

# Fenugreek in the Ecological Areas of Belarus and France

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**Abstract**—On the territory of France fenugreek is spread since long on a line from the Gironde to the Italian border. In Belarus experimental cultivation has begun since 2004.

Experiments with fenugreek variety Ovari 4 were conducted about time of sowing in order to study their growth, development, and evaluation of productivity in the North-east part of Belarus and Central part of France. Reaching full ripeness of seeds the plants of fenugreek in the Central part of France requires about 94-97 days. Average seeds yield of 2011-2012 is 1259kg/ha. Plant height is about 36.8cm. Plants were affected by aphid and in the high moist agro-climatic conditions by powdery mildew.

In North-east part of Belarus plants need 86-93 days to full ripeness. Plants of fenugreek have stem about 59cm. The average seeds yield of 2007-2009 was about 723kg/ha. Plants were resistant to aphid and diseases.

**Keywords**—Fenugreek, time of sowing, variety, yield.

## I. INTRODUCTION

FENUGREEK (*Trigonella foenum-graecum* L.) is the annual crop of the *Fabaceae* family. It is one of oldest medical and spice plant in India and Mediterranean region [2]. Although originally from south-eastern Europe and western Asia, fenugreek grows today in many parts of the world, including India, Egypt, Ethiopia, Morocco where it widely cultivated and occasionally in England [9], Russia, Canada and USA (see Table I).

TABLE I  
FENUGREEK PRODUCING AREAS

Regions	Countries
Europe	Austria, France, Germany, Greece, Portugal, Russia, Belarus, Spain, Swiss, Turkey, England, Hungary
Africa	Egypt, Ethiopia, Kenya, Morocco, Sudan, Tunisia
Asia	China, India, Iran, Israel, Japan, Liven, Pakistan
South America	Argentina
North America	Canada, USA
Australia	Australia

On the territory of France fenugreek is spread on a line from the Gironde to the border Italian. For Belarus it is new plant. Cultivation has begun since 2004 on the experimental field of Belarussian State Agricultural Academy [15] and 2006 on the Central Botanical garden of Academy of Sciences of Belarus [14].

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The herb is widely used in cooking as it adds a distinctive flavor to food is an appetizer and lends a good aroma to curries. Its extract used to flavor maple syrup in Germany, cheese Switzerland [13].

The plant is often used for the pharmaceutical industry. The seeds of fenugreek contain the most potent medicinal effects of the plant. Seeds are often used to increase milk supply [10]-[12]. Lots of researchers indicated fenugreek as plant with anti-diabetic effect [19]-[21]. The presence of steroidal saponins in fenugreek seeds stimulates ovulation and spermatogenesis [22].

Despite the exceptional agricultural importance of fenugreek in some Asiatic and North African countries, the data about genetic diversity and genetic relationship among these species is limited [7], [8].

For a long time fenugreek has been produced as the most favorite fodder plant in Eastern Mediterranean and subtropical climate countries. Plants have excellent adaptation abilities. In soft whether climate, it can survive during winter [16].

Fenugreek is a source of improved protein balance diet of animals. Fenugreek can be interesting for cultivation as a forage crop for many reasons: as a legume crop, which can profit soil for following crops by fixing nitrogen from the atmosphere [4]; as a dry land crop [5]; as a leguminous component of annual fodder mixtures in feeding for livestock [6]; and to produce the high quality forage, hay or silage [18].

Seeds of fenugreek contain 45-60% of carbohydrate, 6-10% of lipid, 20-30% of protein, 2-3% of alkaloid and also colin, bitter material, fatty acid, vitamins A, B, C, P [17].

## II. MATERIALS AND METHODS

During our experiments we studied how plants of fenugreek from the Hungarian ecological area adapted to the conditions of Belarus and France. Also we wanted to know whether or not variety of fenugreek Ovari 4 can be cultivated in France and Belarus and how it can be used in agricultural system.

Experiments were conducted in different agro-climatic zones: Northeast part of Belarus and Central part of France.

The variety of Fenugreek (*Trigonella foenum-graecum* L.) Ovari-4 has been chosen. The variety used in the studies was taken from University of West Hungary. The Hungarian variety Óvári-4 was awarded with a state certificate in 1994 [3]. The variety and the developed production technology were given patent protection.

Characteristic of variety:

**Ovari 4** is variety of Hungarian breeding. Plant is 50-65cm height. Stalk not downy, with lots of side shoots. Leaf is complex, with three leaflets. Leaves are green and toothed.

The weight of 1000 seed is 14.5g. Vegetation period is 90-100 days.

Experiments have been carried out on sward-podzolic lightly loamy soils of the experimental fields "Tushkovo" of Belarussian State Agricultural Academy (Belarus) in 2006-2009. In France fenugreek was studied for two years (2011 and 2012) on experimental fields (white limestone soil) of Laboratory for Research in Sciences of Agronomy and Biology (LARSAB).

Phosphorus and potassium were added (40kg P<sub>2</sub>O<sub>5</sub>/ha and 80kg K<sub>2</sub>O/ha) before cultivation. At the beginning of vegetation "start" dose of nitrogen (20kg N/ha) was added.

We have conducted experiments with fenugreek about time of sowing in order to study their growth, development, and evaluation of productivity in the North-east part of Belarus and Central part of France.

In conditions of Belarus, seeds were planted in the middle and end of Mai. We shall thus call periods as spring and late spring sowing. In conditions of France, we were sowing in the middle of March and beginning of April. We have used manual sowing. The row space was 35 sm.

Weeds control was manual. The seeding rate was 2 mln. seeds/ha.

The swathing harvest method was chosen. It consists in uprooting the entire plant and letting it dry completely before removing the seeds. This method helps to reduce loss due to the seed shatter [1]. The gained data were adjusted for moisture content of 14%.

The meteorological observation of growing seasons was carried out on meteorological station of Gorky, Mogilev region (Belarus) and LARSAB (France).

Meteorological conditions of research in Northeast part of Belarus: the vegetation period of 2008 was dry; other years were wet.

Meteorological conditions of research in Central part of France: the vegetation periods of 2011 and 2012 were enough wet.

### III. RESULTS AND DISCUSSIONS

Optimization of sowing date can increase yield of fenugreek. In conditions of Hungary the originator of variety suggest to sowing of fenugreek at the end of March [3]. In the Northeast part of Belarus we obtained the best result if sowing at the middle of May. There is link with climatic and soil conditions of the region.

Fenugreek is the dryland crop [5], but it needs enough moisture soil for beginning of vegetation. On French experimental fields, we have observed what the soil moisture as more important as soil warming for the beginning of vegetation of fenugreek. Enough warm soil with deficit of soil moisture continues stage of shoots to 10-14 days and more. While the plants sowing at both optimal conditions of soil had shoot period about 6-8 days.

To reach full ripeness of seeds, the plants of fenugreek in the North-East of Belarus requires from 86 to 93 days (see Table II). In general plants sowed at the late spring term had longer period vegetation (see Fig. 1). Results of Belarussian

experiments show that vegetation period was longer on 7 days.

TABLE II  
DURATION OF ORGANOGENESIS STAGES OF FENUGREEK VARIETY OVARI 4 IN  
CONDITIONS OF BELARUS IN 2007-2009

Stages of organogenesis, days	Spring sowing	Late spring sowing
Seeding - Shoots	7	6
Shoots - Formation of side shoots	18	19
Formation of side shoots - Budding phase	4	6
Budding phase - Flowering	3	3
Flowering - Development of seeds	29	30
Development of seeds - Ripening of seeds	32	35
<b>Total</b>	<b>86</b>	<b>93</b>

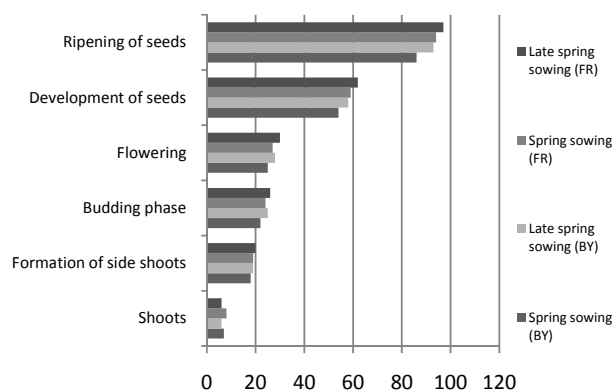


Fig. 1 Duration of organogenesis stages of fenugreek variety Ovari 4

At LARSAB, we noticed that difference of vegetation period duration compare to sowing term is not significant. The average of vegetation period duration is 96 days (see Table III).

We can notice that in conditions of North-east part of Belarus, plans of fenugreek have longer steam 59cm (see Fig. 2), compare to plants which were cultivated in central part of France (36.2-37.4 cm) (see Figs. 3 (a) and (b)).

The seed yield was recorded as 1352 kg/ha on variant with sowing date at the beginning of April (see Table IV). On experimental fields of LARSAB we obtain more efficient results, compare to results of Belarus.



Fig. 2 Plants of fenugreek on experimental field of "Tushkovo" (Belarus)



Fig. 3 (a) Plants of fenugreek before harvest sowed at the middle of March on experimental field of "LARSAB" (France)



Fig. 3 (b) Plants of fenugreek before harvest sowed at the beginning of April on experimental field of "LARSAB" (France)

TABLE III  
DURATION OF ORGANOGENESIS STAGES OF FENUGREEK  
VARIETY OVARI 4 IN CONDITIONS OF FRANCE IN 2011-2012

Stages of organogenesis, days	Spring sowing	Late spring sowing
Seeding - Shoots	8	6
Shoots - Formation of side shoots	11	14
Formation of side shoots - Budding phase	5	6
Budding phase - Flowering	3	4
Flowering - Development of seeds	32	32
Development of seeds - Ripening of seeds	35	35
<b>Total</b>	<b>94</b>	<b>97</b>

TABLE IV  
EFFECT OF TERMS OF SOWING ON BIOMETRICS AND SEED PLANT  
PRODUCTIVITY OF FENUGREEK VARIETY OVARI 4 IN CONDITIONS OF FRANCE  
IN 2011-2012

Biometrics and seed productivity	Spring sowing	Late spring sowing
Plant height, cm	37,4	36,2
Number of plants per 1 m <sup>2</sup> , PCs	106	104
Number of pods on the plant, PCs*	6,7	8,4
Number of seeds per pod, PCs	11,9	10,4
Seeds from 1 plant, PCs	79,7	86,6
Weight of seeds from 1 plant, g	1,1	1,3
Weight of 1000 seeds, g	15,7	15,8
Yield kg/ha**	1166	1352

Environmental conditions of Central part of France are very close to Hungarian ecological area. Plants of fenugreek have easier adapted to conditions of France and level of seeds productivity proves it.

We have obtain yield of seeds about 1166kg/ha at the spring term sowing. Observation of fenugreek shows that one plant forms two times more seeds per plant in France 79.7-86.6 compare 27.0-30.8 seeds per plant in Belarus.

We have noticed that plants which were sowing at the middle of March were affected by aphid (Fig. 4). It has reduced level of seeds yield of fenugreek.

The weather conditions of each year have had essential impact on the plants of fenugreek. The results of our test are shown that in the high moist agro-climatic conditions of France fenugreek was affected by powdery mildew (see Fig. 5).

Plants of fenugreek cultivated at the same environment conditions in Belarus were not affected by aphid and powdery mildew. The average yield for 2007-2009 of variant with spring sowing was about 784kg/ha and for late spring sowing – 662kg/ha (see Table V).



Fig. 4 Plants of fenugreek affected by aphid sowed at the middle of March on experimental field of "LARSAB" (France)



Fig. 5 Plants of fenugreek affected by powdery mildew on experimental field of "LARSAB" (France)

TABLE IV  
EFFECT OF TERMS OF SOWING ON BIOMETRICS AND SEED PLANT PRODUCTIVITY OF FENUGREEK VARIETY OVARI 4 IN CONDITIONS OF BELARUS IN 2007-2009

Biometrics and seed productivity	Spring sowing	Late spring sowing
Plant height, cm	59	59
Number of plants per 1 m <sup>2</sup> , PCs	175	170
Number of pods on the plant, PCs*	15,4	14,2
Number of seeds per pod, PCs	2,0	1,9
Seeds from 1 plant, PCs	30,8	27,0
Weight of seeds from 1 plant, g	0,45	0,39
Weight of 1000 seeds, g	14,5	14,5
Yield kg/ha**	784	662

It is necessary notice that Belarussian fenugreek forms its productivity by numbers of pods on the plant (14.2 – 15.4 pods per plant). At the same, time in France fenugreek provides its productivity by numbers of the seed in the pod

(10.4 – 11.9 seeds per pod).

Weight of 1000 seed is about 14.5g. Weight of seeds from the plant is around 0.4g.

#### IV. CONCLUSION

The results of our experience in France have shown that fenugreek variety Overy-4 was affected by aphid and that in high moist agro-climatic conditions fenugreek was affected by powdery mildew. Stable yield of seeds (1259kg/ha) is possible in combination of using of pesticides. Our research showed that fenugreek can be used in Belarus as a short term forage crop with period of vegetation about 86-93 days and yield of seeds is 723kg/ga.

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