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Effect of Niacin (Nicotinamide) and Humic Acid on Growth and Chemical Traits of *Pelargonium hortorum* L.

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Abstract: This experiment was conducted in the lath house (covered with Saran cloth)at the College of Agriculture, University of Basra to study the response of the plant *Pelargonium hortorum* L. for the spraying with humic acid organic fertilizer at a concentration of 0, 50, 100 gm^{-1} and the nicotine amide at a concentration 0, 40, 80 gm^{-1} in the vegetative and flowering growth and chemical traits, with three spraying. Spraying led to the improvement of all of vegetative and flowering growth indicators and chemical traits, which were included plant height, number of leaves, the number of lateral branches, leaf area, flowering date, flowering duration, number of the inflorescence, number of florets, leaf content of total chlorophyll, anthocyanin pigment, nitrogen, phosphorus and potassium.

***Keywords*:** Geranium, Humic acid, Nicotine amide, Growth

Pelargonium hortorum belongs to the Geraniaceae family, which includes more than 11 genus (Saad 1994). It originated in South Africa, where it is found naturally growing in hot and dry environments in sandy, rocky and sandy hills. (Vanderwalt 1977). Geranium has been propagated, hybrids and Improved qualitative traits since 904 until its species reached in 2004 more than 500 commercial species (Erilk 2006). The demand increased for them significantly in recent years. It has become one of the plant groups of economic value important for the beauty of its leaves and flowers and the multiplicity of colors and sizes and the less of infection with pests and the length of the flowering period (Larson and Fonterno 1992). It increased sales in the United States, especially California, to reach 160 million dollars in the years 1979-1999 (Wazir 1999). Foliar fertilization is one of the important factors in increasing the growth rate, completing the formation of flowering and its quality. This is done by following proper and balanced fertilization programs that provides the plant all its nutrient needs (Abu Dahi and Al Younis 1988). The reduction of the necessary nutrient has negative effects on the biological processes that take place inside the plant. Therefore, it became necessary to provide these elements by spraying them on the vegetative total to be absorbed directly by the plant to avoid being exposed to washing and fixing when added to the soil (AlSahaf 1994). Foliar mineral nutrition has been shown to be an effective method for better nutrient transport within the plant, followed by its contribution to the natural growth of plants (Al-Jawari 2002). Vitamins play a big role in their effects on vegetative and flowering growth. Many endogenous organic substances, such as plant growth regulators and vitamins, have been used to promote growth and improve productivity in many plants (Bearder 1980 and Arteca 1996). Vitamin B3 (niacin) is one of the vitamins, also called Nicotineamide. It is a type of vitamin B group that has an effect in many biological processes in plants because it is a component of the enzyme NADP + and NAD + (Bearder 1980, San and Ota 1977). This vitamin is also called nicotinic acid. For the purpose of not mixing between nicotinic acid and nicotine tobacco, this is called niacin, a white substance that dissolves with water, basal substances, and alcohol, but does not dissolve in ether (AlKilani and Abdul Hassan 1986). Organic fertilizers are represented by humic acid is one of the humus compounds resulting from the decomposition of organic matter (Al-Nuaimi 1999). It chemically symbolizes $2CO_3(COOH)$ $C_{75}H_{33}O_{17}N_3$. It contains carbon, hydrogen, nitrogen, and oxygen in its composition and in varying proportions, resulting in the formation of compounds of varying molecular weights (Senesi 1992). The effect of humic acid on plant growth depends on the source of organic fertilizer and concentration and molecular weight of the humic molecule. Low molecular weights easily reach to the cell membrane of plant cells and enter the cell, while the high molecular weights reaction with the cell wall and are not carried into the cell (Nardi et al 2002). The studies indicate the possibility of using humic acid as a growth regulator by regulating the level of hormones in the plant, in addition to increasing plant resistance to water stress and stimulating plants Pelargonium to increase the percentage of flowers (Piccolo et al 1992, Nardi et al 2002, Morard et al 2011). This study was conducted due to the importance of geranium plant and the need to expand the cultivation of its aesthetic and coordination value, whether cultivated pots or in the garden land.

MATERIAL AND METHODS

This experiment was conducted in the lath house covered with Saran cloth at the Department of Horticulture and landscape gardening at the College of Agriculture, University of Basra on the plant Geranium (*Pelargonium hortorum* L) from Feb. to June 2019. Plants brought from one of the nurseries in Baghdad on 10/2/2019 and at the age of a month. Seedlings were transferred on 12/2/2019 to pots, where they were washed and sterilized with a 4% formalin solution. Before starting the agricultural operations, a random sample of soil was taken for analysis. Table 1 shows some chemical and physical traits of the river soil. The experiment was conducted as a factorial experiment (3×5) according to Randomized Complete Blocks Design with three replicates and the averages were compared using the least difference test (LSD) below the 5% probability level (Alrawi and Khalaf Allah 1980).

Plant height, number of leaves, number of lateral branches, leaf area, flowering date/duration, number of inflorescence, number of florets, chlorophyll content, anthocyanin content, NPK contents were measured/estimated.

RESULTS AND DISCUSSION

Vegetative Growth

The results in Table 3 showed that the spraying plants with a humic acid organic fertilizer at a concentration of 100 mg l^{-1} has a significantly in the effect as it recorded the highest average of plant height, number of leaves, leaf area, number of lateral branches, which amounted to 36.511, 42.76, 3116.0, 5.067, respectively compared with control plants (30.256, 29.26, 2324.0, 2.589, respectively). The same table also shows that the spraying with nicotine amide at a concentration of 80 mg was significant which gave the highest average of plant height, the number of leaves, number of lateral branches, leaf area of 34.467, 39.48, 2908.0, 4.556, respectively compared with control plants i.e., 31.389, 31.33, 2438.0, 2878, respectively. As for the bi-interaction between the organic fertilizer humic acid and nicotine amide, it was found to have a significant effect on improving the vegetative growth indicators, where the treatment of spraying with organic fertilizer humic acid and nicotine amide at a concentration of (100 + 40 mg)was recorded the highest average of plant height, number of leaves, number of lateral branches and leaf area i.e., 39.113, 47.97, 3613.0 and 6.20, respectively compared to the lowest average amounted to 29.300, 27.30, 2099 and 1.767, respectively for control.

The increase in plant height may be due to that the humic acid contains cytokinin and that its addition results in an increase of internal cytokinin and Auxin, which in turn stimulate cell division in the plant (Ervin and Zhang 2004, Schmidt and Zhang 2000). Humic acid treatment also increased the accumulation of carbohydrates that stimulate lateral buds to grow (Turkmen et al 2004). The increase in the number of lateral branches leads to an increase in the number of leaves, which reflected positively on the leaves area because humic acid contains micronutrient that has a positive role in the growth of the plant as it increases the cell division of the meristem (AbdEl_Monem et al 2011).

These results agree with Hafez and Mahmoud (2010) on the potato plant and Safana (2013) on the dahlia plant and Al- Aljubore (2014) on the geranium plant. This is due to the positive effect of being the main component of the biosynthesis of NAD and NADP enzyme compounds as it is needed by the plant in carbohydrate and amino acid metabolism. It is also involved in the formation of the indole acetic acid (IAA) and is elongated by cells (Devlin and Witham 1985).It also enters the synthesis of proteins and nucleic acids involved in the synthesis of organic bases and the growth hormones such as cytokinin (Robinson 1973). It has a relationship with the tryptophan amino acid in plant tissues, which is considered the basis in the construction of Auxin(IAA) important in the expansion and elongation of cells (Abu Dahi and AlYounis 1988).

Flowering Growth

The results in Table 4 showed that the spraying plants with a humic acid organic fertilizer at a concentration of 100 mg l^{-1} was a significantly affect with the highest average of the flowering date, flowering duration, number of the inflorescence, number of florets which gave 69.641, 48.769, 5.833, 13.456, respective values compared with control plants 91.708, 32.726, 3.467, 9.479, respectively. The same table also shows that the spraying with nicotine amide at a concentration of 80 mg was significant which gave the

Table 1. Some chemical and physical traits of the study soil used in the experiment

Traits	Unit	Value
Soil texture	____	Sandy loam
sand	1g-kg	861.8
silt	1g-kg	80.84
clay	1g-kg	57.36
PH	____	7.31
E.C	dsm^{-1}	1.54
Organic matter	%	1.84
Zn++	ppm	1.37
N	ppm	171
P	ppm	2.47

Table 2. Chemical composition of POWHUMUS organic fertilizer according to Humintech GmbH

Potassium humate	85%
Water-soluble potassium (K_2O)	11.00%
Nitrogen	0.80%
Iron	1.00%
Humidity	12-10%
Dry matter	88-90%
Degradation	99.80%
Other materials	15%

highest average of the flowering date, flowering duration, number of the inflorescence, number of florets which gave 76.269, 45.413, 5.100, 12.289, respectively in comparison with control plants i.e., 84.510, 36.253, 3.900 and 10.558, respectively. As for the bi-interaction between the organic fertilizer humic acid and nicotine amide, it was found to have a significant effect on improving the vegetative growth indicators, where the treatment of spraying with organic fertilizer humic acid and nicotine amide at a concentration of (100 + 40 mg)was recorded the highest average of the flowering date, flowering duration, number of the inflorescence, number of florets, which gave 68.400, 54.572, 6.733, 14.543 compared to the lowest average amounted to 97.667, 30.201, 2.733, 8.637, respectively. The increase may be due to the positive effect to organic fertilizer humic acid, which provides natural stimulants such as Auxin and Cytokinin and amino acids, which led to encouraging growth and therefore early flowering (Al-Ani 1987). The reason for the long vase life to the content of humic acid in the micro nutrients that stimulate the vegetative growth and reflected on improving the efficiency of photosynthesis and energy-rich compounds, thus improve plant growth and prolong flowering duration (Adams and Winsor 1979). This allowed it to form the largest number of inflorescences and to increase the number of florets (Morard et al 2011). These results agree with Chang (2012) on Lilium and Ambreen et al (2014) on Petunia. While the reason for the increase in total flowering when treated with nicotine amide due to a cycle in the production of amino acids and nuclear which is reflected positively on the manufacture of carbohydrates and transported from the leaves to flower buds. This leads to a balance between carbohydrates and protein, which have a positive role in the flowering date, flowering period, number of inflorescences and florets (Florent 1986).

Chemical Traits

The results in Table 5 showed that the spraying plants with a humic acid organic fertilizer at a concentration of 100 mg l^{-1} was significantly affected with the highest average of the leaf content of total chlorophyll, percentage of nitrogen, phosphorus, potassium and flower content of anthocyanin pigment, which gave values of 78.03, 2.075, 0.609, 5.228, 33.19, respectively compared to the control plants 66.14, 1.501, 0.451, 3769, 26.26, respectively for control. The same table also shows that the spraying with nicotine amide at a concentration of 80 mg was significant which gave the highest the leaf content of total chlorophyll ,Percentage of nitrogen, phosphorus, potassium and flower anthocyanin pigment (75.59, 1.722, 0.583, 4.754, 31.04, respectively) compared with control plants (69.55, 1.704, 0.486, 4.166, 27.77, respectively).

As for the bi-interaction between the organic fertilizer humic acid and nicotine amide, it was found to have a significant effect on improving the chemical traits, where the treatment of spraying with organic fertilizer humic acid and nicotine amide at a concentration of (100 + 40 mg)was recorded the highest average of the highest the leaf content of total chlorophyll, percentage of nitrogen, phosphorus, potassium and flower content of anthocyanin pigment i.e.,

Table 3. Effect of spraying with organic fertilizer humicacid and niacin (nicotine amide) and their interactions on vegetative growth traits of geranium plant (*Pelargonium hortorum* L)

Traits/ Treatments		Plant height (cm)	Number of leaves (leaf $plant^{-1}$)	Leaves area (cm^2)	Number of lateral branches
Humic acid levels (mg^{-1})					
0		30.256	29.26	2324	2.589
50		33.467	36.48	2725	3.622
100		36.511	42.76	3116	5.067
LSD		0.42	1.664	53.3	0.27
Nicotine amide levels (mg^{-1})					
0		31.389	31.33	2438	2.878
40		34.378	37.68	2818	3.844
80		34.467	39.48	2908	4.556
LSD		0.42	1.664	53.3	0.27
Interaction levels between humic acid and nicotine amide (mg^{-1})					
0		29.3	27.3	2099	1.767
40		29.9	29.1	2065	2.033
80		31.657	31.37	2806	3.967
0	50	31.2	30.3	2484	3.033
40	40	34.1	35.97	2777	3.3
80	80	35.1	43.17	2914	4.533
0	100	33667	36.4	2731	3.833
40	40	39.113	47.97	3613	6.2
80	80	36.733	43.9	3003	5.167
LSD		0.74	2.881	92.2	0.469

Table 4. Effect of spraying with organic fertilizer humicacid and niacin (nicotine amide) and their interactions on flowering growth traits of geranium plant (*Pelargonium hortorum* L)

Traits Treatments		Flowering date (day)	Flowering duration (day)	Number of the inflorescence	Number of florets
Humic acid levels (mg^{-1})					
0		91.708	32.726	3.467	9.479
50		75.856	43.165	4.622	11.36
100		69.641	48.769	5.833	13.456
LSD		0.304	0.133	0.303	0.274
Nicotine amide levels (mg^{-1})					
0		84.51	36.253	3.9	10.558
40		76.426	42.994	4.922	11.448
80		76.269	45.413	5.1	12.289
LSD		0.304	0.133	0.303	0.274
Interaction levels between humic acid and nicotine amide (mg^{-1})					
0	0	97.667	30.201	2.733	8.637
40		90.51	31.092	3.167	8.6
80		86.947	36.884	4.5	11.2
0	50	85.38	35.472	4.067	10.713
40		70.367	43.317	4.867	11.2
80		71.82	50.707	4.933	12.167
0	100	70.483	43.087	4.9	12.323
40		68.4	54.572	6.733	14.543
80		70.04	48.649	5.867	13.5
LSD		0.74	0.527	0.23	0.525

Table 5. Effect of spraying with organic fertilizer humicacid and niacin (nicotine amide) and their interactions on chemical traits of geranium plant (*Pelargonium hortorum* L)

Trait/ Treatments		Chlorophyll (mg 100 g^{-1} fresh weight)	Anthocyanin (mg 100 g^{-1} dry weight)	Nitrogen %	Phosphorus %	Potassium %
Humic acid levels (mg^{-1})						
0		66.14	26.26	1.501	0.451	3.769
50		75.46	29.06	1.72	0.507	4.526
100		78.03	33.19	2.075	0.609	5.228
LSD		1.099	0.451	0.063	0.064	0.187
Nicotine amide levels (mg^{-1})						
0		69.55	27.77	1.704	0.486	4.166
40		74.49	29.71	1.869	0.498	4.604
80		75.59	31.04	1.722	0.583	4.754
LSD		1.099	0.451	0.063	0.064	0.187
Interaction levels between humic acid and nicotine amide (mg^{-1})						
0	0	63.1	24.38	1.508	0.433	3.624
40		66.18	24.79	1.434	0.426	3.375
80		69.13	29.62	1.562	0.495	4.308
0	50	70.86	27.49	1.618	0.496	4.082
40		75.58	28.66	1.776	0.458	4.602
80		79.94	31.04	1.765	0.565	4.895
0	100	74.68	31.44	1.987	0.528	4.792
40		81.72	35.7	2.397	0.611	5.835
80		77.7	32.45	1.841	0.689	5.058
LSD		1.904	0.781	0.11	0.111	0.324

81.72, 2.397, 0.611, 5.835, 35.70, respectively compared to the lowest average amounted to 63.100, 1.508, 0.433, 3.624, 24.38, respectively.

The increase in leaf content of chlorophyll when treated with humic acid may be due to macro and micro nutrient and iron elements (Table 2). Nitrogen stimulates the activity of some enzymes in photosynthesis (Mohammed 1985). Nitrogen and iron also enter the structure of the chlorophyll molecule and stimulate them to build chlorophyll (AlSahaf 1989). While the increase of the anthocyanin pigment may be due to the increase of plant content of substances like auxin and cytokinin and contains macro and micro nutrient and thus increase the process of photosynthesis and carbohydrates that increase the construction of anthocyanin in flowers (Aljubore 2014). These results agree with Parandian et al (2012) and Aljubore (2014) on geranium and Abbas (2018) on Matthiola. The positive effect of humic acid on leaf nutrients for the geranium plant is due to the increase of nitrogen percentage through direct feeding of this nutrient, which increases the vegetative total. This is reflected positively on the photosynthesis products that increase the nitrogen percentage (Minkel and Kirby 1984). The reason for the increase in phosphorus is due to the role of iron in the organic fertilizer humic acid Table 2, which helps in increasing plant growth as well as its effect in increasing the availability of the nutrients. The increase in the nutrients content (nitrogen, phosphorus, potassium) may be due to the spraying plants with vitamin nicotine amide may lead to an increase in carbohydrates during photosynthesis, which leads to increased synthesis of the enzyme nitrate reductase necessary to reduce nitrates and their representation, which leads to an increase and accumulation of nitrogen in the leaves (Witham and Witham 1985). It is also involved in the formation of both co-enzyme NAD + and NADP +, which are composed of the reaction of nicotine amide and Adenosine triphosphate (ATP), which work in the processes of oxidation and reduction in carbohydrate transformation processes and thus increase phosphorus within the plant (Robinson 1973). These results agree with Tarraf et al (1999) found in Lemongrass and Al-Ali (2011) on dahlia.

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