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Interactive effects of humic acid and foliar amino acid treatments on the growth and essential oil content of sweet basil (*Ocimum basilicum* L.) plants

Jaber A. Mansour ⁎ Latifah A.A. Yarboa Abobaker E. Alsanose and Essam A. Hassan

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Abstract: This study investigated the impact of humic acid concentrations (HU, at 0.0, 5.0, 10.0, and 20.0 kg/h as soil conditioner) and foliar spraying with amino acid concentrations (AM at 0, 100, 200, and 300 mg/l) on the growth and essential oil production of sweet basil (*Ocimum basilicum* L.) during 2025. The findings indicated that both HU and AM concentrations significantly enhanced plant height, number of branches per plant, dry weights of herbs and leaves, and essential oil content. The highest growth values were consistently observed with the 20 kg/h HU. Furthermore, the 300 mg/l AM treatment proved to be the most effective foliar application for improving the traits studied. Significant interactive effects were noted for all parameters examined, with the combination of 20.0 kg/h HU and 300 mg/l AM being the most beneficial for all trials, including essential oil constituents (1.8-cineole, linalool, α-terpinol, and bornyl acetate), meanwhile, the highest values of estragole and eugenol were obtained with 200 mg/l AM with 20 kg/ha HU, compared to the other combinations.

Keywords: Sweet basil (*Ocimum basilicum* L.), humic acid, amino acids, growth, herb and volatile oil production.

التأثيرات التفاعلية لحمض الهيوميك والمعالجة الورقية بالأحماض الأمينية على النمو ومحتوى الزيت العطري لنباتات الريحان الحلو (*Ocimum basilicum* L.)

جابر عبد الهادي منصور[1]. لطيفة عبد المجيد عبد الحميد جربوع [2]، ابو بكر الجيلاني السنوسي [3] و عصام علي حسن [4]

1–المعهد العالي للعلوم والتكنولوجيا –الكفرة، ليبيا.

2–قسم علم النبات، كلية العلوم، جامعة الزاوية، ليبيا.

3 – قسم الانتاج النباتي، كلية الزراعة، جامعة سرت، ليبيا

4–قسم البساتين، كلية الزراعة، جامعة الازهر، أسيوط، مصر

المستخلص: بحثت هذه الدراسة تأثير تركيزات حمض الهيوميك (HU)، بمعدلات 0.0، 5.0، 10.0، و20.0 كجم/هكتار كمُحسِّن للتربة والرش الورقي بتركيزات من الأحماض الأمينية (AM)، بمعدلات 0، 100، 200، و300 مجم/لتر على نمو نبات الريحان الحلو (*Ocimum basilicum* L.) وإنتاجه من الزيت العطري خلال عام 2025. وأظهرت النتائج أن كلاً من تركيزات حمض الهيوميك والأحماض الأمينية أدت إلى تحسين معنوي في طول النبات، وعدد الفروع لكل نبات، والأوزان الجافة للأعشاب والأوراق، ومحتوى الزيت العطري. وقد سُجِّلت أعلى قيم للنمو عند استخدام حمض الهيوميك بتركيز 20 كجم/هكتار. علاوة على ذلك، تبين أن المعاملة بالأحماض الأمينية بتركيز 300 مجم/لتر كانت الأكثر فعالية كإضافة ورقية لتحسين الصفات المدروسة. كما لوحظت تأثيرات تفاعلية معنوية لجميع المؤشرات التي تم فحصها؛ حيث كان الجمع بين حمض الهيوميك

Higher Institute for Sciences and Technology - Kufra. Libya.(Japer70alzwai@gmail.com)
⁎ Botany Dept, Fac. of Science, Zawiya Univ. Zawiya. Libya.(l.yarboa@zu.edu.ly)
Plant production Dept, Fac. of Agric, Sirte, Univ., Libya.(abobaker.alsanose@su.edu.ly)
Horticulture Dept., Fac. Agric., Al-Azhar University, Assiut, Egypt (Hessam54@yahoo.com)

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(20.0 كجم/هكتار) والأحماض الأمينية (300 مجم/لتر) هو الأكثر فائدة لجميع المعايير، بما في ذلك مكونات الزيت العطري (1,8-سينول، لينالول، ألفا-تيربينول، وبورنيل أسيتات). وفي المقابل، تم الحصول على أعلى قيم لمركبي الإستراغول والأوجينول عند استخدام الأحماض الأمينية بتركيز 200 مجم/لتر مع حمض الهيوميك بتركيز 20 كجم/هكتار، مقارنةً بالتوليفات الأخرى.

الكلمات المفتاحية: الريحان الحلو (*Ocimum basilicum* L.)، حمض الهيوميك، الأحماض الأمينية، محتوي الزيت العطري.

Introduction

Sweet basil (*Ocimum basilicum* L.) plant belongs to the Lamiaceae family, a family of medicinal plants with over 150 aromatic species that vary in leaf size, blossom color, external features, and flavor. Basil originated in Africa and Asia (Al-Ibrahemi et al., 2023). The essential oil found in the fragrant leaves is utilized in dental and oral treatments, cuisine, medicine, perfumes, and cosmetics. Linalool, geraniol, eugenol, methyl chavicol, thymol, and methyl cinnamate are the main components of Ocimum oil (Pragya et al., 2016). Because it includes organic substances such as phenols, flavonoids, and vitamins, it also has antioxidant, antibacterial, and anticancer properties (Sgherri et al., 2010; Taie and Radwan, 2010).

Humic substances (HS) represent complex organic molecules formed through the natural decomposition and subsequent microbial and abiotic transformation of plant and animal waste (Ampong et al., 2022; Hayes and Swift, 2020). Humic acid (HA) promotes plant growth through a combination of physiological and biochemical mechanisms. It alters plasma membrane transporters, enhancing ion exchange and facilitating nutrient absorption, assimilation, and overall metabolism. By stimulating root cell elongation and division, HA promotes the development of an extensive root system, which increases the plant's capacity for water and nutrient uptake. Its low-molecular-weight fractions exhibit hormone-like characteristics, mimicking the activity of natural plant hormones such as auxins and cytokinins. These compounds influence molecular signaling pathways that regulate key growth processes, including cell division, shoot development, and photosynthesis (Yang and Fu, 2023). In addition to necessary elements including oxygen, hydrogen, nitrogen, and sulfur, HA normally comprises about 60% organic carbon (Sible et al., 2021). Humic acid contributes significantly to the improvement of nutrient bioavailability, i.e., iron, sulfur, and phosphorus (P) (Urrutia et al., 2020; Gerke, 2021). Additionally, by increasing aggregate stability, HA enhances soil structure and water-holding capacity (Fuentes et al., 2018). Many authors have investigated the potential of HA to improve plant growth and essential oil, including *Ocimum basilicum* L. (Sayarer et al., 2023; El Gohary et al., 2023; Feyz et al., 2024; Ehtaiwesh, 2026; Yalçın and Torun, 2026); Thai basil (Dehsheikh et al., 2020); caraway (Omer et al., 2024; Hassan et al., 2024); *Coriandrum sativum* L. (Altarhouni et al., 2024); *Rosmarinus officinalis (*Aly et al., 2024; Abdou et al., 2024); fennel (Abdou et al., 2025); *Cuminum cyminum* L. (Rahghoshahi et al., 2022; Sepehri et al., 2025).

Osmotic control, the activity of plant growth regulators like auxin and gibberellin, detoxification of toxins and heavy metals, and enhancing plant tolerance to a variety of environmental stresses are just a few of the vital physiological processes that amino acids are engaged in (Bashir et al., 2018; Sheng et al., 2020). Applying amino acids also promotes the production of antioxidant enzymes and secondary metabolites (Colla et al., 2015; Teixeira et al., 2015). According to certain research, using Acetic Acid Bacteria (AABs) topically can improve iceberg lettuce development, mineral content (N, K, P, and Mg), bioactive chemicals (such as phenols and flavonoids), and antioxidant capacity (Al-Karaki and Othman, 2023). The shikimate/phenylpropanoid pathway, an essential metabolic route for secondary chemicals in plants, involves several amino acids, including phenylalanine and tyrosine (Al Jitan et al., 2018). Amino acids are used as key ingredients in biostimulants because of their many benefits (Yaseen et al., 2022). As a result, using AABs to enhance the nutritional and medicinal qualities of herbs may be a beneficial and eco-friendly strategy. The positive impact of amino acids on plant growth traits has been documented previously on *Ocimum*

basilicum L. (Jahanbani et al., 2024; Deveikytė et al., 2025; Deveikytė et al., 2025; Ikiz et al., 2025; Abbas and Fadala, 2026); Carum carvi (Wafaa et al., 2021; Aly et al., 2025); cumin (Ali and Mohammed, 2020); mint (Velička et al., 2022; Abdel-Razik et al., 2024; Al-Yasiry and Mijwel, 2024);

This study aimed to explore how humic acid and amino acids, along with their interactions, influence the growth factors and essential oil production in basil plants to identify the most effective strategy for improving these parameters.

Materials and methods:

This study was conducted from March to September 2025 on a private farm in Misurata, Libya. Four HU rates were allocated to main plots and four AM rates to subplots in a split-plot design, yielding 16 treatments that were replicated three times for reliable statistical analysis. On March 10th, sweet basil seeds were planted in a nursery. On April 24th (45 days later), the seedlings were transplanted into 2.1 x 2.1 m plots in six rows, 30 cm apart (planting density was 81632 plants per hectare). Before planting, five soil samples were taken at depths of 0–20 cm and 20–50 cm to examine the physical and chemical characteristics of the soil (Table 1).

Table 1. Some physical and chemical analyses of the experimental soil

Physical analysis				Soil texture
Clay (%)	Silt (%)	Fine sand (%)	Coarse sand (%)	Sandy
6.87	9.79	79.12	4.22	

Chemical analysis												
pH	E C m.mohs /cm	Organic matter (%)	Soluble cations (meq./ L)				Soluble anions (meq. /L)			Available (ppm)		
			Mg^{++}	Ca^{++}	K^{+}	Na^{+}	Cl^{-}	HCO_3^{-}	SO_4^{--}	N	P	K
8.11	0.84	0.74	1.3	1.4	3.1	4.3	5.6	2.3	2.2	53.5	75.3	7.2

Experimental design:

The experimental treatments were set up in a split-plot design with three replicates, including two factors: four concentrations of humic acid (0, 5, 10, and 20 kg/ha), and foliar applications of amino acids (0, 100, 200, and 300 mg/l) applied as a foliar spray three times at intervals of 30 days from transplanting.

Harvest:

Plant height, branch and leaf number/plant, fresh and dry herb, dry herb yields (ton/hectare), as well as essential oil production were all noted when the plants were cut 10 cm above the ground. The yield of essential oil was measured in l/ha and extracted in accordance with the British Pharmacopoeia (1963).

Essential oil extraction from herbs:

Ordinary, 100 g of each replicate of all treatments were weighed and hydro-distilled (HD) for 3 hours using a Clevenger apparatus (Clevenger, 1928). The essential oil content was calculated as a relative percentage (volume/weight). In addition, the total essential oil content was calculated as ml/100 plants using dry weight. The essential oils extracted from sweet basil were collected for each treatment and dried with anhydrous sodium sulphate for chemical identification by gas chromatography. The five most effective treatments, which exhibited the greatest growth and yield, were selected for analysis of their volatile oil components by Gas chromatography–mass spectrometry analysis (GC-MS)

Gas chromatography–mass spectrometry analysis (GC-MS)

The GC-MS system (Agilent Technologies) was equipped with a gas chromatograph (7890B) and mass spectrometer detector (5977A) at Central Laboratories Network, National Research Centre, Cairo, Egypt. The GC was equipped with a VF-624ms column (30 m x 250 µm internal diameter and 1.4 µm film thickness). Analysis was carried out using Hydrogen as

the carrier gas at a flow rate of 1.00 ml/min at a splitless, injection volume of 1.0 µl and the following temperature program: 40 °C for 0 min; rising at 6 °C /min to 200 °C and held for 0 min; rising at 15 °C /min to 220 °C and held for 0 min; rising at 30 °C /min to 250 °C and held for 2 min. The injector and detector were held at 250 °C. Mass spectra were obtained by electron ionization (EI) at 70 eV, using a spectral range of m/z 33-600 and a solvent delay of 3.50 min. The mass temperature was 230 °C and the quadrupole temperature was 150 °C. Identification of different constituents was determined by comparing the spectrum fragmentation pattern with those stored in Wiley and NIST Mass Spectral Library data.

Statistical Analysis

Based on the approach of Mead et al. (1993), all growth, yield, oil production, and chemical composition data were statistically evaluated using Statistics version 9 (Analytical Software, 2008). Mean comparisons were carried out using the LSD test at a 5% significance level.

Results and discussion:

Growth parameters:

Humic acid (HU) treatment greatly improved sweet basil development throughout the growing season by raising plant height, branch number, and leaf number per plant relative to untreated plants. Except for the lower dose of HU (5 kg/ha) for plant height and leaves number/ plants. Taller plants, more branches, and the greatest number of leaves per plant were consistently produced by higher HU rates; the best results were obtained at the maximum rate (20 kg/ha). Plant heights were 46.17 cm; branch and leaf numbers per plant were 7.63 and 43.17, respectively. These results highlight the substantial effect of HU on the growth of sweet basil, likely due to its role in encouraging root cell division and elongation, resulting in deeper and more widespread root systems that improve the plant's ability to absorb water and nutrients (Nardi et al., 2021). Additionally, these findings are consistent with previous studies on basil (Sayarer et al., 2023); cumin (Yalçın and Torun, 2026; Sepehri et al., 2025); *Rosmarinus officinalis (*Abdou et al., 2024).

Furthermore, these findings are consistent with the fact that amino acids (AM) applied topically greatly improved the growth of sweet basil, as shown by higher plant height, branch number, and leaves number /plant (Table 1). All AM concentrations performed better than the control, except the lowest one (100 mg/l), however, 300 mg/l showed the biggest gains. Plant heights under this treatment were 45.33 cm, branch counts were 6.88, and leaf numbers were 41.92 during the growth season. These findings support observations in sweet basil (Deveikytė et al., 2025; Ikiz et al., 2025); cumin (Abbas and Fadala, 2026; Ali and Mohammed, 2020); mint (Abdel-Razik et al., 2024; Al-Yasiry and Mijwel, 2024).

Table 1 demonstrates how the combination of HU and AM greatly increased the growth of sweet basil. The best combination of 300 mg/l AM and 20 kg/ha HU resulted in the highest plant height, branch count, and leaves number/plant during the growth season. The control with 100 mg/l AM showed no improvement, while the majority of combined treatments performed better than the control.

Table (1): Mean Plant height (cm), branch number, and number of leaves/plants in sweet basil as affected by humic acid and amino acid and their interactions.

Treatments			Plant height (cm)	Branch number	Number of leaves/plant
Humic acid	HU 1		40.33 C	5.08 C	37.50 C
A	HU 2		42.08 BC	5.92 B	38.92 C
	HU 3		43.75 B	6.50 B	40.67 B
	HU4		46.17 A	7.63 A	43.17 A
Amino acids	AM1		41.25 C	5.58 C	38.42 C
B	AM2		42.33 BC	6.08 BC	39.42 BC
	AM3		43.42 B	6.58 AB	40.50 B
	AM4		45.33 A	6.88 A	41.92 A
Combination	HU 1	AM1	38.67 H	4.33 H	36.00 I
AxB		AM2	39.67 GH	4.83 GH	37.00 HI
		AM3	40.67 F-H	5.33 E-H	38.00 F-I
		AM4	42.33 C-G	5.83 C-G	39.00 D-H
	HU 2	AM1	40.33 F-H	5.17 F-H	37.33 G-I
		AM2	41.33 E-H	5.67 D-H	38.33 E-I
		AM3	42.33 C-G	6.17 C-G	39.33 D-H
		AM4	44.33 B-D	6.67 B-E	40.67 C-F
	HU 3	AM1	42.00 D-G	6.00 C-G	39.00 D-H
		AM2	43.00 C-F	6.50 B-F	40.00 C-G
		AM3	44.00 B-E	7.00 A-D	41.00 B-E
		AM4	46.67 AB	6.50 B-F	42.67 A-C
	HU4	AM1	44.00 B-E	6.83 B-E	41.33 B-D
		AM2	45.33 BC	7.33 A-C	42.33 BC
		AM3	46.00 AB	7.83 AB	43.67 AB
		AM4	48.67 A	8.50 A	45.33 A
L.S.D. at 5 %			**A: 2.13**	**A: 0.82**	**A: 1.54**
			B: 1.36	**B: 0.73**	**B: 1.35**
			AxB: 2.72	**AxB: 1.46**	**AxB: 2.70**

For a given mean within each column of each section, the same letters are not significantly different ($p \leq 0.05$).

Weight of herb fresh and dry yield:

Table 2 shows that herb fresh weight, herb dry weight, and herb dry weight /hectare (ton) of sweet basil were considerably increased by both HU and foliar-applied AM. Harvest showed an increase in herb fresh weight, herb dry weight, and herb fresh weight /hectare (ton) due to rising HU rates. In addition to yields of 5.50 t ha^{-1}, the highest HU rate tested (20 kg/ha) produced maximum dry weights of 16.54 g. These enhancements corroborate earlier research showing that the carboxyl and phenolic functional groups of HU combine with nutrient elements to form chelate complexes that facilitate plant uptake by preventing the precipitation of micronutrients like iron (Fe), zinc (Zn), and copper (Cu), especially in high-pH soils (Bezuglova and Klimenko, 2022; Yang et al., 2021).

Compared to untreated plants, foliar AM increased herb fresh weight; herb fresh weight (ton/hectare) increased at all AM concentrations, but the 300 mg/l treatment worked best. The dry herb weight under this treatment was 16.21 g in 2025. The corresponding yield was 5.41 hectares (ton). These outcomes were consistent with those published previously (Thomas et al., 2009; Reham et al., 2016). Recent studies have shown that the use of AM in agriculture can increase the yield, metabolism, and the biosynthesis of plant metabolites in tea, lemon

balm, basil, and rosemary. These findings align with previous studies on Ocimum *gratissimum* (Jahanbani et al., 2024; Deveikytė et al., 2025; Wafaa et al., 2021); *Carum carvi* (Aly et al., 2025); and mint (Velička et al., 2022).

Table (2): Mean herb fresh weight /plant, herb dry weight /plant, and herb dry weight /hectare (ton) in sweet basil as affected by humic acid and amino acid and their interacti0ons.

Treatments			Herb fresh weight /plant (g)		Herb dry weight /plant (g)		Herb fresh weight /hectare(ton)	
Humic acid	HU 1		61.17	C	13.58	C	4.99	C
A	HU 2		62.92	BC	14.50	BC	5.14	BC
	HU 3		64.75	B	15.42	AB	5.29	B
	HU4		67.33	A	16.54	A	5.50	A
Amino acids	AM1		61.42	C	13.67	C	5.01	C
B	AM2		63.33	BC	14.58	BC	5.17	BC
	AM3		65.17	AB	15.58	AB	5.32	AB
	AM4		66.25	A	16.21	A	5.41	A
Combination	HU 1	AM1	59.00	G	12.00	E	4.82	G
AxB		AM2	60.67	FG	13.50	DE	4.95	E-G
		AM3	62.00	1	14.17	C-E	5.06	D-G
		AM4	63.00	C	14.67	B-E	5.14	C-G
	HU 2	AM1	60.33	FG	13.50	DE	4.93	FG
		AM2	62.33	D-G	14.00	C-E	5.09	D-G
		AM3	64.00	C-F	15.00	B-D	5.22	C-F
		AM4	65.00	B-E	15.50	A-D	5.31	B-E
	HU 3	AM1	62.00	E-G	14.17	C-E	5.06	D-G
		AM2	64.00	C-F	14.83	B-D	5.22	C-F
		AM3	66.00	A-E	16.00	A-D	5.39	A-D
		AM4	67.00	A-C	16.67	A-C	5.47	A-C
	HU4	AM1	64.33	C-F	15.00	B-D	5.25	B-F
		AM2	66.33	A-D	16.00	A-D	5.42	A-D
		AM3	68.67	AB	17.17	AB	5.61	AB
		AM4	70.00	A	18.00	A	5.71	A
L.S.D. at 5 %			**A: 2.02 B: 2.13 AxB: 4.26**		**A: 1.54 B: 1.35 AxB: 2.70**		**A: 0.20 B: 0.18 AxB: 0.36**	

For a given mean within each column of each section, the same letters are not significantly different ($p \leq 0.05$).

Oil production:

Amino acids (AM) and Humic acid (HU) both considerably raised the percentages of oil production (%/plant, oil/ plant /ml, and oil/ plant L/ha in dried sweet basil leaves over the course of the growing season (Table 4). When compared to the control, HU applications at 5, 10, and 20 kg/ha all increased these nutrient levels; the highest HU rate (20 kg/ha) produced the highest oil production parameters. Higher HU levels promote oil production in sweet basil, as this dose-dependent response demonstrates. These results are consistent with earlier studies on medicinal herbs such as caraway (Sayarer et al., 2023); *Rosmarinus officinalis* (Omer et al., 2024; Hassan et al., 2024; Abdou et al., 2024); and fennel (Abdou et al., 2025).

Amino acids (AM) foliar spraying greatly increased the oil production (%/plant, oil/ plant /ml, and oil/ plant L/ha) of sweet basil; as compared to unsprayed plants, the 300 mg/l AM treatment produced the highest percentages (%/plant, oil/ plant /ml, and oil/ plant L/ha. These findings align with previous research on therapeutic herbs, including *Ocimum basilicum* L. (Ikiz et al., 2025; Abbas and Fadala, 2026), *Carum carvi* (Wafaa et al., 2021; Aly et al., 2025), and mint (Velička et al., 2022; Abdel-Razik et al. 2024; Al-Yasiry and Mijwel, 2024).

All measured basil oil production (%/plant, oil/ plant /ml and oil/ plant L/ha, were statistically significantly impacted by the interaction between HU and AM (Table 3). The greatest gains in most metrics were consistently achieved by treatments that combined foliar application of AM at 300 mg/l with HU4 at 20 kg/ha.

Table (3): Mean essential oil %, essential oil/ plant (ml), and essential oil plant (L/ha) in sweet basil as affected by humic acid and amino acid and their interactions.

Treatments			Essential oil %	Essential oil/ plant (ml/plant)	Essential oil plant (L/ha)
Humic acid **A**	HU 1		0.557 C	0.077 C	6.29 C
	HU 2		0.595 BC	0.087 C	7.07 BC
	HU 3		0.635 AB	0.098 B	8.01 AB
	HU4		0.674 A8	0.112 A	9.14 A
Amino acids **B**	AM1		0.587 C	0.082 C	6.70 C
	AM2		0.606 BC	0.089 BC	7.25 BC
	AM3		0.624 AB	0.098 AB	7.98 AB
	AM4		0.644 A	0.105 A	8.58 A
Combination **AxB**	HU 1	AM1	0.527 F	0.069 G	5.60 G
		AM2	0.5500 EF	0.074 FG	6.07 FG
		AM3	0.5700 D-F	0.080 D-G	6.53 D-G
		AM4	0.5800 C-F	0.085 C-G	6.94 C-G
	HU 2	AM1	0.5633 D-F	0.076 E-G	6.23 E-G
		AM2	0.5833 C-F	0.082 D-G	6.67 D-G
		AM3	0.6067 B-E	0.091 B-G	7.46 B-G
		AM4	0.6267 A-E	0.097 B-F	7.95 B-F
	HU 3	AM1	0.6067 B-E	0.086 C-G	7.02 C-G
		AM2	0.6267 A-E	0.093 B-G	7.59 B-G
		AM3	0.6400 A-D	0.102 A-E	8.35 A-E
		AM4	0.6667 AB	0.111 A-C	9.09 A-C
	HU4	AM1	0.6500 A-C	0.098 B-F	7.97 B-F
		AM2	0.6633 AB	0.106 A-D	8.68 A-D
		AM3	0.6800 AB	0.117 AB	9.58 AB
		AM4	0.7033 A	0.127 A	10.34 A
L.S.D. at 5 %			**A: 0.048** **B: 0.035** **AxB: 0.070**	**A: 0.011** **B: 0.014** **AxB: 0.028**	**A: 1.27** **B: 1.07** **AxB: 2.14**

For a given mean within each column of each section, the same letters are not significantly different ($p \leq 0.05$).

Effect of humic acids and amino acids on volatile oil compounds:

According to volatile oil compounds, the AM at 300 mg/l with HU at 20 kg/ha combination treatment recorded the highest values of 1.8-cineole, linalool, α-terpinol, and bornyl acetate. Also, the highest values of Estragole and Eugenol were obtained with AM at 200 mg/l with HU at 20 kg/ha, compared to the other combinations under study (Table 4) and Fig. 1, 2, 3, and 4.

Table (4): Mean combinations of essential oil (E.O.) components in sweet basil **(*Ocimum basilicum* L.)** as affected by humic acid and amino acid interactions.

Treatments ***E.O components***	**Control without humic or amino acids**	**HU3+AM3**	**HU3+AM4**	**HU4+AM3**	**HU4+AM4**
1.8-cineole	**12.19**	**12.25**	**12.44**	**13.70**	**14.08**
Linalool	**42.30**	**43.42**	**42.68**	**44.19**	**45.22**
α-terpinol	**1.00**	**1.03**	**1.06**	**1.11**	**1.18**
Bornyl acetate	**1.17**	**1.41**	**1.62**	**1.79**	**2.17**
Estragole	**16.58**	**17.05**	**17.33**	**18.05**	**17.18**
Trans-a' ergamotene	**5.22**	**5.44**	**5.12**	**4.15**	**3.44**
Germacrene-D	**2.55**	**2.60**	**2.17**	**1.95**	**1.37**
Alfa-copaene	**5.65**	**5.38**	**5.11**	**3.75**	**2.19**
Eugenol	**6.75**	**7.22**	**8.11**	**8.22**	**7.88**

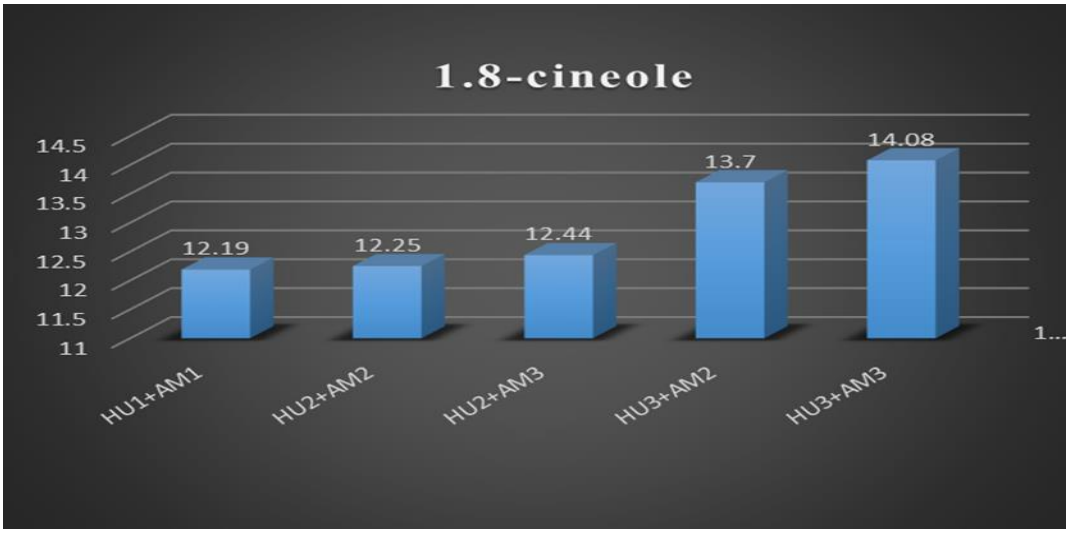


Fig. 1. Effect of Humic acid (HA) and Amino acids (AM) combinations on 1.8-cineole of sweet basil (*Ocimum basilicum* L.) essential oil.

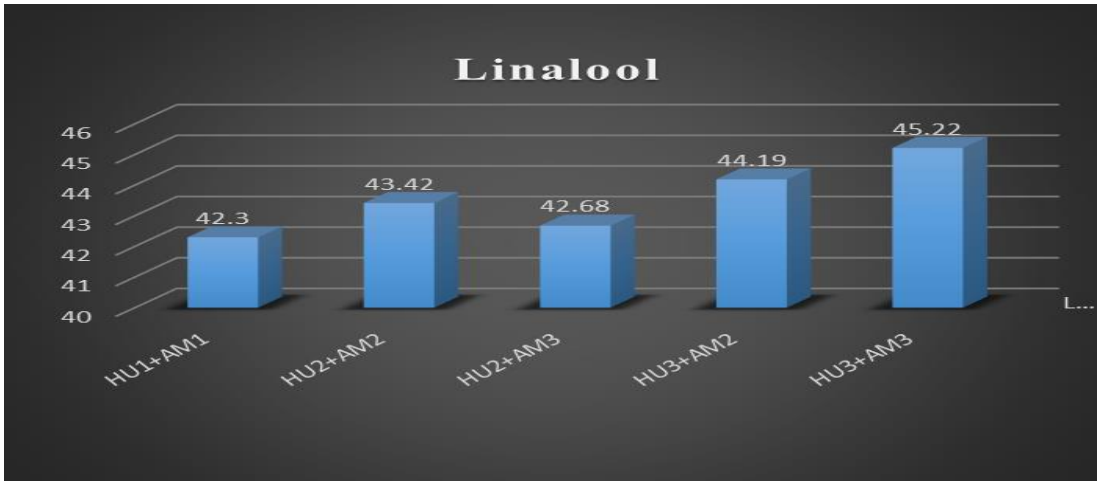


Fig. 2. Effect of Humic acid (HA) and Amino acids (AM) combinations on Linalool of sweet basil (*Ocimum basilicum* L.) essential oil.

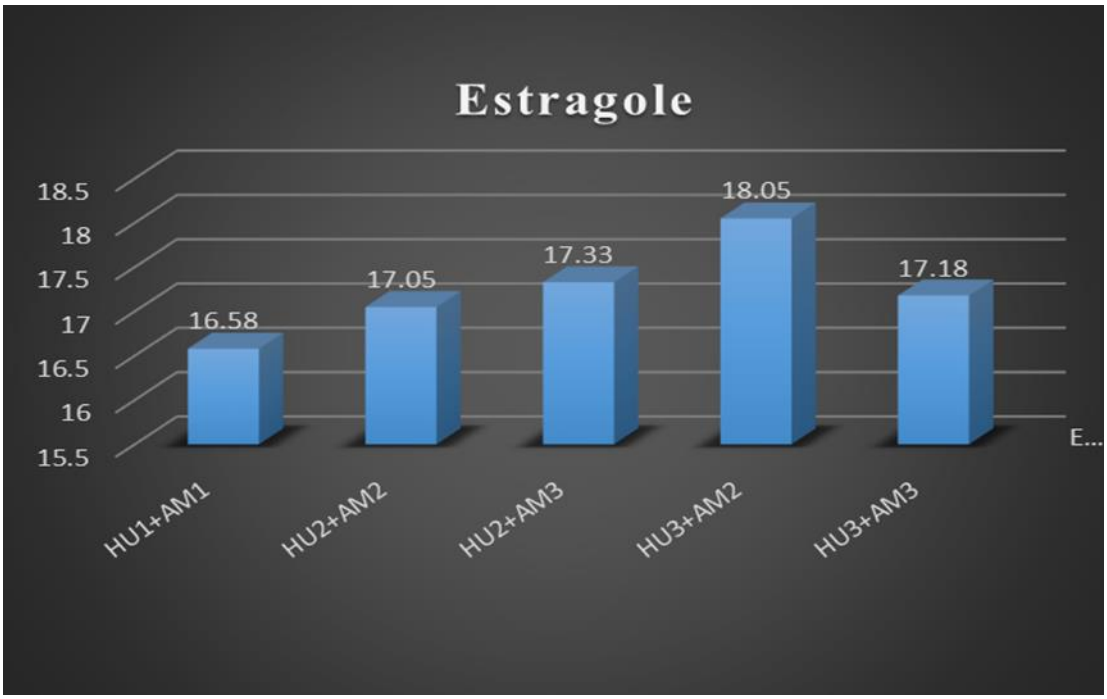


Fig. 3. Effect of Humic acid (HA) and Amino acids (AM) combinations on Estragole of sweet basil (*Ocimum basilicum* L.) essential oil.

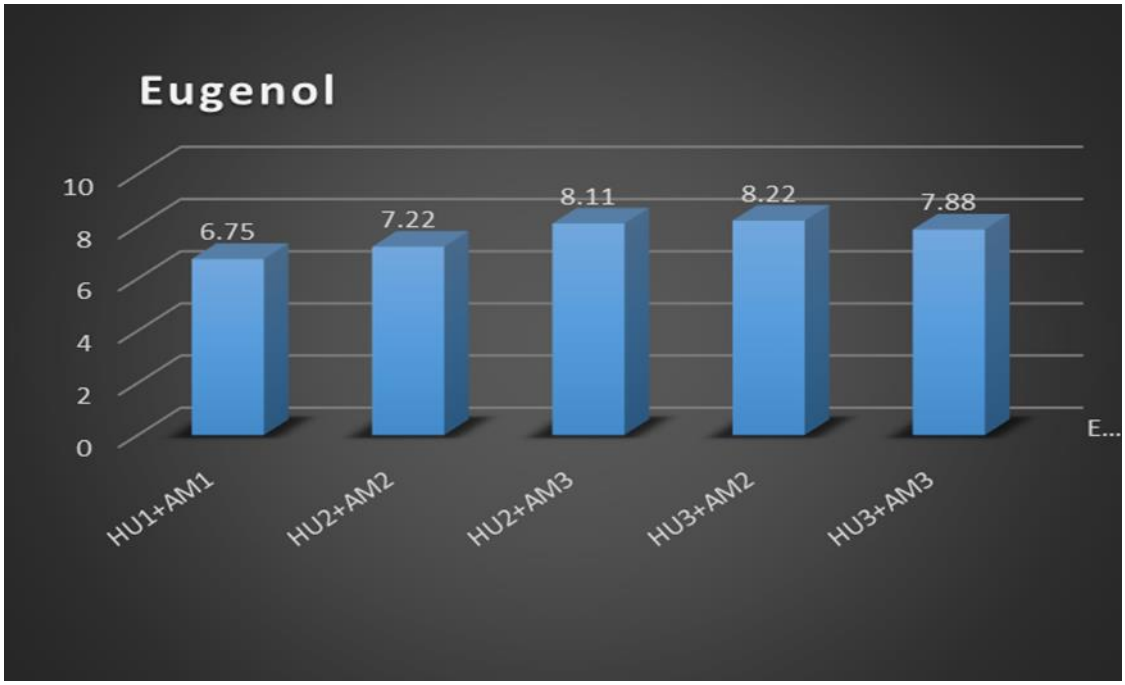


Fig. 4. Effect of Humic acid (HA) and Amino acids (AM) combinations on Eugenol of sweet basil (*Ocimum basilicum* L.) essential oil

Conclusion

The study's most significant finding is that the productivity of the sweet basil (Ocimum *basilicum* L.) plants increased because of the varying humic acid utilized. When compared to the control, the sweet basil plants' growth, herb yield, and oil yield were all markedly enhanced with amino acid treatments. Growth, yield, and the oil index were all significantly impacted by the interaction between organic manure and amino acid treatments. Humic acid (HU4) with a high concentration of amino acid (AM4) was the most effective treatment. The study's most significant finding is that the productivity of the sweet basil (*Ocimum basilicum* L.) plants increased because of the varying humic acid utilized. When compared to the control, the sweet basil (*Ocimum basilicum* L.) plants' growth, herb yield, and oil yield were all markedly enhanced with amino acid treatments. Growth, yield, and the oil index were all significantly impacted by the interaction between organic manure and amino acid treatments. Humic acid (HU4) with a high concentration of amino acid (AM4) was the most effective treatment. According to volatile oil compounds, Amino acids (AM) at 300ppm with Humic acid (HU) (20 kg/ha) combination treatment recorded the highest values of 1.8-cineole, Linalool, α-terpinol, and bornyl acetate. Also, the highest values of Estragole and Eugenol were obtained with (AM) at 200 ppm with (HU) (20 kg/ha). Compared to the other combinations. Therefore, it is recommended to apply 20 kg/ha of humic acid to the soil, combined with a foliar spray of amino acids at a concentration of 300 mg/L, to improve the yield of sweet basil in terms of both herb biomass and essential oil. It is also recommended to conduct the study over several agricultural seasons and in different environments to verify the consistency of the results.

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