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EFFECT OF HUMIC ACID SOIL APPLICATION AND FOLIAR SPRAY OF SOME NUTRIENT ELEMENTS ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF *Lepidium sativum* PLANT

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ABSTRACT:

A factorial experiment between four humic acid levels (0, 1, 2 and 4% as soil application) and three Aromatic-Power fertilizer levels (0, 0.5 and 1 % as foliar spray) was conducted during the two successive winter seasons of 2012/13 and 2013/14 at the Expt. Farm Hort. Res. Station at Sides, Agric. Res. Center, Beni Suef Governorate. The aim of this work was to evaluate the effect of humic acid and aromatic-power and their interactions on growth, yield, fixed and volatile oils production, as well as, some chemical constituents of Lepidium sativum L. plant, as an effective and inexpensive alternative for plant nutrition.

All studied vegetative growth traits; i.e., plant height (cm), branches number/ plant and herb fresh and dry weights/ plot (kg) were significantly increased by humic acid applications. Such enhancements in plant growth were reflected as significant increases in number of silique/ plant, weight of 1000 seeds (g), fruit yield per plot and per fad (kg) and fixed and volatile oils percentages and yields/ fad in seeds as well as percentages of total nitrogen, total protein, total carbohydrates and lipids in seeds. The highest yield and quality were found in plants received the highest humic acid level of 4%. Foliar spray of Aromatic-power fertilizer significantly improved the abovementioned traits of growth, yield, oils production and chemical constituents of seeds. The highest rate of 1% Aromatic-power was the superior in increasing plant growth and yield and its quality. More increases in plant growth and in seed yield and its quality were noticed when humic acid interacted with Aromatic-power fertilization.

Conclusively*, it could be recommend that using humic acid (Hammar compound) as soil application at 4% three times during season interacted with foliar nutrient of Aromatic-power fertilizer at*

1% three times during season as an effective and inexpensive alternative to plant nutrition for enhance garden cress growth and yield.

Key words: *Lepidium sativum* L., humic acid, amino acids- organic acids- chelated-microelements, chemical composition**.**

INTRODUCTION:

Lepidium sativum is known as Garden cress and belongs to family *Brassicaceae*. It has been known centuries ago in eastern regions then spread worldwide. Garden cress is famous in folk medicine. It is known for its pungent odor due to its volatile oil. It is used in treat respiratory disorders, muscle pain, inflammation, and bone fractures. Its extracts of leaves and seeds were found to have alkaloids, flavonoids, glycosides, polypeptides, vitamins, minerals, proteins, fats and carbohydrates. These components give plant its medicinal properties related to antihypertensive, diuretics, fracture healing, respiratory disorders, antimicrobial, milk production, anti-inflammatory, antioxidant, laxative and chemical protection (Falana *et al*. 2014).

Humates are natural organic substances, high in humic acid and containing most of known trace minerals necessary for plant growth and production. Humic acid is a natural polymer organic compound (Senn, 1991). Humic acid is a negatively charged colloid. Thus, it can be stored in soil for long time (Qualls, 2004). It can be used directly as foliar spraying or as soil application (Sharif, *et al*., 2002). Humic acid usually used for promote growth traits and yield. The valuable role of humic acid is related to its direct effect on physiological and biochemical processes in plant and to its indirect effect on improving physical, chemical and biological properties of soil (Tan, 2003). Humic acid increase element's uptake by plants and increase soil's fertility with chelating essential elements (Michael, 2001). In addition, it affects the functions of cell membrane by enhancing respiration, nutrients absorption, biosynthesis of nucleic acids (Yang *et al.*, 2004). According to Ulukan (2008), Humic acid (HA) applications frequently enhanced plant growth and yield through its role in regulates carbon cycle and releases nutrients including nitrogen, phosphorus and sulfur. Additionally, it stimulates plant growth via assimilation of major and minor elements, enzyme activation and/ or inhibition, changes in membrane permeability, protein synthesis and finally activates biomass production.

Amino acids are fundamental ingredients in protein synthesis processes. Previous studies proved that amino acids can directly or indirectly influence the physiological activates of plant. Because of the amino acid pool is only a small portion of the total dissolved organic nitrogen pool, which generally contains less than 10% free amino acids in temperate ecosystems (Yu *et al*., 2002).

Micronutrients are vital elements in plant growth and production. It has been proved that they are essential for better plant growth, resistance to pests and diseases, and proper yield both qualitatively and quantitatively. The best strategy compensate the lack of such elements in plants is foliar spraying. Foliar spraying of microelements permit quickly absorbed by plants and overcome the problem of elements fixation in case of soil applications (Pezeshkpour and Khosravi, 2014). Microelements as iron (Fe), zinc (Zn) and molybdenum (Mo) usually added to foliar fertilizers in order to compensate their deficiency (Kaya *et al*., 2005). Micronutrients, especially Fe and Zn, act either as metal components of various enzymes or as functional, structural, or regulatory cofactors. They are related to photosynthesis, protein synthesis and saccharide metabolism (Marschner, 1995). Molybdenum occurs within plant in several enzymes as nitrate reductase, nitrogenase, xanthine dehydrogenase and aldehyde oxidase (Mengel and Kirkby, 2001). It involved in in nitrogen metabolism in plant tissues (Li *et al*., 2013).

Bio stimulants are usually applied to plants by sprinkling a solution on the leaves to encourage and stimulate plant metabolism processes as well as to improve nutrient use efficiency, yield and quality, and to reduce the impact on the environment (Parrado *et al*.2008).

Thus, the objective of this study was to evaluate the effects of humic acid as soil application and aromatic-power (an organic fertilizer contained some chelated-elements) as foliar spraying and their interactions on the growth, yield and chemical constituents of *Lepidium sativum* L.

MATERIALS AND METHODS

The present study was conducted on *Lepidium sativum* L. in Beni Suef Governorate at the Expt. Farm Hort. Res. Station at Sides, Agric. Res. Center, during the two successive winter seasons of 2012/2013 and 2013/2014. The aim of this work was to evaluate the effect of humic acid at four levels as soil drench and foliar spraying of aromatic-power (organic liquid fertilizer) at three levels and their interaction treatments on growth, yield, fixed and volatile oils production, as well as, some chemical constituents of *Lepidium sativum* L. plant.

On October 15th for the two experimental seasons, *Lepidium sativum* L. seeds were sown in experimental units. Each experimental unit was 3.5 X 3m consisted of five rows with 60 cm between them. Seeds were sown in hills, 3-4 seeds/ hills at 15 cm a part at one side of each row. Two weeks after planting seedlings were thinned maintaining two plants per hill. The mechanical and chemical properties of the used soil are shown in Table 1.

Table 1: Physical and chemical properties of the used soil

Value	**Character** (ppm.)		**Value**	**Characters** %	
40	Avail	N+	Clay soil	Soil type	
18		P+	**53.3**	Clay	
336		K+	**36.2**	Silt	
2.40	Fe		**10.5**	Sand	
0.60	Mn		**2.23**	Org. Matt.	
0.20	Zn		**3.20**	Ca CO_3	
2.00	Cu		**7.60**	PH (1 : 2.5)	
-----------------	-----------------		**0.90**	E.C. (m/mhos/cm)	
7.5	**E**xchange (meq/L)	SO4--	**0.8**	**E**xchange (meq/L)	K+
1.0		Cl-	**4.0**		Ca++
1.0		HCO3-	**2.7**		Na+
--------		CO3--	**2.0**		Mg++

Humic acid levels:

Hammar commercial compound (United for Agricultural Development Company) contained 86% humic acid, 7% folic acid, 6% potassium oxide and 1% microelements (Fe-Cu- Zn-Mo); Ph 7 was used as source of humic acid in this study. The four tested humic acid levels were 0, 10, 20 and 40 g/L; *i.e.,* 0, 1, 2 and 4 %, respectively. It was applied as soil application 3 times during growing season at two-week intervals; starting one month after planting. This was repeated during the two experimental seasons.

Organic liquid fertilizer levels

Organic liquid fertilizer named Aromatic-power (commercial name, production Bio Smart group, Egypt) was used in this study. It contains Zn, Cu, Fe, B, Mn, Mo, Co and K elements at percentages of 3.0, 1.0, 1.0, 0.6, 0.8, 0.1, 0.3 and 12.5, respectively as well as 5.0% amino acids and 20% organic acids. Plants were foliar sprayed with Aromatic-Power fertilizer in the three levels of 0, 5 and 10 cm/ L*; i.e.,* 0.0, 0.5 and 1%, respectively. Spraying was done three times throughout the growing season for the two experimental seasons, the first spray was six weeks after sowing date, and the second and the third ones were with one month intervals.

The Experimental layout:

The experimental treatments were set as a factorial experiment (4 X 3) in a split-plot design between the above mentioned four humic acid levels as main plots and the three Aromatic-Power fertilizer levels as sub-plots in randomized complete blocks design with three replicates. So, the experiment included 12 interaction treatments.

All experimental plots were fertilized with 200 kg/ *fad* calcium superphosphate (15.5% P_2O_5), 100 kg/ *fad* ammonium sulphate (20.5% N) and 50 kg/ *fad* potassium sulphate (48.5 % K_2O). Phosphorus fertilizer was added during soil preparation, while nitrogen fertilizer was applied in two equal doses (after 45 and 75 days from sowing date). Potassium sulphate was applied as one dose after 75 days from sowing date. In addition, all plants were received normal agricultural practices for Garden cress plant whenever needed.

Data recorded:

1. **Growth parameters:**

Ninety days after sowing for the two tested seasons, at full flowering stage, vegetative growth responses to the experimental treatments were recorded. The recorded growth parameters were included plant height (cm), branches number/ plant and herb fresh and dry weights/ plot (kg). Ten plants were randomly chosen from each experimental plot for growth parameter determinations.

2. ***Yield and its components:***

On 15th April in the two experimental seasons yield and its components were recorded. Yield components determinations included number of silique/ plant, weight of 1000 seeds (g) and fruit yield per plot and per faddan (kg).

3. ***Fixed and volatile oil determinations in seeds:***

Fixed oil was extracted from 100g air-dried seeds for each experimental treatment. Extraction was performed using n-hexane for 6 hours in Soxhlet apparatus. Anhydrous sodium sulphate was used to absorb moisture from the extracted oil, and then oil was filtered using what man No.1 filter paper. It was expressed as percentage in dry seeds and oil yield per faddan (L).

Volatile oil percentage of dry seeds for each sample was determined using Clevenger apparatus according to British Pharmacopoeia (1963). It was expressed as percentage in dry seeds and oil yield per faddan (L).

4. Chemical determinations in seeds:

Samples of fresh seeds were randomly taken from each experimental plot, then oven dried at 70 C^o until constant weight and were grinded to determine percentages of total nitrogen, total carbohydrates and lipids according to A.O.A.C. (2006). The protein percentage in the seeds was calculated by multiplication total nitrogen percentage by a factor of 6.25**.**

Statistical Analysis

The obtained data were subjected to the statistical analysis of variance using Mstata-C (1986). Least significant difference (L.S.D) at 5% level was used to compare means.

RESULTS AND DISCUSSION

1. Growth parameters:

Data in Table 2 recorded significant effects in vegetative growth traits of *Lepidium sativum* L. plant under the effect of humic acid, Aromatic-power fertilizer and their interactions. This was confirmed during the two tested seasons.

Gradual increases were found in plant height, branches number/ plant and herb fresh and dry weights/ plot with increasing the tested level of humic acid from 0% up to the highest level of 4%. The highest humic acid tested level (4%) resulted in the tallest plants and the highest values represented branches No. and fresh and dry weights of herb comparing to control and all other tested humic acid levels. This was repeated during the two experimental seasons (Table 2). Shafeek *et al.* (2016) and Shehata *et al.* (2012) on cucumber, as well as, EL-Ghamry *et al*. (2009) on *faba bean* reported similar results. They recorded increases in vegetative growth traits after humic acid applications.

However, the caused enhancement in plant growth after humic acid applications might be due to its direct effect on physiological and biochemical processes in plant and to its indirect effect on improving physical, chemical and biological properties of soil (Tan, 2003). Abdel-Mawgoud *et al*. (2007) stated that soil application of humic acid increased soil porosity, so it shared in ventilation and increase root respiration and penetration in soil; this may reflect an increase in plant growth. Also,

Table 2: Effect of soil application of humic acid# and foliar nutrient@ treatments on vegetative growth traits of *Lepidium sativum* L. plants during 2012/13 and 2013/14 seasons

Humic acid (%) (A)	Aromatic-power fertilizer (%) (B)							
	Cont.	**0.5**	**1**	**Mean**	**Cont.**	**0.5**	**1**	**Mean**
	2012/13				**2013/14**			
	Plant height (cm.)							
Cont.	50.2	53.3	55.5	**53.0**	52.5	53.1	56.5	**54.0**
1	52.1	56.5	59.1	**55.9**	53.2	58.3	60.3	**57.3**
2	53.5	58.1	62.7	**58.1**	56.7	62.6	64.1	**61.1**
4	56.9	63.3	74.1	**64.8**	58.7	65.9	75.1	**66.6**
Mean	**53.2**	**57.8**	**62.9**		**55.3**	**59.9**	**64.0**	
L.S.D. 0.05%	A:6.1 B:5.3 AB:11.2				A:5.3 B:4.5 AB:10.1			
	Number of branches/ plant							
Cont.	6.2	7.6	8.1	**7.3**	6.3	7.5	8.3	**7.4**
1	7.3	9.2	9.9	**8.8**	7.3	9.3	9.7	**8.8**
2	8.2	10.4	10.8	**9.8**	8.5	10.9	11.0	**10.1**
4	8.3	11.6	13.9	**11.3**	8.7	11.8	13.5	**11.3**
Mean	**7.5**	**9.7**	**10.6**		**7.7**	**9.9**	**10.6**	
L.S.D. 0.05%	A:1.2 B:0.9 AB:2.3				A:0.9 B:0.6 AB:1.6			
	Herb fresh weight per plot (kg)							
Cont.	3.23	4.37	4.75	**4.12**	3.51	4.55	4.91	**4.32**
1	3.71	5.52	5.89	**5.04**	4.11	5.89	5.89	**5.29**
2	4.47	6.31	6.83	**5.87**	5.35	6.42	7.13	**6.30**
4	4.75	7.19	9.08	**7.01**	5.50	7.32	8.75	**7.19**
Mean	**4.04**	**5.85**	**6.64**		**4.62**	**6.05**	**6.66**	
L.S.D. 0.05%	A:1.05 B:0.77 AB:1.87				A:0.83 B:0.58 AB:1.43			
	Herb dry weight per plot (kg)							
Cont.	0.76	0.85	0.96	**0.86**	0.70	0.91	1.03	**0.88**
1	0.80	0.99	1.12	**0.97**	0.88	1.12	1.14	**1.05**
2	0.98	1.20	1.37	**1.18**	1.11	1.28	1.43	**1.27**
4	1.03	1.37	1.81	**1.40**	1.19	1.42	1.75	**1.45**
Mean	**0.89**	**1.10**	**1.31**		**0.97**	**1.18**	**1.33**	
L.S.D. 0.05%	A:0.21 B:0.19 AB:0.42				A:0.18 B:0.13 AB:0.32			

Humic acid was used as Hammar compound.

@ Aromatic-power is organic fertilizer containing, it was used as a source foliar nutrient.

Humic acid increases element's uptake by plants and increases soil's fertility with its chelating essential elements (Garcia *et al*., 2008). Zhang and Ervin (2008) reported that humic acid contains hormone like substances, so its application may resulted in increasing endogenous cytokinin and auxin levels which possibly leading to improve plant growth. According to Ulukan (2008), Humic acid stimulates plant growth via assimilation of major and minor elements, enzyme activation and/ or inhibition, changes in membrane permeability, protein synthesis and finally activates biomass production.

Also, data of the same Table 2 exhibited enhancing effects for Aromatic-power fertilizer on plant height, branches No/ plant and herb fresh and dry weights/ plot. The highest values of these vegetative traits were found in plants sprayed with Aromatic-power at the highest tested concentration of 1% comparing to control or the low tested Aromatic-power concentration of 0.5%, this was confirmed during the two seasons. However, the enhancing effect of foliar spray of essential elements on plant growth may result from their vital role in plant. Micronutrients, especially Fe and Zn, act either as metal components of various enzymes or as functional, structural, or regulatory cofactors. They are related to photosynthesis, protein synthesis and saccharide metabolism (Marschner, 1995). Molybdenum occurs within plant in several enzymes as nitrate reductase, nitrogenase, xanthine dehydrogenase and aldehyde oxidase (Mengel and Kirkby, 2001). It involved in in nitrogen metabolism in plant tissues (Li *et al.*, 2013).

Data represented interaction effects between humic acid and Aromatic-power on vegetative growth parameters of garden cress plant (Table 2) show that plants received 4% humic acid interacted with 1% Aromatic-power were the superior in their height, branching and in herb fresh and dry weights comparing to all other interaction treatments between humic and Aromatic-power, this was true in the two seasons. However, obtained results exhibited the synergistic effects between humic acid and nutrient elements applications. Since, it is prediction that adding humic acid to the soil improves soil properties, and this in turn reflected as more activity in root tissues in respiration and nutrient absorption. If this meet more essential elements supplied via Aromatic-power foliar fertilization, plant growth will be enhance.

2. Yield and its components:

Significant increases were noticed in yield and its components of garden cress plant because of humic acid soil application, aromatic-power fertilizer spraying and their interactions (Table 3).

In general, gradual increases in number of silique/ plant, weight of 1000 seeds (g) and fruit yield per plot and per *fad* (kg) were recorded with increasing the tested humic acid level from 0% up to 4%. The maximum values represented these parameters were found in plants received 4% humic acid level during the two seasons. The increments in fruit yield per *fad*, comparing to untreated control plants, reached 48.7 and 49.6% in plants received 4% humic acid during 1st and 2nd seasons, respectively. In this regard, Fadia *et al*. (2016) on *Variety fahl* indicated that foliar spray with 10 ml/L K–humate significantly increased number of seeds/ head, 1000 seed weight and seed yield/ plant. Similarly, Bakry *et al*. (2015) on flax found that humic acid as foliar spray at 20 mg/L gave significant increases in seed yield/ *fed*. When Shaaban *et al*. (2009) studied to what extant humic acid application can minimize soil fertilization of wheat; they found that decreased soil NPK fertilizers to 25% and the use of humic acid as foliar application led to the highest biological yield/ *fad*. Additionally, On *Faba bean*, El-Ghamry *et al*. (2009) studied the effect of humic acid (HA) and amino acids (AA) applications. They found that HA (2000 ppm) interacted with AA (2000 ppm) significantly increased number of pods/ plant and weight of 100 seeds. However, the obtained increases in garden cress yield under the effect of humic acid applications were expected as a result to the caused enhancements in vegetative growth (as mentioned above, Table 2), which in turn increased nutrient absorption and photosynthesis by plant as well as translocation of assimilates toward fruits and seeds production.

Respecting aromatic-power fertilization effects, data in Table 3 show that numbers of silique/ plant, weight of 1000 seeds and fruit yield per plot and per fadden were significantly increased with aromatic-power fertilizer applications comparing to unfertilized control plants in both seasons. It is noticed that the highest values represented the abovementioned yield traits were detected in plants sprayed with the high concentration of foliar nutrient (1% aromatic-power fertilizer). Such treatment recorded increments of 24.5 and 20.6% for number of silique/ plant, 11.7 and 12.6 % for weight of 1000 seeds, 12.9 and 16.6% for fruit yield/ *fad* over than check plants during 1st and 2nd seasons, respectively. Eisa *et al.* (2010) found that the application of amino acids with micronutrients of Fe, Zn and Mn significantly increased the sesame yield.

Table 3: Effect of soil application of humic acid# and foliar nutrient@ treatments on yield parameters of *Lepidium sativum* plants during the 2012/2013 and 2013/2014 seasons

Humic acid (%) (A)	Aromatic-power fertilizer (%) (B)							
	Cont.	**0.5**	**1**	**Mean**	**Cont.**	**0.5**	**1**	**Mean**
	2012/13				2013/14			
	Number of silique/ plant							
Cont.	73.3	77.1	82.5	**77.60**	85.6	85.9	99.1	**90.20**
1	81.7	95.4	101.1	**92.70**	94.5	101.3	118.5	**104.8**
2	88.5	101.6	111.5	**100.5**	101.1	113.5	119.6	**111.4**
4	101.1	112.3	134.1	**115.8**	113.2	114.7	138.3	**122.1**
Mean	**86.2**	**96.6**	**107.3**		**98.6**	**103.9**	**118.9**	
L.S.D. 0.05%	A:12.1 B:9.3 AB:21.7				A:9.1 B:7.7 AB:17.1			
	Weight of 1000 seeds (g)							
Cont.	3.45	3.47	3.66	**3.53**	3.50	3.55	3.66	**3.57**
1	4.31	4.65	4.83	**4.60**	4.50	4.60	5.12	**4.74**
2	4.67	4.70	5.12	**4.83**	4.66	4.73	5.12	**4.84**
4	4.73	5.11	5.56	**5.13**	4.75	5.19	5.71	**5.22**
Mean	**4.29**	**4.48**	**4.79**		**4.35**	**4.52**	**4.90**	
L.S.D. 0.05%	A:0.22 B:0.19 AB:0.43				A:0.21 B:0.19 AB:0.41			
	Fruit yield per plot (kg)							
Cont.	0.86	0.86	0.89	**0.87**	0.85	0.87	0.92	**0.88**
1	1.13	1.13	1.19	**1.15**	1.14	1.15	1.22	**1.17**
2	1.14	1.15	1.33	**1.21**	1.14	1.18	1.38	**1.23**
4	1.14	1.33	1.41	**1.29**	1.15	1.34	1.47	**1.32**
Mean	**1.07**	**1.12**	**1.21**		**1.07**	**1.14**	**1.25**	
L.S.D. 0.05%	A:0.05 B:0.04 AB:0.08				A:0.05 B:0.03 AB:0.08			
	Fruit yield per fad (kg)							
Cont.	326.8	326.8	338.2	**330.6**	323.8	331.4	350.4	**335.2**
1	429.4	429.4	452.2	**437.0**	433.2	437.0	463.6	**444.6**
2	433.2	437.0	505.4	**458.5**	433.2	448.4	524.4	**468.7**
4	433.2	505.4	535.8	**491.5**	437.0	509.2	558.6	**501.6**
Mean	**405.7**	**424.7**	**457.9**		**406.8**	**431.5**	**474.2**	
L.S.D. 0.05%	A:15.6 B:13.9 AB:30.1				A:14.3 B:13.9 AB:29.6			

Humic acid was used as Hammar compound.
@ Aromatic-power is organic fertilizer containing, it was used as a source foliar nutrient.

All interaction treatments between humic acid and aromatic-power fertilizer are shown in Table 3, which resulted significant enhancing effects on garden cress yield and its components*; i.e.,* number of silique/ plant, weight of 1000 seeds and fruit yield per plot and per *fed* comparing to control treatment during the two experimental seasons. Generally, increasing the interacted level of humic acid with the same level of aromatic-power fertilizer increased all the above-mentioned traits. Similarly, under the same concentration of humic acid, increasing the interacted level of aromatic-power fertilizer recorded more increases in yield and its components. The superior treatment regarding increasing the studied yield and its components traits, comparing to all interaction treatments, was the highest humic acid level (4%) combined with the highest aromatic-power fertilizer level (1%). This was confirmed in the two tested seasons. On *Hibiscus sabdariffa* L. plant, Yasser *et al*. (2011) tested the effect of humic acid at 2.0 cm/L, amino acid at 1.0 cm/L and micro elements (mix) at 0.75 kg/fad (commercial name is Micro mix; 6% iron, 3% Zn, 1.2% Cu and3% Mn). They found that the highest values of number of fruits per plant and seed yield per plant were obtained when the plants sprayed by humic acid interacted with amino acid or with microelements in comparison with the rest of the treatments.

3. *Fixed and volatile oil determinations in seeds*:

Results represented effect of humic acid, Aromatic-power fertilizer and their interactions on production of fixed and volatile oils from garden cress seeds expressed as percentages or as yields/ *fad* (L) are presented in Table 4.

Significant increases in fixed and volatile oils percentages and yields/ *fad* were found in seeds of treated plants with humic acid or Aromatic-power fertilizer each alone or in combinations comparing to untreated control plants during the two tested seasons. Results of the main effects of humic acid and of Aromatic-power are shown in Table 4, which clear that the high concentration of humic acid (4%) or of Aromatic-power (1%), each alone, resulted in the highest percentages and yields/ *fad* of fixed and volatile oils comparing to the other tested levels of humic acid or Aromatic-power. In this respect, Bakry *et al*. (2015) indicated that humic acid foliar treatment at 20 mg/L in addition to sulfur fertilizer at rate of 250 and 500 kg/ *fad* gave significant increases in flax oil yield / *fad*. Hendawy *et al*. (2015) reported similar results on mint plant regarding of humic acid effects on essential oil percentage. Nahed *et al*. (2010) found that amino acids of Tyrosine, Thiamine and Tryptophan at 100 ppm promoted oil percentage in *Thuja orientalis* L. As for fertilization effects, Gomaa and Mady (2008) found that boron foliar spray at 75 ppm increased oil productivity of chamomile plants.

Table 4: Effect of soil application of humic acid# and foliar nutrient@ treatments on fixed and volatile oils production in *Lepidium sativum* L. seeds during 2012/2013 and 2013/2014 seasons

Humic acid (%) (A)	Aromatic-power fertilizer (%) (B)							
	Cont.	**0.5**	**1**	**Mean**	**Cont.**	**0.5**	**1**	**Mean**
	2012/13				2013/14			
	Fixed oil (%)							
Cont.	21.31	21.72	22.17	**21.73**	21.17	21.75	22.33	**21.75**
1	21.33	25.32	25.43	**24.03**	21.33	25.33	25.75	**24.14**
2	22.22	25.33	25.58	**24.38**	22.45	25.68	26.69	**24.94**
4	23.76	26.55	27.76	**26.02**	24.75	26.63	27.97	**26.45**
Mean	**22.16**	**24.73**	**25.24**		**22.18**	**24.85**	**25.44**	
L.S.D. 0.05%	A:0.62 B:0.50 AB:1.18				A:0.51 B:0.49 AB:1.11			
	Fixed oil yield/fad (L)							
Cont.	69.64	70.98	74.98	**71.87**	68.55	72.08	78.24	**72.96**
1	91.59	108.7	114.9	**105.1**	92.40	110.7	119.4	**107.5**
2	96.26	110.6	129.3	**112.0**	97.25	115.1	140.0	**117.5**
4	102.9	134.2	148.7	**128.6**	108.2	135.6	156.2	**133.3**
Mean	**90.10**	**106.1**	**116.9**		**91.60**	**108.4**	**123.5**	
L.S.D. 0.05%	A:7.11 B:6.33 AB:14.42				A:6.63 B:6.15 AB:13.05			
	Volatile oil (%)							
Cont.	0.32	0.32	0.34	**0.33**	0.32	0.33	0.36	**0.33**
1	0.32	0.33	0.41	**0.35**	0.34	0.34	0.38	**0.35**
2	0.34	0.41	0.49	**0.41**	0.34	0.37	0.49	**0.40**
4	0.34	0.45	0.56	**0.45**	0.36	0.49	0.58	**0.48**
Mean	**0.33**	**0.38**	**0.45**		**0.34**	**0.38**	**0.45**	
L.S.D. 0.05%	A:0.07 B:0.05 AB:0.11				A:0.06 B:0.05 AB:0.11			
	Volatile oil yield/fad(L)							
Cont.	1.046	1.046	1.150	**1.081**	1.036	1.094	1.261	**1.130**
1	1.374	1.417	1.854	**1.548**	1.473	1.486	1.762	**1.574**
2	1.473	1.792	2.477	**1.914**	1.473	1.659	2.570	**1.901**
4	1.473	2.274	3.001	**2.249**	1.573	2.495	3.240	**2.436**
Mean	**1.342**	**1.632**	**2.121**		**1.389**	**1.684**	**2.208**	
L.S.D. 0.05%	A:0.216 B:0.202 AB:0.402				A:0.215 B:0.202 AB:0.402			

Humic acid was used as Hammar compound.

@ Aromatic-power is organic fertilizer containing, it was used as a source foliar nutrient.

When humic acid interacted with Aromatic power, more increases were found in fixed and volatile oils percentages and yields/ *fad* (Table 4). The highest values in this regard were recorded in plants treated with the highest humic acid level of 4% plus the highest Aromatic-power fertilizer level of 1% comparing to all interaction treatments during the two seasons. This treatment gained 27.7 and 27.9 percentages of fixed oil and 0.56 and 0.58 percentages of volatile oil during 1^{st} and 2^{nd} seasons, respectively, which equal to 148.7 and 156.2 liter/ *fad* of fixed oil as well as 3.00, and 3.24 liter/ *fad* volatile oil in 1^{st} and 2^{nd} seasons, respectively.

4. Chemical determinations in seeds:

Presented data in Table 5 show that soil application of humic acid significantly increased the percentages of total nitrogen, total protein, total carbohydrates and lipids in garden cress seeds in the two seasons. The maximum percentages of the protein, carbohydrates and lipids were obtained in seeds of plants received humic acid at the highest rate of 4%. This rate increased protein percentage by 11.07 and 13.38%, carbohydrates percentage by 9.28 and 10.54% and fats percentage by 8.57 and 9.11% over untreated control plants in the two seasons, respectively. Poloskin *et al*. (2013) stated that application of humic acid increased proteins and fats contents in soybeans and sugar contents in sugar beets. Osmana and Mostafa (2012) reported that application of humic acid significantly increased leaf N and seed protein in pea plant. Also, findings of EL-Nemr *et al.* (2012) pointed that foliar spray of humic acid caused an increment in N and protein percentages in *Cucumis sativus* L. Additionally, Ertani *et al*. (2011) found that humic acid (Actosol) at 5ml/L increased sugars (glucose and fructose) and proteins in maize. When El-Ghamry *et al*. (2009) studied the effect of humic acid (HA) and amino acids (AA) applications on *Faba bean*, found that HA (2000 ppm) interacted with AA (2000 ppm) significantly increased N content in seeds.

As for foliar nutrient treatments, data of the same Table 5 show that all Aromatic-power fertilizer tested levels significantly increased total nitrogen, total protein, total carbohydrates and lipids percentages in garden cress seeds. The high concentration of 1% foliar nutrient gave the highest percentages during the two seasons. This was equal to increases of 7.81 and 8.57% for protein, 7.06 and 7.43% for carbohydrates and 8.30 and 8.57% for fats over than control plants in the two seasons, respectively. El-Khyat (2013) on *Rosmarinus officinalis* and Amran (2013) on *Pelargonium graveolens* found that foliar application of Fe, Zn and Mn increased

Table 5: Effect of soil application of humic acid# and foliar nutrient@ treatments on chemical constituents of *Lepidium sativum* L. seeds during 2012/13 and 2013/14 seasons

Humic acid (%) (A)	Aromatic-power fertilizer (%) (B)							
	Cont.	**0.5%**	**1%**	**Mean(A)**	**Cont.**	**0.5%**	**1%**	**Mean(A)**
	2012/13				2013/14			
	Total nitrogen (%)							
Cont.	3.01	3.30	3.32	**3.21**	2.99	3.27	3.32	**3.19**
1	3.26	3.35	3.39	**3.33**	3.27	3.36	3.40	**3.34**
2	3.32	3.38	3.42	**3.37**	3.32	3.48	3.51	**3.44**
4	3.36	3.50	3.83	**3.56**	3.41	3.57	3.88	**3.62**
Mean(B)	**3.24**	**3.38**	**3.49**		**3.25**	**3.42**	**3.53**	
L.S.D. 0.05%	A:0.21 B:0.09 AB:0.31				A:0.21 B:0.08 AB:0.29			
	Total protein (%)							
Cont.	18.81	20.63	20.75	**20.06**	18.69	20.44	20.75	**19.96**
1	20.38	20.95	21.19	**20.84**	20.45	21.00	21.26	**20.90**
2	20.75	21.13	21.38	**21.09**	20.77	21.75	21.94	**21.49**
4	21.02	21.88	23.94	**22.28**	21.33	22.31	24.25	**22.63**
Mean(B)	**20.24**	**21.15**	**21.82**		**20.31**	**21.38**	**22.05**	
L.S.D. 0.05%	A:0.97 B:0.53 AB:1.55				A:0.84 B:0.55 AB:1.43			
	Total carbohydrate (%)							
Cont.	28.42	28.68	28.93	**28.68**	28.55	28.68	28.98	**28.74**
1	28.45	28.92	28.93	**28.77**	28.33	29.05	29.37	**28.92**
2	28.67	29.74	30.88	**29.76**	28.83	30.20	29.88	**29.64**
4	28.91	31.32	33.79	**31.34**	28.91	31.47	34.93	**31.77**
Mean(B)	**28.61**	**29.67**	**30.63**		**28.66**	**29.85**	**30.79**	
L.S.D. 0.05%	A:1.36 B:0.88 AB:2.29				A:2.02 B:0.93 AB:2.94			
	Lipids (%)							
Cont.	24.15	25.37	25.37	24.96	24.03	25.33	25.37	**24.91**
1	24.37	25.56	25.68	25.20	24.39	25.78	25.75	**25.31**
2	25.12	26.53	27.66	26.44	25.33	26.85	27.89	**26.69**
4	25.66	26.81	28.84	27.10	25.70	26.89	28.95	**27.18**
Mean(B)	24.83	26.07	26.89		24.86	26.21	26.99	
L.S.D. 0.05%	**A:0.63 B:0.57 AB:1.31**				**A:0.49 B:0.37 AB:0.89**			

Humic acid was used as Hammar compound.
@ Aromatic-power is organic fertilizer, it was used as a source foliar nutrient

mineral contents of plants. Abdel-Mawgoud *et al.* (2011) found that foliar application of micronutrients containing iron, Mn, Zn improved pod quality as protein content. Hassan *et al.* (2010) found that foliar application of K increased fruits N content of plum trees.

As for interaction treatments between humic acid and foliar nutrient, plants received humic acid at 4% and foliar sprayed with Aromatic-power at 1% resulted in seeds contained the highest percentages of total nitrogen, total protein, total carbohydrates and lipids. This was confirmed in the two tested seasons. As mentioned above such treatment also, improved plant growth (Table 2) and increased yield as silique No/ plant, seed weight and fruit yield/ *fad* (Table 3) as well as increased seed contents of fixed and volatile oils (Table 4). Such enhancements might be resulted from the increases in nutrient contents of plant tissues due to humic acid and foliar nutrient applications.

General discussion and conclusion:

Generally, previous results showed high positive effects for humic acid and foliar nutrient applications. In addition, the best results were apparent with the high levels of humic acid (4%) or/ and foliar nutrient (1%).

Actually, the interaction between humic acid and foliar nutrient gained more significant improvements in all studied traits of growth, yield and fixed and essential oils as well as seed chemical composition. The superior improving effects were found in plants received the interaction treatment between 4% humic acid and 1% Aromatic-power foliar nutrient.

Finally, the objective of this study was test effective and inexpensive alternatives to plant nutrition. From findings of our study, it can recommend that use humic acid and foliar nutrient to *Lepidium sativum* L. plant, which will reduce the high costs of traditional fertilizers, will reduce the production costs, and will increase the plant productivity.

Conclusively, it could be recommend that using humic acid (Hammar compound) as soil application at 4% three times during season interacted with foliar nutrient of Aromatic-power fertilizer at 1% three times during season as an effective and inexpensive alternative to plant nutrition for enhance garden cress growth and yield.

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تأثير معاملة التربة بحامض الهيومك والرش الورقى ببعض العناصر المغذية على النمو والمحصول والتركيب الكيمياوى لنبات حب الرشاد

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أُجريت تجربة عاملية بين أربع مستويات حامض هيومك (صفر، ١، ٢، ٤ % كإضافة للتربة) وثلاث مستويات من سماد أرومتك بور (صفر ، ٠.٥ ، ١ % رش ورقى) خلال الموسمين الشتويين ٢٠١٢/٢٠١٣، ٢٠١٣/٢٠١٤ فى المزرعة التجريبية لمحطة بحوث البساتين بالسدس محطة بحوث البساتين بمحافظة بنى سويف ، هذف هذا العمل إلى دراسة تأثير حامض الهيومك وسماد الأرومتك-بور وتفاعلاتهم (كبديل فعال وقليل التكلفة لتغذية النبات) على النمو والمحصول وإنتاج الزيت الثابت والزيت العطرى والتركيب الكيمياوى لنبات حب الرشاد.

اشارت النتائج انه زادت معنويا كل خصائص النمو الخضرى التى دُرست (إرتفاع النبات، عدد الافرع للنبات، الوزن الطازج والجاف لكل وحدة تجريبية) نتيجة المعامله بحامض الهيومك، إنعكست هذه الزيادات فى نمو النبات كزيادات معنوية فى عدد القرون/ نبات، وزن ١٠٠٠ بذرة (جم)، محصول الثمار الناتج من الوحدة التجريبية ومن الفدان، والزيت الثابت والعطرى الناتج من البذور (كنسبة مئوية وكمحصول للفدان)، ونسب كل من النيتروجين والبروتينات والكربوهيدرات والدهون بالبذور، وُجد أعلى محصول بأعلى جودة فى النباتات التى تلقت المستوى المرتفع ٤% حامض الهيومك، أدى الرش الورقى بسماد أرومتك - بور إلى تحسن الصفات سابقة الذكر للنمو الخضرى والمحصول والزيت والتركيب الكيمياوى للبذور، وكان التركيز الأعلى لسماد ارومتك – بور ١% الأفضل فى زيادة النمو والمحصول وجودته، لوحظت زيادات إضافية فى نمو النباتات وفى محصول البذور وجودته عند تفاعل حامض الهيومك مع التسميد بسماد أرومتك – بور.

التوصية: يمكن التوصية باستخدام حامض الهيومك (مركب هامار) ثلاث مرات خلال الموسم كمعاملة للتربة بتركيز ٤% مع الرش الورقى بسماد أرومتك – بور ثلاث مرات خلال الموسم بتركيز ١% كبديل مؤثر وقليل التكلفة لتغذية النباتات ولزيادة نمو ومحصول نبات حب الرشاد.