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Effects of humic acid on growth and development of melon in nutrient solution culture

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ABSTRACT

A study on the effects of humic acid on vegetative growth and physiological changes of melon (*Cucumis melo* L.) was investigated. The melon seedlings were grown in nutrient solution culture and established in the greenhouse from December 2022 to February 2023 at the Agricultural Technology Research Institute, Rajamangala University of Technology Lanna, Lampang, Thailand. The experiment was carried out using a completely randomized design (CRD) with six treatments and ten replications, including 0 (control), 25, 50, 100, 150, and 200 mg/L of humic acid, respectively. The result showed that humic acid treatments affected the vegetative growth of melons. The application of humic acid at 50 mg/L gave greater plant height, leaf width, and leaf length than other treatments. The 25 and 50 mg/L humic acid enhanced leaf green color index (SPAD) and chlorophyll fluorescence of melon trees. However, increasing humic acid at 100–200 mg/L reduced vegetative growth and chlorophyll fluorescence.

Keywords: melon, humic acid, hydroponic system

INTRODUCTION

Melon, scientifically known as *Cucumis melo* L. is an annual crop that ripens when it gives off a sweet fruity odor. Melon is a nutritious fruit that is a rich source of vitamins A and C, minerals, fiber, and polyphenols with antioxidant and anti-inflammatory properties. Melon also has a high water content (about 90%) and is low in calories (Britannica, 2023). Melon is also considered a potential crop that can generate income for farmers who grow this fruit plant species under the greenhouse system either in the ground or in bags using planting material (Fhoythaworn and Agkhadsri, 2021). In 2016, the melon planting area in Thailand was about 85.28 hectares in 17 provinces. The main planting areas are Ayutthaya, Nonthaburi, Chanthaburi, and Nakhon Ratchasima provinces (DAE, 2017).

The largest supply of lignite coal and a significant amount of leonardite is found at the Mae Moh mine in Thailand's northern Lampang province. Leonardite is a naturally occurring raw material from which humic acid, fulvic acid, and humin can be produced (Jomhataikool et al., 2017). Base-acid treatment of soil and sediment involves the precipitation of humin, humic acid, and fulvic acid fractions using strong bases and strong acid solutions. (Garcia and Abad, 1996) Leonardite from the Mae Moh mine had a significant concentration of humic acid between 34.7 and 61.58% (Ratanaprommanee and Shutsrirung, 2014).

Humic acid, which originates from different materials and can be found naturally-available in the soil, has many advantageous effects on various aspects and parameters of plant growth. Humic acids have influential roles in soil, such as improving structure, texture, water-holding capacity (WHC), and microbial population (Nardi et al., 2002; Fuentes et al., 2018; Shah et al., 2018). These organic acids also increase crop growth by increasing plant growth promoting auxin hormones with significant effects on both root and shoot growth and increasing photosynthesis (Canellas et al., 2020). Jomhataikool et al. (2019) reported that comparing humic acid to the control, the investigation on rice berries revealed that it was advantageous to leaf and root growth. According to the results of the tomato experiment, humic acid applications between 80 and 240 mg/L can stimulate microbial activity and root growth but should be avoided in soils that are highly contaminated with the pathogens that cause root rot (*Fusarium* spp.) (Yigit and Dikilitas, 2008). Moreover, Humic acid was also observed to boost nutrient uptake efficiency, growth, and yield in the maize experiment. In order to lessen the amount of fertilizer used in the maize growing process, humic acid chemical fertilizer can be used (Ngennoy et al., 2014)

Growing plants using a hydroponic system approach uses water and non-soil components, or nutrient solutions is an effective system that can improve yield and crops safely and reliably; it can grow vegetables even when it is impossible to put crops in conventional soil (Sritontip et al., 2017). Melon also can be developed hydroponically. This method's unique selling point is the rapid development of root systems and effective absorption of crucial nutrients from the culture solution, which leads to greater yield and quality (Tung and Sritontip, 2022). The melon grown in a nutrient solution shows a greater leaf area index (LAI) than coconut media. Moreover, melon produced in U and double U containers offer higher fresh fruit weight and quality (Fatahian et al., 2013). Although melon can be grown in a culture system using nutritional solutions, it is difficult to regulate the output quality; the value of total soluble solids is unpredictable. Humic acid is a growth stimulant that can promote healthy melon development and fruit quality. This research aimed to evaluate the efficiency of humic acid concentrations in nutrient solutions on vegetative growth and physiological changes in melon.

MATERIALS AND METHODS

This study was established in the greenhouse from December 2022 to February 2023 at the Agricultural Technology Research Institute, Rajamangala University of Technology Lanna, Lampang, Thailand. The experimental design was assigned using a completely randomized design (CRD) with six treatments as the following: (1) control, (2) 25 mg/L humic acid, (3) 50 mg/L humic acid, (4) 100 mg/L humic acid, (5) 150 mg/L humic acid and (6) 200 mg/L humic acid, respectively. There were ten replications of each treatment with one plant each. Melon seeds were germinated in 104-cell nursery seedling trays and used plant media from Known-You Seed (Thailand) Co., Ltd. When seedlings were 14 days of age, they were transplanted into a hydroponics system. Seedlings of melon were grown in nutrient solution under a deep-flow technique (DFT) hydroponic system. The U-shaped PVC containers were sized 35 cm in width, 3 m in length, 12.5 cm in height, and 200 liters for nutrient solution containers (Figure 1) (Thichuto et al., 2022). The nutrient solution formula altered from Huett (1993) and Sritontip et al. (2017), the 1 liter of solution fertilizers consisted of stock fertilizers A and B. The stock A fertilizer contained 128 g $Ca(NO_3)_2 \cdot 4H_2O$ and 56 g Fe-EDTA and the stock B fertilizer had 8.7 g $NH_4 \cdot H_2PO_4$, 13.60 g KH_2PO_4, 133 g KNO_3, 51.80 g $MgSO_4$, 0.30 g $MnSO_4$, 0.20 g $ZnSO_4$,0.035 g $CuSO_4$, 0.55 g HBO_3, and 0.0175 g $(NH_4)_2MoO_2$. The pH of the nutrient solution was maintained within the range of 6.5 with the addition of sulfuric acid. The humic acid solution was added in 200 liters for nutrient solution containers.

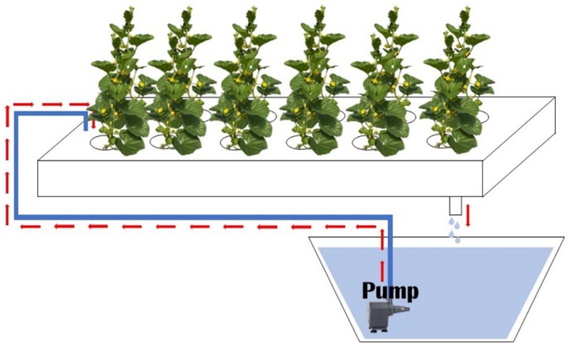

Figure 1. Hydroponic system model for growing of melon.

The physiology characteristics of melon were measured, including the number of leaves, stem height (cm), the diameter of trunk (mm), canopy width (cm), leaf width (cm), leaf length (cm), and stem diameter (mm). Changes in the greenness of the leaf were detected using the Konica Minolta model SPAD-502 plus®. In addition, changes in the chlorophyll fluorescence of melon leaf were measured by using Handy PEA$^+$® (Hansatech instruments, England), and were recorded every week after growing into a hydroponics system. Data were analyzed for Analysis of Variance (ANOVA) which statistical differences with P-values less than 0.05 were considered significant. Then, means were compared by Duncan's Multiple Range Test (DMRT) The statistical model was: $Y_{ij} = \mu + \tau_i + \varepsilon_{ij}$ where: Yij is the jth observation of the ith treatment, μ is the population mean, τ_i is the treatment effect of the ith treatment, and ε_{ij} is the random error (Steel et al., 1997).

RESULTS AND DISCUSSION

The vegetative growth parameters of melon grown in a hydroponic system were compared after being treated with different humic acid concentrations from 7 to 35 days. The results showed that the humic acid concentrations at 25, 50, and 150 mg/L in nutrient solution significantly increased plant height (Figure 2a). In addition, the canopy width of the 50 mg/L humic acid treatment was greater than the other treatments (Figure 2b). The 200 mg/L humic acid treatment yielded the lowest canopy width. The leaf width and leaf length showed that the humic acid at 50 mg/L treatment increased both parameters while the concentration at 100 and 200 mg/L treatments decreased on both (Figure 2c and d).

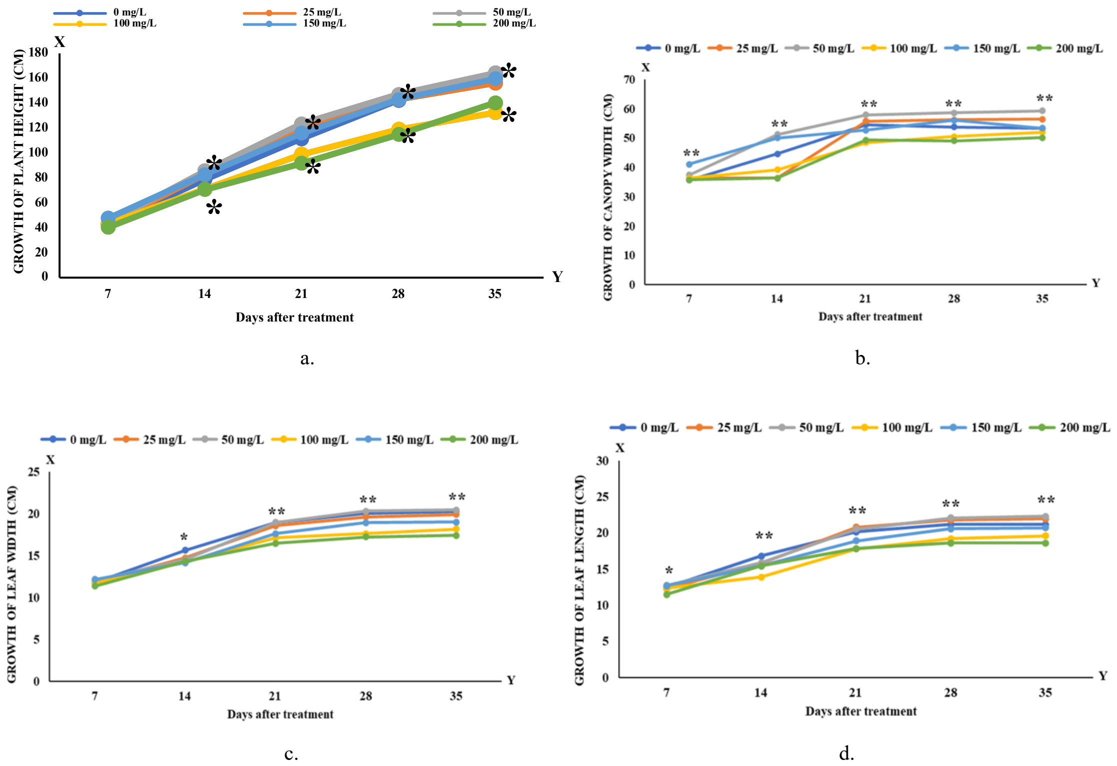

Figure 2. Effect of humic acid on vegetative growth of melon at 7 to 35 days after transplant (a) plant height, (b) canopy width, (c) leaf width, (d) and leaf length.

The physiological characteristics at day 14 found that the stem diameter of 150 mg/L humic acid plants gave the highest (8.74 mm), which was significantly different from those of 50–100 mg/L. However, the leaf number per vine and leaf green color index were not significantly different. Moreover, humic acid at 100–200 mg/L resulted in chlorophyll fluorescence reduction (Table 1).

Table 1. Effect of humic acid on physiological characteristics of melon at 14 days after treatments

Treatments	Leaf number (leaves)	Leaf green color index (SPAD)	Chlorophyll fluorescence (Fv/Fm)	Stem diameter (mm)
Control	10.70	41.80	0.732^{ab}	8.22^{ab}
Humic acid 25 mg/L	11.80	43.46	0.745^{a}	8.06^{ab}
Humic acid 50 mg/L	11.70	41.68	0.740^{a}	6.92^{c}
Humic acid 100 mg/L	10.90	41.35	0.683^{b}	7.91^{b}
Humic acid 150 mg/L	12.50	41.44	0.702^{b}	8.74^{a}
Humic acid 200 mg/L	11.60	41.66	0.686^{b}	8.19^{ab}
F-test	ns	ns	*	**

The values with the same superscript within a column are statistically non-significant by Duncan's test at P > 0.05. The asterisk indicates significantly different means (*for $P \leq 0.05$, **for $P \leq 0.01$), otherwise not significant (ns).

At 35 days after treatment, the results indicated that leaf number was significantly different among the treatments. The number of leaves of control, 50 and 150 mg/L humic acid treatments were significantly higher than that of 100 mg/L humic acid. Moreover, the leaf green color index values (SPAD) of control, 25 and 50 mg/L treatments were significantly higher than other treatments, while the 200 mg/L humic acid plants gave the lowest. Humic acid factors did not affect melon stem diameter at 35 days after treatment. On the other hand, increasing humic acid concentrations lowers chlorophyll fluorescence (Table 2).

Table 1. Effect of humic acid on physiological characteristics of melon at 14 days after treatments

Treatments	Leaf number (leaves)	Leaf green color index (SPAD)	Chlorophyll fluorescence	Stem diameter (mm)
Control	26.80^{a}	57.80^{a}	0.840^{ab}	8.89
Humic acid 25 mg/L	25.70^{ab}	56.03^{a}	0.843^{a}	8.71
Humic acid 50 mg/L	26.00^{a}	56.10^{a}	0.842^{a}	8.69
Humic acid 100 mg/L	24.30^{b}	51.66^{b}	0.839^{ab}	8.64
Humic acid 150 mg/L	26.70^{a}	50.11^{b}	0.838^{b}	9.34
Humic acid 200 mg/L	25.40^{ab}	45.74^{c}	0.826^{c}	9.09
F-test	*	**	**	ns

The values with the same superscript within a column are statistically non-significant by Duncan's test at P > 0.05. The asterisk indicates significantly different means (*for P ≤ 0.05, **for P ≤ 0.01); otherwise not significant (ns).

The application of humic acid of 25 and 50 mg/L resulted in better plant growth, including stem height, canopy width, leaf width, leaf length, leaf greenness (SPAD), and chlorophyll fluorescence than the application of humic acid at 100, 150, and 200 mg/L.

The vegetative growth of melon increased after the plants were treated with humic acid at 25 and 50 mg/L when compared with the control, especially in plant height, canopy width, leaf width, and leaf length to the hormones auxin which promotes growth of plant roots and shoots. The results from this experiment agreed with Rzepka-Plevnes et al. (2011), who reported that the growth of strawberries cultured on a medium supplemented with IBA and humic acid was greater than that of cultured on a medium containing only auxin. Wongwaiwiriyakit (2013) reported that 25 mg/L of humic acid in ¼ MS medium enhanced the growth of eggplant seedlings. Nevertheless, exceeding optimum concentrations of humic acid might not be appropriate for plant growth. Obsuwan et al. (2011) also reported that ¼ MS supplemented with humic acid at concentrations higher than 50 ppm decreased the growth of the eggplant seedlings. This research indicated that the growth of melons was positively impacted by applying humic acid in low quantities. However, a higher concentration of humic acid had an adverse effect.

CONCLUSIONS

Applying 25 and 50 mg/L of humic acid positively affected plant height, canopy width, leaf width, leaf length, leaf green color index, and chlorophyll fluorescence of the melon plant. However, increasing humic acid at 100 to 200 mg/L reduced leaf width, leaf length, leaf green color index, and chlorophyll fluorescence.

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