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# Influence of foliar application of moringa leaf extract and humic acid on growth, yield and chemical composition of cucumber

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## Abstract

An experiment to study the influence of moringa leaf extracts (MLE) and humic acid (HA) foliar application on growth, yield and physico-chemical components of cucumber was carried out at the University of Agriculture Peshawar-Pakistan during 2016.Randomized complete block design with split plot arrangement having three replicates was used. Different levels of MLE (control, 30, 40 and 50gL$^{-1}$) and HA concentrations (Control, 0.5, 1 and 1.5%) were applied for foliar application. Data were recorded on various yield and quality attributes. Statistical analysis showed that MLE and HA affected almost all the studied attributes, while the interaction was found non-significant. Results indicated that foliar application of MLE at the rate of 50 gL$^{-1}$ gave maximum vine length (164.75 cm), single fruit weight (172.25 g), fruit diameter (4.31 cm), total yield (40.93 tons ha$^{-1}$),TSS (2.91$^{o}$Brix), titratable acidity (0.49%) and ascorbic acid content (5.79 mg 100g$^{-1}$) with minimum days to first harvest (54.08) and fruit juice pH (5.36). whereas HA concentration, 1.5 %showed best performance in all the studied attributes as compared to other treatments. Maximum vine length (166.08 cm), single fruit weight (171.50 g), fruit diameter (4.37 cm), total yield (41.84 tons ha$^{-1}$), TSS (2.83 $^{o}$Brix), titratable acidity (0.48%), and ascorbic acid (6.00 mg 100g$^{-1}$) with minimum days to first harvest (54.00) and fruit juice pH (5.27) were recorded using HA at the rate of 1.5%. It was concluded that 50 gL$^{-1}$ MLE improved yield and chemical composition of cucumber, while 1.5% HA also showed best results.

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## Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops belonging to the family Cucurbitaceae. Cucumber is the main source of vitamins A, B6, C and minerals like Magnesium, Potassium and Copper (Vimala *et al.*, 1999). Throughout the world, China is the major producer of cucumber with estimated production of 54.34 million tons. About 73% of cucumber is produced by China. In Pakistan, the total area under cultivation is 23,268 hectare with production of 52,765 tones, with average production of 2.25 tones $ha^{-1}$ (MINNFSR, 2015). Generally, a balanced supply of nutrients is essential for optimum yield and fruit quality (Akhtar *et al.*, 2010).

Foliar spraying is a new method for crop feeding which micro and macro nutrients in form of liquid are used into leaves (Nasiri *et al.,* 2010). Humic acid (HA) is one of the commercial products of an organic fertilizer which contains 44-58% C, 42-46% O, 6-8% H and 0.5-4% N as well as many other elements (Larcher, 2003). 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 (Biondi *et al.*, 1994). Furthermore, HA have the ability to increase the nitrogen use efficiency and which results to enhance the growth and development of the crop. Along with natural sources of PGRs and number of antioxidants, nowadays *Moringa oleifera* is receiving lot of interest (Foidle *et al.*, 2001). Foliar spray of MLE accelerates plant growth and increase yield of crops (Marcu, 2005). Different substances like vitamin C as well as vitamin A, iron, beta-carotene, riboflavin, phenolic acid and calcium are present in the leaves of Moringa (Nambiar*et al.*, 2005). The oil have antioxidant activity contained by the leaves (Njoku and Adikwu, 1997). Similarly zeatin, which is a purine adenine derivative from the group of plant hormone, cytokinin, found in abundant in MLE (MLE) which is recognized for stay green and stress tolerance capabilities. (Barciszweski *et al.*, 2000).

Due to high cost and skill labor in application of inorganic fertilizations and land pollution, harmful nature linked with use of inorganic fertilizer and contribution to climate change that has adverse effect on soil ecosystem, there is a need to examine for alternative sources for plant supplements. Such plants can be promoted as a multipurpose that may develop better, safer and cheaper way of increasing the yield of stable vegetable crops for healthy nourishment (Hussein and Abbaro, 1997) Application of MLE on to leaves of tomato, bell pepper, maize, soya bean, melon, chili and sorghum resulted in increase in their yields (Fuglie, 2000). Objectives of this study were to study the effects of MLE and HA on growth yield and physico-chemical components of cucumber.

## Materials and methods

*Experimental site*

An experiment to study "Influence of foliar application of MLE and HA on growth, yield and chemical composition of cucumber" was conducted at Horticulture Research Farm and Post-harvest Laboratory, The University of Agriculture Peshawar during 2016.

*Design of experiment*

The research was worked out in Randomized Complete Block Design (RCBD) with two factorial split plot arrangement. HA concentrations along with control were allotted to main plot with four levels (0, 0.5, 1 and 1.5 %) while, MLE along with control were allotted to sub plot with four levels (0, 30, 40 and 50 %) having three replications were used. HA and MLEs was applied in liquid form as foliar spray to the cucumber plants.

*Treatments*

The total numbers of treatments were 48. The detail of the factors is given in table 1.

*Preparation of moringa leaf extract (MLE)*

MLE was prepared by collecting young and disease free leaves from moringa tree. These leaves were washed and then leaves were grinded in a grinder to

extract the leaf juice. In order to remove all the green matters juice was filtered by passing through a muslin cloth. An amount of 30g, 40g and 50g of young moringa leaf juice were mixed in one liter of water to prepare solution of different concentrations like 30, 40 and 50 $gL^{-1}$ as experimental treatments.

*Field preparation and sowing techniques*

Before seed sowing, field was turned over, harrowed and leveled. Cultivar Poinsett 76 seeds were sown at 30 cm plant to plant and 1 meter row to row distance on ridges. Two to three seeds were sown at a space of 2.5 cm. When seedlings were germinated, thinning was carried out leaving only one healthy plant. Agronomic practices were applied such as weeding, watering and hoeing, while, insecticide and pesticides were sprayed.

*Stage of foliar application*

The crop was sprayed 30 days after seed sowing.

*Studied attributes*

*Vine length* (cm): From each treatment five plants were randomly selected and through measuring tape their height was measured from bottom to the top of the plant. Their mean was computed.

Days to 1st harvesting: From sowing to 1st appearance of flowering in all treatments of each replication, the days were counted and then average was computed.

Fruit diameter (cm): The fruit diameter of the selected fruits were measured with the help of digital vernier caliper and their mean was taken.

Single Fruit weight (g): Mean was computed by weighing the randomly picked fruit from plants of each treatment of all replications.

Total yield (tons $ha^{-1}$): The total productivity was recorded by the following formulae:

$$\text{Yield tons ha}^{-1} = \frac{\text{Yield per sub plot (kg)}}{\text{Area of sub plot (m}^2\text{)} \times 1000} \times 10000(\text{m}^2)$$

Total soluble solids (°Brix): Total soluble solids were analyzed by using hand held refractometer. Few drops of juice were taken on the prism and reading was recorded and the proposed method given in AOAC (2000) was applied. After every reading slide and prism of the instrument was cleaned.

Percent Titratable Acidity: The percent titratible acidity determined by standard method AOAC (2000) and calculated by following formula.

$$\text{Percent titratable acidity (\%)} = \frac{N \times T \times F \times 100}{D \times S} \times 100$$

Where

N = Normality of NaOH

T = ml of 0.1 N NaOH used

F = Constant acid factor 0.0067 (citric acid)

D = ml of sample taken of tomato juice.

S = ml of diluted sample taken for titration

Ascorbic acid content (mg $100g^{-1}$): "Dye method" was used to find ascorbic acid content. Fruit juice was extracted from the selected fruit samples at the rate of 10 ml and poured into the volumetric flask, then oxalic acid was supplemented to move up the volume to 100 ml. By this 10% solution was made. After that 10 ml solution was picked and titrated with Dye. The observance of pink color indicates the completion of reaction. Furthermore, the content of Vitamin C will be calculated through the given formula:

$$\text{Ascorbic acid content (mg/ 100g)} = \frac{F \times T \times 10}{D \times S} \times 100$$

Where

T = Amount of Dye solution consumed from burette (ml)

F = Constant Factor of Dye

S = Fruit juice (g) taken for dilution

D = Amount of diluted sample used for titration (ml)

Fruit juice pH: Fruit juice pH was measured from the juice of the fruit with the help of pH meter by dipping the probe of the meter into the juice until the reading stop and then the reading was noted.

*Statistical analysis*

All the data collected was analyzed by using Randomized Complete Block Design. In case the data was found significant. Least significant difference was

applied for mean comparison. A statistical package (statistix8.1) was used for analyzing the data (Jan *et al.*, 2009).

## Results

*Plant growth and yield attributes*

**Table 1.** Details of factors.

| Factor A: (Moringa leaf extract $gL^{-1}$) | Factor B: (Humic acid %) |
|---|---|
| $C_0$ = Control | $H_0$ = 0 |
| $C_1$ = 30 $gL^{-1}$ | $H_1$ = 0.5 |
| $C_2$ = 40 $gL^{-1}$ | $H_2$ = 1 |
| $C_3$ = 50 $gL^{-1}$ | $H_3$ =1.5 |

In case of HA, the maximum vine length(166.08 cm), fruit weight (171.50 g), fruit diameter (4.37cm) and total yield (41.84 tons $ha^{-1}$) with minimum days to first harvest (54.00) were recorded in treated plant with foliar spray of 1.5% HA (Table 2).

The foliar spray of MLE at the rate of 50 $gL^{-1}$ gave maximum vine length(164.75 cm), fruit weight (172.25 g), fruit diameter (4.31 cm) and highest fruit yield (40.93 tons $ha^{-1}$) with minimum days to first harvest (54.08) as shown inTable 2.

*Physico-chemical components*

The foliar spray of MLE@ 50 $gL^{-1}$gave maximum total soluble solids (2.91 $^0$Brix), titratable acidity (0.49%) and ascorbic acid content (5.79 mg $100g^{-1}$) with minimum fruit juice pH (5.36)as shown in Table 3.

**Table 2.** Influence of moringa leaf extract (MLE) and humic acid (HA) on plant growth and yield of cucumber.

| Treatments | Characters | | | | |
|---|---|---|---|---|---|
| Moringa leaf extracts ($gL^{-1}$) | Vine length (cm) | Days to 1st harvest | Fruit weight (g) | Fruit diameter (cm) | Total Yield (tons $ha^{-1}$) |
| Control | 156.08C | 62.67A | 161.92C | 3.25C | 30.70C |
| 30 | 160.17B | 58.42B | 165.33BC | 3.75B | 34.08BC |
| 40 | 160.42B | 57.83BC | 166.67B | 3.79B | 36.07B |
| 50 | 164.75A | 54.08C | 172.25A | 4.31A | 40.93A |
| LSD at 1% | 3.33 | 3.99 | 4.65 | 0.49 | 4.42 |
| Humicacid (%) | | | | | |
| Control | 154.75c | 62.42a | 161.75c | 3.18c | 29.43c |
| 0.5 | 160.08b | 58.50b | 166.17bc | 3.75b | 35.14bc |
| 1 | 160.50b | 58.08b | 166.75b | 3.79b | 35.37b |
| 1.5 | 166.08a | 54.00c | 171.50a | 4.37a | 41.84a |
| LSD at 5% | 5.20 | 3.82 | 4.42 | 0.54 | 5.75 |

Mean values followed by different alphabets are statistically different using LSD test at 1 and 5% level of significance.

In case of HA, the increasing trend was recorded in total soluble solid (2.83 $^0$Brix), titratable acidity(0.48%) and ascorbic acid(6.00 mg $100g^{-1}$) with minimum fruit juice pH (5.27) in plants treated with 1.5% HA(Table 3).

## Discussion

*Vine length (cm)*

The analysis of variance indicated that vine length of cucumber plant was significantly affected by MLEs and HA concentrations. The increment in vine length might be due to the presence of macro and micro nutrients in MLE that positively increased vegetative and reproductive growth of plant. Similar results were also observed by Kato *et al.*, (2002). HA is a bio stimulant that stimulates the growth of the plant. It affects the morphological characteristics of plant particularly the vine length is directly related to the

concentration of HA. Sani (2013) who reported that when cucumber plants were sprayed at 15 days interval with HA then the morphological characters including vine length, have shown positive response.

*Days to 1st harvest*

The number of days to fruiting decreases with foliar application of MLEs as it increases nutrient absorption and nutrients supply that encourage more synthesis of assimilates and thus produce early flowering and fruiting. Our finding are supported by Nasir *et al.*, (2016) who claimed that kinnow mandarin treated with MLE produced early fruiting. Plants utilize the foliar application of nutrients more efficiently as compared to soil application. Due to soil application leaching, non-availability of nutrient results in poor growth and ultimately the plant produce late flowers after the completion of its vegetative growth leads to delay harvesting.

Application of HA as foliar spray increases auxin concentration when plants absorb HA that results in early completion of its growth, flowering and hence early fruiting. Kazemi (2014) who reported that the application of HA and calcium chloride as foliar spray resulted in early fruiting.

**Table 3.** Influence of moringa leaf extract (MLE) and humic acid (MLE) on physico-chemical components of cucumber.

| Treatments | Characters | | | |
|---|---|---|---|---|
| Moringaleaf extract ($gL^{-1}$) | TSS (°Brix) | Fruit juice pH | Titratable Acidity (%) | Ascorbic acid (mg $100g^{-1}$) |
| Control | 2.22C | 6.20A | 0.39C | 3.72C |
| 30 | 2.55B | 5.77B | 0.40BC | 4.91B |
| 40 | 2.56B | 5.71B | 0.43B | 4.92B |
| 50 | 2.91A | 5.36C | 0.49A | 5.79A |
| LSD at 1% | 0.21 | 0.32 | 0.03 | 0.85 |
| Humic acid (%) | | | | |
| Control | 2.32c | 6.29a | 0.38c | 3.63c |
| 0.5 | 2.53bc | 5.76b | 0.42bc | 4.80b |
| 1 | 2.57b | 5.72bc | 0.43b | 4.90b |
| 1.5 | 2.83a | 5.27c | 0.48a | 6.00a |
| LSD at 5% | 0.24 | 0.46 | 0.04 | 1.08 |

Mean values followed by different alphabets are statistically different using LSD test at 1 and 5% level of significance.

*Fruit weight (g)*

The increased in fruit weight might be due to the excessive level of potassium and zinc in MLE. Fruit quality is increased through potassium by promoting the translocation of carbohydrates from source to sink (Ramezani and Shekafandeh, 2011). Furthermore, Yasmeen (2011) found that spraying wheat, peas and tomato with MLE at 3.5% increased fruit weight. HA has been proven to promote the quantitative and qualitative characteristics of the fruit. Maximum single fruit weight was found at highest concentration of HA because it help in freeing up the nutrient in the soil due to which more nutrient are available for plant and help to convert the element into suitable plant assimilates for their better fruit growth and yield. Similar result regarding availability of the nutrient for the fruit growth and yield was reported by Mahmoudi *et al.* (2013).

*Fruit diameter (cm)*

The increased in fruit diameter might be due to the high content of cytokinin in MLE which plays good role in enhancing cell division and expansion which results in increased fruit diameter (Sheren *et al.,* 2015). As MLE is a good source of ascorbic acid, the auxinic action of ascorbic acid along with its linkage in cell wall metabolism and cell expansion leads to big fruits (Samirnoff, 1996).The maximum fruit diameter

may be due to the direct involvement of the nutrient at growth and developmental stages of the fruit. Yildirim (2007) reported that foliar application of HA improved the fruit diameter of cucumber. Vasilenko (2002) reported that due to foliar application of HA the fruit diameter increased from 16-17% compared to control.

*Total yield (tons ha$^{-1}$)*

Similar results were observed by Fuglie (2000) who stated that moringa leaves extract improve growth of young plants, increase number of roots, support plants, increase resistance to diseases and pests, produce more and superior fruits and generally increase yield by 20 to 30% . HA enable the plant to uptake more and more nutrients from the soil by making these nutrients in readily available form indirectly. HA improved the fruit weight and yield in term of quantity and quality as reported by Mahmoudi *et al.* (2013).

*Total soluble solid ($^0$Brix)*

This enhancement in the amount of soluble solid contents might be due to the high sugar and starch contents in aqueous solution of MLE. Furthermore, moringa leaf aqueous extract also contain vital amount of cytokinins. Cytokinins helps in the metabolism of carbohydrate and form new source to sink relationship which in term increased the fruit total soluble solids (Dyer *et al.*, 1990). These results are similar with the findings of Sheren *et al.* (2015), who reported that foliar application of MLE increases the total soluble solids in 'Le Conte' pear. This favourable nutritional status, induced by foliar applications of HA could be the indirect cause of the accumulation of sugar in fruit. These findings are in line with those findings of Neri *et al.* (2002) who reported that increased of TSS in strawberry was due to the foliar application of HA. The increase in total sugar in response to HA might be due to formation of maximum amount of carbohydrate within the leaf and fruit tissues, which than converted to the specific sugar like glucose and sucrose (Abbas *et al.,* 2013). Balibrea *et al.,* have reported that an increase of TSS in tomato fruits may depend on a higher sugar import and accumulation.

*Percent Titratable Acidity*

The increased in the total acidity of cucumber fruit juice might be due to the fact that MLE is a good source of certain acids like ascorbic acid, which is directly involved in the rising of total acidity at final harvest, moreover certain nutrients such as potassium also directly involved in the acidity of fruit juice. Higher the potassium, higher will be the juice acidity and lower the potassium, lower will be the juice acidity (Zekri and Obreza, 2009). Plant keep their C:N ratio constant, but due to application of humic the cell utilized extra carbon to make organic acid such as malic acid and citric acid that result in maximum acidity of the fruit (Toor *et al.,*2006). Similar result also reported by Dogan and Demir (2004) in tomato increased titratable acidity found by the addition of HA aggregate culture in green house condition.

*Ascorbic acid content (mg 100g$^{-1}$)*

The increased amount of ascorbic acid in cucumber fruit might be due to the high amount of ascorbate in MLE. The exogenous application of ascorbate in the solution form of MLE trigger the production of internal ascorbic acid, which leads to the high quantity of ascorbic acid in the fruits of treated plants (Mengel, 1997).Nasira *et al.* (2016) also found that foliar application of moringa leaf aqueous extract increased vitamin C of 'Kinnow' mandarin. The application of HA increased the ascorbic acid content in cucumber fruit. It might be due to HA increase the permeability of bio membranes for electrolytes accounted for increased uptake of phosphorus and potassium which increase the ascorbic acid percentage of the fruit (Yildrim, 2007).

*Fruit juice pH*

The decreased in the juice pH of cucumber fruit might be due to the high content of potassium. Higher the potassium application, higher will be the juice acidity and lower the application of potassium, the lower will be the juice acidity (Zekri and Obreza, 2009). Ashraf *et al.* (2012), who reported that foliar application of

MLE on 'Kinnow' mandarine decreased the acidity of fruit juice. Increase the concentration of HA the pH will decrease due to the acidic nature of the chemical also the fruit produce by that plant will be acidic and the juice extracted from that fruit will be also acidic in nature. Kazemi (2014) reported that significant decrease in pH of tomato crop treated with HA as compare to control.

## Conclusion

The results showed that the application of MLE (50 $gL^{-1}$) with HA concentrations significantly effected all the growth, yield and quality attributes. The MLE (50 $gL^{-1}$) enhanced vine length, fruit weight, fruit diameter, Total yield (tons $ha^{-1}$), total soluble solids, titratable acidity and ascorbic acid content. Application of HA at 1.5 % improved the growth, yield and quality attributes of cucumber. The interactive effect of MLE and HA application for all the studied attributes were found non-significant.

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