Comparison of the production of fenugreek (*Trichonella foenum-graecum*) experiments in 2018-2020

Viktor József Vojnich[1] – Károly Penksza[2] – Erzsébet Kesztyűs[1]

[1]University of Szeged, Faculty of Agriculture, Institute of Plant Sciences and Environmental Protection, Hódmezővásárhely

[2]Hungarian University of Agricultural and Life Sciences, Institue of Crop Production, Department of Botany, Group of Agrobotany, Gödöllő

vojnich.viktor@mgk.u-szeged.hu

ABSTRACT

The aim of our study is to compare the results (content values, yield) of fenugreek (Trigonella foenum-graecum L.) experiments in 2018-2020. Fenugreek is an annual herbaceous plant belonging to the legumes (Fabaceae) family. It is a multifunctional crop for use in domestic and farm animal feeds, wild fodder, herbs and spices. During the study period, nutrient supply treatments were applied to increase the production values of the plant. The weed suppressing ability of fenugreek in the post-emergence period (1-3 weeks) is very poor, so we had to use chemical weed control. During the experiment, the T. foenum-graecum stock was irrigated. The plant was harvested 80-90 days after sowing. The study was carried out in Kecskemét in 2018-2019, at the Demonstration Garden of John von Neumann University, Faculty of Horticulture and Rural Development. The 2020 experiment was set up at the University of Szeged, Faculty of Agriculture.

Keywords: *Fenugreek, field experiment, content values, yield, nutrient supply*

ÖSSZEFOGLALÁS

Kutatásunk célja, hogy a 2018-2020 évi szabadföldi görögszéna (Trigonella foenum-graecum L.) kísérlet eredményeit (beltartalmi értékek, hozam) összehasonlítsuk. A görögszéna a pillangósvirágúak (Fabaceae) családjába tartozó egy éves lágyszárú növény. Felhasználását tekintve többcélú gazdasági növény: házi- és gazdasági állatok takarmányozása, vadtakarmány, gyógynövény, fűszernövény. A vizsgált időszakban tápanyag-utánpótlási kezelést állítottunk be, hogy növeljük a növény produkciós értékeit. A görögszéna gyomelnyomó képessége a kelést követő időszakban (1-3 hét) nagyon rossz, ezért vegyszeres gyomirtást kellett alkalmaznunk. A kísérlet ideje alatt a T. foenum-graecum állományt öntöztük. A növényt a magvetéstől számítva a 80-90. napon lekaszáltuk. A vizsgálatot Kecskeméten, a Neumann János Egyetem, Kertészeti és Vidékfejlesztési Kar Bemutatókertben végeztük 2018-2019. A 2020-as kísérletet a Szegedi Tudományegyetem Mezőgazdasági Karán állítottuk be.

Kulcsszavak: *Görögszéna, szabadföldi kísérlet, beltartalmi értékek, terméshozam, tápanyag-utánpótlás*

INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual plant belonging to the order of legumes (*Fabales*) and the family of *Fabaceae*. It is of Mediterranean origin and is native to the Mediterranean coast. It is grown as a spring sown crop in temperate countries (Antal, 2005), and as an overwintering crop in Egypt, Morocco, and India (Makai et al., 1996a). In Hungary, the "Hungarian Herb Book" published in 1807 by Sámuel Diószegi and Mihály Fazekas mentions fenugreek as a wild herb (Makai and Makai, 2004). In Hungary, before 1945, fenugreek was grown in the southern part of the country in horticultural crops. Later, in 1969-1970, the Institute of Agrobotany in Tápiószele started experimental cultivation. In Mosonmagyaróvár, research on the cultivation technology of fenugreek and the production of new intensive varieties began in 1982. Then, in 1987, a new Hungarian fenugreek variety, known as "Óvári-4", was produced. The variety was only recognized by the state later, in 1994 (Makai et al., 1996b). It is currently grown in Hungary on less than 100 hectares. It is grown for feed purposes in the following countries: the United States, Spain, Algeria, Tunisia, Egypt, Ethiopia, Afghanistan, Iran, India, and China (Kalmár and Makai, 1999).

It is grown as a green manure crop in the USA (California state), Chile and southern France. India is the largest producer of fenugreek in the world (Vidyashankar, 2014). During 2011–2012, production was 121,775 tonnes of seeds from an area of 96,304 hectares. Its seed is traded as a spice, and in an oil extract form as oleoresin. India consumes most of the seeds (Petropoulos, 2003). Its export was 799 tonnes in 1960–1961, and increased greatly to 15,135 tons by 1995–1996 and then to 21,800 tonnes during 2011–2012. It was exported to UAE, Sri Lanka, and Japan, and European countries of UK, Netherlands, Germany and France (Fotopoulos, 2003). Its use is very versatile: herbs, spices, fodder plants, various recipes and other utilization possibilities (Bernáth, 2000). The fenugreek crop has several advantages. With the help of N-fixing bacteria of *Rhizobium meliloti* at its root, it is able to fix about 70-90 kg/ha of nitrogen in the soil (Makai et al., 1996a). Due to its high protein content, fenugreek is well suited for feeding domestic and wild animals.

Its medicinal value is already mentioned by the Ebers papyri B.C. in the II Millennium, it was used as an anti-burn medicine (Varga and Berényi, 2001). The infusion of its coarse grind gives a refreshing tea that stimulates digestion, soothes diarrhoea. It is also recommended for enema against gastritis and

intestinal inflammation, in case of rectitis (Stark and Madar, 1993; Bremness, 1997).

Fenugreek Mediterranean descent has been cultivated in ancient Egypt and Babylonia. Its seeds were eaten and also used for healing. To a greater extent, it is used as a green manure plant and green fodder (Czimber, 2001; Makai et al., 2007). Fenugreek seeds (*Trigonella Foenugraeci semen*) contain alkaloids, choline, bitter matter, mucus, fatty oil, protein and vitamin C (Máthé, 1975). Its medical use (especially externally) became widespread in the middle Ages and is now used only in veterinary medicine. Fenugreek seed was mentioned also as an official drug in European medical books (DAB, Ph. Helv., Ph. Hg. VIII., Ph. Eur. VII.).

The aim of our experiment was to evaluate how the content of *T. foenum-graecum* and the value of biomass changed in the three years studied as a result of nutrient replenishment, plant protection and irrigation.

MATERIAL AND METHODS

The 2018 experiment

Sowing was carried out on April 9, 2018 in the designated 100 m^2 plot in Kecskemét. We used the 2017 purchased fenugreek seeds for sowing. The field fenugreek experiment was set up in the Demonstration Garden of John von Neumann University, Faculty of Horticulture and Rural Development. During the research, the treatment calculated for the active ingredient (kg) is as follows: 300 kg / ha Mg. Fertilizer used: Novatec premium (15 N - 3 P_2O_5 - 20 K_2O - 2 MgO). The fertilizer was applied in two doses (April 17 and June 4) to make more efficient use of nutrient replenishment by our legumes. The weed-suppressing ability of fenugreek in the post-emergence period (1-3 weeks) is very poor, so we had to use chemical weed control. Pantera herbicide was applied at a dose of 3 l/ha in the 100 m^2 experimental plot. Time for protection was 26 April. Harvest of *T. foenum-graecum* took place on 3 July. At harvest, the fresh weight value of the mowed plant was weighed (kg) and then dried in a greenhouse in a ventilated place. The weight of the air-dried plants was measured on 2 August. The determination of the content values of the plants (macro elements) took place in the laboratory of the Soil and Plant Research, John von Neumann University, Faculty of Horticulture and Rural Development. Macro elements were determined by the ICP-OES method (Hüvely, 2005).

The 2019 experiment

The field fenugreek experiment was set up in early April 2019 in the Demonstration Garden of John von Neumann University, Faculty of Horticulture and Rural Development. Sowing time was 9-10 April. The treatment applied during the research was 300 kg/ha Mg. Fertilizer used was Novatec premium (15 N - 3 P_2O_5 - 20 K_2O - 2 MgO). The fertilizer was again applied to the open field in two batches for better utilization of the plant. Dates of application were 30 April and 21 May. An herbicide was also used in the second experimental year. Pantera herbicide was applied at a dose of 3 l/ha in the 100 m^2 experimental plot. Time for protection was 17 April. Harvest time for fenugreek was on 28 June. At mowing, the fresh weight of the plant (kg) was measured. The mowed plant was dried in a greenhouse in a ventilated place. The weight of air-dried plants was measured on 1 August. The determination of the content values of the plants (macro elements) took place in the Soil and Plant Research Laboratory of the University. Macro elements were determined using the ICP-OES method.

Data analysis

I. Soil sample

Soil samples were taken from the experimental area. The sample was tested in the laboratory of Soil and Plant Research of John von Neumann University, Faculty of Horticulture and Rural Development. The values of the soil sample are shown in *Table 1*.

Table 1

Soil characteristics of the experimental area (2018)

Denomination(1)	Measurement unit(2)	Value(3)
pH_{KCL}	-	7.61
K_A (Arany type bound)	-	28
water soluble salt(4)	m / m%	<0.02
humus	m / m%	1.43
$CaCO_3$	m / m%	2.62
NO_2-NO_3-N	mg / kg	1.43
P_2O_5	mg / kg	548
K_2O	mg / kg	104
Mg	mg / kg	106
Na	mg / kg	6.61
Cu	mg / kg	13.1
Mn	mg / kg	55
Zn	mg / kg	9.72
Fe	mg / kg	64.1
SO_4	mg / kg	8.4

1. táblázat: A kísérleti terület talajminta értékei (2018)
vizsgálat neve(1), mértékegységek(2), eredmények(3), összes só (vízben oldható)(4)

II. Description of the fertilizer (NovaTec premium 15-3-20 (+ 2MgO + 10S) + TE)

Fertilizer used in the research: NovaTec premium 15-3-20 (+ 2MgO + 10S) + TE. Fertilizer data: 15.0% total nitrogen (N); 8.0% ammoniacal nitrogen (NH_4-N); 7.0% nitrate nitrogen (NO_3-N); 0.0% urea nitrogen (NH_2-N); 3.0% phosphate (P_2O_5) soluble in neutral ammonium citrate and water; 2.4% phosphate (P_2O_5), water soluble; 20.0% potassium oxide (K_2O), water soluble; 2.0% total magnesium oxide (MgO); 1.6% magnesium oxide (MgO), water soluble; 10.0% of total sulphur (S); 8.0% sulphur (S), water soluble;

0.02% of total boron (B); 0.0% total copper (Cu); 0.06% total iron (Fe); 0.0% of total manganese (Mn); 0.01% total zinc (Zn); 0.8% nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP) for all NH_4-N and NH_2-N; low in chlorine (Cl).

Physical properties:

1, physical appearance: solid, granular
2, colour: purple
3, bulk density: 1.250 ± 100 kg/m^3
4, granulometry: 90% = 2-4 mm
5, average particle size (d50): 3.2 ± 0.4 mm
6, pH (1:10 in water): 4.5-5.5 (http[1])

III. Herbicide (Pantera 40 EC)

Name of the herbicide: Pantera 40 EC herbicide, Active substance content: 40 g / l quizalofop-P-tefuril, I. category.

The 2020 experiment

Sowing was carried out on April 9, 2020 in the designated 100 m^2 plot. The field experiment was set up in the Farm of the University of Szeged, Faculty of Agriculture in Hódmezővásárhely. During the research, the treatment calculated for the active ingredient (kg) is as follows: 300 kg / ha Mg. Fertilizer used: Novatec premium (15 N - 3 P_2O_5 - 20 K_2O - 2 MgO). The fertilizer was applied in two doses (April 15 and May 18) to make more efficient use of nutrient replenishment by our legumes. We could not harvest the fenugreek because our crop was destroyed due to significant wildlife damage (rabbit, roe). *T. foenum-graecum* is also used to feed wild animals (Makai et al., 2007; Makai et al., 2008).

Soil samples were taken from the experimental area in Hódmezővásárhely. The values of the soil sample are shown in *Table 2*.

Table 2

Soil characteristics of the experimental area (2020)

Denomination(1)	Measurement unit(2)	Value(3)
pH_{KCL}	-	7.28
K_A (Arany type bound)	-	44
water soluble salt(4)	m / m%	<0.02
humus	m / m%	2.83
$CaCO_3$	m / m%	4.3
NO_2-NO_3-N	mg / kg	5.2
P_2O_5	mg / kg	555
K_2O	mg / kg	251
Mg	mg / kg	240
Na	mg / kg	33.0
Cu	mg / kg	3.5
Mn	mg / kg	38
Zn	mg / kg	2.5
SO_4	mg / kg	<5.0

2. táblázat: A kísérleti terület talajminta értékei (2020)
vizsgálat neve(1), mértékegységek(2), eredmények(3), összes só (vízben oldható)(4)

RESULTS

The experiment of 2018-2019

In both years, fenugreek hatched within a week of sowing. We performed weed control in the 3rd week in 2018 and in the first week after emergence in 2019 so that the development of the crop would not be damaged by the weed. A further aim of our experiment was to quantify whether the fertilizer treatment increases the green mass of the plant and the content of macroelements accumulating in it. The biomass value and content value of fenugreek were the highest in the case of 300 kg / ha magnesium basic fertilizer treatment, which was previously indicated in the literature (Vojnich et al., 2019a, b). The effect of magnesium basic fertilizer treatment has been previously studied (Kiss, 1980, 1983; Verzárné and Kiss, 1980), according to which magnesium has an effect on plant growth and flowering.

In 2018, at the start of the harvest, the average height of the plants was 30 cm. On a plot of 100 m^2, the dry weight of the mown fenugreek was 19.5 kg. The results of the content values of the crop in the above-ground part (stem, leaf) are as follows: N = 3.53 m/m%, P = 0.457 m/m%, K = 1.11 m/m%, Ca = 2, 57 w/w%, Mg = 0.389 w/w% air dry matter. Previous experiments showed that the values of 150 kg / ha magnesium treatment (excluding Ca) were lower for 300 kg / ha Mg treatment, while the data for 450 kg / ha magnesium treatment decreased for N, P and K.

According to our observations, in 2019, the height of the fenugreek stock reached 50 cm. The dry weight after harvest was 32.8 kg. The effect of irrigation was more pronounced in the second experimental year, because *T. foenum-graecum* was able to develop in an even area without border effect. After examining the macronutrients, the following values were obtained: N = 2.71 m/m%, P = 0.340 m/m%, K = 1.14 m/m%, Ca = 1.57 m/m%, Mg = 0.294 m/m% air dry matter.

The experiment of 2020

We could not harvest the fenugreek because our crop was destroyed due to significant wildlife damage (rabbit, roe). *T. foenum-graecum* is also used to feed wild animals (Makai et al., 2007, 2008).

DISCUSSION

The experiment of 2018-2019

Based on our observations, the average height of the plant in the second experimental year was 20 centimeters higher than in 2018.

The development of the dry weight value was influenced by several factors, as a result of which the dry weight value increased by 41% in 2019. In addition to the 2018 designated plot area, a row of hedges stretched, so that due to the border effect, fenugreek could not develop smoothly.

Therefore, in 2019, the plot was relocated to another area. We increased the amount of seeds in the second year, as a result of which our area became almost completely weed-free after the plant protection control, and the stock developed evenly.

In 2019, the plot area was relocated 20 meters further in the John von Neumann University, Faculty of Horticulture and Rural Development Demonstration Garden, but this does not affect the soil values because the soil in the Demonstration garden is uniform. The change of the content values in the % of air dry matter of fenugreek in the two studied years is as follows: in the experiment of 2018 the values of nitrogen, phosphorus, calcium and magnesium are higher, while the value of potassium is lower than the values of macroelement in 2019.

As a result of the applied treatment (300 kg/ha of magnesium), the value of the green mass and the content value of fenugreek developed favourably. In the first year, the macroelement values dominated, while in the second year, the dry weight value dominated.

Without artificial irrigation, we would not have been able to produce such a biomass value as we achieved in the 2019 experiment (32.8 kg dry weight per 100 m^2).

The experiment of 2020

In field crops, a game repellent should be used to control game damage caused by rabbits, roe and deer. In the next experimental year, we will use game repellent.

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