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EFFECT OF ADDING TWO TYPES OF ORGANIC FERTILIZERS IN SOME GROWTH AND YIELD INDICATORS FOR TWO CULTIVARS OF FENNEL (*FOENICULUM VULGARE* MILL.)

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Abstract

This study was conducted in one of the agricultural fields in Al-Khalidiya district, east of the Ramadi city in the silty loam soil for the winter season of 2016 -2017 in order to study the effect of adding two types of organic fertilizer are sheep manures and ostrich manures on some growth indicators for two cultivars of Fennel, first cultivar is (Sahoo), and the second cultivar is (Hanan). The Randomized Complete Block Design (RCBD) was used, with split-plot-design, and with three replicates. The results showed the superiority of ostrich manures in the plant height (134.39 cm.plant^{-1}), number of branches (8.39 branch.plant^{-1}), the number of main inflorescences (62.55 main inflorescences .plant^{-1}), the diameter of the stem (1.407 cm.plant^{-1}), the weight of 1000 seed (9.90 g.plant^{-1}), While sheep manures were excelled in the number of secondary inflorescences (121 secondary inflorescences .plant^{-1}), the number of seeds in the secondary inflorescences (26.96 seed. secondary inflorescences^{-1}), and the unit yield (1419.8 g.unit^{-1}). The Sahoo cultivar was excelled in the plant height (148.22 cm.plant^{-1}), the number of main inflorescences (50.89 main inflorescences .plant^{-1}), the number of secondary inflorescences (145.74 secondary inflorescences .plant^{-1}), the number of seeds in the secondary inflorescences (27.98 seed secondary inflorescences^{-1}), and the diameter of the stem (1.556 cm.plant^{-1}), While Hanan cultivar was excelled in the number of branches (8.78 branches .plant^{-1}), the weight of 1000 seeds (11.21 g.plant^{-1}), and unit yield (1913.9 g.unit^{-1}). while the interaction between Sahoo cultivar and ostrich was excelled by giving it the highest number of branches for the plant (9.33 branches .plant^{-1}), the number of main inflorescences (72.78 main inflorescences .plant^{-1}), the diameter of stem (1.643 cm), while interaction between the Sahoo cultivar and dap fertilizer gave the highest plant height (150.56 cm.plant^{-1}), the number of secondary inflorescences (154.89 secondary inflorescences .plant^{-1}), the interaction Sahoo cultivar and sheep manure gave the highest number of seeds in the secondary inflorescence (28.97 secondary inflorescences .plant^{-1}), While triple interaction between Hanan cultivar, sheep manure, and ostrich manure gave the highest weight of 1000 seeds (11.27 g.plant^{-1}) and the highest unit yield with dap fertilizer (2041.7 g.unit^{-1}).

Key words: Organic fertilizers, yield, *Foeniculum Vulgare* Mill.

Introduction

Fennel (*Foeniculum Vulgare* Mill) is a well-known medical herbal plant belonging to the Apiacea family, which includes more than 250 cultivars of leafy vegetable crops and medical herbs (Piccaglia and Marotti, 2001; Ihsan, 1999), it is also known as Fennel). It is a permanent aromatic plant cultivated in temperate and tropical areas, its native country is the Mediterranean and southern Europe but for its medical and economic importance, its cultivation has spread to all countries of the world (Weiping and Baokang, 2011). Fennel has a great role in the treatment of many diseases, where Figueredo *et al.*, (2012) noted that Fennel leaves are used in treating diarrhea, bronchitis, and Sexual dysfunction. Mehrzad and Samira, (2017) reported that the Fennel extract can be used as an alternative to antibiotics because it contains antibacterial properties. Al-Ridiman, 2004; Hukha *et al.,* (2004) showed that the addition of chemical fertilizers to the soil is beneficial to the plant, but the continuity of adding it negatively affects the health of humans and animals and the environment of the plant represented by soil and groundwater and the replacement of chemical fertilizers with organic fertilizers is one of the important means to maintain the fertility of soil and reduce its pollution, where Ghawwas *et al.,* (2002) noted in a study that the use of organic fertilizer increased the yield of the

fruit and the dry weight of the Fennel. Dahmardeh *et al.,* (2010) found that the use of chemical fertilizers gave a high value. However, when using chicken residues, the productivity increased in addition to the improvement and repair of some soil properties. Azzaz *et al.,* (2009) found that the use of a mixture of organic fertilizer and bio fertilizer has the largest role among the study's factors in terms of the strength of its impact on the indicators of plant growth, the yield, and aromatic oil. Ahmed (2013) noted that the Roselle plant gave high significant differences when using ostrich and chicken manures in terms of increasing plant height, a number of branches, dry weight, and flower yield compared to other fertilization treatments. Salileh *et al.,* (2013) mentioned, when using the manure of cows, chickens, and ostriches, *Calendula officinalis* plant gave high significant differences to some morphological traits of the plant as well as the number of flowers, number of leaves and seeds and weight of 1000 grains, Moradi *et al.,* (2011) found, when studying the effect of the adding organic fertilizer to the cultivated soil with Fennel plant increased and with high significant difference, the percentage of Anethole compound in aromatic oil, While their content of the Fenchone, Estragole and Limonene. As for Abbas and Abdul Muttalib (2011), it was mentioned that the Anethole in the aromatic oil of the Fennel increased with the levels of nitrogen fertilization, while the Fenchone was increased by increasing phosphate fertilizer, Ahmadi and Ahmad (2017) noted that the addition of auxin and organic fertilizer had a highly significant effect on most of the studied traits. The increase was proportional to the additive levels of both study factors. Al-Mohammedi *et al.,* (2014) noted that fertilization of the black caraway with Bat Guano manures at a rate of (175 kg.ha^{-1}) has increased plant height, fruit yield, dry weight, yield components, and seed yield. Bat Guano manures have also improved some of the physical traits for the volatile oil of the black caraway and its chemical components (Al-Mohammedi *et al.,* 2016). Al-isawi and Almehemdi, (2016) concluded that the addition of the Bat Guano at the level of 8g per flowerpot improved the traits of vegetative and root growth of the wheat. However, the domesticity of the local cultivar for the 4g level was clear in most of its traits while the imported cultivar responded to the level of 8g from Bat Guano in the flowerpot.

Materials and methods

A field experiment was conducted in a silty loam soil, Al-Khalidiya district, Al-Anbar province for the winter season 2016-2017 to determine the effect of adding two types of organic fertilizer (sheep and ostrich manure) in the growth and yield of two cultivars of Fennel, first cultivar is (Sahoo) which is symbolized by (A1), and the second cultivar is (Hanan) which is symbolized by (A2). The soil was plowed, smoothed and divided into plots, with dimensions (2×2 m) for one plot, the DAP fertilizer (180 kg.ha^{-1}) was added in two batches with rate of (36g) for one plot as a first batch before cultivating as a factor (control treatment) and was mixed with the soil inside the plot and symbolized by (B1), sheep manures were also added to the soil with rate of (2kg) for the plot and mixed with the soil and symbolized by (B2), as well as for ostrich manures, where 2kg was added to the plot and mixed with soil and symbolized by (B3). The plates were then settled and cultivated with the seeds of the Sahoo (A1) and Hanan (A2) cultivars on 12/16/2016, where they were cultivated in the form of lines within the plot. After 45 days, the second batch of fertilizer DAP with the same amount for the first batch, The irrigation process was conducted continuously when the loss of 50% of soil moisture. The Randomized Complete Block Design (RCBD) was used in split-plot-design, with three replicates, the averages were compared using the Least Significant difference (LSD) test. On the date of 19/3/2017, the Hanan cultivar (A2) started with the formation of flowers where the percentage of flowering was 20% and then continued until it reached 97% in 27/3/2017. The Sahoo cultivar (A1) was delayed by flowering until 28/4/2017, The percentage of flowering was 4% and then continued to increase until 20/20/2017. The percentage was 95%. After maturity, the plant was harvested (A2) on 2017/6/28. The other cultivar (A1) was harvested on 30/6/2017. Some plant traits were measured for the purpose of determining the effect of adding organic manure (B2, B3) on plant height, number of branches, number of main and secondary inflorescences, number of seeds, the diameter of the stem, the weight of 1000 grain and unit yield. Table 1 shows some traits of soil.

Table 1: shows some traits of soil.

Traits	PH	EC (ds.m^{-1})	Texture	OM %	N (ppm)	P (ppm)	K (ppm)
Value	7.4	4.3	Silty loam	0.63	40.7	0.56	58.2

Statistical analysis

The results of the study were statistically analyzed using the statistical analysis program (Genstat) below a probability level of 0.05 to test the study treatments.

Results and Discussion

Plant height (cm)

Table 2 shows significant differences between the two cultivars, the organic fertilizer and the interaction between them, where A1 cultivar gave the highest plant

height amounted to (148.22 cm) while the A2 cultivar gave the lowest plant height amounted to (116.81 cm). The reason may be due to differences in genotypes to express about itself phenotypically in addition to The effect of the addition of organic fertilizer to the soil in terms of improving traits and increase their availability of the nutrient elements for the plant, such as nitrogen, which encourages plant cells to divide and elongation, thus increase the plant height. The same table indicates significant differences between the levels of organic fertilizers, where Ostrich manures (B3) was excelled by giving it the highest plant height amounted to (134.39 cm). These results agree with (Ahmed, 2013) when adding ostrich manures to Roselle plant, where he noted that the plant height has increased significantly compared to other study treatments followed by B2 without a significant difference where amounted to (133.56 cm) compared to the level of B1, which gave the lowest plant height amounted to (129.61 cm). The reason may be due to the difference in the organic fertilizer content of the nutrients and their effect in improving the activity of the bio-processes in the soil and inside the plant, which led to increasing the plant height. In the same table, there was a significant difference between the interaction treatments. The interaction treatments (A1 × B1) gave the highest plant height amounted to (150.56 cm), while the A2×B2 treatment gave the lowest plant height amounted to (108.66). The reason for this may be due to differences in the response of the genotypes to the expression about itself under the influence of different growth parameters.

Table 2: Effect of two types of organic fertilizers in plant height (cm) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	150.56	108.66	129.61	1.81
B2	148.22	118.89	133.56	
B3	145.89	122.89	134.39	
L.S.D 0.05 for interaction	2.56			
Average of cultivars	148.22	116.81		
L.S.D 0.05 for cultivars	1.48			

Table 3: Effect of two types of organic fertilizers in the number of branches for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	8.33	8.00	8.16	0.785
B2	8.56	7.89	8.22	
B3	9.33	7.44	8.39	
L.S.D 0.05 for interaction	1.109			
Average of cultivars	8.74	8.78		
L.S.D 0.05 for cultivars	0.641			

Number of branches

Table 3 shows that the plant cultivar had a significant effect on the number of branches, where the superiority of the A2 cultivar in this trait by giving it an average number of branches amounted to 8.78 while the A1 cultivar gave an average number of branches amounted to (8.74). The reason may be due to the variety of cultivars in their adaptation to the environment and the suitability of the study soil, while did not show both the level of fertilization and the interaction between them any significant difference in the number of branches of both types showed only some differences in appearance between experimental units.

The number of main inflorescences

Table 4 shows significant differences between the two cultivars, the organic fertilizer and the interaction between them, where A1 cultivar gave the highest number of main inflorescences amounted to (50.89 inflorescences.plant^{-1}) while the A2 cultivar gave the lowest plant height amounted to (48.18 inflorescences. plant^{-1}). As for the effect of adding organic fertilizer, the same table indicates significant differences between the types of organic fertilizers, where Ostrich manures (B3) gave the highest number of main inflorescences amounted to (62.55 main inflorescences.plant^{-1}), While sheep manures B2 had the lowest average number of main inflorescences amounted to (39.39 main inflorescences. plant^{-1}) compared to the control treatment B1 which gave the average number of main inflorescences amounted to (46.67 main inflorescences.plant^{-1}). As for the interaction treatments between the two study factors has also given a significant difference, where the interaction treatment (A1 × B1) gave the highest number of main inflorescences amounted to (72.78 main inflorescences.plant^{-1}), while the A2×B2 treatment gave the lowest number of main inflorescences amounted to (36.78 main inflorescences.plant^{-1}). This may be attributed to the fact that the adding organic fertilizer has increased the soil content of the nutrient elements in their availability form to absorb enough to meet the need of the plant and suitable for the plant variety during the period of inflorescences formation, Thus, the number of main inflorescences increased. These results agree with (Ahmed, 2013) observed that the addition of organic fertilizers increased the number of branches in the Roselle plant but its

effect was not significant in increasing the number of pods.

Number of secondary inflorescences

Table 5 indicates that the plant cultivar gave a significant difference in the number of secondary inflorescences for the Fennel plant, where the A2 cultivar was excelled in this trait by giving it an average number of secondary inflorescences amounted to (50.89 secondary inflorescences.plant^{-1}) compared to the A1 cultivar gave an average number of secondary inflorescences amounted to (48.18 secondary inflorescences.plant^{-1}), while the manure type factor did not appear only simple differences between the experimental units in this trait, which did not have a significant effect in this study, As for the interaction index between the two study factors, a significant difference was given in the number of secondary inflorescences, where the number of secondary inflorescences ranged between 154.89 and the highest value in the A1×B1 treatment and the lowest value in the A2 × B1 treatment among the experimental units for this study.

Number of seeds in secondary inflorescences

Table 6 shows that there are significant differences between the two plant cultivars in the number of seeds in the secondary inflorescences, where the A1 cultivar gave the highest average number of seeds in the secondary inflorescences amounted to (27.98 seed. secondary inflorescences^{-1}) compared to the A2 cultivar which gave the lowest average number of seeds in the secondary inflorescences amounted to (24.07 seed. secondary inflorescences^{-1}). The same table indicates that there are significant differences between the levels of the other study factor. The table shows that the type of fertilizer B2 was excelled by giving it the highest number of seeds in the secondary inflorescences and then the fertilizer B3 and B1 (26.96, 26.00, 25.11), respectively, While the interaction index between plant cultivar and fertilizer type did not show significant differences between experimental units.

The diameter of the stem (cm)

Table 7 shows that there were significant differences between the two plant cultivars as well as the type of fertilizer while the interaction did not show any significant difference, where the A1 cultivar gave the highest average for the diameter of the stem amounted to (1.556 cm) compared to the A2 cultivar which gave the lowest average number of seeds in the secondary inflorescences amounted to (1.138 cm). The reason may be due to some differences in the genotypes of the two cultivars in their response to fertilization and expression about itself phenotypically, The table also showed a significant difference between the types of fertilizer in increasing the average diameter of the stem. The treated plant with organic fertilizer B3 gave the highest average of stem diameter amounted to (1.407 cm) followed by fertilizer B2 with a stem diameter amounted to (1.340 cm) and fertilizer B3 with average amounted to (1.293 cm). This may be due to the increase in the soil content from the nutrient elements in their availability form as a result of the addition of organic fertilizers and the reflection on some traits of the yield and its components, As for the interaction

Table 4: Effect of two types of organic fertilizers in the number of main inflorescences (main inflorescences.plant^{-1}) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	43.11	50.22	46.67	2.57
B2	36.78	42.00	39.39	
B3	72.78	52.33	62.55	
L.S.D 0.05 for interaction	3.64			
Average of cultivars	50.89	48.18		
L.S.D 0.05 for cultivars	2.10			

Table 5: Effect of two types of organic fertilizers in the number of secondary inflorescences (secondary inflorescences.plant^{-1}) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	154.89	86.33	120.61	2.075
B2	143.89	98.78	121.34	
B3	138.45	102.89	120.67	
L.S.D 0.05 for interaction	2.93			
Average of cultivars	145.74	96.00		
L.S.D 0.05 for cultivars	1.69			

Table 6: Effect of two types of organic fertilizers in the number of seeds in the secondary inflorescences (seed. secondary inflorescences^{-1}) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	27.13	23.09	25.11	1.04
B2	28.97	24.96	26.96	
B3	27.83	24.16	26.00	
L.S.D 0.05 for interaction	1.473			
Average of cultivars	27.98	24.07		
L.S.D 0.05 for cultivars	0.85			

index between the two study factors, it did not show any significant difference between the experimental units.

The weight of 1000 seeds (g)

Table 8 indicates that there is a significant difference between the two plant cultivars in this trait, where A2 cultivar was excelled by giving it an average weight of 1000 seed amounted to (11.21g) compared to the A1 cultivar, which gave an average weight amounted to (7.44g). This may be due to different genotypes between the two cultivars in term of their ability to benefit from the product of the photosynthesis process and their accumulation in seeds and control of some genes in this process, The table also indicates that the fertilizer type factor also showed a significant difference between the types of fertilizers, where fertilizer B3 gave the highest average for this trait amounted to (9.90 g) followed by B2 with an average weight of 1000 seeds amounted to (9.19 g) and B1 with an average amounted to (8.87 g). The reason may be due to the fact that the addition of soil organic fertilizer has increased the activity of the plant's bio-activities by increasing the availability of the nitrogen component, especially photosynthesis process, due to the good vegetative growth of the plant, which led to the accumulation of nutrients in the seeds and increases their weight. As for the interaction index between the two study factors, it did not show any significant difference between the experimental units.

Unit yield (g)

Table 9 shows that there are significant differences between the two cultivars, the organic fertilizers and the interaction between them in this trait, where the A2 cultivar gave an average unit yield amounted to (1913.9 g) while the A1 cultivar gave an average amounted to (468.9 g). The fertilizer type showed significant differences between the organic fertilizer types, where B2 was excelled by giving it the highest yield amounted to (1419.8 g), followed by B1 and B2 with an average of (1026.3, 1128 g), respectively, The table also showed significant differences in the interaction index between the two study factor. The interaction treatment A2×B1 gave the highest average amounted to (2041.7 g) while the A1×B1 gave the lowest yield amounted to (10.9 g).

Table 7: Effect of two types of organic fertilizers in the diameter of the stem (cm) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	1.467	1.120	1.293	0.09
B2	1.557	1.123	1.340	
B3	1.643	1.170	1.407	
L.S.D 0.05 for interaction	0.1276			
Average of cultivars	1.556	1.138		
L.S.D 0.05 for cultivars	0.07			

Table 8: Effect of two types of organic fertilizers in the weight of 1000 seed (g) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	6.67	11.07	8.87	0.81
B2	7.11	11.27	9.19	
B3	8.54	11.27	9.90	
L.S.D 0.05 for interaction	1.143			
Average of cultivars	7.44	11.21		
L.S.D 0.05 for cultivars	0.66			

Table 9: Effect of two types of organic fertilizers in the Unit yield (g) for two cultivars of Fennel.

CultivarsFertilizers	A1	A2	Average for Fertilizers	L.S.D 0.05 for Fertilizers
B1	10.9	2041.7	1026.3	5.95
B2	1139.6	1700	1419.8	
B3	256	2000	1128	
L.S.D 0.05 for interaction	8.41			
Average of cultivars	468.9	1913.9		
L.S.D 0.05 for cultivars	4.86			

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