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EFFECT OF HUMIC ACID AND MAXIGROW (ORGANIC FERTILIZER) ON GROWTH, FLOWERING AND YIELD OF SNAKE CUCUMBER (CUCUMIS MELO. L)

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ABSTRACT:

A field trial was implemented at the research center field at general directorate of agriculture, Dohuk Governorate, Iraqi Kurdistan region in summer season of (2022-2023) to find out the impact of foliar application of humic acid at three levels (0, 2, and 4) ml L^{-1} and Maxigrow (an organic fertilizer) with three levels (0, 1, and 2) ml L^{-1} and their combinations on outgrowth, flowering and harvest of local snake cucumber. The experiment was organized following a randomized complete block design (RCBD) including three replicates. The data displayed that the individual dose of humic acid at (4) ml.L^{-1} significantly enhanced foliage traits [number of branches, stem diameter (cm), Leaf area (cm^2), plant fresh weight (g), and chlorophyll content (SPAD)] as well as increased flowering characters [number of flowers after 30 days and number of flowers after 40 days] and yielded components [fruit length (cm), fruit diameter (cm), and total yield (ton.ha^{-1})]. The same profound effect was exhibited by the singular dose of Maxigrow at concentration (2) ml.L^{-1}. However, the highest mean values were produced from humic acid at concentration (4) ml.L^{-1} in combination with Maxigrow at concentration (2) ml.L^{-1} in comparison with control. The increased level of humic acid and Maxigrow is advised for organic productivity of local snake cucumber.

KEYWORDS: snake cucumber, humic acid, Maxigrow, organic production.

1. INTRODUCTION

Snake cucumber (Cucumis melo L) is a desirable crop belonging to the Cucurbitaceae family. It is characterized as a tall, slender fruit with taste resembles that of cucumber and is approximately similar to a cucumber inside and consumed immaturely as a substitute to cucumber (Nuñez *et al.* 2008). It is considered as a significant crop, particularly in areas such as the Middle East and North Africa. Snake cucumber has also several other names like Chinese, Oriental, Armenian, serpent cucumber (Splittstoesser, 1990). In fact, it is rendered as a kind of muskmelon (*C. melo*), a species which is correlated to the cucumber (*C. sativus*). Its skin iistinguished with so thin and bumpless. It is not bitter and the fruit is usually consumed without being peeled (Abdel-Ghani and Mahadeen 2014).

In recent years, the application of natural products known as bio-stimulant gained more attention in the vegetable production around the world for the purpose of protecting plants from environmental stresses and to stimulate plant growth and productivity (Majkowska-Gadomska *et al.*, 2019). Humic acid is a recognized as an organic substance produced from animal and plant remnants that degraded and transferred by microbes via a chain of geochemistry activities (Khan *et al*., 2017). When interacted with different other fertilizers, humic acid can undertake a prominent role in amelioration of the soil quality, increase of fertilizer utilization rate, and motivate crop harvest and quality (Selladurai *et al.*, 2016; Ahmad *et al*., 2017; Suman *et al*., 2017). Furthermore, humic acids can boot crop vegetative parts through improving plant hormones required for outgrowth such as auxin and cytokinin, which helps combat to stresses, metabolism of nutrients, and photosynthesis (Canellas *et al.*, 2020; Laskosky *et al.*, 2020; Nardi *et al.*, 2021; Val Tol de Castro*et al.*, 2021). The efficient influence of humic acid on plant was investigated in many studies. Hamail *et al.* (2014) demonstrated that foliar feeding of cucumber plants with numerous biostimulants including humic acid resulted in a marked amelioration of the number of female flowers, fruit set and whole yield. Shafeek *et al*. (2016) confirmed that the foliar and ground addition of humic acid importantly elevated vegetation and harvest attributes of cucumber crop raised under plastic house condition as compared with control. Ullah *et al.* (2019) unveiled that adding humic acid at the rate of 1.5% importantly enhanced growth, yield and chemical composition of cucumber crop relative to control.

In organic farming systems, various commercial preparations called plant outgrowth activators were utilized in agricultural sector. Such products contained varied growth stimulating substances particularly amino acids and seaweed extracts. Seaweeds are valuable bio stimulants manufactured from sea algae. Such extracts are obtainable either as highly soluble powder or aquatic products given as foliar sprays or added to the soil (Battacharyya *et al.*, 2015). Seaweed extracts are natural preparations enriched with different active materials like sugars, molecules with high N content, plant growth regulators and many nutritive elements which enhance plant outgrowth and yield and protects plants against environmental stressful conditions (Khan *et al*2009; Craigie 2011). Numerous studied displayed an effective role of seaweed on plant outgrowth and harvest income. Obeid *et al.* (2011) found that the application of seaweed extract and growth organizer (Atonik) significantly enhanced growth, flowering and yield attributes of cucumber. Ahmed & Shalaby (2012) displayed that treating cucumber plants with some seaweed extracts species in combination with compost significantly increased foliage and yield characters of plant relative to control. El-Sagan (2015) revealed that the foliar application of algae extract at a concentration of (1.5 mg/L) resulted in a remarkable increment in cucumber foliage and yield of cucumber (*cucumis sativus* L.) plants in comparison with control.

2. MATERIALS AND METHODS

The field trial was conducted at the research center, General Directorate of Agriculture, Duhok City, Iraqi Kurdistan region during the summer season of (2022-2023). The seeds of

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local snake cucumber were sown on March 15th. The study encompassed foliar application of humic acid at three concentrations (0, 2, and 4) mg L^{-1} and foliar addition of Maxigrow product with three levels (0, 1, and 2) mg.L^{-1} and their interferences. The humic acid and Maxigrow were sprayed three times. The first one was implemented on April 20th with ten days between spray and spray. The branch number was enumerated at the middle of growing season. The stem diameter was calculated by measuring bar. The leaf area was recorded with leaf area device. The plant fresh weight was estimated with sensitive balance. The chlorophyll was estimated by chlorophyll meter apparatus (SPAD-502, Konica Minolta). The number of flowers was counted at the 30th and 4th day from planting. The fruit length and diameter were calculated by the measuring bar. The number of fruit plant^{-1} was done by enumeration of fruits harvested from plant and then the average was counted. The fruit weight was determined using sensitive balance. The total yield was calculated as yield per experimental unit (ton) subdivided by area of experimental unit multiplied by (8800). The experiment was designed according to randomized complete block design (RCBD) and the data were analyzed using SAS (2010). Means Comparison was performed by Duncan's multiple range tests at 0.05% level.

3. RESULTS AND DISCUSSION VEGETATIVE GROWTH CHARACTERS

3.1 Chlorophyll content (SPAD)

Results respective to the content of the green pigment (chlorophyll) showed effectiveness of humic acid and Maxigrowin improving this parameter. In term of individual mean effect, plants received humic at (4) ml.L^{-1} possessed the peak chlorophyll content (115.67 SPAD) relative to control (95.55 SPAD). Regarding the Maxigrow effect, the highest mean content (120.36 SPAD) was calculated for plants given this organic product at (2) ml.L^{-1} as compared to control (97.49 SPAD). In case of dual interaction, the highest mean content (134.883 SPAD) was measured in leaves of plant given the humic acid at (4) ml.L^{-1} + Maxigrow at (2) ml.L^{-1} as matched to the fewest content (99.283 SPAD) which belonged to the control.

3.2 Plant fresh weight (kg)

The data analysis of plant fresh weight of snake cucumber demonstrated that the foliar application with humic product and Maxigrow organic fertilizer caused a significant increment in the fresh mass of snake cucumber relative to control. The individual effect of humic acid showed supremacy on plant fresh and plants treated with humic acid at (4) ml.L^{-1} had the best fresh weight (3.14) kg relative to control (2.04) kg. Similarly, the utmost mean content (3.02) kg was measured for plants sprayed with the organic product at concentration (2) ml.L^{-1} as matched to control (2.17) kg. In status of bi-lateral effect of factors, providing plants with humic at (4) ml.L^{-1} and Maxigrow at concentration (2) ml.L^{-1} resulted in the best fresh weight (3.117 kg) in comparison with the minimum mean value (2.010 kg) being counted for control plants.

3.3 Stem diameter (cm)

According to Table (1), there were marked variations in the stem diameter of snake cucumber attributed to the application of both factors as matched to control. The single dose of humic acid significantly influenced stem diameter that was evident in plants dosed with humic acid at (4) ml.L^{-1} having the thickest stems (3.11) cm over control (2.10) cm. Respective to sole impact of Maxigrow, the utmost mean diameter (3.21) cm was measured for plants sprayed with the organic product at concentration (2) ml.L^{-1} as matched to control (2.20) cm. Meanwhile, the combination of humic acid and Maxigrow markedly increased such character with the peak mean average (3.400 cm) was recorded for plants received humic acid at dose (4) ml.L^{-1} and Maxigrow at concentration (2) ml.L^{-1} whereas the least mean (2.300 cm) was estimated for plants have had no humic or Maxigrow (control).

3.4 Number of branches

Results in table (1) displayed significant differences in branch number under provision of humic acid and the organic fertilizer Maxigrow along with their interactions. Concerning individual mean effect, plants delivered humic at (4) ml.L^{-1} possessed the topmost branch number (3.24) relative to control (2.16). On the other hand, the greatest mean number (3.16) was calculated for plants given this organic product at (2) ml.L^{-1} as compared to control (2.41). in case of dual impact, the highest number of branches (3.783) was enumerated for plant received humic acid at concentration (4) ml.L^{-1} and Maxigrow at (2) ml.L^{-1} succeeded by the second important average value (3.633) that was calculated for plants given humic acid at (4) ml.L^{-1} and Maxigrow at (1) ml.L^{-1} in comparison with control (2.233).

3.5 Leaf area (cm^2)

The leaf area of snake cucumber showed positive response to the foliar application of humic acid and the organic product Maxigrow as shown in Table (1). With regards to the individual mean effect, plants foliar fed with humic at (4) ml.L^{-1} owned the maximum leaf area (91.45) cm^2 relative to control (79.50) cm^2. Moreover, the premium mean leaf area (90.25) cm^2 was measured for plants which had Maxigrow at (2) ml.L^{-1} as compared to control (62.74) cm^2. Respective to binary effect of both factors, the maximum mean (95.93) cm^2 was attributed to the humic acid at dose of (4) ml.L^{-1} and Maxigrow at concentration (2) ml.L^{-1} when encountered with the lowest mean (81.492) cm^2 that was owed to no treatment of both of the studied factors.

3.6 Number of flowers after 30 days (flower plant^{-1})

The use of humic acid and Maxigrow on snake cucumber led to a profound amelioration in the number of the flowers after 30 days from transplantation. Providing plants with humic acid at (4) ml.L^{-1} produced the peak number of flower (7.94) in comparison with control (4.92). On the other side, the best mean number of flowers (8.35) was enumerated for plants sprayed with Maxigrow at (2) ml.L^{-1} as matched to control (5.10). Furthermore, the binary interaction of both factors also significantly affected the number of flowers after 30 days and treating plants with the highest humic concentration (4 ml.L^{-1}). In addition, the increased Maxigrow dose (2 ml.L^{-1}) created the greatest number of flowers (10.017) which surpassed other doses and control (5.217) as it is obvious in Table (2).

4. FLOWERING CHARACTERS

4.1 Number of flowers after 40 days (flower plant^{-1})

The earned data unveiled an important impact of foliar sprays of humic acid and Maxigrow and their dual interference on flower number of snake cucumber after 40 days from transplanting. Plants foliar-applied with humic acid at (4) ml.L^{-1} gave the highest number of flower (13.45) in comparison with control (10.5). The same positive impact was exhibited by individual dose of Maxigrow and the maximum mean number of flowers (12.75) was counted for plants treated with Maxigrow at (2) ml.L^{-1} as matched to control (9.86). in state of combined effect, the humic at concentration (4) ml.L^{-1} and Maxigrow at (2) ml.L^{-1} displayed efficacy in producing the largest number (15.583) of flowers pared with the next greatest number (14.233) enumerated as a result of application of Maxigrow at (2) ml.L^{-1} when encountered with control

(11.717).Yield characters Fruit length (cm)

Significant variations were observed in the fruit length under the treatment with humic acid and Maxigrow product in Table (2). Dosing plants with humic acid at concentration (4) ml.L^{-1} led to the production of the longest fruit (38.50) cm as compared with control (29.60) cm. Additionally, the greatest mean fruit length (37.22) cm was calculated for plants sprayed with Maxigrow at (2) ml.L^{-1} relative to control (30.12) cm. Concerning the dual effect, the longest fruits (41.433) cm were recorded for plants which had humic acid at level (4) ml.L^{-1} and Maxigrow at dose (2) ml.L^{-1} whereas the shortest fruits (31.517) cm were measured for plants delivered no humic or Maxigrow as demonstrated in Table (2).

4.2 Fruit diameter (cm)

Results of fruit diameter of snake cucumber displayed a valuable efficacy of humic acid and Maxigrow on such trait. Plants given humic acid at (4) ml.L^{-1} have had the thickest fruit (3.01) cm as compared with control (2.41) cm. Meanwhile, the utmost mean fruit diameter (3.55) cm was estimated for plants provided with Maxigrow at (2) ml.L^{-1} over control (2.51) cm. In term of bi-lateral interaction, the thickest fruits (3.95) cm belonged to plants dosed with humic at (4) ml.L^{-1} and Maxigrow at level (2) ml.L^{-1} as compared to the thinnest fruits (2.550) cm being measured for plants treated with no humic or Maxigrow.

4.3 Fruit weight (g)

Data of fruit weight of snake cucumber unveiled a prominent effect of humic acid and Maxigrow on this parameter. Plants dosed with humic acid at (4) ml.L^{-1} yielded the heaviest fruit (90.50) g relative to control (75.5) g. This was also for the single dose of Maxigrow and the maximum mean fruit weight (94.32) g was measured for plants foliar sprayed with Maxigrow at (2) ml.L^{-1} as matched to control (74.63) g. On the other side, the dual interaction between both factors significantly improved fruit weight with the highest average (99.89) g being calculated for plants received humic at (4) ml.L^{-1} and Maxigrow at level (2) ml.L^{-1} in comparison with control (79.82) g as seen in Table (2).

4.4 Number of fruit plant^{-1}

According to the results in Table (2), the foliar application of humic acid and Maxigrow along with their interactions caused a significant enhance in number of fruit per plant when encountered with control. plants have had humic acid at concentration (4) ml.L^{-1} produced the peak average fruit number (29.55) compared to control (18.60). in case of the individual impact of Maxigrow, the topmost mean average (27.50) was enumerated for plants applied with Maxigrow at (2) ml.L^{-1} when compared to control (15.84). Furthermore, the binary interference between the two factors importantly increased fruit number for each plant and the largest average (33.58) was counted for plants treated with humic at (4) ml.L^{-1} and Maxigrow at (2) ml.L^{-1} over control (20.33).

4.5 Total yield (ton.ha^{-1})

The data on the effect of both natural products on total yield indicated that the dual interaction of humic and Maxigrow markedly improved this trait when compared with control. The single dose of humic acid at (4) ml.L^{-1} produced the highest total yield (147. 86) in comparison with control (136.50) ton.ha^{-1}. The same was true for individual level of Maxigrow at (2) ml.L^{-1} giving the excellent total yield (150.02) ton.ha^{-1} relative to control (139.79) ton.ha^{-1}. In state of binary effect, plant sprayed with humic at concentration (4) ml.L^{-1} and foliar dosed with Maxigrow at (2) ml.L^{-1} owned the maximum mean total yield (157.602) ton.ha^{-1} but the least mean value (130.148 ton.ha^{-1}) belonged to plants without treatment as clarified in Table (2).

Table 1: Effect of humic acid and Maxigrow product on vegetative growth characters of local snake cucumber

Treatments	Chlorophyll content (SPAD)	Plant fresh wt. (kg)	Stem diameter (cm)	No of branches	Leaf area (cm^2)
H0	95.55 c	2.04 c	2.10 c	2.16 c	79.50 c
H2	104.42 b	2.50 b	2.75 b	2.55 b	84.35 b
H4	115.67 a	3.14 a	3.11 a	3.24 a	91.45 a
Maigrow0	97.49 c	2.17 c	2.20 c	2.41b	82.74 b
Maigrow1	107.50 b	2.68 b	2.66 b	2.73 ab	88.92 ab
Maigrow2	120.36 a	3.02 a	3.21a	3.16 a	90.25a
H0 Maxigrow0	99.28 d	2.01 c	2.30 c	2.23 d	81.49 f
H0 Maxigrow1	111.13 Bcd	2.38 bc	3.30 a	3.33 c	81.98 f
H0 Maxigrow2	103.86 cd	2.55 b	2.71 b	3.26 c	85.46 e
H2 Maxigrow0	112.50 bc	2.35 bc	3.31 a	3.35 c	86.05 e
H2Maxigro w1	111.95 bc	2.50 b	3.23 a	3.53 b	89.00 cd
H2 Maxigrow2	106.08 cd	2.66 b	3.35 a	3.58 b	91.35 bc
H4 Maxigrow0	109.81 cd	2.367 bc	2.68 b	3.21 c	87.99 de
H4 Maxigrow1	122.66 c	2.460 b	3.11 a	3.63 ab	92.11 b
H4 Maxigrow2	134.883 a	3.117 a	3.40 a	3.78 a	95.93 a

Table 2: Effect of humic acid and Maxigrow product on flowering and yield characters of local snake cucumber

Treatments	No of flowers 30 days	No of flowers 40 days	Fruit weight (g)	Number of fruit.plant-1	Fruit length (cm)	Fruit diameter (cm)	Total yield ton. ha-1
H0	4.92 c	10.50 c	75.50 c	18.60 c	29.60 c	2.41b	136.50 c
H2	5.88 b	11.92 b	83.35 b	21.42 b	36.71ab	2.89 ab	140.15 b
H4	7.94 a	13.45 a	90.50 a	29.55 a	38.50 a	3.01 a	147. 86 a
Maigrow0	5.10 c	9.86 c	74.63 c	15.84 c	30.12 c	2.51b	139.79 c
Maigrow1	6.23 b	11.20 b	87.90 b	20.69 b	36.43 ab	2.94 ab	144.65 b
Maigrow2	8.35 a	12.75 a	94.32 a	27.50 a	37.22 a	3.55 a	150.02 a
H0 Maxigrow0	5.21 f	11.717 c	79.82 c	20.33 c	31.51 c	2.55 e	130.14 f
H0 Maxigrow1	6.18 ed	13.55 b	81.55 c	22.74 bc	34.26 bc	2.78e	130.69 f
H0 Maxigrow2	8.33 b	14.23 a	88.43 b	26.89 b	35.01 bc	2.93 cd	133.16 f
H2 Maxigrow0	8.53 b	14.017 b	93.50 ab	28.72 ab	37.56 ab	3.41 b	137.36 e
H2Maxigrow1	6.18 ed	9.51 d	90.76 b	25.75	36.86 ab	3.28 bcd	146.92 c
H2 Maxigrow2	5.75 e	8.60 d	95.32 ab	24.97 bc	37.25 ab	3.35 bc	155.75 ab
H4 Maxigrow0	6.58 ed	8.61 d	91.85 b	28.55 ab	36.38 b	2.86 de	142.02d
H4 Maxigrow1	6.73 c	13.61 b	94.67 ab	29.41 ab	38.31 ab	3.65 ab	153.27 b
H4 Maxigrow2	10.01 a	15.58 a	99.89 a	33.58 a	41.43 a	3.95a	157.60 a

It is evident from the results that the foliar spraying of humic acid with concentration (4) $ml.L^{-1}$ and Maxigrow at (2) $ml.L^{-1}$ significantly ameliorated vegetative, flowering and yield characters of snake cucumber relative to control. The increment in foliage attributes might be due to the beneficial impact of humic acid and Maxigrow on photosynthesis rate and plant health and hence its outgrowth. Humic acid contains a wide range of substances such as plant growth promoting hormones, amino acids, vitamins and nourishing elements required for internode elongation and plant growth upward with enhanced photosynthesis rate (Khan *et al.* 2009; Craigie 2011; Yasir *et al*.,2016). Moreover, these substances existed in humic acid can boost plant immunity and capacity to withstand hard eco-stresses and illnesses with improving the whole nutrition (Prakash *et al*., 2018). The same findings were demonstrated by Shafeek *et al.* (2016) who stated that the application of humic acid importantly ameliorated vegetation and harvest traits of cucumber as matched with control. Maxigrow, on the other hand, is enriched with nutrients and seaweed extracts that contain a variety of outgrowth promoter matters including auxins, cytokinins and gibberellins. Auxins undertake a key action in stimulation of root architecture progression and cell division and extension granting premium shoot sprouting; leaf area, plant tallness and plant biomass (Moore 2004; Gollan and Wright, 2006). Our results are in line with those of Sagan (2015) who confirmed that the foliar supplying of algae extract at a concentration of (1.5 mg/L) led to a prominent enhance in vegetation and harvest of cucumber (*cucumis sativus* L.) over control.

The improvement in the flowering traits of snake cucumber could be due to humic acid mimicking hormone and suppressing no. of days passed away from transplanting to blooming (Alkharpotly *et al.*, 2017). Similar outcomes were published by Hamail *et al.* (2014) on cucumber. They showed that spraying cucumber plants with numerous biostimulors including humic acid gave the maximum mean values of the flowering and made fruits to set earlier. Seaweed extracts can also promote flowering through initiation of robust plant growth. Seedlings provided with seaweed extracts set extra flowers earlier than those have had no seaweed (Crouch and Van Staden1992). Our outcomes are in lines with those of Obeid *et al.* (2011) who indicated a significant increase in flowering attributes of cucumber under application of seaweed extract (Algean) and growth regulator (Atonik).

The yield traits were notably greater in plants having seaweed extracts and humic acid at increased doses. This might ascribe to combined positive effect of both of them. Seaweed extracts and humic acid exhibit popularity with containing normal growth organizers, vitamins and several nourishing elements that effectively make plant outgrowth and yield better. The results are conforming to that of Ullah *et al.* (2019) who revealed an important increment in yield parameters of

cucumber with application of humic acid. Ahmed and Shalaby (2012) also displayed that treating cucumber with several types of seaweed extracts resulted in the best yield characteristics as compared to control.

CONCLUSION

The organic growing of significant vegetable crops like snake cucumber is very necessary to meet the consumer demand who usually prefers organic products. In our field study, the combination between humic acid and Maxigrow substance, which are organic inputs, caused a marked enhancement in growth, flowering and harvest of local snake cucumber over control. Therefore, the increased dose of humic and Maxigrow is recommended for organic production of local snake cucumber with further investigations to be performed on these compounds efficacy on more horticultural crops.

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