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Improving the Productivity of Rosemary (*Rosmarinus Officinalis* L.) Plants by Using Some Bio Stimulants

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Abstract: The main goal of this work was to study the impacts of humic acid (H) and Seaweed extract application (SW) on growth (plant height, number of branches/plant, fresh weight and dry weight of herb/plant) and (volatile oil %) and volatile oil content of Rosemary (*Rosmarinus officinalis* L.) plants were investigated during period from August 2024 to January 2025 in Misurata city, Libya.Four levels of humic acid including 0, 2, 4 and 6 ml/L in main plots. Four concentrations of Seaweed extract (SW) were assigned in sub-plots at 0, 100, 200 and 300 ppm as well as their interactions. The results demonstrated that the utilize of humic acid as well as Seaweed extract significantly improved the growth parameters, and oil extraction. Regarding this concern, the highest results were recorded through the addition of a high level of humic acid (6 ml/L) along with foliar spray of Seaweed extract (300 ppm) in comparison to the control during period growing. The volatile oil's GC-MS analysis revealed that the usage of biostimulant applications also had an impact on the main ingredients. In comparison to untreated plants, plants sprayed with 300 ppm of seaweed extract and a higher standard humic acid (6 ml/L) generally produced higher proportions of the principal components.

Key words: Humic acid (H), Seaweed extract and Rosemary and (*Rosmarinus officinalis* L.).

1. Introduction

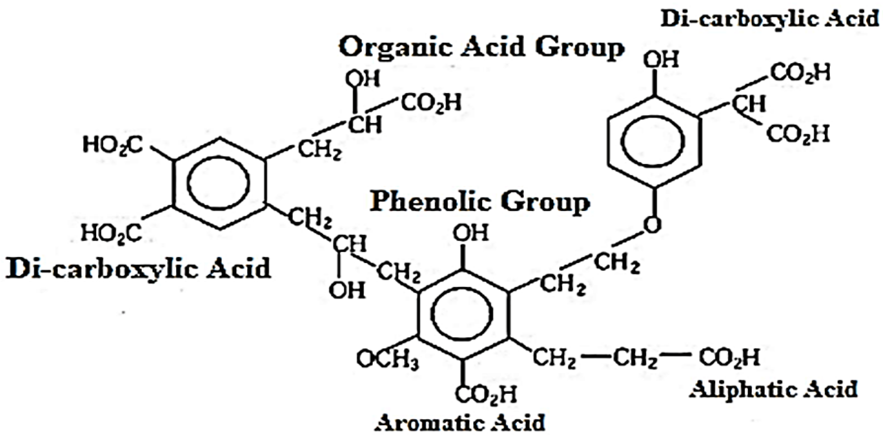
In recent years, most modern medications have been developed from isolated compounds of medicinal plants, based on their ethnopharmacological uses/applications. Indigenous populations around the world have long utilized medicinal plants to treat human and animal diseases (**Batanouny *et al*., 1999, Cragg and Newman, 2013, Mukherjee and Heinrich 2008 and Jardak *et al*., 2017).** Natural products have been playing an increasingly important role in drug research, not only when the bioactive chemicals are used as direct therapeutic agents but also when they are used as a basic model for novel biologically active molecules or as a raw material for drug synthesis (**Mendonça 2006 and Swain 1972)**. To put this resource on par with traditional pharmaceutical products, however, a lot of basic and applied research is needed to validate and use plants as phytopharmaceuticals (**Batanouny *et al*., 1999**). Furthermore, only roughly 10% of the estimated 250,000 plant species in the world have been thoroughly investigated for possible medical use (**Cragg and Newman, 2002**). Additionally, it is imperative to find novel chemicals with medicinal potential because it is likely that about 60,000 species will go extinct by 2050 (**Mukherjee and Heinrich, 2008**).

The Lamiaceae family includes the medicinal plant *Rosmarinus officinalis* L., generally referred to as rosemary (Rotblatt 2000). In addition to being used in cooking because of its distinct scent, this plant is also frequently used by native communities in areas where it grows naturally (**Jardak *et al*., 2017**).

Botanical Name	*Rosmarinus officinalis L.*
Common Name	Rosemary
Family	Lamiaceae
Native Area	Mediterranean
Size	2–6 ft. tall, 2–4 ft. wide
Soil Type	Sandy, loamy, well-drained
Plant Type	Herb, perennial
Hardiness Zones	8–10 (USDA)
Soil pH	Acidic, neutral
Bloom Time	Spring, summer
Sun Exposure	Full sun

The natural antioxidant properties of rosemary extracts extend the shelf life of perishable goods. **Habtemariam (2016)**. Indeed, according to the Food Standards Agency (2012), the EU has authorized rosemary extract (E392) as a natural antioxidant that is both safe and effective for food preservation.

Humic acid is an important component of brown humus that affect the physical quality and chemical content of soil. Also, Humic substances typically consist of heterogeneous mixtures of converted bio compounds that exhibit a supramolecular structure that can be isolated into smaller molecular components by sequential chemical fractionation (**Cordell and Colvard 2005)**.



Humic acid structure

One complicated molecule that is produced when plant and animal materials decompose through the process of dilating is humic acid. The major components of these compounds are fulvic acid, humin, and humic acid. Both plant nutrition and soil fertility depend on these chemicals. Humic acids positively affect plant growth because it helps in the permeability of cell membranes, stimulate enzymatic reactions, improve mitosis and stimulate intracellular vitamins (**Pettit 2008).** The Spraying of rosemary plant with humic acid improved the growth of the vegetative total **(Jalayerinia *et al*., 2017)**. **Al-Ajili (2014)** found that spraying Fennel plants *Foeniculum vulgare* Mill with humic acid at 0, 1, 2.5, 3.5 ml L^{-1} led spraying at a rate of 3.5 ml L^{-1} to significant superiority in the height of the plant, the branch number and the dry weight of the plant (137.11 cm, 8.83 branches plant 1, 168.87 g), respectively. **Ali *et al.* (2022)** showed that the addition of a humic acid with a raye of 7 ml^{-1} produced the highest significant in all vegetative growth qualities of rosemary plants. **Calixto (2005)** discovered that, when compared to the control plant (one without humic acid), humic acid treatments enhanced the vegetative development parameters of caraway plants (plant height, branch number and dry weight per plant). According to **Soliman (2022),** humic acid treatments improve caraway plants' vegetative development characteristics, such as plant height, branch count, and herb dry weight/plant. **Rates (2001)** found that foliar spraying anise plants with humic acid at 2.5, 5.0, and 10.0 ml/l was very efficient in increasing plant height, branch number per plant, dry weight of herb and umbels number per plant. The highest humic acid concentration (10 ml/l) was the most effective. **Bandaranayake (2006)** showed that the application of humic acid significantly increases vegetative growth (plant height and branches number /plant) on *Nigella sativa* plants. **Rout *et al.* (2009)** studied the treatment of *Nigella sativa* plants by applying different humic acid levels (100, 200, and 400 mg/l) and they found that the level of 200 mg/L was Superior in the plant height, the number of branches/plants, fresh, dry weights. **Samuelsson and Bohlin (2001)** assessed how biostimulator chemicals affected rosemary (Rosmarinus officinalis L.) growth and phytochemical characteristics. At the Medicinal Plants Institute (MPI), this experiment was carried out using a randomized full blocks design with three replications. Commercial formulations of aminolforte, kadostim, fosnutren, and humiforte (each at 0.75 and 1.5 $L.ha^{-1}$), 120 $kg.ha^{-1}$ of chemical fertilizers (N.P.K., 15:8:15%), and a control treatment (no chemical fertilizer applications or biostimulators) were among the treatments. Treatment effects were significant ($p \leq 0.01$) for all traits, and foliar application of 1.5 $L.ha^{-1}$ fosnutren produced the highest values of plant height, leaf length, leaf breadth, number of leaves per plant, leaf SPAD value, total dry weight, essential oil, and α-pinene. Additionally, the chemical fertilizer treatments of 1.5 $L.ha^{-1}$ aminolforte and humiforte showed the maximum collar width of the stem, number of branches per plant, and camphor, respectively. On the other hand, the control treatment showed the fewest characteristics.

In addition to trace elements like iron, zinc, manganese and copper, seaweed extract is an excellent source of various primary nutrients like potassium and phosphorus, secondary nutrients like calcium and magnesium, and beneficial elements like nickel and salt. A variety of ailments that are either incurable or infrequently cured by modern medical systems are treated with herbal extracts. The health and healing of almost 80% of the world's population is dependent on medicinal plants **Aliyu (2003**). Seaweed extract was crucial for a variety of crops since it contains high levels of organic matter, microelements, vitamins, fatty acids, and growth regulators like auxins, gibberellins and cytokinin **Crouch and VanStaden (1994)**. Seaweed extracts are healthful for people, animals, and birds, biodegradable, non-toxic, and non-polluting. It is commonly found that such nutrients are more efficient than fertilizers **Booth, E. (1969)**. However, using seaweed extract enhanced the amount of chlorophyll **Whapham *et al.* (1993)** and **Thirumaran *et al.* (2009)**. Seaweed extract improves and controls the physiological functions of the crops. Through a variety of mechanisms, it affects plant physiology to enhance nutrient uptake, yields, quality, and resistance to abiotic challenges in crops as noticed by **Abd El-Aleem *et al.* (2017), Yakhin *et al.* (2017), Rouphael and Colla (2018) and Ronga *et al.* (2019)** In actuality, natural growth regulators found in algae extracts actually postpone the plant's entry into the aging stage. They also stop harvesting, flowering, and leaf fall. Because of the way they affect protein, they also stop yellowing. They stop the breakdown of chlorophyll and conserve it. They promote root growth and induce cell division. It is among the most significant scientific reasons for how algae extracts affect the productivity and development of numerous commercial plants **Rania *et al.* (2016).**

Moreover, algae contain natural phenols like tannins that function similarly to natural growth hormones. They also help plants produce more lignin, which makes them more disease-tolerant. In a similar vein, they facilitate faster nutrient absorption because they include alginic acid, a naturally occurring chelating agent that chelates nutrients with a soil solution. They additionally include many vitamin types, such as C, B1, B2, and B12. Because algae contain free amino acids which promote balanced, productive development and enhance the plant's response to fertilization, they function as both natural antibiotics and growth regulators within the plant **Marrez *et al.* (2014).** Algae extracts can be used directly as organic fertilizers by adding them to the soil or foliar treatment to enhance and improve productivity, quality and its metabolites **Tursun (2022).** The increments in growth aspects, seed yield and oil production due to using biostimulants which have been studied by **Manhart and Delibaltova (2022).** This study aimed to determine the best treatment for improving the essential oil and plant development properties of rosemary (*Rosmarinus officinalis* L.) plants by analysing the effects of several biostimulants and their interactions as well as verifying the appropriate rate of humic acid and seaweed extract to give the best productivity in preparation for generalizing these materials to the productivity of other medicinal and aromatic plants.

2. Materials and Methods

This study is proposed to be conducted during the period from August2024 to January 2025 in Misurata city, Libya, to show the influence of some biostimulants on plant growth characteristics and volatile oil of rosemary (*Rosmarinus officinalis* L.) plants.

2.1. Design of Experiment

This study used a split plot design with three replicates. Humic acid as organic fertilizer was used as the main plots (A) included four treatments, while Seaweed extract (B) were allocated to the sub-plots, thus, the interaction treatments were 16.

Rosemary shoots were transferred to the experimental site on August 27, in 15 cm diameter pots containing 3 rows, with a distance of 60 cm between each row, each row containing 5 plants.

Obtaining rosemary seedlings from a private plantation **-** Tamina **-** Misurata

Humic acid was obtained from Al-Rabi Company **-** Misurata City

The humic acid rates utilized in this study are 2, 4 and 6 ml/L, they were added with irrigation water to plants after 15, 30 and 45 days following transplanting.

The plants were foliar application with Seaweed extract at concentrations (SW1=0, SW2=100, SW3=200, SW4=300 three times at two week intervals starting September 10^{th}, rosemary plants were foliar sprayed until runoff. All other cultural practices were carried out as usual.

2.2. Sampling and data collection

Plants were randomly selected from each plot during December to determine the following variables: plant height (cm), number of branches/plant. The following data were also recorded: fresh and dry herb weight in grams/plant, volatile oil content in herb and then the volatile oil content was then multiplied by the herb yield (g) plant to determine the volatile oil yield (ml/plant).

2.3. Volatile oil isolation from herb

100 g of each replicate of all treatments were weighed, hydro-distilled (HD) for 3 hours using a Clevenger apparatus **Clevenger (1928)**. A relative percentage (volume/weight) was used to determine the essential oil content. In addition, the total essential oils were calculated as ml/100 plants using dry weight. The essential oils extracted from rosemary plants were collected for each treatment and dried with anhydrous sodium sulphate for chemical identification.

2.4. Statistical analysis

All of the data collected for this study were organized, documented, and statistically evaluated utilizing the L.S.D. test at 5% to determine the differences between all treatments (**MSTAT- C 1986).**

3. Results

3.1. Growth and yield parameters

The presented data in Tables (1) reveal that utilizing humic acids (HU) at any level significantly increased rosemary height (cm), branch number and fresh and dry weights of herb (g/plant). Clearly, rosemary plants grown in organic manure (humic acids) at the high level (6 ml/liter) registered the high-rise growth parameter values which increased plant height by 27.96 %, augmented number of branches by 35.46 %, elevated herb fresh weight by 15.71 % and increased herb dry weight by 16.48 % over the control, during the study, respectively. Additionally, the ability of organic fertilization to increase the growth aspects found in this study was revealed by **Hamza *et al.* (2021), Rania and Salama (2021)** and **Rasouli *et al.* (2022)** on coriander plant, **Rania *et al.* (2022)** on *ruta graveolens* and **Abd-El Hameed *et al.* (2023)** on sweet marjoram.

The information provided in Tables (1) on the treatments with showed that, foliar application with seaweed extract resulted in positive in plant growth traits. The utilized of spraing with seaweed extract rresulted in higher values of height (cm), branches number and fresh and dry weights (g/plant). In general, the foliar application with the seaweed extract (300ppm) proved to be more effective in enhancing vegetative growth and yield parameters, than those noticed by control and other ones. The increases percentage of plant height, branches number, herb fresh and dry weight as ranged 18.62, 39.17, 10.14 and 13.11% over un-treated ones, respectively.

According to the studies collected, which also showed that bio-stimulants increased growth parameters output by **Hassan *et al.* (2015)** and **Abdullah *et al.* (2012** on rosemary (*Rosmarinus officinalis* L.) plants,

As for the interaction impact, it was a significant influence on the vegetative growth parameters Tables (1). It was shown that, in comparison to other combinations, treating the plants with the most combined treatments resulted in a considerable rise in these parameters. Furthermore, in comparison to other combination treatments, the most successful method for increasing growth traits (plant height, branches number and fresh and dry herb weights) was treating to plants grown in organic conditions (hemic acids) at a high level (6 m/L) and Spraying with seaweed extract with a concentration of 300 ppm.

Table (1). Effect of Humic acid (H) and Seaweed extract (SW) treatments on Growth and yield parameters of Rosemary (*Rosmarinus officinalis* L.) plants.

	Humic acid (A)									
Seaweed extract (B)	Plant height (cm)					Branches number/plants				
	H1	H2	H3	H4	Mean	H1	H2	H3	H4	Mean
SW1	29.98	34.23	35.56	39.23	34.75	3.833	4.333	4.583	4.833	4.396
SW2	32.67	36.12	37.67	42.00	37.11	4.250	4.833	5.250	6.150	5.121
SW3	34.15	37.70	38.80	43.33	38.50	4.667	5.250	5.667	6.480	5.516
SW4	36.23	40.67	42.33	45.67	41.22	5.220	6.150	6.220	6.880	6.118
Mean	33.26	37.18	38.59	42.56		4.493	5.142	5.430	6.086	
L.S.D 0.05	A:2.69 B: 2.14 AB: 4.27					A: 0.52 B: 0.49 AB: 0.98				
	Fresh weight herb (gm)					Dry weight herb (gm)				
SW1	45.00	46.67	50.00	52.00	48.42	10.90	11.80	12.50	13.00	12.05
SW2	46.33	48.00	51.67	53.67	49.92	11.33	12.08	13.00	13.50	12.48
SW3	48.00	49.67	53.33	55.00	51.50	11.80	12.50	13.50	13.75	12.89
SW4	49.33	51.33	55.00	57.67	53.33	12.80	13.33	14.08	14.30	13.63
Mean	47.17	48.92	52.50	54.58		11.71	12.43	13.27	13.64	
L.S.D 0.05	A: 2.03 B: 1.59 AB: 3.17					A:0.49 B: 0.68 AB:1.35				

Humic acid H1 = 0, H2 = 2 and H3 = 4 and H4= 6 ml/ L., SW = Seaweed extract (SW1 = 0, SW2=100, SW3=200 and SW4=300 ppm)

3.2. Volatile oil Yield

Humic acids (H) applied to rosemary plants had a favorable effect on volatile oil %. Clearly, were significantly raised due to the use of humic acid (H) at all levels, concerning volatile oil %, in relative to untreated plants. Clearly, plants grown in humic acids at the high level registered the maximum values of the which increased volatile oil % by 20.36 over the check treatment, as clearly mentioned in Table (2).

The role of organic manure in increasing oil yield parameters detected in this study was, also insured by **El Gohary *et al.*** and **Sayarer (2023)** on Basil (*Ocimum basilicum* L.) plant, **Omer *et al.* (2020)** and **Hassan *et al.* (2024)** on caraway (*Carum carvi* L.) plant , **Aly *et al.* (2022)** on anise plant and **Aliyu (2003)** on (*Mentha piperita* L.).

In relation to seaweed extract (SW) treatments, the given data in in Table 2 showed that oil yield parameters (volatile oil percentage and plant (ml) of rosemary plants were positively responded to adding seaweed extract, Apparently, treating the plants with foliar application of seaweed extract gave a significant augment in volatile oil % compared to untreated plants. Numerically,

The primitive impact of biostimulants treatments on oil yield aspects revealed in this research was, also mentioned on coriander (Cori*andrum sativum* L.) **Ali *et al.* & Sharma *et al.* (2023)** and **Darzi *et al.* (2012) & Hegazi *et al.* (2015)** on *Anethum graveolens*.

While the treatments of humic acid and seaweed extract did not show any significant effect on the volatile oil content of the plant, as is clear in Table 2.

Table (2). Effect of Humic acid (H) and Salicylic acid (SA), as well as their interactions on Volatile oil % and Volatile oil (ml)/ plant of basil plants

Seaweed extract (B)	Humic acid (A)									
	Volatile oil %					Volatile oil (ml)/ plant				
	H1	H2	H3	H4	Mean	H1	H2	H3	H4	Mean
SW1	0.207	0.210	0.230	0.250	0.224	0.021	0.024	0.029	0.033	0.027
SW2	0.213	0.227	0.243	0.263	0.237	0.024	0.027	0.032	0.035	0.030
SW3	0.223	0.237	0.253	0.270	0.246	0.027	0.030	0.035	0.037	0.032
SW4	0.240	0.247	0.263	0.280	0.258	0.029	0.033	0.037	0.040	0.035
Mean	0.221	0.230	0.248	0.266		0.025	0.029	0.033	0.037	
L.S.D 0.05	A:0.013	B:0.011		AB: 0.021		A: N.S		B:N.S		AB:N.S

Humic acid H1 = 0, H2 = 2 and H3 = 4 and H4= 6 ml/ L., SW = Seaweed extract (SW1 = 0, SW2=100, SW3=200 and SW4=300 ppm)

3.3. Volatile oils components

In Table (3) and Figurs 1,2,3,4,5 and 6 the results of gas chromatographic analysis (GC/MS) of rosemary oil obtained from the study proved that it consists of (7) compounds. When comparing the values of the chemical compounds of the oil, we notice that the Alpha- Pinene, 1,8- Cineole, Camphene and Borneol compounds contain the highest volatile oil compound percentages compared to the other ones. The highest average for the Alpha- Pinene compound (28.66) was recorded in (H4) Humic acid (6 ml/L) + (SW4) Seaweed extract (300 ppm), followed by treatment Humic acid at (6 ml/l) + (SA3) Seaweed extract (200 ppm) which recorded (26.80), followed by treatment Humic acid at (4 ml/L) + (SA4) Seaweed extract (300 ppm) which reached (23.54), while the highest average was for compound

1,8- Cineole (18.46) in treatment Humic acid at (6ml/L) + (SW4) Seaweed extract (300 ppm), followed by treatment Humic acid at (6ml/L) + (SW3) Salyslic acide (200 ppm, which recorded (32.78), which had the highest percentages for the compound. also the highest average was for compound Camphene (11.50) and Borneol (8.30) in the same treatment. This indicates a clear effect of the treatments in increasing the p nroportions of some of the main compounds of rosemery oil. The treatments also have a clear effect on some compounds.

Table (3). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Volatile oil (V.O) components of Rosemary (*Rosmarinus officinalis* L.) Plants

Treatments / V.O components (%)	H1+ SW1	H3 +SW3	H3 +SW4	H4+ SW3	H4 + SW4
Bornyl acetate	6.24	6.77	7.33	8.85	9.25
Caryophyllene	3.44	4.57	5.33	6.41	7.37
Borneol	5.82	6.28	7.12	7.25	8.30
Camphor	8.22	1.05	1.53	0.00	0.00
Camphene	7.88	8.55	9.17	10.38	11.50
1,8- Cineole	14.22	15.44	16.33	17.22	18.46
Alpha- Pinene	20.23	21.24	23.54	26.80	28.66

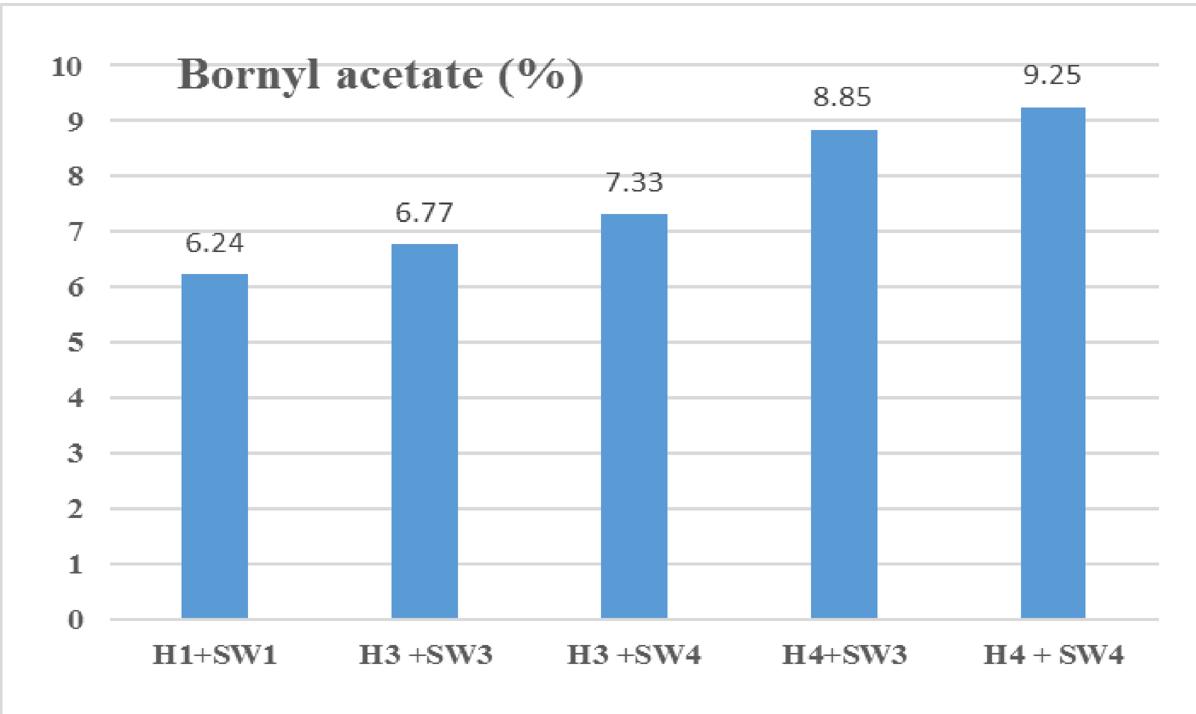


Fig. (1). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Bornyl acetate % of Rosemary (*Rosmarinus officinalis* L.) oil.

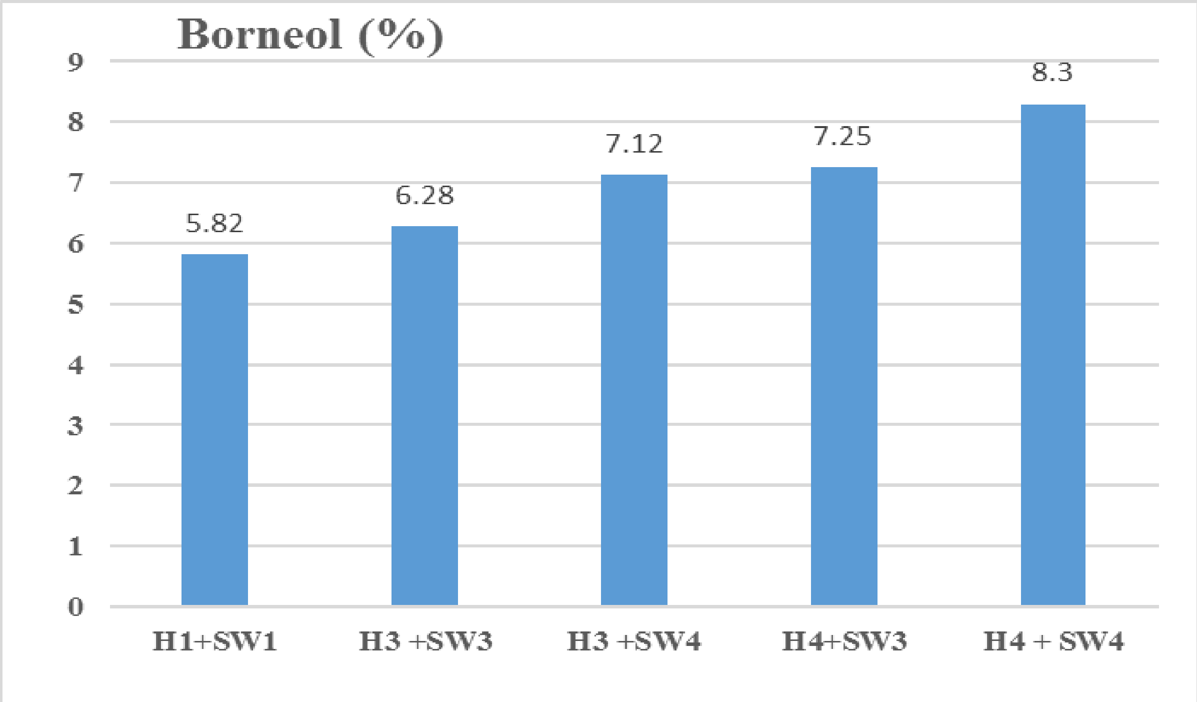


Fig. (2). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Borneol % of Rosemary (*Rosmarinus officinalis* L.) oil

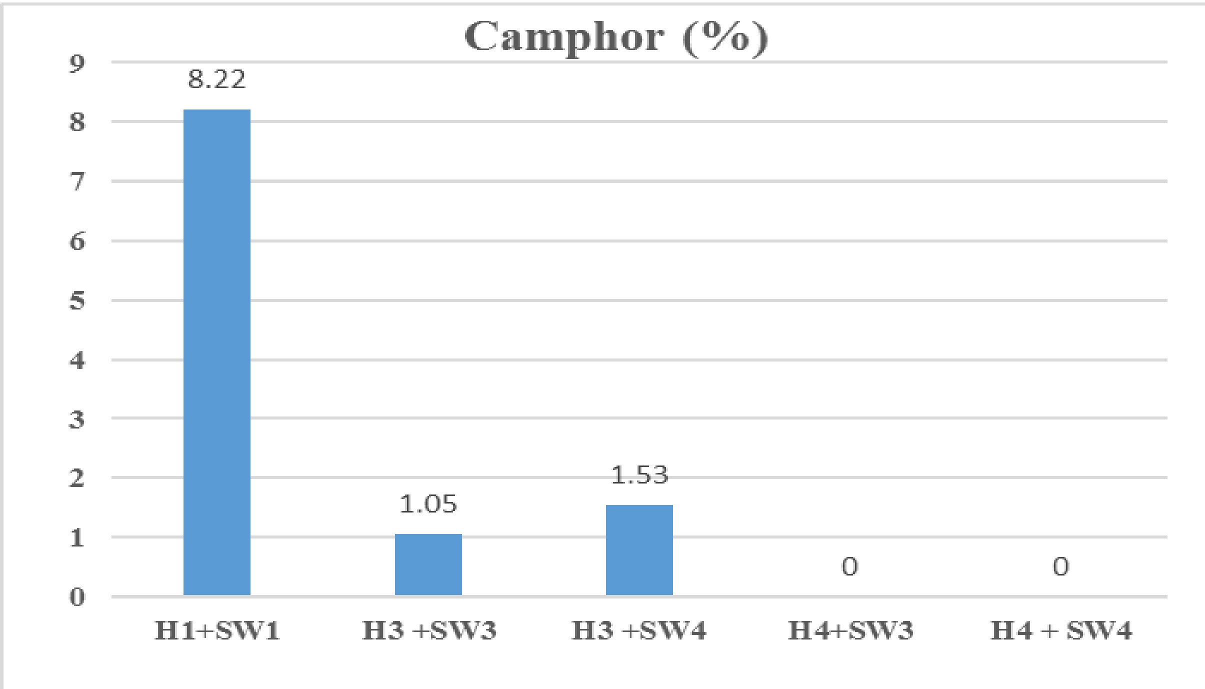


Fig. (3). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Camphor % of Rosemary (*Rosmarinus officinalis* L.) oil

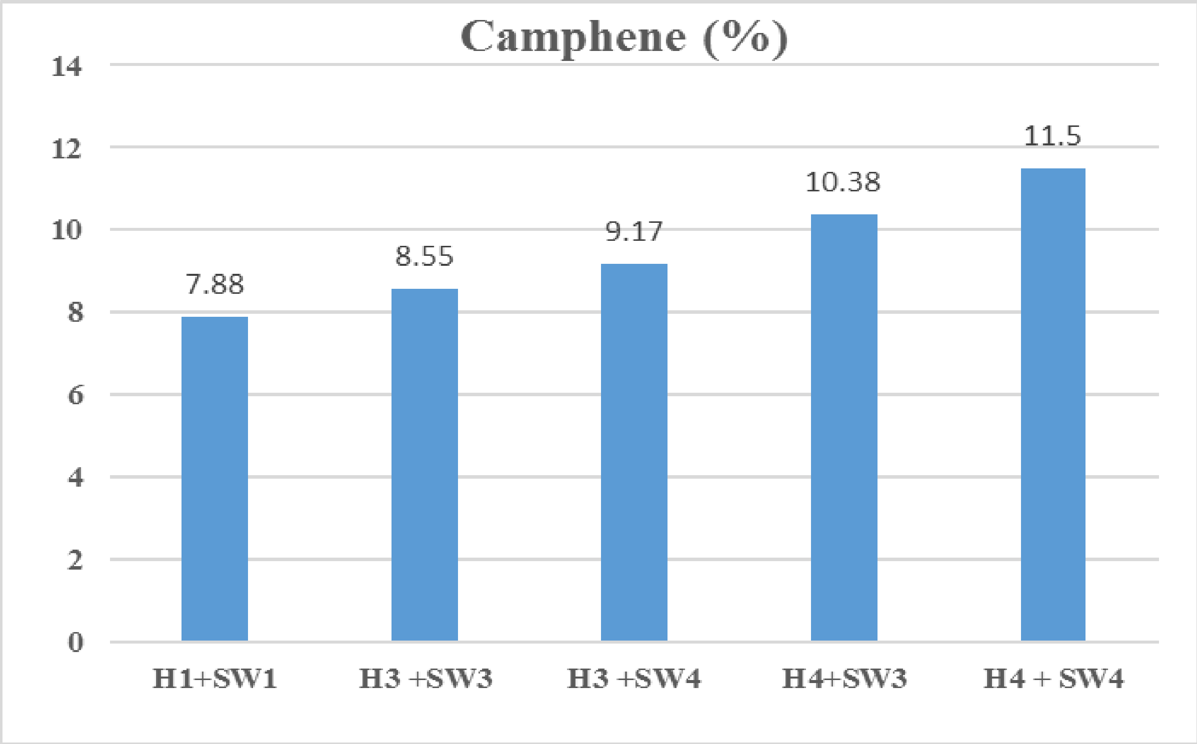


Fig. (4). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Camphene % of Rosemary (*Rosmarinus officinalis* L.) oil

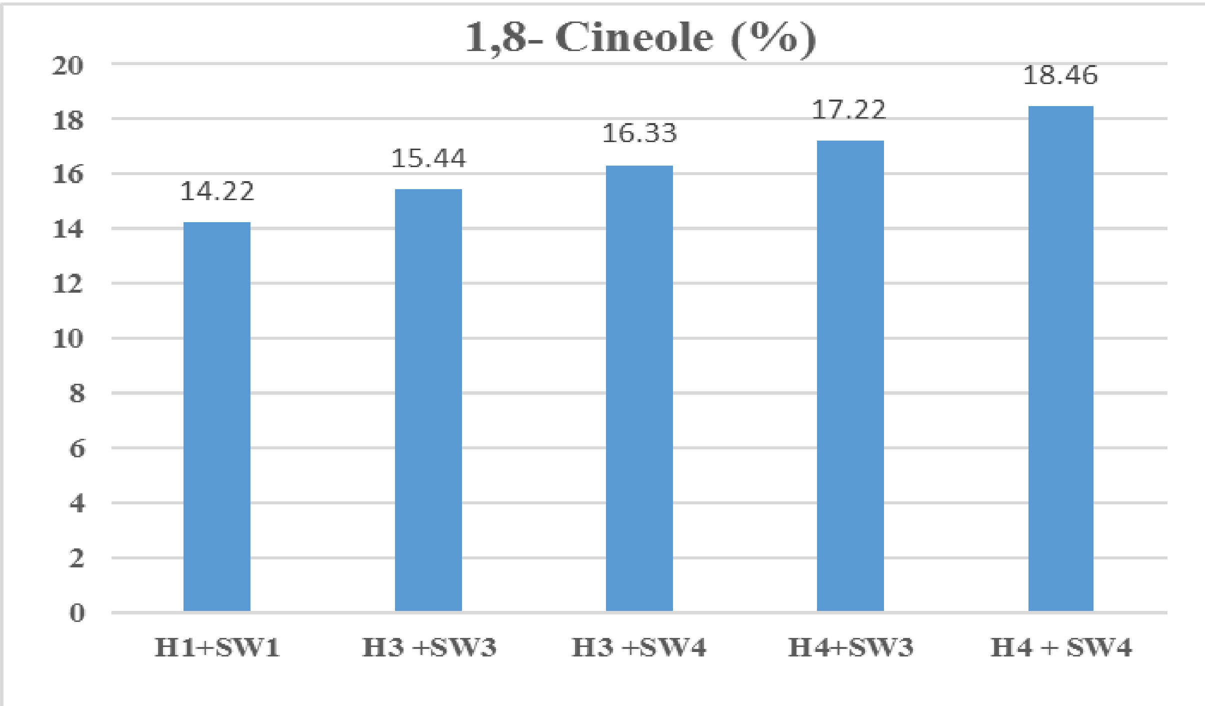


Fig. (5). Effect of Humic acid (H) and Seaweed extract (SW) combinations on 1,8- Cineole % of Rosemary (*Rosmarinus officinalis* L.) oil

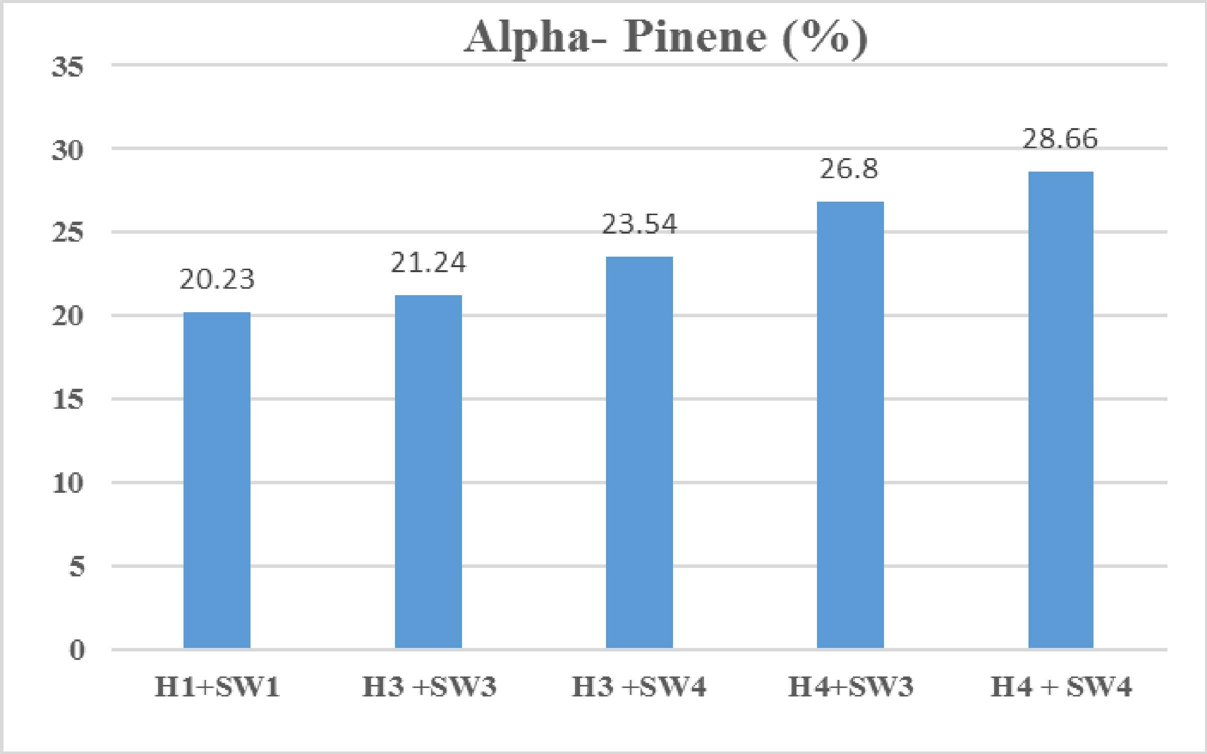


Fig. (6). Effect of Humic acid (H) and Seaweed extract (SW) combinations on Alpha- Pinene % of Rosemary (R*osmarinus officinalis* L.) oil

3. Discussion

The superior plant growth by adding humic acid is attributed to its vital role in providing the plant with the macro- and micro-nutrients necessary to enhance the plant's metabolism and development. It can directly improve plant growth by accelerating photosynthesis and increasing water and nutrient absorption and plant productivity. **El Gohary *et al.* (2023)** Furthermore, organic compounds are expected to raise chlorophyll levels in green plants, assisting in chlorosis resistance and photosynthesis, Humic acid can provide protection against some toxic growth-inhibiting substances introduced in the soil **Sayarer *et al.* (2023).** Humic acid's beneficial effects on growth may possibly result from the best possible supply and availability of nutrients from both organic and inorganic sources, which improved nutrient uptake and accelerated plant growth **Omer and associates (2020)**. Humic acid have a role in producing materials that may affect plant growth such as substances acting as plant hormone analogs or growth regulators **Hassan *et al.* (2024).** Humic acid has a positive effect on the formation of essential oils because it directly affects the solubilization and transport of nutrient elements, which improve vegetative growth characteristics and are crucial for the synthesis of plant constituents like essential oil. A better herb yield and, by extension, a higher essential oil output might result from these ingredients being sufficiently available by **Aly *et al.* (2022).**

Seaweed extract is a great source of several basics nutrients like phosphorus and potassium, secondary nutrients like magnesium and calcium, trace elements like iron, zinc, copper, and manganese, as well as advantageous elements like nickel and salt. A variety of ailments that are either incurable or infrequently cured by modern medical systems are treated with herbal extracts. The health and healing of almost 80% of the world's population is dependent on medicinal plants **Aliyu (2003).**

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Crouch and VanStaden (1994). Seaweed extracts are healthful for people, animals, and birds, biodegradable, non-toxic, and non-polluting. It is commonly found that such nutrients are more efficient than fertilizers; however, using seaweed extract enhanced the amount of chlorophyll **Whapham *et al.* (1993)** and **Thirumaran *et al.* (2009).**

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Moreover, seaweed contains natural phenols like tannins that function similarly to natural growth hormones. They also help plants produce more lignin, which makes them more disease-tolerant. In a similar vein, they facilitate faster nutrient absorption because they include alginic acid, a naturally occurring chelating agent that chelates nutrients with a soil solution. They additionally include many vitamin types, such as C, B1, B2, and B12. Because seaweed contain free amino acids which promote balanced, productive development and enhance the plant's response to fertilization, they function as both natural antibiotics and growth regulators within the plant **Marrez *et al.* (2014).** Seaweed extracts can be used directly as organic fertilizers by adding them to the soil or foliar treatment to enhance and improve productivity, quality and its metabolites **Tursun (2022).** The increments in growth aspects, seed yield and oil production due to using biostimulants which have been studied by **Manhart and Delibaltova (2022).**

4. Summary and Conclusion

The most important results reached from this study is that the different levels of humic acid used led to an improvement in the productivity of the rosemary plant. Growth, yield of herb and oil of the rosemary plants significantly improved with different concentrations of Seaweed extract, compared to control. Humic acid and the Seaweed extract interaction had a significant effect on growth, yield and oil index. The best treatment was humic acid at high level (6ml/L) combined with Seaweed extract (300 ppm). From the results obtained in this study, it can be recommended to use humic acid and seaweed extract to improve the production of Rosemary plants. It is also suggested to use these two substances safely to improve the productivity of other important medicinal and aromatic plants. It can also be recommended to search for other substances that have the same positive effect on plant productivity.

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