



Effect of Humic Acid and Gibberellic Acid on Growth, Flowering and Chemical Composition of African Marigold (*Tagetes erecta*)

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ABSTRACT: Pot experiment was carried out at the nursery of private farm Alaejaylat in Libya during 2020 to study the effect of humic and gibberellic acid on the growth, flowering and chemical composition of *Tagetes erecta* L. Seeds of marigold were obtained from local variety (orange flowers) and sown on first of March. After one month, seedlings were transplanted into plastic pots (30 cm in diameter) filled with sand/clay 1:1(v/v). The experiment laid out in randomized block design (RCBD) with three replications, each block contains 10 pots and each pot had one plant. The experiment consists of seven treatments as untreated (control), humic acid (100, 150 and 200 mg/l) and gibberellic acid (50, 100 and 150 mg/l). Growth attributes were determined as vegetative growth such as plant height, number of branches/ plant, leaves fresh and dry weight, flower characters i.e., number of flowers/ plant, flowers fresh and dry weight and chemical composition like Carotene pigments, total carbohydrates and total nitrogen. Results showed that high concentrations of humic and gibberellic acid recorded the best results of all studied characters, however, humic acid at 200 mg/l and gibberellic acid at 150 mg/l achieved the highest mean values all vegetative growth, flower characters and chemical composition as compared with the control treatment which gave the lowest mean values of all studied characters.

Keywords: African marigold (*Tagetes erecta*), humic acid, GA₃, growth, flowering, chemical composition

INTRODUCTION

African marigold (*Tagetes erecta*) is an yearly herbaceous plant having a place to the family Asteraceae (Compositae). It is local to the Mediterranean put and as of now takes put in more noteworthy than a couple of parts of the world since of its versatility. Aside from being developed for decorative purposes, it has numerous unmistakable makes utilize of due to the truth of its chemical composition, which incorporates terpenes, flavonoids, tannins, coumarins, and basic oils (Ashwlayan *et al.*, 2018). Subsequently, marigold may be a profitable plant for the corrective, nourishment, and pharmaceutical businesses (Bragueto *et al.*, 2019). Marigold may be a potential undertaking bloom with developing request within the setting due to its cultural and devout importance (Adhikari *et al.*, 2020). It may be a blooming fancy yearly with lavish branching and blossoming propensity. A few of the vital inconveniences related with development of this edit are apical dominance (Sunitha *et al.*, 2007), stretch in blooming (Sharma *et al.*, 2006) and enhancement of long and inclined stems (Gawle *et al.*, 2012). These in flip come about in destitute yield/economic returns. Be that as it may, arrangement of encompassing climatic prerequisites by means of choice of location,

sensible social operations, adjusted nourishment and physiological controls with the help of squeezing or utility of plant development controllers can too furthermore improve the surrender of the edit.

It is the higher species achieving up to three to four toes in tallness. Simple culture, more extensive versatility, the dependency of free blossoming, brief length to deliver attractive greenery and beneficial returns are the thought processes behind its developing ubiquity. An enormous change of colors, shape, estimate, and fitting holding quality, makes the blossom bigger well-known (Kumar *et al.*, 2010).

Extricate of Marigold can be utilized as a nematicide (Ravindra *et al.*, 2017; Marahatta *et al.*, 2012). Carotenoids extricated from dry petals are utilized for fowl bolsters to improve egg yolk coloration and Broiler's skin (Singh, 2014; Singh and Sisodia, 2017). They are also utilized as a lure edit for controlling unimaginable bugs like tomato natural product borers. Oil extricated from marigold is utilized in fabricating fragrances and creepy crawly repellents. Engendering of this blossom can be wrapped up by means of utilizing seeds or by utilizing softwood cutting. The lessening methodology is in numerous occurrences went with for keeping up the virtue of assortments.

PGRS play a incredible position in vegetative engendering, restraint of abscission, avoidance of bud torpidity, intensify control, and promoting of blooming, drawing out the vase life of blossoms, and impeding senescence (Singh et al., 2018). Exogenous showering of gibberellic acid on invigorates fertilization, fertilization, and seed set to induce most surrender (Dodda goudar et al., 2002). Gibberellic acid moving forward the first-class of the blossom and is utilized to overcome the expand constraining components to tackle most advantage. It too makes a difference to advance plant development, an expanded change of most important and auxiliary branches, conjointly gathered to grow bloom quality and continues uniformity in bloom measure and assortment which within the allow up guarantees higher generation of blooms. Both more prominent and diminish concentrations of exogenously connected gibberellic acid limit the vegetative, blooming, and exceptional parameters as gibberellic acid labored with its full conceivable up to wonderful most valuable acknowledgment and comments hindrance surpassed off past such concentrations.

Natural cultivating is one of the hones which make the fabricating portable workstation bigger economical notwithstanding unfavorable punishments on the characteristic sources and the environment (Kochakinezhad et al., 2014 and Slam et al., 2014). It not exclusively keeps soil richness, but furthermore preserves soil dampness

Soil analysis

Table (1): Analysis experimental soil

Parameter	Value	Unit
Mechanical Analysis		
Sand	55.52	%
Silt	25.00	%
Clay	19.48	%
Textural class	Loamy sand	
pH (1:1)	7.6	-
EC(1:1, water extract)	0.56	dS/m
O. M	5.2	
Soluble cations		
Ca ²⁺	1.52	meq/l
Mg ²⁺	1.2	meq/l
Soluble anions		
HCO ₃ ⁻	0.54	meq/l
SO ₄ ²⁻	17	meq/l

Plant material:

Seeds of marigold *Tagetes erecta* plants were sown on first of March. After one month, seedlings were transplanted into plastic pots (25cm in diameter) filled with sand/clay 1:1(v/v).

Seeds of marigold had been obtained from neighborhood range (orange flowers) and sown on first of March. After one month, seedlings were transplanted into plastic pots (30 cm in diameter) crammed with sand/clay 1:1(v/v).

(Yadav et al., 2014). Natural fertilizers and their extricates embellish soil richness by way of moving forward supplement maintenance and biking and play an basic part in increment and abdicate of plants (Khalid and Shafei, 2005 and Smash et al., 2014).

Application of HA and chemical fertilizers moves forward plant supplement retention (Ayas and Gulser, 2005). HA may be a commercial venture item comprises of numerous components which embellish the soil ripeness and developing the accessibility of supplement variables and as a result influenced plant extend and abdicate (Hartwigson and Evans, 2000). Humic substance underpins making plant life and makes soil additional rich and profitable, will open up soils water protecting capacity; hence, it makes a difference plants to confront up to dry seasons and fortifies seed germination (Hartwigson and Evans, 2000).

The foremost goal of this work is to inspect the impact of humic acid, and gibberellic acid on growth, flowering and chemical composition of African marigold (*Tagetes erecta*).

MATERIALS AND METHODS

Pot experiment was carried out at the nursery of private farm in Libya during 2020 to determine the effect of humic acid (HA) and gibberellic acid (GA₃) on the growth, flowering and chemical composition of *Tagetes erecta* L.

Experimental Design

The experimental laid out in randomized block diagram (RCBD) in three replications, every block incorporates 10 pots and every pot had one plant.

Each pot used to be fertilized twice with 1.5 g N/pot in shape of ammonium nitrate (33.5% N) and 1 g/pot in shape of potassium sulfate (48% K₂O). These fertilizers had been utilized at 30 and 60 days from sowing. Phosphorous (P) as

calcium superphosphate (15.5% P₂O₅) was once
C.3 Carotene pigments

Carotene pigments were determined according to the procedure outlined by **Ramely (1993)**. Carotene was expressed as mg / 100g fresh weight.

Statistical analysis

All the data collected were subjected to statistical analysis using MSTAT package for analysis of variance (ANOVA) of variance as defined with the aid of using **Gomez and Gomez (1984)**. The remedy method had been as compared the usage of L.S.D. check at 0.05 degree of probability.

RESULTS AND DISCUSSIONS

A) Vegetative growth

From the data in **Table (1) and Fig. (1)** showed that foliar application of GA₃ significantly affected the vegetative growth of marigold i.e. (plant height, number of branches and leaves fresh and dry weights). Significantly higher of plant height (54.40 cm), number of branches (10.83), leaves fresh weight (262.42) and leaves dry weight (262.42), followed by high concentration of humic acid at 200mg/l which recorded plant height (43.94cm), number of branches (13.07), leaves fresh weight (215.61) and leaves dry weight (43.12), as compared with control treatments which recorded the lowest mean values of plant height (32.59 cm), number of branches (7.09), leaves fresh weight (177.56) and leaves dry weight (35.51), during 2020 season.

Owing to the truth extended in GA₃ utility accelerated the intermodal measurement and cellular telephone growth that increases increase of flora and moreover will enlarge auxin content material which extra acceptable the apical dominance indirectly. The results gotten have been concordance with the discoveries of **Kumar et al. (2010)** and **Badge et al. (2013)** in marigold.

An test executed by **Sarkar et al. (2018)** to have a look at the 'reaction of gibberellic acid on increase and physiological tendencies of African Marigold' ended in similar findings. Owing to the truth extended in GA₃ prolonged the intermodal period and cell cellphone growth in order to boom increase of flowers and furthermore will amplify auxin content material fabric which extra the apical dominance indirectly. The outcomes obtained have been concordance with the findings of **Taygi and Kumar (2006)**, **Kumar et al. (2010)** and **Badge et al. (2013)** in marigold.

In this way, from sold files we are able conclude that fair a incitement of GA₃ can able to create impressively higher run of auxiliary branches. As an application of GA₃ lifted cell

division and cell extension, publicizing of protein blend and incitement of branching can too be credited to the disposal of apical dominance thru 5 the squeezing we performed. Comes about procured had been in agreement with the discoveries of **Singh and Arora (1980)** on African marigold; **Kumar and Singh (2003)** in carnation, **Srivastava et al. (2002)** and **Lal and Mishra (1986)** in China aster and marigold.

HA could be a commercial endeavor item incorporates numerous components which make strides the soil ripeness and increasing the accessibility of supplement components and so influenced plant increment and surrender (**Hartwigson and Evns, 2000**).

Regarding the promotive have an impact on of humic corrosive, it impacts extend thru creating hormone analogs or increment controllers (**Albayrak and Camas, 2005**). Besides, **Sathiyabama and Selvakumari (2001)** cited that utility of 10 kg/ha humic corrosive, nearby with 75% of the invigorated NPK measurements utilized to be found to broadly affect fabricating of *Amaranthus*.

The comparable penalties had been reported with the aid of **Mohammadipour (2012)** concluded that the humic corrosive in 250 ml L-1 concentrations, amplified the assortment of clears out for marigold which need to be due to astonishing comes about and the hormonal undertaking of humic corrosive on vegetative development.

combined with soil earlier than sowing at the price of 3 g/pot. Other agricultural methods had been performed in accordance to regular practice. The treatment as follows:

- Control (without fertilizers)
- 100 mg/l humic acid
- 150 mg/l humic acid
- 200 mg/l humic acid
- 50 mg/l GA₃
- 100 mg/l GA₃
- 150 mg/l GA₃

The studied characters:

The growth attributes were determined as following:

A)Vegetative growth:

Plant height (cm), number of branches/plant, leaves fresh weight, leaves dry weight

B) Flower characters

Flowers number / plant, fresh and dry weights of flowers

C) Chemical analysis:

C.1 Nitrogen content (N %)

Add up to nitrogen was chosen in processed plant fabric calorimetrically by utilizing Nessler's method (**Chapman and Pratt, 1978**).

Nessler reply (35 IK/100 ml d.w. + 20g HgCl₂ / five hundred ml d.w.) 120 g NaOH / 250 ml d.w. Perusing was once performed utilizing wave measure of 420 nm .

C.2 Determination of total soluble carbohydrates

Total soluble carbohydrates have been determined, quantitatively, in *Tagetes erecta* L. via Anthron approach in accordance to **Yemm and Willis (1954)**, **Mahadevan, and Sridhar (1986)** as follows:

Extraction changed into as soon as achieved via grinding dry keep in mind in Mahadavaine buffer (sodium citrate buffer, pH 6.8). Extracts had been homogenized for 3 mins and centrifuged at 4000 p.p.m for 15 min. the

supernatant changed into then used to determine general soluble carbohydrates.

Ten grams of the reduce flesh had been taken and extracted by using distilled water in accordance to **A.O.A.C. (1980)**. In order to determine the whole soluble carbohydrates via the above-mentioned strategies and the extract was once heated at 70°C in water both for 10 minutes. 50 micro liter of the extract was then poured into test tubes, 3ml of the anthron reagent had been delivered to every tube and the tubes have been placed in water each at 100°C for 10 min. the reagent blank tubes were dealt with is comparable way, and the absorbance of the combination was measured at 625 nm. The widespread curve used to be prepared from glucose.

Table (1): Vegetative growth of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season.

Treatments	Plant height (cm)	Branches number/ plant	Leaves fresh weight (g) /plant	Leaves dry weight (g) /plant
Control	32.59	7.09	177.56	35.51
HA at 100mg/l	36.14	8.96	192.27	38.45
HA at 150mg/l	40.77	10.45	200.87	40.17
HA at 200mg/l	43.94	13.07	215.61	43.12
GA ₃ at 50mg/l	47.68	8.59	204.37	40.87
GA ₃ at 100mg/l	49.99	9.33	233.30	46.66
GA ₃ at 150mg/l	54.40	10.83	262.42	52.48
LSD _(0.05)	1.86	1.23	11.52	2.30

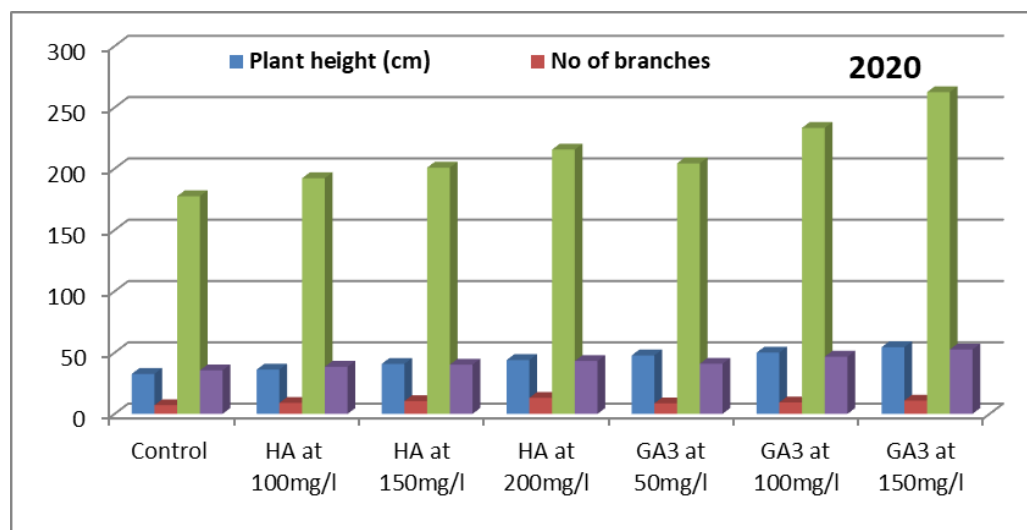


Fig. (1): Vegetative growth of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season.

B) Flower characters

Results presented in **Table (2)** and **Fig. (2)** cleared that foliar application of GA₃ significantly affected the flower characters of marigold i.e.(number of flowers and flowers fresh and dry weights). Significantly higher of number of flowers (81.01 cm), flowers fresh weight (66.33) and flowers dry weight (13.27),

followed by high concentration of humic acid at 200mg/l which recorded higher number of flowers (72.43 cm), flowers fresh weight (60.95) and flowers dry weight (12.19), as compared with control treatments which recorded the lowest mean values of number of flowers (45.92 cm), flowers fresh weight (43.51) and flowers dry weight (8.70), in 2020 season.

Gibberellic acid (GA₃) is additionally assumed to advance plant amplify and amplify wide assortment of transcendent and auxiliary branches which within the conclusion guarantees more prominent fabricating of bloom (Azuma *et al.*, 1997).

Thus, it used to be located that clean flower weight accelerated with an make bigger in GA₃ concentrations. Incitement of the corella development, dust germination, and dust tube grow happened with the GA₃ application which in flip will broaden weight of blossom. Comparable results have been reported with the aid of (Kumar *et al.*, 2010; Ardalani *et al.*, 2014; Kumar and Beniwal, 2017; Tiwari 2018; Sarkar 2018 in marigold and Holkar 2018) in Gladiolus.

Our research discovering confirmed plant utilized with GA₃ 250 ppm was once located

to be exceptional to produce most range of plant existence per plants. Similar quit end result used to be determined in experimentation accomplished with the resource of Khangjarakpam *et al.* (2019) in African marigold.

Blossom progressed when treated with 250ppm GA₃ was since this treatment brought about in most chlorophyll substance and protein substance fabric in leaf and had stimulatory position to play down the challenge of chlorophyllase chemicals subsequently avoids chlorophyll and protein debasement essential to upgrade of cost of photosynthesis. Beneath the control of GA₃, dividing of photosynthates to regenerative sink happened which come about in most degree of blossoms/ plant (Morris, 1996).

Table (2): Flower characters of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season.

Treatments	No of flowers	Flowers fresh weight (g)	Flowers dry weight (g)
Control	45.92	43.51	8.7
HA at 100mg/l	48.53	47.15	9.43
HA at 150mg/l	58.39	51.49	10.3
HA at 200mg/l	72.43	60.95	12.19
GA ₃ at 50mg/l	49.01	46.37	9.27
GA ₃ at 100mg/l	52.56	49.25	9.85
GA ₃ at 150mg/l	81.01	66.33	13.27
LSD _(0.05)	4.72	4.45	0.89

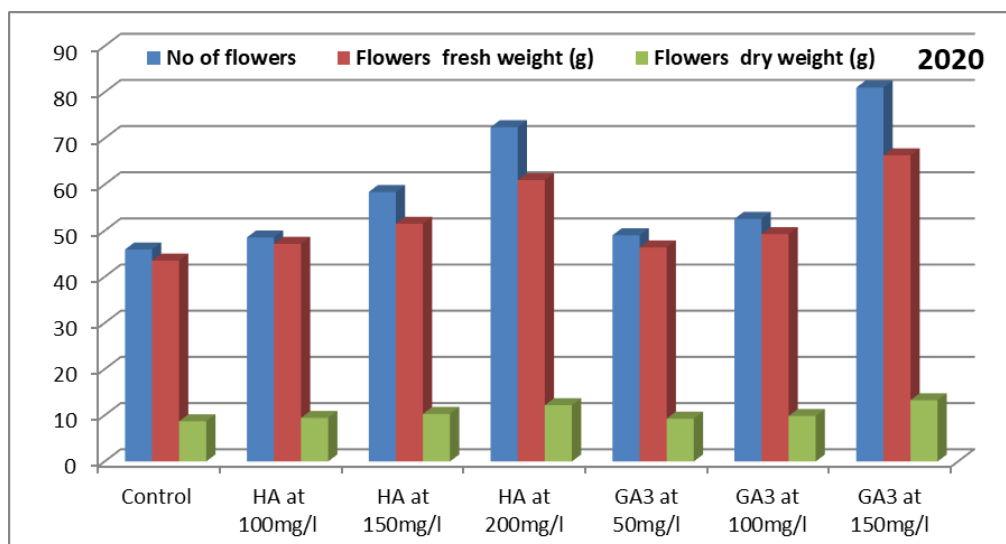


Fig. (2): Flower characters of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season

c) Chemical composition

Results presented in Table (3) and Fig. (3) cleared that sparying of GA₃ positive effect on the chemical composition of marigold i.e.(Carotein, total carbohydrates and nitrogen). Significantly higher of Carotein (0.21mg/100g), total carbohydrates (42.16%) and nitrogen

(5.29%), followed by high concentration of humic acid at 200mg/l which recorded Carotein (0.18 mg/100g), total carbohydrates (35.19%) and nitrogen (4.52%), as compared with control treatments which recorded the lowest mean values of Carotein (0.15mg/100g), total carbohydrates (29.46%) and nitrogen (3.82%), during 2020

season. Light propelled chlorophyll biosynthesis increments the carotenoid substance (Giuliano *et al.*, 1993). GA₃ interceded upgrade in carotenoid in specific lutein biosynthesis in African marigold utilized to be furthermore watched with the help of Valadon and Mummery (1967)

Increased assortment of takes off per plant brought about in higher photosynthesis than the unwinding creating more prominent sum of photosynthates which had been channelized to particular components of the plant helping all

circular advancement for the length of the vegetative portion reflected by way of higher substance fabric of carbohydrates. The GA₃ intervened improvement in development, biomass generation and carbohydrate substance in trim vegetation was watched with the help of Demura and Ye (2010). The over comes about are in near congruity with the discoveries of Singh and Bijimol (2001) in tuberose and Sujatha *et al.* (2002) in gerbera.

Table (3): Chemical composition of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season.

Treatments	Carotein (mg/g)	Total carbohydrates (%)	Nitrogen (%)
Control	0.15	29.46	3.82
HA at 100mg/l	0.16	30.97	3.91
HA at 150mg/l	0.17	31.28	4.3
HA at 200mg/l	0.18	35.19	4.52
GA ₃ at 50mg/l	0.16	37.53	4.49
GA ₃ at 100mg/l	0.18	39.97	4.87
GA ₃ at 150mg/l	0.21	42.16	5.29
LSD _(0.05)	ns	2.69	0.30

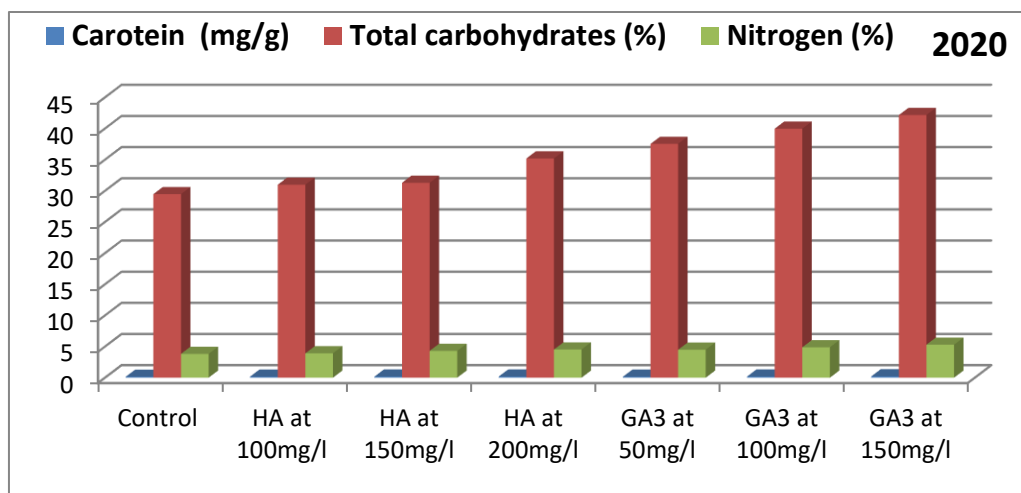


Fig. (3): Chemical composition of African marigold (*Tagetes erecta*) as affected by humic acid and gibberellic acid in 2020 season.

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الملخص العربي

تأثير حامض الهيوميك وحمض الجبريليك على النمو و التزهير والتركيب الكيماوي للقطيفة الأفريقية

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القطيفة من النباتات المزهرة، وهي ذات أوراق خضراء على الساق مع وجود قاعدة على شكل كوب أسفل كل رأس زهرة، كما يشار إلى أن أزهار القطيفة ذهبية، وبرتقالية، وصفراء، وبيضاء جذابة، كما توجد الأزهار بشكل منفرد أو مجتمع.

أجريت تجربة أصص في مشتل مزرعة العجيلات الخاصة في ليبيا خلال عام 2020 لدراسة تأثير حامض الهيوميك والجبريليك على النمو والتزهير والتركيب الكيماوي لنبات القطيفة. خلال موسم 2020. تم الحصول على بذور القطيفة من الصنف المحلي (الأزهار البرتقالي) وزُرعت في الأول من مارس. بعد شهر واحد، تم زرع الشتلات في أواني بلاستيكية (قطرها 30 سم) مملوءة بالرمل / الطين 1:1 (حجم / حجم). نفذت التجربة بتصميم القطاعات العشوائية بثلاث مكررات ، كل قطعة تحتوي على 10 أصص وكل أصيص يحتوي على شتلة واحدة. تتكون التجربة من سبعة معاملات: غير معاملة (كنترول) وحمض الهيوميك (100 و 150 و 200 مجم / لتر) وحمض الجبريليك (50 و 100 و 150 مجم / لتر). تم تحديد صفات النمو على أنها النمو الخضري (طول النبات، عدد الأفرع/ النبات، الأوراق بالوزن الرطب والجاف) ، صفات الأزهار (عدد الأزهار/ النبات، بالوزن الطازج والجاف للأزهار) والتركيب الكيماوي (صبغة الكاروتين، الكربوهيدرات الكلية، النيتروجين). أظهرت النتائج أن التراكيز العالية من حامض الهيوميك والجبريليك سجلت أفضل النتائج لجميع الصفات المدروسة ، ومع ذلك ، أعطى حمض الهيوميك عند 200 مجم / لتر وحمض الجبريليك عند 150 مجم / لتر أعلى القيم المتوسطة لجميع صفات النمو الخضري ، صفات الأزهار. والتركيب الكيماوي مقارنة بمعاملة الكنترول التي سجلت أقل متوسط قيم لجميع الصفات المدروسة تحت ظروف التجربة والظروف المماثلة لها..