl adenine on total chlorophyll of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health g.L^{-1}	Tecamin max ml.L^{-1}	Benzyl adenine (BA)mg.L^{-1} 0	100	200	T.M × BA	Benzyl adenine (BA)mg.L^{-1} 0	100	200	Bio × T.M
0	0	169.536 i	180.407 H	193.542 fg	181.162 d	161.713 h	173.269 G	181.134 d-g	172.039 e
	5	183.386 gh	195.253 Ef	196.401 d-f	191.680 c	174.446 fg	178.275 e-g	183.350 d-f	178.690 d
	10	194.666 fg	204.688 a-f	210.460 a-c	203.271 b	177.147 e-g	184.759 de	186.306 de	182.737 d
6	0	182.102 h	195.727 d-f	205.428 a-f	194.419 c	172.289 g	180.410 d-g	184.893 de	179.197 d
	5	199.327 b-f	205.030 a-f	204.450 a-f	202.936 b	188.862 d	205.318 bc	207.973 a-c	200.718 c
	10	203.632 a-f	206.149 a-f	208.331 a-e	206.037 ab	216.073 a	209.062 a-c	211.941 ab	212.359 a
12	0	198.428 c-f	205.107 a-f	211.699 ab	205.078 b	216.058 a	207.794 a-c	206.407 a-c	210.086 ab
	5	203.525 a-f	207.849 a-e	212.217 ab	207.864 ab	202.096 bc	208.689 a-c	211.240 a-c	207.342 ab
	10	208.834 a-d	211.921 Ab	215.384 a	212.046 a	208.435 a-c	201.335 C	210.345 a-c	206.705 b
Bio health		0	Bio × BA 2	4	Main E of Bio.	0	Bio × BA 2	4	Main E of Bio.
0		182.530 f	193.449 E	200.134 cd	192.038 c	171.102 f	178.768 E	183.597 e	177.822 c
6		195.021 de	202.302 Bc	206.070 bc	201.131 b	192.408 d	198.263 C	201.602 bc	197.425 b
12		203.596 bc	208.293 Ab	213.100 a	208.329 a	208.863 a	205.939 Ab	209.330 a	208.044 a
Tecamin max			T.M × BA		Main E of T.M		T.M × BA		Main E of T.M
0		183.356 d	193.747 C	203.556 b	193.553 c	183.353 c	187.158 bc	190.812 b	187.108 c
5		195.413 c	202.711 B	204.356 b	200.826 b	188.468 bc	197.427 A	200.854 a	195.583 b
10		202.377 b	207.586 Ab	211.391 a	207.118 a	200.552 a	198.385 A	202.864 a	200.600 a
Main effect of Benzyl adenine		193.715 c	201.348 B	206.435 a		190.791 c	194.323 B	198.177 a	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Leaves carbohydrate

According to the data in Table (6) shows that the application Bio health to the soil and foliar application of seedling by Tecamin max and Benzyl adenine especially with in high concentrations led to increase the leaves carbohydrate of sweet orange seedlings when compared with control, the best increase of carbohydrate found in seedlings when treated with 12g.L^{-1} Bio health as it (9.68 and 7.36) respectively in both seasons, and the seedlings treated with 200 mg.L^{-1} benzyl adenine gave the highest value (10.32 and 6.625) respectively for both seasons compared with control which produced less values in both seasons..

Table 6. Effect of Bio health, Tecamin max and Benzyl adenine on leaves carbohydrate of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health g.L^{-1}	Tecamin max ml.L^{-1}	Benzyl adenine (BA)mg.L^{-1} 0	100	200	T.M × BA	Benzyl adenine (BA)mg.L^{-1} 0	100	200	Bio × T.M
0	0	6.133 Gh	9.877 a-f	9.154 a-g	8.388 b	4.033 f	4.725 ef	5.346 c-f	4.701 e
	5	6.807 e-h	9.091 a-g	10.073 a-e	8.657 ab	4.438 ef	6.037 c-f	4.743 Ef	5.072 de
	10	5.512 H	8.695 b-h	10.170 a-e	8.125 b	4.480 ef	5.393 c-f	6.268 b-f	5.380 c-e
6	0	6.822 e-h	8.370 c-h	9.910 a-f	8.367 b	5.741 c-f	6.133 c-f	7.777 a-c	6.550 a-c
	5	6.547 f-h	10.665 a-d	12.273 a	9.828 ab	5.349 c-f	5.218 d-f	6.066 c-f	5.544 c-e
	10	8.040 c-h	9.613 a-f	10.238 a-e	9.297 ab	5.158 d-f	5.760 c-f	7.562 a-d	6.160 b-d
12	0	9.690 a-f	10.140 a-e	10.008 a-f	9.946 ab	6.472 a-f	7.321 a-d	6.821 a-e	6.871 ab
	5	8.362 c-h	10.858 a-c	12.013 ab	10.411 a	6.503 a-e	8.630 ab	7.608 a-d	7.580 a
	10	7.280 d-h	9.713 a-f	9.120 a-g	8.704 ab	6.792 a-e	8.711 a	7.432 a-d	7.645 a
Bio health		0	Bio × BA 2	4	Main E of Bio.	0	Bio × BA 2	4	Main E of Bio.
0		6.151 D	9.221 Ab	9.799 ab	8.390 b	4.317 d	5.385 cd	5.452 Cd	5.051 c
6		7.136 Cd	9.549 Ab	10.807 a	9.164 ab	5.416 cd	5.703 c	7.135 Ab	6.085 b
12		8.444 Bc	10.237 Ab	10.380 a	9.687 a	6.589 bc	8.220 a	7.287 Ab	7.365 a
Tecamin max			T.M × BA		Main E of T.M		T.M × BA		Main E of T.M
0		7.548 C	9.462 B	9.691 ab	8.900 a	5.415 b	6.060 ab	6.648 Ab	6.041 a
5		7.239 C	10.204 Ab	11.453 a	9.632 a	5.430 b	6.628 ab	6.139 Ab	6.066 a
10		6.944 C	9.340 B	9.843 ab	8.709 a	5.477 b	6.621 ab	7.087 A	6.395 a
Main effect of Benzyl adenine		7.243 B	9.669 A	10.329 a		5.440 b	6.436 a	6.625 A	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

Same Table shows that there is no significant effect when the seedlings treated with Tecamin max with different concentration when compared with the untreated sweet orange seedlings in both seasons.The combination effect of the studied factors, the highest leave carbohydrate (12.273) was produced from the interaction of 6g.L^{-1} + 5ml.L^{-1} + 200mg.L^{-1} of Bio health, Tecamin max and Benzyl adenine in first season, whereas the highest leaves carbohydrate (8.711) was resulted from the interaction of 12g.L-1 + 10ml.L-1 + 100mg.L-1 of Bio health, Tecamin max and Benzyl adenine in second season

Leaves dry weight : It is generally clear from the results in Table (8) that, at the soil application of Bio health at both concentrations significantly increase leaves dry weight when compared with control, the highest value (0.783, 0.837) g for both seasons respectively were obtained in seedlings treated with 6g.L^{-1} in first season and 12g.L-1 in second season, whereas the lowest value in leaves dry weight (0.593, 0.719) g were recorded in untreated seedlings.Concerning to the effect of Tecamin max of leaves dry weight of sweet orange seedlings in same Table found that the significant effect of Tecamin max when compared with control, the highest value (0.754, 0.831) g respectively in both seasons recorded when treated with 10 ml.L^{-1} Tecamin max.As for the effect of

Benzyl adenine on the leaves dry weight it was found that non-significant effect was recoded for both concentrations when compared with the control.Leaves dry weight was found to be influenced by the interactions among the studies factors in same Table show the best increasing leaves dry weight (0.886) g was found in seedling that treated with ($6g.L^{-1}$, $10ml.L^{-1}$ and $0mg.L^{-1}$) that included Bio-health, Tecamin max and Benzyl adenine respectively in first season, in the second season (1.072) g was recorded in seedlings treated with ($12g.L^{-1}$, $10ml.L^{-1}$ and $0mg.L^{-1}$) respectively included bio health, Tecamin max and Benzyl adenine .The lowest value (0.496, 0.582) g respectively in both seasons that in untreated Sweet orange seedlings.

Table 7. Effect of Bio health, Tecamin max and Benzyl adenine on leaves dry weight (g) of sweet orange seedlings

Treatments		2020 season				2021 season			
Bio health	T.M	Benzyl adenine (BA)mg.L^{-1}			T.M × BA	Benzyl adenine (BA)mg.L^{-1}			Bio × T.M
g.L^{-1}	ml.L^{-1}	0	100	200		0	100	200	
0	0	0.496 i	0.559 g-i	0.593 f-i	0.549 c	0.584 g	0.604 fg	0.793 b-g	0.660 c
	5	0.545 hi	0.587 f-i	0.599 e-i	0.577 bc	0.674 d-g	0.850 a-e	0.776 b-g	0.767 a-c
	10	0.607 d-i	0.655 c-i	0.699 a-h	0.654 b	0.672 d-g	0.803 b-g	0.718 c-g	0.731 bc
6	0	0.730 a-h	0.850 a-c	0.699 a-h	0.760 a	0.617 e-g	0.827 b-f	0.923 a-c	0.789 ab
	5	0.677 b-i	0.859 Ab	0.734 a-h	0.757 a	0.898 a-d	0.834 b-f	0.787 b-g	0.840 ab
	10	0.886 a	0.840 a-c	0.769 a-f	0.832 a	0.977 ab	0.850 a-e	0.792 b-g	0.873 a
12	0	0.782 a-f	0.732 a-h	0.792 a-e	0.769 a	0.799 b-g	0.757 b-g	0.817 b-g	0.791 ab
	5	0.656 c-i	0.815 a-c	0.795 a-d	0.756 a	0.839 b-f	0.831 b-f	0.825 b-f	0.832 ab
	10	0.762 a-f	0.745 a-g	0.822 a-c	0.776 a	1.072 a	0.794 b-g	0.799 b-g	0.888 a
Bio health		**Bio × BA**			**Main E of Bio.**	**Bio × BA**			**Main E of Bio.**
		0	2	4		0	2	4	
0		0.549 c	0.600 C	0.630 c	0.593 b	0.643 c	0.752 bc	0.762 b	0.719 b
6		0.764 ab	0.850 A	0.734 b	0.783 a	0.831 ab	0.837 ab	0.834 ab	0.834 a
12		0.733 b	0.764 Ab	0.803 ab	0.767 a	0.903 a	0.794 ab	0.814 ab	0.837 a
Tecamin max		**T.M × BA**			**Main E of T.M**	**T.M × BA**			**Main E of T.M**
0		0.669 ab	0.714 Ab	0.695 ab	0.692 b	0.667 c	0.729 bc	0.844 ab	0.747 b
5		0.626 b	0.754 A	0.709 ab	0.696 b	0.804 ab	0.838 ab	0.796 ab	0.813 ab
10		0.751 a	0.747 A	0.763 a	0.754 a	0.907 a	0.815 ab	0.770 bc	0.831 a
Main effect of Benzyladenine		0.682 a	0.738 A	0.722 A		0.792 a	0.794 a	0.803 a	

Means with the same letter are not significantly different according to Duncan multiple ranges test at 5% level

The improvement of all the vegetative growth characteristics of local Sweet orange seedlings as a result of soil application of Bio-health , especially at a concentration of 12 $g.L^{-1}$, could be attributed to its content of humic acid, seaweed extract and microorganisms, as humic acids contribute to stimulating growth through the content of organic compounds, amino acids, and mineral elements, especially potassium , which actively participates in many physiological processes, such as regulating the work of stomata, as its accumulation in the guard cells affects the osmotic pressure. The process directly affects

the water relations inside the plant, including the absorption of water and nutrients from the soil (10, 22, 23). Humic acid contributes to activating the formation of chlorophyll pigment and the assembly of sugars, amino acids and enzymes (14), activating cell division, increasing the growth rate, developing the vegetative and root system, and increasing the dry matter in plant tissues (35). As for the role of seaweed extract in improving the vegetative growth of seedlings, it could be attributed to the inclusion of many nutrients such as vitamins and amino acids in its composition, which have a wide range of impact on the vital activities of the plant (2, 26) as well as "containing plant hormones, especially Auxins and cytokinin's that have an active role in increasing growth and stimulating plant height and side branching (34), and cytokinin's play a major role in stimulating the biosynthesis of chlorophyll in mature tissues, regulating the distribution of nutrients, opening stomata, and delaying leaf senescence (13). The positive role which Tecamin max has played is perhaps due to what it contains of amino acids which reached up to (23) amino-acids, that were necessary for plant growth, and which stimulate metabolism processes which in turn stimulate growth due to the production of necessary growth proteins, vitamins, and enzymes (11, 15), or perchance the increase is due to amino-acids working on supplying plants with nitro substances needed for growth and vital processes, which include the division and elongation of plant cells (18). The superiority of the high concentration of Benzyl adenine in the characteristics of vegetative growth could be attributed to the effect of this compound in increasing the strength of the leaves, branches and main stems, which increases the strength and speed pull of processed food and nutrients (4, 29), so Its growth increases, in addition to its role in regulating various processes such as cell division and differentiation, stimulating cell expansion and the movement of nutrients to a large degree (16), which affects the growth and development of the seedling, also contributes to controlling the effectiveness of the apical and lateral meristems, which leads to the emergence of new branches as well as delaying the aging of leaves through protecting the photosynthetic pigments from breakdown as well as the differentiation of chlorophyll (20).

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