Caspian Journal of Environmental Sciences
Online ISSN: 1735-3866
Print ISSN: 1735-3033

Effects of planting date and spraying with organic fertilizers on vegetative growth indices of dill plant (*Anethum graveolens* L.)

Qudama Z. A. Al-Dulaimy[1], Hameed S. Hammad[1,2], Raad A. Al-Tamimi[1,2*]

1. Horticulture and Landscaping Department, College of Agriculture, University of Diyala, Iraq
2. Soil Science & Water Resources Department, College of Agriculture, University of Diyala, Iraq

**Corresponding author's Email: altamimiraad29@gmail.com*

ABSTRACT

A factorial field experiment in a split-plot design was carried out in Kannan district, Diyala Governorate, mid-east of Iraq, during the agricultural season 2020-2021 to study the effect of planting date and spraying with organic fertilizers on growth and qualitative characteristics of dill plant (*Anethum graveolens* L.). The experiment included three replicates, each comprising 15 factorial treatments. Experiment factors included three planting dates (20/9, 10/10 and 1/11) and three types of organic fertilizers (humic fertilizers, seaweed extracts and amino acids). Organic fertilizers were sprayed three times during the vegetative growth stage. Results indicate that the plants growing on the first date (20/9) significantly outperformed in plant height, the number of leaves, chlorophyll content and dry matter percentage, which amounted to 42.48 cm, 5.8 leaf plant^{-1}, 28.06 mg per 100 g fresh weight and 8.52%, respectively. The second date (10/10) were significantly superior in vegetative yield which amounted to 26.791ton ha^{-1}. All fertilizers were significantly outperformed control treatment in plant height, the number of leaves and branches, chlorophyll percentage, vegetative yield and dry matter percentage.

Keywords: Planting date, Organic fertilizer, Growth indices, Dill plant.
Article type: Research Article.

INTRODUCTION

Dill plant (*Anethum graveolens* L.) belongs to the Apiaceae family, which includes more than 250 species of important leafy and medicinal vegetable crops. These vegetables differ in the content of volatile oils in quantity and quality (Ihssan, 1999). The origin habitat of the dill plant is Minor Asia, Iran and North Africa. Also, dill is present in eastern and western Mediterranean regions (Bouras *et al.* 2006). Each crop has relatively specific growth environmental conditions demand, such as temperature, light, relative humidity and soil factors. So, these conditions play an essential role in determining crop types that can be grown in any region and their yield quantity and quality (krug 1991). Also, planting date has a decisive effect on the vegetative growth of the crop, which is reflected in its yield. Planting date controls, the physiological performance of the crop as well as the metabolism of biomass and its transformation into the economic product (Khichar & Niwas 2006). So a delay or earlier planting out of the optimal or appropriate date will impede vegetative growth and reduce yield quantity and affecting its quality. Al-Samarrai (2001) in her study on dill planted in two dates (1/10 and 1/11) in Baghdad found that the first date is significantly superior in plant height, the number of branches, vegetative yield and dry weight, with an elevations of 5.5%, 36.90%, 49.46% and 45.94%, respectively. Whilst Al-Zuhairi (2018) in his study at Basrah University, Iraq, reported that dill planted at 20/9 is significantly superior in plant height, leave per plant, number of main vegetable branches, fresh weight and stem diameter compared to the planting date of 20/10. The values of these characteristics were 63.78 cm, 26.94 leaf plant^{-1}, 10.26 brunch plant^{-1}, 98.26 g plant^{-1} and 10.78 mm, respectively. Foliar feeding with organic fertilizers is of great importance in increasing plant

Caspian Journal of Environmental Sciences, Vol. 20 No. 4 pp. 793-798 Received: March 26, 2022 Revised: May 02, 2022 Accepted: July 23, 2022
DOI: 10.22124/CJES.2022.5766

Publisher: University of Guilan, Iran

growth and its yield due to the ability to compensate for the shortage in nutrient requirements of plants with a high efficiency (Mikkelsern 2005; Al-Said & Kamal 2008; Ragimov *et al.* 2021; Rakhimova *et al.* 2021; Kamali Omidi *et al.* 2022). Humic acid is one of these organic fertilizers, as well as seaweed extract and amino acids. Humic acid increases plant growth and its content of nutrient elements through increasing physiological activity (Chen & Avid 1990; Anonymous 2005). Seaweed extract acts as a vital stimulator of plant physiological functions (Turan & Kose 2014), whilst, amino acids (Techamin Max is one of them) have positive effects on many plant physiological processes. It stimulates the construction and activity of many organic compounds in plant (Ibrahim *et al.* 2010). Sajit (2013) studied the effect of humic acid spraying at a concentration of 0, 3 and 6 mL L^{-1} on the growth and yield of the dill plant reporting that the concentration of 6 mL L^{-1} is significantly superior in branches and leaves number, green yield and dry yield, amounting 19.2 branches $plant^{-1}$, 133.18 leaf $plant^{-1}$, 27956 kg ha^{-1} and 8908 kg ha^{-1}, respectively. In a study conducted to reveal the response of basil plant (*Ocimum basilicum* L.) to spraying with three levels (0, 75 and 150 mg L^{-1}) of tryptophan amino acid, Al-Shahmani (2020) found that the highest level is significantly superior in all vegetative characteristics and yield. The average of plant height, number of total leaves, number of branches, leaf area and vegetative yield were 28.54 cm, 89.6 leaf $plant^{-1}$, 25.65 branch $plant^{-1}$, 19.29 cm^2 and 45.38 kg ha^{-1}, respectively. Despite the medical, nutritional and economic importance of the dill plant, no study has ever dealt with dill plant in Diyala Governorate, therefore the present study is the first one conducted to assess planting date and foliar application of some organic fertilizers (humic acid, seaweeds and amino acids) to find out:

- Proper planting date which gives the best vegetative yield.
- The best organic fertilizer to be used as a foliar fertilizer and compared its production with the chemical fertilizer.
- The best interaction treatment among organic fertilizer and planting date in vegetative yield production.

MATERIALS AND METHODS

Land preparation and crop management

In this study, land in the Kanaan region, Diyala Governorate, Iraq was chosen. Its astronomical location is 33°45'07.3"N 44°44'33.9"E. Five surface soil samples (0-30 cm) were collected from different places of the field and well mixed to form a composite soil sample. The samples air-dried and were crushed to pass through a 2-mm sieve before being used to determine soil particle size analysis and some soil chemical characteristics (Table 1). The field was prepared for planting by twice orthogonal tillage to a depth of 30-35 cm. Before smoothing and leveling, a decomposed farm manure was added in a ratio of 0.5 kg m^{-2} and mixed with the top 15^{th} cm of the soil. The field was divided into three blocks, each containing 15 experimental units. The area of each experimental unit was 3 m^2 (1.5 m × 2 m). Dill sowing was performed by scattering 5 g of seeds in each line inside the plots. The distance between one line and another was 20 cm. Irrigation water added to experimental units was controlled by calculating the discharge of water passing through pipes at a specified time.

Experiment factors and statistical analysis

A randomized complete block factorial field experiment in a split-plot design was carried out in three replicates. Experiment factors were planting dates and organic foliar fertilization. Planting included three dates, i.e. 20/09, 10/10 and 01/11/2020. The second factor included five treatments as follows:

F_0: Control 1(sprayed with distilled water).

F_1: Control 2 (sprayed with distilled water and fertilized with 400 kg ha^{-1} of each di-ammonium phosphate and urea. These fertilizers were added to soil in two equal batches, before planting and after branching.

F_2: Spraying with humic acid produced by the Turkish Company Mayatek Tarim in a concentration of 3 mL L^{-1}.

F_3: Spraying with seaweed extract named seaweed energy produced by HOUS EAGRI Company in a concentration of 2 mL L^{-1} according to producer instruction.

F_4: Spraying with Tecamin Max in a concentration of 2.5 mL L^{-1} according to the producer instruction (The Spanish Company Agri Tecno). Tecamin Max contained 20 essential amino acids for plant growth.

Spraying was performed in the early morning. Growth traits were measured for ten plants chosen randomly from each experimental trial. These traits included mean plant height (cm), the mean number of leaves per plant, mean leaf length (cm), and the mean number of branches per plant. Dill plants were mowed from their contact with the soil after 55 days. The vegetative yield was weighted for each experimental unit in kg, then yield converted to ton per hectare. One kg of the green crop from each experimental unit air-dried until constant weight. The dry matter percentage (%) was calculated using the following equation:

$$Dry\ matter,\% = \frac{air\ dried\ weight}{fresh\ weight} \times 100 \quad ......\ (Al - Sahaf, 1989)$$

Total chlorophyll content in leaves (mg per 100 g fresh weight = FW) was determined spectrophotometry after marsh 0.5 g of fresh leaves from each experimental unit in 15 mL of acetone (80%) as described by Bajracharya (1999). Data were subjected to analysis of variance (ANOVA) and the means compared using least significant differences (LSD) at 0.05 probability (Al-Rawi & Khalf-Allah 2000) using SAS (2012) soft wear program.

RESULTS

Plant height (cm)

The data in Table 2 show that the first planting date was significantly superior at plant height (42.48 cm), followed by the second date with a significant increase over the third date, which gave the lowest plant height (18.48 cm). Results indicate that spraying with organic fertilizers was significantly superior compared to control treatment (F_0). The highest plant height was appeared at seaweed extract treatment (33.62 cm) followed by (but with slightly no-significant differences) humic acid (33.33 cm), chemical fertilizer (32.75 cm) and Tecamin Max (32.02 cm). The lowest height (29.43 cm) was at the control 1 treatment (F_0). Interaction treatment among the first planting date and humic acid gave the highest plant height (44.63 cm), while the lowest (13.36 cm) was at the third planting date × control 1 treatment (F_0).

Leaves number

The data in Table 3 explained the superiority of the first planting date in the number of leaves (5.82 leaf plant^{-1}) followed by the second planting date (5.25 leaf plant^{-1}). The first and second dates were significantly superior to the third date which exhibited the lowest leaves number (4.41 leaf plant^{-1}). Chemical fertilization treatment displayed significant performance in the number of leaves (5.36 leaf plant^{-1}) compared to control 1 (F_0), followed by an insignificant difference by humic acid (5.31 leaf plant^{-1}) and Tecamin Max (5.30 leaf plant^{-1}) and then the treatment with seaweed extract (5.06 leaf plant^{-1}) with insignificant difference compared to chemical fertilizer. Interaction treatment of the first date and spraying with humic acid excelled with the highest number of leaves (6.16 leaf plant^{-1}), while the interaction treatment of the third date and control (spraying with distilled water only) revealed the lowest number of leaves (3.83 leaf plant^{-1}).

Leaf length (cm)

The data in Table 4 exhibited that the first and second dates were significantly superior to the third date. They displayed the highest mean of leaf length (29.38 and 29.56 cm, respectively), while the lowest average of leaf length was obtained at the third date (14.44 cm). Spraying with humic acid was significantly superior and revealed the highest mean leaf length (26.27 cm), while the shorter leaf length (21.84 cm) was observed at the control treatment. The interaction treatment between the second date and spraying with acid was significantly outperformed all interaction treatments of the first date with control and the fertilization, (32.56 cm).

Number of branches (branch plant^{-1})

Data in Table 5 depict no significant difference in the number of branches per plant among the three planting dates. The second date showed the highest value (17.54) with a slight increment over the first date (17.29). Also, the results confirmed the significant superiority of amino acids (Tecamin Max) over all other treatments. It exhibited the highest number of branches per plant (20.60), followed by seaweed extract (18.22), while the control 1 (F_0) displayed the lowest branches number per plant (11.43). The interaction treatment among first planting date and amino acids was superior, with the highest number of branches (24.33 branch plant^{-1}) and a significant increment over the other interaction treatments. The lowest branch average was observed in the interaction treatment of the third date with control 1 (F_0; 10.43 branch plant^{-1}).

Chlorophyll content

The first planting date was significantly superior to the other planting dates exhibiting the highest chlorophyll content (28.06 mg 100 g^{-1} fresh weight = FW), followed by the second (25.93 mg 100 g^{-1} FW), which in turn displayed a significant rise over the third with the lowest chlorophyll content (22.76 mg 100 g^{-1} FW) (Table 6).

Also, the table indicates that spraying with humic acid recorded the highest chlorophyll content (27.31 mg 100 g^{-1} FW), which significantly outperformed the control 1(F_0) and Tecamin Max treatments and insignificantly the chemical fertilizer and seaweed extract treatments. The lowest chlorophyll content (23.72 mg 100 g^{-1} FW) was observed in the control 1 (F_0). The interaction treatment among first planting date and spraying with humic acid was superior in chlorophyll content (30.78 mg 100 g^{-1} FW), while the lowest chlorophyll content (20.87 mg 100 g^{-1} FW) was recorded in the interaction treatment among third planting date and control 1 (F_0).

Vegetative yield

Obtained data (Table 7) explained that no significant difference was found among the first and second planting dates. Their mean fresh vegetative crops were 25.597 and 26.791ton ha^{-1}, respectively. Both the two dates exhibited significant superiority compared to the third date which displayed the lowest mean of fresh vegetative yield (14.442 ton ha^{-1}). Also, the same table depicted that all types of fertilizers were significantly superior compared to control 1 (F_0). The highest crop (24.879 ton ha^{-1}) was obtained in F_3 (spraying with the seaweed extract), while the lowest mean (17.249 ton ha^{-1}) in the control 1 (F_0). The interaction treatment among the second date and F_3 exhibited the highest mean of yield (29.955 ton ha^{-1}), while the lowest (7.411 ton ha^{-1}) in F_0.

Dry matter (%)

Results in Table 8 revealed that the first planting date was significantly superior in dry matter yield compared to the other dates exhibiting the highest mean percentage (8.52%) followed by the second date, with a mean of 6.37% and a significant increase over the third date which displayed the lowest value (3.96%). From the same table, the dry matter percentage in all fertilization treatments were significantly higher than control 1 (F_0), while differences among fertilization treatments were insignificant. The highest value was recorded in seaweed extract and Tecamin Max treatments (6.57%) while the lowest percentage (5.72%) in control treatment1 (F_0). Interaction treatment among first planting date and T_4 was significantly superior, exhibiting the highest value of dry matter (8.96%), while the interaction treatment between the third planting date and control displayed the lowest (3.50%).

DISCUSSION

Tables (2, 3, 5, 6, 7 and 8) showed that plants of the first date were significantly superior in the vegetative growth characteristics (plant height, number of leaves, chlorophyll content in leaves and percentage of dry matter). This may be attributed to the appropriate climatic conditions (including temperature and relative humidity) during the vegetative growth stage and its contribution in improving the efficiency of physiological functions such as photosynthesis by chlorophyll. The direct correlation of growth indices with chlorophyll verified this conclusion. The Increased photosynthesis efficiency elevated the production of nutritional compounds representing dry matter, as well as plant hormones which upraised cell elongation and division. The superiority of plants grown in the second planting date in leaf length and green yield may be due to a lower temperature and the elevated relative humidity, resulting in a decreased transpiration and an increased leaves water content, leading to a rise in green weight and leaves expansion (Al-Sammaraie 2001; Al-Shahmani 2020). A significant increase occurred in plant height, dry matter percentage and green yield (Tables 2, 7 and 8) at all fertilization treatments may be attributed to the fact that the organic fertilizers are rich in nitrogen and phosphorus. These two elements are involved in the formation of DNA, RNA, proteins and enzymatic compounds, playing a direct role in increasing cell building, cell division and stimulating plant vital activities. These are reflected in vegetative growth parameters including plant height (Abdol 1988; Al-Sahaf 1989; Abo El-Maged *et al.* 2006; Shaheen *et al.* 2007). These results are in agreement with the results of Shehata *et al.* (2011), Sajet (2013) and Azza & Yousef (2015). The high increase in the height of plants sprayed with seaweed extract may be due to its gibberellin content, which encourages the division of apical meristems cells and increases the length of cells. Also, it plays an essential role in the effectiveness of the intercalary meristem, which operates away from the developing apex and apical meristems. Increasing cell division will multiply cell numbers then internodes elongation will occur (Gaafar *et al.* 2013). The superiority effect of Tekamin Max in the number of branches (Table 5) may be attributed to the role of amino acids in stimulating the production of cytokinins which encourage the lateral buds to grow and break the apical dominance (Al-Shahat 1990). The superiority of chemical fertilizers in the number of leaves may be due to rapid and adequate supplying nitrogen and phosphorous contained in the added fertilizer, which play a direct role in enhancing production and growth of leaves. The superiority of humic acid treatment in the chlorophyll content and leaf length may be related to the role of humic acid in upraising plant physiological processes and their reflection in elevating the growth, the plant nutrient contents and plant hormones such as cytokinin and endogenous auxin (Chen & Avaid 1990; Anonymous 2005). In addition, humic acid is a fundamental substance in plant nutrition due to its content of many elements essential for plant growth (Anonymous 2005).

REFERENCES

Abdol, KS 1988, Physiology of nutrients in plants. Ministry of Higher Education and Scientific Research. University of Salah Al-Din, Iraq.

Abou El Magd, MM, El Bassiony, AM & Fawzy, ZF 2006, Effect of organic manure with or without chemical fertilizer on growth quality of some varieties of broccoli plant. *Journal of Applied Sciences Research*, 2: 791-798.

Al Rawi, KM & Khalf Allah, AM 2000, Design and analysis of agricultural experiments. Dar al-Kutub Foundation for Printing and Publishing, University of Mosul, Iraq, 2nd Ed.

Al Sahaf, FH 1989, Applied plant nutrition. Dar al-Hikma Press for Printing and Publishing. University of Baghdad, Iraq.

Al Said, MA & Kamal, AM 2008, Effect of foliar spray with folic acid and some amino acids on flowering, yield and quality of sweet pepper. *Mansoura University Journal of Agricultural Sciences*, 33: 7403-7412.

Al Samarrai, MH 2001, Effect of nitrogen and phosphate fertilization and planting date on growth and quantity. MSc. Dissertation, College of Agriculture, University of Baghdad.

Al Shahat, NAZ 1990, Plant hormones and agricultural applications. National Research Center, Cairo, Egypt.

Al Shahmani, NSK 2020, The role of gibberellic acid and tryptophan in vegetative and qualitative growth indicators and some active compounds of the sweet basil plant *Ocimum basilica* L. MSc. Dissertation, College of Agriculture, University of Kufa, Iraq.

Al Zuhairi, HQK 2018, Effect of planting date and spraying with ascorbic acid and liquid organic fertilizer Algidex on the growth of dill *Anethum graveolens* L., its seed and oil yield and its biochemical activity. MSc. Dissertation, College of Agriculture, Al-Basrah University.

Anonymous 2005, Humic acid, organic plant food and root growth promoters. An earth friendly company (Ecochem) 17/2/2007. File G: humic acid.htm.

Azza, SA & Yousef, RS 2015, Response of basil plant *(Ocimum sanctum* L) to foliar spray with amino acids or seaweed extract. *Journal of Horticultural Science & Ornamental Plants*, 7: 94 - 106**.**

Azza, SM & Yousef, RS 2015, Response of basil plant *(ocimum sanctum* L) to foliar spray with amino acids or seaweed extract. *Journal of Horticultural Science & Ornamental Plants*, 7: 94 - 106**.**

Bajracharya, D 1999, Experiments in plant physiology. Narosa Publishing, Host, New Delhi, India.

Bouras, M, Abu Turabi, B & Al Basit, I 2006, The production of vegetable crops, the theoretical part, Daoudi Press.

Chen, Y & Aviad, T 1990, Effect of humic substances on plant growth. In: P, MacCarthy (Ed.), Humic substances in soil and crop sciences: selected readings. American Society of Agronomy and Soil Sciences, Madison, pp. 161-186.

Gaafar, AM, Morsi, AA & El Ghamy, HE 2013, Chemical, nutritional and biochemical studies of garden cress protein isolate. *Nature and Science*, 11: 8-13.

Ibrahim, SMM, Tahah, LS & Farahat, MM 2010, Influence of foliar application of peptone on growth, flowering and chemical composition of *Helichrysum bracteatum* plants under different irrigation intervals. *Ozean Journal of Applied Science*, 3: 143-155.

Ihsan, SA 1999, A study of some factors affecting the quantitative and qualitative characteristics of the essential oils of mint and tangerine. PhD Dissertation, College of Agriculture, University of Baghdad, Iraq.

Kamali Omidi, T, Khorgami, A, Taleshi, K 2022, Effect of foliar application of humic acid levels and nano-fertilizer application on some quantitative and qualitative traits of pumpkin (*Cucurbita pepo* L.) in climatic conditions of Khorramabad area, Iran. *Caspian Journal of Environmental Sciences*, 20: 467-476.

Khichar, ML & Niwas, R 2006, Microclimatic profiles under different sowing environments in wheat. *Journal of Agrometrology*, 8: 201 -209.

Krug, H 1991, Gemüseproduktion, 2.Auflage. Verlag Paul Parey, Berlin and Hamburg, 541 p.

Mikkelsern, RL 2005, Humic materials for agriculture. *Better Crops*, 89: 6-10.
Ragimov, AO, Mazirov, MA, Zinchenko, SI, Shitikova, AV 2021, Features of environmentally-friendly product obtaining from sugar and fodder beets in conditions of zinc contamination of sod-podzolic sandy loam soils. *Caspian Journal of Environmental Sciences*, 19: 939-945.
Rakhimova, OV, Khramoy, VK, Sikharulidze, TD, Yudina, IN 2021, Influence of nitrogen fertilizers on protein productivity of vetch-wheat grain under different water supply conditions. *Caspian Journal of Environmental Sciences*, 19: 951-954.
Sajt, TFK 2013, Effect of cultivar, liquid organic fertilizer and mowing dates on growth and production of dill plant *Anethum graveolens* L. MSc. Dissertation, College of Agriculture, University of Baghdad, Iraq.
SAS 2012, Statistical analysis system, User's Guide Statistical, Version 9th ed. SAS Institute, Cary, North Carolina, USA.
Shaheen, AM, Rizk, FA, Elbassiony, AM & El Shal, ZSA 2007, Effect of ammonium sulphate and agricultural sulphur on the Artichoke plant growth, heads yield and its some physical and chemical properties. *Research Journal of Agriculture and Biological Sciences*, 3: 82-90.
Shehata, SM, Heba, S. Abdel AZem, Abou El Yazied, A & El Gizawy, AM 2011, Effect of foliar spraying with amino acid and seaweed extract on growth, chemical constitutes**,** yield and its quality of celeriac plant. *European Journal of Scientific Research*, 58: 257-265.
Taiz, L & Zeiger, V 2010, Plant physiology. 4th ed. Sinauer Associates, Inc. Publisher Sunderland, Massachusetts-AHS, USA.
Turan, M & Kose, C 2004, Seaweed extract improve copper uptake of grapevine. *Acta Agriculturae Scandinavica, Section B- Soil and plant Science,* 54: 213- 220.

Bibliographic information of this paper for citing:
Al-Dulaimy, Q,Z,A, Hammad, H,S, Al-Tamimi, R,A 2022, Effects of planting date and spraying with organic fertilizers on vegetative growth indices of dill plant (*Anethum graveolens* L.). Caspian Journal of Environmental Sciences, 20: 793-798.