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ORIGINAL ARTICLE

THE EFFECT OF PLANTING DATE AND SPRAYING WITH LIQUID HUMUS AND THEIR INTERACTIONS ON THE GROWTH OF *CORIANDRUM SATIVUM* L. AND ITS YIELD FROM OIL AND FRUITS

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Abstract: The experiment was conducted during the Agricultural season 2020/2021 in one of the fields of the College of Agriculture, University of Basrah to know the effect of the factors, namely the date of planting, where the plant was cultivated with three dates: 10/10, 18/10 and 16/11 and spraying with liquid humus in three concentrations: 0, 1 and 2 ml.L^{-1} and their interactions in the growth of *Coriandrum sativum* L. and its product from oil and fruits. The results showed that plants cultivated on the first date 10/10 significantly excelled in the total number of leaves.plant^{-1}, number of inflorescences.plant^{-1}, the plant yield from fruits (g.plant^{-1}), fruit content of total soluble carbohydrates (mg.g^{-1}), leaf content of chlorophyll (mg.100g^{-1} fresh weight), yield of one plant from volatile oil (gm.Vegetable^{-1}) and the density of the volatile oil (mg.g^{-1}). Whereas, the plants cultivated on date 10/18 significantly excelled in the percentage of protein in the fruits (%). The plants treated with liquid humus at a concentration (1 ml.L^{-1}) significantly excelled in the number of inflorescences.plant^{-1}, percentage of protein in fruits (%), fruit content of total dissolved carbohydrates (mg.g^{-1}), leaf content of chlorophyll (mg.100g^{-1} fresh weight), density of the volatile oil (mg.µl^{-1}) and the specific weight of the volatile oil. Whereas, plants treated with liquid humus at a concentration of 2 ml.L^{-1} significantly excelled in the total number of leaves.plant^{-1}, fruit yield from oil (g.plant^{-1}) and refractive index of volatile oil. The interaction between the two factors of the experiment had a significant effect on all traits.

***Keywords*:** Planting date, Liquid humus, *Coriandrum sativum* L., Randomized complete block design (RCBD).

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1. Introduction

The genus Coriandrum belongs to the Apiaceae family and it is an annual plant, standing stem, feathery compound leaves, its whole flowers are carried in compound tent inflorescences. Its fruits are either spherical or oval, double-smooth, yellowish-brown in color, or greenish, made up of two carpels fused to each with a single seed, which are collected when their seed turns light brown. It is one of the aromatic, tonic and wind-repellent plants and strengthens the stomach, prevents diarrhea, works to strengthen the heart and reduces blood pressure, as it contains a large percentage of iodine in addition to many other benefits, adding coriander to food increases antioxidants and has the potential to act as a natural antioxidant and thus prevents unwanted oxidation processes in the body [Wangenstee *et al.* (2004)]. Coriander seeds not only have anti-hyperglycemic properties but also have antioxidant properties. An increased intake of coriander seeds protects against diabetes [Deepa and Anuradha (2011)]. It also hydrates it and is considered an antioxidant as it affects the increase of oxidative free radical enzymes and has a role in lipid metabolism as it reduces the effectiveness of the enzyme lipid peroxidase and free fatty acids. It must be noted that coriander oil was used in the production of medicinal drugs, where it has activity against bacteria [Al-Badry (2016)], It is known that some plant drugs have a therapeutic capacity that

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excelled that of manufactured medicines, in addition to being free from harmful side effects, it is generally used in the Middle East in Asian cuisine, South and East Asia, Africa, Latin America and India and the fact that these plants contain a large number of medically active substances reflects the great therapeutic potential for them. It is known that some plant drugs have a therapeutic capacity that excelled the capacity of manufactured medicines, in addition to vinegar and have harmful side effects, the difference in the planting date of a crop will lead to the influence of the stages of crop growth and development by environmental conditions, including low temperatures, frost, long lighting and relative humidity affecting all vital processes that take place inside the plant [Ibrahim (2013), Kallihal *et al.* (2013)]. It was found when they planted coriander plants on three dates: 10/10, 9/11 and 9/12, the results showed that planting on the date of 9/11 gave the highest weight of 1000 seeds and the highest fruit yield. It reduced the number of days from planting to harvest and gave the highest percentage of essential oil and the highest percentage of nitrogen, phosphorous and potassium. In an experiment, Lal *et al.* (2017) conducted on coriander plant in India, where it was cultivated on five dates: 13, 10/23, 2, 12 and 11/22. The results showed that the plants cultivated on 10/23 in the least number of days of germination, plant height, number of secondary branches, number of leaves and seed yield per hectare. Yildirim and Gok (2012) found when two coriander plants are grown in Turkey on 5, 20/4, 5 and 20/5, that plants grown at 5/20 gave the highest percentage of volatile oil and Al-Badri (2016) found when planting coriander plants with two dates: 1/10 and 1/11, the plants planted at the date 1/10 excelled on the plant height, number of leaves, number of inflorescences and the refractive index of volatile oil compared to plants cultivated on the date 1/11. In a study conducted by Al-Bahadli and Abdul-Salman (2016) on the caraway plant in Iraq on two dates, which are 9/20 and 10/10, it was found that the plants cultivated on the 9/20 date significantly excelled on the oil refractive index, while the plants grown on the 10/10 date excelled on the specific density of $mg.\mu l^{-1}$ and specific weight of the oil. The addition of humic as spraying on plants has improved plant growth, nutrient absorption and crop growth, as many types of research, have proven that adding it has led to a reduction in the amount of fertilizers added to the soil, which leads to a reduction in cost and pollution with chemical fertilizers without affecting the amount of yield. This result agrees with Pettit (2003) indicated that humic acid and humic substances have an effect on increasing the physiological activities of the plant and its effect on growth and plant nutrient content. Humic acid plays a large role as an organic biocatalyst that has a significant effect on plant growth and development and increasing yield [Nerdi *et al.* (2004)]. It also has a role in improving soil properties and making nutrients available for absorption by plants [Mohamed *et al.* (2009)]. The yield was increased and were found when the local mint plant, *Mentha spicata* L., was treated with liquid humus in three concentrations: 0, 0, 5 and 0.1 $ml.L^{-1}$, plants treated with liquid humus at a concentration of 0.5 and 1.0 $ml.L^{-1}$ were excelled in plant height and at a concentration of 1.0 $ml.L^{-1}$ significantly excelled in leaf content of total chlorophyll. Bayat and Eiopukhow (2019) found when treating *Ocimum basilicum* L. with three concentrations of 0 and spraying on the leaves at a concentration of 3 $L.ha^{-1}$ and add it to the soil at a concentration of 6 $L.ha^{-1}$. The study showed that adding humic acid to the soil at a concentration of 6 $L.ha^{-1}$ caused an increase in all the studied traits, which are the amount of volatile oil, fresh and dry weight of the plant, total chlorophyll, plant height, root system length and leaf area. In a study conducted by Hatice and Gusler (2005) in Turkey, where humic was used in four concentrations (0, 10, 20 and 30 $gm.L^{-1}$), there was a significant effect of humic acid on the yield of spinach plant, where the yield of the plant increased directly with increasing concentration used. Abdul *et al.* (2012) found using humic acid in three concentrations (0, 3 and 6 $ml.L^{-1}$) on the sweet basil plant *Ocimum basilicum var. Basilicum* L., where sprayed plants with a concentration of 6 $ml.L^{-1}$ were significantly higher in growth indices and produced the highest plant height, number of leaves, number of side branches, percentage of dry matter, leaf content of chlorophyll, leaf content of total soluble carbohydrates and total soluble proteins.

2. Materials and Methods

The experiment was conducted during the 2020-2021 agricultural season in one of the fields of the College of Agriculture, University of Basra. To know the effect of the factors, namely the planted date, where the plant was cultivated with three dates: 10/10, 10/28 and 11/16 and spraying with liquid humus in three concentrations: 0 and 1 and 2 $ml.L^{-1}$ and their interactions in the growth of *Coriandrum sativum* L.

and its product from oil and fruits. The experiment was designed using a factorial experiment conducted in a Randomized Complete Block Design (RCBD) [Al-Rawi and Khalaf Allah (1981)]. The experiment was conducted in Silty clay soil with 7.5 pH and conduction of E.C. 3.6 dS^{-1} and organic matter 3.7%. The experiment land was tillage with two tillage perpendicularly and organic fertilizer of 40 hectares was added to it. Then the soil was smoothed and levelled, then it was divided into 27 plots, 1 m long and 1 m wide. The seeds were grown on the dates mentioned above. After a month had passed from germination, the plants were sprayed with liquid humus three times at an interval of 15 days between one spraying and another. All service operations were conducted according to the recommended and the plants' need from irrigation and fertilization. Experimental measurements were taken from three plants in each experimental unit at the end of the growing season and included plant height (cm), number of leaves.$plant^{-1}$, number of $inflorescences^{-1}$, plant yield of fruits.$plant^{-1}$, total chlorophyll (mg.$100g^{-1}$ fresh weight), fruit content of total dissolved carbohydrates (mg.g^{-1}) and percentage for protein in fruits. The yield of volatile oil, NPT^{-1}, the refractive index of the volatile oil, the density of the volatile oil (mg.μl^{-1}) and the specific weight of the volatile oil. Chlorophyll was estimated in leaves according to Goodwin (1976) method. Total dissolved carbohydrates in fruits were estimated by the method of phenol-sulfuric acid Modified of Phenol Sulphuric Acid Colorimetric Method prepared by Dubois *et al.* (1956), volatile oil was extracted from the pulverized material of the fruits by the method of extraction with organic solvents described by Guenther (1972) using the organic solvent petroleum ether (ether petroleum). The refractive index of the volatile oil was estimated according to Guenther (1972) using a Refractometer at a temperature of 25°C. Estimate the specific weight of each oil sample with a volume of 100µl of oil and divide it by the weight of the same volume of distilled water at a temperature of 25°C. The density of the oil was measured as stated by Guenther (1972) by taking a volume of 200 µl of oil for each treatment with a micro pipette at room temperature (25°C), then weighing and applying the following equation:

$$\text{The specific density of the oil} = \frac{\text{Oil sample weight (volume } 200\,\mu\text{l)}}{\text{Oil sample volume } (200\,\mu\text{l})}$$

3. Results and Discussion

Table 1 showed that the planting date and spraying with liquid humus did not have a significant effect on plant height and the planting date had a significant effect on the total number of leaves.$plant^{-1}$ and the number of inflorescences. $plant^{-1}$ and the plant yield the fruits.$plant^{-1}$, if the date 10/10 excelled on the other two dates in the total number of leaves.$plant^{-1}$ and the number of inflorescences. $plant^{-1}$ and the single plant yield of fruits. Also, spraying with liquid humus had a significant effect on the number of leaves.$plant^{-1}$ and the number of inflorescences.$plant^{-1}$, where the plants treated with a concentration of 2 ml.L^{-1} and 1 ml.L^{-1} were excelled in the number of leaves and the number of inflorescences, respectively and the spraying of liquid humus had no significant effect on the plant yield of fruits. The interaction between the experiment factors had a significant effect on the total number of leaves.$plant^{-1}$ and the number of inflorescences.$plant^{-1}$, where the plants cultivated on the date 10/18 and others treated with liquid humus significantly excelled on the number of leaves and number of flowering. It gave the highest number of leaves which reached 169.00 and the number of flowers 72.33 compared to the lowest number of leaves which amounted to 73.33. It resulted from plants cultivated at 10/10 and treated with liquid humus at a concentration of 2 ml.L^{-1}. The lowest number of inflorescences resulted from plants cultivated on date 18/10 the treatment with liquid humus at a concentration of 1 ml.L^{-1}. The plants planted on the date 10/10 and treated with liquid humus at a concentration of 1 ml.L^{-1} were given the highest yield per plant of fruits reached 4.993 g compared to the lowest fruit yield obtained from plants cultivated on the date 11/16 and treatment with liquid humus at a concentration of 1 ml.L^{-1}.

Table 2 showed that the planting date and spraying with liquid humus has a significant effect on the percentage of protein in fruits (%), the fruit's carbohydrate content (mg.g^{-1}) and the chlorophyll content of leaves (mg.$100g^{-1}$ fresh weight) where it is excelled. Plants grown at the 10/10 date were significant in fruit content of total soluble carbohydrates (mg.g^{-1}) and leaf content of chlorophyll (mg.100 g^{-1} fresh weight), where, the plants cultivated on 10/18 were significantly higher in the percentage of protein in fruits (%) than the other two dates and spraying with liquid humus had a significant effect on the above-mentioned

Table 1: The effect of planting date and spraying with liquid humus and the interaction between them on plant height (cm), number of leaves.$Plant^{-1}$, number of inflorescences.$plant^{-1}$,yield plant from fruits (g.$Plant^{-1}$).

Planting Date	Liquid humus ($ml.L^{-1}$)	Plant height (cm)	Number of leaves. $Plant^{-1}$	Number of inflorescences .$plant^{-1}$	Yield plant from fruits (gm.$Plant^{-1}$)
10/10	0	75.6	130.00	54.33	4.613
	1	82.4	139.00	52.33	4.993
	2	72.6	73.33	45.33	3.443
18/10	0	90.7	169.00	72.33	3.480
	1	89.3	96.33	42.33	3.980
	2	87.2	87.67	70.00	3.837
16/11	0	68.1	147.00	64.00	3.770
	1	81.2	125.33	53.67	2.950
	2	95.8	91.00	58.67	3.667
L.S.D (0.05) for interaction		N.s	5.298	3.783	1.18
Average effect of liquid humus	0	76.9	114.11	50.67	3.649
	1	89.1	117.67	61.56	3.954
	2	81.7	121.11	58.78	3.944
L.S.D (0.05) for liquid humus		N.s	3.059	2.184	Û.ã
Average effect of date	10/10	78.1	148.67	63.56	4.320
	18/10	84.3	120.22	49.44	3.162
	16/11	85.2	84.00	58.00	3.765
L.S.D (0.05) for date		N.s	3.059	2.184	0.61

Table 2: The effect of planting date and spraying with liquid humus and the interaction between them on the percentage of protein (%), fruit content of carbohydrates (mg.g^{-1}) and leaf content of chlorophyll (mg.100g^{-1} fresh weight).

Planting Date	Liquid humus ($ml.L^{-1}$)	Percentage of protein in fruits(%)	Fruit content of carbohydrates (mg. g^{-1})	Leaf content of chlorophyll (mg. 100 g^{-1} fresh weight)
10/10	0	14.87	337.6	32.74
	1	19.88	251.9	35.07
	2	14.31	390.7	21.33
18/10	0	18.86	195.0	26.14
	1	18.08	184.7	30.47
	2	17.42	313.6	24.00
16/11	0	17.78	268.6	28.40
	1	19.11	332.1	25.33
	2	15.78	342.9	26.50
L.S.D (0.05) for interaction		1.564	23.33	2.400
Average effect of liquid humus	0	16.35	326.7	29.71
	1	18.12	231.1	26.87
	2	17.56	314.5	26.74
L.S.D (0.05) for liquid humus		0.903	13.47	1.386
Average effect of date	10/10	17.17	349.1	30.29
	18/10	19.17	256.2	29.09
	16/11	15.84	267.0	23.94
L.S.D (0.05) for date		0.903	13.47	1.386

traits. The plants not treated with humus significantly excelled on the fruit's carbohydrate content ($mg.g^{-1}$) and the leaf content of chlorophyll ($mg.100g^{-1}$ fresh weight), while the plants treated with liquid humus at a concentration of 1 $ml.L^{-1}$ were significantly excelled in the percentage of protein in fruits (%). The interaction between the study factors had a significant effect on the percentage of protein in fruits (%) and the content of leaves of chlorophyll ($mg.100g^{-1}$ fresh weight) where its highest value reached 19.88 and 35.07 resulted from plants cultivated at 10/10 and treated with liquid humus at a concentration of 1 $ml.L^{-1}$ and their lowest values of 14.31 and 21.33. They were obtained from plants cultivated at the same time and treated with liquid humus at a concentration of 2 $ml.L^{-1}$, respectively. The plants cultivated at 10/10 and treated with liquid humus at a concentration of 2 $ml.L^{-1}$ gave the highest value of the fruit's carbohydrate content ($mg.g^{-1}$) with a value of 390.7 compared to the lowest value of 184.7 value obtained from plants cultivated at the date 10/18 treatment with liquid humus at a concentration of 1 $ml.L^{-1}$.

Table 3 showed that the planting date and spraying with liquid humus had a significant effect on the fruit yield from the volatile oil ($plant.g^{-1}$), the volatile oil density ($mg.\mu l^{-1}$), where the plants cultivated by the 10/10 date significantly excelled in the fruit yield from the volatile oil ($plant.g^{-1}$) and the density of the volatile oil ($mg.\mu l^{-1}$) on the other two dates. The spraying with liquid humus at a concentration of 2 $ml.L^{-1}$ gave the highest seed yield from the volatile oil ($plant.g^{-1}$) and the highest refractive index of the volatile oil, while the sprayed plants at the concentration of 1 $ml.L^{-1}$ gave the highest density of volatile oil ($mg.\mu l^{-1}$) and the plants not sprayed with liquid humus gave the highest specific weight of the volatile oils. The interaction between the study factors had a significant effect on all the above-mentioned traits, where the plants cultivated on the date of 11/16 and not sprayed with liquid humus gave the highest fruit yield from the volatile oil ($plant.g^{-1}$) and the highest refractive index of volatile oil reached 1.250 and 1.36590, respectively compared with the lowest value of fruit yield from volatile oil ($plant.g^{-1}$) was 0.370 from plants cultivated on 10/10 and sprayed with liquid humus at a concentration of 2 $ml.L^{-1}$ and the lowest value of refractive index was 1.35127 obtained from

Table 3: The effect of the planting date and spraying with liquid humus and the interaction between them on the seed yield of the volatile oil ($plant.g^{-1}$), the refractive index of the volatile oil, the density of the volatile oil ($mg.\mu l^{-1}$) and the specific weight of the volatile oil.

Planting date	Liquid humus ($ml.L^{-1}$)	The seed yield of the volatile oil ($plant.g^{-1}$)	The refractive index of the volatile oil	The density of the volatile oil ($mg.\mu l^{-1}$)	The specific weight of the volatile oil
10/10	0	1.030	1.35240	0.5303	1.189
	1	0.730	1.35230	0.5420	0.963
	2	0.370	1.35573	0.6393	0.910
18/10	0	0.820	1.35337	0.6377	0.982
	1	0.887	1.35127	0.7440	0.731
	2	0.437	1.36280	0.7300	1.226
16/11	0	1.250	1.36590	0.6637	0.851
	1	0.870	1.35267	0.6637	0.835
	2	0.550	1.35300	0.6327	0.889
L.S.D (0.05) for interaction		0.1470	0.000989	0.01961	0.1656
Average effect of liquid humus	0	0.710	1.35348	0.5706	1.021
	1	0.714	1.35581	0.7039	0.980
	2	0.890	1.35719	0.6452	0.858
L.S.D (0.05) for liquid humus		0.0848	0.000571	0.01132	0.0956
Average effect of date	10/10	1.033	1.35722	0.6106	1.007
	18/10	0.829	1.35208	0.6418	0.843
	16/11	0.452	1.35718	0.6673	1.008
L.S.D (0.05) for date		0.0848	NS.	0.01132	NS

plants grown on date 10/18 and spraying with liquid humus at a concentration of 1 ml.L^{-1}. The plants planted at 10/18 and sprayed with liquid humus at a concentration of 1 ml. L^{-1} gave the highest density of volatile oil (mg.µl $^{-1}$) 0.7440 compared to the lowest density of 0.5303 resulted from plants cultivated at 10/10 and not sprayed with liquid humus. The plants cultivated on the date 10/18 sprayed with liquid humus at a concentration of 2 ml.L^{-1} gave the highest specific weight value of the volatile oil which was 1.226 compared to the lowest value of 0.731 which resulted from the plants cultivated on the same date and sprayed with liquid humus at a concentration of 1 ml.L^{-1}. The plants cultivated at 10/18 and sprayed with liquid humus at a concentration of 1 ml.L $^{-1}$ gave the highest density of volatile oil (mg.µl^{-1}) 0.7440 compared to the lowest density of 0.5303 resulted from plants cultivated at 10/10 and not sprayed with liquid humus. The plants cultivated on the date 10/18 sprayed with liquid humus at a concentration of 2 ml.L^{-1} gave the highest specific weight value of the volatile oil which was 1.226 compared to the lowest value of 0.731 which resulted from the plants cultivated on the same date and sprayed with liquid humus at a concentration of 1 ml.L^{-1}. The excelled of the plants cultivated on the first date in the total number of leaves.plant^{-1}, as well as the greater content of the fruits of total dissolved carbohydrates compared to the plants cultivated in the other two dates, may be due to the appropriate environmental conditions that led to an increase in the efficiency of the photosynthesis process and an increase in metabolites, which led to an increase in the division cells, new vegetative buds, growth of a vegetative group, increased carbohydrate content in leaves, increased accumulation of metabolites in the plant and their transfer to places of storage, including buds and fruits [Guilioni *et al.* (2003)]. This is in agreement with Al-Badri (2016) on the coriander plant and on wheat [Mahmood and Zeboon (2019)]. The reason for the excellence of the plants cultivated at the first date in the number of inflorescences and the plant yield from the fruits on the other two dates may be due to the fact that the delay in sowing significantly reduced the yield and the seed yield due to the insufficient time for the plant to fully complete the vegetative growth phase where the plant entered directly in the flowering and fruiting stage at a faster rate than the plants planted at the early date and this was reflected in the lower yield of the plant from inflorescences and seeds. This is consistent with Zolleh *et al.* (2009) and Moosavi (2012) on the coriander plant and the reason for the increase in the oil yield at the first date is due to the increase in the fruit yield at this date and this is consistent with Al-Badri (2016) on the coriander plant and on the caraway plant and [Hanoon *et al.* (2020)].

The reason for the excellence of the second date plants in the percentage of proteins in the seeds may be due to the fact that the first date plants were characterized by the abundance of their inflorescences, which required the transfer of nutrients (solvents) to them as they were strong consumers. This reflected on the manufacture of proteins, which increased in the second date plants due to their low consumption of carbohydrate those stored as protein substances in the fruits, or due to the efficiency of plants, the first date in the production of solutes, increased the amount of C/N Ratio [Muhammad and Yunis (1985)]. The reason for the increase in the oil yield at the first date is due to the increase in the fruit yield at this date and this is consistent with Al-Badri (2016) on the coriander plant. The treatment with liquid humus led to an increase in all the studied characteristics, except for plant height and one plant yield from seeds. The reason may be due to the fact that spraying humic and fulvic acids contained in humus fertilizer on the leaves increases the permeability of the cell membranes of the leaf, which is the location of many biological processes such as absorption and energy transfer, which leads to the activation of the movement of minerals and their transport in the plant, thus increasing the outputs of biological processes, causing an increase in the traits of vegetative growth and these results agree with Kahlid *et al.* (2006) on the sweet basil plant. The reason for this may be due to the fact that spraying with liquid humus works to stimulate the growth of roots, which leads to an increase in the absorption of water and nutrients from the growth medium or soil and thus leads to stimulating the process of photosynthesis and cell division and the emergence of the principles of primary leaves and their transformation into leaves in fact [Celik *et al.* (2010) or, the reason may be the increase in the volatile oil percentage when treating plants with liquid humic acid that contains humic acid, which works to manufacture and accumulate carbohydrates and then increase the volatile oil and this is consistent with what Abdel-Amin (2010) reached on sweet basil, expelled and Al-Ali (2017) on mint. The reason for the increase in the volatile oil yield, its density and its refractive index when treated with liquid humic acid may be due to the fact that the nutrients present in humic acid play an important role in increasing the amount of fats and their traits through the important roles through the important roles of the biological processes inside the plant and its reflection in the composition of fatty acids and phospholipids and then the amount of fats, their specific weight and their refractive index. This result agrees with Abdel-Rahman *et al.* (2014) found on the lemon grass plant.

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