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GREEN ONION (*ALLIUM CEPA* L.) RESPONSE TO HUMIC ACID AND SEAWEED EXTRACT ON GROWTH AND YIELD TRAITS

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SUMMARY

The current investigations on green onion (*Allium cepa* L.) commenced during the crop season of 2021–2022 at the University of Mosul, Mosul, Iraq. The presented research examined the effect of foliar application of humic acid and seaweed extract on the growth and production of green onions. The first factor involved spraying of humic acid (H) at different concentrations (0, 1, and 2 ml L^{-1}). The second factor had the foliar application of seaweed extract (Super 50) (S) with different concentrations (0, 1, and 2 ml L^{-1}). The study used the local onion cultivar Crystal in the research, planted in a randomized complete block design with three replications. Furthermore, spraying with seaweed extract, and humic acid not only exceeded the control treatment in tubular leaf count, bulb width, and bulb length, but also surpassed the vegetative growth and growth rate in onions. The best measurements came from the foliar treatment, where the interaction of humic acid with seaweed with the same concentration (2 ml L^{-1}) resulted in no significant differences for growth traits and bulb yield. However, the bulb yield was 693.3 t ha^{-1} in the experimental treatments, while 553.3 t ha^{-1} for the control group.

Keywords: Green onion (*Allium cepa* L.), humic acid, seaweed, factors interaction, growth, bulb yield traits

Key findings: Modern fertilization methods, including using organic fertilizers and seaweed, resulted in enhanced vegetative growth attributes and increased yield of green onions (*Allium cepa* L.).

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INTRODUCTION

In Iraq, onions (*Allium cepa* L.) are a considerably significant winter vegetable commodity, with people worldwide consuming them often. Onions are typical for their excellent nutritional value due to their considerable mineral content, particularly calcium and phosphorus. They also contain substantial levels of vitamins enhancing the immune system (Hirschegger *et al*., 2010). Onions are usually exceptional in nutritional values due to their significant content of essential components, including calcium and phosphorus and the presence of carbohydrates, proteins, and vitamins (Gautam and Sinare, 2016).

Based on 5,813.25 hectares of land, Iraq's average local output of onions in 2019 was 200.236 t ha^{-1} (Central Statistical Organization, Department of Agricultural Statistics, 2019). The onion crop cultivation is mainly for fake stems, green leaves, or seedlings. In tropical climates, it may grow as a perennial plant, allowing the plant roots to produce fresh leaves for picking (Hassan, 2004). Since the leaf is the central part of photosynthesis, it shows up in the leaves when there are insufficient elements. Fixing this requires speeding up fertilization with foliar spray (Hafez, 2011). As an alternative way of ground fertilization, this method works better at getting nutrients to plants evenly than adding nutrients to the soil (Hassan, 2002), and it meets 85% of plants' nutritional needs (Abdul, 1988).

Soil stress deteriorates the soil and depletes nutrients, negatively affecting microorganisms, the environment, and human health (Bastaubayeva *et al*., 2023). Fertilizers are a critical agricultural component in enhancing the production of all vegetable crops, including onions. Earlier studies concentrated on chemical fertilizers negatively influencing the health of humans and animals and the environment when employed in agriculture. Thus, organic fertilizers with high nutrient concentrations, which promote balanced and beneficial plant development, were in great demand (Hao *et al.,* 2008). They replaced ready-made fertilizers and pesticides with others having a positive effect on soil fertility and agriculture supporting farmers' positive interest in soil fertility, such as organic fertilizers (Makenova *et al*., 2023).

Humic acid is one of the essential organic fertilizers. Various humic chemicals' recovery used solvents or other alkaline solutions, such as, dark-colored or granules (Moslat and Omar, 2012). As a kind of organic matter, humic acid promotes nutrient digestion and raises the cell membrane permeability (Kaya *et al.,* 2005). The spraying with humic acid increased vegetative growth traits of some vegetable crops. Another modern means of spraying on plants is using seaweed extracts to increase agricultural production due to their rapid effectivity in providing plants with nutrients (Pettit, 2004; Turkment*et al*., 2004).

Various sectors now extensively utilize these natural seaweed and algal extracts as a nutrition source. *Ascophyllumnodosum*, a seaweed extract, is one of the most widely manufactured algae. These marine plants contain all the macro and micronutrients, alginic acid, vitamins and auxins, as well as, two types of gibberellins GA7 and GA3 (Stephenson, 1968). The significance of seaweed extracts described as fertilizer are not because they contain nitrogen, phosphorus, and potassium dissolved in water, but more of the presence of many micro-nutrients required for plant growth and metabolic products. These lead to their rapid absorption by the plant, which treats the symptoms of nutrient deficiency (Turkment *et al*., 2004).

Seaweed is a tripartite chlorophyll plant with no roots, stems, or real leaves. They can survive in saltwater and freshwater, as well as, extreme humidity. They grow very well because the water has minerals that help them (Hafez, 2011) (Table 1). The width of the bulb, wet weight of the bulb, and bulb yield showed validation with the influence of various extracts of seaweed on onion plants, and the concentration (2.5 g/m^2) provided the highest bulb yield (Dogra and Mandradia, 2012). Al-Baili's*et al.* 2015 findings revealed the effect of seaweed extract on local red onions at two different concentrations. Seaweed extract

Table 1. The maximum and minimum temperatures, average wind speed, and rainfall rate during the growing season.

Adjectives	Unit	Value
EC	dc.m-1	0.24
PH	_____	7.40
Nitrogen	%	0.128
Phosphorus	PPm	8.54
Potassium	PPm	122.273
Clay	%	15
Green	%	17
Sand	%	77
Textured	_____	Lomia sand

Table 2. Physical and chemical characteristics of the experimental soil before planting.

Months	Average maximum temperature °C	Average minimum temperature °C	Average wind speed m/s	Rainfall rate mm
11	32.1	21.8	21.1	5.2
12	20.8	13.0	129.8	4.6
1	15.8	9.3	94.0	3.7
2	14.7	5.8	46.2	5.2
3	16.0	7.1	37.9	11.3
4	18.2	8.6	117.6	5.4

addition (5 g l^{-1}) caused a considerable rise in the plant's dry matter percentage, plant height, and average bulb weight. This study aimed to determine if using seaweed extract (Super 50) and natural organic fertilizers, such as, humic acid could increase green onion's growth and output while lowering the use of chemical fertilizers hazardous to the environment and human health.

MATERIALS AND METHODS

Humic acid and seaweed extract testing on green onion's growth and yield transpired at the College of Agriculture and Forestry, University of Mosul's Department of Horticulture and Landscaping's vegetable field in 2021–2022. Before the experiment began, collecting samples from the field soil and various locations occurred, digging down to a depth of 30 cm to ascertain some of the field soil's physical and chemical characteristics (Table 2).

The experiment used two variables: the spraying of humic acid (H) at a concentration of 0, 1, and 2 ml L^{-1}. The second element included applying seaweed extract (Super 50) (S) at a concentration of 0, 1, and 2 ml L^{-1}. The local onion cultivar, Crystal's planting, had a randomized complete block design (RCBD) with three replications. The planting of bulbs ensued in November in a furrow about 3.5 m in length, with a spacing of 10 cm between each plant. Every agricultural procedure, including hoeing, weeding, and irrigation, had a consistent implementation across all regimens (Matloub *et al.*, 1989). The bulbs' manual harvesting was in the third month, when the blossoming groins appeared on select plants and all other plants in the experimental unit. The subsequent measurements' documentation follows.

Five plants selected for vegetative growth traits documented the vegetative growth measurements. The recorded plant height (cm) started from the beginning at the disc stem and extended to the longest tubular leaf. The length of the longest tubular leaf (cm) was notable at the appearance of tubular leaves. The counting of tubular leaves per plant also continued, with the fresh and desiccated weight of tubular leaves (g) recorded. Utilizing five plants randomly selected from each experimental unit guaranteed accurate yield measurements.

Calculating the average weight of one bulb (g) proceeded by dividing the combined weight of five bulbs per experimental unit by

Table 3. Effect of foliar application of organic humic acid fertilizer (H) and seaweed extract (Super 50) (S) on the growth and yield traits of green onion.

Spraying treatments	Plant height (cm)	Leaves plant $^{-1}$	Tubular leaf length (cm)	Tubular dry leaf weight (g)	Tubular leaf weight (g)
Control treatment	60.33b	7.33a	45.33b	23.67b	253.33b
H 1 ml L^{-1}	65.00b	8.00a	49.66a	26.51a b	333.33a b
H 2 ml L^{-1}	66.00ab	6.33a	48.33a b	29.40a b	373.30a b
S 1 ml L^{-1}	64.66ab	7.00a	49.00a b	33.58a b	263.33a b
S 2 ml L^{-1}	65.00ab	8.33a	49.33a b	26.67a b	333.33a b
H 1 ml L^{-1} + S 1 ml L^{-1}	64.667ab	8.000a	48.667a b	31.00a b	366.67a b
H 1 ml L^{-1} + H 2ml L^{-1}	64.00a b	8.00a	50.33a	27.65a b	386.67a b
H 2 ml L^{-1} + S 1 ml L^{-1}	67.33a	8.11a	47.00a b	25.39a b	416.60a b
H 2 ml L^{-1} + S2 ml L^{-1}	68.00a	8.33a	50.00a	35.91a	503.30a

*The averages that share the same alphabetic letters for each factor and for each interaction do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

the total number of bulbs after removing the tubular leaves. The average bulb circumference's (cm) measuring was by counting the tape at the most expansive area in the bulb for five bulbs in the experimental unit. With a measuring tape, the bulb length (cm) measurement comprised the distance between the disc stem and the onset of tubular leaf development. The yield of the experimental unit, divided by the total number of plants, attained the plant yield (kg plant^{-1}). The formula below helped calculate the overall bulb yield (t ha^{-1}).

$$\text{Total yield (t ha}^{-1}) = \frac{experimental\ unit\ yield\ (tons)\ x\ 10001}{Experimental\ unit\ area\ (m2)}$$

All the data analysis used the SAS software (SAS, 1998). Duncan's polynomial test, with a significance threshold of 0.05, helped to compare means (Al-Rawi and Abdel-Aziz, 2000).

RESULTS AND DISCUSSION

The results demonstrated using humic acid and seaweed extract in the spraying treatments yielded considerably better results in vegetative development than the control treatment (Table 3). The table shows, when comparing the contrast treatment to the seaweed and humic acid interaction treatments, the latter produced significantly higher values for plant height. Meanwhile, the comparison treatment showed no statistically significant changes in leaf quantity, and the interaction treatment outperformed the other two regarding tubular leaf weight and length.

The findings also revealed the spraying treatments with seaweed and humic acid in the studied traits represented by yield traits had no noteworthy variations from the comparison treatment (Table 4). Seaweed and humic acid had the highest outcomes for yield characteristics, the bulb's circumference, length, weight, per-plant yield, and total yield. The best measurements obtained from the treatment involved the interaction of humic acid and seaweed at a concentration of 2 ml L^{-1}. These included plant height, tubular leaf length, tubular leaf weight, dry leaf weight, onion head weight, the product of the experimental unit, and the total product of the control treatment. Except for the bulb's length, circumference, and number of tubular leaves, they did not change much from the control treatment.

The increase is due to humic acid's positive effects, improving plant growth by encouraging cell division and development. It exerts a comparable influence on biological processes, including respiration, photosynthesis, and synthesizing carbohydrates and proteins as plant hormones do (Turkment*et al.,* 2004). Additionally, it enhances nutrient assimilation and cell

Table 4. Effect of foliar application of organic humic acid fertilizer (H) and seaweed extract (Super 50) (S) on the growth and yield traits of green onion.

Spraying treatments	Bulb circumference (cm)	Onion length (cm)	Onion weight (g)	Yield plant^{-1} (kg)	Total yield (t ha^{-1})
Control treatment	8.66a	15.00a	50.00 b	1.936b	553.3b
H 1 ml L^{-1}	9.33a	15.66a	68.00a	2.216a	633.3a
H 2 ml L^{-1}	10.00a	16.33a	66.00a	2.310a	660.0a
S 1 ml L^{-1}	8.33a	15.6a	55.00ab	2.170a	620.0a
S 2 ml L^{-1}	9.66a	15.66a	60.00a b	2.100a	600.0a
H 1 ml L^{-1} + S 1 ml L^{-1}	9.66a	16.00a	68.00a	2.1700a	620.0a
H1 ml L^{-1} + H 2 ml L^{-1}	9.66a	17.6a	68.67a	2.403a	686.7a
H 2ml.L^{-1} + S 1 ml.L^{-1}	9.33a	17.33a	66.00a	2.310a	660.0a
H 2ml.L^{-1} + S 2 ml.L^{-1}	9.88a	17.58a	69.33a	2.426a	693.3a

*The averages that share the same alphabetic letters for each factor and for each interaction do not differ significantly among themselves according to Duncan's polynomial test at the 0.05 probability level.

membrane permeability, stimulates enzyme activity within the plant, and functions as an organic compound (Kaya *et al*., 2005).

Humic acid promotes biological processes enhancing the development of root and vegetative systems, thereby, facilitating nutrient and water assimilation and increasing photosynthesis efficiency (Pettit, 2004). Several studies discovered applying humic acid through spraying enhanced the vegetative growth characteristics of particular vegetable crops (Al-Qaisi, 2008; Al-Qaisi*et al*., 2009; Abbas and Hamid, 2016; Al-Aboudi, 2017).

Adding seaweed extract enhanced photosynthesis and increased production of its byproducts, contributing to heightened nutrient accumulation in the leaves and subsequent transport from the source to the estuary (Sheekh and Saieed, 2000). Furthermore, its composition includes organic compounds, vitamins, mineral elements, and natural plant hormones, including auxins (Khan *et al.*, 2009). It also contains numerous macro and micronutrients, including iron, which is crucial for respiration. It activates the oxidation and reduction enzymes in the chain of electron transfer, helps to produce chlorophyll, and stores iron in chloroplasts as phytoferritin, which promotes increased vegetative growth (Al-Sahaf, 1989).

CONCLUSIONS

Modern fertilization methods, including the utilization of organic fertilizers and seaweeds, result in enhanced vegetative growth attributes and increased yield of green onion plants. On the contrary, chemical fertilizers exhibited deleterious impacts on both human health and the environment.

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