THE EFFECT OF HUMIC ACID AND HIGH POTASSIUM ON SOME GROWTH CHARACTERISTICS AND YIELD OF CAULIFLOWER

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ABSTRACT

The experiment was conducted at the agricultural research station during 2018-2019 planting season to determine the effect of two levels of humic acid (1.5, 3.0) g L^{-1}, high potassium composite fertilizer (1.5, 3.0) g L^{-1} and the number of treatments (twice and three times) on the growth and production of cauliflower. Randomized Complete Block design was used and the mediums were tested by lest significant deference at 0.05 probability. The most important results show that the potassium treatment had a significant increase in most indicators of vegetative growth, yield and chemistry, the maximum yield (25.45 $t.ha^{-1}$) was obtained with 3 $g.l^{-1}$. While the humic acid had a significant increase in chlorophyll, percentage ratio of dry matter in leaves and curd, percentage of nitrogen and potassium in leaves. The number of treatment has effect in the curd weight, total yield, carbohydrates and percentage potassium in leaves. The interaction between both factors had significant increase in all characteristics of the study.

Keywords: Cauliflower; humic acid; high potassium; yield.

INTRODUCTION

Cauliflower (*Brassica oleracea* L. Var botrytis) is one of the most crop important of crucifer family, It is awinter anaual plant and morphological looks like Broccoli, but Broccoli is more sensitive to hot and dry weather [1,2]. Cauliflower is enriched with nutrient elementsm, protein, fat, carbohydrates, Ca, P, Fe, Ni, K, Mg, Vitamin A, thiamin, ribofanin, niacin and ascorbic acid [3]. The annual statistics refer that the productivity of cauliflower in Iraq for the year 2016 was 13.48 thousand tons, with total area of 10196 thousand hectares, but the total production in the world was 25,234 million tons, China had the highest international production which was 10.264 million tons [4]. Cauliflower productivity is greatly affected by the quantities of fertilizer, especially chemical fertilizer, which plays a large role in increasing productivity, It is needs high level of potassium, It is one of the essential elements for plants [5]. Which is the second largest element required for the plant [6]. It is one of the most abundant nutrients in the soil required by the plant, however a small percentage of it is ready for absorption [7], potassium increases the resistance of plants to abiotic factors (frost, aridity, airless soil conditions, salinity and sodicity) and biotic factors such as disease [8]. Plants with adequate potassium during growth can provide good yields even under stressed conditions [9]. It is plays an important role in the nutrition of plant, photosynthesis, cell division, lignin, cellulose, transition, the manufacture of material from source to the other parts of plant and raise the efficiency of plant in absorption of the nutrients specially nitrogen and phosphorous and then improve the nutriential balance. This leads to improve the growth of plant and increases the production and quality [10]. Although the importance of potassium for the production of cauliflower, few studies have examined the effects of these nutrients on the productivity. In a study carried out by Al-hakim [11] in Babylon, cauliflower var. white cloud was treated with two concentration (1-2)% of potassium nitrate, gibrillin and cycocel they showed that the level 2% had a significant increase in number of leaves, curd weight and diameter in addition the total yield. Silva et al. [12] treated different K doses (0, 50, 100, 150 and 200 $kg.h^{-1}$ K2O) in Brazil on the yield of cauliflower and broccoli, the maximum yield indicators of broccoli with 160 kg ha-1 K2O but cauliflower increased with 200 kg ha-1 K2O in curd diameter (21.8 cm), curd weight (1086 g), total yield (38.29 $t.h^{-1}$) in addition the total content of potassium which was 34.9 $g.kg^{-1}$. But chemical fertilizers have a great detriments to human health, beneficial organisms in the soil, and the deterioration of the physical and chemical soil properties. Therefore, researchers have been looking for alternatives to reduce those disadvantages by adding organic fertilizers to soil or spraying them on vegetative system such as the humic acid is Considered one of the organic materials and it is the final product of analyzing it. One of the major impacts of humic acid on plant growth is the reinforcement in nutrient uptake and the elongation of the lateral root growth, often recognized as “auxin-like effect,” which is a result of the induction of ATPase activity in the plasma membrane [13,14,15].

Humus material may have direct and indirect effect on plant growth [16]. Indirect effect includes improving the soil characters like aggregation, aeration, permeability, retention of water, ion transport and its availability for the way by storing the pH [17]. Humic acid increasing the permability of the cellular membrane and the absorption of nutrients [18].

Current study aims to know the efficiency of potassium fertilizer and humic acid in increasing the growth and productivity of cauliflower plant under local conditions.

MATERIALS AND METHODS

The experiment was carried out in the autumn of the agricultural season 2018 at the Agriculture Research station, Agriculture College, Basrah University in clay silty soils. It was carried out as a factorial experiment according to Complete Block Design Randomized (RCBD) and with three replications The study aimed to examined the effect of two factors, the first factor five concentrations, two concentrations of humic acid (addition) and two of high-potash compound fertilizers (spraying) each of 1.5 and 3. 0 $gm.l^{-1}$ in addition to the control (0 $g.L^{-1}$) and the second factor, the number of times of treatment twice and three times. The trial includes 30 trial units. The mediums were analyzed by GenStat program [19] and the test of Least Significant Difference (L.S.D) was used to compare the mediums at the probability of 0.05.

Hybrid Nahar cauliflower seeds were grown on 15/9/2018, when the seedlings reached the suitable size and age for transplanting (10-13) cm and (6-8) real leaves were transplanted on 15/10/2018, the space between them was 40 cm in the middle of rows. Every experimental unit had 8 seedlings, all agricultural processes which include irrigation, replanting, thinning, cultivation and diseases protection was done.

Variables Estimated

In the current study, the following variables were evaluated:

- Number of leaves. Plant^{-1}
- Leaf Area (cm^2)
- Dry matter (%)
- Total chlorophyll (mg in 1 g) was estimated according [20].
- Crud diameter (cm)
- Crud weight (g)
- Total yields ($t.h^{-1}$)
- Dry crud matter (%)
- The amount of carbohydrates (mg / g-1 [21].
- Nitrogen (%)
- Potassium (%)
- Phosphorus (%)

RESULTS AND DISCUSSION

Table 1 showed that the high significant increase in the number of leaves (12.98 leaf), leaf area (10131) cm^2 comparing with the control, while humic acid at 3.0 $g.L^{-1}$ had a significant increase in the percentage of dry weight of leaves (6.22)% which had Noth potassium fertilizer at 1.5g L^{-1} had a significant difference with the most of the treatments except the concentration of 1.5 $g.L^{-1}$ of the humic acid and control. The treatment with 1.5 $g.L^{-1}$ humic acid gave high chlorophyll content which was 11.12 $mg.g^{-1}$ of fresh weight comparing with lowest chlorophyll content at the concentration of 3 $g.L^{-1}$ high potassium, while the number of treatment of both fertilizers had no significant effect in the most of vegetative characters except leafy area that the treatment with three time had significant superior at twice treatment (8091) cm^2. The interaction between the two factors had significant effects in all treatments, as the treatment with 1.5 $g.L^{-1}$ high potassium and three time spraying had a significant increase in the number of leaves (13.17 leaves), leaves area (10970 Comparison with the lowest value obtained in plants treatment three times with distilled water (9.83 leaves, 4411 cm^2). Treatment with humic acid at 3 $g.L^{-1}$ and three times had a significant increase in dry weight 6.46% comparing with the control (3.7%). Plants treated with humic acid at 1.5 $g.l^{-1}$ with twice times had a significant increase in chlorophyll content (11.41 $mg.g^{-1}$) of fresh weight comparing with the plants treated with high potassium fertilizer at 1.5 $g.L^{-1}$ with twice times. Potassium is an essential component for plant growth as it works to regulate and stimulate cells as it contributes to regulating plant osmotic potential, regulating respiration, protein representation and stimulating enzymes [22], which helps vegetative growth, this agreed with [7] on tomoto (*Lycopersicon esculentum* L.). The increase in the chlorophyll in low concentration of humic acid can be attributed to the positive effect of humic in increasing photosynthesis and the resulting increased chlorophyll in the leaves [23], this agreed with Dawood et al. [24] found on the faba bean plant. Al-Ghazy [25] on the cucumber plant and Mahmood et al. [26] on cauliflower that the humic acid cause a significant increase in dry weight and chlorophyll content in the leaves.

Table 2 showed that the treatment with high potassium fertilizer at the concentration of 1.5, 3 $g.l^{-1}$ had a significant effect on crud diameter (17.38, 17.28 cm), crud weigh (872.0, 877.7 g) and total yield (25.29, 25.45 $t.h^{-1}$), humic acid at both concentrations and high potassium at 3.0 $g.L^{-1}$ were superior at the percentage of dry crud weight as follow 11.57, 12.0 and 11.21%, respectively. Three times had a significant effect in crud weigh (790.1 g) and total yield (22.91 $t.h^{-1}$) respectively. The interaction between high potassium at the 1.5 $g.l^{-1}$ and three times spraying had a significant increase in crud diameter (18.37 cm) comparison with the lowest value (12.54 cm) comparison between the control plants with spray twice, the interaction between 3 $g.l^{-1}$ potassium and twice times had a significant increase in the crud weight and total yield as follow, 893.7 g and 25.92 $t.h^{-1}$, respectively, the interaction between 3 g.l-1 humic acid and three times had a significant increase the percentage of dry crud as follow 13.58%, comparing with the control plants and twice times as follow 540 g, 15.67 $t.h^{-1}$ and 10.18%, respectively. The reason may be that Potassium has vital role in the transfer of photosynthesis products to floral tablets, which leads to their expansion and increase their size [27] and thus its transfer to the floral tablets and increase the weight and total yield, this agreed with Al Hakeem [11]; Islam et al. [28] and Porto et al. [29].

Table 1. Effect of humic acid, potassium fertilizer and number of treatments on some vegetative characteristics of cauliflower

Treatment and concentration		Number leaves. $Plant^{-1}$	Leaf area (cm^2)	Dry matter (%)	Chlorophyll ($mg.100g^{-1}$)
Effect fertilizer	0	9.72	4469	3.74	10.82
($g.l^{-1}$)	Hum. 1.5	11.35	5781	4.22	11.12
	Hum. 3.0	12.32	8507	6.22	10.81
	K 1.5	12.98	10131	6.03	10.54
	K 3.0	12.75	9256	5.89	10.35
L.S.D 0.05		0.599	1011.3	0.883	0.474
Num.	2	11.97	7164	5.07	10.71
Treat.	3	11.93	8091	5.37	10.75
L.S.D 0.05		N.S	639.6	N.S	N.S
Num. Treat.	0	10.00	4518	3.70	10.78
2	Hum. 1.5	11.00	7856	4.33	11.41
	Hum. 3.0	12.16	7856	5.98	10.76
	K 1.5	12.80	9292	5.92	10.29
	K 3.0	13.00	8869	5.38	10.30
Num. Treat.	Control	9.83	4411	3.78	10.85
3	Hum. 1.5	11.70	6275	4.10	10.84
	Hum. 3.0	12.47	9157	6.46	10.85
	K 1.5	13.17	10970	6.10	10.78
	K 3.0	12.50	9644	6.40	10.40
L.S.D 0.05		0.846	1430.2	1.249	0.670

Table 2. Effect of humic acid, potassium fertilizer and number of treatments on some yields characteristics of cauliflower

Treatment and concentration		Crud diameter (cm)	Crud weight (g)	Total yields ($t.h^{-1}$)	Dry crud matter (%)
Effect fertilizer	0	13.02	583.3	16.92	10.21
($g.l^{-1}$)	Hum. 1.5	14.65	708.9	20.56	11.57
	Hum. 3.0	15.36	831.6	24.12	12.00
	K 1.5	17.38	872.0	25.29	10.84
	K 3.0	17.28	877.7	25.45	11.21
L.S.D 0.05		1.945	38.82	1.125	1.159
Number	2	15.70	759.2	22.02	10.82
Treatment	3	15.37	790.1	22.91	11.52
L.S.D 0.05		N.S	24.55	0.711	N.S
Num. Treat.	0	13.19	540.0	15.67	10.18
2	Hum. 1.5	14.97	666.1	19.32	11.89
	Hum. 3.0	16.49	824.8	23.92	10.42
	K 1.5	16.40	871.7	25.28	10.80
	K 3.0	17.46	893.7	25.92	10.79
Num. Treat.	Control	12.84	626.7	18.17	10.23
3	Hum. 1.5	14.33	751.7	21.80	11.25
	Hum. 3.0	14.23	838.3	24.31	13.58
	K 1.5	18.37	872.3	25.30	10.88
	K 3.0	17.09	861.7	24.99	11.63
L.S.D 0.05		2.751	54.90	1.591	1.639

Table 3 showed that there was significant effect for fertilization treatments in all chemical characters in the experiment. The concentration of 3 $g.l^{-1}$ of high potassium gave a significant effect in carbohydrates (42.0 $mg.g.l^{-1}$ dry weight) and 1.5, 3.0 $g.l^{-1}$ potassium significant in potassium percentage (0.055, 0.056%), the concentration of 1.5 $g.l^{-1}$ humic acid had a significant effect in nitrogen (1.89%) and phosphorous (0.293%). Treatment at three times was superior only in carbohydrates content (37.32 $mg.g.l^{-1}$), while the number of treatment had no significant effect on nitrogen, potassium and phosphorous percentage. The interaction between both factors had a

Table 3. Effect of humic acid, potassium fertilizer and number of treatments on some chemical qualities of cauliflower

Treatment and concentration		Carbohydrate (mg^{-1})	Nitrogen (%)	Potassium (%)	Phosphorus (%)
Effect	0	26.75	1.39	0.815	0.215
fertilizer	Hum. 1.5	33.05	1.89	0.768	0.293
($g.l^{-1}$)	Hum. 3.0	39.52	1.62	1.075	0.250
	K 1.5	38.76	1.66	1.380	0.257
	K 3.0	42.00	1.63	1.393	0.253
L.S.D 0.05		3.119	0.155	0.272	0.0240
Num.	2	34.17	1.62	1.139	0.251
Treat.	3	37.32	1.65	1.034	0.256
L.S.D 0.05		1.973	N.S	N.S	N.S
Num.	0	26.23	1.24	0.843	0.192
Treat.	Hum. 1.5	31.93	1.89	0.674	0.293
2	Hum. 3.0	37.83	1.55	1.117	0.240
	K 1.5	36.93	1.71	1.515	0.264
	K 3.0	40.64	1.73	1.543	0.268
Num. Treat.	0	27.26	1.54	0.787	0.239
3	Hum. 1.5	34.17	1.89	0.863	0.293
	Hum. 3.0	41.21	1.68	1.033	0.260
	K 1.5	40.60	1.61	1.242	0.250
	K 3.0	43.36	1.54	1.244	0.239
L.S.D 0.05		4.411	0.219	0.385	0.034

significant effect in all chemical characters of leaves. Plants treated with high potassium and spraying with three times had a significant effect on carbohydrates content (43.36 $mg.g.l^{-1}$ dry weight) comparing the control at twice treatments (26.23 $mg.g.l^{-1}$), the plants treated with 3 $g.L^{-1}$ potassium and twice treatments were superior in potassium percentage (0.1.543%) comparing 1.5 $g.l^{-1}$ of humic acid with twice times (0.0.674%), moreover the twice and three times treatments of 1.5 $g.l^{-1}$ humic acid had a significant increase in nitrogen (1.89%) and phosphorous (0.293%) comparing twice times and control (1.24 and 0.192%), respectively. Potassium has a vital role for stimulating the transition of material which product in photosynthesis [25] and it has a role in the most physiological processes in the plant like Protein composition and carbohydrate representation [30]. Moreover organic material has a role in improving the nitrogen absorption from the soil and helping the absorption of calcium, magnesium and phosphorous that makes it available to the plant root system [31], The use of organic fertilizer reduces phosphate fixation by clay colloids and calcium carbonate [32] and this agreed with Karakurt et al. [33] that showed the significant effect of humic acid for increasing the absorption of macronutrients and micronutrients for plants.

CONCLUSIONS

From the results of the experiment it is noted that humic acid and potassium fertilizer helped improve some of the characteristics of vegetative growth, and this was reflected in the increase in the yield and quality of Crud. The number of treatment times also had a significant effect in increasing the leaf area and the amount of carbohydrates, which led to an increase in the total yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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