FENNEL (*Foeniculum vulgare* Mill., ssp. *dulce* Janch., convar. *Azoricum* Thell.) PLANTS GROWING IN TTANSYLVANIAN PLATEAU

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Abstract: Sweet fennel is grown as a vegetable plant, but also as a medicinal, aromatic plant. It is important due to the rich content of vitamins, mineral salts and essential oils. The thickened sheath of the leaves, which by overlap forms the edible side similar to an onion bulb, from which various dishes are prepared. Fresh leaves and petiole can be used in salads. Fennel (seeds) can be used to flavor food or beverages (refreshing or alcoholic) as well as in canning, bakery, confectionery, perfumery and medicine industry (Ciofu et al., 2004). Sweet fennel comes from Mediterranean Sea area, where wild species grows in the spontaneous flora. It is a known species from antiquity when it was used by Greeks and Romans as a medicinal plant. In Europe, it is spread in culture in France, Italy and Spain. In our country, fennel culture is less practiced, although favorable conditions exist. Culture can be set up by sowing directly or by seedling. Production is influenced by pedoclimatic conditions but also by the cultivar used. Experience was carried out in 2017, in Cluj-Napoca, a favorable area for culture due to specific pedoclimatic conditions.

Keywords: fennel, cultivar, plant growth

INTRODUCTION

Sweet fennel behaves in culture as an annual plant. In the soil develops a pivotal, branched root. Vast majority of roots penetrate up to 40-50 cm deep. High quality bulbs must be white, sweet and have a diameter of at least 5 cm (Indrea et al., 2012, quoted by Ioana Neacşu, 2016). The strain in the early stages of development is made up of close nodes and very short internodes. At the nodes, the leaves are inserted, whose sheath are well developed.

Due to the short internodes, leaves sheath cover one another by forming a swelling like a bulb, which is the edible part of this plant. Bulb sizes vary depending on variety and technology applied to the crop reaching up to 10 cm in diameter. The shape of these bulbs may be more or less globular, and the consistency is fleshy. Sheaths constituting the thickened part, are white in color, are aromatic and have a sweet taste (Butnariu et al., 1992, quoted by Ioana Neacsu, 2016). If the bulb is not harvested in time, plant continues its growth, floral stem starts growing from the central bud, internodes are stretched and a floral stem of over 1 m (can reach up to 150-180 cm), branched and cylindrical is formed. By overlapping sheaths, the edible part, bulb, with conical shape is formed, which can reach the harvesting phase at a weight of 250-600 g, representing 40-45% of the plant weight, 8-10% roots, 50% the rest of the leaves (Apahidean and Apahidean, 2016, Gedda, 2007). At bulb formation, 4-6 leaves participate in case of early varieties and about 8 leaves at late ones. Color of the bulb is light green or white, depending on the variety (Chaux and Foury, 1994). Leaves are feather like, sectioned, threadlike, with developed petiole. In the young phase, the sheath of the petiole develops to become very thick and wide. Flowers are small, hermaphrodite, actinomorphic, yellow with greenish tones, grouped in large inflorescences (Butnariu et al., 1992, quoted by Ioana Neacsu, 2016)

With southern Mediterranean origin, sweet fennel is pretentious to heat. It is sensitive to cold, especially to late spring and early autumn hoar-frost, which is why it usually sowed

at beginning of May when soil has warmed (14-16°C), so that sprout takes place after danger of late spring frost. Although it endures high summer temperatures, it vegetates well at moderate temperatures of 20-25˚C when it produces the highest yields (Ciofu Ruxandra et al., 2004, Stan et al., 2003). Sweet fennel is very sensitive to winter cold, that is why in Europe is exclusively grown as an annual plant, not supporting heavy winters. Vegetation period is 130-180 days, seeds germinate at a minimum temperature of 5-10^{o}C, showing a prediction for soils rich in humus and calcium (Lagunovschi-Luchian Viorica, Vânătoru, 2016).

Fennel production is influenced by crop period, cultivar used and applied technology. In less favorable areas for fennel cultivation, production was higher if it was set up on 21 May (planting seedlings at 3-4 leaf stage, which were produced in protected areas) compared to planting on 7th of July, or July 27 (Suhonen Irma and Kokkonen Leena, 1990). Research carried out by Blazewicz-Wozniak Marzena (1998-2000) in Poland highlighted a better crop growth when crops were established in April compared to those sown in May and June respectively. Bulb production has been favorably influenced by using different soil mulch materials. In hot climates (Egypt), yields of different varieties that were transplanted on September 15 and October 1 respectively combined with different fertilization doses of potassium sulfate (doses of 0, 45, 60 and 75 kg of K_2O/0.4 ha) gave good results. Zwejahrig cultivar grown in the first epoch at a fertilization dose of 75 kg K_2O/0.4 ha had the best plant growth, the highest production but also a higher content in chemical constituents (Abou El-Magd et al., 2010).

MATERIALS AND METHODS

Experience was carried out in 2017, being located in the field Vegetable growing discipline, within USAMV Cluj. In the experimental zone, climate is continental temperate, being influenced by the vicinity of Apuseni Mountains and in autumn and winter influences from west are also felt. Average annual temperature in Cluj-Napoca is 8.2^{o}C and the precipitation average is 663 mm.

During growing period, average monthly temperatures were 5^{o}C-April, 10^{o}C-May, 13^{o}C-June and 15^{o}C-July. Atmospheric humidity was between 65% in April and 70% in June. Precipitation value was 66.4 l/m2-April, 42.4 l/m2-May, 45.4 l/m2-Jun and 44.6 l/m^2-July respectively. Total amount of precipitation in 2017 was 472.7 l/m2.

Biological material used in the experiments was *Foeniculum vulgare* Mill., Ssp. *dulce* convar. *azoricum*, hybrids Rondo F1, Orion F1 as well as Rede variety.

Rondo F1 - is a vigorous and productive, resistant to early blooming, fast-growing hybrid that is early and destined for summer and autumn crops. Produces round, uniform white bulbs with a fine structure that are harvested 75 days after planting.

Orion F1 - is intended for autumn crops, bulbs are white round in shape. It has a good tolerance to diseases and pests. Reaches harvest period approximately 85 days after planting.

Rede - is a medium-sized variety, intended for summer and autumn crops, can be harvested after about 70 days.

Purpose of the experience was to determine how some fennel cultivars behave, cultivated in the field by seedling. Objectives were to determine plant growth: in height, diameter of leaf rosette, number of leaf/plant, growth rate of plants and formation of the edible part.

Experience was placed in randomized blocks in three rehearsals. Sowing for the production of seedlings took place on March 21, 2017, in a greenhouse. Plants began to rise

on 28 March and the mass rising took place on April 2. Planting of seedlings was carried out on a properly prepared land on 10.05.2017, plants being in the phase of 1-2 leaves. Three rows (40 cm between rows) were planted on a 150 cm layer, plant spacing being 20 cm. During the vegetation period, specific maintenance works were applied. No phytosanitary treatments were required, phase fertlization was performed at 13.06, using 300 kg/ha of complex chemical fertilizers (15-15-15).

Regular observations have been made on plant growth and bulb development.

RESULTS AND DISCUSSIONS

Table 1

Cultivar influence on growth of fennel plants in height (cm)

Cultivar	Date of observations/ plant height				Difference	Daily average growing rhythm
	17.05	13.06	5.07	13.07		
Orion F_1	7.74	51.40	82.66	93.66	85.92	1.51
Rondo F_1	8.98	47.40	72.33	76.66	67.68	1.18
Rede	8.00	41.00	65.33	65.90	57.90	1.02
Average	8.24	46.60	73.44	78.74	70.50	1.24

From data presented in Table 1, it is noted that at 17.05 the average plant height was between 7.74 cm (Orion F1) and 8.98 cm (Rondo F1) and at 13.07 it reached a height of 57.9 cm (Rede) and 85.92 cm (Orion F1). Average plant growth rate in height was 1.24 cm/day being higher at Orion F1 (1.51 cm/day) and lower at Rede (1.02 cm/day) respectively.

Table 2

Cultivar influence on growth of leaf rosette in fennel plants

Cultivar	Date of observations				Difference	Daily average growing rhythm
	17.05	13.06	5.07	13.07		
Leaf rosette diameter (cm)						
Orion F_1	8.06	37.20	74.66	81.66	73.60	1.29
Rondo F_1	6.50	38.00	61.66	84.66	78.16	1.37
Rede	4.46	40.40	68.33	74.00	69.54	1.22
Average	6.34	38.53	68.21	80.10	73.76	1.29
Average number of leaves/plant						
Orion F_1	2.00	5.40	7.66	9.66	7.66	0.13
Rondo F_1	2.00	5.00	8.00	9.00	7.00	0.12
Rede	1.80	5.20	8.00	8.66	6.86	0.12
Average	1.93	5.20	7.88	9.10	7.17	0.123

Leaf rosette diameter averaged 6.34 cm in 17.05, after about 2 months reached at 80.10 cm, average daily rate being 1.29 cm/day (Table 2). Rondo hybrid had a daily average rhythm of 1.37 cm/day, leaf rosette diameter reaching 78.16 cm. Average number of leaves per plant rose from an average of 1.93 to 9.10 leaves/plant.

Bulb development was appreciated by determining its height, width and thickness on June 21 and July 5 respectively, then calculating the difference for establishing the average

daily rhythm (Table 3). From recorded data it was found that height of the bulb before harvest was between 8.37 cm (Rede) and 9.19 cm (Orion F1), the bulb's width was between 7.58 cm (Rondo F1) and 8.45 cm (Rede) and bulb thickness had higher values at Orion F1.

Table 3

Cultivar influence on bulb growth on fennel plants grown by direct sowing

Cultivar	Date of observations		Difference	Daily average growing rhythm
	21.06	5.07		
Bulb height (cm)				
Orion F_1	6.36	9.19	2.83	0.20
Rondo F_1	5.97	9.09	3.12	0.22
Rede	5.55	8.37	2.82	0.20
Average	5.96	8.88	2.92	0.21
Buld width (cm)				
Orion F_1	5.16	7.89	2.83	0.20
Rondo F_1	5.10	7.58	2.48	0.18
Rede	4.72	8.45	3.73	0.26
Average	4.99	7.97	3.01	0.21
Bulb thickness (cm)				
Orion F_1	2.39	3.91	1.52	0.11
Rondo F_1	2.40	3.75	1.35	0.09
Rede	2.82	3.85	1.03	0.07
Average	2.53	3.84	1.30	0.09

Table 4

Cultivar influence on fennel plants weight and edible part weight

Cultivar	Average weight (g)				% weight of bulb from total weight of the plant
	Leaves	Roots	Bulb	Total	
Orion F_1	243.33	38.33	138.33	419.99	32.93
Rondo F_1	175.00	28.33	113.33	316.66	35.78
Rede	223.33	38.33	111.66	373.32	29.90
Media	213.88	34.99	121.10	369.99	32.87

Average weight of fennel plants was between 316.66 g (Rondo F1) and 419.99 g (Orion F1). At the time of observations, average bulb weight averaged 121.10 g (Table 4). On average, bulb weight represented 32.87% of the total weight of fennel plants, percentage being higher for Rondo hybrid (35.78%).

CONCLUSIONS

Based on results obtained from field fennel research, under specific conditions of Transylvanian Plateau, using Orion, Rondo and Rede cultivars, the following conclusions were drawn:

- average plant growth rate in height was 1.24 cm/day being higher at Orion F1 (1.51 cm/day), respectively lower at Rede (1.02 cm/day);

- at Rondo hybrid leaf rosette diameter had a daily average rhythm of 1.37 cm/day, reaching 78.16 cm;

- average number of leaves per plant rose from an average of 1.93 to 9.10 leaves/plant;

- bulb height before harvest was 8.37 cm (Rede) and 9.19 cm (Orion F1), bulb's width was between 7.58 cm (Rondo F1) and 8.45 cm (Rede) and bulb thickness had higher values at Orion F1;

- on average, bulb weight represented 32.87% from the total weight of fennel plants, percentage being higher for Rondo hybrid (35.78%).

REFERENCES

1. Abou El-Magd, M.M., Zaki, M.F., Eldewiny, C.Y. (2010). Effect of planting dates and different levels of potasium fertilizer on growth, yield and chemical composition of sweet fennel cultivars under newly reclaimed sandy soil conditions, Journal of American Science, 6(7), 89-105.
2. Apahidean, Al.S., Apahidean, Al.I. (2016). Legumicultura, Ed.Risoprint, Cluj-Napoca.
3. Blazewicz-Wosniak, M. (2010). Effect of soil and plant covering and sowing time on the yield of fennel bulbs grown from sowing directly in the field, Folia Horticulture, 22/2, 59-66.
4. Ciofu, R. Stan, N., Popescu, V., Chilom, P., Apahidean, S., Horgoş, S., Berar, V., Lauer, K.L., Atanasiu, N. (2004) Tratat de Legumicultură, Ed.Ceres.
5. Choux, Cl., Foury, Cl. (1994). Production legumiers, Tome 3, TEC-DOC, Paris.
6. Indrea D., Apahidean, Al.S., Apahidean, M., Măniuţiu, D., Sima, R. (2012). Cultura legumelor, Ed.Ceres, Bucureşti.
7. Lagunovschi-Luchian, V., Vînătoru, C. (2016). Legumicultură, Ed.ALPHA MDN, Buzău.
8. Neacşu, I. (2016). Cercetări privind unele particularități agrotehnologice ale culturii de fenicul (*Foeniculum vulgare* Mill., ssp. *dulce* Janch., convar. *Azoricum* Thell.) Teză de doctorat, Cluj-Napoca.
9. Stan N., Munteanu, N., Stan, T. (2003). Legumicultură, Vol.III, Ed. *Ion Ionescu de la Brad*, Iaşi.
10. Suhonen, I., Kokkonen, L., (1990) The effect of planting date on growth, seed stalk development and yield of sweet fennel, Journal of Agricultural Science in Finland, Vo.62, 237-244.