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THE EFFECT OF PLANTING DATES AND THE LEVELS OF NPK FERTILIZERS ON SOME VEGETATIVE AND FRUITS CHARACTERS OF FENNEL *FOENICULUM VULGARE* L.

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Abstracts

The experiment was conducted in a field in Al-Dagharah distract which followed to Al-Diwanyah province during the autumn season 2017-2018 to study the effect of planting dates and the levels of NPK fertilizer and its interaction on some vegetative and fruits characters of *Foeniculum vulgare* L., the experiment including two factors the first factor the planting dates are represented by four dates (1\11, 15\11, 30\11, 12\15) respectively, whereas the second factor included four levels of the NPK fertilizers N_0 P_0 K_0), (N_{60} P_{50} K_{30}), (N_{90} P_{75} K_{45}) and (N_{120} P_{100} K_{60}) Kg H^{-1} respectively, Randomized Complete Block Design (RCBD) was used in this experiment according to Split –plot design as the dates were put in the main plots and the fertilizers were put in the subplots and with three replicates, the results were statistically analyzed by using the least significant differences (L.S.D) at probability level ($p \leq 0.05$), some of the characters were studied as the plant height , the fresh and dry weight of the total vegetative growth, the fresh and dry weight of the root, the number of clusters, the number of fruits, weight of fruits, weight of 1000 fruit and the yield of hectare from fruits Kg H^{-1}. the results showed that the planting of Fennel plant in the first date 1\11 resulted toincrease in all studied vegetative and fruits characters as compared with plants which planting at fourth date 15\12, also there was significant exceeding of the plants which fertilized by the higher level N_{120} P_{100} K_{60} in the all studied characters as compared with control treatment.

***Key words*:** Planting dates, NPK fertilizer, *Foeniculum vulgare* Mill.

Introduction

The medicinal plants are currently characterized by its importance in the agricultural production in many countries of the world as they are a major source of the medicinal drugs production and plant extracts, as well as it considering the source of the active substances which used in the preparation of pharmaceutical materials (Evans, 1998). Fennel belongs to umbelliferae and it considered from an important plant in the world which combining medicinal, aromatic and nutritional uses and it fruit considered from the most substances in the herbal medicine centers in Iraq because of it entry into the composition of a lot of therapeutic herbal materials (Al-zubaydi, 1993) and It is a herbaceous annual or bipolar plant or perennial, it stem is a standing and branched with strongly vegetative growth (Al-Musli, 2005) and for the success of the medicinal plants planting especially *Foeniculum vulgare* L. in Iraq and its various regions we must be identified the appropriate dates for planting that through it we can know the suitable growth period of the plant. It was also found that the determining the amount of fertilizer and the time of the adding has a significant effect on the plant which it needing the macronutrients NPK to complete its life's cycle, the nitrogen considering the most important nutrient which plant needing it in all life stages because of the role which played in the plant growth and increasing the production (Chatcopoluok and Koutsos *et al.*, 2006) also it entering in the formation of protein molecule as well as its presence in the most important molecules as purines and pyrimidines which entering in the formation of nucleic acids that considering the basic in the protein formation (Alkhatib, 2007), phosphor and potassium are also important nutrients in the plant growth, phosphorus enters in the formation of nucleic acids, phosphorous lipids, co-enzymes and it enters in the ATP formation and other compounds, whereas Potassium is considered an important element in the activation of more than 60-80 enzymes, especially important enzymes in the using of energy, breathing and nitrogen metabolic and also it works in the opening and closing the Stomata and protein formation in the plant by increased the absorption of nitrogen in the plant (Abu Dahi and Alyuns, 1988; Al-Naimi, 1991; IPI, 2002; Havlin *et al.,* 2005) and because the difference of environmental conditions and the low of scientific studies of this plant which is medically and economically important in the country, the experiment aimed to determining the best planting date of Fennel *Foeniculum vulgare* L. according to region condition and determining the best amount of NPK fertilizer to increase the production quantitatively and qualitatively .

Materials and Methods

The experiment was conducted in a field in Al-Dagharah distract which followed to Al-Diwanyah province (Southwest Baghdad)during the autumn season 2017\2018 in the soil well-known properties as showed in the Table (1)

Table 1: Some chemical and physical properties of soil experiment before planting

Properties		Value	Unit
The Chemical properties	Soil interaction (pH)	7.7	-
	Electrical conductivity(EC)	3.2	ds/m^{-1}
	Available nitrogen	18	Mg Kg^{-1}
	Available phosphor	10	Mg Kg^{-1}
	Available potassium	160	Mg Kg^{-1}
The physical properties	Sand	33.0	%
	Clay	50.0	%
	Silt	17	%
	Soil texture	Clay	

The experiment including study the effect of two factors the first factor was planting dates which was 1\11, 15\11, 30\11 and 15\12 that symbolize as D1, D2, D3, D4 respectively and its occupied the main plots, whereas the second factor was the levels of NPK were four levels selected from NPK which its N_0 P_0 K_0 that symbolize as F1, N_{60} P_{50} K_{30} that symbolize as F2 , N_{90} P_{75} K_{45} that symbolize as F3 and N_{120} P_{100} K_{60} that symbolize as F4and its occupied the subplots, Urea fertilizer (N % 46) was used as a nitrogen source and diammonium Phosphate (DAP) as a phosphor source and potassium sulphate K_2SO_4 as a potassium source, the land of experiment was cultivation by using the moldboard plow and then soften by using the disc harrows after that it was settled by leveling machine and then divided according to the used design into 3 replicates, each replicate contain 16 experimental unit and the diminution of it was (3×3) m and it consist of 3 furrows, the distance between the furrows and other 70 cm, the distance between the experimental unit and other 1 m and the distance between the holes 20 cm, 3-7 seeds were putting per hole at depth (3-5) cm then the DAP was added by two parts, the first part before the planting with partition and the second before flowering stage and the nitrogen fertilizer was added as a urea (N% 46) and the potassium fertilizer was added as potassium sulphate of the included units by fertilization and by two parts, the first after the thinning process of plant and the second before the flowering stage, The weeding process was conducted manually and continuously from the beginning of planting to maturation date to eliminate the competition of weeds, 5 plant was randomly taken from the middle furrows to each experimental unit to study the vegetative growth characters and 10 plants were taken to study fruit growth character, some characters were measured as plant height (cm) as measured from the connection region between the stem and soil to the top of plant , fresh weight and dry weight of the root and vegetative growth (gm $plant^{-1}$) and then the fresh weight of the root and growth vegetative were recorded and after drying, the dry weight of the root and vegetative were recorded both alone, also the number of cluster in the plant (cluster $plant^{-1}$) the mean of the cluster was recorded of 10 plants were taken from middle furrows to each experimental unit and the number of cluster fruits (fruit $cluster^{-1}$) was recorded through calculated the number of fruits in the all 10 plants and then the mean was calculated based on sample plants, the mean of weight of fruits (gm $plant^{-1}$) was calculated of the 10 plant fruits, weight of 1000 fruit (gm) was calculated by taken 1000 fruit randomly of all experimental units and then its weight was measuring by using a sensitive scale and fruits yield (Kg H^{-1}) the fruit yield was calculated of the single plant for 10 plants which was taken from middle furrows of all experimental units and then multiply in the number of plants in the plant density.

Result and Discussion

The Plant Height

As can be showed in the table (2)there were a significant differences between planting dates as the first date 1\11 gave the highest mean to the plant height attained 96.67 cm which significantly exceeded on all dates followed by the second date 15\11 with significantly exceeding from the third date 30\11 by recorded two means attained 85.15 cm and 80.28 cm, while the fourth date 15\12 recorded significant decreasing from all dates which attained 73.00 cm, the reason of the plant height in the first date may be due to suitable of temperature to the plants of the first date which resulted to increase the efficiency of photosynthesis and gave strongly root and vegetative growth which lead to an increase the plant growth in the longitudinal direction, thus increasing the height (Abdul Qadir *et al*., 1982) and this result agreed with (Ayub *et al.*, 2008; Selim *et al*., 2013) who pointed to increase the plant height in the planting at early date of Fennel plant, also the results showed that the treatment F4 (N_{120} P_{100} K_{60}) recorded the highest mean of plant height attained 96.11 cm followed by F3 (N_{90} P_{75} K_{45}) and F2 (N_{60} P_{50} K_{30}) which recorded two means attained 87.39 and 81.22 cm with a significant difference between its, whereas the control treatment (F1) recorded a significant decreasing on all levels which attained it mean 70.37 cm the reason maybe due to the role of the macronutrients (NPK) in stimulating the growth vegetation especially the nitrogen which plays an

important role in the increasing vegetative growths and increasing growth of metastatic tissues also it entry in the amino acids synthesis including tryptophan acid which is considered the basis in the composition and origin of Indole acetic acid (IAA)which plays an important role in the cellular division and elongate of cells that allowing the increase of plant height, as well as the reason also return to the potassium in the plant (Devlin *et al*., 1985; Abu Dahi and Alyuns, 1988; Al-Naimi, 2000) and these result agreed with what was achieved by (Bagari *et al*., 2010) who indicated an increasing of the plant height by increased the levels of the adding fertilizer from nitrogen (100 kg NH^{-1}) on the Fennel plant, also its agreed with (Abou El-Magd *et al*., 2010) when they used the higher levels from Potassium on the Fennel plant .

Table 2 : Effect of planting dates and fertilizer levels (NPK) and its interaction on the plant height (cm)

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	80.67	96.93	100.73	108.33	96.67
D211/15	68.93	84.93	90.90	95.83	85.15
D311/30	71.57	75.63	81.13	92.80	80.28
D412/15	60.33	67.40	76.80	87.47	73.00
Fertilization mean	70.37	81.22	87.39	96.11	
L.S.D (0.05)	Dates		Fertilization		Interaction
	2.221		4.142		N.S

The Fresh weight of vegetative (gm plant^{-1})

The results in the table (3) showed that the planting dates significantly affected in the fresh weight of the vegetative mean which the first date 1\11 gave the highest mean attained 478.8 gm plant^{-1} which significantly exceeded on the other dates followed by second date 15\11 which achieved the mean attained 227.0 gm plant^{-1}, while the lately dates 30\11 and 15\12 recorded the lowest means of the fresh weight of the of the vegetative attained 113.1 and 95.2 gm plant^{-1} respectively with a significant difference between them, the reason of increase the fresh weight of the vegetative in the first date maybe due to the suitable of temperature of plants which increase the ability of the vegetative to absorbed the water and nutrients and increase the photosynthesis efficiency, thus leading to the accumulation of photoassimilates in the plant (Guilioni *et al*., 2003) these result agreed with what found by Abou El-Magd *et al*. (2010) who all referred to exceeded an earlier date 15\9 by giving the highest mean of the fresh weight of the Fennel plant. The results of the table (3) also showed that the all levels of the fertilizer NPK were achieved a significant increase in the mean of fresh weight of the vegetative as compared with control treatment (without fertilization F1)which it mean attained 136.1 gm plant^{-1} which it recorded as thelowest mean of the fresh weight of the vegetative, whilst $F4N_{120}$ p_{100} K_{60} was exceeded on other treatments it was achieved the highest mean attained 341.6 gm plant^{-1} followed by $F3N_{90}$ P_{75} K_{45} and $F2N_{60}$ P_{50} K_{30} with means attained 247.4 and 188.9 gm plant^{-1}which significantly differed between them respectively, the reason may be due to role of the macronutrients in the increasing of the vegetative especially Nitrogen, as the plants supporting with sufficient amount of nitrogen leads to increase the hormone amount that presence in the plant that stimulating the increasing the plant vegetative, also the role of phosphorus in increasing vegetative growth, Potassium is an important in the photosynthesis process which increases the fresh weight of the plant, these result agreed with (Al-Dogji *et al*., 2010; Al-Jarallah, 2011) who referred to increase the fresh weight of Fennel plant with high level of nitrogen fertilization, also it agreed with what found by Abou El-Magd *et al*. (2010) when they increasing the addition of potassium fertilizer on Fennel plant, whereas the effect of the interaction between planting dates and fertilizer levels (NPK) the results indicated to significant exceeding in the fresh weight mean of vegetative, the first planting date 1\11 with all levels of fertilizer NPK led to achieved a significant increasing in the fresh weight of vegetative followed by the second date 15\11 and the third date 30\11 as comparing with delay the date into 15\12 with the same added levels however the combination ($F4N_{120}$ P_{100} K_{60}×11/1) was achieved the heights mean attained 752.7 gm plant^{-1}, whereas the combination (F1× 15\12)recorded the lowest mean attained 46.7 gm plant^{-1}

Table 3 : Effect of planting dates and fertilizer levels (NPK) and its interaction on the Fresh weight of the vegetative (gm plant^{-1})

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	258.4	373.1	531.0	752.7	478.8
D211/15	174.9	217.7	243.3	272.1	227.0
D311/30	64.6	91.0	120.0	176.6	113.1
D412/15	46.7	74.0	95.4	165.0	95.2
Fertilization mean	136.1	188.9	247.4	341.6	
L.S.D (0.05)	Dates		Fertilization		Interaction
	42.36		29.91		62.52

The dry weight of vegetative (gm plant^{-1})

From results in the table (4) we noticed a significant differences between dates in the vegetative as the first planting date 1\11 exceeding significantly on other dates in the dry weight of the vegetative which it

gave the highest mean attained 5.74 gmplant^{-1} followed by the second date 15\11 then the third date with means attained 34.74 gm and 21.52 gm respectively, whilst the lowest mean of the weight of the vegetative was recorded to the fourth date was attained 15\12 with mean attained 16.28 gm plant^{-1}, the reason of first date exceeding on other dates maybe due to the dry weight that took the same direction that taking by the vegetative and these result agreed with results of Bagari *et al.* (2010) who referred to exceed the early planting date in the dry weight of the Fennel plant, whereas the levels of the fertilizer its was observed all levels of NPK fertilizer was significantly exceeding in the dry weight of plant, however F4 significantly exceeding by recorded the highest mean attained 49.61 gm plant^{-1} followed by F3 and F2 with means attained 37.27 and 26.45 gm plant^{-1}, whilst F1 recorded the lowest mean attained 14.71 gm plant^{-1}, the reason may be due to role of the nutrients N, P, K which entered in the photosynthesis and these results agreed with (Al-Jarallah, 2011) when he increased the level of adding nitrogen fertilizer of Fennel ,also the interaction between planting dates and fertilizer treatments significantly affected in the dry weight of the vegetative as the combination (11\1 × F4) gave the highest mean attained 90.33 gm plant^{-1} with significant differences from other combinations, whereas the combination (15\12 × F1) gave the lowest mean to the character attained 10.77 gm plant^{-1}

Table 4 : Effect of planting dates and fertilizer levels (NPK) and its interaction on the dry weight of the vegetative (gm plant^{-1})

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	20.90	44.50	67.23	90.33	55.74
D211/15	14.37	29.67	39.47	54.43	34.48
D311/30	12.80	18.20	25.77	29.33	21.52
D412/15	10.77	13.43	16.60	24.33	16.28
Fertilization mean	14.71	26.45	37.27	49.61	
L.S.D (0.05)	Dates		Fertilization		Interaction
	2.901		3.850		7.040

The Fresh Weight of Root (gm plant^{-1})

The result in the table (5) showed a significant differences between the planting dates in the fresh weight mean of root as the first date 1\11 significantly exceeding on other next dates and gave the highest mean attained 27.39 gm plant^{-1} followed by the second date 15\11 with mean attained 13.71 gm plant^{-1} ,while the lately dates third and fourth gave the lowest mean of the root fresh weight attained 8.71 and 7.02 gm plant^{-1} respectively and with a significant differences between its, the reason of the fresh weight of the root increasing may be due to increased the acquired period from planting until 50% flowering which it gave the needing period to build a good root system, which came from the increasing that achieved in the vegetative of the plant on the first date (Table 3) the root system is largely dependent on the carbohydrate which produced in the vegetative, therefore, the factors that affecting on photosynthesis and the use of carbohydrate in the process of breathing and the passage of food to the root all affect significantly on the growth of the root (Azzam, 2006) these results agreed with what found by Mahdi *et al*. (2009) when they study on the Fennel plant. the results of the table(5) explained that the all levels of NPK fertilizer significantly affecting in the fresh weight of root, however F4 achieved the highest mean of the fresh weight of root attained 18.57 gm followed by F3 and F2 with means attained 15.61 and 13.23 gm with a significant differences between its, whereas F1 gave the lowest mean attained 9.42 gm and the reason may be due to the role that played by nitrogen and phosphorus in strengthening the plant root system, which is considered a very necessary of the plant stabilization in the soil and for the absorption of water and nutrients from the soil which has helped to increase the root size, as well as the role that played by potassium in increasing the capacity of potassium on absorbing and securing the work in the conveyor wood pipes and improving the work of the root system in the plant, which led to increasing its size (Hadad *et al*., 2008), whereas the interaction effect between planting dates and the levels of NPK fertilizer, all planting dates and the levels of NPK fertilizer were achieved a significant increase in the fresh weight of root as comparing with F1, the combination (1\11× F4) gave the highest mean attained 36.70 gm, whereas the combination (15\12 ×F1) gave the lowest mean attained 4.97 gm.

Table 5 : Effect of planting dates and fertilizer levels (NPK) on the fresh weight of the root (gm plant^{-1})

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	15.73	27.00	30.13	36.70	27.39
D211/15	10.33	11.87	14.90	17.73	13.71
D311/30	6.63	7.87	9.57	10.77	8.71
D412/15	4.97	6.20	7.83	9.10	7.02
Fertilization mean	9.42	13.23	15.61	18.57	
L.S.D (0.05)	Dates		Fertilization		Interaction
	0.868		1.008		1.875

The dry Weight of Shoot (gm plant^{-1})

The result in the Table (6) showed a significant differences between the planting dates in the dry weight mean of shoot as the first date 1\11 significantly exceeding by recording the mean attained 4.23 gm

plant^{-1} with a significant differences from other dates followed by the second date 15\11 which recorded mean attained 3.14 gm plant^{-1}, whereas no significant differences between the third date 30\11 and fourth date 15\12 which its means attained 2.73 and 2.64 gm plant^{-1},these may explained for the increasing in the fresh weight of the root (table 5) which reflected in the dry matter of the root and increasing it ,these results agreed with Mahdi *et al*. (2009) when they study about Fennel plant, the results of the Table (6) explained that all levels of the NPK fertilizer were achieved a significant increasing in the dry weight of root as comparing with F1 which gave the lowest mean attained 1.84 gm which was recorded as a lowest mean of the dry weight of root, while F4 significantly exceeding on the other treatments which it achieved the highest mean of the dry weight of root attained 4.40 gm followed by F3 and F2 by recorded means attained 3.60 and 2.90 gm with a significant differences between its and this is an evidence that the plant's response to the amount of added fertilizer, the reason may be due to the role of the macronutrients in the photosynthesis through the direct increase of the growth and leaf area index and then the photosynthesis and increase the transfer of it products to different places in the plant including the root system where potassium plays an important role in helping of the manufactured materials transfer to the root system and it role in the increase the dry weight of root beside it role in fresh weight increasing which reflected on it dry weight (Al-Naimi, 2000) these result agreed with Abbas (2007) when he studies about coriander and using a high level 300 gm plant^{-1} from nitrogen fertilizer but it never agreed with the same author when he used the phosphate fertilizer to the same experiment which he noticed exceeding of the phosphate fertilizer treatment 300 Kg H^{-1} in the dry weight character of the root .

Table 6 : Effect of planting dates and fertilizer levels (NPK) on the dry weight of the root (gm plant^{-1})

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	2.16	3.66	4.93	6.16	4.23
D211/15	1.93	2.76	3.46	4.40	3.14
D311/30	1.70	2.60	3.06	3.56	2.73
D412/15	1.56	2.56	2.93	3.50	2.64
Fertilization mean	1.84	2.90	3.60	4.40	
L.S.D (0.05)	Dates		Fertilization		Interaction
	0.2914		0.3752		N.S

The number of clusters (Cluster plant^{-1})

The results in the table (7) referred to a significant differences between the planting dates in the number of the clusters, the first date 1\11 significantly exceeding on all other dates in the number of clusters and gave the highest mean attained 88.02 cluster plant^{-1} followed by the second date 15\11 with mean attained 62.86 cluster plant^{-1}, whereas no significant differences between third date 30\11 and fourth date 15\12 and its means has reached 40.01 and 33.06 cluster plant^{-1} which recorded as lowest means in the number of clusters of the single plant , the reason of first date exceeding maybe due to many reason as the suitable environmental condition which it resulted to a good vegetation growth, the length of growth period on the first date and increased photosynthesis efficiency, therefore accumulation of metabolic products in the plant and transfer it to storage places in the buds which encouraged the provision of suitable conditions for the transformation of vegetative buds into flowering buds and increase the cell division, which led to an increase the number of clusters in the plant (Guilioni *et al*., 2003; Richard, 1997) and this agreed with what found by Selim *et al*. (2013) when they study about Fennel. An increasing was observed in the number of clusters of plant with an increase in the level of NPK fertilizer, F4 has been exceeding which gave the highest mean attained 71.73 cluster plant^{-1} with a significant differences from other treatments followed by F3 and F2 with means attained 58.47 and 52.50 cluster plant^{-1} whereas F1 gave the lowest mean attained 41.25 cluster plant^{-1}, the reason may be due to the role of the nitrogen in increasing the number of branches in the vegetative growth stage, which was reflected on the increasing of the number of cluster in the plant and the role of potassium which increase the number of flowers in the plant and thus increasing the number of cluster (Abu Dahi and Alyuns, 1988 ; Hamman *et al*., 1996) these results have been agreed with what Al-Nasrallah (2012) indicated that the used of the higher level from nitrogen fertilizer 180 Kg H^{-1} and 90 Kg H^{-1} from phosphate fertilizer led to increasing the number of clusters in the plant in the Iraqi conditions, also its agreed with Ismail *et al*. (2017) when they studied Anise plant by increasing the adding level of phosphate fertilization. From the table (7) we noticed a significant differences of the interaction between the two factor on the number of the clusters as the combination (1\11 × F4) has been exceeding and gave the highest mean attained 109.33 cluster plant^{-1} with a significant differences from other combinations, whereas the combination (15\12 × F1) recorded the lowest mean of the clusters attained 27.47 cluster plant^{-1}.

Table 7 : Effect of planting dates and fertilizer levels (NPK) and its interaction on the number of clusters (cluster plant^{-1})

Dates	Fertilization				
	F1 Control	F2N60 P50 K30	F3N90 P75 K45	F4N120 P100 K60	Dates Mean
D111/1	68.43	81.73	92.60	109.33	88.02
D211/15	39.27	62.20	65.87	84.10	62.86
D311/30	29.83	34.93	40.20	55.07	40.01
D412/15	27.47	31.13	35.20	38.43	33.06
Fertilization mean	41.25	52.50	58.47	71.73	
L.S.D (0.05)	**Dates**		**Fertilization**		**Interaction**
	9.944		**3.458**		**10.801**

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