

## CULTIVATION METHOD INFLUENCE ON PLANT GROWTH AND PRODUCTION, IN SOME VARIETIES OF FENNEL (*Foeniculum vulgare* Mill., Ssp. *dulce* Janch., Convar. *azoricum* Thell.)

MARIAN Cristian, Alexandru Ioan APAHIDEAN\*, Alexandru Silviu APAHIDEAN

*University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture  
3-5 Mănăştur Street, Cluj-Napoca, 400372, Romania*

\*Corresponding author: [alexandru.apahidean@usamvcluj.ro](mailto:alexandru.apahidean@usamvcluj.ro)

**Abstract:** Florence fennel is grown as a vegetable but also as an aromatic, medicinal plant. As a vegetable plant, it is cultivated for the thickened sheath of the leaves which, by overlapping, form the edible part similar to an onion bulb from which different dishes are prepared. Fresh leaves and petioles can be used to flavor dishes. Fennel fruits are also used due to their special aroma and are used for flavoring food or beverages (soft or alcoholic) as well as in the canning, bakery, confectionery, perfumery and medicine industries. Fennel leaves contain 60-90 mg% vitamin C, 8-10 mg% provitamin A and 6 mg% essential oils. Flavor and pharmacological properties are ensured by the presence of essential oils in the plant. Experience was carried out in 2018, in Cluj-Napoca, a favorable area for culture due to specific pedoclimatic conditions. In the experimental culture, the influence of the cultivation method (direct sowing, planting of seedlings) on the growth and development of plants as well as fennel production was followed.

**Keywords:** fennel, cultivars, culture methods, plant growth, production.

### INTRODUCTION

Florence fennel comes from Mediterranean Sea area where the wild species grows in spontaneous flora. It is a species known since antiquity, when it was used by Greeks and Romans as a medicinal plant. In Europe, it is widespread in culture in France, Italy and Spain. In our country, fennel cultivation is scarcely practiced, although there are favorable conditions. The crop can be established by direct sowing or by seedlings. Production is influenced by pedoclimatic conditions, by the cultivar used but also by the cultivation technology.

Florence fennel behaves in culture as an annual plant. In the soil it develops a pivoting, branched root. The vast majority of roots penetrate up to 40-50 cm deep. High quality bulbs must be white, with a sweet taste and have a diameter of at least 5 cm (Indrea et al., 2012, quoted by Ioana Neacșu, 2016). The stem in the early stages of development consists of close nodes and very short internodes. Leaves with a very developed sheath are inserted at the nodes. Due to the short internodes, leaf sheaths cover each other forming a bulb-like swelling, which is the edible part of this plant. Bulbs dimensions vary depending on the variety and the technology applied to the crop, reaching up to 10 cm in diameter. Shape of these bulbs can be different, more or less globular, and the consistency is fleshy. The sheaths that make up the thickened part are white, aromatic and have a sweet taste (Butnariu et al., 1992, quoted by Ioana Neacșu, 2016). 4-6 leaves participate in the formation of the bulb in the case of early

varieties and approximately 8 leaves in the case of the late ones. The color of the bulb is light green or white, depending on the variety (Chaux and Foury, 1994, Apahidean and Apahidean, 2020). If the bulb is not harvested in time, the plant continues to grow, flower stalk starts to grow from the central buds, the internodes elongate and form the flower stalk over 1 m high (up to 150-180 cm), branched, fistulous and cylindrical. By overlapping the sheaths, the edible part is formed, the bulb, of flattened conical shape, which can reach a weight of 250-600 g in the harvesting phase, which represents 40-45% of the weight of the plant, 8-10% of the roots, 45- 50% the rest of the leaves (Apahidean, Apahidean, 2020, Gedda, 2007). Leaves are 3-4 times penatsect, filiform, petiolate. Flowers are small, pentamerous, hermaphroditic, actinomorphic, yellow with greenish hues, grouped in large inflorescences (compound umbels) (Butnariu et al., 1992, quoted by Ioana Neacșu, 2016).

Having a southern, Mediterranean origin, fennel is pretentious to heat. It is sensitive to cold, especially in late spring and early autumn frosts, which is why it is sown (or planted seedlings) in late April-early May (depending on the growing area), when soil is warmer (14-16°C). Although it withstands high temperatures during the summer, it grows well at temperatures more moderate than 20-25°C, when it gives the highest yields (Ciofu Ruxandra et al., 2004, Stan et al., 2003). Vegetation period is 130-180 days, seeds germinate at a minimum temperature of 5-10°C, showing a preference for soils rich in humus and calcium (Lagunovschi-Luchian Viorica, Vânătoru, 2016).

Fennel production is influenced by the growing period, the cultivar used and the technology applied. Organic fertilizations with vermicompost (50%) and compost (50%) ensured better plant growth as well as higher production (Abd El-Rheem et al., 2019). In areas less favorable for fennel cultivation, production was higher if it was established on 21 May (by planting seedlings in the 3-4 leaf stage, which were produced in protected areas) compared to the 7 July seasons, respectively July 27 (Suhonen Irma and Kokkonen Leena, 1990). Research conducted by Blazewicz-Wozniak Marzena (1998-2000) in Poland showed a better growth of plants in the crop established in April compared to those sown in May and June, respectively.

## MATERIAL AND METHODS

Experience took place in 2018, being located in the field of Vegetable growing discipline within USAMV Cluj. In the experimental area the climate is continental, temperate, being influenced by the vicinity of the Apuseni Mountains and in autumn and winter you can feel the influences from the west. The average annual temperature in Cluj-Napoca is 8.2°C and the average rainfall is 663 mm. During the experiment, the average monthly temperatures were 5°C-April, 10°C-May, 13°C-June and 15°C-July. Atmospheric humidity was between 65% in April and 70% in June. The precipitation value was 66.4 l / m<sup>2</sup>-April, 42.4 l / m<sup>2</sup>-May, 45.4 l / m<sup>2</sup>-June and 44.6 l / m<sup>2</sup>-July, respectively. The total amount of precipitation in 2018 was 472.7 l / m<sup>2</sup>.

Biological material used in the experiment was represented by three cultivars of *Foeniculum vulgare* Mill., ssp. *dulce* convar. *azoricum*, hybrids Rondo F1, Orion F1 and Rede variety.

Rondo F1 - is a vigorous and productive hybrid, tolerant to flowering, with a fast growth, it is early and intended for summer and autumn crops. Produces round, uniform white bulbs with a fine structure that is harvested 75 days after planting.

Orion F1- is intended for autumn crops, the bulbs have a round, white color. It has a good tolerance to diseases and pests. It reaches harvest after about 85 days from planting.

Rede- is a variety with medium vigor, intended for summer and autumn crops, reaching harvest after about 70 days.

Purpose of the experiment was to determine the behavior of some fennel cultivars, grown in the field by seedling and direct sowing. The objectives pursued were to determine the growth of plants in height, the diameter of the leaf rosette, the number of leaves / plant, the development of the bulb and the production achieved.

Experiment was of bifactorial type (factor A- culture method, with two graduations, a1 sown directly, a2-seedling; factor B-cultivar, with three graduations, b1-Orion F1, b2-Rondo F1, b3-Rede). By combining the experimental factors, six experimental variants resulted. The experiment was placed in randomized blocks, in three repetitions. Sowing for the production of seedlings took place on March 26, 2018, in the greenhouse, in alveolar palettes using peat as substrate. Plants began to emerge on March 30 and the mass emergence took place on April 5. Seedlings were planted on a properly prepared land, on 11.05. 2018, plants being in the phase of 1-2 leaves. Variants cultivated by direct sowing were sown on 10.04.2020. Three rows (40 cm between rows) were established on a layer of 150 cm, the distance between plants per row being 20 cm (for the variants sown directly the distance between plants was achieved by thinning the plants per row, in phase 1 -2 true leaves). During vegetation period, specific maintenance works were applied. No phytosanitary treatments were required, phasal fertilization was performed on 15.06, using 300 kg / ha of complex chemical fertilizers (15-15-15).

Periodic observations were made on plant growth, bulb development and at harvest (16.07), production was established.

## RESULTS AND DISCUSSIONS

Table 1

**Growing fennel plants using different cultivation methods  
at the beginning of the growing season (17.05.2018)**

Variant		Plant height cm	Leaf rosette diameter cm	Number of leaves/plant
Culture method	Cultivar			
Direct sowing	Orion F <sub>1</sub>	8.5	9.2	2.5
	Rondo F <sub>1</sub>	9.7	8.5	2.5
	Rede	9.2	5.7	2.2
	Average	9.1	7.8	2.4
Planted seedlings	Orion F <sub>1</sub>	21.1	16.6	3.2
	Rondo F <sub>1</sub>	22.3	11.4	3.8
	Rede	19.1	17.6	3.4
	Average	20.8	15.2	3.5

From data presented in table 1 it is found that at the beginning of the vegetation period (on 17.05), average height of the plants was between 8.5 cm and 9.2 cm for variants grown by direct sowing and between 19.1 cm and 22.3 cm for the variants established by planting seedlings. Leaf rosette diameter was on average 7.8 cm for the directly sown and 15.2 cm for the planted ones, respectively. Average number of leaves per plant was 2.4 for sown varieties and 3.5 for planted varieties. After analyzing data on fennel plants growth at the beginning of the vegetation period, a better development of plants in variants established by planted seedlings was found, compared to those established by direct sowing.

At the end of the vegetation period, after two months from the first observations, a recovery of the vegetative growth of the fennel plants that were cultivated by direct sowing was observed. Thus, from table 2 it results that plants height cultivated by direct sowing was on average 79.6 cm compared to 75.6 cm for the variants cultivated by seedling. Leaf rosette diameter was 81.2 for the variants cultivated by direct sowing and 82.8 cm respectively for those cultivated by seedlings. Average number of leaves / plant had close values of 10.1 and 9.7, respectively. In both culture systems Orion hybrid had the best growth, followed by Rondo, with quite close values.

Table 2

**Growing fennel plants using different cultivation methods  
at the beginning of the growing season (16.07.2018)**

Variant		Variant	Plant height cm	Leaf rosette diameter cm
Culture method	Cultivar			
Direct sowing	Orion F <sub>1</sub>	94.6	82.7	10.5
	Rondo F <sub>1</sub>	77.5	85.8	10.3
	Rede	66.7	75.3	9.5
	Average	79.6	81.2	10.1
Planted seedlings	Orion F <sub>1</sub>	88.3	90.6	10.3
	Rondo F <sub>1</sub>	70.3	77.0	10.0
	Rede	68.3	81.0	8.7
	Average	75.6	82.8	9.7

Table 3

**Bulb degree of development, at the time of harvest, in some varieties of fennel  
grown by different methods**

Variant		Height cm	Width cm	Thickness cm
Culture method	Cultivar			
Direct sowing	Orion F <sub>1</sub>	12.3	9.5	4.7
	Rondo F <sub>1</sub>	10.8	10.2	4.9
	Rede	12.7	9.8	3.8
	Average	11.9	9.8	4.5
Planted seedlings	Orion F <sub>1</sub>	13.5	10.2	4.8
	Rondo F <sub>1</sub>	12.2	10.9	5.0
	Rede	13.4	8.8	3.7
	Average	13.0	9.9	4.5

At the time of harvest, fennel bulb had an average height of 11.9 cm for the varieties grown by direct sowing and 13.0 cm for those grown by seedlings (Table 3). In both culture methods, Orion hybrid had the highest values (12.3 cm and 13.5 cm, respectively). Bulb width had on average values close in the two culture systems, 9.8 cm, respectively 9.9 cm and bulb thickness had on average the same value of 4.5 cm. In both culture systems, Orion and Rondo hybrids formed a better developed bulb compared to Rede.

**Table 4**  
**Weight of plants, at harvest, in some fennel varieties grown by different methods (g)**

Variant		Leafs	Root	Bulb	Plant total
Culture method	Cultivar				
Direct sowing	Orion F <sub>1</sub>	320.5	58.0	225.7	604.2
	Rondo F <sub>1</sub>	275.3	47.3	242.4	565.0
	Rede	290.6	45.7	190.8	527.1
	Average	295.5	50.3	219.6	565.4
Planted seedlings	Orion F <sub>1</sub>	433.3	53.3	326.6	813.2
	Rondo F <sub>1</sub>	239.3	47.3	290.0	630.6
	Rede	371.7	55.0	181.7	608.4
	Average	348.1	51.8	266.1	668.1

In table 4 results regarding the weight of plants at harvest are presented, which shows that on average plants obtained by seedlings achieved a higher average weight compared to those that come from direct sowing. Thus, the average weight of leaves was 295.5 g for variants by direct sowing compared to 348.1 g for those obtained by seedling. Average root weight was approximately equal (50.3 g and 51.8 g, respectively). Bulb average weight was 219.6 g for plants grown by direct sowing and 266.1 g for those obtained by seedling. Hybrid Orion, cultivated by seedling produced the best developed plants, having a total weight of 813.2 g of which the bulb represented 326.6 g.

**Table 5**  
**Unilateral influence of cultivation method on fennel production**

Culture method	Production		± d t/ha	Differnce significance
	t/ha	%		
Direct sowing	22.0	90.5	-2.3	o
Planted seedlings	26.6	109.5	2.3	*
Average (control)	24.3	100.0	-	-

LSD P 5%            2.1

LSD P 1%            4.3

LSD P 0.1%        7.2

Analyzing the unilateral influence of cultivation method on production, a favorable influence of the seedling cultivation method, where there was an increase in

production of 9.5% compared to experience average, difference in production being significant.

Average fennel production for the three cultivars was between 18.6 t / ha for Rede variety and 27.6 t / ha for Orion hybrid (Table 6). Unilateral influence of cultivar on production shows that Rondo hybrid achieved a production increase of 9.8% with a significant difference in production compared to average. Orion hybrid achieved a production increase of 13.6%, the production difference being significant.

Table 6

#### Influența unilaterală a cultivarului asupra producției de fenicul

Cultivar	Production		± d t/ha	Difference significance
	t/ha	%		
Orion F <sub>1</sub>	27.6	113.6	3.3	*
Rondo F <sub>1</sub>	26.7	109.8	2.4	*
Rede	18.6	76.54	-5.7	oo
Average (control.)	24.3	100.0	-	-

LSD P 5%            2.3

LSD P 1%            4.9

LSD P 0.1%        7.5

Analysis of the combined influence of the two experimental factors on production shows that it was between 18.2 t / ha and 32.7 t / ha (Table 7). Compared to experience average, Orion hybrid, cultivated by seedling, achieved a production increase of 34.5%, the production difference being very significant. Rondo hybrid, cultivated by seedling, achieved a production increase of 19.3%, the production difference being distinctly significant. In the direct sowing system, highest production was achieved by Rondo hybrid, without differences in production compared to the control. Rede variety obtained lower yields in both cropping systems, the differences from the control being distinctly significantly negative.

Table 7

#### Combined influence of the cultivation method and the cultivar on fennel production

Variant		Production		± d t/ha	Difference significance
Culture method	Cultivar	t/ha	%		
Direct sowing	Orion F <sub>1</sub>	22.6	93.0	-1.7	-
	Rondo F <sub>1</sub>	24.3	100.0	0.0	-
	Rede	19.1	78.6	-5.2	oo
Planted seedlings	Orion F <sub>1</sub>	32.7	134.5	8.4	***
	Rondo F <sub>1</sub>	29.0	119.3	4.7	**
	Rede	18.2	74.9	-6.1	oo
Average (control)		24.3	100.0	-	-

LSD P 5%            2.2

LSD P 1%            4.5

LSD P 0,1%        7.9

## CONCLUSIONS

Based on the results obtained from this research carried out on fennel field culture, in the specific conditions of Transylvanian Plateau area, using Orion, Rondo and Rede cultivars by direct sowing and respectively by seedlings, the following conclusions were drawn:

- at the beginning of the vegetation period, a better development of plants was obtained in variants established by planting seedlings compared to those established by direct sowing;

- at the end of the growing season, a recovery of vegetative growth of fennel plants which were grown by direct sowing was found;

- in both culture systems the hybrid Orion had the best growth, followed by Rondo, with close values;

- in both culture systems Orion and Rondo hybrids formed a better developed bulb compared to Rede;

- Orion hybrid, cultivated by seedlings obtained the best developed plants, having a total weight of 813.2 g of which the bulb represented 326.6 g;

- compared to experience average, Orion hybrid, cultivated by seedlings, achieved a production increase of 34.5%, the production difference being very significant. Rondo hybrid, cultivated by seedling achieved a production increase of 19.3%, the production difference being distinctly significant.

## REFERENCES

1. Abd El-Rheem. Kh., M., Entsar M., Heba, E., El-Batran, S. (2019). Study of Replacement
2. of Compost with Vermicompost and Its Effect on Quality and Quantity Yield and Nutritional Status of Sweet Fennel Plants Grown in Sandy Soil, Research Journal of Agriculture and Biological Sciences, 14(30), 1-5.
3. Apahidean Al.I., Apahidean, Al.S. (2020). Legumicultura, Ed.Risoprint, Cluj-Napoca.
4. 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.
5. Ciofu, R., Stan, N., Popescu, V., Chilom, P., Apahidean, S., Horgoș, A., Berar, V., Lauer, K.F., Atanasiu, N. (2004). Tratat de Legumicultură, Ed.Ceres.
6. Choux, Cl., Foury, Cl. (1994). Production legumiers, Tome 3, TEC-DOC, Paris.
7. Lagunovschi-Luchian V., Vînătoru, C. (2016). Legumicultură, Ed.ALPHA MDN, Buzău
8. Neacșu 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*, Iași.
10. Suhonen I, L. Kokkonen.(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.