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ORIGINAL ARTICLE

Effect of Foliar Application with Potassium Nitrate and Methyl Jasmonate on Growth and Fruit Quality Of Cucumber

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ABSTRACT
A study was carried out to investigate the effect of 3 levels of methyl jasmonate (0.25, 0.5 and o.75) and 2 levels of potassium nitrate (4 and 6 mM) spray on the plant growth and quality parameters of cucumber. The application of methyl jasmonate and potassium nitrate alone or in combination had significant effect on cucumber vegetative growth, yield and its quality. Potassium nitrate application alone or in combination significant increased leaves-NK content, chlorophyll and dry weight. Methyl jasmonate application alone or in combination significant increased fruit quality of cucumber while reduced leaves-NK content, chlorophyll and dry weight. Regarding yield and yield components, a significant increased was observed when plants were spray with 0.25 mM methyl jasmonate +6 mM potassium nitrate. In general, the combination of 0.25 mM methyl jasmonate +6 mM potassium nitrate significantly increased the TSS, yield and vitamin C.
Key words: *cucumber, foliar application, yield, quality*
Abbreviations: MJ, Methyl jasmonate; TSS, Total soluble solids; K, potassium nitrate.

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INTRODUCTION

Cucumber plant (*Cucumis sativus* L.) is one of the important vegetable crops in Iran. Cucumber plants with rapid growth and development until the end of the period between 2 and 5/2 months to take [1]. Cucumber is a primary source of vitamins and minerals for human body but its caloric and nutritional value is very low [2]. Generally, a balanced supply of nutrients is essential for optimum yield and fruit quality [3]. Foliar spraying is a new method for crop feeding which micro and macro nutrients in form of liquid is used into leaves [4]. Foliar application reduces the cost of production that encourages the commercial growers for its commercial production. In this regard, the effect of spray of methyl jasmonate at very low concentrations could be exploited beneficially as its natural occurrence in plants in minute quantities is known to control their development. Jasmonic acid (JA) and methyl jasmonate, are cyclopentanone compounds and are regarded as naturally occurring plant growth regulators [5]. Ghasemnezhad and Javaherdashti [6] were expressed that MeJA could enhance the total phenolics and therefore induce the defense mechanism of raspberry against low temperature stress. Potassium (K) is one of the principle plant nutrients underpinning crop yield production and quality determinations. When potassium uptake is lower than demand, foliar potassium is mobilized to the fruit, to the detriment of plant growth and fruit set and quality [7]. Intensive research has been done to investigate the effects of K on fruit quality of vegetables grown in hydroponics, showing the significance of K in the nutrition of these crops [8]. Lin *et al.,* [9] found that increasing potassium levels significantly increased the concentration of total sugar, total soluble solids, glutamic acid, aspartic acid, alanine, and volatile acetate of muskmelon. The aim of the present study was to test the effects of foliar spraying of MJ and K alone or in combination on the growth, yield and fruit quality characteristics of cucumber fruit.

MATERIALS AND METHODS

In order to determine, the effect of different levels of methyl jasmonate and potassium nitrate used in spraying solution on the yield and quality of tomato during 2012-2013 growth seasons in Ilam (Elevation 1339 m, Latitude East 33.638, Longitude North 46.431), Iran. Seeds of cucumber cultivar L., cv. Alpha beta were sown in January and were transplanted during March. Methyl jasmonate (0.25, 0.5 and 0.75 mM) and potassium nitrate (4 and 6 mM), 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. The following characteristics were recorded, plant height, total yield, mean fruit weight, soluble solid content, total nitrogen and potassium in leaves. 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. The number of branches was counted for the middle ridge in each treatment at the first picking and the average number of branches per plant was calculated. 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 plot 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 (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.

Statistical Analysis

The experiment was laid out in randomized complete block design with 4 replications, each consisting of 3 pots with each pot containing one plant. 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 DISCUSSION

Plant height, chlorophyll and chemical contents in leaves of cucumber

Results in tables (1) showed the effect different K and MJ concentration and combination between them on morphological characters and chemical contents in leaves of cucumber. Generally, vegetative growth parameters and chemical analysis i.e. plant height, leaf chlorophyll content, dry weight and total N and K content in fuits responded negatively to increasing MJ concentration, while K increased plant height, chlorophyll and chemical contents in leaves of cucumber. The results in table (1) indicated an decrease in plant height, leaf chlorophyll content, dry weight and total N and K content at the higher MJ concentration (0.75 mM) in comparison with the lower of MJ concentration (0.25 mM). The maximum plant height (214.35 cm), dry weight (6.76 g), leaf chlorophyll content (28.15 SPAD), and total N (3.13 %) and K (3.51 %) content was recorded with 6 mM K application (Table1). The effect of combination different K and MJ concentration on morphological characters and chemical contents in fruits is shown in Table (1). Combination between factors was not significant for morphological characters and chemical contents. The exogenous application of MJ evoked major effects, indicating that MJ was responsible for the decline in the growth related traits. These results are also consistent with Heijari *et al.,* [11] who reported, seedling diameter, shoot fresh weight, root fresh weight and root length were hampered by MJ treatment in Scots pine. MJ-induced loss of photosynthetic pigments would decrease the amount of energy absorbed by the photosynthetic apparatus, thereby attenuating energy requiring anabolic events such as photosynthesis. MJ-treatment in our study is in accordance with that of Jung [12], who reported the significant loss of pigment contents due to MJ-treatment. Similar observations were reported by Zhang *et al.,* [13]. However, morphological characters was strongly inhibited by increasing MJ concentration. The present findings are in agreement with the results obtained by Adel and Thomas [14] who reported increase in plant height of soybean at high than at low K application. Plants cannot complete a normal life cycle without sufficient K. Plants grown for food take up and use large quantities of K, P and K deficient plants often have slow growth, poor drought resistance, weak stems, and are more susceptible to lodging and plant disease [15]. These results are in agreement with previous investigation indicated by Zhang *et al.,* [16] and Lin and Danfeng [17]. They found that increasing in vegetative growth, net photosynthetic rate, NPK content and chlorophyll content were associated with increasing of K levels. Potassium affects respiration, photosynthesis, leaf NPK content, chlorophyll development, water content of leaves, carbon dioxide (CO_2) assimilation and carbon movement [18].

Fruit length, mean fruit weight, yield and fruit diameter per plant of cucumber

The mean fruit weight was not affected by application of K and MJ alone, but combination K and MJ application resulted in a significant increase in the mean fruit weight. The mean fruit weight (105.63 g) was recorded with 0.25 mM MJ+ 6 mM K application (Table 1). The combination of MJ and K significantly increased the fruit length and fruit diameter from 15.34 and 2.3 in the control to 25.18 and 3.5 with 0.25 mM MJ+ 6 mM K (Table 1). The yield per plant of cucumber increased significantly with foliar application of K and MJ either alone or in combination. The yield increased to its maximum (6 kg/plant) with combination of K and MJ (0.25 mM MJ+ 6 mM K) application. This macroelement significantly affects the quantity and quality of tomato yield in greenhouses cultivation with a limited volume of the growing medium [19]. K deficiency resulted in a decrease in net photosynthetic rate and dramatic decrease in crop yield [20]. Golcz *et al.,* [21] have reported that the total yield, marketable yield, commercial fruit yield and total average yield per plant were increased by increasing application rates of potassium (K) fertilizers on pepper plant.

Fruit quality

The maximum TSS of 3.9 % was, however, recorded with 0.25 mM MJ+6 mM K application. (Table 1). The TSS of cucumber fruit was significantly affected by the application of K and MJ either alone or in combination. 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 [22]. Balibrea *et al.,* [23] have reported that an increase of TSS in tomato fruits may depend on a higher sugar import and accumulation. Sofia [24] mentioned that the increase of TSS together with the increase of reducing sugars in the fruits of plants grown 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. By increasing K from 200 to 350 ppm, acidity increased from 4.02 to 4.63% and juice pH increased from 3.87 to 4.14. K is known as electroneutrality maintenance element of organic acids in tomato fruit [25].Also, The present findings are in agreement with the results obtained by Gonzalez-Aguilar *et al.,* [36] reported Application of MJ on guava caused increased T.S.S and decreased TA in fruit. Ayala-Zavala *et al.,* [37] demonstrated that strawberry fruits treated with MJ were maintained higher level of TSS and PH. However, further investigations are required to elucidate the possible role of K and MJ on plant growth regulating activity.

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

Treatments (mmolL^{-1})	Plant height (cm)	Dry weight of leaves(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	161.05bc	5b	17.76c	22.08b	15.34c	85.67bc	2.3bc	2.88bc	2.6b	3.3b	2 c
0.25 mM MJ	190.14b	3.96c	17c	18.87bc	23.15a	96.34ab	3.5a	4.65b	2.13c	3bc	3.1b
0.5 mM MJ	167.14bc	3.67c	17.56c	18.9bc	18.16bc	87bc	1.78c	3.3b	2.07c	3.04bc	2.56bc
0.75mM MJ	160.65bc	3cd	14.76cd	18.45bc	18bc	84bc	1.67c	3.34b	2.1c	2.99bc	2.48bc
4 mM K	200.98ab	5.56ab	24.45ab	26.76ab	20.05ab	99.34ab	3.06ab	5.5ab	3ab	3.28ab	3.15b
6 mM K	214.35a	6.76a	28.14a	28.15a	23.54a	103.12a	3.45a	5.78a	3.13a	3.51a	3.23ab
0.25 mM MJ+ 4 mM K	190.14b	4.43bc	20.13bc	19.67bc	22b	98.06ab	3ab	5.45ab	2.11c	2.91bc	3.17b
0.25 mM MJ+ 6 mM K	185.15b	4.3bc	17c	19bc	25.18a	105.63a	3.5a	6a	2.14c	3bc	3.9a
0.5 mM MJ+ 4 mM K	159.15bc	4.4bc	17.05c	18.95bc	22b	89.34bc	2.89b	3.23b	2.06c	3.01bc	2.4bc
0.5 mM MJ+ 6 mM K	159.13bc	4.38bc	16.56c	18.9bc	21.78b	86.13bc	2.8b	3.21b	2.1c	3bc	2.45bc
0.75 mM MJ+ 4 mM K	158.156bc	4.3bc	16.76c	18.69bc	22.01b	89bc	2.75b	3.28b	2.1c	2.98bc	2.37bc
0.75 mM MJ+ 6 mM K	158.09bc	3.37bc	16.57c	18.57bc	22b	87bc	2.71b	3.2b	2.07c	3bc	2.4bc

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

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