Scientific J. Flowers & Ornamental Plants
www.ssfop.com/journal
ISSN: 2356-7864 **doi: 10.21608/sjfop.2022.262796**

RESPONSE OF ANISE PLANTS TO HUMIC ACID, AMINO ACIDS AND THIAMINE TREATMENTS

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ABSTRACT: A field experiment was carried out to investigate the influence of humic acid at 2.5, 5.0 and 10.0 ml/l and a mixture of three amino acids (tryptophan, methionine and cysteine) and thiamine (vitamin B1) each at 100, 200, and 400 ppm on the vegetative growth, yield and oil content of anise plants. Treating anise plants with humic acid at 2.5, 5.0 and 10.0 ml/l as a foliar spray was very effective on stimulating plant height, stem diameter, branch number/plant, herb dry weight, number of umbels/plant, weight of 1000 fruits, fruit yield per plant and per feddan, as well as, essential oil percentage and yield in comparison with untreated plants. In most cases, the most effective humic acid concentration was the highest one (10 ml/l) which gave the highest values of the aforementioned parameters. The application of the mixture of amino acids and thiamine each at 100, 200 and 400 ppm led to a significant increment of the vegetative growth traits, fruit yield and, essential oil % and yield compared to check treatment. In this regard, increasing the concentration of amino acids and vitamin B1 gradually increased the obtained values of the above-mentioned parameters. Also, spraying the mixture of the three amino acids was significantly more effective than thiamine treatments. In this concern, the highest concentration (400 ppm) of each material was the most effective, giving the best results compared to the other treatments including control. The interaction between the two examined factors i.e. humic acid and amino acids and vitamin B1 was, generally, significant on all parameters of vegetative growth, yield, oil content. The most effective treatment was the application of humic acid at 10 ml/l and amino acids mixture at 400 ppm, to improve the vegetative growth, fruits yield and oil yield of anise plants.

Scientific J. Flowers & Ornamental Plants, 9(3):153-165 (2022).

Received:
10/8/2022
Accepted:
30/8/2022

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Keywords: Anise plant, humic acid, thiamin, amino acids.

INTRODUCTION

Anise plant *Pimpinella anisum* L., is a herbaceous annual native to the Mediterranean region and Egypt. It is one of the aromatic fruit group plants which contains 3-5% of the essential oil as reported by Stuart (1982). The principal constituents of the essential oil are menthol (80-90%), α-pinene and methylcharicol. This essential oil has an antispasmodic and carminative actions and diminishes the desire to cough. It has good tasty so it is used as an aromatic ingredient in food industry as a flavoring agent, to promote lactation in nursing mothers and as a medicine against bronchitis and indigestion (Muller-Schwarze, 2006).

Many researchers examined the influences of different stimulant substances on the vegetative growth, yield and essential oil production of different medicinal and aromatic plants which were forced on humic substances, amino acids and vitamins. Humic acid is a part of humus compounds which plays an important role in nutrition balance of the plant. Agriculturists all over the world are accepting humic acid as an

integral part of their fertilization program. It could be applied directly to plant foliage as a foliar spray or to the soil as a granular form (Delfine *et al*., 2005). Humic materials have direct and indirect effects on the physiological and biochemical processes in plants as well as on physical, chemical and biological properties of soil (Senn, 1991 and Tan, 2003).

Amino acids are necessary compounds playing positive, biological and physiological roles in plant growth for example biosynthesis of vitamins co-enzymes, alkaloids, pigments, purine, pyrimidine bases and terpenoids. They are precursors of activators of phytohormones and growth substances (Singh *et al*., 2012). They are biostimulants which have positive effects on plant growth, yield and significantly mitigates the injuries caused by abiotic stresses (Kowalczyk and Zielony, 2008). Amino acids application could improve the growth and productivity of plants due to their direct roles in augmenting the protein synthesis and essential enzymes in the plant tissues which organize the metabolic events of antioxidants activation (Cerdana *et al.,* 2009).

Vitamin B1 is a necessary ingredient for biosynthesis of the co-enzyme thiamine pyrophosphate which plays an important role in carbohydrate metabolism. It is an essential nutrient for both plant and animal. In plants, it is synthesized in the leaves and transport to the roots where it controls their growth. Vitamin B1 is an important cofactor for the translocation of pentose to nucleotide synthetic pathways (Kawasaki, 1992). Ropinson (1973) reported that vitamin B complex acts as co-enzymes in the enzymatic reaction by which carbohydrates, fats and proteins are metabolized and involved in photosynthesis and respiration processes.

Therefore, the objective of the present investigation was to study the response of anise, *Pimpenila anisum* L. plants to different treatments of humic acid, amino acids and thiamine to find out the most suitable treatments which enhances the vegetative growth, yield and yield components, and oil production of anise plants.

MATERIALS AND METHODS

The present investigation was conducted during two successive seasons 2017/2018 and 2018/2019 at a private Farm, Abou Tisht, Qina Governorate and the laboratory of Faculty of Agriculture, Minia University to examine the influence of humic acid, amino acids mixture (tryptophan, methionine and cysteine) and vitamin B1 on the vegetative growth, yield and volatile oil of anise plants.

The anise seeds were obtained from Horticultural Research Station, Bani Swaif Governorate. The seeds were sown for both experimental seasons on Oct., 20th in 2.5 × 2 m plots containing 3 rows, 60 cm apart so, each plot contained 60 plants. Five seeds were planted per hill (25 cm apart) on one side of the ridge. The growing seedlings were thinned to two plants per hill, after one month from planting.

Physical and chemical properties of the soil which were determined according to Jackson (1958) and are shown in Table (1). A complete rerandomized block design in split–plot arrangement with three replicates was followed in this experiment, where four humic acid treatments were assigned to the main plots (A) and seven treatments of amino acids and vitamin B1 were occupied the sub plots (B), therefore, the interaction treatments (A × B) were 28 treatments.

Humic acid in form of Humitta (25% humic acid) was applied at the concentrations of 0, 2.5, 5.0 and 10.0 ml/l while, the seven treatments of a mixture of three amino acids i.e tryptophan, methionine and cysteine and vitamin B1 were as follows:

1. Control (tap water)
2. Amino acid mixture 100 ppm
3. Amino acid mixture 200 ppm

Table 1. Physical and chemical properties of the soil.

Particle size distribution:	
Sand (%)	57.5
Silt (%)	16.2
Clay (%)	26.3
Texture class	Loam
Saturation percentage (%)	62.0
pH (1:2.5) in water	7.4
EC (ds/m^2)	0.880
Calcium carbonate (%)	6.5
Organic matter (%)	1.1
Soluble anions in saturated soil paste extract (mmol):	
Ca	2.7
Mg	1.5
Na	17.0
K	0.21
Soluble anions in saturated soil paste extract (mmol):	
COHCO	5.7
SO_4	1.8
Cl	5.0
N (%)	0.09
Available P (ppm)	20.97
DTPA- extractable Fe (ppm)	12.6
DTPA- extractable Mn (ppm)	6.4
DTPA- extractable Cu (ppm)	2.6
DTPA- extractable Zn (ppm)	1.7

4. Amino acid mixture 400 ppm
5. Vitamin B1 100 ppm
6. Vitamin B1 200 ppm
7. Vitamin B1 400 ppm

Humic acid concentrations were applied as a foliar sprays three times for each season, the first spray was done on Dec., 19th, while amino acids and vitamin B1 were sprayed on the next day for both growing seasons then at 15 days interval for the second and third sprays. The control plants were sprayed with tap water.

All experimental plants received a recommended dose of mineral NPK in the form of ammonium nitrate (33.5% N) at 200 kg/fed, calcium super phosphate (15.5% P_2O_5) at 300 kg/fed and potassium sulphate (48% K_2O) at 100 kg/fed. In this concern, calcium super phosphate fertilizer was applied during soil preparation, while ammonium nitrate and potassium sulphate were added in three equal batches at monthly intervals, starting from Dec., 20th for both experimental seasons.

Data recorded:

At the end of the experiment (third week of April for both seasons) plants were cut above the soil surface and the vegetative growth and yield traits parameters were recorded. Essential oil % of anise seeds was determined by water distillation following the method of British Pharmacopoeia (1963) then essential oil yield per plant and feddan were calculated.

Statistical analysis:

All vegetative growth, yield and yield component traits as well photosynthetic pigments and essential oil % and yield were statistically analyzed according to Mead *et al.* (1993). using MSTAT.C (1986) for Windows. The differences between the means were tested using L.S.D test at 5%.

RESULTS AND DISCUSSION

Vegetative growth:

Data listed in Tables (2, 3, 4 and 5) represented the effect of foliar spray of humic acid at 2.5, 5.0 and 10.0 ml/l, a mixture of amino acids (tryptophan, methionine and cysteine) as well as vitamin B1 each at 100, 200 and 400 ppm on the vegetative growth traits of anise plants. In this concern, recorded data revealed that plant height was significantly affected with humic acid treatment in the second season However, stem diameter and herb dry weight/plant were significantly increased by humic acid treatments compared to control treatment in both seasons. Similarly, branch number/plant was significantly affected with the mixture of amino acids and vitamin B1 in the second season. Overall, the highest values of vegetative growth traits were resulted from the highest tested concentration of humic acid (10 ml/l).

Table 2. Effect of humic acid, amino acids mixture and vitamin B1 treatments on plant height (cm) of anise plant during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	72.44	71.59	75.00	73.78	73.20
Amino acids 100 ppm	74.77	76.49	76.72	78.00	76.49
Amino acids 200 ppm	75.89	77.77	79.05	80.22	78.23
Amino acids 400 ppm	78.35	82.61	81.55	85.16	81.91
Vitamin B1 100 ppm	73.04	74.20	74.33	75.03	74.15
Vitamin B1 200 ppm	74.44	75.33	76.22	78.05	76.01
Vitamin B1 400 ppm	75.46	77.22	77.16	78.27	77.02
Mean A	74.91	76.45	77.14	78.35	
L.S.D. 5%		A: N.S.	B: 3.75	AB: N.S.	
			Second season		
Control	70.63	79.45	84.50	83.65	79.55
Amino acids 100 ppm	82.75	89.65	90.90	96.77	90.01
Amino acids 200 ppm	90.87	90.48	92.27	98.67	93.07
Amino acids 400 ppm	95.13	95.25	97.57	99.93	96.97
Vitamin B1 100 ppm	80.33	81.25	89.80	89.67	85.26
Vitamin B1 200 ppm	81.30	85.93	91.03	91.50	87.44
Vitamin B1 400 ppm	81.44	86.33	92.02	91.53	87.83
Mean A	83.20	86.90	91.15	93.10	
L.S.D. 5%		A: 2.64	B: 2.57	AB: 5.14	

Table 3. Effect of humic acid, amino acids mixture and vitamin B1 treatments on stem diameter (cm) of anise plant during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	0.53	0.58	0.62	0.63	0.59
Amino acids 100 ppm	0.65	0.65	0.70	0.71	0.68
Amino acids 200 ppm	0.66	0.67	0.73	0.75	0.70
Amino acids 400 ppm	0.69	0.72	0.75	0.80	0.74
Vitamin B1 100 ppm	0.62	0.61	0.55	0.63	0.60
Vitamin B1 200 ppm	0.62	0.67	0.62	0.65	0.64
Vitamin B1 400 ppm	0.63	0.67	0.63	0.69	0.65
Mean A	0.63	0.65	0.66	0.70	
L.S.D. 5%		A: 0.04	B: 0.05	AB: 0.11	
			Second season		
Control	0.63	0.64	0.66	0.73	0.66
Amino acids 100 ppm	0.64	0.65	0.71	0.75	0.69
Amino acids 200 ppm	0.76	0.73	0.75	0.76	0.75
Amino acids 400 ppm	0.76	0.79	0.84	0.87	0.82
Vitamin B1 100 ppm	0.67	0.72	0.73	0.72	0.71
Vitamin B1 200 ppm	0.69	0.72	0.73	0.74	0.72
Vitamin B1 400 ppm	0.69	0.73	0.74	0.76	0.73
Mean A	0.69	0.71	0.74	0.76	
L.S.D. 5%		A: 0.04	B: 0.05	AB: 0.1	

Table 4. Effect of humic acid, amino acids mixture and Vitamin B1 treatments on branch number/plant of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	6.3	6.0	6.3	6.0	6.2
Amino acids 100 ppm	6.3	7.3	7.0	7.3	7.0
Amino acids 200 ppm	7.0	7.0	7.3	7.0	7.1
Amino acids 400 ppm	7.7	6.7	7.3	7.7	7.3
Vitamin B1 100 ppm	6.3	7.3	6.3	6.3	6.6
Vitamin B1 200 ppm	6. 7	7.0	6.7	7.0	6.8
Vitamin B1 400 ppm	7.0	7.0	6.7	7.3	7.0
Mean A	6.8	6.9	6.8	7.0	
L.S.D. 5%		A: N.S.	B: N.S.	AB: 1.4	
			Second season		
Control	6.7	7.3	7.0	6.7	6.9
Amino acids 100 ppm	7.0	8.3	9.0	9.7	8.5
Amino acids 200 ppm	7.7	9.3	10.3	11.0	9.6
Amino acids 400 ppm	9.3	10.3	10.6	10.7	10.2
Vitamin B1 100 ppm	7.3	7.0	8.3	8.3	7.7
Vitamin B1 200 ppm	6.7	8.3	8.3	7.7	7.8
Vitamin B1 400 ppm	7.7	8.3	8.3	7.7	8.0
Mean A	7.5	8.4	8.95	8.8	
L.S.D. 5%		A: 0.8	B: 0.9	AB: 1.9	

Table 5. Effect of humic acid, amino acids mixture and vitamin B1 treatments on herb dry weight (g) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	34.72	42.68	39.71	43.35	40.11
Amino acids 100 ppm	57.52	50.85	56.01	73.44	59.45
Amino acids 200 ppm	58.02	56.30	56.17	78.64	62.28
Amino acids 400 ppm	59.91	59.87	56.24	79.10	63.78
Vitamin B1 100 ppm	35.75	45.21	46.74	52.75	45.11
Vitamin B1 200 ppm	40.91	48.73	50.81	55.52	48.99
Vitamin B1 400 ppm	47.85	52.71	54.10	60.42	53.77
Mean A	47.81	50.90	51.39	63.31	
L.S.D. 5%		A: 6.23	B: 5.89	AB: 11.78	
			Second season		
Control	49.29	53.20	54.02	60.47	54.24
Amino acids 100 ppm	54.67	61.55	56.22	61.67	58.52
Amino acids 200 ppm	58.38	61.57	66.78	65.99	63.18
Amino acids 400 ppm	61.35	69.29	68.20	82.10	70.23
Vitamin B1 100 ppm	55.25	51.56	55.90	60.50	55.80
Vitamin B1 200 ppm	56.99	53.50	59.90	61.07	57.86
Vitamin B1 400 ppm	57.27	58.40	61.40	65.21	60.57
Mean A	56.17	58.43	60.34	65.28	
L.S.D. 5%		A: 5.30	B: 5.35	AB: 10.70	

All previous traits except branch number in the 1st season were significantly affected following mixture of amino acids and vitamin B1 application. Generally, 400 ppm of amino acids application yielded the highest significant values. In accordance with these findings were those of Awad (2016) and Sharaf El–Deen *et al.* (2012) on fennel, Hassan (2019) and Omar (2020) on caraway, and Abd-El-Satar (2020) on *Anethum graveolens*.

Treating anise plants with the mixture of amino acids and vitamin B1 led to a significant augmentation of the vegetative growth parameters (plant height, stem diameter, branch number/plant and herb dry weight) compared to untreated plants. Increasing concentration of each of amino acids and vitamin B1 caused a gradual enhancement of these traits. Spraying with amino acids was more effective than thiamine treatments in both experimental seasons (Tables, 2, 3, 4 and 5). These results were in harmony with the findings of Ali (2007) and Yassen *et al.* (2010) on anise plant, Talaat and Youssef (2002) on basil, Hendawy and Ezz El-Deen (2010) on fennel, El-Leithy (2019) on coriander and Abd El-Satar (2020) on dill plant regarding the promoting effect of amino acids. Abdou *et al.* (2015) on coriander, Abd El-Rahman (2016) on chamomile, Botros (2013) on caraway and Marzok (2017) on basil plants concerning the stimulating effect of thiamine on the vegetative growth.

Regarding the interaction between the two tested factors namely humic acid and two stimulants (amino acids and vitamin B1), it is noticed from Tables (2, 3, 4 and 5) that the effects of the interaction on vegetative growth characters of anise plants (except the plant height in the 1st season) were significant. The most effective interaction treatments were obtained with using humic acid at 10 ml/l and the mixture of the three amino acids at 400 ppm which produced the highest values of vegetative growth traits of anise plant.

Yield parameters:

It is evident from data illustrated in Tables (6, 7, 8 and 9) that the yield parameters of anise plant i.e weight of 1000 fruits (seeds)/plant as well as fruits yield per plant and per feddan were, in most cases, significantly responded to the application of humic acid, amino acids and thiamine compared to check treatment. Although the number of umbels/plant was not significantly affected due to humic acid application in the two experimental seasons.

Humic acid treatments enhanced significantly weight of 1000 fruits, fruits yield/plant and per feddan in the first and second seasons (Tables 6,7, 8 and 9). The highest values of these three yield parameters were obtained from plants sprayed with the highest concentration (10 ml/l) compared with other concentrations. The beneficial influence of humic acid on the vegetative growth was recorded also by Sharaf El-Deen *et al*. (2012) on fennel, El-Banna and Fouda (2018) and Omar (2020) on caraway and Beyzi *et al.* (2017) on coriander.

The influence of the two stimulants i.e mixture of amino acids and thiamine each at 100, 200 and 400 ppm, in most cases, on yield parameters of anise plants was significant in the two growing seasons. In this regard, the amino acids treatments were more effective than vitamin B1 in promoting the above-mentioned yield parameters. Increasing the concentration of both stimulants led to a gradual stimulation in these parameters. Hence the highest yield components were obtained due to the high amino acids mixture concentration (400 ppm).

The effectiveness of amino acids on enhancing the yield was found by Yassen *et al.* (2010) on anise, Hendawy and Ezz El-Deen (2010) on fennel, El-Leithy (2019) on coriander and Abd El-Satar (2020) on dill, while the stimulating influence of thiamine on yield parameters was also found by Reda *et al*. (1977) on *Ammi visnaga*, Abdou *et al.*

Table 6. Effect of humic acid, amino acids mixture and vitamin B1 treatments on number of umbels/plant of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	41.67	34.67	46.67	45.67	42.17
Amino acids 100 ppm	45.67	51.33	53.00	54.67	51.16
Amino acids 200 ppm	56.33	51.67	52.67	55.67	54.08
Amino acids 400 ppm	56.33	64.00	54.33	61.33	59.00
Vitamin B1 100 ppm	44.33	45.67	47.00	47.33	46.08
Vitamin B1 200 ppm	38.33	46.33	48.67	47.00	45.08
Vitamin B1 400 ppm	34.67	42.33	48.67	48.67	43.58
Mean A	45.33	48.00	50.14	51.47	
L.S.D. 5%		A: N.S.	B: 5.10	AB: 10.19	
			Second season		
Control	61.33	68.00	67.67	70.67	66.91
Amino acids 100 ppm	75.00	74.33	75.33	75.67	75.08
Amino acids 200 ppm	76.33	79.67	80.33	83.67	80.00
Amino acids 400 ppm	91.00	85.00	94.00	93.67	90.91
Vitamin B1 100 ppm	70.67	70.67	71.67	73.33	71.58
Vitamin B1 200 ppm	72.33	73.33	75.00	77.33	74.50
Vitamin B1 400 ppm	72.67	76.00	77.33	83.33	77.33
Mean A	74.19	75.28	77.33	79.66	
L.S.D. 5%		A: N.S.	B: 6.380	AB: N.S.	

Table 7. Effect of humic acid, amino acids mixture and vitamin B1 treatments on weight of 1000 fruits (g) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	2.867	2.400	3.100	2.533	2.725
Amino acids 100 ppm	3.033	3.400	3.533	3.467	3.358
Amino acids 200 ppm	3.167	3.600	3.533	3.533	3.458
Amino acids 400 ppm	3.333	3.600	3.600	3.533	3.517
Vitamin B1 100 ppm	2.800	2.400	3.267	2.867	2.833
Vitamin B1 200 ppm	2.900	2.433	3.333	2.833	2.875
Vitamin B1 400 ppm	2.967	2.500	3.333	3.433	3.058
Mean A	3.010	2.905	3.386	3.171	
L.S.D. 5%		A: 0.285	B: 0.162	AB: 0.323	
			Second season		
Control	3.250	3.150	3.100	3.133	3.158
Amino acids 100 ppm	3.433	3.617	3.633	3.800	3.621
Amino acids 200ppm	3.417	3.667	3.767	3.900	3.688
Amino acids 400 ppm	3.650	3.783	3.900	3.967	3.825
Vitamin B1 100 ppm	3.267	3.300	3.333	3.233	3.283
Vitamin B1 200 ppm	3.383	3.300	3.433	3.267	3.346
Vitamin B1 400 ppm	3.600	3.333	3.567	3.333	3.458
Mean A	3.429	3.450	3.533	3.519	
L.S.D. 5%		A: N.S.	B: 0.215	AB: 0.430	

Table 8. Effect of humic acid, amino acids mixture and vitamin B1 treatments on fruit yield/ plant (g) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	17.75	18.25	19.33	22.66	19.49
Amino acids 100 ppm	18.59	21.43	22.98	24.30	21.82
Amino acids 200 ppm	22.23	22.90	23.17	24.80	23.27
Amino acids 400 ppm	23.81	23.49	24.27	25.57	24.28
Vitamin B100 ppm	17.90	19.63	19.24	22.66	19.85
Vitamin B1 200 ppm	18.00	20.60	22.16	22.90	20.91
Vitamin B1 400 ppm	18.42	21.15	22.48	23.92	21.49
Mean A	19.53	21.06	21.94	23.83	
L.S.D. 5%		A: 0.87	B: 1.34	AB: 2.69	
			Second season		
Control	20.32	20.65	20.47	20.07	20.37
Amino acids 100 ppm	22.22	21.93	22.49	24.50	22.78
Amino acids 200 ppm	22.90	23.28	23.53	25.45	23.79
Amino acids 400 ppm	24.52	24.04	25.47	25.63	24.91
Vitamin B1 100 ppm	20.62	21.64	20.74	22.05	21.26
Vitamin B1 200 ppm	21.64	21.85	22.34	22.09	21.98
Vitamin B1 400 ppm	23.23	22.74	23.02	22.48	22.86
Mean A	22.20	22.30	22.58	23.18	
L.S.D. 5%		A: 0.54	B: 1.66	AB: 3.31	

Table 9. Effect of humic acid, amino acids mixture and vitamin B1 treatments on fruits yield/feddan (kg) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	852	876	942	1087	939
Amino acids 100 ppm	892	1028	1103	1166	1047
Amino acids 200ppm	1067	1099	1112	1190	1117
Amino acids 400 ppm	1143	1127	1164	1227	1165
Vitamin B1 100 ppm	859	927	923	1087	949
Vitamin B1 200 ppm	864	989	1063	1099	1003
Vitamin B1 400 ppm	884	1015	1079	1148	1031
Mean A	937.3	1009	1055	1143	
L.S.D. 5%		A: 42	B: 65	AB: 129	
			Second season		
Control	975	991	982	963	978
Amino acids 100 ppm	1066	1038	1105	1176	1096
Amino acids 200 ppm	1114	1117	1129	1230	1147
Amino acids 400 ppm	1176	1153	1222	1233	1196
Vitamin B1 100 ppm	989	1049	995	1058	1022
Vitamin B1 200 ppm	1038	1052	1072	1060	1055
Vitamin B1 400 ppm	1099	1091	1079	1079	1087
Mean A	1065	1070	1083	1114	
L.S.D. 5%		A: 28	B: 79	AB: 157	

(2015) and El-Leithy (2019) on coriander and Botros (2013) on caraway.

The interacting effect of humic acid, amino acids and vitamin B1 on the yield components of anise plants was significant in the two experimental seasons except the number of umbels/plant in the second seasons (Tables 6, 7, 8 and 9). The most effective interaction treatment which produced the highest values of yield and yield components was for treating with humic acid at 10 ml/l combined with the mixture of three amino acids at 400 ppm.

Volatile oil content:

It is clear from the data listed in (Tables 10, 11 and 12) that using humic acid, a mixture of amino acids and vitamin B1 on anise plants significantly promoted oil percentage in the fruits and oil yield/plant as well as per feddan compared to untreated plants in the first and second seasons.

In respect to humic acid treatments, data revealed that humic acid at 2.5, 5.0 and 10.0 ml/l significantly improved volatile oil % and yield/plant as well as /feddan in the fruits of anise plants compared with control. The highest values of the oil determination were obtained as a result of humic acid at the highest concentration (10 ml/l) in the two growing seasons. The role of humic acid in increasing volatile oil % and yield was also reported by Acimovic *et al*. (2015) on caraway, Khalid (2015) on sweet fennel and Said Al-Ahl *et al.* (2016) on dill.

In relation to the response of anise plants to foliar spray with mixture of amino acids and vitamin B1 each at 100, 200 and 400 ppm, data listed in Tables 10, 11 and 12 clarify that oil % and oil yield per plant and per feddan were significantly increased as a result of application of amino acids and vitamin B1 treatments in comparison with unsprayed plants. It is noticed that increasing the concentration of amino acids and thiamine led to a gradual increment in oil % and yield in both experimental seasons. Also, the highest results of volatile oil determination were obtained due to the mixture of amino acids at 400 ppm.

Table 10. Effect of humic acid, amino acids mixture and vitamin B1 treatments on volatile oil percentage in the fruits of anise plants during the two seasons (2017/2018 and 2018/ 2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	2.270	2.540	2.750	2.980	2.635
Amino acids 100 ppm	2.530	2.540	2.800	3.800	2.917
Amino acids 200 ppm	2.570	2.810	2.880	3.500	2.940
Amino acids 400 ppm	2.620	2.670	2.890	3.700	2.970
Vitamin B100 ppm	2.470	2.600	2.750	2.800	2.655
Vitamin B1 200 ppm	2.470	2.660	2.770	2.900	2.700
Vitamin B1 400 ppm	2.430	2.900	2.950	3.000	2.820
Mean A	2.480	2.674	2.827	3.240	
L.S.D. 5%		A: 0.124	B: 0.158	AB: 0.227	
			Second season		
Control	2.470	2.530	2.750	2.780	2.632
Amino acids 100 ppm	2.600	2.700	2.700	3.400	2.850
Amino acids 200 ppm	2.700	2.700	2.800	3.350	2.887
Amino acids 400 ppm	2.600	2.850	3.130	3.400	2.995
Vitamin B1 100 ppm	2.420	2.500	2.800	2.900	2.655
Vitamin B1 200 ppm	2.300	2.690	2.840	3.270	2.775
Vitamin B1 400 ppm	2.630	2.800	2.920	3.000	2.837
Mean A	2.531	2.681	2.848	3.157	
L.S.D. 5%		A: 0.127	B: 0.184	AB: 0.271	

Table 11. Effect of humic acid, amino acids mixture and vitamin B1 treatments on oil yield/ plant (ml) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	0.402	0.463	0.531	0.674	0.517
Amino acids 100 ppm	0.470	0.544	0.643	0.923	0.645
Amino acids 200 ppm	0.571	0.643	0.667	0.867	0.687
Amino acids 400 ppm	0.623	0.627	0.701	0.946	0.724
Vitamin B100 ppm	0.442	0.510	0.608	0.634	0.548
Vitamin B1 200 ppm	0.444	0.547	0.613	0.664	0.567
Vitamin B1 400 ppm	0.447	0.613	0.663	0.717	0.610
Mean A	0.485	0.563	0.632	0.775	
L.S.D. 5%		A: 0.029	B: 0.031	AB: 0.032	
			Second season		
Control	0.501	0.522	0.562	0.557	0.535
Amino acids 100 ppm	0.577	0.592	0.607	0.832	0.652
Amino acids 200 ppm	0.618	0.628	0.658	0.852	0.689
Amino acids 400 ppm	0.637	0.684	0.797	0.871	0.747
Vitamin B1 100 ppm	0.499	0.541	0.580	0.639	0.564
Vitamin B1 200 ppm	0.497	0.587	0.634	0.722	0.610
Vitamin B1 400 ppm	0.610	0.636	0.671	0.674	0.647
Mean A	0.562	0.598	0.644	0.735	
L.S.D. 5%		A: 0.028	B: 0.038	AB: 0.045	

Table 12. Effect of humic acid, amino acids mixture and vitamin B1 treatments on oil yield/feddan (l) of anise plants during the two seasons (2017/2018 and 2018/2019).

Amino acids mixture and vitamin B1 (B)	Humic acid (ml/l) (A) 0.0	2.5	5.0	10.0	Mean B
			First season		
Control	19.29	22.22	25.49	32.35	24.84
Amino acids 100 ppm	22.56	26.11	30.86	44.30	30.96
Amino acids 200 ppm	27.41	30.86	32.01	41.61	32.97
Amino acids 400 ppm	29.90	30.09	33.65	45.41	34.76
Vitamin B100 ppm	21.21	24.48	29.18	30.43	26.32
Vitamin B1 200 ppm	21.31	26.25	29.42	31.87	27.21
Vitamin B1 400 ppm	21.45	29.42	31.82	34.41	29.28
Mean A	23.30	27.06	30.34	37.20	
L.S.D. 5%		A: 1.17	B: 1.74	AB: 1.93	
			Second season		
Control	24.05	25.05	26.97	26.73	25.70
Amino acids 100 ppm	27.69	28.41	29.13	39.93	31.29
Amino acids 200 ppm	29.66	30.14	31.58	40.89	33.07
Amino acids 400 ppm	30.57	32.83	38.25	41.81	35.86
Vitamin B1 100 ppm	23.95	25.97	27.84	30.67	27.10
Vitamin B1 200 ppm	23.85	28.17	30.43	34.65	29.28
Vitamin B1 400 ppm	29.28	30.53	32.21	32.35	31.09
Mean A	27.01	28.73	30.91	35.29	
L.S.D. 5%		A: 1.62	B: 2.06	AB: 2.57	

In this concern, amino acids treatments were more effective than vitamin B1 treatments in stimulating oil content in both seasons.

Many investigators came to similar findings that amino acids and thiamine treatments enhanced the oil production, for example Ali *et al.* (2007) on caraway and Yassen *et al.* (2010) on anise, Abd El-Rahman *et al*. (2008) on fennel and Abd El-Satar (2020) on dill regarding amino acids treatments and Naguib and Khalil (2002) on black cumin, El-Leithy (2019) on coriander, Matter (2009) on fennel, Botros (2013) on caraway and Marzok (2017) on sweet basil concerning thiamine treatments.

It is obvious from data recorded in tables (10, 11 and 12) that the interaction effect of humic acid and amino acids, as well as vitamin B1 on volatile oil determinations in the fruit of anise plants was significant in the first and second seasons. The most effective interaction treatment which gave the highest essential oil % and yield per plant and per feddan was spraying anise plants with humic acid at 10 ml/l and with a mixture of amino acids at 400 ppm.

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إستجابة نباتات اليانسون لمعاملات حمض الهيوميك والاحماض الأمينية والثيامين

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أُجريت تجربة حقلية لدراسة تأثير حمض الهيوميك بتركيزات ٢,٥، ٥، ١٠ مل/لتر وخليط من ٣ أحماض أمينية هي التربتوفان، الميثونين، السيستين وكذلك الثيامين (فيتامين ب١) كلاً بتركيزات ١٠٠، ٢٠٠، ٤٠٠ جزء في المليون علي النمو الخضري والمحصول وإنتاجية الزيت الطيار في نباتات اليانسون. أدت المعاملة بحمض الهيوميك رشا بتركيز ٢,٥، ٥، ١٠ مل/لتر الي تشجيع طول النبات وسمك الساق وعدد الفروع/نبات وكذلك الوزن الجاف للعشب وعدد النورات/نبات ووزن الألف ثمرة ومحصول الثمار للنبات وللفدان بالإضافة إلى زيادة النسبة المئوية للزيت الطيار ومحصوله للنبات وللفدان مقارنة بمعاملة المقارنة وكان التركيز الأعلى (١٠ مل/لتر) من حمض الهيوميك هو الأكثر تاثيراً حيث أعطي أعلى القيم للصفات السابق ذكرها. أدي استخدام خليط الأحماض الأمينية الثلاثة وفيتامين ب١ كلاً بتركيز ١٠٠، ٢٠٠، ٤٠٠ جزء في المليون إلى زيادة معنوية في صفات النمو الخضري ومحصول الثمار والنسبة المئوية للزيت الطيار ومحصول الزيت مقارنة بمعاملة الكنترول وفي هذا المجال أدت الزيادة التدريجية في تركيز هذه المواد الي زيادة مضطردة في تلك الصفات السابق ذكرها. كذلك فإن الرش بخليط الاحماض الامينية الثلاثة كان اكثر تاثيراً من الرش بالثيامين وكان التركيز الأعلى ٤٠٠ جزء بالمليون هو الاكثر تأثيرا مقارنة بباقي التركيزات الأخرى حيث أعطي أعلي النتائج. معاملات التفاعل بين حمض الهيوميك والأحماض الأمينية والثيامين كان لها تأثيراً معنوياً على صفات النمو الخضري والمحصول وعلى تقديرات الزيت الطيار وكانت أكثر معاملات التفاعل تأثيراً هي الرش بحمض الهيوميك بتركيز ١٠ مل/لتر مع استخدام خليط الأحماض الأمينية بتركيز ٤٠٠ جزء في المليون والتي أدت إلى تحسين النمو الخضري ومحصول الثمار والزيت لنبات اليانسون.