Effect of planting dates and different levels of potassium fertilizer on growth, yield and chemical composition of sweet fennel cultivars under newly reclaimed sandy soil conditions

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Abstract: Two field experiments were conducted at the Agricultural research Station, National Research Centre, El-Nobaria province, El Beheira Governorate, Egypt, during the two successive winter seasons of 2007/2008 and 2008/2009 on sweet in an area of newly reclaimed soil to study the effect of transplanting dates and different rates of potassium salphate fertilizer on vegetative growth, yield, quality and chemical content of six sweet fennel cultivars (cvs. Dolce, Zefa Fino, Selma, Fino, De Florance and Zwejahrig). Transplanting dates were early (15^{th} September) and late (1^{st} October) combined with four rates of potassium salphate,i.e. 0, 45, 60 and 75 kg K_2O/ fedd.(Feddan = 0.40 ha.). Results indicated that transplanting dates differed statistically in their effect on the vegetative growth of sweet fennel plants. The highest vegetative growth expressed as plant height, leaves number /plant, fresh and dry weight of the total plant and its organs, bulb dimensions (thickness, width and length); total green yield and macro-nutrients content in leaves and bulbs (N, P and K) were obtained by early plantation (15^{th} September). On the other hand, lower values of vegetative growth, green yield and quality of bulbs were obtained in the late plantation (1^{st} October). Results summarized that sweet fennel cultivars as mentioned previously differed statistically in their vegetative growth, bulb dimensions and total green yield as well as chemical content in leaves and bulbs of sweet fennel plants. Zwejahrig cultivar was superior in its vegetative growth expressed as plant height; leaves number; fresh and dry weight of the total plant and its organs; bulb dimensions (thickness, width and length); total green yield and macro-nutrients (N, P and K) content in leaves and bulbs compared with other cultivars. On the other hand, the lowest values were recorded by cvs. Dulce and Zefa Fino. With respect to potassium fertilizer rates, results reveal that sweet fennel plants treated with 75 kg K_2O/ fed. showed higher vegetative growth parameters (plant length, leaves number and bulb dimensions, thickness, width and length), fresh and dry weight of leaves, bulbs and total plant; total green yield; physical bulb quality (flatten, cylinder and elongated shape ratios) and macro-nutrients content (N, P and K) in tissues of sweet fennel leaves and bulbs than the lower rates of potassium. The results indicated that combined effect of transplanting dates and cultivars of sweet fennel caused significant increases in vegetative growth, green yield, bulb quality and chemical contents. The highest vegetative growth, yield and quality as well as chemical contents were obtained by cv. Zwejahrig combined with early date. The interaction effect between cultivars and rates of potassium fertilizer gave a significant increase in vegetative growth, bulb yield and chemical constituents. The highest values were obtained by adding the highest potassium rate (75 kg K_2O / fed.) to cv. Zwejahrig plants. The highest values were obtained by early date combined with the highest potassium rate (75 kg K_2O/ fed.). In addition, the highest vegetative growth with the maximum total green yield was obtained under the combination of cv. Zwejahrig in early date and the highest potassium rate. [Journal of American Science 2010;6(7):89-105]. (ISSN: 1545-1003).

Key words: Sweet fennel; Cultivars; Sowing dates; Potassium mineral fertilizer; N; P; K; Green yield and quality; Chemical content

1. Introduction

Sweet fennel (*Foeniculum vulgare* Mill.) is a plant belonging to the Umbelliferae (Apiaceae) family, which is an annual, biennial or perennial aromatic herb, depending on the variety **(Farrell, 1988, Wichtl and Bisset, 1994**). It is native to North Africa, Mediterranean Region, southern Europe and Asia **(Abd El- Wahab and Mehasen, 2009)**. It contains phytochemical hormones (saponins), flavonoids, lipids, proteins and essential oils. Medicinal and aromatic plants are important economic products which represent significant sources of economic revenue and foreign exchange and are among the most important agricultural export products **(Watt and Breyer, 1962)**. The Egyptian government in collaboration with the WHO seeks to protect fennel plants that serve as a source for pharmaceutical compounds and who might increase the export of these plants from Egypt to allover the world **(Egypt Magazine, 2000)**. Fennel is used in folk medicine as a stimulant, diuretic, carminative and sedative **(Charles *et al*. 1993)** and galactagogic, emmenagogic, expectorant and antispasmodic **(Chiej, 1984)**. It is also considered as a spice due to terpenoid compounds isolated from its fruits volatile oil **(Masada,**

1976). Also, fennel fruits are widely used in the preparation of various dishes like soups, sauces, pastries, confectioneries, pickles and meat dishes etc. **(Bhati *et al*. 1988)**. The leaf stalks and the tender shoots are also used in salads. Fennel is used in cooking for liqueurs **(Bhati *et al.* 1988)**. The essential oil of fennel is used to flavor different food preparations and in perfumery industries. There is a need to know which cultivar, sowing dates and K fertilizer rate are the most appropriate for a good quality. Therefore, it is important to increase its productivity through adoption of the proper agricultural practices among which is optimized fertilization. Sweet fennel develops an edible bulb, a thickened base of leaves, which is becoming increasingly popular as a specialty vegetable in the United States **(Simon, 1990)**.

Many investigators studied that effect of sowing dates on growth of sweet fennel plants **(Abdallah *et al*., 1978; Yadav *et al*., 2000**; **Sudeep *et al*., 2006**; **Abd El-Wahab *et al*., 2009). Baruah (2004)** on fennel found that fennel seeds should be sown from 15 September to 1 October for higher vegetative growth. Very little information is available on the specific requirements of sweet fennel fertilization in Egypt, especially in newly reclaimed land. So, this investigation carried out on potassium requirements for improving green yield and qualities of sweet fennel bulbs, grown in sandy soil are discussed. Potassium is necessary in young growing tissues for cell elongation and possibly for cell division. Potassium is very mobile in plants and therefore circulates freely and has vital role in maintenance of torpor pressure. It also helps in several physiological processes and uptake of other nutrient elements **(Sadananan *et al*., 2000)**. **Alt *et al*. 1999**; **Sadanandan *et al*., 2002** on fennel and **El-Bassiony, 2006** on onion confirmed that vegetative growth and yield tended to increase with increasing potassium levels. Some studies were conducted for evaluating sweet fennel cultivars (**Fawzy *et al*., 2006; Osman , 2009 and Zaki *et al*., 2009**). To successfully grow sweet fennel in the newly reclaimed soils, many factors have to be considered, such as using the right cultivars, suitable transplanting date, fertilization, compensating for the low amounts of available nutrients and low organic matter content as well as poor hydrophilic, chemical and biological properties. The best means of maintaining soil fertility and productivity could be done through periodic suitable rate of potassium fertilizer.

2. Material and Methods

Two field experiments were carried out on sweet fennel ***(Foeniculum vulgare Mill.*** Family: *Apiaceae*) in an area of newly reclaimed soil at El-Noberia, Beheira, Governorate, Egypt, during the two successive winter seasons of 2007/2008 and 2008/2009. The aim of this work was to study the effect of some agricultural practices such as transplanting dates and different levels of potassium mineral fertilizer on growth, vegetative yield, bulb quality and chemical content of sweet fennel. Soil samples were collected at random before planting from the top layer (0-30 cm depth) for physical and chemical analysis. Soil analysis is presented in Table (1) and was analyzed using the procedures described by **Page *et al*, 1982 and Klute, 1986.** Organic manure (poultry manure) contents of total available N, P and K are presented in Table (2) analyses followed the procedure of **Klute, 1986**. Seeds of sweet fennel were imported from Holland and Germany. Seeds were sown in foam trays filled with a mixture of peat moss and vermiculite (1:1 volume) and grown in nursery on the 1st and 15th of August in 2007 season and 3rd and 18th of September in 2008 season. Seedlings were transplanted in open field at 45 days age.

Table (1): Physical and chemical properties of the experimental soil during the two seasons of 2005/2006 and 2006/2007.

A. Physical properties															
Season			Sand %			Clay %			Silt %			Texture			
1st			58.75			5.56			35.69			Sandy			
2nd			57.72			5.81			36.47			Sandy			
B. Chemical properties															
Season	pH	E.C. (m mosh /cm	OM (%)	$CaCo_3$ (%)	Macro elements (ppm)			Cations (meq./L)				Anions (Meq./L)			
					N	P	K	Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}
1st	7.83	2.24	0.60	19.7	20	65	168	11.00	4.20	4.80	1.39	Nil	1.40	1.80	18.19
2nd	7.78	2.18	0.58	19.6	18	56	161	11.20	3.26	3.82	1.43	Nil	1.42	1.70	16.59

Treatments were as follows:

1) - Transplanting dates: Included two treatments [Early cultivating date (15 September) and late cultivating date (1 October)].

2) - Cultivars: Seeds of seven sweet fennel cultivars (cvs. Dolce, Zefa Fino, Selma, Fino, De Florance and Zwejahrig) were sown in the nursery.

3) - Potassium levels: potassium was applied at four (0, 45, 60 and 75 K_2O units per feddan) using potassium sulphate (48 % K_2O).

The soil of the experiment was carefully prepared. Ditches 20 cm depth and 20 cm width were ditched at drip irrigation lines. Poultry manure was added through these ditches and covered with sand. Drip irrigation was practiced three days before transplanting and continued allover the growth season as requirements in every growth stage. Agricultural practices of growing sweet fennel were followed till harvest time. Potassium fertilizer treatments were added in three equal portions beginning 30 days after transplanting. The area of the experimental plot was 15.0 m^2 consisted of three rows, each row was 5 m length and 1m width and the planting distance was 50 cm apart. Seedlings were transplanted on two sides of each row.

Experimental design: A split-split plot design with four replicates was followed. Transplanting date's treatments were located in the main plots, whereas the cultivars of sweet fennel were assigned in the sub-plots and potassium levels located in the sub- sub plots.

Data recorded: A random sample of five plants was taken from each experimental treatment 90 days after transplanting and the following data were recorded during the two seasons**.**

I) Vegetative growth characters: Plant height (cm); leaf number per plant; bulb dimensions (length, width and thickness); leaves, bulbs and total plant fresh and dry weight (g/plant).

II) Total green yield and Physical bulb quality: All the plants of each plot were harvested at vegetative growth stage and the following data were recorded:

1) - Total green yield (ton/ fed).
2) - Flatten shape ratio = W / T
3) - Cylinder shape ratio = L / (WT) 0.05
4) - Elongated shape ratio = L / W

Where: W, width (cm); T, thickness (cm) and L, length (cm). Flatten shape, cylinder shape and elongated shape ratios were calculated according to **Pascale and Barbieri (1995)** equations.

III) Chemical composition; plant samples of leaves and bulbs were oven at 70 ^{0}C and digested. N, P and K were determined according to **Cottenie *et al*. (1982**).

Statistical analysis:- The data of the experiment was tabulated and subjected to statistical analysis according to **Snedecor and Cochran (1980)**.

3. Result Analysis

I) Vegetative growth characteristics:

A). Effect of transplanting dates: Table (2) shows clearly that sweet fennel vegetative growth expressed as plant height; leaves number /plant and bulb dimensions (thickness, length and width) as well as fresh and dry weight of leaves, bulbs and total plant were statistically influenced by transplanting dates. The highest values of these parameters were obtained with the early transplanting date (15 September) compared with the late date (1 October). These increases were statistically significant and similar in the two seasons. These increases in vegetative growth might be due to the suitable temperature and relative humidity appeared to be reflected on the vegetative growth and consequently yield and quality, since the obtained high yield of those characters was more pronounced in the early date **(Abd El-Wahab and Mehasen, 2009).** Also, this may be due to high temperature at maturity which resulted in forced maturity of the crop **(Sudeep *et al*., 2006). Abou El-Magd and El-Abagy (2003)** reported that the vegetative growth of the early sweet fennel plants was superior expressed as fresh weight of total plant and its organs. Many investigators reported that early sowing increased growth of sweet fennel plants (Abdallah *et al*., 1978; Yadav *et al*., 2000; Baruah (2004; Sudeep *et al*., 2006; Abd El-Wahab and Mehasen, 2009.

Table (2): Effect of transplanting dates on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

Transplanting dates	Plant Length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (g/plant)			Dry weight (g/plant)		
			Thickness (cm)	Width (cm)	Length (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
First season (2005-2006)											
Early	73.39	11.10	7.90	12.15	10.95	509.09	406.52	915.60	59.00	45.64	104.64
Late	67.60	10.29	6.33	11.73	9.84	359.35	323.35	682.70	50.87	35.90	86.77
L.S.D. at 0.05	2.85	0.25	0.45	0.09	0.28	17.88	8.36	12.66	1.95	1.03	1.38
Second season (2006-2007)											
Early	71.88	10.19	6.69	10.95	10.45	478.95	387.54	866.50	54.64	43.05	97.70
Late	65.63	9.31	5.23	10.53	9.37	327.69	304.65	632.34	46.75	34.23	80.98

L.S.D. at 0.05	0.79	0.04	0.39	0.22	0.12	14.70	6.55	9.67	1.43	1.38	2.27

Table (3): Effect of varieties on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

Cultivars	Plant length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (g/plant)			Dry weight (g/plant)		
			Thickness (cm)	Width (cm)	Length (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
First season (2005-2006)											
Dolce	69.67	10.17	6.42	11.19	9.22	429.77	295.92	725.69	55.14	41.26	96.40
Zefa fino	68.96	10.25	6.78	11.20	10.83	396.99	294.74	691.73	49.24	35.20	84.43
Selma	70.17	10.38	7.15	12.11	9.33	440.34	369.60	809.94	54.13	40.92	95.05
Fino	74.67	11.21	7.42	12.26	11.08	442.69	385.82	828.51	57.21	42.68	99.88
De Florance	70.63	10.88	7.38	12.18	10.85	393.76	379.69	773.45	50.08	38.28	88.36
Zwejahrig	68.88	11.29	7.56	12.71	11.10	501.76	463.82	965.59	63.83	46.28	110.11
L.S.D. at 0.05	1.32	0.30	0.20	0.28	0.29	10.90	9.17	15.06	1.86	1.87	2.86
Second season (2006-2007)											
Dolce	68.29	9.13	5.37	5.37	9.99	8.72	400.05	275.84	675.89	50.73	38.51
Zefa fino	67.04	9.50	5.62	10.00	10.33	362.27	278.40	640.68	45.78	33.95	79.72
Selma	68.33	9.42	6.04	10.91	8.83	409.79	349.10	758.89	50.04	38.42	88.47
Fino	72.83	10.21	6.19	11.06	10.58	413.39	365.32	778.71	52.71	40.18	92.88
De Florance	68.63	9.88	6.18	10.98	10.35	363.21	363.35	726.56	45.58	36.20	81.78
Zwejahrig	67.38	10.38	6.36	11.51	10.69	471.21	444.57	915.79	59.33	44.61	103.94
L.S.D. at 0.05	0.62	0.16	0.15	0.18	0.20	7.71	7.65	10.61	1.08	1.10	1.71

B). Effect of cultivars: Data in Table (3) show that cultivars were statistically differed in their vegetative growth. The highest values of vegetative growth expressed as leaves number and bulb dimensions (thickness, width and length) as well as fresh and dry weight of leaves, bulbs and total plant were obtained from cv. Zwejahrig compared with other cultivars. In comparison, the lowest values of plant growth were obtained by cvs. Dulce and Zefa Fino. The tallest plants were obtained by cv. Fino. The above mentioned findings were true in both seasons. Zwejahrig cv. recorded the highest vegetative growth copared with other caltivars.These results might be correlated with the gene action of the tested cultivars (**Fawzy *et al*., 2006).**

C). Effect of potassium levels: Data present in Table (4) reveal that vegetative growth of sweet fennel plants was enhanced by increasing potassium fertilizer levels up to 75 kg K_2O / fed. Moreover, The highest values of vegetative growth expressed as plant height; leaves number and bulb dimensions (thickness, width and length) as well as fresh and dry weight of leaves, bulbs and total plant were obtained from application of potassium at the rate of 75 kg K_2O / fed compared with other potassium treatments in both seasons. These results were in agreement with those obtained by **Alt *et al*. 1999** on fennel and **El-Bassiony, 2006** on onion.

Table (4): Effect of potassium levels on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

K levels	Plant length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (g/plant)			Dry weight (g/plant)		
			T (cm)	W (cm)	L (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
First season (2005-2006)											
0	66.33	9.75	6.10	10.81	9.49	356.52	281.36	637.89	40.27	29.31	69.57
45	70.64	10.58	6.95	11.75	9.99	420.77	339.82	760.59	55.77	39.60	95.37
60	72.47	11.19	7.41	12.51	10.76	467.23	404.77	872.00	61.83	45.68	107.51
75	72.53	11.25	8.01	12.69	11.36	492.35	433.77	926.12	61.88	48.49	110.37
L.S.D.at.05	1.30	0.38	0.28	0.29	0.32	14.64	12.31	19.52	2.47	2.34	3.49
Second season (2006-2007)											
0	63.86	8.83	4.99	9.61	9.04	324.03	260.86	584.89	35.77	27.47	63.24
45	67.61	9.56	5.91	10.55	9.66	390.22	322.10	712.32	51.33	36.26	87.59
60	71.33	10.28	6.47	11.31	10.44	436.68	385.10	821.78	57.89	44.85	102.74
75	72.19	10.33	6.47	11.49	10.51	462.35	416.33	878.68	57.80	45.99	103.79
L.S.D.at.05	0.66	0.25	0.21	0.23	0.23	8.64	8.60	11.91	1.49	1.32	2.10

Where: T= Thickness W= Width L= Length

Potassium is necessary in young growing tissues for cell elongation and possibly for cell division. Potassium is very mobile in plants and therefore circulates freely and has vital role in maintenance of torpor pressure. It also, helps in several physiological processes and uptake of other nutrients. Potassium is known to play a vital role in photosynthesis and carbohydrate formation in fennel. It has also been shown that K plays a key role in the activation of more than 60 enzymes in plants. Contrast to other elements that are involved in the formation of cell structure, K functions in the cell sap. The high mobility of K permits it to move quickly from cell to cell or from older parts to newly developed tissues and storage organs. It has also, a role in stomata respiration, photosynthetic transfer; crop development studies on the removal of various nutrients during harvest of spice crops showed that all the spice remove more amount of K than any other element **(Sadanandan *et al*., 2002).**

D). Effect of interaction

Interaction between transplanting dates and cultivars: The obtained data revealed that the interaction treatments (Table, 5) significantly affected all growth parameters in the two seasons, except bulb width which failed to reach the 5% level of significance in the first season. In general, the highest values of vegetative growth of sweet fennel were obtained by cv. Zwejahrig grown in the early transplanting date. On the contrary, the lowest vegetative growth of sweet fennel was obtained by the combined effect of the late transplanting and cvs. De Florance, Selma, Fino, Dulce and Zefa Fino in a descending order in the two seasons.

Table (5): Effect of the interaction between transplanting dates and cultivars on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

Trans-Planting dates	Cultivars	Plant length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (gm/plant)			Dry weight (gm/plant)		
				T (cm)	W (cm)	L (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
First season (2005-2006)												
Early	Dolce	73.08	10.33	7.20	11.21	9.78	505.12	328.22	833.34	56.04	49.25	105.29
	Zefa fino	69.25	10.58	7.39	11.02	12.05	506.86	303.83	810.69	56.82	35.17	91.99
	Selma	73.83	10.25	8.26	12.09	9.18	503.34	414.70	918.04	56.29	46.30	102.59
	Fino	76.25	11.75	7.81	12.53	11.81	486.54	368.33	854.87	59.18	39.26	98.44
	De Florance	74.42	12.17	7.89	12.78	11.30	484.47	436.01	920.48	58.00	45.61	103.61
	Zwejahrig	73.50	11.50	8.88	13.25	11.61	568.18	588.00	1156.18	67.70	58.22	125.92
Late	Dolce	66.25	10.00	5.63	11.17	8.66	354.41	263.62	618.04	54.25	33.27	87.52
	Zefa fino	68.67	9.92	6.17	11.38	9.61	287.12	285.65	572.77	41.65	35.23	76.87
	Selma	66.50	10.50	6.05	12.13	9.47	377.33	324.50	701.83	51.97	35.55	87.51
	Fino	73.08	10.67	7.03	11.99	10.34	398.85	403.30	802.15	55.23	46.09	101.32
	De Florance	66.83	9.58	6.88	11.57	10.39	303.05	323.36	626.41	42.17	30.95	73.12
	Zwejahrig	64.25	11.08	6.24	12.18	10.60	435.35	339.65	774.99	59.96	34.33	94.29
L.S.D.at.05		3.22	0.73	0.50	N.S.	0.71	26.70	22.46	36.88	4.55	4.58	7.01
Second season (2006-2007)												
Early	Dolce	70.50	9.25	6.06	10.01	9.28	474.57	308.56	783.13	51.54	46.25	97.79
	Zefa fino	69.75	10.08	6.28	9.82	11.55	476.31	291.66	767.97	53.16	34.34	87.49
	Selma	72.17	9.25	6.89	10.89	8.68	472.79	394.20	866.99	51.79	43.80	95.59
	Fino	74.58	10.75	6.55	11.33	11.31	458.49	347.83	806.32	54.68	36.76	91.44
	De Florance	72.58	11.17	6.69	11.58	10.80	453.92	415.51	869.43	53.50	41.44	94.94
	Zwejahrig	71.67	10.67	7.68	12.05	11.11	537.63	567.50	1105.13	63.20	55.72	118.92
Late	Dolce	66.08	9.00	4.68	9.97	8.16	325.53	243.12	568.65	49.92	30.77	80.68
	Zefa fino	64.33	8.92	4.97	10.18	9.11	248.24	265.15	513.38	38.40	33.56	71.96
	Selma	64.50	9.58	5.18	10.93	8.97	346.78	304.00	650.78	48.30	33.05	81.35
	Fino	71.08	9.67	5.83	10.79	9.84	368.30	382.80	751.10	50.73	43.59	94.32
	De Florance	64.67	8.58	5.68	10.37	9.89	272.50	311.20	583.70	37.67	30.95	68.62
	Zwejahrig	63.08	10.08	5.04	10.98	10.27	404.80	321.65	726.44	55.46	33.49	88.96
L.S.D.at.05		1.51	0.40	0.37	0.43	0.48	18.89	18.73	26.00	2.65	2.69	4.19

Where: T= Thickness W= Width L= Length

Interaction between transplanting dates and K levels: Results presented in Table (6) indicated that vegetative growth characters were significantly affected by the interaction between transplanting dates and mineral potassium fertilizer except bulb width in the first season. The highest values of vegetative growth characters expressed as leaves number and bulb thickness as well as fresh and dry weight of leaves, bulbs and total plant were obtained by early transplanting date combined with the high level of potassium fertilizer (75 kg K_2O / fed) compared with other treatments. In contrast, the lowest values of plant growth were obtained by late transplanting date combined with zero level of mineral potassium fertilizer (control). The above mentioned findings were true in both seasons.

Table (6): Effect of the interaction between transplanting dates and K levels on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

Trans-Planting dates	K levels	Plant Length (cm)	Leaves No./ plant	Bulb dimensions T (cm)	W (cm)	L (cm)	Fresh weight (g/plant) Leaves	Bulb	Total	Dry weight (g/plant) Leaves	Bulb	Total
First season (2005-2006)												
Early	0	69.56	10.00	6.72	10.97	10.10	428.82	303.73	732.55	45.08	31.23	76.31
	45	74.56	10.89	7.70	11.96	10.53	497.02	385.60	882.62	58.18	44.22	102.40
	60	74.39	11.61	8.17	12.86	11.22	550.64	461.09	1011.72	67.34	52.33	119.67
	75	75.06	12.06	9.03	12.79	11.99	553.20	475.65	1028.85	65.41	54.77	120.18
Late	0	63.11	9.50	5.49	10.66	8.97	284.23	258.99	543.22	35.45	27.38	62.83
	45	66.72	10.28	6.19	11.54	9.54	344.51	294.04	638.55	53.36	34.98	88.34
	60	70.56	10.78	6.65	12.15	10.21	379.94	348.45	728.39	56.33	39.03	95.36
	75	70.00	10.44	6.99	12.59	10.63	434.28	391.90	826.18	60.02	42.21	102.23
L.S.D.at.05		1.71	0.44	0.32	N.S.	N.S.	17.36	17.41	24.79	3.06	3.31	4.58
Second season (2006-2007)												
Early	0	67.22	9.17	5.52	9.77	9.38	399.93	283.23	683.17	40.58	29.51	70.09
	45	71.33	9.83	6.72	10.76	10.03	466.47	365.10	831.57	53.12	40.05	93.17
	60	73.94	10.72	7.44	11.66	10.97	523.98	440.59	964.56	63.95	50.94	114.89
	75	75.00	11.06	7.08	11.59	11.43	525.42	461.26	986.69	60.91	51.71	112.62
Late	0	60.50	8.50	4.46	9.46	8.71	248.12	238.49	486.62	30.95	25.44	56.39
	45	63.89	9.28	5.11	10.34	9.28	313.96	279.10	593.06	49.53	32.48	82.01
	60	68.72	9.83	5.49	10.95	9.91	349.39	329.62	679.01	51.83	38.75	90.58
	75	69.39	9.61	5.86	11.39	9.59	399.29	371.40	770.68	54.68	40.27	94.95
L.S.D.at.05		0.93	0.36	0.30	N.S.	0.30	12.21	12.16	16.85	2.11	1.87	2.98

Where: T= Thickness W= Width L= Length

Interaction between cultivars and K levels: Data in Table (7) reported that the highest values of most vegetative growth characters were obtained by cv. Zwejahrig combined with the high level of potassium fertilizer (60 and 75 kg K_2O / fed.) compared with other treatments. The lowest values of vegetative growth characters were obtained by cv. Zefa Fion which received zero level of potassium fertilizer. These results were similar in both seasons.

Interaction between transplanting dates, cultivars and K levels: Data in Table (8 and 9) reported that the highest values of most vegetative growth characters were obtained by the interaction between early transplanting date and cv. Zwejahrig combined with the high level of potassium fertilizer (75 kg K_2O / fed.) compared with other treatments. These results were similar in the two seasons.

Table (7): Effect of the interaction between cultivars and K levels on vegetative growth of sweet fennel during 2005/2006 and 2006/2007 seasons.

Cultivars	K levels	Plant Length (cm)	Leaves No./ plant	Bulb dimensions T (cm)	W (cm)	L (cm)	Fresh weight (g/plant) Leaves	Bulb	Total	Dry weight (g/plant) Leaves	Bulb	Total
First season (2005-2006)												

Dolce	0	62.83	9.17	5.48	10.57	8.75	368.84	241.94	610.78	40.10	26.39	66.49
	45	68.83	10.50	6.02	11.17	9.03	433.55	266.32	699.87	55.23	34.12	89.35
	60	72.33	10.67	6.47	11.92	9.28	491.30	345.58	836.87	71.45	52.00	123.45
	75	74.67	10.33	7.70	11.10	9.80	425.39	329.86	755.24	53.80	52.53	106.33
Zefa fino	0	68.33	9.33	6.20	10.67	9.80	337.98	245.88	583.86	34.83	31.40	66.22
	45	72.50	10.33	6.77	11.15	10.07	373.85	274.68	648.53	49.43	37.82	87.25
	60	67.00	10.67	7.05	11.48	10.77	396.50	303.54	700.04	52.75	33.90	86.65
	75	68.00	10.67	7.10	11.48	11.18	467.97	354.84	822.81	59.93	37.67	97.60
Selma	0	66.17	9.50	6.43	10.58	8.70	356.37	267.61	623.97	41.23	26.30	67.53
	45	71.33	10.00	6.77	12.23	9.13	443.22	373.41	816.63	55.74	40.71	96.45
	60	72.83	10.50	7.42	13.35	9.57	488.79	446.50	935.30	63.26	50.65	113.92
	75	70.33	11.50	8.00	12.27	9.90	472.97	390.88	863.85	56.28	46.03	102.31
Fino	0	71.67	10.33	6.48	11.07	9.80	372.91	303.65	676.55	43.33	33.99	77.32
	45	73.83	10.83	7.18	12.30	10.63	424.36	370.11	794.47	57.44	41.36	98.80
	60	78.00	11.50	7.82	12.62	11.68	457.84	413.59	871.42	62.00	42.71	104.71
	75	75.17	12.17	8.18	13.05	12.68	515.67	455.92	971.60	66.06	52.64	118.70
De Florence	0	64.83	9.50	6.17	10.87	9.68	310.21	285.37	595.58	38.42	25.61	64.03
	45	70.67	10.67	7.17	11.28	10.42	361.59	312.14	673.73	53.47	39.22	92.69
	60	73.50	11.17	7.68	12.20	11.27	418.55	360.25	778.80	48.79	33.37	82.16
	75	73.50	12.17	8.52	14.35	12.02	484.67	560.99	1045.66	59.64	54.93	114.57
Zwejahrig	0	64.17	10.67	5.85	11.12	10.47	392.84	343.73	736.57	43.68	32.16	75.84
	45	66.67	11.17	7.78	12.37	10.93	488.04	442.26	930.30	63.31	44.36	107.66
	60	71.17	12.67	8.02	13.47	11.72	538.76	559.15	1097.90	72.75	61.45	134.20
	75	73.50	10.67	8.58	13.90	12.30	595.76	510.16	1105.92	80.58	47.14	127.72
L.S.D.at.05		2.97	0.76	0.56	0.72	0.49	30.07	30.16	42.94	5.30	5.73	7.94
						Second season (2006-2007)						
Dolce	0	61.50	8.17	4.62	9.37	8.45	338.29	221.44	559.73	35.60	24.56	60.16
	45	66.33	9.17	5.05	9.97	8.73	403.00	245.82	648.82	51.06	31.62	82.68
	60	70.83	9.67	6.12	10.72	8.78	460.75	325.08	785.82	66.95	49.50	116.45
	75	74.50	9.50	5.70	9.90	8.90	398.17	311.02	709.19	49.30	48.36	97.66
Zefa fino	0	64.17	8.83	5.00	9.47	9.30	290.76	225.38	516.15	30.33	30.56	60.89
	45	66.33	9.50	5.63	9.95	10.07	343.30	254.18	597.48	48.27	31.99	80.25
	60	68.33	10.00	5.87	10.28	10.77	377.62	283.04	660.66	48.25	34.74	82.99
	75	69.33	9.67	5.98	10.28	11.18	437.42	351.01	788.42	56.27	38.50	94.77
Selma	0	64.17	8.50	5.40	9.38	8.20	325.82	247.11	572.92	36.73	23.80	60.53
	45	68.17	9.00	5.83	11.03	8.63	412.67	352.91	765.58	51.24	38.21	89.45
	60	71.17	9.67	6.35	12.15	9.23	458.24	426.00	884.25	58.76	48.15	106.92
	75	69.83	10.50	6.57	11.07	9.23	442.42	370.38	812.80	53.44	43.53	96.97
Fino	0	69.17	9.33	5.28	9.87	9.30	347.36	283.15	630.50	38.83	31.49	70.32
	45	71.83	9.83	6.33	11.10	9.63	393.81	349.61	743.42	52.94	38.86	91.80
	60	76.33	10.50	6.78	11.42	11.18	427.29	393.09	820.37	57.50	40.21	97.71
	75	74.00	11.17	6.35	11.85	12.18	485.12	435.42	920.55	61.56	50.14	111.70
De Florence	0	62.50	8.50	4.97	9.67	9.18	279.66	264.87	544.53	33.92	23.11	57.03
	45	67.83	9.67	5.97	10.08	10.33	331.04	308.30	639.35	45.64	33.39	79.03
	60	71.67	10.17	6.48	11.00	11.52	388.00	339.75	727.75	47.63	37.53	85.16
	75	72.50	11.17	7.32	13.15	10.35	454.12	540.49	994.61	55.14	50.76	105.90
Zwejahrig	0	61.67	9.67	4.65	9.92	9.83	362.29	323.23	685.52	39.18	31.32	70.51
	45	65.17	10.17	6.65	11.17	10.55	457.49	421.76	879.25	58.81	43.52	102.33
	60	69.67	11.67	7.22	12.27	11.15	508.21	543.65	1051.85	68.25	58.95	127.20
	75	73.00	10.00	6.92	12.70	11.22	556.88	489.66	1046.53	71.08	44.64	115.72
L.S.D.at.05		1.61	0.62	0.52	0.57	0.52	21.16	21.07	29.18	3.65	3.24	5.15

Where: T= Thickness W= Width L= Length

Table (8): Effect of the interaction between transplanting dates, cultivars and K levels on vegetative growth of sweet fennel during the first season of 2005/2006.

Trans-Planting dates	Cultivars	K	Plant Length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (g/plant)			Dry weight (g/plant)		
					T (cm)	W (cm)	L (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
First season (2005-2006)													
Early	Dolce	0	67.00	9.33	6.33	10.47	9.27	418.90	247.37	666.27	32.54	24.85	57.38
		45	71.67	11.00	6.73	11.60	9.43	511.37	297.88	809.24	54.13	38.29	92.42
		60	73.67	10.67	7.07	12.77	9.83	616.00	414.78	1030.78	82.87	64.95	147.82
		75	80.00	10.33	8.67	10.00	10.57	474.21	352.87	827.08	54.62	68.91	123.53
	Zefa fino	0	67.33	9.33	6.60	10.13	10.40	403.02	239.14	642.16	36.70	29.03	65.73
		45	74.67	10.33	7.40	11.03	10.87	499.79	284.21	784.00	60.37	36.26	96.63
		60	67.00	10.67	7.70	11.33	11.70	533.76	313.97	847.73	62.06	30.77	92.84
		75	68.00	12.00	7.87	11.57	12.23	567.53	378.00	945.53	68.16	44.62	112.77
	Selma	0	69.67	9.67	7.47	10.60	9.10	470.15	316.67	786.81	54.49	32.57	87.06
		45	77.00	10.00	7.80	12.93	9.37	491.32	465.47	956.79	54.93	51.39	106.33
		60	78.00	10.33	8.43	13.67	9.53	568.20	509.13	1077.33	62.29	58.22	120.51
		75	70.67	12.00	9.33	11.17	9.87	483.70	367.54	851.24	53.43	43.03	96.46
	Fino	0	74.00	10.67	6.67	11.63	10.53	391.80	250.47	642.27	42.77	25.68	68.46
		45	76.00	11.33	7.57	12.43	11.00	468.31	359.96	828.27	55.13	37.01	92.14
		60	77.33	12.33	8.17	12.73	12.03	523.63	397.47	921.10	72.26	41.55	113.80
		75	77.67	12.67	8.83	13.30	13.67	562.41	465.44	1027.85	66.55	52.81	119.36
	De Florence	0	69.67	10.67	6.50	11.00	10.33	389.17	296.67	685.83	49.83	31.83	81.66
		45	74.67	11.67	7.43	11.43	10.83	471.79	343.80	815.59	64.51	45.50	110.01
		60	76.33	12.00	8.33	12.47	11.70	488.28	378.45	866.73	53.03	41.59	94.62
		75	77.00	14.33	9.30	16.23	12.33	588.63	725.13	1313.77	64.62	63.52	128.14
	Zwe-jahrig	0	69.67	10.33	6.73	11.97	10.97	499.87	472.09	971.96	54.17	43.43	97.60
		45	73.33	11.00	9.27	12.33	11.67	539.57	562.27	1101.83	60.00	56.85	116.85
		60	74.00	13.67	9.30	14.20	12.50	573.95	752.72	1326.67	71.53	76.90	148.44
		75	77.00	11.00	10.20	14.50	13.30	642.68	564.93	1207.61	85.10	55.72	140.81
Late	Dolce	0	58.67	9.00	4.63	10.67	8.23	318.78	236.51	555.29	47.66	27.94	75.60
		45	66.00	10.00	5.30	10.73	8.63	355.73	234.76	590.49	56.33	29.95	86.27
		60	71.00	10.67	5.87	11.07	8.73	366.59	276.37	642.96	60.02	39.05	99.07
		75	69.33	10.33	6.73	12.20	9.03	376.56	306.84	683.41	52.98	36.14	89.12
	Zefa fino	0	69.33	9.33	5.80	11.20	9.20	272.94	252.63	525.56	32.95	33.77	66.72
		45	70.33	10.33	6.13	11.27	9.27	247.91	265.15	513.06	38.49	39.38	77.88
		60	67.00	10.67	6.40	11.63	9.83	259.24	293.12	552.36	43.43	37.04	80.47
		75	68.00	9.33	6.33	11.40	10.13	368.40	331.68	700.08	51.71	30.72	82.43
	Selma	0	62.67	9.33	5.40	10.57	8.30	242.58	218.55	461.13	27.97	20.04	48.01
		45	65.67	10.00	5.73	11.53	8.90	395.12	281.35	676.47	56.54	30.03	86.57
		60	67.67	10.67	6.40	13.03	9.60	409.39	383.87	793.26	64.24	43.08	107.32
		75	70.00	11.00	6.67	13.37	9.93	462.23	414.22	876.45	59.12	49.04	108.15
	Fino	0	69.33	10.00	6.30	10.50	9.07	354.01	356.83	710.84	43.88	42.30	86.18
		45	71.67	10.33	6.80	12.17	10.27	380.40	380.26	760.66	59.75	45.71	105.46
		60	78.67	10.67	7.47	12.50	11.33	392.04	429.70	821.75	51.74	43.88	95.62
		75	72.67	11.67	7.53	12.80	11.70	468.93	446.41	915.34	65.56	52.47	118.03
	De Florence	0	60.00	8.33	5.83	10.73	9.03	231.25	274.08	505.33	27.01	19.38	46.40
		45	66.67	9.67	6.90	11.13	10.00	251.40	280.47	531.87	42.44	32.95	75.38
		60	70.67	10.33	7.03	11.93	10.83	348.83	342.05	690.88	44.56	25.14	69.70
		75	70.00	10.00	7.73	12.47	11.70	380.71	396.85	777.56	54.66	46.34	101.00
	Zwe-jahrig	0	58.67	11.00	4.97	10.27	9.97	285.80	215.37	501.17	33.20	20.88	54.09
		45	60.00	11.33	6.30	12.40	10.20	436.52	322.25	758.77	66.61	31.86	98.48
		60	68.33	11.67	6.73	12.73	10.93	503.56	365.58	869.14	73.96	46.00	119.96
		75	70.00	10.33	6.97	13.30	11.30	548.84	455.38	1004.22	76.07	38.57	114.64
L.S.D.at.05			N.S.	1.08	N.S.	1.02	N.S.	42.53	42.65	60.73	7.50	8.11	11.23

Where: T= Thickness W= Width L= Length

Table (9): Effect of the interaction between transplanting dates, cultivars and K levels on vegetative growth of sweet fennel during the second season of 2006/2007.

Trans-Planting dates	Cultivars	K	Plant Length (cm)	Leaves No./ plant	Bulb dimensions			Fresh weight (g/plant)			Dry weight (g/plant)		
					T (cm)	W (cm)	L (cm)	Leaves	Bulb	Total	Leaves	Bulb	Total
Second season (2006-2007)													
Early	Dolce	0	64.00	8.33	5.13	9.27	8.77	388.35	226.87	615.22	28.04	23.68	51.72
		45	69.00	9.33	5.77	10.40	8.93	480.82	277.38	758.19	49.63	35.79	85.42
		60	71.33	9.67	7.47	11.57	9.33	585.45	394.28	979.73	78.37	62.45	140.82
		75	77.67	9.67	5.87	8.80	10.07	443.66	335.70	779.36	50.12	63.08	113.20
	Zefa fino	0	66.00	9.33	5.40	8.93	9.90	372.47	218.64	591.11	32.20	29.86	62.06
		45	68.67	9.67	6.33	9.83	11.37	469.24	263.71	732.95	59.20	30.42	89.63
		60	71.67	10.33	6.53	10.13	12.20	526.54	293.47	820.01	57.56	34.94	92.50
		75	72.67	11.00	6.83	10.37	12.73	536.98	390.83	927.82	63.66	42.12	105.77
	Selma	0	68.00	8.67	6.27	9.40	7.80	439.60	296.17	735.76	49.99	30.07	80.06
		45	73.33	9.00	6.80	11.73	8.40	460.77	444.97	905.74	50.43	48.89	99.33
		60	76.00	9.33	7.23	12.47	9.43	537.65	488.63	1026.28	57.79	55.72	113.51
		75	71.33	10.00	7.27	9.97	9.10	453.15	347.04	800.19	48.93	40.53	89.46
	Fino	0	71.00	9.67	5.47	10.43	10.03	371.25	229.97	601.22	38.27	23.18	61.46
		45	74.00	10.33	7.07	11.23	10.50	437.76	339.46	777.22	50.63	34.51	85.14
		60	76.00	11.33	7.30	11.53	11.53	493.08	376.97	870.05	67.76	39.05	106.80
		75	77.33	11.67	6.37	12.10	13.17	531.86	444.94	976.80	62.05	50.31	112.36
	De Florence	0	67.33	9.67	5.30	9.80	9.83	358.62	276.17	634.78	45.33	29.33	74.66
		45	71.33	10.67	6.23	10.23	10.33	441.24	323.30	764.54	53.34	36.33	89.67
		60	75.33	11.00	7.13	11.27	11.83	457.73	357.95	815.68	55.19	39.09	94.28
		75	76.33	13.33	8.10	15.03	11.20	558.08	704.63	1262.72	60.12	61.02	121.14
	Zwe-jahrig	0	67.00	9.33	5.53	10.77	9.97	469.32	451.59	920.91	49.67	40.93	90.60
		45	71.67	10.00	8.10	11.13	10.67	509.02	541.77	1050.78	55.50	54.35	109.85
		60	73.33	12.67	9.00	13.00	11.50	543.40	732.22	1275.62	67.03	74.40	141.44
		75	74.67	10.67	8.07	13.30	12.30	628.80	544.43	1173.23	80.60	53.22	133.81
Late	Dolce	0	59.00	8.00	4.10	9.47	8.13	288.23	216.01	504.24	43.16	25.44	68.60
		45	63.67	9.00	4.33	9.53	8.53	325.18	214.26	539.44	52.49	27.45	79.94
		60	70.33	9.67	4.77	9.87	8.23	336.04	255.87	591.91	55.52	36.55	92.07
		75	71.33	9.33	5.53	11.00	7.73	352.68	286.34	639.02	48.48	33.64	82.12
	Zefa fino	0	62.33	8.33	4.60	10.00	8.70	209.05	232.13	441.18	28.45	31.27	59.72
		45	64.00	9.33	4.93	10.07	8.77	217.36	244.65	462.01	37.33	33.55	70.88
		60	65.00	9.67	5.20	10.43	9.33	228.69	272.62	501.31	38.93	34.54	73.47
		75	66.00	8.33	5.13	10.20	9.63	337.85	311.18	649.03	48.88	34.88	83.76
	Selma	0	60.33	8.33	4.53	9.37	8.60	212.03	198.05	410.08	23.47	17.54	41.01
		45	63.00	9.00	4.87	10.33	8.87	364.57	260.85	625.42	52.04	27.53	79.57
		60	66.33	10.00	5.47	11.83	9.03	378.84	363.37	742.21	59.74	40.58	100.32
		75	68.33	11.00	5.87	12.17	9.37	431.68	393.72	825.40	57.95	46.54	104.49
	Fino	0	67.33	9.00	5.10	9.30	8.57	323.46	336.33	659.79	39.38	39.80	79.18
		45	69.67	9.33	5.60	10.97	8.77	349.85	359.76	709.61	55.25	43.21	98.46
		60	76.67	9.67	6.27	11.30	10.83	361.49	409.20	770.70	47.24	41.38	88.62
		75	70.67	10.67	6.33	11.60	11.20	438.38	425.91	864.29	61.06	49.97	111.03
	De Florence	0	57.67	7.33	4.63	9.53	8.53	200.70	253.58	454.28	22.51	16.88	39.40
		45	64.33	8.67	5.70	9.93	10.33	220.85	293.31	514.16	37.94	30.45	68.38
		60	68.00	9.33	5.83	10.73	11.20	318.28	321.55	639.83	40.06	35.97	76.04
		75	68.67	9.00	6.53	11.27	9.50	350.16	376.35	726.51	50.16	40.50	90.66
	Zwe-jahrig	0	56.33	10.00	3.77	9.07	9.70	255.25	194.87	450.12	28.70	21.71	50.42
		45	58.67	10.33	5.20	11.20	10.43	405.97	301.75	707.72	62.11	32.70	94.81
		60	66.00	10.67	5.43	11.53	10.80	473.01	355.08	828.09	69.46	43.50	112.96
		75	71.33	9.33	5.77	12.10	10.13	484.95	434.88	919.84	61.57	36.07	97.64
L.S.D.at.05			2.28	0.88	N.S.	0.81	0.73	29.92	29.80	41.27	5.16	4.58	7.29

Where: T= Thickness W= Width L= Length

II) Total green yield and physical bulb quality:

A). Effect of transplanting dates: Results in Table (10) Show that total green yield and physical bulb quality (Flatten shape and Elongated shape ratios) of sweet fennel plants were influenced significantly by transplanting dates. The highest values of these parameters were obtained with the early transplanting date (15 September) compared with the late date (1 October). These increases were statistically significant and similar in the two seasons. This increase in the total green yield amounted to 3.861 and 3.934 ton/fed which equals 25.14 and 27.02 % in the two seasons, respectively. These increases might be due to the resulting increases in the vegetative growth and N, P and K content of leaves and bulbs as well as dry matter content by the early plantation. These findings were similar and true in both seasons of study. These increases in total green yield and good quality might be due to the suitable temperature and relative humidity appeared to be reflected on the vegetative growth and consequently yield and quality, since the obtained high yield of those characters was more pronounced in the early date **(Abd El-Wahab and Mehasen, 2009).** These results were in agreement with those obtained by **Abdallah *et al*., 1978; Yadav *et al*., 2000**; **Baruah, 2004**; **Sudeep *et al*., 2006** and **Abd El-Wahab *et al*., 2009.**

Table (10): Effect of transplanting dates on total green yield, Physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during the two successive seasons (2005/2006 and 2006/2007).

Trans-planting dates	Total yield (ton /fed.)	Bulb shape			Chemical content					
		Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
					Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs
First season (2005-2006)										
Early	15.354	1.56	1.13	0.91	2.35	1.81	0.29	0.51	2.69	2.97
Late	11.493	1.87	1.15	0.84	2.16	1.51	0.25	0.47	2.49	2.93
L.S.D. at 0.05	0.117	0.03	N.S.	0.02	0.01	0.02	0.00	0.01	0.04	0.03
Second season (2006-2007)										
Early	14.557	1.65	1.24	0.97	2.38	1.86	0.34	0.49	2.71	2.97
Late	10.623	2.04	1.28	0.89	2.19	1.56	0.30	0.45	2.51	2.93
L.S.D. at 0.05	0.162	0.12	N.S.	0.00	0.02	0.02	0.00	0.01	0.04	0.03

B). Effect of cultivars: Data presented in Table (11) show that the differences between cultivars were significant. The highest values of total green yield and good physical bulb quality of sweet fennel plants were obtained from cv. Zwejahrig compared with other cultivars. On the contrary, the lowest values of green yield and quality were obtained by cvs. Dulce and Zefa Fino. The cultivar Zwejahrig resulted in statistical increases in the total green yield amounted to 4.685 and 4.065 ton/fed which equals 28.81 and 25.01 % of the cultivars of Zefa Fino and Dulce in the first and amounted to 4.622 and 4.030 ton/fed which equals 30.04 and 26.19 % in the second seasons, respectively. The above mentioned findings were true in both seasons. The superiority of cv. Zwejahrig might be due to the higher vegetative growth and its high content of N, P and K of bulbs which led to higher photo-synthetic activity and metabolic condensation. These results were completely similar in both seasons.

Table (11): Effect of cultivars on total green yield, Physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during 2005/2006 and 2006/2007.

Cultivars	Total yield (Ton /fed.)	Bulb shape			Chemical content					
		Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
					Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)										
Dolce	12.192	1.80	1.10	0.83	2.37	1.43	0.30	0.42	2.30	2.91
Zefa fino	11.572	1.68	1.20	0.94	2.53	1.54	0.25	0.45	2.45	2.96
Selma	13.607	1.74	1.02	0.78	2.15	1.39	0.30	0.43	2.70	2.76
Fino	13.919	1.67	1.17	0.91	2.09	1.88	0.29	0.56	2.62	2.97
De Florance	12.994	1.66	1.15	0.90	2.52	1.85	0.24	0.51	2.74	3.08
Zwejahrig	16.257	1.74	1.18	0.90	1.88	1.89	0.24	0.57	2.74	3.01
L.S.D. at 0.05	0.223	0.04	0.03	0.03	0.04	0.05	0.01	0.01	0.02	0.03
Second season (2006-2007)										
Dolce	11.355	1.91	1.21	0.88	2.41	1.48	0.35	0.40	2.32	2.91
Zefa fino	10.763	1.81	1.38	1.04	2.56	1.59	0.30	0.43	2.47	2.96
Selma	12.749	1.85	1.11	0.82	2.18	1.44	0.35	0.41	2.72	2.76
Fino	13.082	1.81	1.28	0.96	2.12	1.93	0.34	0.54	2.64	2.97
De Florance	12.206	1.79	1.27	0.96	2.55	1.90	0.29	0.49	2.76	3.08

Zwejahrig	15.385	1.92	1.29	0.94	1.91	1.94	0.29	0.55	2.76	3.01
L.S.D. at 0.05	0.178	0.04	0.03	0.03	0.04	0.05	0.01	0.01	0.02	0.03

C). Effect of potassium fertilizer levels: Data present in Table (12) reveal that total green yield and physical bulb quality of sweet fennel plants was enhanced by increasing potassium fertilizer levels up

to 75 kg K_2O / fed. Linear and gradual increases in total green yield were recorded by the increased levels of potassium fertilizer up to its highest level. Physical quality and N, P and K content followed the same trend of total green yield by the increases in potassium levels.

Table (12): Effect of potassium levels on total green yield, Physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during 2005/2006 and 2006/2007 seasons.

Potassium levels	Total yield (Ton/fed.)	Bulb shape			Chemical content					
		Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
					Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)										
0	10.716	1.80	1.18	0.88	1.87	1.33	0.20	0.36	2.36	2.70
45	12.778	1.73	1.12	0.86	2.28	1.53	0.26	0.49	2.59	2.93
60	14.617	1.71	1.12	0.86	2.44	1.90	0.32	0.60	2.73	3.11
75	15.582	1.61	1.13	0.90	2.44	1.88	0.31	0.50	2.69	3.05
L.S.D. at 0.05	0.295	0.06	0.03	0.03	0.05	0.07	0.01	0.01	0.03	0.04
Second season (2006-2007)										
0	9.826	1.97	1.32	0.95	1.90	1.38	0.25	0.34	2.38	2.70
45	11.967	1.83	1.24	0.92	2.31	1.58	0.31	0.47	2.61	2.93
60	13.806	1.79	1.24	0.93	2.47	1.95	0.37	0.58	2.75	3.11
75	14.762	1.80	1.23	0.93	2.47	1.93	0.36	0.48	2.71	3.05
L.S.D. at 0.05	0.200	0.06	0.05	N.S.	0.05	0.07	0.01	0.01	0.03	0.04

These results were in agreement with those obtained by **Alt *et al*. 1999** on fennel and **El-Bassiony, 2006** on onion. Data in Table (12) show that there were significant differences in flatten, cylinder and elongated shape ratios by using different levels of potassium fertilizer treatments in the two seasons of study. Appling of the high rate of potassium fertilizer (75 kg K_2O / fed.) caused a significant decreases in flatten shape ratio and increases in cylinder and elongated shape ratios of sweet fennel bulbs.

These results indicated that the high level of potassium fertilizer increased the exportable yield of sweet fennel crop. Higher values of flatten and cylinder shape ratios and lower values of elongated shape were recorded by zero potassium level (control). These results were similar in the two seasons. The depression in the flatten shape bulbs means that bulbs tended to be round in shape more than flattening, the decrease in cylinder shape ratio and increase in elongated shape bulbs means increases in the round bulbs, this is considered an improvement in quality of fennel bulbs **(El-Shakry, 2005)**.

D). Effect of interaction:

Interaction between transplanting dates and cultivars: The obtained data revealed that the interaction treatments significantly affected total green yield and bulb quality of sweet fennel is shown in Tables (13). Generally, it could be concluded that, the highest total green yield and good bulb quality of sweet fennel plants were recorded by the combined effect of early transplanting date and Zwejahrig cultivar. On the contrary, lower values of total green yield and bulb quality of sweet fennel were obtained by the combined effect of the late transplanting and cvs. De Florance, Selma, Fino, Dulce and Zefa Fino in a descending order in the two seasons.

Interaction between transplanting dates and K levels: Results presented in Table (14) indicated that total green yield was significantly affected by the interaction between transplanting dates and levels of potassium fertilizer in the two seasons. The highest values of total green yield was obtained by early transplanting date combined with the high level of potassium fertilizer at the rate of 75 kg K_2O / fed compared with other treatments. In contrast, the lowest values of total green yield were obtained by late transplanting date combined with zero level of potassium fertilizer (control). The above mentioned findings were true in both seasons.

Interaction between cultivars and K levels: Data in Table (15) reported that total green yield and physical bulb quality were significantly influenced by the interaction between cultivars and K levels in the two seasons except

bulb cylinder shape ratio did not reach to the level of significance in the first season. The highest values of green yield and bulbs good quality were obtained by cv. Zwejahrig combined with the high level of potassium fertilizer at the rate of 60 and 75 kg K_2O / fed compared with other treatments. These results were nearly similar in both seasons.

Interaction between transplanting dates, cultivars and K levels: Data in Table (16 and 17) demonstrated that, total green yield and physical bulb quality were significantly influenced by the interaction between transplanting dates**,** cultivars and K levels in the two seasons. The highest values of most vegetative growth characters were obtained by the interaction between early transplanting date and cv. Zwejahrig combined with the high level of mineral potassium fertilizer at the rate of 75 kg K_2O / fed compared with other treatments. These results were similar in the two seasons.

Table (13): Effect of the interaction between transplanting dates and potassium levels on total green yield, Physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during 2005/2006 and 2006/2007 seasons.

Trans-planting dates	Cultivars	Total yield (Ton/fed.)	Bulb shape			Chemical content					
			Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
						Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)											
Early	Dolce	14.000	1.58	1.10	0.89	2.46	1.58	0.33	0.45	2.41	2.95
	Zefa fino	13.522	1.50	1.26	1.03	2.63	1.69	0.27	0.47	2.57	2.98
	Selma	15.423	1.48	0.95	0.79	2.24	1.54	0.32	0.45	2.81	2.78
	Fino	14.362	1.62	1.20	0.94	2.19	2.01	0.32	0.58	2.71	2.99
	De Florance	15.464	1.62	1.14	0.90	2.62	1.99	0.26	0.53	2.82	3.10
	Zwejahrig	19.354	1.53	1.13	0.92	1.98	2.04	0.27	0.57	2.85	3.03
Late	Dolce	10.383	2.02	1.11	0.78	2.29	1.28	0.28	0.40	2.20	2.87
	Zefa fino	9.622	1.85	1.15	0.84	2.43	1.39	0.23	0.42	2.34	2.94
	Selma	11.791	2.01	1.08	0.76	2.06	1.24	0.28	0.41	2.59	2.74
	Fino	13.476	1.71	1.15	0.88	1.99	1.75	0.27	0.53	2.53	2.95
	De Florance	10.524	1.69	1.17	0.90	2.42	1.70	0.22	0.48	2.67	3.06
	Zwejahrig	13.160	1.96	1.23	0.88	1.78	1.73	0.22	0.57	2.63	2.99
L.S.D. at 0.05		0.546	0.10	0.08	0.06	N.S.	N.S.	N.S.	0.02	N.S.	N.S.
Second season (2006-2007)											
Early	Dolce	13.157	1.66	1.21	0.94	2.50	1.63	0.38	0.43	2.43	2.95
	Zefa fino	12.902	1.57	1.47	1.18	2.66	1.74	0.32	0.45	2.59	2.98
	Selma	14.566	1.58	1.01	0.81	2.27	1.59	0.37	0.43	2.83	2.78
	Fino	13.546	1.76	1.32	1.00	2.22	2.06	0.37	0.56	2.73	2.99
	De Florance	14.606	1.74	1.25	0.95	2.65	2.04	0.31	0.51	2.84	3.10
	Zwejahrig	18.566	1.62	1.17	0.93	2.01	2.09	0.32	0.55	2.87	3.03
Late	Dolce	9.553	2.16	1.22	0.83	2.32	1.33	0.33	0.38	2.22	2.87
	Zefa fino	8.625	2.05	1.28	0.90	2.46	1.44	0.28	0.40	2.36	2.94
	Selma	10.933	2.12	1.21	0.83	2.09	1.29	0.33	0.39	2.61	2.74
	Fino	12.618	1.86	1.24	0.91	2.02	1.80	0.32	0.51	2.55	2.95
	De Florance	9.806	1.85	1.30	0.96	2.45	1.75	0.27	0.46	2.69	3.06
	Zwejahrig	12.204	2.22	1.41	0.95	1.81	1.78	0.27	0.55	2.65	2.99
L.S.D. at 0.05		0.437	0.10	0.09	0.06	N.S.	N.S.	N.S.	0.02	N.S.	N.S.

Table (14): Effect of interaction between transplanting dates and K levels on total green yield, physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during 2005/2006 and 2006/2007 seasons.

Trans-planting dates	K levels	Total yield (Ton/fed.)	Bulb shape			Chemical content					
			Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
						Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)											
Early	0	12.307	1.65	1.18	0.92	1.97	1.45	0.23	0.38	2.46	2.71
	45	14.828	1.57	1.10	0.89	2.37	1.63	0.29	0.52	2.67	2.97
	60	16.997	1.59	1.10	0.88	2.54	2.12	0.34	0.62	2.84	3.13
	75	17.285	1.42	1.13	0.95	2.54	2.03	0.33	0.52	2.79	3.07
Late	0	9.126	1.96	1.18	0.84	1.77	1.21	0.18	0.35	2.26	2.69
	45	10.728	1.88	1.13	0.83	2.19	1.43	0.23	0.47	2.50	2.89
	60	12.237	1.84	1.14	0.84	2.35	1.68	0.30	0.58	2.62	3.09
	75	13.880	1.81	1.14	0.85	2.34	1.74	0.28	0.48	2.59	3.03
L.S.D. at 0.05		0.417	N.S.	N.S.	N.S.	N.S.	0.10	N.S.	N.S.	N.S.	N.S.
Second season (2006-2007)											
Early	0	11.477	1.79	1.29	0.96	2.00	1.50	0.28	0.36	2.48	2.71

	45	13.970	1.62	1.19	0.94	2.40	1.68	0.34	0.50	2.69	2.97
	60	16.205	1.57	1.19	0.95	2.57	2.17	0.39	0.60	2.86	3.13
	75	16.576	1.64	1.29	1.01	2.57	2.08	0.38	0.50	2.81	3.07
	0	8.175	2.14	1.36	0.93	1.80	1.26	0.23	0.33	2.28	2.69
Late	45	9.963	2.04	1.28	0.90	2.22	1.48	0.28	0.45	2.52	2.89
	60	11.407	2.01	1.28	0.91	2.38	1.73	0.35	0.56	2.64	3.09
	75	12.947	1.97	1.18	0.84	2.37	1.79	0.33	0.46	2.61	3.03
L.S.D. at 0.05		0.283	N.S.	0.07	0.05	N.S.	0.10	N.S.	N.S.	N.S.	N.S.

Table (15): Effect of interaction between cultivars and potassium levels on total green yield, physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during 2005/2006 and 2006/2007 seasons.

Cultivars	K levels	Total yield (Ton/fed.)	Bulb shape			Chemical content					
			Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
						Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)											
	0	10.261	1.98	1.16	0.83	2.06	1.21	0.25	0.37	1.90	2.69
Dolce	45	11.758	1.89	1.11	0.81	2.59	1.28	0.29	0.45	2.32	2.84
	60	14.059	1.85	1.07	0.79	2.64	1.39	0.36	0.54	2.47	3.00
	75	12.688	1.49	1.07	0.91	2.20	1.85	0.32	0.33	2.52	3.11
	0	9.809	1.74	1.21	0.93	2.17	1.19	0.21	0.32	2.39	2.89
Zefa fino	45	10.895	1.67	1.16	0.90	2.47	1.61	0.26	0.49	2.47	2.95
	60	11.761	1.65	1.20	0.94	2.59	1.41	0.27	0.60	2.54	3.16
	75	13.823	1.64	1.24	0.98	2.88	1.94	0.27	0.40	2.41	2.84
	0	10.483	1.69	1.06	0.82	1.67	1.01	0.21	0.31	2.37	2.32
Selma	45	13.719	1.84	1.01	0.75	2.21	1.23	0.28	0.45	2.78	2.91
	60	15.713	1.84	0.98	0.72	2.69	1.84	0.37	0.50	2.92	2.93
	75	14.513	1.61	1.01	0.82	2.05	1.48	0.36	0.48	2.74	2.87
	0	11.366	1.71	1.16	0.89	1.45	1.45	0.22	0.42	2.38	2.52
Fino	45	13.347	1.73	1.13	0.87	2.15	1.51	0.28	0.52	2.58	2.89
	60	14.640	1.62	1.18	0.93	2.34	2.53	0.35	0.72	2.72	3.49
	75	16.323	1.60	1.23	0.97	2.42	2.04	0.32	0.59	2.80	2.97
De Florance	0	10.006	1.77	1.18	0.89	2.10	1.62	0.17	0.29	2.62	2.88
	45	11.319	1.58	1.16	0.92	2.44	1.68	0.26	0.52	2.65	3.03
	60	13.084	1.60	1.17	0.93	2.48	1.90	0.28	0.54	2.86	3.11
	75	17.567	1.68	1.10	0.85	3.08	2.20	0.26	0.68	2.84	3.31
	0	12.374	1.93	1.32	0.95	1.75	1.52	0.17	0.48	2.50	2.91
Zwejahrig	45	15.629	1.65	1.13	0.89	1.82	1.89	0.20	0.55	2.72	2.95
	60	18.445	1.72	1.14	0.87	1.91	2.34	0.30	0.71	2.89	2.99
	75	18.579	1.67	1.14	0.89	2.03	1.80	0.31	0.54	2.84	3.19
L.S.D. at 0.05		0.721	0.15	N.S.	0.07	0.13	0.18	0.03	0.03	0.06	0.09
Second season (2006-2007)											
	0	9.403	2.06	1.29	0.90	2.09	1.26	0.30	0.35	1.92	2.69
Dolce	45	10.900	2.02	1.25	0.88	2.64	1.33	0.34	0.43	2.34	2.84
	60	13.202	1.81	1.11	0.82	2.67	1.44	0.41	0.52	2.49	3.00
	75	11.914	1.76	1.20	0.93	2.23	1.90	0.37	0.31	2.54	3.11
	0	8.671	1.92	1.36	0.99	2.20	1.24	0.26	0.30	2.41	2.89
Zefa fino	45	10.038	1.80	1.34	1.02	2.50	1.66	0.31	0.47	2.49	2.95
	60	11.099	1.78	1.38	1.05	2.62	1.46	0.32	0.58	2.56	3.16
	75	13.246	1.76	1.42	1.09	2.91	1.99	0.32	0.38	2.43	2.84
	0	9.625	1.79	1.18	0.88	1.70	1.06	0.26	0.29	2.39	2.32
Selma	45	12.862	1.93	1.10	0.79	2.24	1.28	0.33	0.43	2.80	2.91
	60	14.855	1.95	1.07	0.77	2.72	1.89	0.42	0.48	2.94	2.93
	75	13.655	1.73	1.09	0.85	2.08	1.53	0.41	0.46	2.76	2.87
	0	10.592	1.87	1.29	0.94	1.48	1.50	0.27	0.40	2.40	2.52
Fino	45	12.489	1.77	1.15	0.87	2.18	1.56	0.33	0.50	2.60	2.89
	60	13.782	1.69	1.27	0.98	2.37	2.58	0.40	0.70	2.74	3.49
	75	15.465	1.89	1.41	1.03	2.45	2.09	0.37	0.57	2.82	2.97
	0	9.148	1.96	1.33	0.95	2.13	1.67	0.22	0.27	2.64	2.88
De Florance	45	10.741	1.69	1.33	1.03	2.47	1.73	0.31	0.50	2.67	3.03
	60	12.226	1.71	1.37	1.05	2.51	1.95	0.33	0.52	2.88	3.11
	75	16.710	1.79	1.06	0.80	3.11	2.25	0.31	0.66	2.86	3.31
	0	11.517	2.20	1.49	1.00	1.78	1.57	0.22	0.46	2.52	2.91
Zwejahrig	45	14.771	1.78	1.26	0.95	1.85	1.94	0.25	0.53	2.74	2.95
	60	17.671	1.79	1.21	0.91	1.94	2.39	0.35	0.69	2.91	2.99
	75	17.582	1.90	1.21	0.88	2.06	1.85	0.36	0.52	2.86	3.19
L.S.D. at 0.05		0.490	0.15	0.12	0.08	0.13	0.18	0.03	0.03	0.06	0.09

Table (16): Effect of the interaction between cultivars, transplanting dates and K levels on total green yield, physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during the first season (2005/2006).

Trans-planting dates	Cultivars	K levels	Total yield (Ton/fed).	Bulb shape			Chemical content					
				Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
							Leaves	Bulbs	Leaves	Leaves	Bulbs	Leaves
First season (2005-2006)												
Early	Dolce	0	11.193	1.65	1.14	0.89	2.16	1.36	0.27	0.40	1.98	2.70
		45	13.595	1.73	1.07	0.81	2.68	1.43	0.31	0.48	2.43	2.98
		60	17.317	1.81	1.04	0.79	2.71	1.54	0.38	0.56	2.58	3.01
		75	13.895	1.15	1.14	1.06	2.30	2.00	0.34	0.35	2.63	3.12
	Zefa fino	0	10.788	1.55	1.28	1.03	2.27	1.14	0.21	0.34	2.50	2.89
		45	13.171	1.50	1.20	0.99	2.57	1.53	0.28	0.51	2.58	2.97
		60	14.242	1.48	1.26	1.03	2.69	1.99	0.29	0.63	2.65	3.19
		75	15.885	1.47	1.29	1.06	2.98	2.09	0.30	0.42	2.54	2.87
	Selma	0	13.218	1.42	1.02	0.86	1.77	1.16	0.23	0.31	2.48	2.34
		45	16.074	1.66	0.93	0.73	2.26	1.38	0.31	0.47	2.89	2.93
		60	18.099	1.62	0.89	0.70	2.79	1.99	0.38	0.52	3.03	2.95
		75	14.301	1.21	0.97	0.89	2.16	1.63	0.38	0.50	2.85	2.89
	Fino	0	10.790	1.75	1.20	0.91	1.55	1.60	0.25	0.44	2.49	2.53
		45	13.915	1.67	1.14	0.89	2.25	1.59	0.30	0.54	2.69	2.91
		60	15.474	1.56	1.18	0.94	2.44	2.68	0.37	0.74	2.83	3.51
		75	17.268	1.51	1.26	1.03	2.52	2.19	0.34	0.61	2.83	2.99
	De Florance	0	11.522	1.70	1.22	0.94	2.20	1.77	0.20	0.31	2.73	2.90
		45	13.702	1.54	1.18	0.95	2.54	1.83	0.28	0.54	2.63	3.05
		60	14.561	1.50	1.15	0.94	2.58	2.05	0.30	0.56	2.97	3.13
		75	22.071	1.75	1.01	0.76	3.18	2.33	0.28	0.70	2.95	3.33
	Zwejahrig	0	16.329	1.80	1.23	0.92	1.85	1.69	0.20	0.45	2.61	2.93
		45	18.511	1.33	1.10	0.95	1.92	2.04	0.22	0.57	2.83	2.97
		60	22.288	1.55	1.10	0.88	2.01	2.49	0.32	0.72	3.00	3.01
		75	20.288	1.42	1.10	0.92	2.13	1.95	0.32	0.53	2.95	3.21
Late	Dolce	0	9.329	2.30	1.17	0.77	1.96	1.06	0.22	0.35	1.83	2.68
		45	9.920	2.05	1.16	0.81	2.51	1.13	0.26	0.43	2.21	2.69
		60	10.802	1.89	1.09	0.79	2.58	1.24	0.33	0.51	2.35	2.99
		75	11.481	1.82	1.01	0.75	2.10	1.70	0.29	0.30	2.41	3.10
	Zefa fino	0	8.829	1.93	1.14	0.82	2.07	1.23	0.20	0.29	2.28	2.89
		45	8.619	1.84	1.12	0.82	2.37	1.69	0.23	0.46	2.36	2.93
		60	9.280	1.82	1.14	0.85	2.49	0.84	0.24	0.58	2.43	3.13
		75	11.761	1.80	1.19	0.89	2.78	1.79	0.25	0.37	2.29	2.81
	Selma	0	7.747	1.96	1.10	0.79	1.57	0.86	0.18	0.30	2.26	2.30
		45	11.365	2.02	1.09	0.77	2.16	1.08	0.26	0.42	2.67	2.89
		60	13.327	2.06	1.06	0.74	2.59	1.69	0.36	0.47	2.81	2.91
		75	14.724	2.01	1.06	0.75	1.93	1.33	0.33	0.45	2.63	2.85
	Fino	0	11.942	1.67	1.11	0.86	1.35	1.30	0.20	0.39	2.27	2.52
		45	12.779	1.79	1.13	0.85	2.05	1.42	0.25	0.49	2.47	2.87
		60	13.805	1.68	1.18	0.91	2.24	2.38	0.32	0.69	2.61	3.47
		75	15.378	1.70	1.19	0.91	2.32	1.89	0.29	0.56	2.77	2.95
	De Florance	0	8.490	1.85	1.15	0.84	2.00	1.47	0.15	0.26	2.51	2.86
		45	8.935	1.61	1.14	0.90	2.34	1.53	0.23	0.49	2.67	3.01
		60	11.607	1.70	1.19	0.91	2.38	1.75	0.25	0.51	2.75	3.09
		75	13.063	1.62	1.20	0.94	2.98	2.06	0.24	0.65	2.73	3.29
	Zwejahrig	0	8.420	2.07	1.40	0.98	1.65	1.35	0.15	0.50	2.39	2.89
		45	12.747	1.97	1.15	0.82	1.72	1.74	0.17	0.52	2.61	2.93
		60	14.601	1.89	1.18	0.86	1.82	2.19	0.27	0.70	2.78	2.97
		75	16.871	1.91	1.18	0.85	1.93	1.65	0.30	0.55	2.73	3.17
L.S.D. at 0.05			1.020	0.21	N.S.	0.10	N.S.	0.25	N.S.	N.S.	N.S.	N.S.

Table (17): Effect of the interaction between cultivars, transplanting dates and K levels on total green yield, Physical bulb quality and chemical content of N, P and K in leaves and bulbs of sweet fennel during the second season (2006/2007).

Trans-planting dates	Cultivars	K levels	Total yield (Ton/fed).	Bulb shape			Chemical content					
				Flatten ratio	Cylinder ratio	Elongated ratio	N (%)		P (%)		K (%)	
							Leaves	Bulbs	Leaves	Bulbs	Leaves	Bulbs
Scond season (2005-2006)												
Early	Dolce	0	10.336	1.81	1.27	0.95	2.19	1.41	0.32	0.38	2.00	2.70

		45	12.738	1.80	1.15	0.86	2.74	1.48	0.36	0.46	2.45	2.98
		60	16.460	1.55	1.00	0.81	2.74	1.59	0.43	0.54	2.60	3.01
		75	13.093	1.50	1.40	1.15	2.33	2.05	0.39	0.33	2.65	3.12
		0	9.931	1.66	1.43	1.11	2.30	1.19	0.26	0.32	2.52	2.89
	Zefa fino	45	12.314	1.55	1.44	1.16	2.60	1.58	0.33	0.49	2.60	2.97
		60	13.776	1.55	1.50	1.21	2.72	2.04	0.34	0.61	2.67	3.19
		75	15.587	1.52	1.51	1.23	3.01	2.14	0.35	0.40	2.56	2.87
		0	12.361	1.50	1.02	0.83	1.80	1.21	0.28	0.29	2.50	2.34
	Selma	45	15.216	1.73	0.95	0.72	2.29	1.43	0.36	0.45	2.91	2.93
		60	17.242	1.72	1.00	0.77	2.82	2.04	0.43	0.50	3.05	2.95
		75	13.443	1.38	1.08	0.92	2.19	1.68	0.43	0.48	2.87	2.89
		0	10.100	1.92	1.34	0.97	1.58	1.65	0.30	0.42	2.51	2.53
	Fino	45	13.057	1.59	1.18	0.94	2.28	1.64	0.35	0.52	2.71	2.91
		60	14.617	1.58	1.26	1.00	2.47	2.73	0.42	0.72	2.85	3.51
		75	16.410	1.94	1.51	1.09	2.55	2.24	0.39	0.59	2.85	2.99
	De Florance	0	10.664	1.86	1.37	1.00	2.23	1.82	0.25	0.29	2.75	2.90
		45	12.844	1.64	1.29	1.01	2.57	1.88	0.33	0.52	2.65	3.05
		60	13.703	1.58	1.32	1.05	2.61	2.10	0.35	0.54	2.99	3.13
		75	21.214	1.86	1.02	0.75	3.21	2.38	0.33	0.68	2.97	3.33
		0	15.471	1.98	1.30	0.93	1.88	1.74	0.25	0.43	2.63	2.93
	Zwejahrig	45	17.653	1.39	1.14	0.97	1.95	2.09	0.27	0.55	2.85	2.97
		60	21.430	1.45	1.07	0.89	2.04	2.54	0.37	0.70	3.02	3.01
		75	19.710	1.65	1.19	0.92	2.16	2.00	0.37	0.51	2.97	3.21
		0	8.471	2.31	1.31	0.86	1.99	1.11	0.27	0.33	1.85	2.68
	Dolce	45	9.063	2.23	1.35	0.90	2.54	1.18	0.31	0.41	2.23	2.69
		60	9.944	2.08	1.21	0.84	2.61	1.29	0.38	0.49	2.37	2.99
		75	10.736	2.01	1.00	0.71	2.13	1.75	0.34	0.28	2.43	3.10
		0	7.412	2.17	1.28	0.87	2.10	1.28	0.25	0.27	2.30	2.89
	Zefa fino	45	7.762	2.04	1.25	0.87	2.40	1.74	0.28	0.44	2.38	2.93
		60	8.422	2.01	1.27	0.89	2.52	0.89	0.29	0.56	2.45	3.13
		75	10.904	1.99	1.33	0.94	2.81	1.84	0.30	0.35	2.31	2.81
		0	6.889	2.07	1.33	0.92	1.60	0.91	0.23	0.28	2.28	2.30
	Selma	45	10.507	2.12	1.25	0.86	2.19	1.13	0.31	0.40	2.69	2.89
		60	12.469	2.18	1.13	0.76	2.62	1.74	0.41	0.45	2.83	2.91
		75	13.867	2.09	1.11	0.77	1.96	1.38	0.38	0.43	2.65	2.85
Late		0	11.084	1.82	1.24	0.92	1.38	1.35	0.25	0.37	2.29	2.52
	Fino	45	11.922	1.96	1.12	0.80	2.08	1.47	0.30	0.47	2.49	2.87
		60	12.948	1.81	1.29	0.96	2.27	2.43	0.37	0.67	2.63	3.47
		75	14.520	1.83	1.31	0.97	2.35	1.94	0.34	0.54	2.79	2.95
		0	7.632	2.07	1.29	0.90	2.03	1.52	0.20	0.24	2.53	2.86
	De Florance	45	8.638	1.74	1.37	1.04	2.37	1.58	0.28	0.47	2.69	3.01
		60	10.749	1.84	1.42	1.04	2.41	1.80	0.30	0.49	2.77	3.09
		75	12.205	1.73	1.11	0.84	3.01	2.11	0.29	0.63	2.75	3.29
		0	7.562	2.41	1.68	1.08	1.68	1.40	0.20	0.48	2.41	2.89
	Zwejahrig	45	11.890	2.17	1.37	0.93	1.75	1.79	0.22	0.50	2.63	2.93
		60	13.912	2.13	1.36	0.94	1.85	2.24	0.32	0.68	2.80	2.97
		75	15.453	2.15	1.23	0.84	1.96	1.70	0.35	0.53	2.75	3.17
L.S.D. at 0.05			0.693	N.S.	0.16	0.11	N.S.	0.25	N.S.	N.S.	N.S.	N.S.

III. Chemical composition

A). Effect of transplanting dates: Data presented in Table (10) demonstrated that, the N, P and K content in tissues of sweet fennel leaves and bulbs were significantly increased by early plantation compared with the late one. Increases in N, P and K content of leaves and bulbs with the late plantation were statistical and similar in the two seasons. These results were in accordance with those reported by **Yadav *et al.*, 2000**; **Sudeep *et al.*, 2006**; **Abd El-Wahab *et al.*, 2009** on fennel.

B). Effect of cultivars: Data presented in Table (11) indicated that cultivation of cv. Zwejahrig (German cultivar) increased N, P and K content in bulbs but decreased N and P content in leaves of sweet fennel plants. On the contrary, the lowest values of N, P and K content in bulbs were obtained with cv. Dulce. These findings were similar and true in both seasons of study. These results were in accordance with those reported by **Fawzy *et al.*, 2006 and Zaki *et al.*, 2009** on sweet fennel cultivars.

C). Effect of potassium fertilizer levels: Data present in Table (12) reveal that N, P and K content in leaves and bulbs of sweet fennel plants were enhanced by increasing potassium fertilizer levels up to 60 kg K_2O / fed. Linear and gradual increases in N, P and K content were recorded by the increased levels of potassium fertilizer up to 60 kg K_2O / fed. These findings were similar and true in both seasons of study. These results were in accordance with those

reported by **Alt *et al*. 1999**; **Sadanandan *et al*., 2002** on fennel and **El-Bassiony, 2006** on onion confirmed that N, P and K content tended to increase with increasing potassium levels. Furthermore, potassium plays a direct or indirect role in plant metabolism (**Kandil, 2002**) on fennel.

D). Effect of interaction:

Interaction between transplanting dates and cultivars: The obtained data revealed that the interaction treatments did not affect N, P and K content in leaves and bulbs except P in leaves of sweet fennel reached to the level of significance (Tables, 13). These results were similar in both seasons.

Interaction between transplanting dates and K levels: Results presented in Table (14) indicated that the interaction between transplanting dates and levels of potassium fertilizer in both seasons did not reach the level of significance for N, P and K content in leaves and bulbs except N content in bulbs was significantly affected by the interaction between sowing dates and K levels. The highest values of N content in bulbs was obtained by early cultivation combined with the high level of potassium fertilizer at the rate of 75 kg K_2O / fed compared with other treatments. In contrast, the lowest values of N content in bulbs were obtained by late cultivation combined with zero level of potassium fertilizer (control). The above mentioned findings were true in both seasons.

Interaction between cultivars and K levels: Data in Table (15) reported that N, P and K content in leaves and bulbs of sweet fennel were significantly influenced by the interaction between cultivars and K levels in the two seasons. The highest values of N, P and K content were obtained by cvs. Fino and Zwejahrig, respectively combined with the high level of potassium fertilizer at the rate of 60 and 75 kg K_2O / fed compared with other treatments. These results were nearly similar in both seasons.

Interaction between transplanting dates, cultivars and K levels: Data in Table (16 and 17) demonstrated that, N, P and K content in leaves and bulbs of sweet fennel did not significantly influenced by the interaction between transplanting dates**,** cultivars and K levels except N content in bulbs was significantly affected by the interaction in the two seasons. The highest values of N content in bulbs were obtained by the interaction between early cultivation for cv. Zwejahrig combined with the high level of mineral potassium fertilizer at the rate of 60 kg K_2O / fed compared with other treatments. These results were similar in the two seasons.

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