

T.R.
VAN YUZUNCU YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF HORTICULTURE

**EFFECT OF HUMIC ACID AND FOLIAR POTASSIUM APPLICATIONS ON
GROWTH, YIELD AND YIELD COMPONENTS OF MELON**

M. Sc. THESIS

PREPARED BY: Ahmed Muhammed TAHIR
SUPERVISOR: Prof. Dr. Suat ŞENSOY
Co-Supervisor: Prof. Dr. Abdul Jabber Ihsan SAEID

VAN-2020

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ACCEPTANCE and APPROVAL PAGE

This thesis entitled “Effect Of Humic Acid And Foliar Potassium Applications On Growth, Yield And Yield Components In Melon” presented by Ahmed Muhammed TAHIR under supervision of Prof. DR. Suat ŞENSOY in the Department of Horticulture has been accepted as a M. Sc. thesis according to Legislations of Graduate Higher Education on 29/07/2020 with unanimity of votes members of jury.

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Ahmed Muhammed TAHIR

ABSTRACT

EFFECT OF HUMIC ACID AND FOLIAR POTASSIUM APPLICATIONS ON GROWTH, YIELD AND YIELD COMPONENTS OF MELON

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M. Sc. Thesis, Horticulture Science
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A field study was conducted at the research field of research center Duhok province/Iraq at the summer growing season in 2019 to investigate the effect of humic acid and potassium fertilization and their interactions on the growth and yield of melon crop. The trial encompassed foliar spraying of potassium fertilizers at four levels (0, 0.3, 0.6, and 0.9 mg/L), and soil application of humic acid at four levels (0, 500, 1000, and 2000 mg/L). The experiment consisted of 16 treatments with three replicates in a completely randomized block design. The vegetative growth and flowering traits, some leaf mineral contents as well as some yield and quality characters and fruit mineral content were studied. The vegetative growth characters were not significantly influenced by humic acid and foliar application of potassium and their interactions at different doses in comparison with control. The effect of different doses of humic acid and potassium fertilization did not significantly increased most nutrient leaf content (N, Ca, and K) except (P) which was enhanced by application of both fertilizers. The yield quantitative characters of melon [number of fruits/ plant, total yield and fruit moisture content (%)] were not significantly different from control. The humic acid and foliar application of potassium fertilizer have a significant impact on the fruit content of phosphorus (P) and calcium (Ca) but did not remarkably enhanced nitrogen (N) and potassium (K) in fruits of melon. Both humic acid and potassium applications with different doses have resulted in a significant enhancement in carbohydrate content (%) in fruits and total soluble solids (TSS %), but did not cause any increment in the vitamin C compared to control.

Keywords: Humic acid, Melon, Potassium, Quality, Yield

ÖZET

HÜMİK ASİT VE YAPRAKTAN POTASYUM UYGULAMALARININ KAVUNUN BÜYÜME, VERİM VE VERİM BİLEŞENLERİ ÜZERİNE ETKİSİ

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Bu çalışma, 2019 yaz döneminde Duhok eyaleti/İrak'Ta bir araştırma merkezi sebze araştırma alanında, hümik asit ve yaprakta potasyum uygulamalarının kavunun büyüme ve verimi üzerindeki etkisini etkilerini araştırmak için bir arazi çalışması şeklinde yürütülmüştür. Deneme, dört seviyede (0, 0.3, 0.6 ve 0.9 mg / L) yaprakdan potasyum gübrelemesi ve dört seviyede (0, 500, 1000 ve 2000 mg / L) topraktan hümik asit uygulaması şeklinde yapılmıştır. Deneme, tesadüf bloklarında üç tekerrürlü 16 uygulamadan oluşmuştur. Vejetatif büyüme karakterleri, bazı yaprak mineral içeriği ve çiçeklenme özelliklerinin yanı sıra bazı verim ve kalite karakterleri ve meyve mineral içeriği incelenmiştir. Vejetatif büyüme karakterleri, potasyumun yaprak uygulaması ve hümik asit uygulamasından önemli ölçüde etkilenmemiştir. Farklı dozlarda hümik asit ve potasyum gübrelemesinin etkisi, her iki gübrenin uygulanmasıyla artan fosfor (P) hariç, yapraklardaki besin elementlerinin çoğunu (N, Ca ve K) önemli ölçüde artırmamıştır. Kavunun kantitatif verim karakterleri [meyve/bitki sayısı, toplam verim ve meyve nem içeriği (%)] uygulamalarda önemli ölçüde farklı çıkmamıştır. Potasyum ve hümik asit uygulamaları, meyve içeriğinde fosfor (P) ve kalsiyum (Ca)'un üzerinde önemli bir etkiye sahip olurken, kavun meyvelerinde azot (N) ve potasyum (K)'u önemli ölçüde artırmamıştır. Farklı dozlarda hem hümik asit hem de potasyum uygulaması, meyvelerdeki karbonhidrat içeriğinde (%) ve suda çözünür kuru madde miktarını (SÇKM) önemli bir artışa yol açmakla birlikte, kontrol ile karşılaştırıldığında C vitamininde herhangi bir artış gözlenmemiştir.

Anahtar kelimeler: Hümik asit, Kavun, Kalite, Potasyum, Verim.



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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this study are presented below, along with descriptions.

Symbols	Description
HA	Humic acid
N	Nitrogen
P	Phosphor
K	Potassium
Ca	Calcium
Mg	Magnesium
Na	Sodium
Mn	Manganese
Fe	Iron
B	Boron
C	Carbon
S	Sulfur
Cu	Copper
Zn	Zinc
G	gram
mg	milligram
kg	kilogram
Cmol	Cent mol
mmol	mili mol
ml	mililiter
L	litter
Cm	Centimeter
m	meter
m²	square meter
mm	millimeter

ha hectare

Symbols	Description
----------------	--------------------

t	ton
ds m	decimal
k.m	kilo meter
km²	square kilometer
%	Percent

Abbreviations	Description
----------------------	--------------------

TR	Turkish Republic
R	Replication
B	Block
M.C	Mono-Cropping
I.C	Intercropping
S.C	Sweet Corn
F.B	Fresh Bean
ECe	Electric Conductivity
CEC	Cation Exchange Capacity
D.M	Dry Matter
F.M	Fresh Matter
O.M	Organic Matter
O.F	Organic Fertilizer
LER	Land Equivalent Ratio
ANOVA	Analysis of Variance
cv	Cultivar
et al.	Et all (and others)
e.g.	For example

Abbreviations	Description
etc.	Et cetera
Exp.	Experiment
Fig.	Figure
var.	Variety
FAO	Food and Agricultural Organization
SPSS	Statistical Package for the Social Sciences
GPS	Global Positional System
E.v.a	Equal variance assumed
E.v.n.a	Equal variance not assumed
B.Sc.	Bachelore of Science
M.Sc.	Master of Science
Ph.D.	Philosophy of Doctora

1. INTRODUCTION

Melon (*Cucumis melo* L.) is the foremost tasty and well known summer vegetable belongs to Cucurbitaceae family including cucumber (*Cucumis sativus* L.), watermelon [*Citrullus lanatus* (Thunb.) Matsum. & Nakai] and squash (*Cucurbita* spp.). Melon is native to tropical Africa and can also be utilized as a dessert. The melon is well known with the rich bioactive compounds such as phenolic flavonoids and vitamin A and C, β - carotene as well as carbohydrates and minerals. Moreover, the melon contains some calorie (around 17 kcal 100g⁻¹). Muskmelon may be a very profitable vegetable with a promising production within the modern recovered soils (Tamer et al., 2010; Mohamed and Ali, 2016).

Seriously utilization of chemical fertilizers and pesticides beside culturing framework specifically impact the soil, microbial community structures and fall apart structure and mineral supplement substance of soils and cause dangers to human wellbeing (Caesa et al., 2010). Natural production is secure and can supply high quality and nourishment without causing any harm to soil and environment wellbeing. Natural fertilizers are at first defined from either plant or animal leftovers. All natural fertilizers are competent of moving forward the accessibility of different components in soils through fulvic and humic acids which have an unique part in retaining the elements in complex and chelate forms. These materials have the ability to retain plant nutrients for a while and are deteriorated gradually by soil microorganisms (Shafeek et al., 2015).

Many studies have revealed that the application of organic fertilizer made amelioration in soil fertility, suppressed soil-borne diseases, strengthened microbial flora structure, thus decreased continuous barriers for the crop growth. Humic acid is a type of organic matter which is produced and accumulated by animal and plant residues that broken down and transformed by microorganisms through a series of geochemistry processes. Combined with various inorganic fertilizers, humic acid can play an important role in improvement of the soil quality, increase of fertilizer utilization rate, and promote crop yield and quality (Selladurai et al., 2016; Khan, et al., 2017; Ahmad et al., 2017; Suman et al., 2017).

Application of mineral nutrients through soil lead to leaching of most received elements. Therefore, feeding plants through foliar spraying is an effective way of

supplement of required macro and micronutrients especially during the critical period of intensive plant growth when such method can upraise plants mineral content and enhance crop yield (Kadu et al., 2018).

After nitrogen and phosphorus, potassium is the third major plant nutrient that the plant needs it in large quantities and is usually provided for plants through the fertilizer. It should be in the form of cation (K^+) in order to be available to the plants. The importance of potassium comes into mind because of its essentiality for a variety of process i.e. photosynthesis, fruit formation, winter hardiness and disease resistance. It has also an important role in protein synthesis especially in grain filling (Shafeek et al., 2015).

So as along no similar studies have been carried out before in Dohuk governorate. This research will be the first of its kind in the conservation of Dohuk Governorate in terms of the quality and quantity of compost added within the field for the purpose of production and quality good and access to a product of high quality and the success of adding this fertilizer type and quantity. The aims of the study are to investigate the effect of humic acid and potassium fertilization and their interactions on the growth and yield of melon crop. The study might also answer the following aspects:

- 1-To increase the productivity of melon,
- 2-To study the effect of humic acid and potassium on melon growth and yield and its components,
- 3- To increase the quality and quantity of melon by using organic fertilizer such as humic acid nad f oliar spraying potassium,
- 5- To activate vegetative growth, to increase productivity and to improve soil properties,
- 6- To increase the absorption of some plant nutrients.

2. LITERATURE REVIEW

2.1 Humic Acid

2.1.1 General overview

The continuous use of synthetic chemical fertilizers for enhancement of vegetable production has resulted in the deterioration of soil and brought disasters to human health and the whole environment. Therefore, intensive scientific attempts have been done to find out proper ecofriendly substitutes for these harmful chemicals. Among these finding choices comes the humic acid. Humic acid is that organic matter which is found naturally in the soil and has various benefits to the soil related to structure improvement, retain moisture and microbial activity. It also works as chelating agent, which prevent fixation, leaching, and oxidation of elements and thus promote the ion exchange capacity and nutrient availability in the soil all together improve plant growth and yield (Ouni et al., 2014).

2.1.2 Importance of humic acid in plant growth and soil fertility

Humic substances (HS), which basically comprise of humic corrosive and fulvic corrosive, are the foremost complex and organically dynamic characteristic compounds of soils. The HS such as humic extricates of leonardit, compost or other natural fertilizer increment plant development and microbial exercises through positive effect son soil physicochemical properties and microbial community structure of soils, and making strides the accessibility of supplement take-up for plant development and advancement (Canellas and Olivares, 2014). In addition, Puglisi et al. (2013) detailed significant effects of HS on root development, particularly horizontal root development and root hair grwoth. Humic corrosive (HA) is an important component of natural matter, which is utilized as a bio-fertilizer in the development of several vegetables and field crops. The expanded large scale- and micronutrient take-up and root development by the application of HA have been archived in field tests (Xuet al., 2013).

2.1.3 Effect of humic acid on vegetative growth

Fahmy (2012) studied the effect of some treatments (magnetic iron, humic acid, compost and amino acids) on the growth, yield and fruit chemical composition of cucumber and melon crops. The recorded data showed that plants applied with humic acid along with other fertilizers significantly increased vegetative growth parameters such as plant length, number of internodes on the main stem, number of branches per plant, fresh and dry weights as well as number of leaves per plant in comparison with control plants.

The response of growth, yield and fruit quality of cantaloupe plants (*Cucumis melo* L.) to organic and mineral fertilization was researched by Shafeek et al. (2015) and they found that the combination of organic fertilizers and chemical fertilizers improved vegetative growth of the crop as compared with control plants. The foliar and ground application of humic acid predominately improved vegetative growth characters of cucumber crop grown under plastic house condition as compared with control (Shafeek et al., 2016).

In a field trial that was conducted to find out the effect of humic acid on the growth and yield of cucumber (*Cucumis sativus* L.) grown in a greenhouse, it had been revealed that the humic acid was supreme in enhancing the vegetative growth traits in terms of the dry weight of the plant and the percentage of chlorophyll, nitrogen, and potassium, and holds rate per plant (Yaser et al., 2016).

Mohamed and Ali (2016) investigated the effect of organic and bio fertilizers in presence of chemical fertilization on the growth and productivity of cantaloupe plants. The obtained data showed that the all fertilizers (chemical fertilizer + compost + humic acid +bio fertilizer) made a significant increase in the plant vegetative growth characters (plant height, number of branches/plant, fresh and dry weights of plant as well as leaf area. The effect of humic acid on growth and yield of three cultivars of summer squash (*Cucurbita pepo* L.) have been investigated in a field trial. The trial results demonstrated that humic acid at concentration of (50 mg/litter) gave the highest fresh, dry weight /plant when encountered with other treatments and control (Esho and Saeed, 2017).

Abdellatif et al. (2017) found that the humic acid dose applied to soil lead to a significant increase in vegetative components of tomato crop (*Solanum lycopersicum* L.) namely plant height and fresh weight at level 14.4 kg·ha⁻¹.

Shalaby and El-messairy (2018) performed a field experiment to detect the effect of humic acid and boron treatment to mitigate salt stress on melon plant (*Cucumis melo* 'Galia'). They concluded that soil application of humic acid at Humic acid at 21 L ha⁻¹ significantly improved plant vegetative components in term of plant length, plant fresh and dry mass, chlorophyll (SPAD). Abd El-Haiel et al. (2019) showed in a field study that was carried out to investigate the effect of humic acid, amino acid and essential oils on the vegetative growth, biochemical parameters and fruit yield of cantaloupe. Their results that the mixture of humic acid and amino acids resulted in a significant improvement in the vegetative characters, biochemical parameters and fruit yield of crop.

The comes about of a field try conducted to explore the impacts of humic corrosive and yeast applications on development and abdicate of cucumber (*Cucumis sativus* L.) uncovered a critical increment within the plant stature with the humic corrosive application (Al-madhagi, 2019). Kıran et al. (2019) explored the impacts of humic acid application on plant development parameters of Şemame (drought and salt-tolerant) and Ananas (drought and salt-sensitive) melon genotypes. The result indicated that the humic acid application in irrigated system critical increased the studied plant tolerance parameters.

Al-madhagi (2019) carried out an experiment to inspect the effect of humic acid and yeast on the growth and yield of cucumber (*Cucumis sativus* L.) and his data demonstrated a profound increase in vegetative traits such as percentage of leaf dry matter and chlorophyll SPAD due to interaction between the two bio stimulants when compared with untreated plants.

2.1.4 Effect of humic acid on flowering and yield

Hamail et al. (2014) investigated the impact of N-forms and bio stimulants (humic acid, fulvic acid, EM and yeast extract) on flower characters and yield of cucumber plants and they stated that foliar spraying of cucumber plants with bio-

stimulants significantly improved the mean values of the number of female flowers, fruit setting, early and total yield as compared with the control treatment. El-Masry et al. (2014) carried out a field trial inspecting the impact of humic acid soil application to squash plants (*Cucurbita pepo* L.) and demonstrated that treating plant with humic acid resulted in a significant increase in fruit yield and its components (number of fruits plant⁻¹, yield plant⁻¹ and total yield of fruits fed⁻¹) when compared with control.

Ekinici et al. (2015) studied in a field trial the influence of calcium, boron humate and humic acid on growth, yield and mineral content of tomato and cucumber crops. The marketable yield, average fruit weight, fruit diameter, and fruit length, total soluble solids (TSS) and fruit dry matter were notably increased due to treatment with previously mentioned humic acid substance and its salts boron humate and humic acid. Mohamed and Ali (2016) showed in their field study on the effect of organic, bio fertilizers and mineral fertilizers on the growth and productivity of cantaloupe crop that the humic acid significantly improved yield parameters such as fruit diameter, fruit circumference, fruit fresh weight TSS %, total sugars % and total yield.

Dinu et al. (2016) implemented a field experiment to detect the influence of Lignohumat, a granular humic product, which was applied during vegetation, in three stages and three fertilization doses (100; 150 and 200 g/ha.) on melon plants. The results showed that the humic substance improved crop yield i.e. the average number of fruits/plants, their average weight, and the production/m² as well as the quality of fruits: soluble dry matter, total dry matter, reducing sugars, vitamin C, and carotene. Esho and Saeed (2017) have illustrated a positive impact of humic acid on three cultivars of squash and cleared that treating plants with humic acid prominently increased yield traits like fruit length, number of fruits /plant and total yield as well as number of male and female flowers of the plant and sex ration.

Kumar et al. (2017) inspected the effect of foliar and soil application of humic acid and nutrient mixtures on quality parameter of Tomato (*Lycopersicon esculentum* Mill.) under polyhouse condition and they concluded that both foliar (0.1%) and soil addition (10 kg/ha) of humic acid along with nutrient mixtures spray (0.2% Ca + 0.5% Mg + 0.2% B + 0.5% Zn) significantly enhanced tomato fruit quality in term of total Soluble Solids (TSS), ascorbic acid content, lycopene content.

Alkharpotly et al. (2017) performed an experiment to search the impact of humic acid and seaweed extracts on growth, yield and fruit quality of strawberry (*Fragaria × ananassa* Duch.). The obtained data of the study indicated that the mixture of both humic acid and seaweed extracts superiorly enhanced the yield parameter of the plant.

Al-Zubaidi (2018) investigated the impact of humic acid on growth, yield and quality of three potato varieties and their data indicated a remarkable enhance in most of yield parameters. Application of humic acid and boron has shown be effective in amelioration of yield characters of melon plants and that was evident in fruit mass, total yield, and also leaf nutrient content (N and K) and total soluble solids (TSS) of fruits (Shalaby and El-messairy, 2018). Sarhan and Mohammed (2018) tested the influence of spraying with humic acid on growth and yield of grafted watermelon (*Citrullus lanatus*) and discovered a profound impact of humic acid on the yield which was apparent in double application at a concentration of 3 ml L⁻¹ giving the highest yield (fruit weight), fruit diameter and total soluble solids. Abd El-Baky et al. (2018) conducted a field research detecting the effect of foliar spray of humic acid and Naphthalene Acetic Acid on the growth and yield of cucumber crop. They found that humic acid at level of (3g L⁻¹) and high level of naphthalene acetic acid (100 ppm) made the highest values of cucumber yield and yield components such as number of fruits, fruit length, fruit diameter and yield per plant.

Al-madhagi (2019) showed that providing cucumber plants with humic acid and yeast significantly enhanced the yield and humic at 100 mg L⁻¹ alone increased the yield about 14.88% whereas the interaction of 100 humic × 4000 mg L⁻¹ of yeast increased the yield by 168.26%. Ullah *et al.* (2019) carried out a study on the influence of Influence of foliar application of moringa leaf extract and humic acid on growth, yield and chemical composition of cucumber and Maximum vine length, single fruit weight, fruit diameter, total yield, TSS, titratable acidity, and ascorbic acid were recorded using HA at the rate of 1.5%.

Salam et al. (2019) conducted a field study about the influence of spraying some squash cultivars with growth stimulants on flowering and yield of crop and their results pointed out the superiority of growth stimulants in ameliorating most flowering, fruit yield and quality characters. The effect of bread yeast and humic acid on the growth and yield of broad bean (*Vicia faba* L.) was searched by Yousif et al. (2019) and the

experiment data unveiled a positive action of both bio-stimulants in improving the vegetative and yield traits of the crop.

2.1.5 Effect of humic acid on mineral content

A field research has been done to study the increase of nitrogen (N) efficiency (ammonium nitrate 33.5% N; 150, 200, 250 and 300 kg fed⁻¹) under three concentrations of humic acid as water solution 0.5, 1.0 and 1.5g L⁻¹ applied as soil drench on squash plant. His earned data showed a significant improvement in the percentage of N, P and K in fruits (El-Masry *et al.*, 2014). Young Suh *et al.* (2014) executed a field trial to study the effect of humic acid applied as soil drench and fulvic acid applied as foliar on the mineral content of potato crop. Humic acid was incorporated into soil at a rate of 40 or 80 g·m⁻² with 8 kg of soil-mix before planting potato seeds. The soil application of humic acid at the rate 80 g·m⁻² significantly improved mineral content in potato tubers and in the soil.

In another field trial that was carried out to detect the of soil humic acid application with concentrations (0, 40, 80, 120, 160 and 200 L ha⁻¹) on the fruit quality and nutrient concentration in tomato (*Lycopersicon esculentum* L.). The research results indicated that plants received humic acid at level of 80 L ha⁻¹ contained the highest mineral concentration in their leaves namely N, P, K, Ca, Zn and Mn (El- Asri *et al.*, 2015).

Ibrahim and Abd El-Kader (2015) conducted a field study detecting the impact of humic acid applied as soil drench, rice straw compost, effective microorganisms and NPK fertilizers on growth, yield and NPK content of bottle gourd (*Lagenaria siceraria*). They noticed that humic acid interaction with 75% recommended dose of NPK fertilizers gave the highest concentration of minerals (N, P, and K) in fruits of gourd plants in comparison with other treatments.

Mohamed and Ali (2016) studied the effect of humic acid along with some organic, bio fertilizers and mineral fertilizers on mineral content of cantaloupe plants and the plant content of (N, P, K, Ca, Mg, Fe, Zn and Mn) was significantly increased by all tested fertilizers.

Aghaeifardet al. (2016) considered the impacts of humic corrosive and salicylic corrosive on surrender, natural product quality and mineral substance of strawberry (*Fragaria × ananassa* Duch.) cv. Camarosa. The humic corrosive, notwithstanding of application dosage, had a prevalent effect on leaf mineral substance such as potassium, phosphorus, calcium and magnesium compared with salicylic corrosive and control. Sonmez and Gulser (2016) explored the impacts of humic corrosive and calcium nitrate applications on development and supplement take-up of pepper (*Capsicum annuum*) plants. Humic corrosive treatment caused the most elevated K, Ca, Fe, Mn, Zn and P substance compared to control plants. Similarly, humic corrosive and ocean growth extricate mixtures significantly moved forward mineral substance of okra (*Abelmoschus esculentus*) plants (Prakash et al. 2018). Yasir et al. (2016) detailed a critical increment in P and K contents of cucumber clears out when examining the impacts of humic corrosive and natural fertilizers on development and abdicate.

The influence of humic acid as foliar spray on growth, yield and mineral content of tomato was investigated. The results illustrated a positive effect of humic acid on vegetative characters as well as nutrients content (N, P, K and Ca) of leaves (Abou El Hassan and Hussein, 2016).

Soil and foliar application of humic acid and its interaction with nutrient mixtures (Ca, Mg, and Zn) resulted in a significant improvement in leaf nutrient content (Kumar et al., 2017).

Shalaby and El-messairy (2018) have revealed that treating melon plants with humic acid through soil application and spraying boron to the foliage gave a profound amelioration in mineral content of (N and K). Abd El-Baky et al. (2018) have demonstrated that splashing cucumber plants with humic acid with concentration (3 gl-1) and Naphthalene acetic acid (NAA) at concentration (100 ppm) produced high values of N, P, K, Ca and Mg uptake by plants.

Paulauskiene A. et al. (2018) studied the influence of humic substance, compost and complex fertilizers on mineral content of pumpkin fruit (*Cucurbita moschata* L). They found that all fertilizers significantly enhanced macro and micronutrient content in pumpkin crop. Tursun T et al. (2019) performed a field trial investigating the impact of humic acid on the growth and mineral content of parsley (*Petroselinum sativum* Hoffm.). Their analyzed data revealed that the application of humic acid to the parsley

plants caused a significant improvement in the mineral content of plants in comparison with control plants.

2.2 Potassium

2.2.1 General overview

The plants usually exhibit abnormal symptoms which are used as certain indicators for sufferance from hidden hunger that attribute to the deficiency of main plant nutrients like nitrogen (N), phosphorus (P) and potash (K). Among all the main plant nutrients potassium (K) is known to be effective and possess an important role under rain fed, moisture stress, upland condition. It is considered as one of the most necessary element in plant nutrition and its importance is going back to the role of K in biochemical pathways in plants. K enhances the photosynthetic rates of crop leaves, CO₂ assimilation and makes carbon movement easier owning favorable impacts on metabolism of nucleic acids, proteins, vitamins and growth substances. These are showed apparently in metabolites formed in plant tissues which directly affect the growth and development processes (Sarma et al., 2015).

2.2.2 Importance of potassium for plant growth and productivity

Plants always need different macronutrients and micronutrients at various growth stages starting from seed germination to seed production. Potassium is known as one of the most necessary macronutrients, along with nitrogen (N) and phosphorous (P) (Fageria, 2016). The importance of potassium emerges with its requirement for various biochemical and physiological processes that are mainly responsible for plant growth and development. Potassium plays a key role in protein synthesis, carbohydrate metabolism, and enzyme activation. It contributes in the cation-anion balance, osmoregulation, water movement, energy transfer, and many other processes. Potassium also acts as anti-stress factor helping plant to tolerate various abiotic stresses such as drought, salinity, metal toxicity, high or chilling temperatures, etc. (Wang et al., 2013). When K deficiency is experienced by plants, they symptomize stunted growth and

yellowing in their leaf margins. Moreover, more adverse phenomena appear on plants involving a poor root system, lodging, and yield reductions with deficiency in potassium. In addition, any shortage in K fertilizer enhances plant susceptibility to several diseases and pest infestation and exposes plants to severe damage under various stress conditions (Hasanuzzaman et al., 2018).

2.2.3 Effect of potassium on vegetative growth

Merghany et al. (2015) carried out a field explore to decide the impacts of K fertilization rates on development and surrender of melon. Vegetative parameters especially stem length and new and dry weight of melon plants significantly moved forward with the K fertilization.

The impacts of single or combinations foliar K (four times 1, 2 and 3 ml L⁻¹ as 37.5% K₂O) and ethephon (150, 250 and 350 ppm; one time at 2-4 genuine leaf arrange) applications on development and abdicate of summer squash (*Cucurbita pepo* L.) have been examined by Fekry (2016). The most critical number of clears out, new and dry weights per plant and a few other development parameters were gotten with 2 ml K L⁻¹+250 ppm ethephon treatment. Additionally, the most noteworthy plant stature and chlorophyll substance in cucumber plants were recorded in foliar K andgibberellic corrosive applications (Pal et al., 2016).

Shafeek (2015) found that treating cantaloupe plants with organic and NPK fertilizers gave the peak values of vegetative components (plant length, number of leaves/plants, number of shoot/plants and fresh and dry weight of plants. The effect of poultry manure and organic fertilizer (NPK 20:10:10) on the growth and quality of cucumber was investigated. The obtained results indicated that the NPK fertilizers in combination with organic fertilizers improved the number of leaves per plant (Okoli and Nweke, 2015).

Adeyeye et al. (2016) performed a field test to study the impact of different levels of compost and NPK fertilizers on growth and yield of watermelon (*Citrullus lanatus*). They reported a notable role of both fertilizers in ameliorating the vegetation of the plant, especially number of leaves/plant and vine length. Souza et al. (2018) conducted a field experiment to inspect the effect of different potassium (K) and

nitrogen (N) doses on growth of eggplant (*Solanum melongena* L.) applying Four levels of K (0, 54, 108, and 216 kg ha⁻¹) and four levels of N (0, 67, 134, and 268 kg ha⁻¹). The experiment results indicated that the vegetative parameter such as plant height, stem diameter and leaf area were significantly improved more by nitrogen (N) than by potassium (K).

Gardini (2016) studied the effect of Nano potassium fertilizer on pumpkin crop growth under drought conditions operating fertilizer (0, 0.5, 1.5 and 2.5 in thousand) and droughts (1, 3 and 6 days) were applied. His data showed that the maximum stem diameter, number of branches and number of leaves were observed in plants foliar sprayed with (2.5) per thousand ml Nano potassium. Bottela et al. (2017) tested the influence of potassium (K) fertilizer on vegetative biomass and yield quality of pepper plants and they reported that the potassium nutrition positively affected the fruit yield parameters more than vegetative growth parameters. Al-Moshileh et al. (2017) conducted a field trial investigating the effect of potassium fertilization on growth and yield of tomato and cucumber applying four levels of K fertilizer as potassium sulphate (100, 150, 200 and 250 ppm) through fertigation method to both tomato and cucumber plants.

Fouda and Abd-Elhamied (2017) researched the impact of mineral fertilizers and some natural fertilizers on growth and yield of eggplant crop (*Solanum melongena* L.) and they reported a significant enhance in vegetative parameters of plants like (plant height, No. of leaves/plant, No. of branches/plant, fresh and dry weight and chlorophyll content due to increasing rate of NPK from 50 up to 100% of the recommended dose.

The interaction between potassium (K) and nitrogen (N) fertilizers has been shown to supremely improve the vegetative traits of cherry tomato crop (Ddamulira et al., 2019).

Abd-Elaziz et al. (2019) studied the effect of foliar application of salicylic acid and potassium silicate on growth and yield of squash plants. The experiment results revealed a significant improvement in vegetative traits of plant in term of plant height, number of leaves per plant and fresh and dry weight of plant due to treatment with potassium silicate (K₂SiO₄) when compared control plants.

2.2.4 Effect of potassium on flowering and yield

Imran et al. (2014) investigated the impact of different Levels of NPK Fertilizers on the growth and yield of greenhouse cucumber (*Cucumis sativus*). The results illustrated that application of NPK fertilizers treatments at 1000 grams fertigation⁻¹ positively influenced day to flowering, fruit setting, fruit per plant, fruit weight, fruit length and yield per hectare as compared with control and other treatments.

Merghany et al. (2015) carried out an investigation to study the response of some melon cultivars to three potassium fertilization rate 100, 150 and 200 kg/fed on productivity and yield quality of melon. Significant differences between treatments were observed in measuring parameters and the rates of 150 and 200 kg/fed produced the maximum measured number of fruits per plant, fruit weight per plant, and the highest crop yield. Okoli and Nweke (2015) measured a significant increase in the quality of marketable fruits and weight of fruits of cucumber plants that attributed to the interaction between the poultry manure and the mineral fertilizer (NPK) when compared with control plants.

The beneficial effect of application of potassium (K) on the growth and quality of tomato has been researched and the maximum yield and quality parameters were measured for plants received Potassium level of 60 kg ha⁻¹ either applied in single or in two splits (Nisar et al., 2015). Irfan et al. (2015) carried out an experiment to evaluate the influence of potassium on fruit quality and yield of tomato crop spraying the plants with several levels with varying levels (0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0%). The exogenous application of 0.6% K significantly increased fruit weight and diameter and application of 0.5, 0.6 and 0.7% K maximally improved ascorbic acid contents of tomato.

The development, blooming and abdicate of squash were essentially expanded with the single or combined foliar K and ethephon applications (Wafaa 2016). Buddy et al. (2016) detailed the most noteworthy add up to surrender and natural product quality parameters (TSS, length, distance across and weight of natural products and the number of natural products per plant) with the foliar gibberellic corrosive and K applications. Akram et al. (2017) examined the effect of P and K applications on abdicate and quality of chili pepper. The most elevated number of blooms per plant (90.83), number of

natural products per plant (30.17), natural product length (9 cm), natural product size (13.03), and natural product weight per plant (465.5 g) were recorded in 100 kg P ha⁻¹ of P and 120 kg K ha⁻¹ applications.

Mahmoud et al. (2017) conducted two field study to detect the influence of bio-fertilizers EM (effective microorganisms) used through four methods *i.e.* dipping of seedlings in activated EM 5cm³/L solution (30 minutes before cultivation), soil addition treatment 3 L/fed., foliar spray treatment 1.5 L/fed., beside control treatment (without EM) and mineral fertilizers applied at three rates (100% NPK, 50% NPK and 25% NPK of recommended dose) on growth and yield character of cantaloupe. NPK fertilizer as recommended dose 100% gave the best values of yield characters as did the interaction between EM and NPK fertilizer.

Fouda and Abd-Elhamied (2017) reported an improvement in the yield and its quality for eggplant crop due to application of yeast, ascorbic acid and mineral fertilization (NPK) which was evident in fruit length, fruit diameter, number of fruit/plant, total yield ton/ha, protein %, total carbohydrate (%), fiber (%) and vitamin C. Treating plants with four levels of K fertilizer as calcium sulphate have brought a beneficial influence on the marketable yield and yield quality of cucumber and tomato crop ,especially (%) of total soluble solids and fruit firmness (Al-Moshileh et al., 2017).

Bouzo (2018) evaluated the impact of potassium (K) and calcium (Ca) applied through fertigation with three doses for each one on yield and fruit quality of melon (*Cucumis melo*) through two field experiments. They reported a significant influence of potassium (K) on the quality and yield of harvested fruits when compared with calcium (Ca) treatment. Siva et al. (2018) reported that the N, P, K Levels caused a significant improvement in yield and quality parameters of pointed gourd (*Trichosanthes dioica* Roxb.) in term of number of fruits per vine, fruit length, fruit diameter, yield per vine, total yield, ascorbic acid content, protein content and total soluble solids.

Kadu et al. (2018) inspected the effect of potassium, boron and zinc on the yield and quality of watermelon [*Citrullus lanatus* (thunb.)]. The plants received with different levels of potassium (K₀, K₁, K₂ and K₃ @ 0, 25, 50 and 75 kg ha⁻¹), respectively and foliar applied with micronutrients (M₀, M₁, M₂, M₃ @ 0, 0.5% Zn, 0.1 % B and 0.5% Zn + 0.1 % B). The analyzed data demonstrated a prominent role of

75 kg K₂O ha⁻¹ along with 0.5% Zn and 0.1% B in enhancing yield parameters and quality of watermelon.

Abd-Elaziz et al. (2019) evaluated the effect of calcium silicate and salicylic acid on the yield and quality of squash plants and found that foliar application of calcium silicate and salicylic acid alone or combined led to optimal yield and good quality squash. Ddamulira et al. (2019) showed that the N and K fertilizers positively affected the flowering (days to flowering), maturity period and yield of cherry tomato.

2.2.5 Effect of potassium on mineral content

Nascimento *et al.* (2016) performed a field trial evaluating the impact of potassium fertilizer and cattle manure on the yield and mineral content of watermelon. They showed that the best mineral content of leaves (N, P, K, Ca and S) was found in plants treated with K₂O dose of 15 kg ha⁻¹. Pal et al. (2016) reported that the interaction between potassium fertilizer and gibberellic acid possessed a superior impact on mineral content in leaves of cucumber such as N, P, and K.

Kalavati and Modi (2016) studied the influence of Potassium Solubilizing *Enterobacter hormaechei* (KSB-8) and some chemical fertilizers on the growth, yield and mineral content of cucumber and the trial treatments consisted of four levels (C1 Positive control, C2 Negative Control, T1: KSB-8 Inoculation with Chemical Fertilizer 25 kg/ha and Rock potassium 25 kg/ha and T4: KSB-8 Inoculation with only chemical fertilizer 50 kg/ha). The results illustrated a superior role of the potassium solubilizing microorganisms in enhancing the potassium content in leaf.

Mohammed (2017) conducted a field study to evaluate the response of white eggplant crop to potassium silicate and boron sprayed to the foliage with three concentrations for boron as H₃BO₃ (0, 0.75, 1 and 1.5 g L⁻¹) and the same number of concentrations for potassium silicate K₂SiO₃ (0.75, 1 and 1.5 g L⁻¹). Spraying plants with 1.5 g L⁻¹ of potassium silicate gave the highest P% (0.532%) and K% (3.403%) in leaves whereas N% was mostly affected by boron application.

Amira et al. (2017) studied in two field tests the effect of potassium and phosphate on the growth, yield and mineral content of sweet pepper (*Capsicum annuum* L.) using different sources of phosphate fertilizers and foliar application of potassium as

K₂O (0, 100 and 200 ppm) and they recorded maximum percentage of (N, P, K and Ca) in the leaves of sweet pepper plants received (200 ppm) of K₂O along with phosphate fertilizer.

The mineral content (N, P, K, Ca, Fe, Zn and Mn) was significantly improved by NPK fertilizer treatment specifically the (30:22:31 kg NPK/ha) level when compared with other levels (Maragal et al., 2018).

Duymus et al. (2018) determined the effect of nitrogen and potassium fertilization on the yield and nutrient uptake in grafted watermelon and they stated that the different doses of N fertilizers did not cause any change in K content of shoots and only the increased doses of N enhanced N content whereas the K application only influenced the K content.

Tohidloo, et al., (2018) inspected the impact of different potassium concentrations {235 (control), 350, 450 and 600 mg L⁻¹} on the growth, and fruit biochemical characteristics of strawberry genotypes of Camarosa, Selva and Parus. The maximum K concentration was measured in leaves and fruits of Silva genotype received 450 mg L⁻¹ of K fertilizer.

Application of nitrogen and potassium fertilizers exhibited a supreme influence on mineral content of N and K in cherry tomato (Ddamulira et al., 2019). Dunsin et al. (2019) executed a field research evaluating the impact of organic fertilizers and NPK fertilizer yield and fruit mineral content of squash (*Cucurbita pepo* L). The trial data indicated that the application of NPK increased the fruit mineral content of Mn, K, Fe and Ca. the response of parthenocarpic cucumber to different doses of NPK fertilizer has been investigated using four fertilizer levels (15:7:16, 20:12:21, 25:17:26 and 30:22:31 kg NPK/ha). Abd-Elaziz et al. (2019) reported a significant increase in leaf mineral content (N, P, K) of squash plants received potassium silicate in combination with salicylic acid.

3. MATERIALS AND METHODS

3.1 Study Location

The field experiment was conducted in a field of in the vegetable research field at the research center, General directorate of agriculture, Dohuk province, North of Iraq during summer season in 2019.



Figure 3.1. Location of field experiment.

3.2 Soil of Study Location

The soil texture of the study site was clay loam. Several soil samples were taken from different sites of the field at a depth of (25-30 cm). The soil samples were air dried and then sieved using a 2.0 mm sieve for purpose of analysis of some soil physical and chemical properties, as illustrated in below table.

Table 3.1. Some physical and chemical properties of the plastic house soil

Properties	Sand (g/ kg)	Silt (g/ kg)	Clay (g/ kg)	Tex- ture	pH	EC (dS/ m)	O.M (g)	N (g/ kg)	P (mg/ kg)	K (mmol/ L)
value	24.03	42.50	33.48	Clay loam	7.84	0.92	3.4	74	6.11	15.99

Table 3.2. Monthly climatologically data during the experiment.

Months	Air temperature (C)			Average of soil Temperature (C)		Average of Relative Humidity (%)	Average of sum of Rain (mm)
	Max	Min	Average	Deep of 10 cm	Deep of 30 cm		
May	31.148	18.274	24.719	17.5	16.3	45.93	14.5
Jun	38.616	24.233	31.425	21.7	19.8	31.829	0.4
July	39.5	24.083	31.796	23.5	22.4	30.802	0



Figure 3.2. Thermometer deep.

3.3 Preparation of Trial Field

The ground of research field was well ploughed then the softening of soil was carried out. After that the complex fertilizer (NPK 20:20:20) was applied to the soil (20kg/1000m²). The complex fertilizer is beneficial for soil properties since these fertilizers are good sources of plant nutrients particularly (N, P, and K) that can be added to the soil as supplement to its natural fertility which elevate the plant growth and development (Abd El-Aziz, 2007).

3.4 Cultural Practices

The seeds of muskmelon were sown in the field on March 19th 2019. The cultural practices were performed in each experimental unit such as weeding and softening of soil around seedlings in addition to continuous observation of diseases and pests.

3.5 Experimental Treatments

The experiment included foliar application of potassium with four levels (0, 0.3, 0.6, and 0.9) mg/L and soil application of humic acid at four levels (0, 500, 1000, and 2000) mg/L with three replicates and their interactions. The humic acid solution was prepared by mixing certain humic milliliters with tap water and the mixture was shaken well. The prepared solutions were applied three times. The first spray was carried out on May 27th 2019 with ten days' interval between each spray.

3.6 Experimental Design and Analysis

The experiment treatments were arranged in a factorial Randomized Complete Block design (RCBD) with two factors. The first factor was Humic acid drenched (soil application) with four levels (0, 500, 1000, and 2000) mg/L during evening (around 6 pm) and the second factor was potassium fertilizer applied to the foliage at four levels (0, 0.3, 0.6, and 0.9) mg/L during evening. Therefore, the study consisted of (16) treatments ($4 \times 4 = 16$) each treatment was replicated three times and each replicate were represented by five plants with interspace of (100 cm x 90 cm) between plants. The data were analyzed using SPSS program.

3.6.1 Humic acid

Humic acid (HA) is an organic matter that composes of a heterogeneous blend of many compounds that share the same chemical properties. It acts different functions in the soil and on plant growth. Humic substances (HS) are considered as a key

constituent of soil fertility characteristics, because they are effective in controlling chemical and biological properties of the rhizosphere (Nardi et al., 2005, Trevisan et al., 2009). Some researchers proposed that the humic acid influence on plant growth attributes to its role in enhancing cell membrane permeability, respiration and photosynthesis, oxygen uptake, phosphate uptake, and root cell elongation (Cacco and Dell'Agnolla 1984, Türkmen et al., 2004).



Figure 3.3 Humic acid.

3.6.2 Potassium fertilizer

Foliar potassium fertilizer as K_2O was applied to the plants at four levels during the evening (6 pm), at different doses (0, 0.3, 0.6, and 0.9 mg/L.) Commercial Agri-K was used as a K source.



Figure 3.4. Potassium application.

3.7 Experimental Measurements

The internal plant was chosen and used for measuring all vegetative growth and yield parameters and the external plants (guard plants) were excluded from that purpose.

3.7.1 Vegetative growth characters

3.7.1.1 Number of leaf plant⁻¹

At the end of the season, the accounting of the number of leaves, Plant⁻¹ was carried out using five plants in each experimental unit and the non -attached leaves from each experimental unit were exceptional in the process and the average was measured.

3.7.1.2 Canopy height (cm)

For measurement of the plant height, the measuring bar was used and the process was done by starting from the contact point between the stem and the soil surface till the upper growing point of plant stem choosing five plants from each experimental unit at the end of the season with calculating the average.

3.7.1.3 Leaf area plant⁻¹ (cm²)

The leaf area per plant was measured and this step was carried out at the second harvests. The leaf area meter was used for estimation of the leaf area of two physiologically completed leaves from each of the five plants in the experimental unit. Then the average was calculated.

3.7.1.4 Leaf chlorophyll leaf content (%)

The percentage of chlorophyll in the leaves was estimated after 45 days of transplanting from five plants in each experimental unit and for this purpose the

(Chlorophyll Meter, SPAD-502, and Konica Minolta) was used for determining the parameter.



Figure 3.5. Leaf Chlorophyll leaf content (%).

3.7.1.5 Number of branches (Piece)

The number of branches per plant was accounted at the mid-growing season using five plants from each experimental unit then the average was estimated.

3.7.1.6 Stem diameter (cm)

The stem diameter was measured using the measuring bar for five fully physiologically grown stems in each experimental unit and the average was calculated.



Figure 3.6. Stem diameter (cm).

3.7.1.7 Leaf moisture content (%)

The evaluation of leaf moisture content was carried out via measuring the fresh weight of leaves of five plants from each experimental unit then the leaves were dried at room air temperature then was oven dried at $(70)^{\circ}\text{C}$ for 48 hours and the fruit moisture content was calculated as follow: -

$$\text{Fruit moisture content (\%)} = \frac{\text{Fresh weight} - \text{dry weight}}{100}$$

3.7.2 Mineral contents in leaves

The random sample was collected from leaves of plants parts in each experimental unit during the flowering stage. The cleaning and washing out of leaves was done after that the leaves were dried at the room air temperature then they were dried in electric oven at 70°C for 48 hours until they reached the weight stability (Al – Sahaf, 1989). Each sample was crashed and grinded by electric grinder then a (0.5) mg was weighed as standard weight from each grounded sample, then the digestion of the standard sample was implemented using the concentrated Sulphuric acid and Perchloric acid. After digestion process the prepared solution was ready for nutrient analysis.

3.7.2.1 Nitrogen percentage (%)

The total percentage of nitrogen in leaves was determined according to modified method of Kjeldahl and the sample analysis was carried out by use of the Microkjeldahl instrument (A.O.A.C., 1980) that cited by Black (1965).



Figure 3.7. Nitrogen percentage (%).

3.7.2.2 Phosphorus leaf percentage (%)

The measurement of Phosphorus percentage (%) in leaves was performed according to colorimetric methods and the Spectrophotometer was used (Matt, 1970).



Figure 3.8. Phosphorus leaf percentage (%).

3.7.2.3 Potassium leaf percentage (%)

The estimation of leaf potassium percentage (%) was carried out according to flame method by using Flame photometer instrument (A.O.A.C., 1970 and Al -Sahaf, 1989).



Figure 3.9. Potassium leaf percentage (%).

3.7.2.4 Calcium percentage (%)

Calcium content (%) in the leaf was evaluated through atomic absorption spectrophotometer that cited by Bhargava and Raphupathi (1999).

3.7.3 Flowering characters

3.7.3.1 Number of flowers on 30th day

The number of flowers on thirtieth day was accounted after thirty days of the emergence of seedlings during the growing season for five plants in each experimental unit and the average was determined.



Figure 3.10. Number of flowers on 30th day.

3.7.3.2 Number of flowers on 40th day

The number of flowers on fortieth day was enumerated after forty days of the emergence of seedlings during the growing season for five plants in each experimental unit and the average was evaluated.

3.7.4 Yield measurements

3.7.4.1 Yield quantitative characters

Harvesting of fruits was done three to four times per week and the following characters were evaluated:

3.7.4.1.1 Number of fruit plant⁻¹

Five plants from each experimental unit were pointed for enumeration of the number of fruit per plant. The process begun from the first harvest and continued until the end of the growing season and the number of fruits per plant was calculated using the following equation: -

$$\text{Fruit. Plant-1} = \frac{\text{Total fruit number/experiment unit}}{\text{Plant number in each experimental unit}}$$

3.7.4.1.2 Fruit moisture content (%)

The estimation of fruit content was carried out at harvest through measuring the fresh weight of fruit pulp of five plants from each experimental unit then the fresh pulps was oven dried at (70) C⁰ for 48 hours and the fruit moisture content was calculated as follow: -

$$\text{Fruit moisture content (\%)} = \frac{\text{Fresh weight} - \text{dry weight}}{100}$$

3.7.4.1.3 Total yield (ton. ha⁻¹)

The total yield was measured from each experimental unit and the process started from the first harvest until the last harvest at the end of the growing season.

3.7.4.2 Fruit quality traits

3.7.4.2.1 Carbohydrate content in fruits (%)

The measurement of fruit carbohydrate percentage (%) was performed according to flame method via using Flame photometer instrument (A.O.A.C., 1970 and Al - Sahaf, 1989).

3.7.4.2.2 Vitamin C (%)

Ascorbic acid (vitamin C) was measured by using 2, 6 Dichloro phenol indophenols as described in. (A.O.A.C. 1970).

3.7.4.2.3 Total soluble solids (brix° TSS)

The total soluble solids in fruits were evaluated in the juice and the process was implemented by use of the Hand Refractometer apparatus and five fruits from each experiment unit have been taken as samples for this purpose (A.O.A.C, 1980).



Figure 3.11. Total soluble solids (brix° TSS).

3.7.5 Fruit mineral contents

The random sample was collected from pulps of melon fruits in each experimental unit during the harvesting stage. The fruit pulps were air-dried then they were dried in electric oven at 70°C for 48 hours until they reached the weight stability (Al –Sahaf, 1989). The sample were crashed and grinded by electric grinder then a (0.5) mg was weighed and taken as standard weight from each grounded sample, then the digestion of the standard sample was carried out through use of the concentrated Sulphuric acid and Perchloric acid. After digestion process the prepared solution was ready for nutrient analysis.

3.7.5.1 Nitrogen percentage (%)

The total percentage of nitrogen in fruits was determined according to modified method of Kjeldahl and the sample analysis was conducted using the Microkjeldahl instrument (A.O.A.C., 1980) that cited by Black (1965).

3.7.5.2 Phosphorus percentage (%)

The Phosphorus percentage (%) in fruits was measured using the Spectrophotometer according to colorimetric methods (Matt, 1970).

3.7.5.3 Potassium percentage (%)

The measurement of leaf potassium percentage (%) was performed according to flame method by using Flame photometer instrument (A.O.A.C., 1970 and Al -Sahaf, 1989).

3.7.5.4 Calcium percentage (%)

Calcium content (%) in the fruit was measured through atomic absorption spectrophotometer that cited by Bhargava and Raphupathi (1999).



4. RESULTS AND DISCUSSION

4.1 Vegetative Growth Characteristics

4.1.1 Canopy height (cm)

The impacts of potassium (K) and humic acid (HA) application and their interaction on canopy height of melon plants were given Table 4.1. The K and HA dosages and their interaction did not have a measurably noteworthy impact on the stature of melon plants. The highest canopy height value (59.933cm) was recorded in HA3xK3 taken after by K1xHA1 (57.567 cm) treatment. The lowest canopy height value (49.400cm) was gotten in HA2xK3 interaction (Table 4.1). The highest canopy height value (55.525cm) was measured in K2 taken after by HA2 (54.767 cm) application. The lowest canopy height value (50.317 cm) was recorded in HA2 taken after by K1 (51.264 cm) doses.

Table 4.1. Effect of HA and K fertilizer and their interaction on canopy height of melon (cm)

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	57.567	44.200	50.033	53.256	51.264
K ₂	57.467	52.933	55.500	56.200	55.525
K ₃	52.467	49.400	59.933	55.400	54.300
K ₄	50.633	54.733	53.600	54.200	53.292
Mean	54.533	50.317	54.767	54.764	

HA: Humic acid; K: Potassium.

4.1.2 Number of branches (Piece)

The number of branches in melon plants did not exhibit any significance from statistics aspect due to the application of humic acid (HA) and potassium (K) fertilizers and interaction between them as demonstrated in table (4.2).

The greatest average number of branches (5.767) was accounted for melon plants that delivered the dose HA1*K1 (control). The next highest average number of branches (5.700) were recorded for plant treated with HA2*K2 in comparison with the rest treatments.

Concerning the lowest average number of branches, the least value (4.900) was accounted for melon plants applied with the dose HA2*K3. Similarly, the mean values for HA and K application did not lead to any evident increase in average number of branches (Table 4.2).

Table 4.2. Effect of HA and K fertilizer and their interaction on branch number of melon (piece)

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	5.767	5.300	5.400	5.489	5.489
K₂	5.667	5.700	5.233	5.533	5.533
K₃	5.600	4.900	5.400	5.433	5.333
K₄	5.633	5.600	5.533	5.500	5.567
Mean	5.667	5.375	5.392	5.489	

HA: Humic acid; K: Potassium.

4.1.3 Leaf areas (mm)

Data listed in table (4.3) reveal the impact of humic acid (HA) and the potassium (K) fertilizer and their interaction on the leaf area of melon crops. The application of different doses humic acid (HA) and potassium (K) to the melon did not significantly increase leaf area as compared with control. The melon plants treated with the dose HA1*K2 possessed the maximum value (72.223 mm) of leaf area followed by plants applied with the dose HA4*K4 which owned a leaf area of (71.494 mm) compared with the other treatments.

The least value of leaf area (61.158mm) was measured due to application of the dose HA3*K4 to the melon plants. The peak mean value of leaf area (69.259 mm) was measured for the HA1 dose and the second maximum mean (67.035 mm) was belonged to the K2 dose. The least mean value of leaf area (64.863 mm) was for the dose HA2 (Table 4. 3).

Table 4.3. Effect of HA and K fertilizer and their interaction on leaf area of melon

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	70.381	63.497	69.731	62.076	66.421
K₂	72.223	66.895	66.990	62.033	67.035
K₃	66.404	66.772	62.803	67.083	65.766
K₄	68.026	62.286	61.158	71.494	65.741
Mean	69.259	64.863	65.170	65.672	

HA: Humic acid; K: Potassium.

4.1.4 Stem diameter

The stem diameter of the melon crop did not significantly enhance by treatment with the (HA) and the potassium (K) fertilizer when encountered with control plants as illustrated in table (4.4). The different doses of both fertilizers were not effective in improving the stem diameter.

The maximum stem diameters (1.000 cm) and (990 cm) were estimated for melon plants treated with the doses HA2*K4 and HA1*K3 respectively while the minimum stem diameter (0.700 cm) was measured in plants took the dose HA2*K1 as shown in table (4.4).

Regarding the mean value of parameter, there were no significant variations among the different treatments of both fertilizers which were ranging between (0.85 cm) and (0.91 cm) as documented in table (4.4).

Table 4.4. Effect of HA and K fertilizer and their interaction on stem diameter (cm) of melon

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	0.850	0.700	0.927	0.924	0.850
K₂	0.907	0.880	0.933	0.840	0.890
K₃	0.990	0.843	0.847	0.847	0.882
K₄	0.897	1.000	0.923	0.960	0.945
Mean	0.911	0.856	0.908	0.893	

HA: Humic acid; K: Potassium.

4.1.5 Number of leaf plant⁻¹

Results in table (4.5) revealed that the number of leaf per plant in melon did not show any statistically significant amelioration in attribution to the application of HA and K fertilizers and their interactions in comparison with control treatment.

The remarkable number of leaves per plant (53.200) was accounted in the interaction between HA and K at the dosage HA1*K2 and the second peak value (52.067) was calculated for interaction of both fertilizers at dose HA2*K4 as compared with the remaining doses.

Concerning the lowest number of leaves per plant, a minimum value of (29.200) was accounted for plants applied with the dose HA2*K1. In case of mean value of leaf number, the highest number of leaves per plant (47.558) was observed at the HA1 application and the least mean value (39.683) was calculated for plants received K1 treatment as obvious in the table (4.5).

Table 4.5. Effect of HA and K fertilizer and their interaction on number leaf

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	44.467	29.200	43.267	41.800	39.683
K ₂	53.200	40.700	45.167	39.133	44.550
K ₃	49.567	42.800	41.067	48.033	45.367
K ₄	43.000	52.067	43.533	40.800	44.850
Mean	47.558	41.192	43.258	42.442	

HA: Humic acid; K: Potassium.

4.1.6 Leaf moisture contents

The effect of application of HA and potassium (K) and their interactions on the percentage of moisture in leaves of melon crop was not statistically varied from the control ones as listed down in the table (4.6).

Anyway, the greatest percentage of moisture (66.451 %) was found in the leaves of plants delivered the dose HA3*K4 followed by plants treatment with HA3*K2 that contained (66.448%) of moisture in their leaves. Meanwhile, the lowest percentage of moisture (63.931%) was recorded in the leaves of melon plants due to the dual interaction (HA1*K4) between the two fertilizers as it is clear in the table (4.6).

Relating the mean values of application of both fertilizers (HA and K), nearly the same amount of moisture was noticed in the leaves of melon plants for all means.

Table 4.6. Effect of HA and K fertilizer and their interaction on the leaf

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	65.636	65.009	64.587	65.019	65.063
K ₂	65.608	65.947	65.059	66.448	65.765
K ₃	65.457	65.906	64.249	65.944	65.389
K ₄	63.931	63.997	66.451	65.204	64.896
Mean	65.158	65.215	65.086	65.654	

HA: Humic acid; K: Potassium.

4.1.7 Chlorophyll content mg 100 g⁻¹

The data obtained in the table (4.7) indicated no significant variations in term of chlorophyll content regarding to the application of HA and potassium (K) along with their interactions as compared with control. Both fertilizers did not improve the chlorophyll content in melon.

The highest content of chlorophyll (58.210 mg 100 g⁻¹) was measured in leaves of plants treated with the dose HA₃*K₄ and its encounter content of chlorophyll (56.513 mg 100 g⁻¹) came after it for the dose HA₃*K₁ as compared to other treatments. The least value (49.430 mg 100 g⁻¹) of chlorophyll content was estimated at the dual interaction HA₄*K₄ as shown in the table (4.7).

The mean value of chlorophyll content for K application was not significantly different from the mean value of that parameter for the HA application. The greatest mean value (55.635) mg 100 g⁻¹ belonged to HA₃ thereafter came mean value (54.279 mg 100 g⁻¹) for K₃ application.

Table 4.7. Effect of HA and K fertilizer and their interaction on the Chlorophyll Content mg 100 g in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	53.063	49.760	56.513	52.042	52.845
K ₂	55.700	54.497	53.517	52.313	54.007
K ₃	51.590	56.410	54.300	54.817	54.279
K ₄	52.723	55.373	58.210	49.430	53.934
Mean	53.269	54.010	55.635	52.151	

HA: Humic acid; K: Potassium.

It is clear from the tables (1,2,3,5,6 and 7) that the application of HA and K fertilization had no significant influence on the vegetative growth characters of melon crop such as canopy height, chlorophyll content, leaf area, leaf moisture content, number of leaf per plant and stem diameter when compared with untreated plants (control). This could be attributed to the effect of drought stress (the study was conducted on rainfed condition) on the performance of HA and K fertilization. Productivity of plants is reliant on environmental conditions. Water stress as one of the most critical environmental stresses is capable of limiting plant development and crop productivity. The development of plant is different strategies to get rid of the negative effects of drought (Allakhverdiev and Murata, 2004; Jithesh et al., 2006; Kalaji and Łoboda, 2009). These strategies include escape, dehydration avoidance, and development of physiological tolerance to drought (Berger et al., 2010).

Water deficiency enhances cell shrinkage, promotes the cytoplasm viscosity and cell wall folding, which in turn leads to membrane damage and protein denaturation (Flexas et al. 2000). Increased activity of antioxidant enzyme is usually based on for drought resistance. (Lu et al., 2007) and changes in plant morphology, anatomy, physiology, and biophysics (Jajoo and Kawamori 2006; Kreslavski et al., 2009).

The main importance of effect of water restriction comes through its influence in the photosynthesis rate and stomata conductance for gas exchange. Either the assimilation rate or conductance is intensely more reactive than the other factor to changes in environmental or plant internal conditions. In this case, water-use efficiency is not remained constant, enhancing gradually with decreasing soil water availability (Turner, 1997).

Water stress primarily decreases the canopy development (Jefferies, 1995; Wang et al., 2003; Fleisher et al., 2008). Long-term drought conditions can reduce leaf area index and canopy longevity (Fleisher et al., 2008) and may result in decreased intercepted photo synthetically active radiation (PAR) and net assimilation over the course of the growing season (Susnoschi and Shimshi, 1985; Deblonde and Ledent, 2001). Furthermore, stable or short-term drought stress limits the development and distribution of natural and artificial vegetation and the performance of cultivated plants more than any other environmental reason (Ferreles and Soriano, 2006).

Selim et al. (2012) conducted a field trial to study the influence of HA application and water stress on the growth and yield of potato crop. The experiment results showed that water unstressed plants were found to show more efficiency than water stressed plants in improving the plant growth traits and tuber production, biochemical indicators and leaf mineral nutrient contents.

Delfine et al. (2005) also conducted a field experiment on the effect of HA on the development and yield of durum wheat and their obtained data showed that the HA had no significant effect on the photosynthesis or stomata conductance. Another reason for limited enhance in vegetative growth characters is might be because of the leaching of HA through soil drenching or to the effect of daytime on the K absorption through foliage feeding. In dry hot weather, the foliar application of fertilizers may be ineffective due to increased evaporation rate as a result of high temperature and low relative humidity. Abbas Zareian *et al.* performed a field trial and showed that folia K application did not significantly influenced plant vegetative growth parameters and the net photosynthesis, stomata conductance was decreased under drought stress.

The insignificant effect of HA and K fertilization could be resulted from the insufficient irrigation or water deficit. The water deficit can have a serious influence on yield (Sharma et al., 2016), fruit size (Fabeiro et al., 2002; Long et al., 2006), and can lead to an important decrease in biomass resulting in reduced plant development and ultimately plant death (Kusvuran, 2010). This suppress in growth under drought stress is brought about as a consequence of several physiological responses including modifications of ion balance, mineral nutrition and photosynthetic efficiency. Despite plants can be severely influenced by drought at any time of their life, and is a seldom challenges to growth and productivity, germination and seedling growth are the most critical stages during which the drought stress can be hazardous (early-season drought).

In expansion, encountering early dry season thrust in the midst of the seedling organize, when plants are exceptionally helpless to stretch, altogether inhibits the development and delays the advancement (Blum, 1996). So also, the warm push too retards the development of melon plants. The studies appeared that the impacts of warm and dry season stretch on plant development are exceptionally comparable. Considers conducted in different parts of the world exploring the plants forced to heat and dry spell stress revealed that a few plants proceed developing amid seriously dry season

periods on the off chance that they competent of controlling water misfortune successfully and reach water sources in the lower parts of soil profile. In different tall temperatures may adverse effect these plants in a brief period of time compared to the dry spell push (Semenov and Halford, 2009).

4.2 Leaf Mineral Content

4.2.1 Leaf nitrogen (N) contents (%)

Results showed in table (4.8) illustrated that the nitrogen (N) content of melon leaf was not significantly affected by application of the HA and K fertilizer when compared into comparison with the control treatment.

The maximum percentage of nitrogen has been measured in the leaves of melon plants given the dose HA₃*K₂ that was (2.053%) as compared to the other treatments and control. In contrast, the minimum percentage of the nitrogen (1.344%) was contained in the leaves of melon plants treated with both fertilizers (HA + K) at HA₂*K₂ as evident in the table (4.8).

Respecting to the mean values of nitrogen percentage, there were no significant variation among all treatments for both K and HA application.

Table 4.8. Effect of HA and K fertilizer and their interaction on the leaf nitrogen (N) content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	1.512	1.456	1.437	1.493	1.475
K ₂	1.661	1.344	2.053	1.400	1.615
K ₃	1.643	1.512	1.419	1.400	1.493
K ₄	1.699	1.643	1.587	1.652	1.645
Mean	1.629	1.489	1.624	1.486	

HA: Humic acid; K: Potassium.

4.2.2 Leaf phosphorus (P) contents (%)

The phosphorus percentage in the leaf of melon applied with different doses of HA and K is showed in table (4.9). The earned results indicated a significant influence of both fertilizers on the phosphorus percentage in leaves in comparison with control.

The highest percentage of phosphorus (0.257%) was estimated due to the dual interaction of HA and K at the dose HA4*K4 followed by the doses HA1*K4 and HA1*K3 that produced the second maximum value (0.216%) of phosphorus in the leaves of plant treated with these doses. On the other side, the lowest value (0.129%) of phosphorus content was recorded in plants given the dose HA2*K1. In case of mean values, the peak value (0.219%) was measured for K4 application and for HA application it was highest (0.194%) at HA3 and HA4 respectively. So, the obtained results there were only statistically difference at the HA * K in term of effect of different doses of HA and K on phosphorus content in melon leaf.

Table 4.9. Effect of HA and K fertilizer and their interaction on the leaf Phosphorus (P) content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K₁	0.146	0.129	0.160	0.142	0.144 C***
K₂	0.173	0.170	0.190	0.179	0.178 B
K₃	0.216	0.201	0.214	0.192	0.206 A
K₄	0.216	0.190	0.214	0.257	0.219 A
Mean	0.188 AB*	0.173 B	0.194 A	0.193 A	

(* = P < 0.05, ** = P < 0.01, *** = P < 0.001) **HA**: Humic acid; **K**: Potassium.

4.2.3 Leaf potassium (K) contents (%)

The leaf content of K element was not considerably increased by application of different doses of HA and K fertilizers compared with control plants as seen in the table (4.10).

The greatest content of K (1.573%) was measure in the leaves of melon plants took the HA and K at the dose HA3 * K2 and the other high content of K (1.431%) was belonged to plants received the dose HA3 * K3. For the lowest content of K element, it was determined in the leaves of melon plants given the dose HA2 * K1 which was

(1.077%) as demonstrated in the table (4.10). For mean values for HA and K, no prominent variations had been recorded between the different doses of both fertilizers.

Table 410. Effect of HA and K fertilizer and their interaction on the leaf K (K) content (%) in melon

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	1.300	1.077	1.389	1.360	1.282
K₂	1.336	1.383	1.573	1.187	1.370
K₃	1.259	1.265	1.431	1.241	1.299
K₄	1.348	1.312	1.330	1.398	1.347
Mean	1.311	1.259	1.431	1.296	

HA: Humic acid; K: Potassium.

4.2.4 Leaf calcium (CA) contents (%)

Results in the table (4.11) unveiled the response of leaf calcium content of melon to the soil drenching of HA and foliar feeding with the K fertilizer. The application of HA and K resulted in no significant increase in the calcium element in the melon leaves in comparison with the control.

For interactions, the most elevated Ca amount (7.333%) in melon was obtained from K₂ x HA₄ interaction taken after by K₄ x HA₁ and K₄ x HA₂ (7.000%) applications, individually. The most reduced Ca amount was obtained from K₁ x HA₃ (4.333%) application.

No significant variations were also noticed due to mean effect of HA and K and the greatest calcium content (6.625%) was determined for K₄ application and the second highest content (6.250%) was possessed by HA₄ application and the lowest leaf calcium content (5.396%) was found for HA₁ and K₁ applications in consequent as demonstrated in Table 4.11.

Table 4.11. Effect of HA and K fertilizer and their interaction on the leaf calcium (Ca) content (%) in melon

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	4.583	7.000	4.333	5.667	5.396
K₂	4.667	6.333	6.333	7.333	6.167
K₃	5.333	4.500	7.000	6.000	5.708
K₄	7.000	7.000	6.500	6.000	6.625
Mean	5.396	6.208	6.042	6.250	

HA: Humic acid; K: Potassium.

The above mentioned results indicated that most of leaf nutrients (N, K and CA) were not significantly improved with the application of HA and K fertilization and their interactions except the phosphorus nutrient in the leaf which was remarkably improved by doses of HA and K. The non-significant effect of HA could be ascribed to the effect of leaching of nutrients provided by it and reduced uptake of nutrient by roots in the soil of the experiment. Nutrient leaching is defined as the movement of dissolved nutrients downward in the soil profile with percolating water. Nutrients that are leached downward away from the rooting zone of the vegetation are usually lost from the system, despite these nutrients can be recycled if roots grow and extend deeper. Nutrients that are leached might cause to groundwater pollution in regions with intensive agriculture. Nitrate leaching is also considered as a significant source of soil acidification. In moist climates, some nutrients are easily leached even under natural vegetation, but agricultural activities can significantly increase leaching losses (Havlin et al., 1999).

In certain soils, however, water can percolate into the subsoil through constant vertical macro pores when the bulk soil is dry. This is particularly significant in cracking clay soils (Vertisols) at the onset of the rainy season (Smaling and Bouma, 1992). Macro pores are also produced by faunal activity and root development. They can only conduct water under conditions of heavy rainfall; under other conditions they are vacant with air. Nutrient leaching may be enhanced by macro pore or bypass flow after the surface application of fertilizers, as a result of a solution with high nutrient concentration then infiltrates quickly into the soil with little contact with the soil matrix. On the other hand, nutrients present in smaller soil pores are also protected by macro pore flow from being leached by fast channeling away surplus water (Cameron and Haynes, 1986; van Noordwijk et al., 1991).

Some nutrients are more susceptible to leaching than others. The leaching hazards for a nutrient enhances with its mobility in the soil. Among nutrient anions, nitrate is mostly susceptible to leaching because it has a neglect interaction with the adversely charged matrix of most topsoil and is, therefore, very mobile in the soil. As a consequence, leaching may play a significant role in negative nitrogen balances of agricultural systems (Smaling et al., 1993). In seasonal climates, nitrate is also mainly subjected to leaching since a mineralization flush of organic N that creates the release of

large quantities of nitrate in the topsoil often appear when dry soil is rewetted (Birch, 1960).

Phosphate is always immovable in most soils in contrast to nitrate and sulphate, because of its tendency for precipitation and adsorption to mineral surfaces, and leaching is, therefore, far from occurrence, except in certain very sandy and organic soils (Wild, 1988). Dissolved organic phosphorus forms are more moveable in soil than phosphate (Havlin et al., 1999). Phosphorus may also be lost if surface soil particles are eroded in runoff.

Foliar feeding of K, on the other hand, also did not significantly improve most leaf nutrient content of melon, especially K content. This is effective role of K fertilization maybe due to the influence of dry weather and high temperature stress during the summer season. High temperatures stress could result in several defects in plant organs and can decline and decrease yield in plants (Guilioni et al., 1997; Ismail and Hall, 1999; Vollenweider and Gunthardt-Goerg, 2005). In melon, super-optimal temperatures is the major reason of harms like inhibition of seed germination and seedling growth, depression of female flower expression (Kamiya and Tamura, 1965), failure of fertilization, and ultimately suppression of fruit growth and sugar accumulation (Suzuki and Masuda, 1961). Furthermore, the applied K may be mostly invested in the drought tolerance by melon plants as K plays an essential role in the opening and closing of stomata and turgidity of guard cells during hot dry conditions.

Potassium (K) is very critical for existence of crop plants under abiotic stress conditions. K is also necessary for many physiological pathways under stress conditions (Marschner, 1995; Mengel and Kirkby, 2001).

So, the increased content of phosphorus (P) might refer to its immobility and the HA application to the soil. Mohamed and Ali (2016) investigated the effect of HA along with some organic, bio fertilizers and mineral fertilizers on mineral content of cantaloupe plants and they found an important increase in the phosphorus content of leaves.

4.3 Flowering Traits

4.3.1 Number of flowers on 30th day

According to data present in table (4.12), the number of flowers on 30th day was not significantly variants from those accounted for control plants with means that neither doses of K fertilizer and HA nor their interactions possessed a noticeable impact on the number of flowers on 30th day in melon crop.

On the other hand, the highest number of flowers on 30th day was calculated for melon plants that treated with K and HA at the dosage K₂ * HA₁ with the value (8.125) in comparison with other treatments and control plants. The lowest number of flowers (3.000) was recorded in plants applied with K₁ * HA₂. In addition, the maximum mean value of number of flowers on 30th day was accounted for the HA₃ application that was (7.411) as compared to the highest mean value for K (6.945) in K₄ application as illustrated in Table 4.12.

Table 4.12. Effect of HA and K fertilizer and their interaction on the number of flower on 30th day in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	7.333	3.000	7.500	7.014	6.212
K ₂	8.125	6.583	7.364	5.458	6.883
K ₃	6.344	5.938	7.521	6.667	6.617
K ₄	7.042	7.042	7.260	6.438	6.945
Mean	7.211	5.641	7.411	6.394	

HA: Humic acid; K: Potassium.

4.3.2 Number of flowers on 40th day

On contrary to the number of flowers on 30th day, the number of flowers in melon plants on 40th day was significantly enhanced in ascription to the application of HA and K fertilizers when compared with the untreated plants as seen in table (4.13).

Melon plants that received the HA and K fertilizer at the dose HA₁ * K₂ owned the greatest number of flowers on 40th day having (17.625) flowers followed by the dose HA₃ * K₁ which resulted in producing (13.854) flowers in melon crop. For the

minimum number of flowers on 40th day, the dual interaction (HA2 * K1) given to melon made the lowest number of flowers (6.250) in comparison with other treatments.

For mean values of number of flowers, the mean value of HA application surpassed the mean value for K application and it was significant ($P < 0.05$) at the values (13.581) and (13.255) respectively. It can be concluded from the results that the number of flowers was remarkably improved due to (HA * K) interaction (table 4.13).

Table 4.13. Effect of HA and K fertilizer and their interaction on the number of flower on 40th day in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	13.396	6.250	13.854	13.660	11.790
K ₂	17.625	10.796	13.583	10.250	13.064
K ₃	10.823	11.688	13.333	12.828	12.168
K ₄	12.479	13.344	12.250	12.188	12.565
Mean	13.581A*	10.519B	13.255A	12.231AB	

(* = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$). **HA**: Humic acid; **K**: Potassium.

It is obvious from the previous results that the number of flowers on the 30th day was not considerably influenced by the HA and K fertilization, whereas the same was not true for the number of flowers on the 40th day which was notably enhanced by different doses especially K fertilization. This could be because of the role of K in the cell division and translocation of soluble carbohydrates to the apical meristems which promote flowering and hence increase number of flowers.

With increasing K application, the development condition of plant was found to be ameliorated and it flowered earlier. Plant growth is slowed and its flowering is retarded when K is deficient, which may be attributed to the low K that obstacle the transportation of soluble carbohydrates from source to apical meristem, and low carbohydrates accumulation in the apical meristem prevents flowering (Eshghi and Tafazoli, 2006). In addition, K takes place an imperative role in the preservation of the expansion of the cell. When plant is deficient in K, the output of sugar is also inhibited by the plant to preserve its morphological characteristics and cell turgor, and the formation of the genital organs is further impacted (Romheld and Kirkby, 2010). This may also be one of the causes of the late flowering of plants in the absence of Zewail et al.(2011)performed a field study to search the influence of K fertilizer, phosphoric acid and NAA on the development, flowering and yield of faba bean plants (*Faba vulgaris*).

The tested data revealed that the K fertilizer along with other treatments caused a significant increase in the flowering behavior (number of flowers/plant and % of fruit setting) as compared to control plants. Moreover, the application of K plays an important role in the sex ratio in the plant. Moreover, the K contributes in the sex ratio in the plant. It is well-known to minimize the number of male flowers and increases the number of female flowers hence change sex ratio.

4.4 Fruit Quality Characteristics

4.4.1 Number of fruits plant⁻¹

The impacts of HA and K applications and their intuitive on the number natural products per plant were displayed in Table 4.14. The HA and K applications did not have a noteworthy impact on the number of natural product per plant compared to control plants. The most noteworthy number of natural products per plant was recorded in foliar HA4xK3 (3.188 natural products) and taken after by HA1xK2 (2.917 natural products) treatment. In case of mean value effect, there were no significant differences between mean value for HA application and mean value for K application in term of fruit number per plant with the greatest mean value (2.786) being accounted for HA3 and (2.766) for K4 as demonstrated in Table 4.14.

Table 4.14. Effect of HA and K fertilizer and their interaction on the number of fruit

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	2.750	2.562	2.813	2.611	2.684
K₂	2.917	2.667	2.896	2.250	2.682
K₃	2.500	2.375	2.750	3.188	2.703
K₄	2.625	3.000	2.687	2.750	2.766
Mean	2.698	2.651	2.786	2.700	

HA: Humic acid; **K:** Potassium.

4.4.2 Yield in melon (Ton ha⁻¹)

The experimental data listed in table (4.15) revealed that the melon yield (ton ha⁻¹) was not statistically significant from that of control regarding to the different doses of HA and K and their interactions.

The peak value of yield (ton ha⁻¹) was measured for melon plants that treated with HA and K with the dose HA4 * K4 with a total yield of (25.450 ton ha⁻¹) and the next highest value (20.217 ton ha⁻¹) was attributed to the dose HA4 * K3. But the lowest yield (16.150 ton ha⁻¹) was noted for melon plants applied with HA and K at the dose HA2 * K2.

For mean values of yield, it was highest for HA application and K application at HA4 and K4 with mean values of (20.353 ton ha⁻¹) and (20.200 ton ha⁻¹), respectively Table 4.15.

Table 4.15. Effect of HA and K fertilizer and their interaction on the yield ton Ha in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	19.357	19.870	19.483	18.333	19.261
K ₂	18.525	16.150	19.767	17.410	17.963
K ₃	18.233	19.467	18.227	20.217	19.036
K ₄	19.700	19.000	16.650	25.450	20.200
Mean	18.954	18.622	18.532	20.353	

HA: Humic acid; K: Potassium.

4.4.3 Fruit moisture content (%)

The fruit moisture content of melon showed no observable response to the application HA and K fertilization along with their interactions as revealed in table (4.16). All treatments did not significantly differ from the control one (HA1 * K1).

The highest moisture amount (82.490%) was recorded in fruits of plants received both fertilizers at the dose HA4 * K4 which surpassed all other treatments and the dose HA4 * K2 followed it producing the value (82.103%). The inversed amount of

fruit moisture was found in plants treated with the dosage HA3 * K2 with the least percentage (80.447%) of moisture in the fruits.

Regarding mean values of moisture content, there were also no important differences between the mean values of HA and K application as demonstrated in the table (16). The mean value for K ranged from (81.475 %) to (82.034 %) and from (81.447 %) to (81.929 %) for HA.

Table 4.16. Effect of HA and K fertilizer and their interaction on the fruit moisture content (%) in melon

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	80.747	82.320	81.533	81.300	81.475
K₂	81.700	82.413	80.447	82.103	81.666
K₃	81.680	80.833	82.007	81.823	81.586
K₄	82.057	81.790	81.800	82.490	82.034
Mean	81.546	81.839	81.447	81.929	

HA: Humic acid; K: Potassium.

The yield quantitative parameters of melon (total yield, fruit number/plant and fruit moisture content) did not significantly improve with the different doses of HA and K fertilization as clarified in the tables (4.14, 4.15 and 4.16). Despite it is supposed that treating melon plants with HA and K fertilization lead to stimulates and increase plant vegetative development and yield of plants, our obtained data indicated the contrast.

The non-significant influence of HA and K might refer to the effect of hot and drought stresses. Drought conditions directly affect the yield and drought tolerance is the most critical trait correlated with yield (Maleki et al, 2013). A/biotic stresses are the most limiting reasons limiting plant development and metabolism (Makbul et al., 2011). Various studies have indicated that root length is significantly increased in while there is a reduction in shoot length under water stress (Turkan et al., 2004). It is generally evident that the first target of a/biotic stress factors is photosynthetic efficiency (Liu and Huang 2008). The melon is often known to have moderate resistance to salinity and drought. It has been proven that these stresses result in several types of damage such as growth inhibition (Franco et al., 1997).

The stomata conductance value of all the melon genotypes has reduced continuously under drought and salt stress. Drought stress produced an important increase in the root length (Musa et al, 2013).

The interaction of canopy temperature with relative water amount is reversible. Moreover for single plant yield (Naroui Rad, 2017). Under drought stress, in principal component analysis the first component of which accounted for 26.98% of the total variation, was intensely related with fruit traits and single plant yield.

Drought stress may also cause a significant reduction in the shoot fresh and dry weight of treated plants in comparison to the control plants. The reduction in photosynthesis in water stressed plants could be credited to both stomata factors. Most researchers are in agreement about that the stomata closure and the formed CO₂ shortage in the chloroplasts is the main reason for minimized photosynthesis under slight and moderate stresses (Mohammadzadeh and soltani, 2015).

High temperature stress, on the other hand, may also negatively affect the yield of melon under water deficit. Heat stress may also limit the absorption of K through leaf feeding due to low stomata conductance to prevent intense evapotranspiration during hot days of summer season. This may directly influence the root uptake of nutrients and hormone-like substances provided by soil drenching of humic acid. Baker and Reddy (2001) conducted a field trial investigating the effect of heat stress on the development and yield of muskmelon. Their results demonstrated a noteworthy decrease in the production of the crop as a result of the limitations caused by high temperature.

High-temperature stress suppresses root development which negatively reflected on the development of shoot by constraining the supply of water and mineral nutrients, influencing synthesis of hormones produced in roots and translocate to shoots, and altering sink-source relationships between shoots and roots. Anju Giri *et al.* (2017) conducted a field research on the tomato crop to find out the influence of heat stress on the levels of nutrient uptake and assimilation protein in the tomato roots and they reported that the heat stress occasioned in a prominent reduction in the levels of nutrient uptake and assimilation proteins which lead to reduction in yield.

The depressed effect of HA and K on the fruit number might be due to the high flower defoliation and less fruit setting percentage due to the heat and drought stresses. These abiotic stresses could be a reason for reproductive problems (Morrison and

Stewart, 2002; Muhl, du Toit, Steyn, and Apostolides, 2013). They can also influence the size of flower parts (Carroll et al., 2001; Koti, et al., 2005; Sato et al., 2006). If these abiotic stresses emerge during flowering, they affect flowering negatively. High temperature and water stress also influence nectar amounts. Nectar volume generally enhances with elevating temperature, up to a species-specific optimum temperature (Nicolson and Susan, 2007). When temperature increases above the optimum limits, nectar volume decreases which directly influence the pollination and fertilization processes in plants through affecting pollen development and viability (Snider and Oosterhuis, 2011; Mu et al., 2015).

The natural product dampness substance was not emphatically influenced by HA and K applications, whereas the natural products in a few dosages contained marginally higher dampness substance than control. The credited to the interaction of K with water stretch to keep up the natural product dampness. Fish et al. (2010) appeared that K application expanded water resilience and relative water substance in melon plants developed beneath water stretch conditions.

The reduction in the quantitative yield parameters of melon crop may refer to the deficit irrigation along with high summer temperature that reached about $(48)^{\circ}\text{C}$ which negatively reflected on the action of soil drenching of HA and foliar spraying of K fertilizer. Deficit irrigation which is defined as the act of applying water below full crop-water requests, deliberately makes plants subjected to a certain level of moisture stress. Although deficit irrigation can decrease water consumption for the irrigation of annual and perennial crops and increase water use efficiency for irrigation water, but it also reduces yield in some crops and cultivars (Ferreles and Soriano, 2007). Sharma et al. (2014) estimated yield and fruit quality responses of several cultivars of melon (*Cucumis melo* L.) to two irrigation rates (100%ETc and 50%ETc), and showed that deficit irrigation led to a 30% reduction in marketable yield, mainly because of a decrease in fruit size.

High temperature or heat stress also affects plant growth and yield. Temperature is able to influence development in plants at different stages. The reproductive stage in plants is well-known to be the most sensitive stage when compared to the vegetative stage. High temperature might harm reproductive organs at, or prior flowering. The high temperature rates can seriously damage pollen germination and pollen tube growth

which cause a remarkable decrease in the yield. Several studies have proven that the high temperature or heat stress have resulted a significant decrease in the yield in various crops. Fruit formation in different crops such as pea (Ahmed and Hall, 1993), soybean (Ferris et al., 1998), groundnut (Prasad et al., 1999), beans (Porch and Jahn, 2001), pepper (Erickson and Markhart, 2002), and tomato (Sato et al., 2004) showed sensitivity to heat stress and in fruit and seed formation were decreased as temperature rise.

4.5 Mineral Nutrition

4.5.1 Fruit nitrogen (N) content (%)

The nitrogen content in fruits of melon was measured and statistically analyzed as cleared in table (4.17). The nitrogen content of fruit was ranged from (0.672 %) to (1.157 %) with no statistically significance differences in this element content of fruits by application of different doses of HA and potassium (K) applications.

The nitrogen percentage in fruits of melon plants drenched with HA and sprayed with K at the dose HA1 * K3 was higher than other treatments which contained (1.157%) following by (1.045%) of nitrogen that found in fruits of plants have had the dose HA3 * K4. The vice versa was true in fruits of plants given the dose HA4 * K3 which possessed the lowest nitrogen content (0.672%).

Additionally, the mean value of fruit content of nitrogen showed no significant differences of K application and HA application as obvious in Table 4.17.

Table 4.17. Effect of HA and K fertilizer and their interaction on the fruit nitrogen content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	0.803	0.784	0.821	0.896	0.826
K ₂	0.859	0.709	0.933	0.821	0.831
K ₃	1.157	0.821	0.765	0.672	0.854
K ₄	0.803	0.859	1.045	0.700	0.852
Mean	0.905	0.793	0.891	0.772	

HA: Humic acid; K: Potassium.

4.5.2 Fruit phosphorus (P) content (%)

The fruit content of phosphorus was significantly ameliorated with application of HA and K. Both fertilizers with different doses caused a remarkable increase in phosphorus percentage of fruit of melon. The maximum percentage (0.183) % of this element was determined in the fruits of melon plants that have had the dose HA3 * K4 and the subsequent peak value (0.179%) was measured for the doses HA3 * K2 and HA1 * K4 whereas the lowest percentage of phosphorus was estimated in the fruits of plants treated with HA and K at HA2 * K1 with the value (0.095%) as conspicuous in the table (4.18).

In case of mean value influence of K and HA application, the highest mean value (0.152%) was determined for K4 application followed by the mean value (0.151%) which was measured for HA3 while the least mean value (0.115%) was measured for K3 application and (0.116%) for HA2 application. So, when the obtained results were statistically evaluated for the influence of HA and K and their interactions on phosphorus content of fruit, there were statistically significant ($P < 0.05$) difference only in HA*K interactions.

Table 4.18. Effect of HA and K fertilizer and their interaction on the fruit phosphorus content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	0.136	0.095	0.131	0.143	0.126 AB*
K ₂	0.140	0.103	0.179	0.137	0.140 AB
K ₃	0.114	0.122	0.113	0.111	0.115 B
K ₄	0.151	0.143	0.183	0.132	0.152 A
Mean	0.136 AB*	0.116 B	0.151 A	0.131 AB	

(* = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$). **HA**: Humic acid; **K**: Potassium.

4.5.3 Fruit potassium (K) content (%)

HA and K applications did not exhibit any significant influence on the K content in fruits of melon according to data listed in Table 4.19. However, for the interaction, the greatest percentage of K (0.647 %) was measured in HA3 * K1 followed by (0.623

%) for HA4 * K4. In contrast, the minimum percentage of K in fruit (0.505%) was found at HA3 * K4.

For the mean values, the maximum percentages (0.603 %) and (0.579%) was measured for the K1 and HA4, respectively, while the lowest percentages of K (0.524%) and (0.538 %) was recorded for K2 and HA2, respectively. The statistically analyzed data showed that the impact of HA and K and their interactions on fruit K content was not significant when compared to control treatment.

Table 4.19. Effect of HA and K fertilizer and their interaction on the fruit K content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	0.617	0.561	0.647	0.588	0.603
K ₂	0.528	0.511	0.522	0.534	0.524
K ₃	0.540	0.552	0.546	0.570	0.552
K ₄	0.570	0.528	0.505	0.623	0.557
Mean	0.564	0.538	0.555	0.579	

HA: Humic acid; K: Potassium.

4.5.4 Fruit calcium (CA) content (%)

The results showed in the table (4.18) indicated a prominent enhancement in the calcium content of melon fruits in response to soil drench application of HA and foliar sprays of K fertilizers in comparison with control. The calcium content in fruits of melon ranged from (0.762%) to (1.592%). For the maximum percentage of calcium, it was measured in the fruits of melon plants treated with the dose HA1 * K4 which was (1.592%) followed by the (1.408%) that was measured for HA2 * K4. Moreover, the lowest percentage of calcium was estimated for the dose HA2 * K2 resulting in a value of (0.762%) as seen in the table (4.20).

In addition, the peak mean value of calcium percentage (1.379%) was recorded for K4 and the lowest (1.048%) for K2. For HA application, the highest mean value (1.262%) was measured for HA4 and the least mean value (1.148%) for HA3 application. It is clear that there were important changes in calcium percentage of fruit only due to HA * K application.

Table 4.20. Effect of HA and K fertilizer and their interaction on the fruit calcium content (%) in melon

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	0.980	1.796	0.850	1.150	1.194AB*
K ₂	0.898	0.762	1.197	1.333	1.048B
K ₃	1.224	0.844	1.252	1.340	1.165AB
K ₄	1.592	1.408	1.292	1.224	1.379A
Mean	1.173	1.203	1.148	1.262	

(* = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$). HA: Humic acid; K: Potassium.

According to the earned results that listed in tables (17, 18, 19, and 20), it is apparent that the different doses of HA and K fertilizing had no profound influence on the fruit content of N and K, whereas P and Ca nutrients were significantly ameliorated by application of both of them. The considerable amounts of phosphorus and calcium in the fruits could attribute to the immobility of both nutrients in the soil and their availability for uptake by roots. Some nutrients are more susceptible to leaching than others. The leaching hazards for a nutrient enhances with its movement in the soil. Nitrate is generally susceptible to leaching among nutrient anions because it has a neglect collaboration with the negatively charged matrix of most topsoil and is, therefore, very moveable in the soil (Robertson, 1989; Schroth et al., 1999a).

The high calcium content of fruit might be due to the affirmative influence of HA on the Ca content of fruits. Functional groups of HA are commonly forming complexes with metals to via different means. These functional groups of humic molecules allow the percolation of cations in the soil and function as natural chelates in the soil thereby increasing the concentration and uptake of these actions by plant roots. This was found by Sahin et al. (2014) who carried out a field experiment to inspect the effect of HA upon phosphorus uptake on the development, yield and mineral content of tomato crop. Their results showed a important enhancement in the plant content of calcium element when compared with the control.

Humus substances play a major part within the accessibility and assimilation of plant supplements; hence he expanded P substance of natural items with humic corrosive application may be connected with the made strides P take-up alongside other components such as calcium. Sonmez and Gulser (2016) examined the effect of HA and calcium nitrate applications on the development and supplement take-up of pepper

(*Capsicum annuum*) plants. The most elevated Mn, Zn, K, Ca, Fe, and P substance were detailed in humic corrosive applications. Paulauskiene et al (2018) detailed that application of humic corrosive and ocean growth extricates blend unmistakably upgraded mineral substance in okra (*Abelmoschus esculentus*) plants.

The improved content of phosphorus could also refer to the positive impact of K fertilization. K can influence many of the developments that are significant for the establishment of yield in plants such as water budget, production of carbohydrates and the transportation of assimilates. Al-Obeed et al. (2013) showed that the application of K fertilizer produced a significant increase in the phosphorus content of the plant.

The non-significant effect of HA and K and their interaction on the fruit K ratio may be because of presence of enough amounts or levels of this element in the soil of the trial site which limited the response of the melon plants to the K fertilization. No melon plant answer to K doses was obtained in a soil having 57 to 68 mg kg⁻¹ of K (Coelho et al., 2001). Another possibility of less positive effect of K fertilization on the mineral composition of melon fruits could be the involvement of the most foliar absorbed K in the drought and heat stress tolerance during the hot dry weather. Potassium (K) is very critical for existence of crop plants under ecological stress conditions. K and Ca are always known for their essential contribution in augmenting plants tolerance against drought stress (Nasri et al. 2008; Yuan-yuan et al. 2009).

Drought inhibits plants from taking up mineral matters from their growing media causing insufficiency symptoms of such mineral matters on plants (Arjenaki et al. 2012). Potassium is also vital for many physiological pathways, such as photosynthesis, transportation, turgidity and initiation of enzymes under stress (Marschner, 1995; Mengel and Kirkby, 2001). Furthermore, the concentration of K in the fruits is usually greatly decreased with the rise in the fruit size development. This was found by Changwei Shen et al. (2016) carried out a field test to study foliar K application on fruit development rate, K gathering, yield, and quality of 'Kousui' Japanese pear and they found that the K content of fruits was remarkably decreased with increase in the fruit size from expansion stage to maturation which meant that the foliar application of K is mostly required during the fruiting period of the plant lifecycle.

The inconsiderable fruit content of nitrogen is maybe to the higher levels of calcium content. Fruits with lower calcium content are more susceptible to several

physical, physiological and pathological disorders and have a shorter postharvest storage life. In general, high nitrogen content in fruits lead to low conserving quality and excessive nitrogen levels are commonly delaying the maturity of fruits, stimulates poor visual color development and also prevents the change of ground color from green to yellow. This is ascribed to the imbalance in the essential amino acids resulted from high levels of nitrogen in the soil. The higher percentage of nitrogen in the fruit directly reduce the calcium content and Ca/K ration which lead to increase the susceptibility of fruits to abrasion, bruising injury, physiological disorders and various pathogens (Mohammed Wasem Sidiqui, 2015).

4.6 Fruit Quality Characteristics

4.6.1 Carbohydrate content in fruits (%)

The effect of soil application of HA and leaf feeding of K fertilizers on the carbohydrate content (%) and their interaction was measured and given in the table (4.21). The carbohydrate content of fruits was ranging from (10.442%) to (17.482%) and the maximum content of carbohydrate was recorded for the dose HA3 * K2 that gave (17.482%) of carbohydrate in melon fruits. The next highest content (17.388%) was found in fruits of plants treated with HA and K fertilization at the dose HA3 * K4 compared to control and other different treatments. Away from this, the lowest carbohydrate content was evaluated in response to the dose HA2 * K1 resulting in (10.442%) of carbohydrates in the melon fruits. Concerning the mean values of carbohydrate content, there were also statistically significant variations for K and HA application and the highest mean value (15.482%) belonged to the HA3 followed by the second maximum mean value (14.592) % owned by K2 application. The lowest mean value for K was (11.726%) and for HA it was (12.313%). Our statistically evaluated results indicated that the influence of HA and K fertilization was important at their dual interactions (HA * K).

Table 4.21. Effect of HA and K fertilizer and their interaction on the fruit carbohydrate content (%) in fruits

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	14.207	10.442	16.285	14.837	13.943A*
K ₂	15.624	13.451	17.482	11.812	14.592A
K ₃	12.820	10.678	10.773	12.632	11.726B
K ₄	12.506	14.679	17.388	11.812	14.096A
Mean	13.789AB*	12.313B	15.482A	12.773B	

(* = P < 0.05, ** = P < 0.01, *** = P < 0.001). HA: Humic acid; K: Potassium.

4.6.2 Vitamin C content in fruits (%)

The results in Table 4.22 shows the statistically measured influence of HA and K and their interactions on the ascorbic acid (vitamin C) content of melon fruits. Both the HA and K fertilizers led to no significant improvement in the vitamin C content of melon when bringing it to comparison with the control treatment.

The greatest value of vitamin C (74.667%) was estimated in the fruit of melon that were applied with HA and K at the dose HA₃ * K₄ and HA₄ * K₃ in consequent. On contrary, the lowest amount of vitamin C was found in the fruits of melon plant given the dose HA₂ * K₁ having (42.000%) of vitamin C compared to other different treatments. Concerning the mean value effect of HA and K, it was also no significant relating the vitamin C content. The peak mean value of this vitamin (65.333%) was recorded due to HA₃ application followed by (63.583%) which was measured in case of mean value for K application and the lowest mean value for HA was (56.000%) and for mean value of K it was measured as (58.333%) as shown in Table 4.22.

Table 4.22. Effect of HA and K fertilizer and their interaction on the vitamin C content (%) in fruits

Applications	HA ₁	HA ₂	HA ₃	HA ₄	Mean
K ₁	65.333	42.000	60.667	65.333	58.333
K ₂	60.667	60.667	51.333	60.667	58.333
K ₃	51.333	56.000	74.667	65.333	61.833
K ₄	51.333	65.333	74.667	63.000	63.583
Mean	57.167	56.000	65.333	63.583	

HA: Humic acid; K: Potassium.

4.6.3 Total soluble solids content in fruits (° brix)

The soluble solid contents of the melon applied with different doses of K and HA were measured and given in Table 1. SSC values ranged from 7.000 ° brix to 8.333 ° brix and the highest SSC value was found in HA3*K3 application with 8.333 ° brix. It was found that this value was followed by HA3*K4 with the 8.250 ° brix. The lowest SSC value was determined in HA2*K3 application with 7.000 ° brix and this value followed by 7.167 ° brix value measured HA1*K1, HA1*K3 and HA3*K1 applications. In addition, the highest mean value was determined means of K4 applications with 7.813 ° brix and this value followed by means of HA3 application with 7.708 ° brix while the lowest mean value was found K2 application with 7.396 ° brix this value followed by means of HA1 application with 7.417 ° brix. So, when obtained results evaluated statistically for the effect of altered levels of the K and HA fertilization on the soluble solid contents of melon, it was found that there were statistically significant ($P < 0.05$) difference only in HA*K interactions as illustrated in the table (4.23).

Table 4.23. Effect of HA and K fertilizer and their interaction on the total soluble solids content (brix°) in fruits

Applications	HA₁	HA₂	HA₃	HA₄	Mean
K₁	7.167	7.500	7.167	7.889	7.431
K₂	7.667	7.500	7.083	7.333	7.396
K₃	7.167	7.000	8.333	7.500	7.500
K₄	7.667	7.833	8.250	7.500	7.813
Mean	7.417	7.458	7.708	7.556	

(* = $P < 0.05$, ** = $P < 0.01$, *** = $P < 0.001$). **HA**: Humic acid; **K**: Potassium.

It is obvious from the analyzed data the most of the fruit quality characters (carbohydrate percentage and total soluble solids) was considerably affected by different doses of HA and K fertilization and the vitamin (C) content was exceptional and its content in fruits of treated plants was not greatly variant from that of control plants. The increased fruit content of carbohydrates and total soluble solids could outcome of the beneficial impact of HA on the fruit quality. HA is the organic substance that is naturally existed in the soil and can provide various advantages to the soil such as structure amelioration, conservation of moisture and microbial activity, also function as

a chelating agent, which inhibits fixation, leaching, and oxidation of mineral matters and thus stimulates the ion interchange capacity and nutrient obtainability in the soil (Ouni et al., 2014). In addition, HA is considered as one of the organo-mineral stimulants that enhance the soil productiveness and has a good effect at the different stages of plant development from seed germination and seedling emergence to the development of plant organs (Kahraman, 2017).

Furthermore, the HA mimics the plant growth regulators and increases the enzyme action and improve the penetrability of the cell membrane hence promoting the plant development and yield amount and quality (Asri et al., 2015). Shalaby and. El-Messairy (2018) investigated the effect of HA on the development and yield of melon plants and they reported that the dosing plant with HA significantly increased yield and yield quality like total soluble solids (TSS) %.

Mohamed and Ali (2016) conducted a field study on the influence of organic, bio fertilizers and mineral fertilizers on the development and productivity of cantaloupe crop and found that the HA significantly improved yield parameters such as fruit diameter, fruit circumference, fruit fresh weight TSS %, total sugars % and total yield. Ekinci et al. (2015) studied in a field experiment to effect of calcium, boron humate and HA on development, yield and mineral matter level of tomato and cucumber and revealed that the HA caused a profound improvement in the fruit quality parameters of both crops.

On the other hand, K fertilization similarly acts an significant role in the amelioration of fruit quality. The increased influence of K on plant development may be attributed to the fact that K has a vital function in sevral metabolic pathways (Taiz and Zeiger, 1998). Any deficiency or excessiveness in K level may negatively influence fruit quality, while sufficient K nourishment is directly correlated with enhanced yields, fruit size, high TSS and ascorbic acid amounts, better fruit color, improved shelf life, and shipping quality of several horticultural crops (Asri and Sonmez, 2010).

Tang et al. (2012) researched the effect of K doses on fruit quality in two varieties of melon in soilless culture at protected cultivation. Four K doses in nutrient solution were used. Their data demonstrated that the K doses of 234-351 mg/L significantly enhanced the concentrations of TSS, sucrose, and volatile acetate components in fruit flesh, which should enrich the taste and aroma of melon.

Bouzo (2018) estimated the effect of potassium (K) and calcium (Ca) applied through fertigation with three doses for each one on yield and quality of melon (*Cucumis melo* L.) through two field experiments. They observed a significant impact of K on the quality and yield when compared with calcium (Ca) treatment.

The improve percentage of carbohydrates in the fruits of melon maybe because of the supportive effect of K fertilizer on them. As it is common, K has an essential role in the photosynthesis process and the subsequent carbohydrate transport and metabolism, which cause to increase the crop yield and improve the fruit quality (Lu et al., 2016). K is necessary not only for higher total yield but also for the ameliorated quality of the harvest. Thus, K guarantee high-value crops and profits to growers. K is sometimes called the “quality element” for its connection with better crop production, which is agreed by many scientists.

The reason for low or non-significant amount of ascorbic acid (vitamin C) in the pulp fruits of melon crop could be the increased percentage of TSS related complexes like reducing sugars, non-reducing sugars and total sugars which decreases the percentage of ascorbic acid during the ripening stage of fruits. Menon and Ramana Rao (2012) evaluated nutritive value of melon fruit as exposed by its biochemical traits during altered degrees of ripening and showed that the young melon fruits had greater vitamin C content than the fully ripened fruits and the sweetness of muskmelon fruit was due to high accumulation of sucrose sugar due to starch degradation by activity of amylase enzyme.



5. CONCLUSION AND RECOMMENDATIONS

A. Conclusions

Based on the results of the field experiment, it can be concluded:

- 1- Foliar K and soil HA applications did not have a noteworthy effect on vegetative development parameters such as the number of branches, canopy height, stem diameter, chlorophyll amount, leaf number and leaf moisture content (%).
- 2- Various dosages of humicacide and K applications did not altogether increase the leaf N, K and Ca amountd, while P amount of leaves was significantly improved with the applications of both HA and K.
- 3- HA and K applications did not essentially make differences in yield components.
- 4- HA and K applications had a positive effect on fruit P and Ca amounts, whereas did not greatly ameliorated the fruit content of N and K.
- 5- Some traits such as carbohydrate percentage in the fruit and total soluble solids (brix°) were significantly increased due to application of HA and K applications.

B. Recommendations

Depending upon the precedent conclusions the following recommendations can be presented: -

- 1- Further attention and care should be taken to the muskmelon production in the northern of Iraq to obtain more local harvest of this important summer crop.
- 2- Following proper fertilization management system to provide melon crop with correct required doses of needed fertilizers during various stages of plant growth and development through the growing season to enhance the yield and productivity of this delicious crop.
- 3- Further doses of different required fertilizers should be applied to melon especially, the organic or natural fertilizers such seaweed extracts, plant extracts, effective microorganisms (EM), yeast, ascorbic acid to inspect their effects on this crop growth and development.

- 4- More field researches about growth and yielding of melon should be conducted in Dohuk province border to study more about the production of this crop and to increase the quality and quantity of fruits.



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GENİŞLETİLMİŞ TÜRKÇE ÖZET (EXTENDED TURKISH SUMMARY)

HÜMİK ASİT VE YAPRAKTAN POTASYUM UYGULAMALARININ KAVUNUN BÜYÜME, VERİM VE VERİM BİLEŞENLERİ ÜZERİNE ETKİSİ

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1. ÖZ

Bu çalışma, 2019 yaz döneminde Duhok eyaleti/İrak'Ta bir araştırma merkezi sebze araştırma alanında, hümik asit ve yaprakta potasyum uygulamalarının kavunun büyüme ve verimi üzerindeki etkisini etkilerini araştırmak için bir arazi çalışması şeklinde yürütülmüştür. Deneme, dört seviyede (0, 0.3, 0.6 ve 0.9 mg / L) yaprakdan potasyum gübrelemesi ve dört seviyede (0, 500, 1000 ve 2000 mg / L) topraktan hümik asit uygulaması şeklinde yapılmıştır. Deneme, tesadüf bloklarında üç tekerrürlü 16 uygulamadan oluşmuştur. Vejetatif büyüme karakterleri, bazı yaprak mineral içeriği ve çiçeklenme özelliklerinin yanı sıra bazı verim ve kalite karakterleri ve meyve mineral içeriği incelenmiştir. Vejetatif büyüme karakterleri, potasyumun yaprak uygulaması ve hümik asit uygulamasından önemli ölçüde etkilenmemiştir. Farklı dozlarda hümik asit ve potasyum gübrelemesinin etkisi, her iki gübrenin uygulanmasıyla artan fosfor (P) hariç, yapraklardaki besin elementlerinin çoğunu (N, Ca ve K) önemli ölçüde artırmamıştır. Kavunun kantitatif verim karakterleri [meyve/bitki sayısı, toplam verim ve meyve nem içeriği (%)] uygulamalarda önemli ölçüde farklı çıkmamıştır. Potasyum ve hümik asit uygulamaları, meyve içeriğinde fosfor (P) ve kalsiyum (Ca)'un üzerinde önemli bir etkiye sahip olurken, kavun meyvelerinde azot (N) ve potasyum (K)'u önemli ölçüde artırmamıştır. Farklı dozlarda hem hümik asit hem de potasyum uygulaması, meyvelerdeki karbonhidrat içeriğinde (%) ve suda çözünür kuru madde miktarını

(SÇKM) önemli bir artışa yol açmakla birlikte, kontrol ile karşılaştırıldığında C vitaminde herhangi bir artış gözlenmemiştir.

Anahtar kelimeler: Hümik asit, Kavun, Kalite, Potasyum, Verim.

2. GİRİŞ

Kavun (*Cucumis melo* L.), hıyar (*Cucumis sativus* L.), karpuz [*Citrullus lanatus* (Thunb.) Matsum & Nakai] ve kabak (*Cucurbita* spp.)'ı da içeren Cucurbitaceae familyasına ait en lezzetli ve popüler yaz meyveli sebzelerden biri olarak kabul edilir. Tropikal Afrika'ya özgüdür ve tatlı ve ferahlatıcı bir meyve olarak tüketilebilir. Meyvesi, fenolik, flavonoidler ve vitaminler (A ve C), β -karoten, ayrıca karbonhidratlar ve mineraller gibi biyoaktif bileşiklerle zengindir. Ayrıca, düşük miktarda yağ ve kalori içerir (yaklaşık 17 kcal / 100g). Kavun, yeni geri kazanılmış topraklarda ümit vaat eden çok karlı bir sebze mahsulüdür (Tamer ve ark., 2010; Mohamed ve Ali, 2016).

Toprak işlemenin yanı sıra kimyasal gübreler ve böcek ilaçlarından ciddi şekilde faydalanılması özellikle toprağı, mikrobiyal topluluk yapılarını etkiler ve toprak yapı ve mineral madde içeriğini bozar ve insan refahı için gerçek tehlikelere neden olur (Caesa ve diğerleri, 2010). Bununla birlikte, organik tarım güvenli ve toprak ve çevre refahına zarar vermeden yüksek kalitede ve güvenlikte besin sağlayabilir. Doğal gübreler ilk başta bitki veya canlı artıklarından elde edilir. Tüm doğal gübreler, elementlerin karmaşık ve şelat formlarında tutulmasının ayrılmaz bir parçası olan fulvik ve hümik asitler aracılığıyla topraklardaki farklı bileşenlerin erişilebilirliğini artırmak için önem arz ederler. Bu malzemeler bitki besinlerini bir süre tutma yeteneğine sahiptir ve toprak mikroorganizmaları tarafından kademeli olarak parçalanırlar (Shafeek ve ark. 2015).

Bu çalışmada Hümik asit ve potasyum uygulamalarının ve kavun büyümesi ve verimi üzerine etkileri araştırılmaya çalışılmıştır. Çalışma ayrıca aşağıdaki yönlerle de cevap verebilir:

- 1- Kavun verimini arttırmak,
- 2- Hümik asit ve potasyumun büyüme, verim üretimi ve bileşenleri üzerindeki etkisini incelemek,

- 3- Yapraklara potasyum püskürterek ve hümik asit gibi organik gübre kullanarak kavun kalitesini ve miktarını arttırmak,
- 5-Vejetatif büyümeyi aktive etmek, verimliliği arttırmak ve toprak özelliklerini iyileştirmek,
- 6- Bazı bitki besin maddelerinin alımını arttırmak.

3. MATERYAL VE YÖNTEM

1. Çalışma lokasyonu

Tarla denemesi 2019 yaz sezonu boyunca Irak'ın kuzeyindeki Dohuk ilinin Tarım genel müdürlüğü, sebze araştırma araştırma merkezi alanında gerçekleştirilmiştir.

2- Çalışma Yeri Toprağı

Çalışma sahasının toprak dokusu killi tınılıdır. Alanın farklı yerlerinden (25-30 cm) derinlikte birkaç toprak örneği alınmıştır.

3 - Araştırma Alanının Hazırlanması

Araştırma alanının zemini iyi sürülmüş, daha sonra toprağın yumuşatılması gerçekleştirilmiştir. Bundan sonra, toprağa (20kg 1000m²) kompoze gübre (NPK 20:20:20) uygulanmıştır.

4- Kültürel Uygulamalar

Kavun tohumları, ekim işlemi ile 19 Mart 2019'da tarlaya ekilmiştir. Kültürel uygulamalar, hastalıkların ve zararlıların sürekli gözlemlenmesinin yanı sıra çapa ile yabancı ot kontrolü yapılmıştır.

5- Uygulamalar

Denemede dört doz (0, 0.3, 0.6 ve 0.9) mg / L yapraktan potasyum uygulaması ve dört doz (0, 500, 1000 ve 2000) mg / L hümik asit toprak uygulaması içermektedir.

Deneme üç tekrarlamalı olarak yürütülmüştür. Uygulamalar akşam (saat 6'da) yapılmıştır.

6- Deneme Deseni

Deneme, Faktöriyel Tam Tesaüfi Deneme deseninde (RCBD) iki faktörle düzenlenmiştir. Birinci faktör, dört seviyede (0, 500, 1000 ve 2000) mg / L topraktan hümkik asit; ikinci faktör ise yaprakdan dört doz (0, 0.3, 0.6, ve 0.9) mg / L potasyum uygulaması şeklindedir. Çalışma (16) uygulamadan ($4 \times 4 = 16$); her uygulama üç kez tekerrürden ve her tekerrür, bitkiler arasında 90 cm aralıklı beş bitki ile temsil edilmiştir. Veriler SPSS programı kullanılarak analiz edilmiştir.

7- Ölçüm ve Analizler

*** Vejetatif Büyüme Özellikleri**

- 1- Bitkide Yaprak Sayısı
- 2- Kanopi Yüksekliği (cm).
- 3- Yaprak Alanı
- 4-Yaprak Klorofil yaprak içeriği (%).
- 5- Dal Sayısı (Adet).
- 6- Gövde Çapı (cm).
- 7-Yaprak Nemi İçeriği (%).

***Yapraklarda Mineral Madde İçeriği**

- 1- Azot yüzdesi (%).
- 2- Fosfor yüzdesi (%).
- 3- Potasyum yüzdesi (%).
- 4- Kalsiyum yüzdesi (%).

*** Çiçek**

- 1- 30. günde çiçek sayısı.
- 2- 40. günde çiçek sayısı.

*** -Verim Özellikleri**

- 1- Meyve Sayısı
- 2- Meyve Nemi İçeriği (%).
- 3- Toplam Verim (ton. Ha-1).

*** Meyve Kalite Özellikleri**

- 1- Meyvelerdeki karbonhidrat içeriği (%).
- 2- C Vitamini içeriği (%).
- 3- SÇKM (briks °).

*** Meyve Mineral Madde İçeriği**

- 1- Azot yüzdesi (%).
- 2- Fosfor Yüzdesi (%).
- 3- Potasyum yüzdesi (%).
- 4- Kalsiyum yüzdesi (%).

4. SONUÇ

Araştırmasının sonuçlarına göre şu sonuç çıkarılabilir:

- 1- Susuz yetiştirilen kavun bitkilerinde potasyum ve hümik asitin uygulamalarının, dal sayısı, bitki boyu, gövde çapı, klorofil içeriği, yaprak alanı, yaprak sayısı ve yaprak nemi içeriği gibi vejetatif büyüme karakterleri.

2- Kavun bitkilerinin hümik asit ve potasyum gübreleri ile çeşitli dozlarda muamele edilmesi, yaprakların (N, K ve Ca) besin içeriğini önemli ölçüde arttırmazken, yaprak fosfor (P) içeriğinde belirgin bir şekilde artış gözlenmiştir.

3- Susuz yetiştirilen kavun bitkilerinde potasyum ve hümik asitin uygulamalarının, verim bileşenleri üzerinde belirgin bir etkisi olmamıştır.

4- - Kavun bitkilerinin hümik asit ve potasyum gübreleri ile çeşitli dozlarda muamele edilmesi, meyvelerin P ve Ca besin içeriğini önemli ölçüde arttırırken, meyve N ve K içeriklerinde belirgin bir şekilde artış gözlenmemiştir.

5- Meyvede karbonhidrat yüzdesi ve SÇKM içeriği, hümik asit ve potasyum uygulamalarından olumlu şekilde etkilenmişlerdir.

CURRICULUM VITAE

Ahmed Mohammed TAHER was born in 1994, in Duhok province, Iraq. He completed primary school in Duhok, secondary and high school in Duhok province. He graduated from Horticulture Department, College of Agriculture College and University of Dohuk in 2010. He Has completed his MSc in The Department in of Horticulture, The Institute of Natural and Applied Sciences, Van Yuzuncu Yil University in Van - Turkey on August 2020.



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