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ORIGINAL ARTICLES

Foliar Nutrition Of Two Sweet Fennel Cultivars Affect Their Vegetative Growth, Green Yield And Bulb Quality

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ABSTRACT

Field experiments were conducted in the Horticultural research station at Kassasein area, Ismaelia Governorate, Egypt in 2003 and 2004 winter seasons. Five foliar nutrition treatments were applied on two sweet fennel cultivars. The aim of this work was to investigate their effect on the vegetative growth , green yield and bulb quality. Results indicated that Zefa fino cv., was superior in its vegetative growth, green yield and bulb quality expressed as width, thickness and length as well as flatten, cylinder and elongated shape ratios compared with Dulce cv.,. Foliar nutrition enhanced vegetative growth , green yield and quality. The higher concentration of both K_2O and stimiful recorded higher vegetative growth, green yield and bulb quality. Flatten shape ratio, cylinder shape ratio and elongated shape ratio were influenced by cultivars, foliar nutrition and their interaction in the same pattern of vegetative growth and green yield.

Key words: Foliar nutrition,sweet fennel, cultivars, bulb quality and yield

Introduction

Sweet fennel is an annual, biennial or perennial crop depending on variety (Farrell, 1988 and Wichtl and Bisset, 1994).

It is native to North Africa, Mediterranean area, southern Europe and Asia (Abd El-Wahab and Mehasen, 2009). It is cultivated as aromatic or vegetable crop. It contains phytochemical hormones (*Saponins*), Flavonaids, lipids, proteins and essential oils. Medicinal and aromatic plants are important economic product which represent significant sources of economic revenue and foreign exchange and are among the most important agricultural export products (Watt and Breger, 1962). Sweet fennel for human purposes (Hussein and Abou El-Magd, 1991 and Abou El-Magd and Hussein 1992) also is grown as a salad and Fodder crop. It is suitable for human consumption as a salad crop or cooking purposes in many countries of North Africa and Mediterranean area (Tonisia, Lybia, Algerie, Morocco, Spain and Italy). Also sweet fennel fruits are widely used in the preparation of various dished like soup, sauces, pastries, confectioneries, pickles and Meat dishes etc. (Bhati *et al*., 1988). The leaf stalks and the tender shoots are also used in salads. Sweet fennel is used in cooking for liqueurs (Bhati *et al*., 1988). There is a need to know which cultivar, fertilization methods and levels 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 specially vegetable in the united states (Simon, 1990). Sweet fennel varieties were studied by many workers (Abou El-Magd *et al*., 2005 ; Fawzy *et al*., 2006 and Abou El-Magd *et al*., 2010). Fawzy *et al*., 2006 evaluated six varieties of sweet fennel crop (Dulce, Zefa fino, Fino, De Florence, Zweijahrig and Selma). They found that Zefa fino and De Florence recorded higher vegetative growth and green yield. Koudela and Petrikova (2008) evaluated three sweet fennel cultivars (precocedi Bologna, Rudy F1 and Zefa fino). Nutritional value ranged in the following intervals. Vitamin c 87-347 mg/kg, k 4.241- 5.851 mg / kg, Na77-512 mg/ kg, ca 56-363 mg/ kg Mg 82-389 mg/kg, dietary fiber 5.75 -7.59 g/kg, weight of bulb 199-383 g. They found significant influence of cultivar on k content. They reported also that Zefa fino showed significantly higher average yield in summer terms and Rudy F1 in autumn terms. Abou El-Magd *et al*., 2010 evaluated six sweet fennel cultivars (cvs. Dulce, Zefa fino, Selma, Fino, De Florence and Zwejahrig). They found that these cultivars differed statistically in their vegetative growth, bulb dimensions and total green yield. They added that zwejahrig cultivar was superior in its vegetative growth expressed as fresh weight of leaves bulbs and total plant and its organs, bulb dimensions (thickness, width and length) and total green yield compared with other cultivars.

Foliar Nutrition of sweet fennel plants was also an interesting subject of study for many workers, (Koudela and Petrikova, 2008 ; Abou El-Magd *et al*., 2010 ; Khalid, 2012 and Majeed 2013).

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Khan *et al*., (1999) found that soil and foliar nutrition levels of N and P affected the essential oil constituents of fennel. Abou El-Magd *et al*., 2010 reported that sweet fennel plants receiving 75 kg k2o / fed showed higher values of vegetative growth, fresh and dry weight of total plant and its organs, N, P and K content as well as Total green yield and bulb quality compared with the lower levels. Khalid (2012) found that the highest level of N, P + Foliar trace elements increased positively vegetative growth of anise, coriander and sweet fennel. In addition, essential oil, fixed oil, total carbohydrates, soluble sugars, crude protein and N, P and K contents were increased by increasing N, P level foliar nutrition of trace elements. Majeed (2013) fount that foliar nutrition of dill plants increased plant height, stem diameter , shoot dry weight and number of leaves. He added that all rates of foliar fertilizer caused significant increase in cortex thickness, number and thickness of vascular bundles and vascular units diameter.

The aim the present study was to investigate the effect of foliar nutrition on the vegetative growth, green yield and bulb quality of two sweet fennel cultivars.

Materials And Methods

Experiments were carried out on some sweet fennel (Foeniculum Vulgare Mill) cultivars at El Kassaseen Horticultural station, Ismailia Governorate, Egypt in the winter seasons of 2003 and 2004. The soil of the experiment was sandy in texture. Chemical and physical analysis are shown in Table (1). The soil of the experiment was carefully prepared. Ditches of 20 cm width and depth were prepared in the locations of irrigation lines. Organic manure mixed with superphosphate fertilizer were spread in the ditches and covered by sand. Drip irrigation lines were elongated over the ditches. Irrigation took place three days before transplanting. Irrigation lines were 75cm apart and drippers were 50cm apart in this system.

Table 1: Physical properties and chemical analysis of the experiment soil.

Physical properties							
Sand %	Clay %	Silt %	Texture		F.C. %	W.P.%	Bulk density g/cm^3
87.96	11.38	0.66	Sandy		16.77	5.65	1.44
Chemical analysis							
E.C.	pH	Meq./L					
m/moh		Ca	Mg^{++}	Na^{+}	K^{+}	HCO_3^{-}	Cl^{-}
9.1	8.4	26.00	3.00	62.00	2.79	2.1	26.00

Healthy seedlings of 60 days age were transplanted in the first week of November, two besides every dripper. Drip irrigation was adapted half an hour tow times daily, in the morning and afternoon.

Irrigation time was increased as plant growth increased till harvest time. Nitrogenous Fertilizer (150kg amm. Sulphate per Feddan) was added at two equal portions 30 and 60 days after transplanting.

Treatments of the experiment were as follows:

A- Cultivars: two cvs. Dulce and Zefa fino.

B- Foliar nutrition treatments:

-Control (without any nutrient).

- Low potassium level (k2o solution 38% 1 Cm /liter).
- High potassium level (k_2o solution 38% 2 Cm /liter).
- Low stimiful level (1 Gm /liter).
- High stimiful level (2 Gm /liter).

Stimiful chemical content cleared in Table (2). Foliar nutrition was applied at 60 days after transplanting. Split-plot design was followed in this experiment in which cultivars were arranged in the main plots and foliar nutrition treatments were arranged at random in the sub-plots. Plot area was 50.6m^2 in which three lines 25 m length and 75 cm width.

Table 2: Chemical content of stimiful fertilizer

Macro nutrients	Micro nutrients	Chelate compound
Nitrogen 25%	Boron 0.044%	EDTA
	Ferrous 0.170%	
Phosphorus 16%	Molybdenum 0.001%	
	Zinc 0.03%	
Potassium 12%	Cupper 0.085%	
	Cobalt 0.010%	
Amino acids 2%	Magnesium 0.02%	
	Manganese 0.085%	

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Results And Discussion

A. Vegetative growth:

1. Effect of cultivars:

Data in table (3) indicated that cv. Zefa fino recorded higher values of vegetative growth expressed as plant height, leaves number and fresh weight of leaves, bulbs and total plant in the two seasons of the experiment.

Differences between the two cultivars in their vegetative growth characteristics did not reach the level of significance in the first season. On the contrary, data of the second season reflected significant differences between the two cultivars in their vegetative growth characteristics. Zefa fino cv. Recorded higher and significant increases in plant height, leaves number and fresh weight of bulb and total plant compared with cv. Dulce. It could be concluded from the data that cv. Zefa fino exceeded cv. Dulce in their vegetative growth. Fawzy *et al*., 2006 compared some sweet fennel cvs. and came to similar results. They reported that cv. Zefa fino and De Florence recorded higher plant growth expressed as plant height and leaves number as well as fresh weight of leaves, bulbs and total plant compared with Zefa Fino and zweijahrig cvs.

In addition, AbouEl-Magd *et al*., 2010 compared six sweet fennel cvs. (Dulce, Zefa Fino, Selma, Fino, De Florence and Zwejahrig). They reported that the tested cvs. differed statistically in their vegetative growth. The highest values of vegetative growth, i.e. taller plants with denser leaves and higher values of fresh and dry weight of leaves, bulbs and total plant were recorded by cv. zwejahrig.

2-Effect of foliar nutrition:

Data in table (5) indicated that foliar nutrition of sweet fennel increased its vegetative growth expressed as plant height and leaves number as well as fresh weight of leaves, bulbs and total plant. Differences between foliar nutrition treatments in plant height, leaves number and fresh weight of bulb and total plant failed to reach the level of significance in the first season. On other hand, bulb fresh weight of the high concentration of potassium or stimifall recorded higher and significant values of bulb fresh weight. In the second season, differences between foliar application treatments were significant in all the vegetative growth parameters expressed as plant height, leaves number as well as fresh weight of total plant ant its organs (bulbs and leaves). Increases in vegetative growth of sweet fennel plants were significant by the increase in the concentration of the two tested nutrients.

The highest values of plant height, leaves number and fresh weight of total plant and its organs were recorded by the higher concentrations of potassium and stimiful. In addition, there were no clear differences between the different treatments of potassium and stimiful. El- Bassiony *et al*., 2006 came to similar results by the foliar application of some micro-nutrients. Their results cleared that vegetative growth of sweet pepper expressed as plant height, leaves number and branch numbers as well as fresh and dry weight of leaves were better by foliar nutrition. In addition, Fawzy *et al*., 2007 reported that foliar application of potassium recorded better vegetative growth of eggplants compared with soil application. Khalid (2012) reported that plant height, leaves number, fresh and dry weight in anise, coriander, and sweet fennel plants were significantly affected by changes in NP+Foliar trace elements treatments. Thus the various growth characters in general increased under the various NP fertilization levels + foliar trace elements compared with NP fertilization treatments. Highest values of plant growth characters were obtained with the high level of NP+ Foliar trace elements treatment. NP and foliar elements affected in plant morphology. Kandil, (2002) reported that chemical fertilization of NP and K (amm nitrate, calcium superphosphate and potassium sulphate) gave higher fennel growth parameters than did fertilization with the natural sources of N,P and K. AbouEl-Magd *et al*., (2006) with respect to potassium fertilizer rates, results reveal that sweet fennel plants treated with the higher potassium rate showed higher vegetative growth parameters i.e., plant length, leaves number as well as fresh and dry weight of leaves, bulbs and total plant and macro nutrients content (N, P and K) in tissues of sweet fennel leaves and bulbs than the lower rates of potassium. Majeed (2013) found that the foliar fertilizer oligo green HF increased vegetative growth of dill plants expressed as plant height, stem diameter, leaves number and dry weight. He added that cortex thickens and vascular bundles number and thickness were increased. The positive effect of foliar fertilizer on plant height and growth in general may be due to the role of micronutrients in the fertilizer. It is known that iron has a direct role in increasing chlorophyll content and synthesis of cytochrome and serotoxin (Focus, 2003). In addition, Du Four and Guein (2005) mentored that the positive effect of micro nutrients on leaves number may be due to their stimulatory effects on carbohydrates synthesis and hormonal regulations. The increase in dry weight may be the result of the stimulation of carbohydrates metabolism and then an increase in the accommodation of dry matter. In addition, the increase in vegetative growth due to the fertilizer would increase photosynthesis rate and in turn the accumulation of carbohydrates and as a result the dry matter. Increases in the vegetative growth by foliar fertilization might also be due to the increase in cortex thickness as well as number

and thickness of vascular bundles (Majeed 2013). It could be concluded that the increase in vegetative growth resulting by foliar nutrition might be referred to its effect on increasing number and thickness of vascular bundles, cortex thickness, vegetative growth, photosynthesis, carbohydrates synthesis and dry matter accumulation.

3- Effect of interaction:

Interaction of cultivars and foliar nutrition affected vegetative growth of sweet fennel. Interaction treatments led to insignificant results on the vegetative growth in the first season. On the other hand, significant results were recorded in the second season. Plant height, leaves number as well as fresh weight of total plant and its organs, recorded higher values by the interaction between cultivars and foliar application treatments. Higher values of vegetative growth of sweet fennel plants were obtained by the combined effect of any of the tested cultivars and the higher concentrations of potassium or stimiful. These results were true and significant in the second season only.

It is concluded from tables, (3,5 and 7) that cultivars, foliar nutrition treatments and their interaction influenced sweet fennel growth expressed as plant height, leaves number as well as fresh weight of total plant and its organs (leaves and bulbs). Results did not reach the level of significance in the first season. In the second season, results of vegetative growth of cultivars, foliar nutrition treatments and their interaction were significant.

B. Total green yield:

1- Effect of cultivars:

Data in table (3) indicated that total green yield of sweet fennel was influenced by cultivars. Zefa fino cultivar outyielded Dulce cv. in the two seasons of the experiment. Increases due to Zefa fino did not reach the level of significance in the first season.

In the second season, differences between cultivars were statistically significant. Increases in total green yield due to Zefa fino were 0.48 and 1.846 tons per feddan compared with dulce in the successive seasons. These increases represented 6.1 and 15.8 % in the first and second seasons, respectively. These results were the reflection of the response of vegetative growth to cultivars. Results of total green yield were parallel to those of vegetative growth. It is obvious that the increases in Zefa fino green yield were the reflection of the increases in the vegetative growth compared with variety Dulce. Fawzy *et al*., (2006) evaluated six cultivars of sweet fennel. They reported that the highest green yield was produced by De Florence cv. and the lowest by zweijahrig cv. other cultivars ranged between the two cultivars. AbouEl-Magd *et al*., (2006) evaluated six cultivars of sweet fennel. They reported that the highest green yield was produced by De Florence cv. and the lowest by zweijahrig cv. Other cultivars ranged between the two cultivars. AbouEl-Magd *et al*., (2010) reported that the highest values of total green yield were obtained from cv. zweijahrig compared with other cultivars and the lowest by dulce and Zefa fino.

2- Effect of foliar nutrition:

Total green yield of sweet fennel crop was statistically influenced by foliar application of potassium solution and stimiful (Table 5). Higher green yield of sweet fennel was obtained by foliar application of potassium solution and stimiful compared with the control. Increases in total green yield amounted to 2.03, 5.43, 3.83 and 4.94 as well as 9.82, 12.89, 10.89 and 12.03 tonns per feddan in the first and second seasons, respectively due to foliar application of low k_2o, high k_2o, low stimiful and high stimiful, respectively. These values amounted to 20.1, 40.2, 32.2 and 38.0 as well as 51.1, 57.8 , 53.4 and 56.1 % for the same respective treatments in the two seasons.

Results of total green yield were parallel with those of vegeatative growth. It could be concluded that the increases in the total green yield were due to the increases in vegetative growth and fresh weight of total plant and its organs, i.e. leaves and bulbs. Increases in total green yield due to foliar application of potassium solution or stimiful compared with the control were significant in the two seasons of the experiment. The highest values of total green yield were obtained by foliar application of the high concentration of each of potassium or stimiful. Lower values of total green yield were obtained by the low concentration of potassium and stimiful. These increases in total green yield of sweet fennel due to foliar application of potassium or stimiful were true and significant in the two seasons.

These increases in the total green yield are in agreement with those obtained by Khalid (2012) ; Abou El-Magd *et al*., (2010) and Majeed (2013). Potassium is known to play a great role in photosynthesis and carbohydrates formation in sweet fennel. It has been also shown that k plays a key role in the activation of more

than 60 enzymes in plant. It has also a role in stomata regulations, respiration, photosynthetic activity and carbohydrates transfer. In addition, the increase in total green yield was also due to micronutrients which enhanced vegetative growth, N,P and K content of the plant tissues as well as higher carbohydrates accumulation and dry matter(AbouEl-Magd *et al*., 2010). Majeed (2003) added that foliar application of macro and micronutrients enhanced vegetative growth, carbohydrates and dry matter content. The increase in total green yield due to foliar nutrition was the result of the increase in the vegetative growth, N.P and K content, photosynthesis rate, carbohydrates and dry matter accumulation.

Effect of interaction:

Interaction of sweet fennel cultivars and foliar nutrition treatments statistically affected total green yield of sweet fennel crop (Table 7). The highest values of total green yield were obtained by the interaction of both Zefa fino and Dulce cvs. with the high concentration of each potassium or stimiful.

The interaction between cultivars and the low concentrations of each potassium and stimiful affected total green yield of sweet fennel. The lowest values of total green yield were obtained by both cultivars combined with the control. The highest green yield was recorded by the combined effect of any of Zefa fino or Dulce cv. with the high concentration of potassium or stimiful. Lower values of green yield were obtained by the interaction of Zefa fino and the lower level of potassium or stimiful. The lowest values of green yield were obtained by cv. Dulce and the control treatment. AbouEl-Magd *et al*., (2010) reported that total green yield of sweet fennel was significantly increased by the combined effect of cultivars and K levels in the two seasons.

Bulb quality:

Effect of cultivars:

Bulb dimensions were differed among the different cultivars of sweet fennel. Width, thickness and length of sweet fennel bulbs varied by cultivars (table 4). Differences between cultivars did not reach the level of significance. Width, thickness and length of Zefa fino bulbs exceeded those of variety dulce. Flatten shape ratio of Dulce bulbs was higher in the two seasons, compared with those of Zefa fino cv.

There were contradictions in the values of cylinder shape ratio and elongated shape ratio between the two seasons of the experiment. It could be concluded that cylinder shape ratio and elongated shape ratio did not differ between Dulce and Zefa fino cvs. Fawzy *et al*., 2006 reported that cultivars differed in their bulb quality. In comparison of six varieties i.e. Dulce, Zefa fino, fino, De Florence, zweijahrig and selma they found that De Florence cv. gave the highest values of bulb dimentions (width, thickness and length). They added that the lowest values of flatten, cylindrical and elongated shape were obtained by De Florence and the highest by zweijahrig. On the other hand, AbouEl-Magd *et al*., (2010) fount that zweijahrig cultivar recorded the highest values of bulb quality (thickness, width and length as well as flatten, cylindrical and elongated shape ratios as compared with Dulce and Zefa fino.

Effect of foliar nutrition:

Bulb dimentions of sweet fennel expressed as width, thickness and length were affected by foliar nutrition treatments (Table 6). The lowest values of bulb dimentions were recorded by the control. Foliar application of potassium or stimiful increased bulb dimentions expressed as width, thickness and length. These increases were significant in the second season. Nevertheless, differences in bulb thickness and length did not reach the level of significance in the first season. The highest values of bulb width, thickness and length were recorded by the high concentrations of potassium or stimiful.

Flatten shape ratio of sweet fennel bulbs tended to decrease but, cylinder shape ratio tended to increase by foliar application of potassium and stimiful. Elongated shape ratio was increased by foliar nutrition. These increases were higher by the increase in foliar nutrient concentration. These results were nearly similar in the two seasons of the experiment.

3-Effect of interaction:

Bulb dimentions expressed as width, thickness and length of sweet fennel bulbs was affected by the interaction of cultivars and foliar nutrition treatments (Table 8). Bulb dimensions were increased by the combined effect of cultivars and foliar nutrition. Results did not reach the level of significance in the first season by the interaction of Zefa fino and the higher concentrations of foliar nutrients compared with the other interaction treatments. Results of thickness and length were similar to bulb width in their response to interaction.

Higher values of bulb thickness and length were recorded by the interaction of Zefa fino and the high concentrations of foliar nutrients.

Flatten shape ratio seemed to decrease by the interaction of cultivars and foliar nutrition compared with the control.

It is clear that the values of flatten shape ratio fluctuated without clear trend by interaction in the two seasons. Cylinder shape ratio tended to increase by the interaction of varieties and foliar nutrition. The combined effect of cultivars and nutrients concentrations tended to increase cylinder shape ratio. These increases were higher by the combined effect of Zefa fino and the high concentrations of foliar nutrition. Elongated shape ratio tended to increase by the interaction treatments. These increases fluctuated by the increase in the foliar nutrition concentrations. These results were similar in the two seasons of the experiment.

Table 3: Effect of cultivars on vegetative growth and green yield of sweet fennel (2003-2004 and 2004-2005).

cultivars	Plant Height (cm)	Leaves No.	Fresh weight (g)			Total yield (ton /fed.)	Increase	
			Bulb	Leaves	Total/plant		(ton /fed.)	(%)
2003-2004								
Dulce	59.02	10.37	201.68	154.95	356.63	7.930	---	---
Zefa fino	63.60	9.57	194.85	183.43	378.28	8.410	0.48	6.10
L.S.D. at 0.05	NS	NS	NS	NS	NS	NS	---	---
2004-2005								
Dulce	63.30	9.53	261.71	265.50	527.51	11.730	---	---
Zefa fino	67.14	10.07	358.38	252.16	610.54	13.576	1.846	15.70
L.S.D. at 0.05	1.89	0.53	21.42	NS	34.72	1.224	---	---

Table 4: Effect of cultivars on bulb quality of sweet fennel (2003-2004 and 2004-2005).

Cultivars	Bulb (cm)			Flatten shape Ratio	Cylinder shape Ratio	Elongated shape Ratio
	Width (W)	Thickness (T)	Length (L)			
2003-2004						
Dulce	3.96	8.24	11.89	2.07	7.70	1.48
Zefa fino	4.43	8.77	11.44	2.00	9.53	1.32
L.S.D. at 0.05	NS	NS	NS	NS	NS	NS
2004-2005						
Dulce	8.49	5.18	9.15	1.68	7.58	1.08
Zefa fino	7.90	5.34	8.67	1.55	7.19	1.10
L.S.D. at 0.05	NS	NS	NS	NS	NS	NS

Table 5: Effect of foliar nutrition on vegetative growth and green yield of sweet fennel (2003-2004 and 2004-2005).

Foliar Fertilizer	Plant Height (cm)	Leaves No.	Fresh weight (g)			Total green yield (ton /fed.)	Increase	
			Bulb	Leaves	Total/plant		(ton /fed.)	(%)
2003-2004								
Control	61.58	10.13	142.49	118.30	260.79	8.07	---	---
Low k2o	57.60	9.67	165.75	173.59	339.34	10.10	2.03	20.1
High k2o	62.31	9.75	234.75	205.51	440.26	13.50	5.43	40.2
Low stimiful	64.02	9.92	215.81	163.18	378.99	11.90	3.83	32.2
High stimiful	61.06	10.38	232.53	185.39	417.92	13.01	4.94	38.0
L.S.D. at 0.05	NS	NS	7.36	NS	NS	1.08	---	---
2004-2005								
Control	47.55	7.67	155.00	132.29	287.29	9.40	---	---
Low k2o	67.37	9.17	323.01	267.53	590.53	19.22	9.82	51.1
High k2o	72.60	9.83	365.46	314.72	680.19	22.29	12.89	57.8
Low stimiful	70.13	11.00	352.93	278.07	631.00	20.36	10.89	53.4
High stimiful	70.98	11.33	353.85	301.53	655.38	21.43	12.03	56.1
L.S.D. at 0.05	2.99	0.83	33.86	33.49	67.35	1.89	---	---

Table 6: Effect of foliar nutrition on bulb quality of sweet fennel (2003-2004 and 2004-2005).

Foliar Fertilizer	Bulb (cm)			Flatten shape Ratio	Cylinder shape Ratio	Elongated shape Ratio
	Width (W)	Thickness (T)	Lingth (L)			
2003-2004						
Control	4.10	7.89	10.80	1.95	8.93	1.37
Low k2o	4.26	7.66	11.92	1.79	10.01	1.63
High k2o	3.87	9.49	12.30	2.14	10.21	1.30
Low stimiful	8.58	9.38	11.59	2.19	9.66	1.26
High stimiful	8.31	8.10	11.70	1.82	9.84	1.45
L.S.D. at 0.05	NS	0.55	NS	NS	NS	NS
2004-2005						
Control	6.97	3.38	6.95	2.06	5.94	1.00
Low k2o	8.32	5.05	9.00	1.66	7.42	1.08
High k2o	8.43	5.43	8.78	1.55	7.26	1.04
Low stimiful	8.02	5.83	10.07	1.41	8.33	1.27
High stimiful	9.27	6.60	9.75	1.41	7.99	1.06
L.S.D. at 0.05	0.37	0.71	0.79	NS	NS	NS

Table 7: Effect of interaction of cultivars and foliar nutrition on vegetative growth and green yield of sweet fennel (2003-2004 and 2004-2005).

Varities	Folair nutrition	Plant Height (cm)	Leaves No.	Fresh weight (g)			Total green yield (ton /fed.)	Increase	
				Bulb	Leaves	Total/plant		(ton /fed.)	(%)
2003-2004									
Dulce	Control	63.48	11.00	134.99	108.50	243.48	7.57	--	---
	Low k2o	52.22	9.33	153.14	133.56	286.70	8.80	1.23	14.0
	High k2o	.62.13	11.00	268.57	191.00	459.57	14.56	6.89	47.3
	Low stimiful	.64.78	11.00	219.41	155.68	375.09	11.89	4.32	36.3
	High stimiful	52.50	9.50	232.29	186.02	418.31	13.01	5.44	41.8
Zefa fino	Control	59.67	9.25	149.99	128.10	278.10	8.56	---	----
	Low k2o	62.97	10.00	178.35	213.62	391.98	11.41	2.85	25.0
	High k2o	62.48	8.50	200.92	220.01	420.94	12.44	3.88	31.2
	Low stimiful	63.25	8.83	212.20	170.67	382.87	11.90	3.34	28.1
	High stimiful	69.62	11.25	232.77	184.75	417.52	13.01	4.45	34.2
L.S.D. at 0.05		NS	NS	10.41	NS	NS	1.53	---	---
2004-2005									
Dulce	Control	43.10	7.67	97.99	110.12	208.11	7.13	---	---
	Low k2o	64.07	9.67	291.26	285.66	576.92	19.32	12.19	63.1
	High k2o	72.13	10.33	308.57	342.08	650.65	22.24	15.11	67.9
	Low stimiful	72.63	10.00	268.79	285.63	554.43	18.82	11.69	62.1
	High stimiful	64.57	10.00	341.96	304.00	645.96	21.28	14.15	66.5
Zefa fino	Control	52.00	7.67	212.01	154.45	366.46	11.67	---	---
	Low k2o	70.67	8.67	354.75	249.40	604.14	19.12	7.45	39.0
	High k2o	73.07	9.33	422.36	287.37	709.73	22.33	10.66	47.7
	Low stimiful	67.63	12.00	437.07	270.51	707.57	21.91	10.24	46.7
	High stimiful	72.33	12.67	365.73	299.07	664.80	21.59	9.92	45.9
L.S.D. at 0.05		4.23	1.18	47.89	47.37	77.64	2.67	---	---

Table 8: Effect of interaction of cultivars and foliar nutrition on bulb quality of sweet fennel (2003-2004 and 2004-2005).

Cultivars	Folair nutrition	Bulb (cm)			Flatten shape Ratio	Cylinder shape Ratio	Elongated shape Ratio
		Width (W)	Thickness (T)	Lingth (L)			
2003-2004							
Dulce	Control	3.73	8.28	10.55	2.22	8.65	1.27
	Low k2o	3.85	5.78	11.17	1.50	9.55	1.93
	High k2o	4.73	10.32	13.43	2.18	11.10	1.30
	Low stimiful	3.98	8.87	13.23	2.20	11.03	1.49
	High stimiful	3.50	7.95	11.05	2.27	9.29	1.39
Zefa fino	Control	4.47	7.50	11.05	1.68	9.29	1.47
	Low k2o	4.78	9.53	12.67	2.08	10.47	1.33
	High k2o	4.15	8.67	11.17	2.10	9.31	1.29
	Low stimiful	4.53	9.88	9.95	2.18	8.22	1.02
	High stimiful	4.23	8.25	12.35	1.95	10.38	1.50
L.S.D. at 0.05		NS	NS	NS	NS	NS	NS
2004-2005							
Dulce	Control	7.47	3.53	7.50	2.12	6.36	1.00

	Low k2o	8.30	5.30	9.00	1.57	7.34	1.08
	High k2o	8.43	5.57	9.13	1.51	7.55	1.08
	Low stimiful	8.97	5.23	10.57	1.72	8.74	1.18
	High stimiful	9.30	6.27	9.57	1.48	7.91	1.03
Zefa fino	Control	6.47	3.23	6.40	2.00	5.52	0.99
	Low k2o	8.33	4.80	9.00	1.74	7.50	1.08
	High k2o	8.43	5.30	8.43	1.59	6.97	1.00
	Low stimiful	7.07	6.43	9.57	1.10	7.91	1.35
	High stimiful	9.23	6.93	9.93	1.33	8.07	1.08
L.S.D. at 0.05		0.52	1.01	1.11	NS	NS	NS

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