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The effect of organic and chemical fertilization on vegetative and floral characteristics of *Pelargonium graveolens L.*

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ABSTRACT

The experiment was carried out in the lathhouse the Department of Horticulture and Landscape, College of Agriculture, Tikrit University during the spring of 2020. The aim of this experiment was to investigate the effect of humic acid and NPK fertilizers on the vegetative growth and flowering of *Pelargonium graveolens L.* Two factors including humic acid fertilizer (without, with addition at 3 g pot-1) and chemical fertilizer NPK (without addition, addition at 1g L-1, or at 2 g L-1) were used. The experiment was implemented according to the randomized complete block design (RCBD). The results showed that addition of humic acid had the highest percentage of phosphorus in the leaves (0.447%). On the other hand, the treatment of 1g liter-1 NPK was superior in plant height (42.330 cm plant -1) and number of flowers (34.718) while the treatment of 2g L-1 had the highest number of leaves (217.08) and leaf area (189.06 cm2).

INTRODUCTION

Pelargonium graveolens L. is a perennial herbaceous plant that belongs to the family of Geraniaceae recognized with high economic value. It originated in Southern Africa and is widely cultivated in India, China and Egypt. The plant is evergreen and characterized by strong growth, light purple flowers in the form of cluster inflorescences, and simple and lobed leaves uneven in size with rose-like scent. The active ingredient of the plant is concentrated in the shoot system (Shawl et al., 2006; Singh et al., 2011; Al-Mawsili and Al-Gamil, 2019). Humic acid is known as one of the compounds resulting from the humification of organic matter. This acid increases cytokinin and auxin and contains many nutrients lead to an increase in plant growth and yield (Ervin and Zhang, 2004).

The acid can increase the permeability of cell membranes, production of enzymes, and stimulating of intracellular vitamins. It also improves cell division and elongation and has a positive role in soil fertility (Pettit, 2003). In addition, it regulates the movement of nutrients necessary for the plant to absorb potassium and phosphorous. Moreover, increases plant's ability to resist diseases, whether related to insects, fungal, or physiological, as well as resist unsuitable weather conditions such as high temperatures and frost (Canellas et al., 2015). Salman and Sajt (2013) observed the effect of organic fertilizer on *Brassica rapa* var. rapa. They showed that the addition

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of organic fertilizer at concentration of 6 ml led to a significant increase in the number of leaves and branches, dry matter, chlorophyll content in the leaves and the percentage of NPK. Kasouha et al., (2014) showed that there was significant effect of humic acid in the number of leaves, number of inflorescences and number of flowers of *Crocus sativus* plant.

For plant growth and development, the basic nutrients including nitrogen, phosphorous and potassium (NPK) are required. These elements perform vital functions to complete plant life cycle (Al-Kartani, 1988). Nitrogen is included in many energy compounds such as NADPH and ATP. It is involved in green plastids, mitochondria, and the formation of cell membranes. It is also included in the synthesis of proteins, chlorophyll and some coenzymes (Bidwell, 1979). Phosphorous has roles in biological processes such as cell division and formation and transfer of genetic traits as well as analysis of carbohydrates inside plant cells. On the other hand, potassium activates plant enzymes and participates in some vital activities (Al-Naimi, 1999; Tisdale et al., 1993).

Akanbi et al., (2010) observed that adding NPK at four different levels (0, 200, 300, 400 kg Ha^{-1}) on *Solanum melongena* gave significant increases in plant height, leaf area and stem diameter (39.8, 3.2, and 820.6 cm, respectively) while the comparison treatment recorded lowest (31.2, 2.7, and 638.3 cm respectively). Suge et al., (2011) found a significant increase in the rate of vegetative growth represented by plant height and weight of the shoot. The values were 51.89 cm and 322.75 g respectively, while the comparison treatment recorded 47.42 cm and 280.88 g respectively. These increases were attributed to the addition of chemical fertilization of NPK.

The study aimed to examine the response of *Pelargonium graveolens* L. to humic acid and NPK fertilizers. The effects of humic acid and NPK fertilizers on the vegetative and flowering behavior were tested.

Materials and Methods

The experiment was carried out in the lathhouse at the Department of Horticulture and Landscape, College of Agriculture, Tikrit University during spring season of 2020. *Pelargonium graveolens L.* seedlings were obtained from a nursery in Salah ad Din governorate during February 2020. The selected seedlings were similar in their size, growth at the age of two months and height range 7-8 cm. The plants were transferred to large pots of size 11,756 cm^3. The pots were filled with a mixture of 2: 1 (v: v) loam: peat moss. The experiment included two factors: the first was humic acid in powder form that added to the soil at 5 cm depth. The acid was used at two levels without adding (control) and adding of 3 g pot^{-1} at two times. The first time of addition was on April 14, 2020 and the second was one month later. The second factor was without NPK (control) and spraying with NPK (product name Tron 20-20-20, made in Jordan) at two levels: 1 g L^{-1}, and 2 g L^{-1} sprayed until complete wetness and for two times. The first was on April 14, 2020, and the second was one month later.

The experiment was designed according to randomized complete block design (RCBD) with three replicates. Each experimental unit consisted of three pots (a plant in each pot). At the end of the experiment, on June 7, the following measurements were taken: plant height, number of leaves, leaf area, number of flowers, and percentage of phosphorus in leaves. Leaf area was measured following Patton (1984) method. The method concluded taking 10 leaves per pot. The leaves were randomly taken from the upper third of the plant and placed on (A4) paper. Then, they were cloned, cut and weighed to take the average. All results were statistically analyzed, and the averages were compared according to the Duncan polynomial test at p= 5% (SAS Institute, 2009).

Results

There were no significant differences in plant height when treating the plant with humic acid. However, the addition of NPK was significant. The treatment of 1 g L^{-1} NPK had the highest plants (42.330 cm). It was significant compared to the lowest plant (38.246 cm) under the treatment of control (without any addition). The table also showed there was a significant difference in the interaction of humic acid and NPK. The treatment of humic acid at 3 g pot^{-1} with NPK at 1 g L^{-1} was significantly different from the treatment of humic acid at 3 g pot^{-1} without NPK (0 level). The values were 42.49 for the highest plants and 37.05 for the lowest plant respectively (Table 1).

Table (1) The effect of humic acid and NPK fertilizers and their interaction on plant height (cm plant^{-1})

Humic acid g pot^{-1}	NPK g L^{-1}			Humic acid
	0	1	2	
0	39.44 ab	42.16 a	41.16 ab	40.923 a
3	37.05 b	42.49 a	41.66 ab	40.403 a
NPK	38.246 b	42.330 a	41.413 ab	

Means followed by same letters within column are not different at (P=0.05)

The results displayed there were no significant differences in the number of leaves when the plant was treated with humic acid than control. The results indicated the treatment of spraying 2g L^{-1} of NPK was significantly different from the other levels. This treatment recorded the highest number of leaves (217.08). The lowest number with this factor was recorded under the treatment of without NPK (145.42) (Table 2).

The same table also showed significant differences for the interactions between the two factors. The addition of humic acid (3 g pot^{-1}) recorded significant increases when interacted with NPK addition at any level (1, 2 g L^{-1}) than without NPK. The treatment of 3 g pot^{-1} humic acid with 2 g L^{-1} had the highest number of leaves (229.08) compared to the treatment of 3 g pot^{-1} without NPK (127.42).

Table (2) The effect of humic acid and NPK fertilizers and their interaction on the number of leaves (leaf plant^{-1})

Humic acid g pot^{-1}	NPK g L^{-1}			Humic acid
	0	1	2	
0	163.42 bc	182.17 ab	205.08 ab	183.56 a
3	127.42 c	186.17 ab	229.08 a	180.89 a
NPK	145.42 c	184.17 b	217.08 a	

Means followed by same letters within column are not different at (P=0.05)

The results also showed there were no significant differences in leaf area when treated with humic acid. The results indicated that the addition of NPK fertilizer at the level 1 g L^{-1} was significantly different from without addition (level of 0). This addition treatment had the highest value of leaf area (189.06 cm) compared to without addition treatment (148.63 cm). The results also indicated significant difference for the interaction between the two factors. The treatment of 3 g pot^{-1} humic acid with 2 g L^{-1} exhibited the highest value of leaf area. This treatment recorded 190.85 cm^2 compared to 145.07 (lowest value) recorded under the treatment of 3 g pot^{-1}with no addition of NPK (Table 3).

Table (3) The effect of humic acid and NPK fertilizers and their interaction on the area (cm^2 leave^{-1})

Humic acid g pot^{-1}	NPK g L^{-1}			Humic acid
	0	1	2	
0	152.19 bc	182.80 ab	187.27 ab	174.08 a
3	145.07 c	156.42 abc	190.85 a	164.11 a
NPK	148.63 b	169.61 ab	189.06 a	

Means followed by same letters within column are not different at (P=0.05)

The results in Table (4) indicated no significant differences in the number of flowers when treating the plants with humic acid. However, the results showed significant increase when NPK was sprayed at 1 g L^{-1} compared to spraying 2 g L^{-1}. The treatment of 1 g L^{-1} resulted the highest number of flowers (34.718) compared to the lowest number (26. 441) when NPK level was increased to 2 g L^{-1}.

The same table exhibited significant differences in the flower number when the two factors interacted. The treatment of interaction between humic acid at 3g. pot $^{-1}$ and NPK at 1 g.L^{-1} recorded significant difference in flower number. This treatment had the highest number (38.662) compared to the lowest (23.943) under the treatment of 3g pot^{-1} without NPK.

Table (4) The effect of humic acid and NPK fertilizers and their interaction on the number of flowers (flower plant $^{-1}$)

Humic acid g pot^{-1}	NPK g L^{-1}			Humic acid
	0	1	2	
0	32.107 ab	30.775 ab	25.885 b	29.589 a
3	23.943 b	38.662 a	26.997 b	29.867 a
NPK	28.024 ab	34.718 a	26.441 b	

Means followed by same letters within column are not different at (P=0.05)

There was significant difference in the percentage of phosphorus when treating the plants with humic acid. The treatment of 3g pot^{-1} was significantly different from the treatment of control. The addition treatment resulted in the highest percentage of phosphorus (0.447%) compared to the lowest (0.369 %) under the treatment of control. It is also shown that there was no significant difference under NPK addition (Table 5).

The same table also showed significant differences in the percentage under the interaction. The interaction of 3g pot^{-1} humic acid with no NPK recorded the highest percentage (0.568) compared to the rest of interaction treatments. the lowest percentage was 0.315 when no humic acid and no NPK were added.

Table (5) The effect of humic acid and NPK fertilizers and their interaction on the percentage of phosphorous in plant leaves (%)

Humic acid g pot^{-1}	NPK g L^{-1}			Humic acid
	0	1	2	
0	0.315 b	0.388 b	0.404 b	0.369 b
3	0.568 a	0.367 b	0.405 b	0.447 a
NPK	0.441 a	0.377 a	0.404 a	

Means followed by same letters within column are not different at (P=0.05)

Discussion

The results showed a significant increase of phosphorus in the plant when under humic acid. This result agreed with (Al-Nasir, 2010) who concluded that adding humic acid increased phosphorus percentage in plant. This increase in phosphorus percentage may be attributed to positive effect of this acid. The acid may have improved absorption of nutrients that support plant growth including phosphor. This acid might also have enhanced the physical and chemical properties of the substrate, which provided macro and micro elements for the plant (Al-keltawi, 2003; Ali, 2005; Khader, 2007; Haghighi et al., 2011). The increase may also be due to the role of humic acid in binding some mineral elements in the soil. This can make the elements more available to absorption by the plant. This acid can also be binding calcium, which limits its link with the phosphorus. Thus, phosphorus would be more available and provided to the plant (Khaled and Fawy, 2011).

The results also showed significant effect of NPK fertilizer in plant height, number of leaves, leaf area, number of flowers. These characteristics were increased when NPK was added compared to the control. These results were compatible with Suge et al. (2011) who concluded that adding NPK increased growth characteristics in plant. This increase may be due to the presence of NPK elements necessary for the plant. These elements have well-known roles in plant growth and development. Nitrogen is essential in plant tissue structures and fundamental bioprocesses (Hassan et al., 1990). Phosphorus has an effective role through the composition of energy-carrying compounds and enzymatic attachments (Jawad, 1988). Potassium contributes to the representation of important proteins and carbohydrates in photosynthesis (Havlin et al., 2005). The positive effect of NPK on plant growth characteristics can be explained through the role of the nutrients added. This can induce auxin due to increase in nitrogen, which induces elongation of plant cells (Velasquez et al., 2016). Phosphorus is important in the formation of energy compounds and enzymatic accompaniments. These all help to stimulate and activate the bioprocesses, thus it leads to an increase in vegetative growth in the plant (Singh et al., 2013). Potassium has a significant role in encouraging the growth of meristematic tissues and aiding the division of plant cells. It is also involved in activation of enzymatic systems and the process of photosynthesis, and transfer its outputs to different parts in the plant (Al-Naimi, 1999).

The interaction of, humic acid and NPK had significant effects in the characteristics studied. This can be due to providing more suitable condition for the plant to absorb more nutrient and support its growth (Al-Nasir, 2010).

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تأثير التسميد العضوي والكيمياوي في النمو الخضري والزهري لنبات الشاي العطري

Pelargonium graveolens L.

رغد تحرير سالم **ثامر عبدالله الزهوان**

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الكلمات المفتاحية: الشاي العطري ، NPK ، حامض الهيومك

الخلاصة

نفذت تجربة عاملية في الظلة الخشبية التابعة لقسم البستنة وهندسة الحدائق، كلية الزراعة, جامعة تكريت للموسم الربيعي 2020. هدفت التجربة الى دراسة تأثير التسميد بحامض الهيومك والسماد الكيميائي NPK في النمو الخضري والزهري لنبات الشاي العطري *Pelargonium graveolens L.*. تضمنت التجربة عاملين العامل الاول اضافة السماد العضوي حامض الهيومك Humic acid بمستوين بدون اضافة (المقارنة) والاضافة بتركيز 3 غم سندانة-1 . اما العامل الثاني فهو استخدام ثلاث مستويات من السماد الكيميائي :NPKبدون اضافة (المقارنة) , رش 1 غم لتر-1 , ورش 2 غم لتر-1 على النبات. نفذت التجربة وفق تصميم القطاعات العشوائية الكاملة (RCBD) بينت النتائج تفوق معاملة اضافة حامض الهيومك بصفة نسبة الفسفور في الاوراق والتي بلغت 0.447 %. في حين تفوقت معاملة اضافة NPK 1 غم لتر-1 في ارتفاع النبات 42.330 سم نبات-1 وعدد الازهار34.71 زهرة نبات-1 بينما كانت معاملة 2غم لتر-1 أعلى في عدد الاوراق 217.08 ورقة نبات-1 والمساحة الورقية 189.06 سم2 ورقة-1 .