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Response of Garlic Plants to Foliar Spray by Biostimulating Treatments

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Abstract

The present experiment was conducted to determine the effects of foliar spraying with Salicylic acid $1g^{-1}$, seaweed extract $1g^{-1}$,potassium phosphate $2ml^{-1}$ compared with the control on garlic plants growth, bulb yield and bulb quality during the two growing seasons. The obtained results showed that all garlic growth parameters significant and/or highly significant affected by foliar spraying treatments after 120 and 210 days of sowing in both seasons. All tested foliar spraying treatments exceeded the control treatment in all growth traits in both seasons.The highest plant height and leaves fresh weight were recorded in plants that treated with seaweed extract in both seasons. Garlic plants that sprayed with potassium phosphate had the highest leaves number/plant, plant fresh and dry weight and leaves content of total chlorophyll in both seasons. Also, the data revealed that garlic yield measurements significantly affected by all tested foliar spraying treatments after 120 days of sowing in both seasons when compared with control. Garlic plants that sprayed with potassium phosphate had the highest neck thickness, bulb diameter, bulb length and bulb weight in both seasons. While, the highest bulb yield was found in garlic plants was sprayed with seaweed extract in both seasons. Garlic plants that sprayed with seaweed extract recorded the highest shoot fresh weight, one bulb weight, bulb diameter, total cloves weight/bulb and average of clove weight in both seasons. While, the highest bulb length was found in garlic plants that treated with potassium phosphate and the highest number of cloves/bulb was recorded in plants that sprayed with GA3 in both seasons.

Keywords: Salicylic; Seaweed; Potassium phosphate; Growth; Clove; Bulb quality.

Introduction

Garlic (*Allium sativum*) is the oldest and important herb plant. Garlic is well known around the globe as a cooking spice, medicinal plant **(Kimura *et al.*, 2017)** as well as a bio pesticide. The importance of garlic is due to its use not only for culinary but also for therapeutic and medicinal purposes in both traditional and modern medicine. It is consumed either as raw vegetable (fresh leaves or dried cloves), or after processing in the form of garlic oil, garlic extracts and garlic powder with differences in chemical composition and bioactive compounds content between the various forms **(Lanzotti *et al.*, 2014)**. In many rogations across the world as Egypt, the genus Allium is used continuously as a food condiment along with shallot and onion **(Hadianto *et al.*, 2019)**. The world total harvested area in 2022 season was 1.7 million hectares produced about 29.1 million metric tons while the total harvested area in Egypt in the same year was 17.9 thousand hectares with total production reached 396.4 thousand metric tons **(FAOSTAT, 2022)**.

To maximize production and quality, farmers may also resort to supporting plants with nutrients and growth regulators that led to increase the size and weight of bulbs. Potassium phosphate plays a major role in the enzymatic activity and storage process of plants and bulbs (**Abou El-Nasr and Ibrahim, 2011; Samy and El-Zohiri, 2021)** found that potassium phosphate significantly improved garlic growth traits (plant length, number of leaves, leaf area, total fresh weight, total plant dry weight), bulb characters, chemical constituents, yield, and yield components. Potassium phosphate also plays a very important role in the construction process and the transfer of energy between different parts of the plant. In many previous studies, it was found that foliar spraying with phosphorus improved the yield and quality of bulbs (**Diriba-Shiferaw *et al.*, 2015**). **Anwar *et al.*, (2021)** indicated that potassium phosphate had a significant positive effect and recorded the highest values of plant height, fresh and dry weight of whole plant.

Seaweed extracts contain various micro elements (Cu, Zn, B, Co) in addition to macro elements and contain Auxins, Gibberellins' and Cytokinins, when spray on plants lead to increase

root growth ability, nutrient elements absorption, and stem thickness and growth significantly **(Jensen, 2004)**. **Muhie *et al.*, (2020)** found that soaking cloves in seaweed extract significantly enhanced growth and seedling emergence compared to control. Also, sprayed seaweed extracts at (8 ml^{-1}) recorded the highest value of leaves number $plant^{-1}$, stem diameter and chlorophyll contents. The same concentration also showed significant effect on yield and bulb quality and recorded the highest value of cloves weight, cloves number.$bulb^{-1}$, bulbs weight and bulbs length, cloves length and cloves diameter compared with untreated plants **(Yousif, 2018)**.

Some nontraditional growth regulators, such as salicylic acid, can also create a significant balance in the activity and quantity of enzymes responsible for growth, which promotes increased growth, yield, and crop quality (**Nangare *et al.*, 2018**). **Chattoo, *et al.*, (2020)** indicated that foliar application of salicylic acid at 30 and 120 days after transplanting recorded maximum plant height, number of leaves $plant^{-1}$, average bulb weight, maximum polar diameter, equatorial diameter, total bulb yield, neck thickness. This work amid to evaluate the role of some post biostimulting treatments on garlic growth, yield and quality of bulbs.

Materials and Methods

The present experiments were conducted at the privet farm in El-Menya Governorate to evaluate the effect of some pre-sowing treatments post sowing foliar spraying with Salicylic acid $1g^{-1}$, seaweed extract $1g^{-1}$, potassium phosphate $2ml^{-1}$ compared with the control on garlic plants growth, bulb yield and bulb quality during the two growing seasons 2021/2022 and 2022/2023.

Experimental Procedures

Soil analysis of experimental sites

Before sowing, soil samples were randomly taken to measure physical and determine chemical properties. A random sample was taken from surface layer up to 30 cm depth. It was air-dried, crushed, and tested for physical and chemical properties. Chemical and physical properties of the experimental soil are shown in Table 1.

Table 1. The experimental soil physical and chemical properties as the average of 2021/2022 and 2022/2023 seasons.

Physical Soil Analysis										
Particle size distribution							Texture	pH	EC $Ds.m^{-1}$	Organic Matter
Sand %		Silt %		Clay %						
19.02		25.78		54.20			Clay-Loamy	7.94	1.07	1.21%
Chemical Soil Analysis										
Available macro nutrients (mg/kg)			Cations $meq.l^{-1}$				Anions $meq.l^{-1}$			
N	P	K	Na^{+}	K^{+}	Mg^{++}	Ca^{++}	So_{4-}	Cl	HCo_{3-}	Co_{3--}
22.50	9.10	64.00	3.91	0.84	1.65	3.36	1.79	3.82	4.15	-

Experimental layout

Cloves of Aga seeds cultivar was obtained from Horticulture Department, Agricultural Research Center**,** Giza, Egypt. Cloves used in the present study were uniform in shape and free from physiological and disease infection. Planting was done on the 15th of September, in both seasons under surface irrigation system. The land was plowed well with the addition of 20 m3 of Municipal fertilizer, 400 kg of superphosphate, 100 kg of agricultural sulfur, and 50 kg of ammonium sulphate per feddan. Cloves were sown in rows with a row 4 meters long and 60 cm apart. Each plot was four rows and cloves were sown on both sides of the row, with 10 cm between hills.

Treatments layout

A field experiments were designed in randomized block design with three replicates was used to evaluate the effect of the foliar spraying with salicylic acid (1g/l water), seaweed extract 1 g^{-1} potassium phosphate $2ml^{-1}$ and the control treatment. In this experiment bulb plants were sprayed three times the first one was after 50 days of sowing with 15 days intervals between each two following sprayings.

1- The commercial salicylic acid it name SOURD it contain (25% SA+ 25% K) of United Company was used as source of salicylic acid.
2- The commercial seaweed extract AKADIAN pure algae extract of *Scophyllum nodotheum*, produced by

Holding company for chemical industries, was used as source of algae.

3- The commercial potassium phosphate ATALANTS produced by SHOURA chemical company was used as source of potassium phosphate.
4- Control was spraying with tap water.

All other agricultural practices were carried out, including the application of herbicide, ridging, fertilization and pest control according to the technical recommendations for the crop issued by the Egyptian Ministry of Agriculture and Land Reclamation.

Data recorded

Vegetative growth characteristics

After 120 days from sowing, a random sample of five plants were taken from each plot to determine; Plant height (cm, Number of leaves/plant, Leaves fresh weight, Plant fresh weight (g), Plant dry weight (g) and leaves content of total chlorophylls.

To estimate foliage fresh and dry weight, five randomly chosen plants from each plot were weighed directly to determined average fresh weight/plant. Then the five selected plants were artificially dried in oven at 60 ^{o}C for 48 hr until reach a constant weight to estimate average dry weight/plant.

Leaf total chlorophyll contents **(mg/100 g FW)** it was estimated in samples of fresh leaves according to **Moran (1982).**

Yield characteristics after 120 days of sowing:

After 120 days from sowing, a random sample of five plants were taken from each plot to determine: Neck thickness (cm), Bulb diameter (cm), Bulb length (cm), Bulb weight (g) and 5. Bulb yield (g).

Yield characteristics after 210 days of sowing.

After 210 days from sowing, a random sample of five plants were taken from each plot to determine: Plant fresh weight (g), One bulb weight (g), Bulb diameter (cm), Bulb length (cm), Number of cloves/bulb, Total clove weight/bulb (g) and Average clove weight (g).

Statistical analysis

The data were subjected and analyzed by using **one-way** ANOVA followed by LSD test through SPSS 16 (version 4). The treatments means were compared using least significant difference (LSD) tested at 5% level of probability as described by **Gomez and Gomez (1984).**

RESULTS

Effect of some foliar spraying treatments on growth and yield of garlic plants after 120 days of sowing.

Growth characteristics after 120 days of sowing:

The presented data in Table 2 and 3 confirmed that all garlic growth parameters significant and/or highly significant affected by foliar spraying treatments after 120 days of sowing in both seasons of the study. Plant height of garlic plants significantly differ under all tested foliar spraying treatments in both seasons (Table 2). The highest plant height was recorded in plants that treated with seaweed extract, followed by potassium phosphate, then plants that treated with SA, in both seasons when compared with the control**.** Leaves number/plant were significantly increased under all foliar spraying treatments compared to the control in both seasons. The highest leaves number/plant was found in cloves that sprayed with potassium phosphate, followed seaweed extract, then plants that treated with SA, in the first and second seasons, respectively. The superiority of potassium phosphate did not differ significant with seaweed extract in the second season. On the other side, garlic plants in the control treatment had the lowest leaves number/plant in the two seasons, respectively. In addition, in Table 2 showed that leaves fresh weight were significantly higher under all tested foliar spraying treatments than control in both seasons. The highest leaves fresh weight was found in garlic plants that treated with seaweed extract, followed potassium phosphate, then SA, while the lowest leaves fresh weight was found in the control treatment in both seasons.

Table 2. Effect of some foliar spraying treatments on plant height, number of leaves/plant and leaves fresh weight of garlic plants after 120 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Plant height (cm)		Number of leaves		Leaves fresh weight (g)	
	1St Season	2nd season	1St Season	2nd Season	1St season	2nd season
SA 1 g^{-1}	84.33 a	84.60 c	11.60 c	11.07 b	66.00 c	68.80 c
Sea weed extract 1 g^{-1}	84.60 a	86.33 a	11.87 b	11.80 a	74.47 a	75.60 a
Potassium phosphate 2g^{-1}	84.53 a	84.93 b	12.20 a	11.80 a	68.20 b	73.87 b
Control	81.87 b	84.00 d	10.87 d	10.60 c	63.60 d	64.47 d
LSD 5%	0.44	0.33	0.19	0.20	1.55	1.68
Significant	*	**	**	*	**	**

The obtained results in Table 3 indicated that Plant fresh weight significantly increased under all used foliar spraying treatments in both seasons. The highest plant fresh weight was found in garlic plants that treated with potassium phosphate, followed by seaweed extract, then SA, in both seasons when compared with the control. Also, data illustrated in Table 3 cleared that plant dry weight was high significantly under all foliar spraying treatments than control in both seasons. The highest plant dry weight was found in garlic plants that treated with potassium phosphate, followed by seaweed extract, then plants that treated with SA in both seasons. On the other hand, garlic plants under the control treatment had the lowest plant dry weight in the two studies seasons. Leaves content of total chlorophyll significantly increased under all tested foliar spraying treatments in both seasons. The highest leaves content of total chlorophyll was found in garlic plants that sprayed with potassium phosphate, followed plants that treated with seaweed extract, then SA, in both seasons. Without any significant differ between the potassium phosphate and seaweed extract in the second season. Also, SA treatment did not differ significant with seaweed extract in the first season. The lowest leaves content of total chlorophyll was found in the control treatment in both seasons, respectively.

Table 3. Effect of some foliar spraying treatments on plant fresh and dry weight and leaves content of total chlorophyll of garlic plants after 120 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Plant fresh weight (g)		Plant dry weight (g)		Leaves content of total chlorophyll (mg/100g FW)	
	1St Season	2nd season	1St Season	2nd season	1St season	2nd season
SA 1 g^{-1}	130.93 c	139.80 b	22.87 b	20.63 b	63.11 b	68.23 b
Sea weed extract 1 g^{-1}	139.07 b	149.27 a	25.53 a	23.07 a	63.27 b	69.13 a
Potassium phosphate 2g^{-1}	152.67 a	153.33 a	25.60 a	23.70 a	64.83 a	69.20 a
Control	127.07 d	120.27 c	20.53 c	18.73 c	62.33 c	68.11 c
LSD 5%	3.77	4.91	0.81	0.76	0.35	0.19
Significant	**	**	**	**	*	*

Yield characteristics after 120 days of sowing:

The data in Table 4 and 5 revealed that garlic yield measurements significantly affected by all tested foliar spraying treatments after 120 days of sowing in both seasons of the study. Results in Table 4 showed that neck thickness of garlic plants significantly affected by all used foliar spraying treatments in both seasons. The highest neck thickness was recorded in plants that treated with potassium phosphate, followed by seaweed extract, then SA, in both seasons when compared with untreated treatment (control). Data in Table 4 revealed that bulb diameter was significantly increased under all tested foliar spraying treatments than control in both seasons. The highest bulb diameter was found in garlic plants that sprayed with potassium phosphate, followed plants that treated with seaweed extract, then SA in the first and second seasons. On the other side, garlic plants in the control treatment had the lowest bulb diameter in the two seasons of the study. The obtained results in Table 4 cleared that bulb length significantly influenced by all tested foliar spraying treatments in both seasons. The highest bulb length was found in garlic plants that treated with potassium phosphate, followed seaweed extract, then garlic plants that sprayed with sea weed extract, while the lowest bulb length was found in the control treatment in both seasons.

Table 4. Effect of some foliar spraying treatments on neck thickness, bulb diameter and bulb length of garlic plants after 120 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Neck thickness (cm)		Bulb diameter (cm)		Bulb length (cm)	
	1St season	2nd season	1St season	2nd season	1St season	2nd season
SA 1 g^{-1}	1.60 c	1.58 c	3.15 c	3.23 c	3.16 c	3.53 b
Sea weed extract 1 g^{-1}	1.75 b	1.69 b	3.45 b	3.49 b	3.37 b	3.59 b
Potassium phosphate 2g^{-1}	1.79 a	1.75 a	3.76 a	3.59 a	3.60 a	3.74 a
Control	1.52 d	1.57 c	3.13 c	2.92 d	2.94 d	3.20 c
LSD 5%	0.04	0.03	0.10	0.10	0.09	0.08
Significant	**	**	*	**	**	**

The results in Table 5 revealed that bulb weight significantly differ under all used foliar spraying treatments in both seasons. The highest bulb weight was found in garlic plants that treated with potassium phosphate (37.87 and 33.53 g) followed by SA (32.07 and 30.93 g) then plants that seaweed extract (31.93 and 27.20 g) in both seasons, respectively. On the other hand, garlic plants under the control treatment had the lowest bulb weight with averages of 28.73 and 22.40 g in the first and second seasons, respectively. Also, Data presented in Table 5 cleared that bulb yield significantly affected by the used foliar spraying treatments in both seasons. The highest bulb yield was found in garlic plants that sprayed with seaweed extract (151.40 and 142.93 g) followed by potassium phosphate treatment (143.47 and 131.07 g) then plants that treated with SA (138.67 and 124.53 g) in both seasons, respectively. On the other hand, garlic plants under the control treatment had the lowest bulb yield with averages of 106.53 and 104.93 g in both seasons, respectively.

Table 5. Effect of some foliar spraying treatments on bulb weight and bulb yield after 120 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Bulb weight (g)		Bulb yield (g)	
	1St season	2nd season	1St season	2nd season
SA 1 g^{-1}	32.07 b	30.93 b	138.67 b	124.53 c
Sea weed extract 1 g^{-1}	31.93 b	27.20 c	151.40 a	142.93 a
Potassium phosphate 2g^{-1}	37.87 a	33.53 a	143.47 b	131.07 b
Control	28.73 c	22.40 d	106.53 c	104.93 d
LSD 5%	**1.27**	**1.61**	**6.57**	**5.30**
Significant	*	**	*	**

Yield traits after 210 days of sowing:

The presented data in Table 6 and 7 showed that garlic yield measurements significantly influenced by foliar spraying treatments after 210 days of sowing in both seasons of the study. The Results illustrated in Table 6 showed that shoot fresh weight of garlic plants was significantly higher under all used foliar spraying treatments than the control in both seasons. The highest shoot fresh weight was recorded in plants that sprayed with seaweed extract, followed by potassium phosphate then SA in both seasons. In this contrast, garlic plants under the control treatment had the lowest shoot fresh weight in the first and second seasons. The Results illustrated in Table 6 showed that one bulb weight of garlic plants significantly differ all used foliar spraying treatments in both seasons. The highest one bulb weight was recorded in plants that treated with seaweed extract, followed by potassium phosphate, then SA in both seasons. On the other side, garlic plants under the control treatment had the lowest one bulb weight in the first and second seasons. Data in Table 6 revealed that bulb diameter significantly increased under all tested foliar spraying treatments compared to the control treatment in both seasons. The highest bulb diameter was found in garlic plants that sprayed with seaweed extract, followed plants that treated with SA, then plants that treated with potassium phosphate, in the first and second seasons when compared with the control. In addition, the obtained results in Table 6 cleared that bulb length significantly influenced by all tested foliar spraying treatments in both seasons. The highest bulb length was found in garlic plants that treated with potassium phosphate, followed SA without any significant differ between the two treatments in the first season, then cloves that seaweed extract, while the lowest bulb length was found in the control treatment in both seasons.

Table 6. Effect of some foliar spraying treatments on shoot fresh weight, one bulb weight, bulb diameter and bulb length of garlic plants after 210 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Plant fresh weight (g)		One bulb weight (g)		Bulb diameter (cm)		Bulb length (cm)	
	1St season	2nd Season	1St season	2nd season	1St season	2nd season	1St season	2nd season
SA 1 g^{-1}	45.62 b	40.18 c	97.13 b	92.27 b	6.11 b	6.01 ab	4.85 a	4.37 b
Sea weed extract 1 g^{-1}	49.61 a	45.78 a	104.40 a	105.20 a	6.27 a	6.11 a	4.81 a	4.39 b
Potassium phosphate 2g^{-1}	48.07 a	42.17 b	98.73 b	94.00 b	5.99 c	5.92 b	4.87 a	4.46 a
Control	34.06 c	32.72 d	73.87 c	72.60 c	5.47 d	5.15 c	4.41 b	4.07 c
LSD 5%	2.35	1.84	4.49	4.52	0.12	0.15	0.07	0.06
Significant	*	**	*	*	*	*	*	*

The Results shown in Table 7 cleared that number of cloves/bulb significantly affected by tested foliar spraying treatments in both seasons. The highest number of cloves/bulb was recorded in plants that sprayed with SA (24.73 and 22.73) followed by potassium phosphate (24.20 and 22.40) then seaweed extract (21.40 and 22.40) in both seasons, respectively. In this contrast, garlic plants under the control treatment had the lowest number of cloves/bulb with averages of 21.53 and 21.80 in the first and second seasons, respectively. The Results in Table 7 showed that total cloves weight/bulb significantly differed under all used foliar spraying treatments in both seasons. The highest total cloves weight/bulb was recorded in plants that sprayed with seaweed extract (80.60 and 77.47 g) followed by SA (81.80 and 74.53 g) then potassium phosphate (79.40 and 75.07 g) in both seasons, respectively when compared with the control treatment had the lowest total cloves weight/bulb with averages of 62.60 and 60.40 g in the first and second seasons, respectively. Data in Table 7 indicated that average of clove weight significantly affected by all tested foliar spraying treatments in both seasons. The highest average of clove weight was found in cloves that treated with seaweed extract, followed by SA treatment, then plants that treated with potassium phosphate in the first and second seasons. On the other hand, garlic plants in the control treatment had the lowest average of clove weight in the two seasons of the study.

Table 7. Effect of some foliar spraying treatments on number of clove/bulb, clove weight and average of one clove weight after 210 days of sowing during 2020/2021 and 2021/2022 seasons.

Factors	Number of bulb seeds/bulb		Total clove weight/bulb (g)		Average bulb seed weight (g)	
	1St season	2nd season	1St season	2nd Season	1St season	2nd season
SA 1 g^{-1}	24.73 a	22.73 a	81.80 b	74.53 b	4.25 a	3.71 b
Sea weed extract 1 g^{-1}	21.40 b	22.40 b	85.60 a	77.47 a	4.49 a	4.05 a
Potassium phosphate 2g^{-1}	24.20 a	22.40 b	79.40 b	75.07 b	3.64 b	3.61 b
Control	21.53 b	21.80 c	62.60 c	60.40 c	2.73 c	3.05 c
LSD 5%	0.58	0.13	3.39	2.58	0.26	0.14
Significant	*	*	*	*	*	*

Discussion

Growth characteristics

The highest plant height and leaves fresh weight were recorded in plants that treated with seaweed extract in both seasons. seaweed extracts contain various micro elements (Cu, Zn, B, Co) in addition to macro elements and contain Auxins, Gibberellins' and Cytokinins, when spray on plants lead to increase growth ability **(Jensen 2004; Vernieri *et al.*, 2005; and Khan *et al.* 2009**). Our results are in similar with those obtained by **Yousif, (2018)** who found that sprayed seaweed extracts at 8 ml^{-1} recorded the highest value of leaves number plant-1, stem diameter and chlorophyll contents of garlic as compared with untreated plants. However, **Hidangmayum, and Sharma (2017)** confirmed that that treatment seaweed extract was found to be the best treatment in terms of chlorophyll 'a', chlorophyll 'b' and carotenoid content.**, Abbas *et al.* (2020); Muhie *et al.* (2020)** found that in onion that treated with seaweed extract was to be the best treatment in terms of leaf number and plant height.

Garlic plants that sprayed with potassium phosphate had the highest leaves number/plant, plant fresh and dry weight and leaves contents of total chlorophyll in both seasons. Potassium phosphate plays an important role in energy building and transfer and these increase plant growth and development. In the previous studies, **Jitarwal *et al.* (2018)** that application of potassium phosphate to the Garlic crop significantly increased the plant height (cm), number of leaves per plant, total chlorophyll content in leaves (mg/g), fresh weight of leaves and neck thickness. Also, **Anwar et al. (2021)** indicated that the treatment of potassium phosphate had a significant effect and recorded the highest values of plant height, fresh and dry weight of whole plant. **Shafeek *et al.* (2013)** reported that the elevated onion plant growth parameters (the tallest plant, the biggest leaves number, the vigorous fresh and dry weight of plant. However, **Shafeek et al. (2016)** showed that the elevated potassium phosphate grant the tallest plant, the highest number of leaves per plant and the biggest fresh and dry weight of plants. While, **Zyada and Bardisi (2018)** emphasized that potassium phosphate at 1 and 2 ml^{-1}, was the best levels used for its superiority in producing the tallest plants, number of leaves/plant, leaves and roots. **Jiku *et al.* (2020)** found that, plant height, number of leaves $plant^{-1}$, fresh and dry weights of leave s (g $plant^{-1}$) were significantly higher due to different doses of potassium phosphate application. In the same way, **Samy and El-Zohiri (2021)** showed that increasing potassium phosphate significantly improved most studied growth traits (plant length, number of leaves, leaf area, total fresh weight, and total plant dry weight.

Yield characteristics

The presented results confirmed that, garlic plants that sprayed with potassium phosphate had the highest neck thickness, bulb diameter, bulb length and bulb weight after 120 days of sowing in both seasons. While the highest bulb length was found in garlic plants that treated with potassium phosphate after 210 days of sowing in the two seasons. in the same way of our findings, **Mulatu and Getachew (2015)** showed that potassium phosphate had significantly influenced bulb diameter, bulb fresh and dry weight, mean clove fresh weight and bulb yield. Also, **Jitarwal *et al.* (2018)** found that application of potassium phosphate to the Garlic crop significantly increased bulb diameter, Fresh weight of bulb (g), weight of bulb after curing (g), number of cloves per bulb, bulb yield(kg/plot), bulb yield q/ha, net returns and B:C ratio as compared to control. While, **Anwar *et al.* (2021)** found that potassium phosphate application caused a maximum values of average bulb weight, bulb diameter, number of cloves/ bulb and total yield/feddan. In the same line, **Gashaw, (2021)** recorded significantly highest bulb weight, and total bulb yield from potassium phosphate. Respect to potassium phosphate effects, **Zyada and Bardisi (2018)** emphasized that potassium phosphate at 2 ml^{-1} was the best levels used for its superiority in producing the highest bulb and neck diameters, the heaviest dry weight of bulbs and bulbs and total yield in both seasons. While, **Jiku *et al.* (2020)** found the maximum total yield and size of garlic bulb were obtained with potassium phosphate produced the highest fresh and dry weights of bulbs. **Wang *et al.* (2022)** revealed optimal Potassium phosphate increased the biomass and vegetation index in garlic, and promoted the transfer of nitrogen, phosphorus, and potassium nutrients from the stem and leaf to bulb, thereby increasing bulb production. The application of potassium phosphate increased the number of cloves, the diameters of the cloves and bulbs, and reduced variations in bulb size.

The highest bulb yield was found in garlic plants that sprayed with seaweed extract after 120 days of sowing in both seasons. Also, Garlic plants that sprayed with seaweed extract recorded the highest: shoot fresh weight, one bulb weight, bulb diameter, total cloves weight/bulb and average of clove weight after 210 days of sowing in both seasons. in the same line of these results, **Hidangmayum and Sharma (2017)** confirmed that that treatment seaweed extract was found to be the best treatment in terms of fresh bulb diameter ,bulb fresh weight, cloves number and weight, harvest index, chlorophyll ‘a’, chlorophyll ‘b’ and carotenoid content. **Abbas *et al.* (2020)** showed that the application of 0.5% SWE caused a significant increase in total soluble solids, mineral content (N, P, and K), bulb weight and yield. The highest number of cloves/bulb was recorded in plants that sprayed with SA after 210 days of sowing in both seasons. similar findings were showed before by, **El-Sayed *et al.* (2007)** who found that Gibberellic acid application at 10 ppm caused significant increases on number of cloves/bulb and clove weight in both seasons. Also, **Singh *et al.* (2018)** showed that yield attributing parameters were also observed better in terms of number of cloves. In the same way, **Desta *et al.* (2022)** showed that SA influences all categories of clove numbers and size.

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أستجابة نباتات الثوم لبعض معاملات الرش المستحثة للنمو

أجريت التجارب الحقليه في أحد المزارع الخاصة التابعة لمحافظة المنيا لتقييم تأثير بعض معاملات ما قبل الزراعة (التغطية بالشبكة السوداء، التبريد عند درجة حرارة 5 درجة مئوية لمدة 48 ساعة، النقع في مستخلص الأعشاب البحرية والنقع في 20 جزء في المليون GA3 مقارنة بالكنترول) والرش الورقي بعد الزراعة بحامض الساليسيليك (1جم/لتر) ومستخلص الطحالب البحرية (1جم/لتر) وفوسفات البوتاسيوم (2سم/لتر ماء) مقارنة بالكنترول على نمو نباتات الثوم ومحصول الأبصال وجودتها. خلال موسمي النمو 2022/2021 و2023/2022. وقد أكدت البيانات إلى تأثر جميع صفات نمو الثوم معنويا بمعاملات الرش الورقي بعد 120 يوماً من الزراعة في كلا موسمي الدراسة. تفوقت جميع معاملات الرش الورقي المختبرة على معاملة الكنترول في جميع صفات النمو في كلا الموسمين. سجلت في النباتات المعاملة بمستخلص الطحالب البحرية أعلى ارتفاع للنبات ووزن الأوراق الطازجة في كلا الموسمين. أعطت نباتات الثوم التي تم رشها بفوسفات البوتاسيوم أعلى القيم لعدد الأوراق/نبات ووزن النبات الطازج والجاف ومحتوى الأوراق من الكلوروفيل الكلي في كلا الموسمين. أظهرت البيانات أن تأثر جميع صفات محصول الثوم معنوياً بجميع معاملات الرش الورقي المختبرة بعد 120 يوماً من الزراعة في كلا موسمي الدراسة. أدت جميع معاملات الرش الورقي المختبرة إلى زيادة صفات المحصول مقارنة بمعاملة الكنترول في كلا الموسمين. كانت لنباتات الثوم التي تم رشها بفوسفات البوتاسيوم أعلى القيم لسمك العنق وقطر وطول ووزن البصلة في كلا الموسمين، في حين أن أعلى محصول للأبصال كان في نباتات الثوم التي تم رشها بمستخلص الأعشاب البحرية في كلا الموسمين. أظهرت البيانات أن جميع صفات محصول الثوم تأثرت معنوياً بمعاملات الرش الورقي بعد 210 يوم من الزراعة في كلا موسمي الدراسة. أدت جميع معاملات الرش الورقي إلى زيادة معنوية في جميع صفات المحصول مقارنة بالكنترول في كلا الموسمين. سجلت نباتات الثوم التي تم رشها بمستخلص الطحالب البحرية أعلى القيم للوزن الطازج للمجموع الخضرى، وزن البصلة الواحدة، قطر البصلة، الوزن الكلى للفصوص/البصلة، ومتوسط وزن الفص في كلا الموسمين. بينما تم تسجيل أعلى طول للبصلة في نباتات الثوم المعاملة بفوسفات البوتاسيوم، كما تم تسجيل أعلى عدد فصوص للبصلة في النباتات التي تم رشها بحامض الجبريليك في كلا الموسمين.