ROW SPACING AND FOLIAR FERTILIZATION EFFECTS ON PRODUCTION OF *FOENICULUM VULGARE* MILL.

Elena PATROLEA[1], Constantin LUNGOCI [1], Teodor ROBU[1]

e-mail: epatrolea@uaiasi.ro

Abstract

Throughout history, people have become aware of the possibility of using plants, both as raw materials in food and for treating various medical conditions. Also, along with the evolution of mankind, the methods of using various species of aromatic and medicinal plants have been attained. At the same time, a multitude of information about the curative effects of plants, as well as the level of toxicity of some species, has also been accumulated. The objective of this research was to establish the effects of row spacing and foliar fertilization on fresh grass, seeds and essential oil production of two fennel varieties: *Foeniculum vulgare* var. *vulgare* and *Foeniculum vulgare* var. *dulce*. The field experiment was set in Research Station – Ezăreni Farm University of Life Sciences, Iasi, in three years, 2020, 2021 and 2022. The results showed a significant impact of both rows spacing and foliar treatments on the production values. A genetic influence of variety can also be distinguished, the fresh grass, seed and essential oil production showing higher values in case of *Foeniculum vulgare* var. *vulgare*, compared to *Foeniculum vulgare* var. *dulce*. In case of both fennel varieties, the highest production values were obtained with 50 cm between rows and complex foliar treatment (amino acids, macronutrients and micronutrients).

Key words: row spacing, foliar treatments, seed production, grass production, essential oil production

Foeniculum vulgare Mill. is an aromatic species used since ancient times. It has its origins in the southern part of the Mediterranean region, but fennel is now found in the spontaneous flora and can be cultivated in the northern, eastern and western hemispheres, especially in the area of Asia, North America and Europe.

This species has been known for thousands of years, being used in various cures by the Egyptian, Chinese, Indian and Roman civilizations. In the Roman Empire, fennel was cultivated mainly for its strongly flavored seeds. The king of the Franks, Charlemagne, was among those who strongly encouraged the cultivation of fennel in Central Europe (Krishnamurthy K.H., 2011).

Foeniculum vulgare Mill. is frequently used in traditional medical practice to treat a wide variety of ailments. It is used in systems of medicine such as Ayurveda, Unani, Siddha, as well as in alternative medicine practices in India and Iran (Rahimi R., 2013).

MATERIAL AND METHOD

Plant material

For the establishment of the experiment, the fennel seeds were obtained from Department of Plant Sciences within the University of Life Sciences „Ion Ionescu de la Brad", Iași and from National Agricultural Research and Development Institute Fundulea.

Field experiment

The experiment was set up on May in every year of research, using fennel seedlings. The plants were harvested in October, upon completion of the ripe stage. In this research, three different row spacing were used: 50 cm, 75 cm and 100 cm. Regardless the row spacing, the space between plants on the row was 30 cm.

The foliar treatments applied are: AA (a foliar fertilizer with amino acids), AA+M+µ (fertilizer with amino acids, macronutrients and micronutrients) and M+µ (fertilizer with macronutrients and micronutrients).

Field measurements

In order to establish the average weight of a plant and seeds/plant, 10 plants were weighed, and an average value was obtained. Based on these determinations, the production of the two fennel varieties was calculated: fresh grass production/ha and seed production/ha.

Subsequently harvesting, the plants were dried at room temperature, protected from sunlight. After 14 days, seed and grass samples were prepared for essential oil extraction.

Volatile oil extraction

Dried samples (seeds and grass) were hydro distilled for 3 hours using a Clevenger type apparatus, as reported by European Pharmacopeia. The essential oil production was expressed as l/ha.

Statistical analysis

[1] Iasi University of Life Sciences, Romania

Data were presented as mean of three replications. The results were analyzed using analysis of variance (ANOVA) and the least significant difference (LSD) test was performed.

RESULTS AND DISCUSSIONS

In the three years of experience, the number of plants per hectare was kept the same, in each plot. In order to highlight the influence of row spacing and foliar fertilization on grass, seed and essential oil production, the average of the three years of experience was considered.

Fresh grass production

In case of var. *vulgare,* for all row spaces (50 cm, 75 cm and 100 cm) the highest values of fresh grass production were obtained with AA+M+µ fertilizer, 11 t/ha, 7.8 t/ha, respectively 7 t/ha (*figure 1*).

In the plot sown at 50 cm between rows, positive significant differences were recorded with all three fertilizers, while at the other two distances (75 cm, 100 cm) the values showed highly significant negative differences compared to blank sample (50 cm, unfertilized), for all foliar fertilizers.

Var. *dulce* showed the biggest grass production by using AA+M+µ fertilizer and 50 cm between rows, 7.8 t/ha.

A genetic influence of the variety can be distinguished, the fresh grass production per hectare being much higher in case of *Foeniculum vulgare* var. *vulgare*, with values between 6.4 t/ha and 11 t/ha, while *Foeniculum vulgare* var. *dulce* obtained average yields between 4.8 t/ha and 7.8 t/ha.

Foeniculum vulgare var. *vulgare* and *Foeniculum vulgare* var. *vulgare* can achieve fresh grass production of up to 7.8 t/ha and 11 t/ha, when the plants are cultivated at 50 cm between rows and a complex foliar treatment is applied (amino acids, macronutrients, microelements).

Seed production

From data showed in *figure 2*, it is affirmative that row spacing and foliar treatments have a significant influence on seed production of both fennel varieties.

Bitter fennel obtained the maximum production values on the plot sown at 50 cm between rows and treated with AA+M+µ (828.5 kg/ha), in comparison with the blank unfertilized (772.1 kg/ha).

For sweet fennel, the highest seed production value was recorded in the plot cultivated at 50 cm between rows and in which the AA+M+µ treatment was used - foliar fertilizer with macronutrients, trace elements (Cu, Mn, Fe, Zn) and amino acids, with a value of 675.8 kg/ha, compared to the unfertilized blank sample (624.3 kg/ha), the difference being statistically significant ($P<0.05$).

The data obtained in this research presented a significant impact of row spacing and foliar treatments on grass and seeds production.

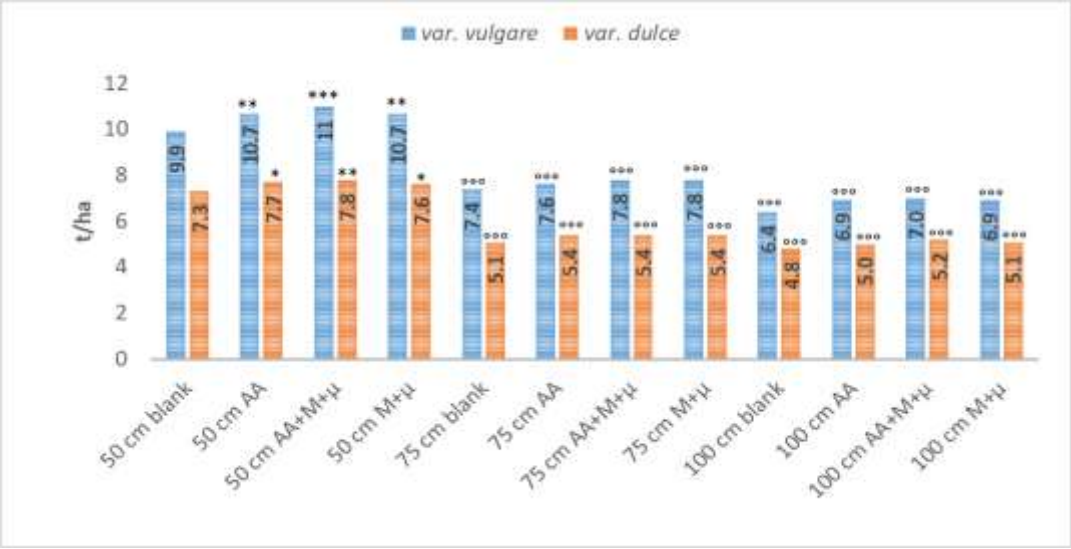

Figure 1 **Grass production of two fennel varieties**

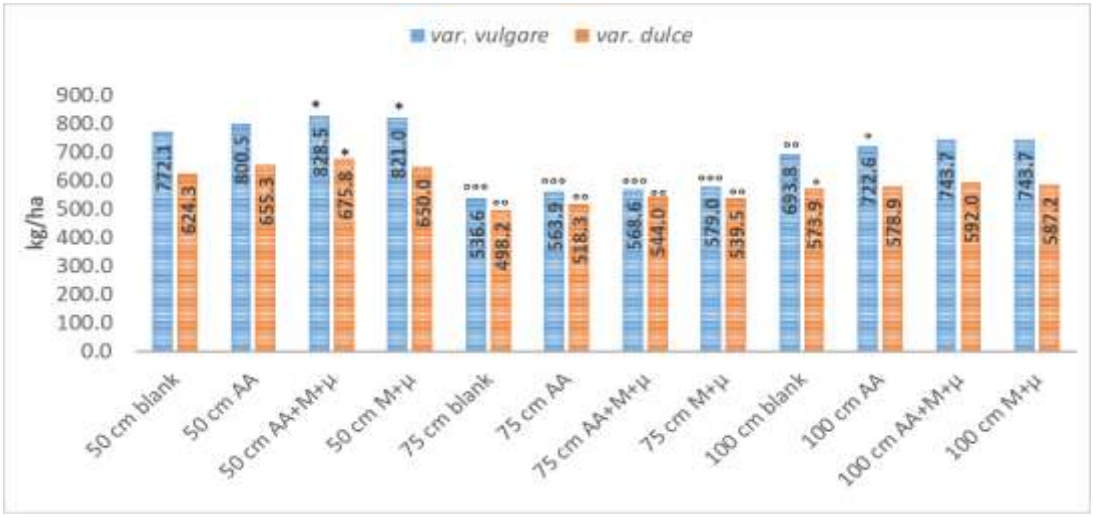

Figure 2 **Seed production of two fennel varieties**

The higher values obtained in the blank sample (50 cm) are explained by the higher number of plants per hectare, compared to the distance of 75 cm and 100 cm between rows.

At greater distances between the rows, therefore at a lower plant density and greater nutrition space, and a higher amount of sunlight, the following are ascertained: the plants have greater weight; the branching degree is higher; the number of seeds on plant is greater.

However, these high parameters do not offset the production values obtained at the distance of 50 cm between the rows, which achieves an optimum between the space of nutrition and photosynthesis.

Essential oil production

The data presented in *figure 3* and *figure 4*, showed an appreciable impact of row spacing and foliar treatments on the production of essential oil extracted from fennel seeds and grass.

The maximum value of seeds volatile oil production for bitter fennel was recorded for 50 cm row spacing and AA+M+µ fertilizer, with a value of 19.5 l/ha, compared to the unfertilized sample (16.4 l/ha), the difference being statistically significant ($P<0.001$). For sweet fennel, the highest value was obtained with the same distance between rows and fertilizer (12.5 l/ha), in comparison to blank sample (10.3 l/ha).

A significant difference is noticed between oil production extracted from seeds and grass. In both fennel varieties, the largest amount of essential oil is found in the seeds.

The highest production value of essential oil extracted from grass was obtained at 50 cm between rows with AA+M+µ (6.4 l/ha in case of var. *vulgare* and 1.8 l/ha for var. *dulce*).

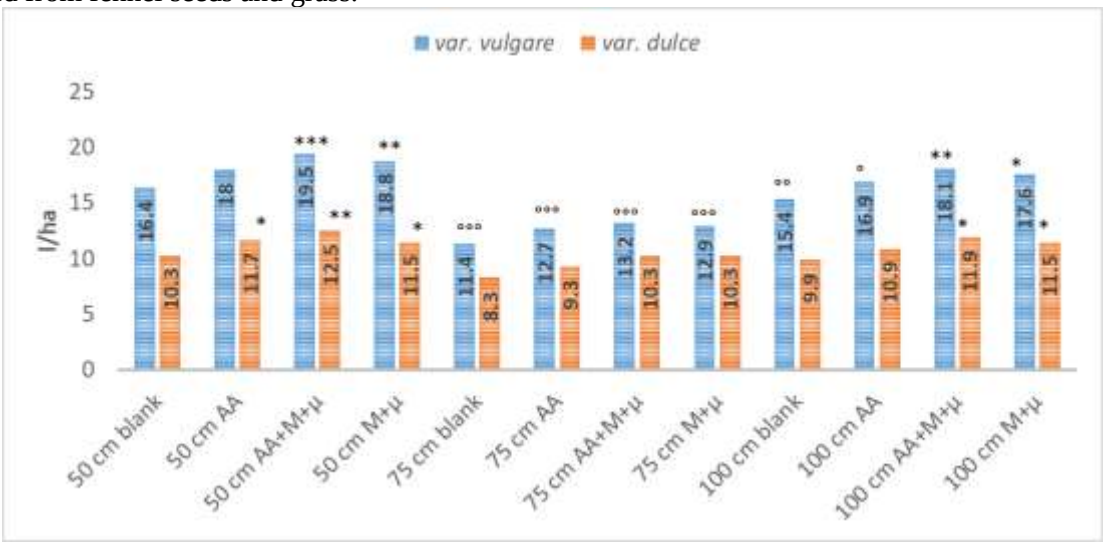

Figure 3 **Seeds essential oil production of two fennel varieties**

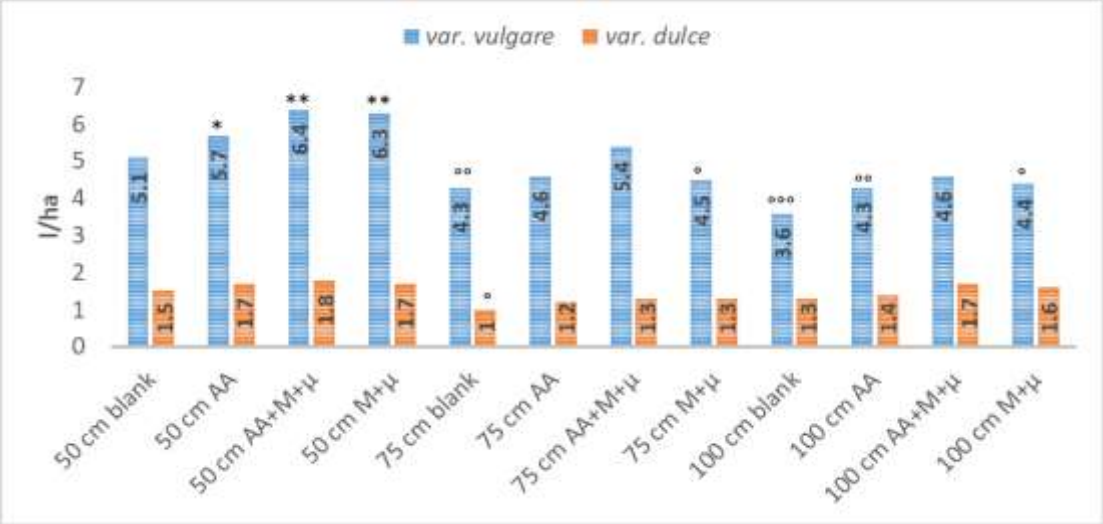

Figure 4 **Grass volatile oil production of two fennel varieties**

CONCLUSIONS

It can be concluded that both, row spacing and foliar fertilization have a significant influence on the grass, seed and essential production of *Foeniculum vulgare* var. *vulgare* and *Foeniculum vulgare* var. *dulce*.

In order to obtain maximum production values for the two fennel varieties, it is recommended to cultivate the plants at 50 cm between rows and apply a complex foliar treatment (amino acids, macronutrients, micronutrients).

ACKNOWLEGMENTS

The work was supported by the project „PROINVENT", Contract no. 62487/03.06.2022 – POCU/993/6/13 – Code 153299, financed by The Human Capital Operational Programme 2014-2020 (POCU).

REFERENCES

Arabaci O., Bayram E., **2004** - *The effect of nitrogen fertilization and different plant densities on some agronomic and technologic characteristic of Ocimum basilicum L.(Basil)*. Journal of Agronomy.

Ashraf M., Ali Q., Iqbal Z., 2006 - *Effect of nitrogen application rate on the content and composition of oil, essential oil and minerals in black cumin (Nigella sativa L.) seeds*. Journal of the Science of Food and Agriculture, 86(6), 871-876.

Badgujar S.B., Patel V.V., Bandivdekar A.H., 2014 - *Foeniculum vulgare Mill: a review of its botany, phytochemistry, pharmacology, contemporary application, and toxicology.* BioMed research international, 2014.

Delfieh M., Modarres-Sanavy S.A.M., Farhoudi R., 2016 - *Effects of organic, biologic and chemical nitrogen fertilizers on fennel (Foeniculum vulgare mill.) yield and essential oil*. Journal of Essential Oil Bearing Plants, 19(2), 339-348.

Farnsworth N.R., Soejarto D.D., 1991 - *Global importance of medicinal plants*. The conservation of medicinal plants, 26, 25-51.

Krishnamurthy, K.H., 2011 - *Medicinal plants: Madhurika, saunf or fennel (Foeniculum vulgare, Gaertn)*. Journal of New Approaches to Medicine and Health, 19(1), 1-4.

Patrolea E., Robu T., 2020 - *Botany and chemistry of Foeniculum vulgare var. dulce Mill. and Foeniculum vulgare var. vulgare Mill: A review*. Revista Lucrări Științifice, vol. 63(2)/2020, Seria AGRONOMIE, 169-172.

Piccaglia R., Marotti M., 2001 - *Characterization of some Italian types of wild fennel (Foeniculum vulgare Mill.)*. Journal of agricultural and food chemistry, 49(1), 239-244.

Rahimi R., Ardekani M.R.S., 2013 - *Medicinal properties of Foeniculum vulgare Mill. in traditional Iranian medicine and modern phytotherapy*. Chinese journal of integrative medicine, 19, 73-79.