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Organic Fertilization and Foliar Application with some Microelements and Biostimulants Effects on Productivity and Quality of Cauliflower

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ABSTRACT

Two field experiments were carried out at a private Farm in Aga Center, Dakahlia Governorate, Egypt, throughout 2015/2016 & 2016/2017 seasons to study the influence of organic fertilization treatments and foliar application with some microelements and biostimulants as well as their interaction on growth, yield and its components, chemical composition and quality of cauliflower Holland Fargo cultivar. This experiment was conceded in design of strip-plot with four replicates. The obtained results showed that organic fertilizing cauliflower plants with humic acid at the rate of 20 kg/fed performed better than other organic fertilization treatments (compost and farmyard manure) and produced the best results of vegetative growth characters, yield and its component, chemical constituents in the leaves and heads and quality parameters of heads, while spraying cauliflower plants with mixture of microelements solution (Zn at 200 mg/L, B at 100 mg/L and Fe at 500 mg/L) three times 30, 45 and 60 days from transplanting exceeded other foliar spraying treatments and produced the best results of the same parameters mentioned previously. It can be accomplished that organic fertilizing soil of cauliflower Holland Fargo cultivar with humic acid at the rate of 20 kg/fed in addition foliar spraying three times 30, 45 and 60 days from transplanting with the mixture of microelements solution i.e. zinc (Zn) at the rate of 200 mg/L, boron (B) at the rate of 100 mg/L and iron (Fe) at the rate of 500 mg/L in order to obtain high growth, yield and its components, chemical composition and quality.

Keywords: Cauliflower, organic manures, microelements, chitosan, algae, yeast extract.

INTRODUCTION

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is widely cultivated all over world and Egypt for its nutritive values, high productivity and wider adaptability under different ecological conditions. Cauliflower contains various kinds of vitamins, especially vitamin C. It also contains minerals like potassium, sodium, calcium, iron, phosphorus and magnesium. The total area grown with cauliflower in Egypt 2017/2018 season was about 10394 fed, which produced about 124984 tons with an average yield of 12.025 t/fed (FAO, 2019).

The agricultural processes for example; organic fertilization treatments and foliar application with some microelements and biostimulants that has awfully important consequence on growth, yield and its components, chemical composition and quality of cauliflower.

Among organic manures, FYM is the most substantial due to it holds most of the nutrients required for crop growth inclusive reasonable amounts of nutrients which become available to plants upon decomposition besides enhancing availability of native as well as applied nutrients. Sen *et al.* (2017) reported that the application of FYM at 5t/ha registered highest dry matter and highest nutrient content in leaf, curd and root parts of cauliflower over control plants. Parmar *et al.* (2018) found that the maximum increase in organic carbon, soil carbon biomass, bacteria, fungi, actinomycetes and phosphatase enzyme, availability of major and micronutrients, yield of cauliflower and net returns were observed with farmyard manure application. Subedi *et al.* (2019) demonstrated that it could be saving of 50% of nitrogen where it can be substituted with the application of organic fertilizer (FYM) to increase the yield and morphological character of cauliflower.

Compost as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Positive effects of compost on soil structure, aggregate stability and water-holding capacity were reported (Odlare *et al.*, 2008). Setyowati *et al.* (2018) indicated that application of compost at the rate of 20 t/ha exhibited highest plant height, number of leaves leaf, total plant dry weight, curd diameter and fresh curd weight of cauliflower compared to the other compost levels (0, 5, 10, 15 and 25 t/ha). Shams and Farag (2019) showed that the highest application rate of compost (14.4 m^3 ha^{-1}) increased the growth, total yield and NPK content in curd of cauliflower as compared with other studied rates (0, 4.8 and 9.6 m^3 ha^{-1}).

Humic acid is a commercial product contains many elements which improve the soil fertility, increase the availability of nutrients, enhancing roots, plant growth, development and plant tolerance against both biotic and a biotic stresses and quality of crop, and consequently increase plant growth and yield. Refai *et al.* (2018) showed that soil applications of potassium humate had the greatest stimulation effect on plant growth characters of cauliflower under different irrigation regimes in compared with control treatment. Hussein (2019) concluded that cauliflower plants treated with humic acid decreased NO_3 accumulation in curds and enhanced quality characters.

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Mahmood *et al.* (2019) showed that significant effect of adding liquid humic acid (10 ml L^{-1}) on number of leaves, dry weight of plant, total yield, chlorophyll content and nutrient uptake of nitrogen, phosphorus and potassium absorbed in cauliflower leaves.

The foliar application with some microelements and biostimulants likes chitosan, algas and yeast extract have very important role in improving fruit set, productivity and quality of vegetables. It has also beneficial role in recovery of nutritional and physiological disorders in vegetables.

The micronutrients required in little quantities are as imperative as macronutrients. The responsibility of micronutrients in regulation plant growth and yield is recognized. Dissimilar micronutrients have definite character in cauliflower production. Micronutrients although mandatory in trace quantity, play fundamental task in completion of life cycle of crop. Among micronutrients, Zn, B and Fe are more important than others due to its availability in soil, mobility in plants and soil and more dependency upon pH in soil. Chaudhari *et al.* (2017) reported that highest marketable curd yield per plot, marketable curd yield per hectare and other yield attributes *viz.* curd diameter, gross weight of curd and net weight of curd were recorded due to foliar spraying with micronutrients of 1% General grade-1 (Fe-2.0, Mn-0.5, Zn-4.0, Cu-0.3 and B-0.5) + Ammonium molybdate. Moklikar *et al.* (2018) showed that the highest growth traits of cauliflower (length of leaf and total biomass production), yield per plot, TSS and ascorbic acid were recorded by foliar spraying with $FeSO_4$ 0.5% + Borax 0.2% + $ZnSO_4$ 0.5%. Ali *et al.* (2019) reported that promotional effects of either B or Mo foliar application on growth, yield and quality of cauliflower curds compared with untreated plants. Nevertheless, the combined application of B and Mo together was more effective than application of B or Mo when they separately applied.

Chitosan is a natural polymer derived from deacetylation of chitin. Chitin is readily available from shellfish waste from food processing. As a high molecular polymer, nontoxic, bioactive agent, chitosan has become a useful appreciated compound due to its fungicidal effects and elicitation of defense mechanisms in plant tissues (Terry and Joyce, 2004). Chitosan forms a semi-permeable film that regulates gas exchange, reduces respiration and transpiration rates and slows down the ripening processes (Shehata *et al.*, 2012).

Algas extract contains a great number of substances that influence plant growth and development (Ordog, 1999). It have been reported to benefit to plants by producing growth promoting regulators (gibberellin and auxin), vitamins, amino acids, polypeptides, antibacterial and antifungal substances that exert phytopathogen bio-control and polymers, especially exopolysaccharides, that improve plant growth and productivity (Zaccaro *et al.*, 1999). Begum *et al.* (2018) stated that seaweed extract have been widely used as bio-stimulants in crop production due to presence of multiple growth regulators (cytokinin, auxins, gibberellins and betaines) besides existence of macronutrients and micronutrients, which are indispensable for early seed germination, plant growth and establishment, resistance to biotic and abiotic stress and better crop performance.

Yeast extract was suggested to participate in a beneficial role during vegetative and reproductive growths through improving flower formation and their set in some plants due to its high auxin and cytokinins content and enhancement carbohydrates accumulation. Also, it was reported its stimulatory effects on cell division and enlargement, protein and nucleic acid synthesis and chlorophyll formation (Wanas, 2006), in addition to its characterized by its richness in protein (47%), carbohydrates (33%), nucleic acid (8%), lipids (4%) and different minerals (8%) such as Na, Fe, Mg, K, P,S, Zn, Mn, Cu, Si, Cr, Ni, Va and Li, in addition to thiamin, riboflavin, pyridoxine, hormones, sugars and other growth regulating substances such as; biotin, B_{12} and folic acid (Mahmoud, 2001). Refai *et al.* (2018) showed that applications of active dry yeast extract had the greatest stimulation effect on plant growth characters of cauliflower under different irrigation regimes in compared with control treatment.

Therefore, this investigation aimed to study the effect of organic fertilization treatments and foliar application with some microelements and biostimulants on growth, yield and its components, chemical composition and quality of cauliflower Holland Fargo cultivar.

MATERIALS AND METHODS

The strip-plot design with four replications was approved in this experiment. The organic fertilization treatments (without organic fertilization *i.e.* control treatment, farmyard manure "FYM", compost and humic acid) were allocated in vertical-plots. FYM (20 m^3/fed) and compost (6 m^3/fed) were added after determining the experimental units on soil surface and then turned over via hack. Chemical analysis of used FYM and compost in both seasons are presented in Table 1. Humic acid (20 kg/fed) in the form of potassium humate was manufactured by Jiangxi Pingxuang Anhua Biotechnology Co. LTD in China to Elahlia Agriculture Development Co in Egypt, and its chemical analysis is presented in Table 2.

Table 1. Chemical analysis of farmyard manure and compost used in this study during the two growing seasons.

Properties	Farmyard manure	Compost
pH (1 : 5)	6.81	6.07
EC (dS m^{-1})	4.21	3.82
Organic matter (OM %)	32.70	35.90
Organic carbon (OC %)	19.00	20.90
Total nitrogen (TN %)	1.25	1.51
C / N ratio	15.20	13.80
Total phosphorus (TP %)	0.44	0.53
Total potassium (TK %)	0.71	0.91
Available Fe (ppm)	55.12	59.16
Available Mn (ppm)	23.15	14.41
Available Zn (ppm)	18.30	19.75

The following foliar application with some microelements and biostimulants were devoted in horizontal-plots:

1- Without foliar application (control treatment).
2- Microelements solution *i.e.* zinc (Zn) in the form of Zn-EDTA at the rate of 200 mg/L, boron (B) in the form of

Zn-EDTA at the rate of 100 mg/L and iron (Fe) in the form of Fe-EDTA and at the rate of 500 mg/L.

3- Chitosan at rate of 2.0 g/L.
4- Algas at rate of 1.0 g/L.
5- Yeast extract at rate of 100 ml/L.

Table 2. Chemical analysis of potassium humate used in this study during the two growing seasons.

Analysis	Value
Moisture	15 (%)
Organic matter (dry basis)	80.0 (%)
Humic acid (dry basis)	65-70 (%)
Potassium (dry basis) as K_2O	8-10 (%)
Heavy elements	2.55 (ppm)
Water solubility	> 98.9 (%)
Appearance	Black flake

Chitosan powder (Poly-(1.4-B-D-glucopyranosamine); 2-Amino-2-deoxy- (1-4)-B-D-glucopyranan) was prepared by dissolving a proper amount in 5 % acetic acid solution. Algas were obtained from Al-Hayah for Agricultural Projects. Active dry yeast was dissolved in water at the rate of 5 g/liter followed by adding sugar at ratio 1:1 and kept overnight for activation and reproduction of yeast and multiplied efficiently during conducive aerobic. This technique for yeast preparation was modified by Spencer et al. (1983).

The foliar solution volume was 200 Liter/fed and spraying by hand sprayer (for experimental plots) until saturation point. Foliar spraying with these microelements and biostimulants solutions was carried out three times at the aforementioned rates after 30, 45 and 60 days from transplanting.

Each experimental basic unit included three ridges, each of 0.80 m width and 4.0 m length, resulted an area of 9.60 m2. The soil of experimental site was characterized as a sand clay loam in texture with an electrical conductivity (EC) of 1.29 dS m-1 and a pH of 8.07.

The experimental field well prepared for each experiment through two ploughing, leveling, compaction, ridging and then divided into the experimental units.

Cauliflower seedlings were obtained from special Nursery, which were without delay sown in the reasonably moist soil on 17th and 19th October in the 1st and 2nd seasons, in that order. Seedlings were sown in hills by hand at 50 cm apart on one side of the ridge.

Phosphorus fertilizer as calcium superphosphate (15.5 % P2O5) was applied at the recommended rate (30.0 kg P2O5/fed) during soil preparation. Potassium fertilizer in the form of potassium sulphate (48.0 % K2O) at the recommended rate (24.0 kg K2O/fed) and nitrogen fertilizer as ammonium nitrate (33.5 % N) at the suggested rate (83.75 kg N/fed) were used in two equivalent doses, the 1st was added after 21 days from transplanting (before the first irrigation) and the 2nd was added after 35 days from transplanting (before the second irrigation).

Through the two growing seasons, every other agricultural practices for growing cauliflower were prepared according to the recommendations of Ministry of Agriculture and Land Reclamation, except for the factors under study.

Studied characters:

A. Vegetative growth characters:

After approximately 103 days from the transplanting, samples of 5 plants were randomly taken from each experimental unit to determine the following growth characters:

1. Number of leaves/pant.
2. Leaves weight/plant.
3. Plant weight.

B. Yield and its component:

After approximately 120 days from the transplanting (harvesting stage), samples of 5 heads were harvested from each experimental unit to determine the following parameters:

1. Head weight.
2. Total yield/fed.

C. Chemical constituents in the leaves and heads:

Dry matter percentage (%): The plant samples (leaves and heads) were weighed as fresh weight and oven dried at 70 °C until constant weight and weighted, then dry matter percentage in leaves and heads was calculated.

D. Quality parameters of heads:

1. Total sugars percentage (%): It was determined according to the method of Forsee (1938).

2. Vitamin-C content "ascorbic acid" (mg/100 g FW): It was determined as mg/g fresh weight according to the method reported in AOAC (1990).

3. Nitrate (NO3-N) and nitrite (NO2-N) contents (ppm): It were determined in dry heads as methods described by Singh (1988).

According the strip-plot design, all data were statistically analyzed accorded to the ANOVA technique as available by Gomez and Gomez (1984) and dealing out means were contrast by means of least significant of difference technique at 5 % level of probability as characterized by Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1- Treatments of organic fertilization effects:

As shown the obtained resulted (Tables 3 and 4), treatments of organic fertilization *i.e.* control treatment (without organic fertilization), farmyard manure, compost and humic acid significantly affected cauliflower vegetative growth characters (number of leaves/pant, leaves weight and plant weight after 103 days from the transplanting), yield and its component (head weight and total yield/fed), chemical constituents in the leaves and heads (leaves and heads dry matter percentages) and quality parameters of heads (sugars percentages, vitamin-C, nitrate and nitrite contents in heads) in both seasons.

It is obvious that from obtained results of this study presented in Tables 3 and 4, organic fertilizing cauliflower plants with humic acid at the rate of 20 kg/fed performed better than other organic fertilization treatments (compost and farmyard manure) and resulted in the highest number of leaves/pant, leaves weight, plant weight, head weight, total yield/fed, leaves and heads dry matter percentages, sugars percentages and vitamin-C and the lowest contents of nitrate and nitrite in heads in both growing seasons. The second best organic fertilization treatments was c compost at the rate of 6 m3/fed, followed by farmyard manure at the rate of 20 m3/fed and lastly control treatment (without organic fertilization) concerning its effect on vegetative growth characters, yield and its component, chemical

constituents in the leaves and heads and quality parameters of heads in both seasons.

The increases results may be ascribed to its provides stable supply of both macro- and micronutrients, and improves soil physical, chemical and biological properties, and consequently supports the maximum yield. The superiority of humic acid than compost and farmyard manure might have been due to humic acid is a commercial product recognized as a plant growth promoter contains many elements as shown in Table 2. In addition, humic acid have beneficial effects on soil structure and soil microbial populations as well as increase modify mechanisms involved in plant growth stimulation, cell permeability and nutrient uptake, which was the main reason of enhanced vegetation growth (Ayas and Gulser, 2005). Also, compost have positive effects on the growth of cauliflower, and have great potential to improve vegetable growth, because it supplies with essential nutrients and reduces pollution caused by using mineral fertilizers (Farahzety and Siti-Aishah, 2013). FYM had beneficial effect on nutrient availability in soil due to improvement in soil physical, chemical and microbiological properties. Concerning superiority of compost on vegetative growth characters than farmyard manure, that may be due to its organic matter, organic carbon and total nitrogen were 35.90, 20.90 and 1.51%, while in FYM were 32.70, 19.00 and 1.25 %, respectively and C/N ratio is more suitable for mineralization, moreover it contains P, K, Fe and Zn concentrations are higher than in FYM as shown in Tables 1. These results are in accordance with those observed by Sen *et al.* (2017), Parmar *et al.* (2018), Refai *et al.* (2018), Setyowati *et al.* (2018), Hussein (2019), Mahmood *et al.* (2019), Shams and Farag (2019) and Subedi *et al.* (2019).

Table 3. Number of leaves/pant, leaves weight, plant weight, head weight and total yield/fed of cauliflower as affected organic fertilization treatments and foliar application with some microelements and biostimulants as well as their interaction during 2015/2016 and 2016/2017 seasons.

Characters / Seasons / Treatments		Number of leaves/pant		Leaves weight/plant (kg)		Plant weight (kg)		Head weight (kg)		Total yield (t/fed)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A- Organic fertilization treatments:											
Without		15.00	14.40	0.716	0.758	1.461	1.613	0.745	0.855	7.452	7.950
Farmyard manure		17.33	17.73	1.077	1.156	2.004	2.263	0.927	1.034	9.268	10.338
Compost		19.40	20.53	1.496	1.574	2.468	2.607	0.973	1.094	9.728	11.020
Humic acid		21.60	23.53	1.989	1.906	3.275	3.299	1.286	1.393	12.860	13.933
LSD at 5 %		0.40	0.31	0.027	0.021	0.056	0.045	0.040	0.033	0.399	0.447
B- Foliar spraying treatments:											
Without		16.33	17.50	1.154	1.154	1.995	2.096	0.841	1.390	8.406	9.420
Microelements		20.83	20.66	1.493	1.546	2.615	2.727	1.122	1.588	11.224	11.753
Chitosan		17.58	18.16	1.267	1.244	2.188	2.352	0.921	1.485	9.214	10.894
Algae		18.58	19.58	1.352	1.443	2.383	2.534	1.031	1.770	10.310	11.084
Yeast		18.33	19.33	1.331	1.355	2.329	2.519	0.998	1.680	9.980	10.901
LSD at 5 %		0.72	0.65	0.028	0.024	0.047	0.31	0.030	0.034	0.302	0.433
C- Interaction:											
Without	Without	13.33	13.00	0.495	0.563	1.144	1.376	0.649	0.813	6.490	8.130
	Microelements	17.33	15.66	0.859	0.949	1.774	1.881	0.915	0.932	9.150	9.320
	Chitosan	14.33	13.33	0.686	0.659	1.369	1.510	0.626	0.769	6.255	6.103
	Algae	15.66	15.33	0.794	0.845	1.563	1.684	0.769	0.911	7.690	8.510
	Yeast	14.33	14.66	0.744	0.773	1.454	1.614	0.768	0.851	7.675	7.687
Farmyard manure	Without	15.00	16.00	0.880	0.960	1.694	1.941	0.814	0.981	8.140	9.813
	Microelements	20.00	19.33	1.310	1.366	2.308	2.510	0.998	1.168	9.975	11.203
	Chitosan	16.00	17.33	0.973	1.051	1.825	2.143	0.852	1.052	8.520	10.923
	Algae	18.00	18.33	1.144	1.241	2.129	2.312	0.986	1.148	9.855	11.683
	Yeast	17.66	17.66	1.077	1.164	2.062	2.409	0.985	1.120	9.850	11.477
Compost	Without	17.00	19.00	1.355	1.377	2.206	2.232	0.851	0.855	8.510	8.547
	Microelements	22.00	22.33	1.655	1.774	2.668	2.860	1.013	1.114	10.130	11.143
	Chitosan	19.00	19.33	1.459	1.465	2.435	2.526	0.977	1.053	9.765	10.533
	Algae	20.00	20.66	1.519	1.680	2.505	2.734	1.038	1.086	10.380	10.857
	Yeast	19.00	21.33	1.490	1.571	2.528	2.685	0.985	1.061	9.855	10.610
Humic acid	Without	20.00	22.00	1.887	1.716	2.936	2.835	1.049	1.119	10.485	11.190
	Microelements	24.00	25.33	2.146	2.094	3.710	3.657	1.564	1.563	15.640	15.630
	Chitosan	21.00	22.33	1.948	1.801	3.038	3.230	1.090	1.370	10.897	14.293
	Algae	22.00	24.33	2.012	2.007	3.355	3.395	1.385	1.485	13.847	14.853
	Yeast	21.00	23.66	1.950	1.910	3.334	3.377	1.343	1.429	13.430	13.700
LSD at 5 %		1.08	0.96	0.059	0.042	0.074	0.062	0.062	0.047	0.621	0.769

2- Treatments of foliar spraying effects:

The obtained results of this study (Tables 3 and 4), demonstrate that the studied treatments of spraying significantly affected vegetative growth characters of cauliflower (number of leaves/pant, leaves weight and plant weight after 103 days from the transplanting), yield and its component (head weight and total yield/fed), chemical constituents in the leaves and heads (leaves and heads dry matter percentages) and quality parameters of heads (sugars percentages, vitamin-C, nitrate and nitrite contents in heads) in together seasons.

From obtained results (Tables 3 and 4), it can be seen that, foliar spraying cauliflower plants with mixture of microelements solution (Zn at 200 mg/L, B at 100 mg/L

and Fe at 500 mg/L) three times 30, 45 and 60 days from transplanting exceeded other foliar spraying treatments and produced the highest number of leaves/pant, leaves weight, plant weight, head weight, total yield/fed, leaves and heads dry matter percentages, sugars percentages and vitamin-C and the lowest contents of nitrate and nitrite in heads in together growing seasons. The obtained results because of spraying with mixture of microelements solution, algas, yeast extract and chitosan as a modern trends in fertilizing cauliflower may be due to micronutrients likes; Zn, B and Fe are associated with the carbohydrate metabolism and reproductive phase of the plants along with photosynthesis or various enzymatic activities (Sidhu *et al.*, 2019).

Table 4. Leaves and heads dry matter, sugars percentages, Vitamin-C (VC), nitrate (NO3-N) and nitrite (NO2-N) contents as affected organic fertilization treatments and foliar application with some microelements and biostimulants as well as their interaction during 2015/2016 and 2016/2017 seasons.

Characters / Seasons / Treatments		Leaves dry matter (%)		Heads dry matter (%)		Total sugars (%)		VC (mg/100 g FW)		NO_3-N (ppm)		NO_2-N (ppm)	
		2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A- Organic fertilization treatments:													
Without		13.14	14.333	14.46	15.67	4.18	3.71	42.47	39.66	140.2	127.0	1.833	1.672
Farmyard manure		13.45	14.485	14.85	16.08	4.38	4.06	44.68	42.94	131.6	116.2	1.529	1.405
Compost		13.75	14.787	15.24	16.50	4.59	4.19	46.83	45.47	122.0	109.7	1.215	1.138
Humic acid		14.07	15.161	15.68	16.85	4.78	4.46	49.46	48.82	113.5	101.3	0.928	0.894
LSD at 5 %		0.15	0.21	0.06	0.07	0.09	0.11	0.45	0.36	1.2	1.3	0.039	0.048
B- Foliar spraying treatments:													
Without		13.22	14.37	14.64	15.69	4.24	3.78	44.72	43.18	130.0	116.1	1.549	1.520
Microelements		14.00	15.12	15.48	16.86	4.72	4.41	47.10	45.33	122.8	110.5	1.210	1.053
Chitosan		13.41	14.47	14.85	15.97	4.36	3.93	45.25	43.70	128.7	114.9	1.455	1.381
Algae		13.79	14.85	15.27	16.58	4.61	4.33	46.39	44.75	125.2	112.5	1.308	1.158
Yeast		13.61	14.62	15.06	16.27	4.48	4.08	45.85	44.15	127.3	113.6	1.358	1.274
LSD at 5 %		0.19	0.22	0.05	0.05	0.06	0.08	0.77	0.61	1.4	1.4	0.035	0.037
C- Interaction:													
Without	Without	12.75	13.81	14.04	15.09	3.93	3.43	41.30	38.53	144.3	130.2	2.020	1.803
	Microelements	13.54	14.57	14.89	16.26	4.42	3.99	43.73	40.76	136.4	122.1	1.667	1.480
	Chitosan	12.96	14.90	14.26	15.37	4.06	3.57	41.80	39.13	142.0	129.1	1.910	1.817
	Algae	13.33	14.32	14.65	15.97	4.31	3.86	43.06	40.23	138.0	126.5	1.750	1.573
	Yeast	13.15	14.06	14.47	15.66	4.18	3.72	42.46	39.63	140.2	127.4	1.817	1.687
Farmyard manure	Without	13.07	13.93	14.44	15.48	4.14	3.66	43.63	41.93	135.3	118.5	1.730	1.620
	Microelements	13.84	14.98	15.28	16.70	4.62	4.38	45.76	44.16	127.1	113.8	1.340	1.187
	Chitosan	13.27	14.26	14.64	15.76	4.26	3.80	44.16	42.36	133.6	117.3	1.590	1.507
	Algae	13.64	14.75	15.07	16.38	4.52	4.50	45.26	43.43	129.4	115.0	1.443	1.300
	Yeast	13.44	14.50	14.85	16.07	4.38	3.96	44.60	42.83	132.9	116.1	1.540	1.413
Compost	Without	13.35	14.41	14.84	15.91	4.35	3.88	45.73	44.40	123.0	112.1	1.417	1.357
	Microelements	14.15	15.29	15.66	17.07	4.84	4.51	48.16	46.56	118.2	107.3	1.077	0.917
	Chitosan	13.55	14.51	15.02	16.20	4.46	4.03	46.20	45.00	123.8	110.8	1.297	1.237
	Algae	13.95	14.94	15.46	16.82	4.72	4.33	47.20	46.06	122.4	108.4	1.133	1.023
	Yeast	13.75	14.77	15.25	16.50	4.59	4.19	46.86	45.33	122.6	109.7	1.153	1.157
Humic acid	Without	13.71	14.64	15.26	16.26	4.54	4.16	48.23	47.86	117.4	103.7	1.030	1.300
	Microelements	14.46	15.66	16.09	17.39	5.02	4.76	50.73	49.83	109.7	98.9	0.757	0.630
	Chitosan	13.88	14.92	15.47	16.56	4.67	4.31	48.83	48.33	115.6	102.5	1.023	0.963
	Algae	14.24	15.41	15.91	17.17	4.90	4.62	50.03	49.26	111.2	100.1	0.907	0.737
	Yeast	14.08	15.15	15.68	16.87	4.79	4.46	49.50	48.83	113.6	101.3	0.923	0.840
LSD at 5 %		0.33	0.49	0.16	0.15	NS	NS	0.86	0.68	2.6	2.3	0.172	0.188

While, foliar spraying with algas at 1.0 g/L three times also came in the second rank after microelements treatment and followed by foliar spraying with yeast extract at 100 ml/L and then foliar spraying with chitosan at 2.0 g/L relating to its influence on growth characters, yield and its component, chemical constituents in the leaves and heads and quality parameters of heads in both seasons. These results may be due to algas contains a great number of substances such as; growth promoting regulators (gibberellin and auxin), vitamins, amino acids, polypeptides, antibacterial and antifungal substances that influence plant growth and development (Zaccaro *et al.*, 1999). Besides, foliar application with yeast could be of a great importance for plant growth due to its a rich source of phytohormones (especially cytokinins), vitamins, enzymes, amino acids and minerals (Mahmoud, 2001). Also, Chitosan have fungicidal effects and elicitation of defense mechanisms in plant tissues (Terry and Joyce, 2004), which was reflect on increases in plant growth characters such as number of leaves/pant, leaves weight and plant weight of cauliflower.

The control treatment associated with lowest values of vegetative growth characters, yield and its component, chemical constituents in the leaves and heads and quality parameters of heads in together seasons. These results were parallel with those reported by Moklikar *et al.* (2018), Refai *et al.* (2018) and Ali *et al.* (2019).

3. Interaction effects:

The obtained results (Tables 3 and 4), indicate that there was significant effect due to the interaction between organic fertilization treatments and foliar application with some microelements and biostimulants on vegetative

growth characters of cauliflower (number of leaves/pant, leaves weight and plant weight after 103 days from the transplanting), yield and its component (head weight and total yield/fed), chemical constituents in the leaves and heads (leaves and heads dry matter percentages) and quality parameters of heads (vitamin-C, nitrate and nitrite contents in heads) in both seasons. Vice-versa concerning its effect on sugars percentages in cauliflower heads in together seasons.

The obtained results (Tables 3 and 4), clear that the highest number of leaves/pant, leaves weight, plant weight, head weight, total yield/fed, leaves and heads dry matter percentages, sugars percentages and vitamin-C and the lowest contents of nitrate and nitrite in heads were resulted from organic fertilizing cauliflower soil with humic acid at the rate of 20 kg/fed in addition foliar spraying three times 30, 45 and 60 days from transplanting with the mixture of microelements solution *i.e.* zinc (Zn) at the rate of 200 mg/L, boron (B) at the rate of 100 mg/L and iron (Fe) at the rate of 500 mg/L in both seasons. The second best interaction treatment was organic fertilizing cauliflower soil with humic acid at the rate of 20 kg/fed as well foliar spraying three times too with algas at rate of 1.0 g/L concerning its effect on vegetative growth characters, yield and its component, chemical constituents in the leaves and heads and quality parameters of heads in both seasons. On the other hand, the lowest results of vegetative growth characters, yield and its component, chemical constituents in the leaves and heads and quality parameters of heads were obtained from control treatment of both studied factors (without organic fertilizing with any organic fertilizers under study and without foliar spraying with any treatment) in both seasons.

CONCLUSION

From obtained results of this study it can be concluded that organic fertilizing soil of cauliflower Holland Fargo cultivar with humic acid at the rate of 20 kg/fed in addition foliar spraying three times 30, 45 and 60 days from transplanting with the mixture of microelements solution *i.e.* zinc (Zn) at the rate of 200 mg/L, boron (B) at the rate of 100 mg/L and iron (Fe) at the rate of 500 mg/L in order to obtain high growth, yield and its components, chemical composition and quality.

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تأثير التسميد العضوى والرش ببعض العناصر الصغرى والمنشطات الحيوية على إنتاجية وجودة القنبيط

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أجريت تجربتان حقليتان بحقل خاص بمركز أجا، محافظة الدقهلية ، مصر ، خلال مواسم 2016/2015 و 2017/2016 لدراسة تأثير معاملات التسميد العضوي وهى؛ بدون تسميد عضوى (معاملة المقارنة)، سماد بلدى بمعدل 20 م3 / فدان، كمبوست بمعدل 6 م3 / فدان وحمض الهيومك بمعدل 20 كجم / فدان والرش الورقى ببعض العناصر الدقيقة والمنشطات الحيوية وهى؛ بدون رش ورقى (معاملة المقارنة)، رش ورقى بمحلول العناصر الصغري (الزنك بمعدل 200 ملجم / لتر ، البورون بمعدل 100 ملجم / لتر والحديد بمعدل 500 ملجم / لتر) ، رش ورقى بالشيتوزان بمعدل 2.0 جم / لتر ، رش ورقى بالطحالب بمعدل 1.0 جم / لتر ورش ورقى بمستخلص الخميرة بمعدل 100 مل / لتر على النمو والمحصول ومكوناته ، التركيب الكيميائي وجودة القنبيط صنف هولندا فارجو تحت الظروف البيئية لمحافظة الدقهلية، مصر. وقد أجريت هذه التجارب في تصميم الشرائح المتعامدة فى أربعة مكررات. تم تخصيص الشرائح الرأسية لمعاملات التسميد العضوي. بينما تم تخصيص الشرائح الأفقية لمعاملات الرش الورقى ببعض العناصر الدقيقة والمنشطات الحيوية. ويمكن تلخيص النتائج المتحصل عليها كما يلي:* تشير النتائج التي تم الحصول عليها من هذه الدراسة ، أن نباتات القنبيط المُسمدة عضوياً بحمض الهيومك بمعدل 20 كجم / فدان كانت أفضل من غيرها من معاملات التسميد العضوي (السماد البلدى والكمبوست) وأدت للحصول على أفضل النتائج القيم لصفات النمو الخضري ، المحصول ومكوناته ، المكونات الكيميائية في الأوراق والرؤوس وصفات جودة الرؤوس في كلا الموسمين.* نباتات القنبيط التي تم رشها بخليط من محلول العناصر الدقيقة (الزنك بمعدل 200 ملجم / لتر ، البورون بمعدل 100 ملجم / لتر والحديد بمعدل 500 ملجم / لتر) ثلاث مرات بعد 30 و 45 و 60 يومًا من الشتل تفوقت معنوياً على معاملات الرش الورقي الأخرى وأنتجت أفضل النتائج لصفات النمو الخضري ، المحصول ومكوناته ، المكونات الكيميائية في الأوراق والرؤوس وصفات جودة الرؤوس في كلا الموسمين.* من النتائج التي تم الحصول عليها من هذه الدراسة ، يمكن التوصية بالتسميد العضوى للقنبيط صنف هولاند فارجو بحمض الهيومك بمعدل 20 كجم / فدان بالإضافة إلى الرش الورقي بخليط من محلول العناصر الدقيقة (الزنك بمعدل 200 ملجم / لتر ، البورون بمعدل 100 ملجم / لتر والحديد بمعدل 500 ملجم / لتر) ثلاث مرات بعد 30 و 45 و 60 يومًا من الشتل للحصول على أفضل النتائج لصفات النمو الخضري ، المحصول ومكوناته ، المكونات الكيميائية في الأوراق والرؤوس وصفات جودة الرؤوس تحت ظل الظروف البيئية لمحافظة الدقهلية ، مصر.