Effect of different ecological environments on organic cultivated SoyBean (*Glycine max (L.) Merril*.)

EVA HUNYADI BORBÉLYNÉ[1]

Key words: soy bean, ecological factors, organic, yield elements

Abstract

Organic soy production-particularly for feedstock in organic animal husbandry is needed in Hungary as well as the rest of the EU. The crop area in Hungary devoted to soybeans has increased to almost 40.000 hectares. In 2012 organic cultivatation accounted for 491 hectares. For this research, we analysed the effects of ecological environment on yield potential factors. The greatest difference was seen in plant height and the number of pods per plant in the area receiving the lowest rainfall during the growth period. The nodes numbers were also impacted. Little difference was seen between varieties in droughty conditions while at the test site experiencing the highest precipitation, significant differences were observed. There was a strong positive correlation between the times of the flowering and the plant height and between the plant height and the number of pods.

Introduction

In recent years different protein sources have gained importance. Crop cultivation plays an important role in meeting the demand for many of these. In order to improve the quantity and the quality of yields; we must acquire a complex ecological attitude and exercise a more rational use of natural resources. To succeed requires favourable material, technical and social circumstances. The exploitation of genetic capability – as a form of renewable resource – is a fundamental method for increasing yields. To do this we must harmonize the biological needs of the given variety, its ecological attributes, with the circumstances of its cultivation.

Today, the soybean is one of the most important plant sources of protein and vegetable fats (Balikó et al. 2005). In the past decade the crop area in Hungary devoted to soybeans has increased to almost 40,000 hectares. In 2012 organic cultivatation accounted for 491 hectares. Organic soy production for feedstock in organic animal husbandry is needed in Hungary as well as the rest of the EU. Current production in Hungary is just 10 % of the market demand. In Hungary the 2-2.2 t/ha average yield appears to be static for the time being (Kurnik and Szabó 1987). According to Delate et al. 2008, over nine years of comparison, there was no significant difference in corn or soybean yields in the organic and conventional systems. The main reason for this appears to be related to variable weather conditions, most Hungarian soy production occurs under rained conditions. Unpredictable weather tests the genetic makeup of different varieties showing high amounts of variation under stressed conditions.

Soy is an excellent preparatory crop. It improves soil structure and leaves considerable nitrogen in the soil from residues for the following crop (Walter and Samuel 1980, Marcus-Wyner and Rain1983, Márton et al. 1990, Németh 1995). Soy is also a reliable crop, tolerant of temporary water excess and slightly tolerant to cold post establishment, but the symbiotic bacterium (Bradyrhizobium japonicum) need sufficient soil temperature to colonize root nodules (Zimmer et al. 2012).

Soy is demanding crop that responds well to physical and chemical soil improvement. The grain of present-day varieties contains on average 40-43% protein and 21% oil in by dry matter weight. For this research, we analysed the effects of ecological environment on yield potential factors of soybeans planted in Hungary.

Material and methods

In my work, I oversaw and summarized the research conducted at ÖMKI on-farm research sites in 2013. The objective of the research was to determine, via the examination of trials in different areas, the biotic and abiotic stress-factors that effect organic soybean yields with special attention to the traditional production regions and determine the specific varieties of soybean which favour these areas.

During the trial period, we recorded weather conditions, the time of flowering, the average number the pods per plant, the average number of seed per pod, the average number of branches per plant, the average plant heights, and relying on these we can state that there were significant differences. In the vegetation period of growth I surveyed the standing crop and compared the collected data on yield influencing characteristics

[1] Research Institute for Organic Agriculture (ÖMKi), Hungary, www.biokutatas.hu, eMail: eva.hunyadi@biokutatas.hu

using a statistical functions in Excel. I further explored their relationships to predicted norms for the trial sites. These data collected during the growth period will be combined with harvested yield data to determine the potential of varieties in specific agro ecological conditions.
The location of the research site

The observations were carried out at the 3 organic soybean farms. 2 research sites were in the west part of Hungary (Győrsövényház, Tornyiszentmiklós) and 1 research sites were located in the east (Földes). The soil of the research sites have different characteristics with relatively deep but poorly drained soils in the east and shallow soils with less water holding capacity in the west.
Beside soil conditions, profitable cultivation of soybeans depends on temperature, the amount of rainfall, and humidity during the period of flowering. In Hungary, the environmental conditions for soybeans are generally good during the vegetation period with ample time between frosty days of autumn and spring. Recently however, rainfall has been lower that the optimal 160-180 mm in summer.
In 2013, the period of this research, there was a long draught period between 15 June and 10 August. Precipitation ranged from 10-110 mm in the experiment areas, with the driest area in the northwest of Hungary, Győrsövényháza. Highest precipitation was observed in Tornyiszentmiklós, see Figure 1.

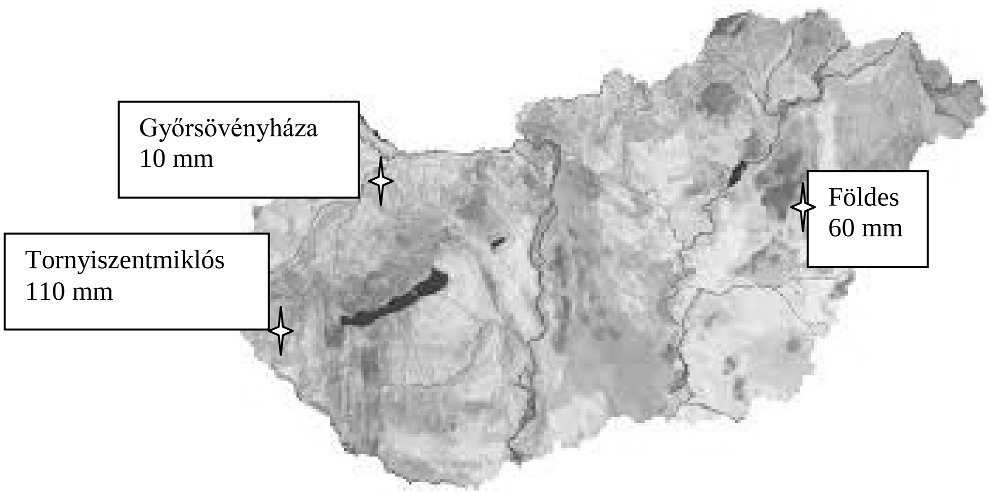

Figure 1: Precipitation in research area (15. 06 - 10. 08. 2013)

The circumstances of the research

Growing conditions varied (sowing time, sowing distance, row cultivation) at the different research sites (Table 1). On-farm research is intended to sample results from normal operation, so farmers were allowed to practice their standard production, see Table 1. In my work, I oversaw and summarized the research conducted at ÖMKI on-farm research sites in 2013. The objective of the research was to determine, via the examination of trials in different areas, the biotic and abiotic stress-factors that effect organic soybean yields with special attention to the traditional production regions and determine the specific varieties of soybean which favour these areas. During the trial period, we recorded weather conditions, the time of flowering, the average number the pods per plant, the average number of seed per pod, the average number of branches per plant, the average plant heights, and relying on these we can state that there were significant differences. In the vegetation period of growth I surveyed the standing crop and compared the collected data on yield influencing characteristics using a statistical functions in Excel –correlation with method of Pearson (Sváb 1981). I further explored their relationships to predicted norms for the trial sites. These data collected during the growth period will be combined with harvested yield data to determine the potential of varieties in specific agro ecological conditions.

Table 1: Growing system parameters in 2013

Research area	Földes	Győrsövényháza	Tornyiszentmiklós
Humus content of soil (%)	2.2	2	1.9
Previous crop	maize	buckwheat	winter wheat
Row spacing (m)	0.76	0.50	0.76

Results

Table 2: The average phenological parameters of soybean *(Glycine max (L.) Merril)* varieties (2013)

Variety	Length of flowering (days)	Plant high (cm)	Diverg. Nr.	Pods/plant Nr.	Seed/pods Nr.	Nodes/plant Nr.	1st pod h. (cm)
Győrsövényháza							
1*	34	50	0	5	2,2	7	6
2**	31	43	0.5	7	1,8	6	6
3***	31	55	1.5	6	1,6	9	9
4****	34	63	1.2	7	2,8	10	6
Mean	**33**	**52.8**	**0.8**	**6.3**	**2.1**	**8**	**8.6**
Tornyiszentmiklós							
1*	43	92	1.5	32	2,8	12	10
2**	40	75	0.5	14	2,4	13	9
3***	39	73	1.5	15	2,2	13	7
4****	48	95	1.2	26	2,8	12	11
Mean	**43**	**83.8**	**1.2**	**21.8**	**2.6**	**12.5**	**9.3**
Földes							
1*	51	100	1	35	2,9	14	8
2**	51	75	3	32	2,5	11	6.5
3***	51	85	4	32	2,3	12	8.5
4****	55	72	1	24	2,8	10	10
Mean	**52**	**83**	**2.3**	**30.8**	**2.6**	**11.8**	**8.3**

***** Pannónia Kincse, ****** Royalpro, ******* Hipro 15, ******** Isidor

The results of observations reveal that ecological factors can fundamentally influence the yield factors of soy bean as much or more than cultural factors. The greatest difference was seen in plant height (mean of 52.8 vs. 83.8 cm) and the number of pods per plant (mean of 6.3 vs. 30.8 pods per plant, see Table 2.) in the area receiving the lowest rainfall during the growth period. The nodes numbers were also impacted.

Little difference was seen between varieties in droughty conditions while at the test site experiencing the highest precipitation, significant differences were observed.

There was positive correlation (significant at $P<0.05$) between the times of the flowering and the plant height ($r=0.7506$) and between the plant height and the number of pods ($r=0.8703$, significant at $^*P<0.01$)). A positive correlation was found only in Tornyiszentrmiklós between the number of pods and yield ($r=0.8332$)*.

Discussion

In 2013, the yield was highly variable (Tornyiszentrmiklós: 1800 - 3492 kg ha $^{-1}$, Foldes: 1300 -1800 kg ha $^{-1}$, Győrsövényháza not evaluable- due to the dry growing season the seeds have not been able to develop), so the effect of the studied parameters on yields requires further analysis.

The different conditions in different geographical areas may influence yields decisively: however, they influence specific varieties in a different manner: yields were of Pannónia Kincse: 1400-3492 kg ha $^{-1}$, of Hypro 15 1800-2005 kg ha $^{-1}$:

Water stress has a primary role in determining the flowering period (difference was 19 day between the areas for the mean length of flowering) and in shaping of yield-elements (pods/plants and seed/pod were reduced by drought stress effect too. Favourable soil conditions however enable soybeans to utilize the rainfall from before the vegetation period so that high yields could be achieved even with less precipitation during the vegetation period.

References

Balikó S, Bódis L, Kralovánszky P (2005): A szója termesztése. Mezőgazda Kiadó, Budapest, 217p.

Delate K, Cambardella C, Chase C, Turnbull R (2008) Beneficial System Outcomes in Organic Fields at the Long-Term Agroecological Research (LTAR) Site, Greenfield, Iowa, USA. Poster at: Cultivating the Future Based on Science: 2nd Conference of the International Society of Organic Agriculture Research ISOFAR, Modena, Italy, June 18-20, 2008.

Kurnik E, Szabó L (1987): A szója, Glycine max (L.) Merril. Magyarország Kultúrflórája. Akadémia Kiadó, Budapest III.18.

Marcus-Wyner L., Rains DW (1983): Patterns of ammonium absorption and acetylene deduction during soybean developmental growht. Physiol. Pl. 59. K., 1. sz. 79-82. Copenhagen.

Márton L -Kismányoky, T.-Kádár, I. (1990): Testing the N-supply and N-turnover of soyabean in lysimeters. Plant production. 39: 55-64.

Németh T (1995): Talajaink szervesanyag-tartalma és nitrogénforgalma. MTA Talajtani és Agrokémiai Kutató Intézete. Budapest.

Sváb J (1981): Biometriai módszerek a kutatásban. Mezőgazdasági Kiadó Vállalat Budapest 551 p.
Walter,O.S., Samuel RA (1980): Modern soybean production. Champ, Illinois. USA.

Zimmer S, Messmer M, Haase T, Mindermann A,- Schulz H, Wilbois K, Heß, J (2012): Eignung von Bradyrhizobien-Impfpräparaten zur Inokulation von Sojabohnen. In: Pekrun, C.; Wachendorf, M.; Müller, T.; Utermann, J. and Düker, A. (*Eds*.) Mitteilungen der Gesellschaft für Pflanzenbauwissenschaften Band 24 Bodenfruchtbarkeit – Bedeutung und Bestimmung in Pflanzenbau und Bodenkunde, Verlag Liddy Halm, Göttingen, Deutschland, pp. 341-342.