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Effect of humic acid and yeast on the yield of greenhouse cucumber

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ABSTRACT

Purpose: Cucumber is a very sensitive plant even under standard conditions, and its fruit, reaches the harvest stage rapidly. In addition to, in Yemen a lot of fertilizer and fungicide chemical have used during the production. For this purpose, effect of exogenously applied of bio-stimulators (humic acid and yeast) was examined. **Research method**: Cucumber HATEM F1 Cultivar was used as plant material. Plants were grown during the clean horticulture practices under polyethylene greenhouse condition. The experiment designed as completely randomized blocks design (RCBD). Humic acid at 0, 100 and 300 mg L^{-1}, as well as yeast at 0, 2000 and 4000 mg L^{-1}, sprayed once alone or in combination. **Findings**: As compared to control, humic at 100 mg L^{-1} alone increased the yield about 14.88%. Yeast at 4000 mg L^{-1} alone offered the significantly ($P \leq 0.05$) highest of the plant (88.2%) and higher yield (91.00%). Yeast at 2000 mg L^{-1} significantly increased leaves DM% (26.6%). Yeast significantly increases chlorophyll SPAD. The interaction of 100 humic × 4000 mg L^{-1} of yeast increased the yield by 168.26% than the control. **Research limitations:** Further studies were needed to clarify the interaction effect of both substances by using the higher modern technique. **Originality/Value:** The finding obtained from this study could probably use to manage and successfully applied to the production of organic cucumber. Moreover, it could be suggested that the combination between yeast at 4000 mg L^{-1} and humic at 100 mg L^{-1} is the best for the productivity of cucumber.

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the major vegetable crops worldwide and the member of the Cucurbitaceae family. It is the fourth most important vegetable crop after tomato, cabbage, and onion (Tatlioglu, 1993). According to FAO (2016), the estimated total world production in 2016 was about 80,616,692 tons with a planting area of about 2,144,672 ha. In Yemen, the cultivated area and production in 2011 have stimulated about 1,195 ha and 17,897 tons, respectively.

Cucumber is a primary source of vitamins and minerals in the human diet, although its calorie and nutritional value are very low (Mah, 1989). In addition, it has a high medicinal value forhuman. It is well known for natural diuretic and thus can serve as an active drug for secreting and promoting the flow of urine. Due to the high content of potassium (50-80 mg/100g), cucumber can be highly useful for high and low blood pressures (Waseem et al., 2008). Compared with many vegetable crops, cucumber reaches the harvest stage rapidly, and its fruit products are using not only for fresh eating and culinary cooking but also for salad and pickling (Kadans, 1979).

Foliar sprays of bio-stimulant as humic and yeast substances have promoted the growth and increases yield and quality in a number of plant species (El-Nemr et al., 2012; Karakurt et al., 2009; Yildirim & Yapici, 2007). It increasing nutrient uptake, serving as a source of mineral plant nutrients and regulator of their release (Atiyeh et al., 2002; Chen et al., 1990; El-Nemret al., 2012). Likewise, humic substances have been shown to stimulate shoot and root growth and nutrient uptake of vegetable crops (Akinremi et al., 2000; Cimrin & Yilmaz, 2005; Tattini et al., 1990). At low concentrations, humic substances enhance cell elongation in excised pea root segments, increase algal and microbial growth, but works as inhibitors at higher concentrations (Bhardwaj & Gaur, 1970; Tan & Nopamornbodi, 1979).

In addition, all bio-stimulators have beneficial effects on plants under stress situations. The bio-stimulators can be applied in the root zone or on the leaves. It should be investigated which treatment is the most effective one (Boehme et al., 2005).

Abdel Nabiet al. (2014) showed that foliar spraying of cantaloupe plants with yeast extract at 5g L^{-1} significantly surpassed other treatments (without treatments, spraying with EM or Agrispon) and produced the highest values of all studied parameters of growth and yield. Ahmed et al. (2013) showed that increasing of foliar application of active yeast extracts up to 4 g L^{-1} improved the vegetative growth characters of potato plants as expressed as plant length, stems, leaves number/plant, leaf area/plant, fresh and dry weights of the whole plant as well as gave the highest total tuber yield. El-Nemr et al. (2012) found that spraying HA and bio-stimulators through foliar application led to a positive effect on plant growth, fruit-set, yield quantity and quality of cucumber plants. Shehata et al. (2012) studied the effect of foliar application of yeast rates (1, 2, 3 or 4 g L^{-1}) on cucumber yield and its component and showed that active dry yeast increased significantly cucumber yield, number of fruits/plant, average weight of fruit, fruit length and fruit diameter.

Therefore, cucumber, which is a very sensitive plant even under standard conditions, and its fruit reaches the harvest stage rapidly, and also a lot of fungicide have used during its production period. So, this study is aimed to examine the influence of exogenously applied of bio-stimulators as humic acid and yeast on fruit yield and quality of cucumber plants grown under cleaning horticulture practice conditions.

MATERIALS AND METHODS

Plant material and growing practices

This study was conducted at Sana'a University, Faculty of Agriculture, Yemen. Cucumber Beta-Alpha (HATIM F1) cultivar was obtained from Al-hadah Trade and Agencies Est. Seeds of the plants were sown in polyethylene greenhouse, the soil of the greenhouse was prepared with six rows bed, each row bed considers as a replicate (block), the wide of each row was 70 cm., The seeds planted with 40 cm distance between each one with two plants in width of row bed. Completely randomized blocks design (RCBD) was used as the design of this experiment. Plants were grown under clean horticulture practices (no poison chemical). Fresh cow milk at 10% was used as an anti-fungal disease, and Azadirachti oil product was also used. Removing of the affected leaf was one of the practices ussed. The plants were grafting as a single stem.

Treatments and parameters

After one month of growing, plants sprayed once with humic acid or yeast alone and in combination. Three levels of each factor were applied, 0, 100 and 300 mg L^{-1} of humic acid (Potassium Humate, content 80% humic acid) while 0, 2000 and 4000 mg L^{-1} of yeast (Table 1).

Table 1. The nutritional yeast contains 18 amino acids and 15 minerals†

Minerals	Unit	Value per 100 g	Amino Acids	Unit	Value per 100 g	Vitamins	Unit	Value per 100 g
Calcium, Ca	mg	30	Tryptophan	g	0.54	vitamin C	mg	0.3
Iron, Fe	mg	2.17	Threonine	g	1.99	Thiamin	mg	10.99
Magnesium, Mg	mg	54	Isoleucine	g	1.89	Riboflavin	mg	4
Phosphorus, P	mg	637	Leucine	g	2.92	Niacin	mg	40.2
Potassium, K	mg	955	Lysine	g	3.28	Pantothenic acid	mg	13.5
Sodium, Na	mg	51	Methionine	g	0.59	Vitamin B-6	mg	1.5
Zinc, Zn	mg	7.94	Cystine	g	0.5	Folate, total	µg	2340
Copper, Cu	mg	0.436	Phenylalanine	g	1.75	Folate, food	µg	2340
Manganese, Mn	mg	0.312	Tyrosine	g	1.13	Folate, DFE	µg	2340
Selenium, Se	µg	7.9	Valine	g	2.31	Choline, total	mg	32
Lipids			Arginine	g	2.03	Betaine	mg	3.4
Fatty acids, total saturated	g	1.001	Histidine	g	0.91	Vitamin B^{-1}2	µg	0.07
12:00	g	0.049	Alanine	g	2.32	Vitamin K	µg	0.4
16:00	g	0.706	Aspartic acid	g	4.15			
18:00	g	0.246	Glutamic acid	g	6.47			
Fatty acids, total monounsaturated	g	4.309	Glycine	g	1.93			
16:1 undifferentiated	g	2.289	Proline	g	1.65			
18:1 undifferentiated	g	2.02	Serine	g	1.98			
Fatty acids, total polyunsaturated	g	0.017						
18:2 undifferentiated	g	0.017						

† The nutritional yeast according to Nutrient Data Laboratory, ARS, USDA (2007). The nutritional value of yeast per 100 mg of dry yeast.

Four plants used per experimental unit. After 3 months of applied the treatment, plant height was measured by using tab measurement, fruit °Brix (TSS%) was recorded using a hand-held refractometer. Chlorophyll was recorded by using SPAD 502 chlorophyllmeters, and percent of dry matter of leaves. The leaves were dried under room condition and the dry weight was recorded when the weigh staple. Fruit harvested according to the customer market needed with the kg content about 20-25 fruits. Harvested fruit number and weight per plant was recorded and arranged weekly and the week was conceder as the factor. Leaf dry matter percent content was measured according to the following formula (1):

$$\text{Dry matter (DM) \%} = \frac{\text{dry weight}}{\text{fresh weight}} \times 100 \qquad (1)$$

Data analysis

All obtained data were statistically analyzed according to the technique of analysis of variance (ANOVA) by using Genstat (version 12.1, VSN, International, Ltd., UK, 2009) statistical program. Least Significant Difference (LSD) method used to test the differences between treatment means at the 0.05 level of probability and the mutable range Duncan used to test the means of interaction factors (yeast × humic acid) and (yeast × humic acid × week).

RESULTS

In general, application of humic acid and yeast led to increasing the yield (number and weight) of cucumber as shown in Table 2 and Figure 4. Application of 1 mg L^{-1} humic acid (alone) increased the yield by 14.88% than control. It was recorded that application of yeast (4000 mg L^{-1}) alone resulted significantly ($P \leq 0.05$) higher yield 91.00% than the control treatment (Table 2).

Table 2. The effects of humic, yeast on plant height, leaf dry matter, TSS and SPAD value of cucumber

Source of variation		Plant height (cm)	DM (%)	TSS (Brix%)	SPAD value
Humic		0.005	<.001	<.001	0.032
0		196.10^{b}†	14.43^{b}	3.572^{b}	46.06^{a}
100		219.10^{a}	13.09c	3.231c	42.84b
300		210.00^{a}	15.96a	3.756^{a}	43.92^{ab}
L.S.D$^{0.05}$		12.096	1.25	0.1182	no
Yeast		0.016	<.001	0.004	0.007
0		197.2^{b}	12.97^{b}	3.418^{b}	42.04^{b}
2000		213.4^{a}	16.42^{a}	3.472^{b}	46.24^{a}
4000		214.5a	14.09^{b}	3.669^{a}	44.54$_{a}$
L.S.D$^{0.05}$		12.096	1.25	0.1182	2.338
Humic × Yeast		0.002	0.005	<.001	<.001
0	0	161.5 ^{c}	13.4^{bc}	3.100^{e}	37.08^{e}
0	2000	205.8b	15.15b	3.746bc	49.93a
0	4000	220.8ab	14.74b	3.869b	51.17a
100	0	218.6ab	11.43c	3.493d	47.23ab
100	2000	228.1a	14.1b	3.167e	42.97c
100	4000	210.6ab	13.73b	3.033e	38.33de
300	0	211.6ab	14.08b	3.661cd	41.80cd
300	2000	206.4b	20.02a	3.504d	45.83bc
300	4000	212.0 ab	13.79b	4.104a	44.13bc
Duncan's MRT		20.952	2.164	0.2047	4.05

†Means with different alphabet in same column indicate significant differences (P < 0.05).

Table 3. Probability values for the effects of humic, yeast and weeks on fruit weight and number of cucumber

Source of variation	Fruit weight (g/plant)	Fruit number/plant
Humic	0.024	0.024
0	2055[b]†	41.1[b]
100	2360.8[a]	47.2[a]
300	2004.4[b]	40.1[b]
L.S.D$^{0.05}$	274.2	5.48
Yeast	<.001	<.001
0	1556.4[c]	31.1[c]
2000	1891[b]	37.8[b]
4000	2972.8[a]	59.5[a]
L.S.D$^{0.05}$	274.2	5.48
Week	<.001	<.001
2	788.2[e]	15.8[e]
4	1548[d]	31[d]
6	2405.2[c]	48.1[c]
8	2845.2[b]	56.9[b]
10	3113.8[a]	62.3[a]
L.S.D$^{0.05}$	354	7.08
Humic×Yeast	<.001	<.001
Humic×Week	0.464	0.464
Yeast ×Week	0.01	0.01
Humic×Yeast ×Week	0.8	0.8

†Means with different alphabet in same column indicate significant differences ($P < 0.05$).

The combined effect of yeast and humic acid (humic acid × yeast) showed a significant ($P \leq 0.05$) increase in yield, where 100 humic acid × 400 mg L^{-1} of yeast increased the yield of cucumber about 168.26% compared to the control, while no significant difference was found with application of yeast alone at 4000 mg L^{-1}.

The effect of humic acid on weight and number of fruit per plant was recorded as significant after four weeks of harvest, the humic acid (200 mg L^{-1}) lose its significance after sixth week. The effect of yeast showed its significant difference in the 2nd week of the application as mentioned in Figures 2 and 3. Nevertheless, no significant difference was noted on theinteraction of humic acid × yeast × weeks (Table 2).

A significant difference was observed by humic acid and yeast during the weeks (Fig. 2 and 3) whereas no difference was noted as significant by the interaction of humic acid × yeast × weeks (Table 2). Application of humic acid and yeast (alone) resulted as an increase in TSS level of fruit, However, the highest concentration of both bio-stimulate (300 mg L^{-1} humic acid × 4000 mg L^{-1} yeast) was produced by the similar response of yeast separately. At higher concentration humid and yeast combination decreased the achievement of yeast in terms of TSS when compared to the application of yeast separately.

Application of humic acid at 200 mg L^{-1} lead to a reduction in the level of chlorophyll while no significant difference was observed between control and higher concentration of humic acid treatments. Meanwhile, the application of yeast had a significant increase in the content of chlorophyll, 4000 mg L^{-1} produced about 6% more than control. However, the effects of both substances showed that the humic acid led to the declined effect of yeast extract. Where, the interaction of both bio-stimulant gave the lower value of chlorophyll with no significant difference when compared to control treatment.

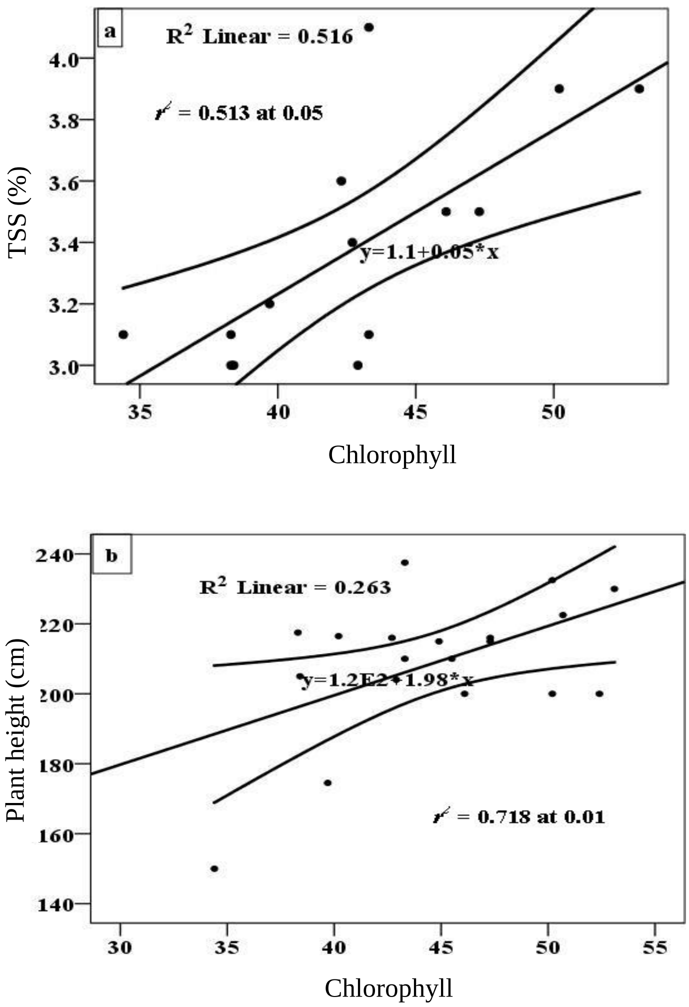

Fig. 1. The correlation between chlorophyll, TSS (a) and plant height (b)

Application of humic acid increased the plant height. Humic acid at 100 mg L^{-1} increased the plant height about 10.50% more than control, with no significant difference between the two concentrations of humic acid. Furthermore, application of yeast at a level of 4000 mg L^{-1} presented the significance in plant height (18.22%) when compared to the control treatment as shown in Table 2. However, the interaction effect showed that the application of yeast alone presented an equivalent value by an application on a combination with the humicacid. Meanwhile, the combination of humic acid (100 mg L^{-1}) with 2000 mg L^{-1} yeast led to increasing the exploit of yeast with no significance applied with 100 mg L^{-1} humic acid alone. Effect of humic acid and yeast eitheralone or in combination, in terms of the leaves dry matter (DM%) revealed that humic acid at 300 mg L^{-1} gives the highest value of dry matter 10.6% more than control. Application of yeast in 2000 mg L^{-1} was also significantly increased the leaves DM % with about 26.6% higher than the control treatment. However, the interaction effect of 300 mg L^{-1} humic acid× 2000 mg L^{-1} yeast gives the significantly higher value (20.02%) of leave DM % when compared with those in a single application of each substance. By contrast, the same interaction treatment gives the lowest value of chlorophyll.

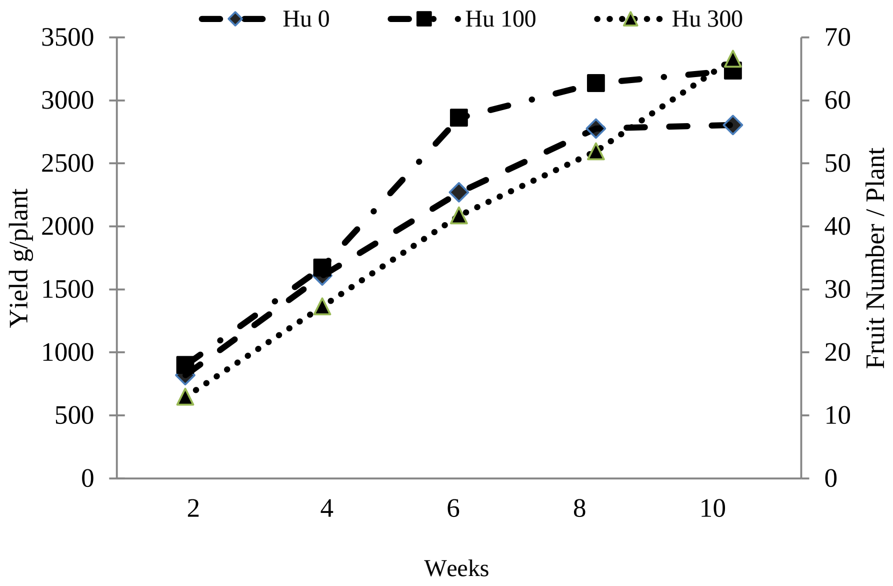

Fig. 2. The interaction effect of humic and weeks on yield and fruit number per plant

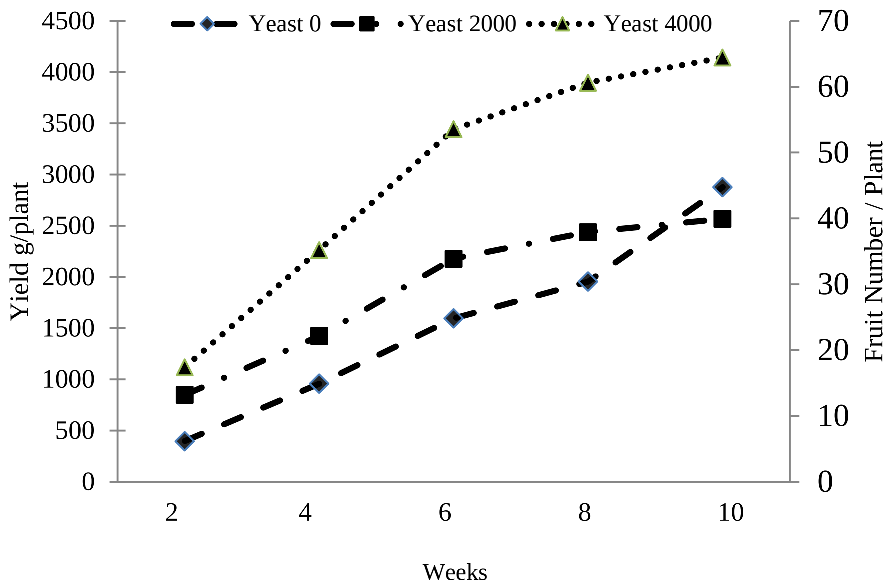

Fig. 3. The interaction effect of yeast and weeks on yield and fruit number per plant

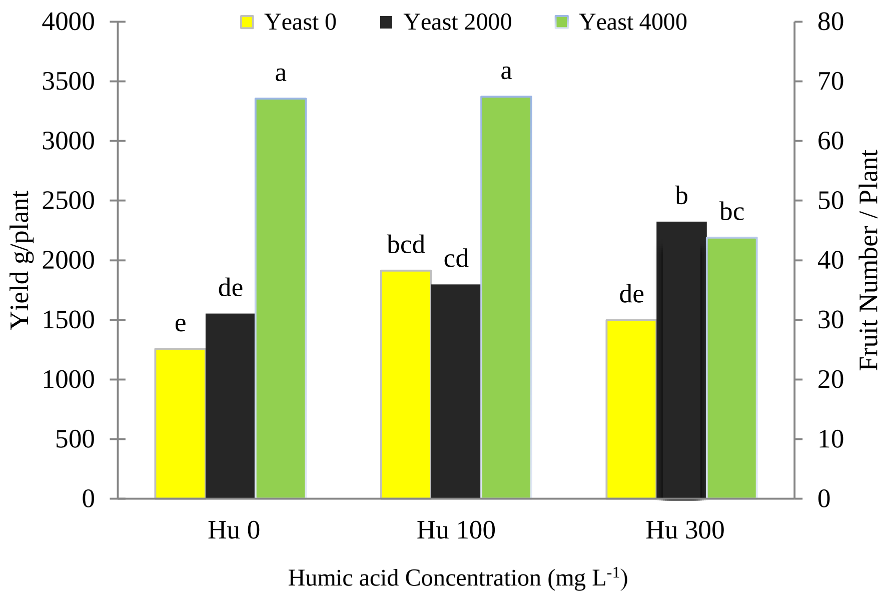

Fig. 4. The interaction effect of humic acid and yeast on yield and fruit number per plant

DISCUSSIONS

Preceding study and research confirmed that humic substances had a beneficial effect on plant physiology. It was noted that it had direct effects on cell membrane permeability, respiration, nucleic acid, biosynthesis, ion absorption, hormone and enzyme activity (Chen & Schnitzer, 1978). The indirect effect of the humic acid provides minerals and biochemical substances, increases the microorganisms which carries trace elements and growth promoters (Adani et al., 1998; Boehme et al., 2005; Halime et al., 2011; Tattini et al., 1990). According to Nutrient Data Laboratory, ARS, (USDA, 2007), the nutritional yeast contains 18 amino acids, and 15 minerals and enzyme.

Humic acid was reported to increase plant height. Humic acid plays a vital role to provide minerals, nutrient (nitrogen, potassium and phosphorous) uptake, necessary for plant growth. In addition, it is acting as a source of plant growth regulators, carbohydrates, amino acids, and vitamins. Abbas (2013) reported that humic acid led to increase the level of endogenous substances i.e; cytokinin, gibberellins, and auxin. Additionally, it can also be used as a carrier for trace elements and growth regulators. Thus, increases in nutrient uptake enhanced the vegetative growth of the plant, stimulates plant growth hormones and increasing cell division (Atiyeh et al., 2002).

At the same time, the application of yeast had a significant effect on plant height. A previous study mentioned that the application of yeast extract enhanced vegetative growth of several plants such as potato (Ahmed et al., 2013), tomato (El-Ghamrinyet al., 1999; Khedr & Farid, 2000; Omar, 2003) eggplant (El-Tohamy et al., 2008), sweet pepper (Ghoname et al., 2010). In general, the benefit of yeast was accredited as a natural bio-substance. Yeast has useful nutritional and growth promoting properties. It contains (i), natural growth regulators (hormones) (Abbas, 2013), especially cytokinins, which play an important rule, had a stimulative effect on cell division and enlargement, useful in the synthesis of protein and nucleic acids synthesis (Barnett et al., 1990). And GAs plays its role in promoting cell enlargement, IAA increased plant growth (Fathy & Farid, 1996). (ii), Carbohydrates and sugars (Abbas, 2013). (iii), Amino acids, (Bevilacqua et al., 2008) demonstrated that yeast extract contains growth factors and a relatively larger proportion of free amino acids and short peptides of two-three amino acids long than protein hydrolisates, which consequently an increased the vegetative growth of plants. Additionally, Tryptophan which considered the precursor of IAA, nucleic acids, vitamins like vitamins B1, B2, B3 and B1, enzymes and minerals content (Bevilacqua et al., 2008; Fathy & Farid, 1996; Khedr & Farid, 2000).

Humic acid plays an important role in the percentage of plant dry matter. The current result takes the same direction. Similar findings had been reported on different plants like soybean and peanut (Tan & Tantiwiramanond, 1983), lettuce (Mirdad, 2016), Mint rhizomes (Roosta et al., 2016), *Nigella sativa* (Azizi & Safaei, 2017). Due to acts as a promoting of plant growth hormones, carbohydrates, amino acids and vitamins (Adani et al., 1998; Boehme et al., 2005; Halime et al., 2011; Tattini et al., 1990).

At the same time, yeast had the ability to improve leaf dry matter. Previousreports showed that yeast improves the dry matter of several plants (Abbas, 2013; Dawa et al., 2012; Dawood et al., 2013; El-Sherbeny et al., 2007; EzzEl-Din & Hendawy, 2010; Hanafy et al., 2010; Mady, 2009; Mahmoud et al., 2013; Shafeek et al., 2015; Sharaf El-Din. et al., 2009; Wanas, 2002). Due to the role of yeast on increase of carbon dioxide released through fermentation process effectively activates the photosynthesis and accelerates the biosynthesis of carbohydrates. Thus, the increase in chlorophyll and carotenoids contents may enhance photosynthesis efficiency and also increase in dry matter.

Chlorophyll content plays an important role in plant photosynthesis. Humic acid alone decreased the photosynthetic rate. In fact, the literature indicates that different result regarding the impact of humic acid on chlorophyll accumulation. Liu et al. (1998) evaluated the effect of a commercial preparation of humic acid on the photosynthesis, chlorophyll concentration of creeping bentgrass and reported that chlorophyll content was unaffected by humic acid. Also, EkİnĪ et al., (2015) studied the effect of humic acid applied at different concentrations on tomato and cucumber plants. No statistically significant differences were observed among the treatments in terms of total soluble solids, fruit dry matter, and chlorophyll. In another study, humic substances increased the protein content in leaf, but apparently decreased the chlorophyll content (Ferretti et al., 1991). Roosta et al. (2016) concluded that nano-fertile-treated humic acid contained 60% better chlorophyll and photosynthesis condition and thus carbon fixation was carried out well. The study by Yang et al. (2004) describes that humic substances (fulvic acid or humin or fulvic acid) may accelerate the chlorophyll degradation of litter in the ecosystem. The chlorophyll a and b may be different enzymes depends on the type of humic substances, despite their soil sources, stimulate the activities of both chlorophylls a and b. However, Yang et al. (2004) reported that the type of humic substances may inhibit the biosynthetic pathway of chlorophyll, stimulate the degradative pathway of chlorophyll, or both. Compared with another type of humic, fulvic acid stimulates and activity more chlorophyllase, humic acid stimulates more an activity of chlorophyllase b, and humin exhibited the least effect on chlorophyllase a and b. This could probably explain why humic acid decreased the total chlorophyll.

Application of yeast significantly improved chlorophyll. Dawood et al. (2013) reported that the application of yeast on soybean significantlyincreaseed the level of chlorophyll. Overall, the increase in chlorophyll pigment could be attributed to the role of yeast. Cytokinins delay the aging of leaves by reducing the degradation of chlorophyll and enhancing the protein and RNA synthesis by affecting the balance between photosynthesis and photorespiration in plants (Olaiya, 2010; Shalaby & El-Nady, 2008) and decreased in abscisic acid (ABA) (Abbas, 2013). Moreover, Abbas (2013) reported that applying yeast is beneficial to field bean plants that increased contents of chlorophyll a, b, and total chlorophyll, increased values of leaves endogenous cytokinins, IAA, GA_3, while decreased ABA.

Effect of humic acid on yield has been reported on different plants. Most of the studies describe that the plant yield was improved with the application of humic acid. For example; on cabbage (Abbas & Hammad, 2016), on apple (Bahrami et al., 2015), on King Ruby (Belal, 2015), on strawberry (Dolatiyan et al., 2016), on tomato (Husein et al., 2015), on Pepino (Javanmardi & Shahian, 2017), on Crisphead lettuce (Mirdad, 2016), on okra (Nadeem et al., 2017; Suhail & Obaid, 2016). In the other study, humic acid led to a decrease or no effect on the plant yield. The study introduced by Barzegar et al. (2016) revealed that application of humic acid on okra under that deficit irrigation zone significantly decreased the fruit yield.

In the current study, the application of the humic acid increased the yield of cucumber. Moreover, the role of the humic acid in terms of increasing yield probably due to increase the average of single fruit weight as found by EkİncĪ et al. (2015), who found that humic acid treatments applied at different rates positively affected the total marketable yield, average fruit weight, fruit diameter, fruit length of tomato and cucumber. While in the current study, yield was recorded according to the market needed (20-25 fruits Kg^{-1}). Otherwise, some studies also reported that the significant effect of humic acid was observed on time and number of the application like the study by Shahin et al. (2015). Also, Shehata and EL-helaly (2010) found that the higher level of humic acid arrested or decreased the snap beans yield and growth. However, application of humic acid at 300 mg L^{-1} had no effect on the yield when compared with control the same as the chlorophyll content. Yang et al. (2004) reported that reduces chlorophyll accumulation and photosynthesis, which, in turn, reduce yield and total plant growth. That could explain why the humic led to reduce the yield of cucumber.

At the same time, application of yeast significantly improved yield. In many studies, have been shown that the yeast increasing yield of several plants. Moreover, yeast extract was suggested to participate in a positive function during vegetative and fruiting growths through improving flower formation and their set in some plants due to its high level of hormones like auxin and cytokinins content and enhancement carbohydrates accumulation (Barnett et al., 1990). In addition, its attributed to the favorable influence on metabolism and biological activity and stimulating effect on photosynthetic pigments and enzyme activity, which in turn encourage yielding plant (El-Sherbeny et al., 2007; Wanas, 2002). On the other hand, yeast enhances the level of potassium uptake, which is a major plant nutrient and required by the plants in large amount.

Actually, potassium is essential for a variety of processes such as photosynthesis, fruit formation, winter hardiness, and disease resistance. It could also explain the reason for increased weight and number of the fruits when treated with yeast.

Total soluble solid is one of important factor considered as quality parameters. In this study, the application of humic acid increased the level of fruit TSS. Previous reports had confirmed the beneficial effect of humic substances on the percentage of TSS. EkİncĪ et al. (2015) reported that no statistically significant difference was observed among the treatments in terms of total soluble solids, on tomato and cucumber. Javanmardi and Shahianin (2017) was also reported no significant difference of humic acid treatments in terms of total soluble solids on tomato. In another studies, humic acid increased the level of TSS%, in apple (Bahrami et al., 2015) and in grapevine (Mohamadineia et al., 2015).

At the same time, application of yeast increased the level of fruit TSS%. In fact, yeast has stimulating on photosynthetic pigments and enzyme activity, which had a beneficial effect on carbohydrate accumulation (Barnett et al., 1990; El-Sherbeny et al., 2007; Mady, 2009; Wanas, 2002). Various studies showed that the yeast increasing level of TSS and carbohydrate. Mady (2009) found that yeast extract gave the best values of total sugar content and its beneficial effect on carbohydrate accumulation in leaves of field bean. Spraying yeast solution increased the vegetative growth characters, yield/plant, tubers dry matter percentage and total soluble solids (Ahmed et al., 2013). Yeast extract enhanced partitioning of photoassimilates from leaves (source) to flowers and immature fruits (sink) (Hopkins, 1995). Besides, this enhancement could be an indicator of expectable high yielded fruits (Wanas, 2002). Its contents of cryoprotective agents i.e. sugars, amino acids and several vitamins. That may be able to explain the rationale of yeast action on enhanced fruit TSS%. Meanwhile, fruit is the sink of accumulative of photosynthesis product, the result showed that there was apositive significant correlation between chlorophyll level and TSS% (r^2 = 0.718 at 0.01) (Fig. 1).

Literature shows that little information is available in terms of the interaction of both used substances. Fatma et al. (2015) found that foliar application of 20 g L^{-1} yeast extract plus 60 ml L^{-1} humic acid (contains 2.9%) of apricot gave the best effect on tree yield and increased vegetative growth parameters, total leaf chlorophyll, and improved fruit quality. In This study, interaction method showed that little effect of humic acid with active yeast, which gives the same significant result with application yeast alone as shown on yield, TSS, DM% and plant height or decreased the effect of yeast as observed on chlorophyll. Both bio-stimulant contributed the same mode of action, such as providing mineral and effect on the nucleic acid. The humic acid effect on enzymatic activity and the yeast is content enzymes and vitamins, fatty acid and amino acid. That could possibly the interaction effect related to enzymes, which had a different role for both substances. However, more studies are needed to clarify the interaction effect of both substances by using the higher mode of technology.

CONCLUSION

Individual application of yeast had offered the significantly higher yield. Furthermore, the interaction effect of both substances showed that the humic acid led to enhance the effect of yeast. Nevertheless, yeast enhances the effect of humic acid. It could be recommended that the application of a combination of yeast at 4000 mg L^{-1} with humic acid at 100 mg L^{-1} proved to be the best for higher yield. Further studies were needed to clarify the interaction effect of both substances by using the higher modern technique.

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اثر اسید هومیک و مخمر بر عملکرد خیار گلخانه‌ای

عصام عبدالباسط حیدر المذحجی

چکیده:

خیار یک گیاه بسیار حساس حتی در شرایط رشد استاندارد است. میوه آن به سرعت به مرحله برداشت می‌رسد و علاوه بر آن، در یمن مقادیر زیادی قارچ کش و مواد شیمیایی در پرورش خیار استفاده می‌شود. برای این منظور، اثر محلول‌پاشی با مواد تحریک کننده (اسید هومیک و مخمر) بر خیار گلخانه‌ای مورد بررسی قرار گرفت. خیار رقم حاتم نسل اول به عنوان ماده گیاهی در این آزمایش استفاده شد. گیاهان در شرایط باغبانی پاک تحت شرایط گلخانه‌ای پلی اتیلن پرورش یافتند. آزمایش به صورت طرح بلوک کاملا تصادفی طراحی شد. اسید هومیک در غلظت‌های ۰، ۱۰۰ و ۳۰۰ میلی‌گرم در لیتر و همچنین مخمر در غلظت‌های ۰، ۲۰۰۰ و ۴۰۰۰ میلی‌گرم در لیتر به صورت جداگانه و یا ترکیبی یک مرتبه محلول پاشی شدند. نتایج نشان داد که در مقایسه با شاهد، کاربرد اسید هومیک ۱۰۰ میلی‌گرم در لیتر به تنهایی باعث افزایش عملکرد در حدود ۱۴/۸۸ درصد گردید. مصرف مخمر در غلظت ۴۰۰۰ میلی‌گرم در لیتر به تنهایی بیشترین عملکرد گیاه را موجب شد. مخمر در غلظت ۲۰۰۰ میلی‌گرم در لیتر به طور معنی‌داری موجب افزایش ماده خشک برگ (۶/۲۶ درصد) شد. همچنین مخمر به طور معنی‌داری موجب افزایش سبزینه شد. کاربرد همزمان ۱۰۰ میلی‌گرم در لیتراسید هومیک و ۴۰۰۰ میلی‌گرم در لیتر مخمر عملکرد را به میزان ۱۶۸/۲۶ درصد نسبت به شاهد افزایش داد. یافته‌های حاصل از این مطالعه احتمالا می‌تواند برای مدیریت و موفقیت در تولید خیار ارگانیک استفاده شود. علاوه بر آن، می‌توان گفت که تیمار ترکیبی ۱۰۰ میلی‌گرم در لیتراسید هومیک و ۴۰۰۰ میلی‌گرم در لیتر مخمر بهترین تیمار برای تولید خیار گلخانه‌ای می‌باشد.

کلمات کلیدی: مواد تحریک کننده زیستی، خیار، محلول‌پاشی برگی، عملکرد