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Potential Pre-planting Clove Treatments Affected Growth and Yield traits of Eggaseed-1, Garlic (*Allium sativum* L.) Cultivar

S.I. Ahmed[1], M.M. Samy[1*] and Asmaa S. Ezzat[2]

[1]Potato and Vegetatively Propagated Vegetables Dep., Hort. Res. Inst., Agric. Res. Center, Egypt
[2]Hort. Dept., Faculty of Agriculture, Minia University
*Corresponding Author: mazamahmoud@yahoo.com

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ABSTRACT

Two field experiments were conducted during the two successive winter seasons of 2019/2020 and 2020/2021 at Sids Horticulture Research Station, Beni Suef Governorate, Egypt to investigate the response of garlic clove (Eggaseed-1 cv.) for humic acid soil application and pre sowing treatments, i.e., soaking in water for 24h then placing in moist peat-moss until root initiation, Soaking in Gibberellic acid (GA_3) 10 ppm or humic acid (50 g/L water) for 12h, cooling at 5°C or 10°C for 20 days, water soaking for 12h and dry clove treatment (control) as well as their interactions. Application of 6 kg/fed. potassium humate interacted with Cloves soaked in water for 24h then placed in moist peat-moss until root initiation gave the highest germination percentage after 30 days from planting, plant height, leaves number/plant and nick diameter as well as improved yield and yield component parameters as plant fresh weight, bulb diameter, bulb dry matter, total fresh and cured yield followed by humate potassium plus soaking cloves in 10 ppm GA_3 for 12h recommended to produce higher yield with better quality of Eggaseed-1 cv.

KEYWORDS: Garlic,Humic acid, Gibberellic acid.

1. INTRODUCTION

Garlic (*Allium sativum* L.) is a valuable cash crop in Egypt. With an average yield of 280,216 metric tons from an estimated cultivated area of 11,875 hectares (Hectare = 2.380 feddan). Egypt ranks the fourth in world garlic production, behind China, India, and Bangladesh (Atlasbig, 2020). Garlic is an important aromatic herbaceous plant belonging to Alliaceace and widely used as a spice crop throughout the world (Swati *et al.*, 2013). Balady, Sids-40 and Eggaseed-1 are the main garlic cultivars grown in Egypt. Eggaseed-1 is characterized by hard dry leaf sheath (dry protective leaf) than Balady or Sids-40 which cause delaying in germination. Plant growth regulators enhance sprouting of garlic (Moon and lee, 1980; Rahim and Fordhan, 1988). Also, soaking of seed cloves in GA_3 solution stimulate sprouting and bulbing and its development (Moon and Lee, 1980). Rahman *et al.* (2006) noted that application of GA_3 has the capability to break dormancy and accelerates garlic sprouting. Furthermore, Ahmed and Hemada (2012) indicated that soaking garlic cloves in water or 5 ppm GA_3 for 24 hours improved vegetative growth, bulb fresh weight, total fresh yield and cured yield. Fekry (2017) stated that soaking garlic cloves in 250 ppm GA_3 for 12 hours as pre sowing treatment increased the morphological traits, yield and its component. Samy *et al.* (2014) on potato concluded that dipping the tubers in GA_3 caused increasing vegetative growth characters and total tuber yield. Ibrahim (2010) compared between different media (clay, sand, vermiculate, compost and peat moss) for sunflower sprout production for fresh human consumption after soaking in water. In this respect, Wet peat moss layers are used by Abd El-Latif *et al.* (2015) for accelerating germination of globe artichoke stumps in vernalization process. El-Shabasi, *et al.* (2018) reported that soaking garlic cloves in water for 24h and then placing in moist peat moss until root initiation improved vegetative growth, increasing total produce and bulb quality. Clove sprouting and emergence are controlled mainly by temperature (Takagi, 1990). While Ade-Ademilua *et al.* (2009) found that pre-planting cold treatment of garlic cloves enhanced total leaf area, fresh and dry weight of plants under open shade. Plants from treated cloves had better yield (clove, bulb, clove size and clove dry weight) than plants from untreated cloves. Potassium humate (humic acid) is a commercial product contains many elements necessary to the development of plant (Mohsen *et al.*, 2017). Several studies indicated that treating garlic plants with humic acid enhanced plant growth, increased yield and quality of plant and bulbs (Denre *et al.*, 2014; Mahmoud and Youssif, 2015; Zeinali and Moradi, 2015, Mohsen *et al.*, 2017 and Fekry, 2017)

This study was conducted to investigate the responses of garlic (Eggaseed-1 cv.) to soil humic application and/or clove pre-sowing treatments on

germination, development and yield under field condition

2. MATERIALS AND METHODS

Tow field experiments were carried out at Sids Horticulture Research Station, Beni Suef Governorate, which is a part of the Agricultural Research Centre located in Giza, Egypt during the two winter seasons of 2019/2020 and 2020/ 2021 in a clay loam soil to investigate the response of garlic clove (Eggaseed-1 cv.) for humic acid application and pre sowing treatments. Planting date was September 15th in both seasons. The N.P.K. fertilizers at the rate of 180 kg N/ fed., 65 kg P_2O_5 /fed. and 48 kg K_2O/fed. were applied to all treatments where, Calcium superphosphate (15.5% P_2O_5) was added during soil preparation, Ammonium nitrate (33.5% N) was divided into four equal doses, the first was applied during soil preparation, the second, third and fourth dose were applied after 30, 60 and 90 days from planting and before irrigation. Potassium sulphate (48% K_2O) was divided into two equal portions, which were added after 3 and 4 month from planting date respectively.

All other cultivation applications were accomplished as recommended for garlic yield trial packages. A split-plot in a randomized complete block design with three replications was used. The area of each sub- plot was 10.5 m^2 (1/400/fed.), as 5 rows, 0.6 m apart and 3.5 m long. Cloves were planted 10 cm apart on two row sides.

The main plots were allocated for soil application of potassium humate included control (no humic applied), whereas the seven pre-sowing treatments were arranged in the sub-plots to obtain 14 treatments as follows:

Main-plot (Soil application):

a): Control (no humic applied)
b): Humic application (6 kg/fed.)

Sub-plot (pre-sowing treatments):

T_1= Soaking in water for 24h then placing in moist peat-moss until root initiation.
T_2= Soaking in GA_3 10 ppm 12h.
T_3= Soaking in humic acid (50 g / L water) 12h.
T_4= Colling cloves at 5°C for 20 days
T_5= Colling cloves at 10°C for 20 days
T_6= Soaking in water 12h.
T_7=Dry clove (control)

Humic acid as (potassium humate): Black granules of potassium humate 65% humate, 25% fulvic acid and 10% K_2O was added at rate of 6 kg/fed. divided to three equal parts and mixed with sand before addition to the soil to ensure the uniform distribution for the plants. Potassium humate were added after one month from planting date and every 30 days for three times throughout the growing season.

The plants were harvested on April 1st for both seasons except treatments stored under low temperature where cooling Treatments at 5° C (T4) and 10° C (T5) for 20 days were harvested at February 25st and March 10th, respectively (30-20 days earlier than other treatments) for both seasons.

2.1. Data recorded:

Vegetative growth

Germination percentage was determined after 30 days from planting, the germinated cloves were counted and germination percentage was estimated using the following formula:

$$\textbf{Germination}\ (\%) = \frac{\textbf{Number of germinated cloves per plot}}{\textbf{Total number of planted cloves per plot}} \times 100$$

At two weeks before harvest, ten plants were randomly taken from each experimental plot to determine Plant height (cm), Leaves number/plant and Nick diameter (cm).

Fresh bulb characters: On the same samples obtained two weeks before harvest Fresh weight of whole plant (g/plant), Fresh Bulb diameter (cm) and Bulb dry matter percentage were measured.

Fresh yield at harvesting date: Fresh yield kg/plot and all data were calculated as ton/fed.

Cured yield: The harvested garlic plants were left in the field to be cured for 21 days and cured plants were then weighted. Cured yield (ton/fed.) was calculated.

2.2. Statistical analysis:

Data were compared using analysis of variance (ANOVA) procedures according to Gomez and Gomez (1984) through MS STAT programme. The LSD test was used for mean separations of the studied parameters.

3. RESULTS AND DISCUSSION

3.1. Vegetative growth traits:

Changes in germination percentage, vegetative growth traits (Plant height, Leaves number/plant and Nick diameter), fresh bulb characters (fresh weight of whole plant, fresh bulb diameter and bulb dry matter percentage) and both Fresh yield and Cured yield as affected by soil application of potassium humate are presented in Table 1 and Fig.1. The results indicated that significantly highest values by application of 6 kg/fed. potassium humate in all studied traits were obtained in both seasons except number of leaves in 1st one comparing with control (no humic applied). Results in Fig. 1 show that applying 6 kg/fed. humic acid exhibited a high increment in all vegetative growth traits, *i.e.*,

Germination % , Plant height, Leaves numbers/plant and Nick diameter by 1.37, 6.82, 7.50, and -18.79 % (as average of both seasons) as well as each of

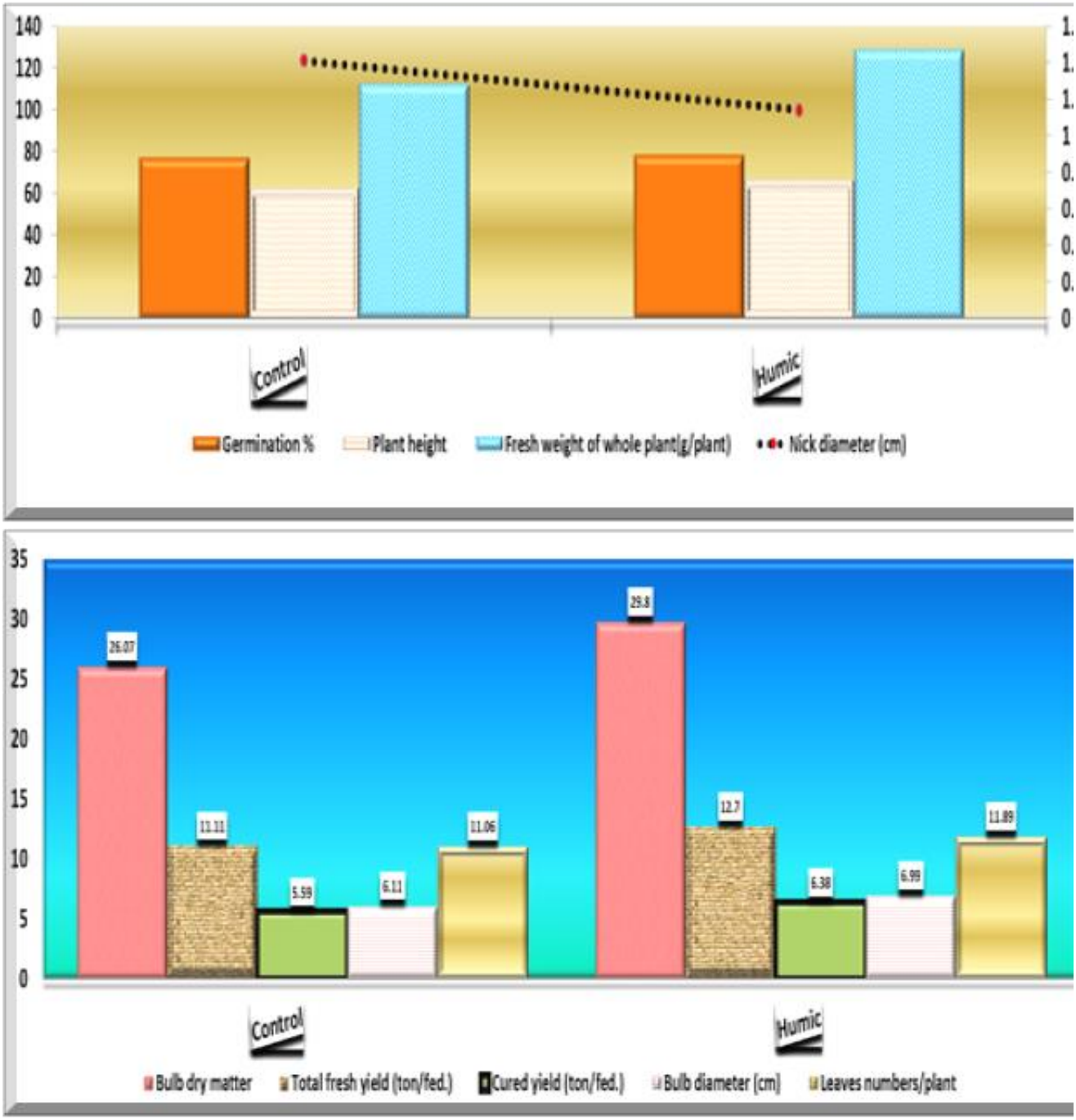

Fig 1. Changes values in all studied traits as affected by soil humic application on garlic plants (average of both seasons).

Fresh weight of whole plant, bulb dry matter, total fresh yield/fed., cured yield/fed. and bulb diameter by about 14% (as average of both seasons) comparing with the control treatment (no humic applied). Potassium humate is a commercial product contains many elements which were improve the soil fertility and increase the availability of nutrient elements by holding them on mineral surfaces, consequently, affect plant growth and yield (El-Sharkawy and Abdel-Razzak, 2010). The positive effect of humic acid addition on plant growth and germination% may be due to containing of humic acid certain nutrients which are correcting the widespread occurrence of deficiency symptoms. This is attainted through increasing the soil water holding capacity, promoting soil structure and enhances the metabolic activity of microorganisms. Results are in agreement with those obtained by Mahmoud and Hafez (2010), El Nemer *at al*. (2012), Samy *et al.* (2015) and Shafeek *et al.* (2015).

Table 1. Germination%, vegetative growth, Fresh bulb characters as well as fresh and cured yield traits of garlic cvs Eggaseed-1 as affected by humic soil application and pre-sowing treatments during both winter seasons of 2019/2020 and 2020/ 2021

Treatments		Main-plot			Sub-plot							
		Control	Humic	LSD	T1	T2	T3	T4	T5	T6	T7	LSD
Germination %	1st season	76.46	77.14	0.56	88.75	83.95	75.9	86.8	85.2	61	56	0.6
	2nd season	78.23	79.67	0.53	90.1	85.6	78.7	87.85	86.85	64.2	59.35	0.84
Plant height	1st season	61.74	66.69	3.1	74.35	68.8	67.85	52	62.1	64.1	60.3	1.47
	2nd season	63.10	66.66	3.33	74.8	70.3	68.15	54.3	59.95	65.35	61.3	2.3
Leaves numbers/plant	1st season	11.03	11.41	NS	12.35	11.85	11.65	9.3	10.45	11.55	11.4	0.22
	2nd season	11.09	12.37	0.86	12.85	12.6	12	10.1	10.9	12.05	11.6	0.3
Nick diameter (cm)	1st season	1.33	1.17	0.14	0.845	0.95	1.17	1.9	1.52	1.08	1.275	0.1
	2nd season	1.49	1.12	0.17	0.88	1.01	1.19	1.9	1.65	1.125	1.365	0.13
Fresh weight of whole plant(g/plant)	1st season	110.29	126.04	3.17	139.29	133.93	129.65	80.36	107.14	121.07	115.72	3.47
	2nd season	115.00	131.43	4.86	150	139.29	133.93	85.71	112.5	123.22	117.86	3.8
Bulb dry matter	1st season	25.00	28.57	1.94	35.36	30.00	26.79	21.43	23.57	25.72	24.65	1.47
	2nd season	27.14	31.02	1.84	37.50	32.15	30.00	23.57	25.72	27.86	26.79	1.84
Total fresh yield (ton/fed.)	1st season	10.900	12.457	0.252	15.000	13.822	13.393	7.500	9.643	11.679	10.715	0.2
	2nd season	11.329	12.947	0.342	15.643	14.250	13.607	8.250	10.179	11.786	11.250	0.18
Cured yield (ton/fed.)	1st season	5.471	6.253	0.183	7.605	6.965	6.645	3.750	4.820	5.895	5.355	0.18
	2nd season	5.700	6.514	0.197	7.820	7.070	6.535	4.500	5.145	6.000	5.680	0.2
Bulb diameter (cm)	1st season	5.99	6.84	0.3	8.25	7.5	6.75	4.61	5.68	6.22	5.90	0.2
	2nd season	6.24	7.14	0.31	8.68	7.715	6.97	4.82	5.90	6.54	6.22	0.2

Control (no humic applied), Humic: Humic soil application (6 kg/fed.), T_1= Soaking in water for 24h+moist peat-moss, T_2= Soaking in GA_3 10 ppm 12h, T_3= Soaking in humic acid (50 g / L water) 12h, T_4= Colling at 5°C, T_5= Colling at 10°C, T_6= Soaking in water 12h, T_7=Dry clove (control).

In this respect they reported that both liquid and solid forms of humic acid applications are effective to increase growth parameters of plants. Moreover, Denre *et al.* (2014) found that the maximum yield of garlic was observed by application of 300 followed by 400 and 200 ppm humic acid. Also, Ekinci *et al.* (2015) revealed that humic acid application at different rates positively affected the yield of tomato and cucumber plants. Mahmoud and Youssif (2015) stated that the highest values of the investigated garlic yield and its components were, generally, recorded with application of potassium humate at the rate of 7 kg/fed. as soil addition in both seasons.

3.2.Pre-sowing treatments:

Data presented in Table 1 and Fig.2 show the effect of pre-sowing treatments on vegetative growth parameters, (Plant height, Leaves number/plant and Nick diameter), fresh bulb characters (fresh weight of whole plant, fresh bulb diameter and bulb dry matter percentage) and both Fresh yield and Cured yield. It is clearly illustrated that T1, T2, T3 and T6 pre-sowing treatments significantly increased all abovementioned traits comparing with T7 (control) in both seasons and reverse trend regarding to both T4 and T5. No significant differences between T2 and T3 in plant height (both seasons) and number of leaves/plant (1st season), T6 and T7 (control) for bulb dry matter (both seasons) and number of leaves/plant (1st season), T1 and T2 as well as T3 and T6 for number of leaves/plant (2nd season).

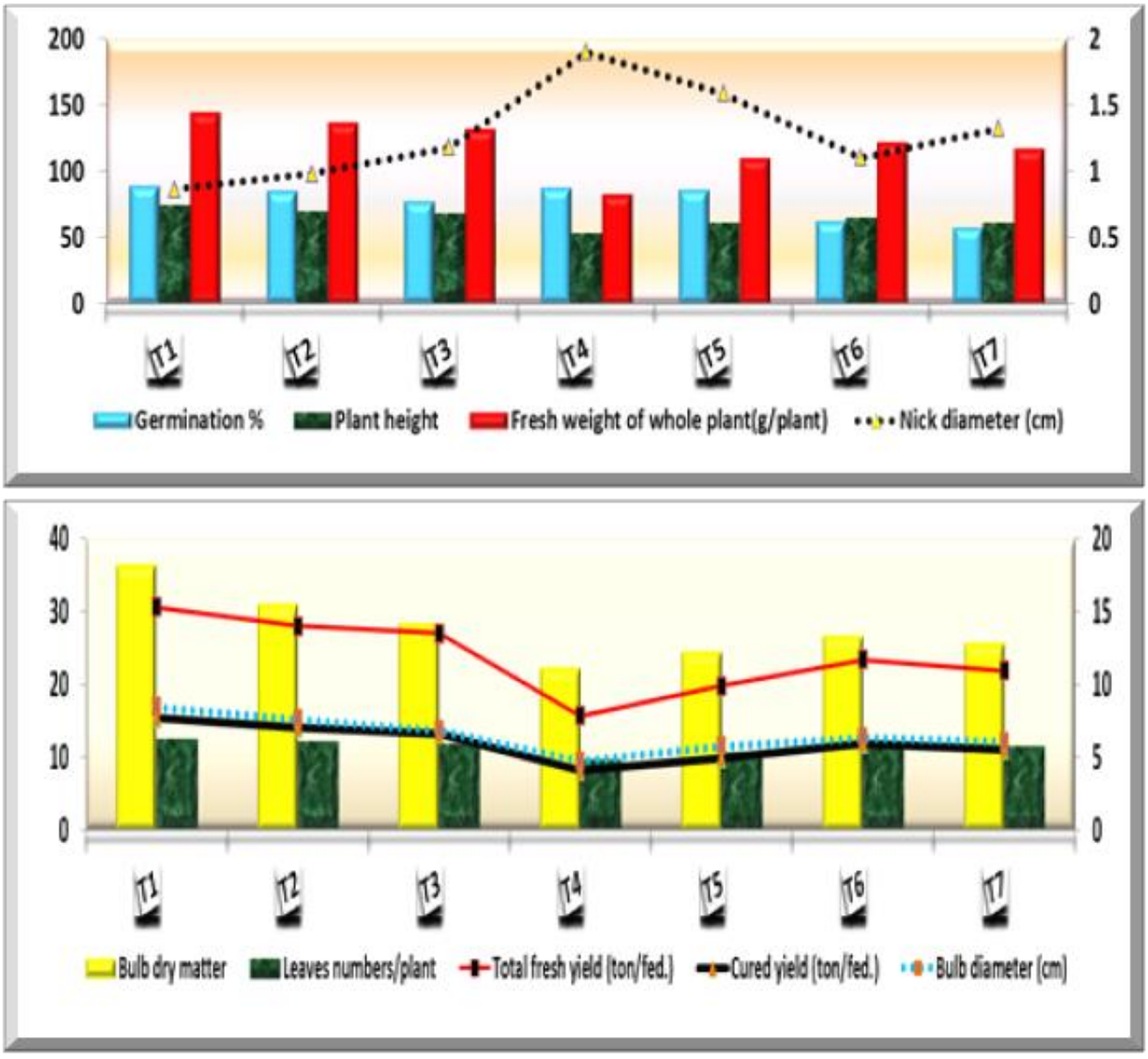

Fig 2. Changes values in all studied traits as affected by pre-sowing treatments on garlic plants (average of both seasons).

It is obvious from Table 1 and Fig.2 that T_1 (soaking in water then placing in moist peat-moss) exhibited the highest values of germination percentage after 30 days from planting in both seasons.

Treated plants with the different pre-planting treatments showed also, that T_1 (soaking in water then placing in moist peat-moss) exhibited a high significant increment in all studied traits in both seasons, *i.e.*, Germination, Bulb dry matter, Bulb diameter, Cured yield/fed., Total fresh yield/fed., Nick diameter, Fresh weight of whole plant, Plant height and Leaves numbers/plant by 55.1%, 41.7%, 39.8%, 39.8%, 39.5%, 34.7%, 23.9%, 22.7% and 9.6% in descending order (as average of both seasons, Fig.2), over the corresponding untreated plants (control) followed by T_2 in all abovementioned traits except germination %, in which T_4 that had the second order. Generally, the pre-sowing treatments were ordered as T_1, T_2, T_3, T_7, T_6, T_4 and T_5, in descending order in their positive effects on all studied traits except both generation % and neck diameter. However, the lowest values of germination percentage after 30 days from planting was noticed by the control (T_7) whereas, T_5 exhibited the lowest values for all other traits. Similar results were reported by Rahman *et al.* (2006), Ahmed and Hemada (2012) and El-Shabasi *et al*. (2018) who reported that Sids-40 garlic clove seed soaking in water then placing in moist peat-moss until root initiation could be recommended to produce higher yield with better quality.

3.3. Interaction effects:

Table 2 and Fig. 3 show the abovementioned studied traits of garlic plants treated with different pre-sowing treatments with two soil application treatments (control without humic and supply of humic application). It is clearly noted that all pre-sowing treatments combined with the humic soil application treatment gave statistically equivalent or increase values in all vegetative growth traits compared to the corresponding common agricultural practice treatments (pre-sowing × control), indicating the efficient role of the humic substances in an increasing organic matter in soil and reduce the negative effect of soil stress which increased yield of plants (El-Hefny, 2010 and Gad El-Hak *et al*. 2012.

Upon treatment of plants treated with the humic acid plus T_1 (Soaking in water for 24h then placing in moist peat-moss until root initiation) treatment, a highest value in all vegetative growth traits was observed in both seasons (Table 2) and average (Fig. 3), resulting in an increment percentage (as average of both seasons) by 54.2, 41.7, 39.8, 39.8, 39.5, 26.1, 23.9, 19.7 and 8% in descending order for Germination percentage, Bulb dry matter %, Bulb diameter, Cured yield/fed., Total fresh yield/fed., Plant height, Fresh weight of whole plant, Nick diameter and Leaves numbers/plant over the corresponding control (humic×T_7 dry cloves), respectively followed by humic × T_2 (Soaking in GA_3 /10 ppm, 12h) for Total fresh yield (ton/fed), Cured yield (ton/fed), Bulb diameter, Bulb dry matter, Plant height, Fresh weight of whole plant, Nick diameter and Leaves numbers/plant by 27.8, 27.2, 25.6, 20.8, 17.7, 17, 16.5 and 5.9%, respectively and humic×T_4 (Colling cloves at 5^{o}C for 20 days) for germination percentage by 46. Nevertheless, the beneficial effects of the applied treatments (supply of humic application plus pre-sowing treatments) may be explained due to the nutritional status of plants greatly affects their ability to adapt to adverse environmental conditions, and the increase in plant growth may be attributed to the valuable effects on stimulating the meristmatic activity, for producing more tissues and organs, and cell enlargement, in addition to its vital contribution in several biochemical processes in the plant related to growth (Marschner, 1995) and may be, due to also, the functional role of potassium where, tightly related with membrane stability and integrity, signal transduction system (Pottosin and Schonknecht, 2007). However, the indirect effects of humic compounds on soil fertility include, Furthermore, directly; humic acid compounds may have various biochemical effects either at cell wall membrane level or in the cytoplasm and/or humic substances may possibly enhance the uptake of minerals through the stimulation of microbiological activity (Gad El-Hak *et al.*, 2012 and Manas *et al*., 2014). The same trend was found by, El-Nemer *et al.* (2012), Denre *et al*. (2014), Samy *et al.* (2015) and Shafeek *et al*. (2015).

4. CONCLUSION

The present study demonstrated the effects of soil addition with potassium humate at rate of 6 kg/fed. had a significant positive effect and had the highest results on growth, yield and quality of garlic plants. This substances, which exhibited significant positive effect for yield/fed. was also combined significant/highly significant desirable negative or positive (due to the point of view) effects for germination and neck diameter. The treatments are recommended as a low cost and ecofriendly for amendments to improve soil properties increasing vegetative growth, yield, quality and chemical composition of garlic plant.

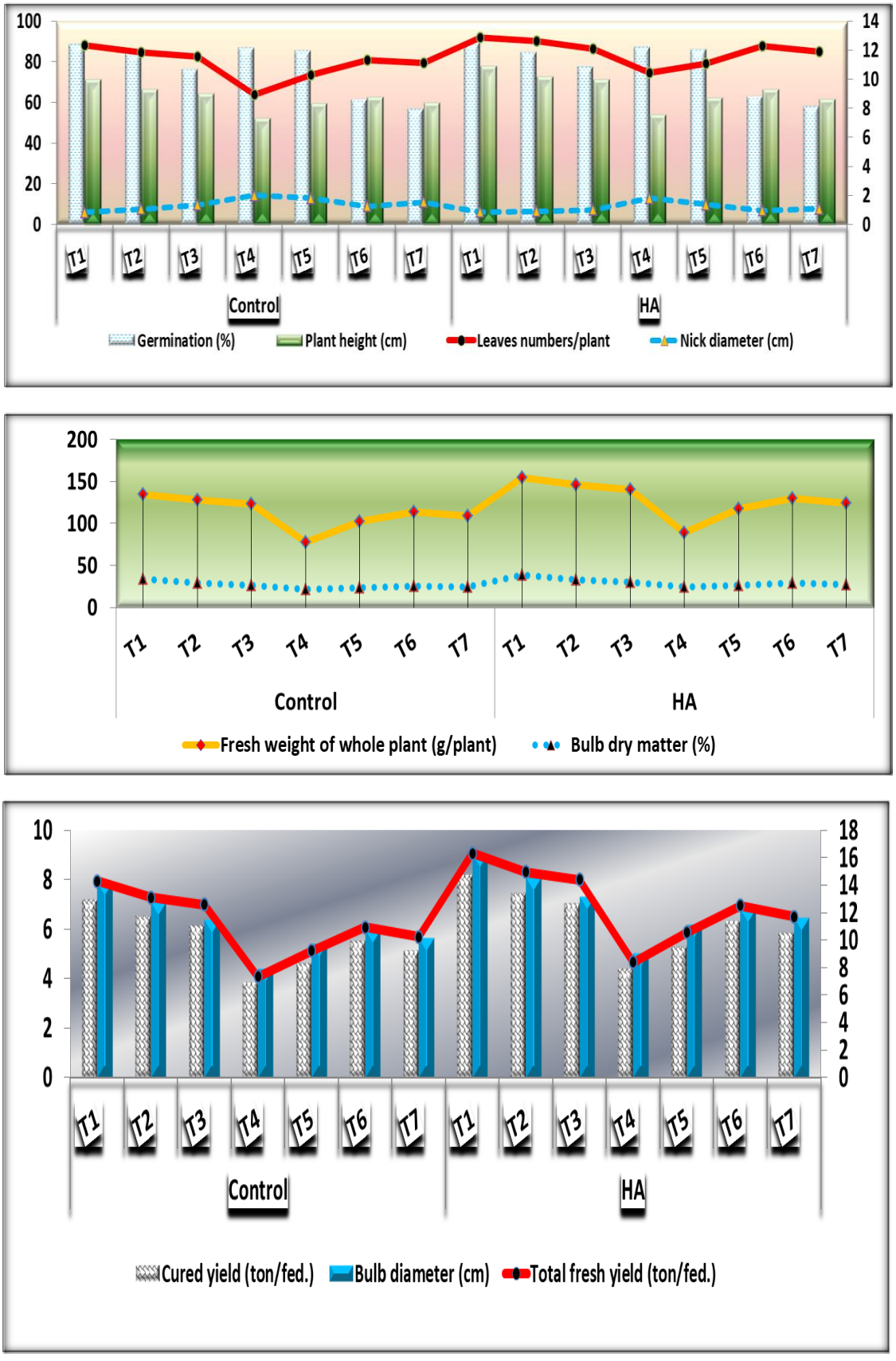

Fig 3. Germination%, vegetative growth, Fresh bulb characters as well as fresh and cured yield traits of garlic cvs Eggaseed-1 as affected by the interaction between humic soil application and pre-sowing treatments

Table 2. Germination%, vegetative growth, Fresh bulb characters as well as fresh and cured yield traits of garlic cvs Eggaseed-1 as affected by the interaction between humic soil application and pre-sowing treatments during both seasons

Treatments		Germination %	Plant height	Leaves numbers/plant	Nick diameter (cm)	Fresh weight of whole plant (g/plant)	Bulb dry matter	Total fresh yield (ton/fed.)	Cured yield (ton/fed.)	Bulb diameter (cm)
First season										
Control	**T1**	88.4	70.3	12.2	0.8	130	33	14	7.1	7.7
	T2	83.6	65	11.8	1	125	28	12.9	6.5	7
	T3	75.6	63.7	11.5	1.3	121	25	12.5	6.2	6.3
	T4	86.7	50.9	8.9	1.9	75	20	7	3.5	4.3
	T5	85	60.7	10.2	1.7	100	22	9	4.5	5.3
	T6	60.7	62.4	11.4	1.2	113	24	10.9	5.5	5.8
	T7	55.2	59.2	11.2	1.4	108	23	10	5	5.5
HA	**T1**	89.1	78.4	12.5	0.89	148.6	37.71	16	8.11	8.8
	T2	84.3	72.6	11.9	0.9	142.9	32	14.743	7.43	8
	T3	76.2	72	11.8	1.04	138.3	28.57	14.286	7.09	7.2
	T4	86.9	53.1	9.7	1.9	85.7	22.85	8	4	4.91
	T5	85.4	63.5	10.7	1.34	114.3	25.14	10.286	5.14	6.06
	T6	61.3	65.8	11.7	0.96	129.1	27.43	12.457	6.29	6.63
	T7	56.8	61.4	11.6	1.15	123.4	26.29	11.429	5.71	6.29
LSD		0.74	2.04	NS	0.11	3.61	1.5	0.22	0.17	0.24
Second season										
Control	**T1**	89.2	72.3	12.5	0.9	140	35	14.6	7.3	8.1
	T2	85	67.8	11.9	1.1	130	30	13.3	6.6	7.2
	T3	78.1	65.3	11.6	1.4	125	28	12.7	6.1	6.5
	T4	87.3	53.5	9	2.1	80	22	7.7	4.2	4.5
	T5	86.3	58.9	10.4	1.9	105	24	9.5	4.8	5.5
	T6	63	63.4	11.2	1.3	115	26	11	5.6	6.1
	T7	58.7	60.5	11	1.7	110	25	10.5	5.3	5.8
HA	**T1**	91	77.3	13.2	0.86	160	40	16.686	8.34	9.26
	T2	86.2	72.8	13.3	0.92	148.6	34.29	15.2	7.54	8.23
	T3	79.3	71	12.4	0.98	142.9	32	14.514	6.97	7.43
	T4	88.4	55.1	11.2	1.7	91.4	25.14	8.8	4.8	5.14
	T5	87.4	61	11.4	1.4	120	27.43	10.857	5.49	6.29
	T6	65.4	67.3	12.9	0.95	131.4	29.71	12.571	6.4	6.97
	T7	60	62.1	12.2	1.03	125.7	28.57	12	6.06	6.63
LSD		0.83	2.44	0.24	13	3.93	0.14	0.23	0.15	0.24

Control (no humic applied), Humic: Humic soil application (6 kg/fed.), T_1= Soaking in water for 24h+moist peat-moss, T_2= Soaking in GA_3 10 ppm 12h, T_3= Soaking in humic acid (50 g / L water) 12h, T_4= Colling at 5°C, T_5= Colling at 10°C, T_6= Soaking in water 12h, T_7=Dry clove (control).

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الملخص العربى

التأثير المحتمل لمعاملات ما قبل الزراعة للفصوص على نمو ومحصول الثوم صنف ايجاسيد ١

سعيد إبراهيم أحمد[١]، محمود محمد سامي[١] وأسماء صلاح عزات[٢]

[١]قسم بحوث البطاطس والخضر خضرية التكاثر – معهد بحوث البساتين – مركز البحوث الزراعية – مصر
[٢]قسم البساتين – كلية الزراعة – جامعة المنيا

أجريت تجربتان حقليتان خلال عامين متتاليين فى الموسم الشتوى ٢٠١٩/٢٠٢٠، ٢٠٢٠/٢٠٢١بمحطة بحوث البساتين بسدس– مركز البحوث الزراعية– مصر لدراسة إستجابة صنف الثوم ايجاسيد ١ لاضافة الهيوميك ارضى مع استخدام بعض معاملات فصوص تقاوى الثوم قبل الزراعة بالمعاملات التالية :

١- بالنقع فى الماء لمدة ٢٤ ساعة ثم وضع الفصوص فى البيتموس الرطب حتى ظهور مبادئ الجذور .
٢- النقع فى الجبريليك أسيد بمعدل ١٠ جزء فى المليون لمدة ١٢ ساعة
٣- النقع فى الهيوميك أسيد بمعدل ٥٠ جرام لكل لتر ماء لمدة ١٢ ساعة
٤- التبريد على درجة ٥ م° لمدة ٢٠ يوم
٥- التبريد على درجة ١٠ م° لمدة ٢٠ يوم
٦- النقع فى الماء لمدة ١٢ ساعة
٧- معاملة الكنترول (فصوص جافة).

وأعطت تفاعل اضافة الهيومك الى التربة مع معاملة النقع فى الماء لمدة ٢٤ ساعة ثم وضع الفصوص فى البيتموس الرطب حتى ظهور مبادئ الجذور أعلى القيم فى النسبة المئوية للإنبات وطول النبات وعدد الأوراق وقطر العنق كما حسن قياسات صفات مكونات المحصول والمحصول مثل وزن النبات الكلى الطازج وقطر البصلة والنسبة المئوية للمادة الجافة بالإضافة الى المحصول الطازج والمحصول المعالج ولذلك نوصى باضافة ٦ كجم/فدان هيومات بوتاسيوم مع المعاملة بنقع الفصوص فى الماء لمدة ٢٤ ساعة ثم وضع الفصوص فى البيتموس الرطب حتى ظهور مبادئ الجذور يليه تفاعل الهيومك مع معاملة نقع الفصوص قبل الزراعة فى محلول الجبريليك أسيد بمعدل ١٠ جزء فى المليون لمدة ١٢ ساعة لإنتاج أفضل محصول كما ونوعا للصنف ايجاسيد ١.