Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 03-06
©2013 Academy for Environment and Life Sciences, India
Online ISSN 2277-1808
Journal's URL:http://www.bepls.com

ORIGINAL ARTICLE

Effect of Foliar Application of Humic Acid and Potassium Nitrate on Cucumber Growth

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ABSTRACT
The study was carried out to evaluate the effects of foliar application of humic acid and potassium nitrate on vegetative and reproductive growth, yield and quality of cucumber plants as a completely randomized block design with 6 replications, each consisting of 4 pots with each pot containing one plant. Humic acid (20 and 40 ppm) and potassium nitrate (100 and 200 mg/L) solutions were applied as foliar sprays either alone or in combination. Data were recorded for plant height, yield, fruit weight and total soluble solid content of the fruit. Results indicated that humic acid and potassium nitrate increased vegetative and reproductive growth by increasing both plant height and dry weights and yield. In general, a combination of humic acid+ potassium nitrate (40 ppm +100 mg/ L K) was the most effective in increasing fruit quality.
***Key Words**: Humic acid, Potassium nitrate, Vegetative growth, Reproductive growth*

Received 10/08/2013 Accepted 17/09/2013

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops belonging to the family Cucurbitaceae. Cucumber is a primary source of vitamins and minerals for human body but its caloric and nutritional value is very low [1]. Generally, a balanced supply of nutrients is essential for optimum yield and fruit quality [2]. Foliar spraying is a new method for crop feeding which micro and macro nutrients in form of liquid is used into leaves [3]. Humic acid (HA) is a promising natural resource that can be used as an alternative to synthetic fertilizers to increase crop production. It exerts either a direct effect, such as on enzymatic activities and membrane permeability, or an indirect effect, mainly by changing the soil structure [4]. Humic acid application, berry weight, titratable acidity and maturity index values of Italy grape cultivar increased significantly in the full bloom period [5]. Albayrak and Camas [6] found that increasing application of humic acid up to1200 (ml/ha) has significantly promoted root and leaf yield of forage turnip (*Brassica rape* L.). Soil pH increased with rising levels of HA addition and the same trend was also observed for organic C and CEC of the soils by Sharif *et al.,* [7]. The application of Humic reduces the requirement of other fertilizers. It also increases crop yield, soil aeration, and drainage. It can also be improved by humic, the establishment of desirable environment for the development of microorganisms. Potassium (K) is major essential nutrient and it is being taken up by the crop plants in quite large quantities similar to or more than nitrogen. Although K is not a constituent of any organic molecule or plant structure, it is involved in numerous biochemical and physiological processes and pivotal role to plant growth, yield, quality and stress [8]. It is well known that potassium plays a key role in carbohydrate metabolism and photosynthesis [9] and, as a consequence, an optimum potassium supply determines better sugar content into sink organs. The aim of the present study was the effects of foliar spraying of HA and K either alone or in combination on the growth, yield and fruit quality characteristics of cucumber fruit.

MATERIALS AND METHODS

The study was performed in a greenhouse at the Research Farm, Ilam, Iran, in 2013 and 2014. Cucumber (*Cucumis sativus* L.) cv. Mostar was used as plant material. Humic acid (20 and 40 ppm) and potassium nitrate (100 and 200 mg/L), either alone or in combination, were applied as foliar spray when the fruits were berry-sized. All foliar spraying was carried out early in the morning. Plant height was determined

for 5 plants in the middle row in each treatment after the first picking. For this purpose, the plant height from the soil line to the top was determined with a measuring tape and averaged to represent corresponding treatments. Total nitrogen of the sample was determined by Kjeldahl method [10]. For determination of K contents of leaf, plant samples were air-dried and were then ground. K was determined after dry digestion of dry and sub-samples in a HCL preparation. Potassium was determined by flame photometry. The total yield for each treatment was calculated by weighing the fruit picked in each treatment and converting the weight to yield (kg/plant). The average fruit weight was estimated by weighing 10 fruits in each treatment, with the help of an electronic balance measuring in grams to the third decimal place, and then converting to average fruit weight. Total soluble solids were determined on a portable refractometer 300003 (Sper Scientific Ltd., Scottsdale, Ariz.) standardized with distilled water. Photosynthetic pigments chlorophyll was determined using chlorophyll meter (SPAD-502, Minolta Co. Japan), which is presented by SPAD value. Average of 3 measurements from different spots of a single leave was considered. The experimental design was a complete randomized blocks with four replications for each treatment.. Data were analyzed by SPSS 16 software and and comparing averages was done by Duncan's test and a probability value of %5.

RESULTS AND DISCUSSIONS

Vegetative factors, chlorophyll and leaf NK content

Our results showed that application of HA and K either alone or combination significantly influenced plant height, number of leaf and dry weight (Table 1). The highest rates of these variables were found at 20 ppm HA+100 mg/L K. In other words, application of higher concentrations of these factors reduced plant height and dry weight as other treatments (Table 1). It is evident that increase in HA (from 20 to 40 ppm) and K concentration (from 100 to 200 mg/L) reduced plant height, number of leaf and dry weight (Table 1). HA and K either alone or combination significantly affected chlorophyll and leaf NK content (Table 1). The highest chlorophyll and leaf NK content were obtained at 20 ppm HA+100 mg/L K. Results indicated a rise in chlorophyll and leaf NK content as HA and K concentration increased. Foliar application of 20 ppm HA+10 mM Ca resulted in the maximum plant height (218.87 cm), N (3.18 %), K (3.12 %) and dry weight (5.8 g). Fernández-Escobar *et al.,* [11] found that application of HA stimulated chlorophyll content and accumulation of K, B, Mg, Ca and Fe in leaves. Ayas and Gulser [12] reported that HA application was the main reason of enhanced nitrogen uptake in spinach. The results are accordance to Abdel Fatah *et al.,* [13], who observed that application of humic acid improved growth parameters. K promotes photosynthesis and transport assimilates of the carbohydrates to the storage organs. These results are in agreement with those obtained by Marschner [14] and Sarrwy *et al.,* [15] who found that foliar application of K, improved the chlorophyll and fruits-NK content. These results are in agreement with previous investigation indicated by Zhang *et al.,* [16]; Lin and Danfeng [17]. They found that increasing in vegetative growth, net photosynthetic rate; NPK content and chlorophyll content were associated with enhancement of K levels.

Table 1- Effect of foliar spraying of HA and K on growth, yield and quality of cucumber plants during 2012 and 2013 seasons.

Treatments	Plant height (cm)	Dry weight of plant (g)	Number of leaves per plant	Chlorophyll (SPAD)	Fruit length (cm)	Mean fruit weight (g)	Fruit diameter (cm)	Total yield (kg/Plant)	N (%)	K (%)	TSS (%)
Control	150.55c	3.34c	20c	12.56c	12.56c	72.4c	2.12c	2.67c	1.78c	1.6c	2c
20 ppm HA	213.34a	5.76a	30a	20a	19ab	98ab	2.98ab	6ab	3ab	2.97ab	3.12a
40 ppm HA	198b	4.12b	26.56b	15.78b	15b	85.23b	2.4b	5.32b	2.19b	2.13b	2.4b
100 mg/L K	210a	5.65a	29.89a	20.78a	18.66ab	97.67ab	3ab	5.96ab	2.9ab	2.87ab	3.2a
200 mg/L K	190.89b	4b	26b	15.45b	15.21b	84b	2.43b	5.2b	2b	2.12b	2.43b
20 ppm HA+100 mg/L K	218.87a	5.8a	31.56a	18.78ab	20.12a	100.56a	3.56a	6.3a	3.38a	3.42a	3.34a
20 ppm HA+200 mg/L K	191.56b	4.16b	26.67b	16b	15.34b	87.55b	2.51b	5.32b	2.12b	2.14b	2.54b
40 ppm HA+100 mg/L K	184.34bc	4.1b	26b	16.76b	15.21b	86b	2.45b	5.3b	2.17b	2.1b	2.47b
40 ppm HA+200 mg/L K	184.1bc	4b	26.3b	16.34b	15.1b	85.67b	2.4b	5.3b	2.1b	2b	2.4b

Means followed by same letter are not significantly different at 5% probability using Duncan's test.

Fruit length, mean fruit weight, yield, TSS and fruit diameter per plant

HA application significantly increased reproductive growth and yield when accompanied by K treatment (Table 1). HA and K combination had significant effect on fruit length, mean fruit weight, yield and fruit diameter per plant. The highest fruit length (20.12), mean fruit weight (100.56 g) observed when 100 mg/L K and 20 ppm HA were used together (Table 1). HA in low concentration significantly increased fruit diameter and yield when accompanied by K, and the highest values of this parameter (3.56 and 6.9 kg/plant)were obtained at 20 ppm HA+100 mg/L K (Table 1). Different HA and K levels have significant effect on fruits TSS contents (Table 1). HA and K increased fruits TSS content (3.12 and 3.2 %) when plants were sprayed with 20 ppm HA and 100 mg/L mg/ L K, respectively (Table 1). Combination between factors was significant for fruits TSS contents. In plants, the potassium is related to the synthesis of proteins and carbohydrates, sugars and starch storage and this stimulated the growth and improved utilization of water and the resistance to pests and diseases [18]. Balibrea *et al.,* [19] have reported that an increase of TSS in tomato fruits may depend on a higher sugar import and accumulation. Sofia, [20] mentioned that the increase of TSS together, reducing sugars in the fruits of plants grown in addition with the higher K levels in the nutrient solution confirm that K played an important role in the configuration of quality profile in tomato fruits. These researchers showed that the largest number of flower was obtained under 60 kg/ha of potassium fertilizer. Study of Pal and Ghosh [21] on African marigold demonstrated that the yield of flower increased along with the increasing quantity of potassium fertilization from zero to 200 kg/ha. Mirdehghan and Rahemi [22] reported accumulation of all the macro and microelement within the fruit also increased during fruit growth and development. Thalooth *et al.,* [23] found that foliar application of potassium increased the biological yield of vetch. Sawan *et al.,* [24] also reported that the use of potash fertilizer in the cotton fields increases the dry matter yield significantly. The positive effects of the humic substances were also observed on the studies such as dry matter yield increases on corn and oat seedling [25], yield that increases on radish and green bean seedlings [26]. Similar results were also obtained from pepper fruit treated with HA [27]. However, in another study, Yildirim [28] have reported a significant enhancement in fruit diameter and length as a result of exogenous HA application in tomato.

Saleh *et al.,* [29] and Yildirim [30] have reported a significant enhancement fruit quality as a result of exogenous HA application in tomato. The same results were noticed when humic acid applied on 'Canino' apricot when it enhanced T.S.S and decreased acidy [31]. According to the results significant improvement on tomato quality characteristics was observed. It seems that under higher concentration of K and HA could find a better relation between spraying and quality.

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How to cite this article

Mohsen Kazemi. Effect of Foliar Application of Humic Acid and Potassium Nitrate on Cucumber Growth. Bull. Env. Pharmacol. Life Sci., Vol 2 (11) October 2013: 03-06