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Lilianna Głąb, Małgorzata Gniadzik
Wroclaw University of Environmental and Life Sciences
l.glab@upwr.edu.pl

SOYBEAN CULTIVATION IN POLAND

Abstract

Soybean (Glycine max. L. Merr) is the most important legume in the world, it comes from South East Asia and was cultivated as early as 2800 BC. in China. It was first introduced to Europe in the 17th century as an ornamental plant. In the eighteenth century in France, Germany and Italy, its economic potential was recognized and cultivation began on a larger scale (Jasińska i Kotecki 1993, pp. 113-114). The popularity of soybean cultivation is due to the composition of seeds that are rich in protein (35-40%) and fat (18-22%). The content of these components determines the main directions of seed utilization in production of soybean meal and soybean meal extract (Boczar i Sznajder 2011, pp. 6-28).

Today, the largest soybean producers are the United States, Brazil, Argentina, China and India. Soybean area covers more than 118 million hectares in the world. Approximately 4.5 million hectares of soybeans are grown in Italy mainly in Italy and in Ukraine (USDA FAO 2014). Thanks to the use of genetic engineering new varieties are resistant to total and selective herbicides and insects (Carpenter 2010, pp. 319–321). Varieties cultivated in the Member States of the European Union are not genetically modified in any way

Keywords: poland, importance, economy.

Introduction

The first trials of soybean cultivation in Poland were undertaken in 1878 by Andrzej Sempołowski. The field experiment ended in failure - plants did not mature. In the seventies of the 20th century, further research was carried out at the Institute of Breeding and Acclimatization of Plants (IHAR) in Radzików, which resulted in obtaining soybean varieties with shorter vegetation period ie 120-130 days (Jasińska i Kotecki 1993, 113).

In recent years, a growing interest in soybean cultivation in Poland has been clearly observed. It is connected with the warming of the climate and the appearance of short-growing varieties. Poland, as a Member State of the European Union, may use seeds of varieties entered in the Community Plant Variety Directory (CCA). 35.

Poland imports about 2 million tons of transgenic soybean meal. For years, attempts have been made to make Polish agricultural producers independent of foreign deliveries. Council Ministers Resolution No. 222/2015 of 15 December 2015 establishes a multiannual program 2016-2020 "Increasing the use of national feed protein for the production of high-quality animal products under sustainable development", which main aim is development of legume agrotechnology. This program is a continuation of efforts to reduce the import of genetically modified feed and replace it with national protein sources. In addition, research results will be used for the purpose of disseminating modern crop technologies that take into account the possibilities of introducing integrated agricultural production.

Farmers deciding to grow soybeans can benefit from a special area payment for legume crops and the obligation to plant green beans. Greening is a new element in direct payments established by Regulation (EU) No 1307/2013 of the European Parliament and of the Council of 17 December 2013 laying down provisions for direct payments for the years 2014-2020. The very concept of greenery is defined as a payment for agricultural practices that are beneficial to the environment.

One of the main problems of soybean cultivation in Poland is the low settling of the lowest pods, which results in large losses at harvest. In addition, soybean as a thermophilic plant, has high thermal requirements and is sensitive to weather conditions. All these factors influence the instability of yielding (Hołubowicz-Kliza 2007, p. 29).

Nowadays, the economic importance of soybean cultivation in Poland can be attributed to maize cultivation in the past century. In the 1990s, the area of grain maize was closed within the limit of 50 thousand. ha. With the improvement of crop technology, the increase in the demand for grain has increased its area to over 0.6 million ha in 2013-2015 (Użytkowanie gruntów i powierzchnia zasiewów 2015, pp. 92-93).

1. Placement, tillage and soybean sowing

Soybeans prefer sites with a pH close to neutral (6.5-7.0), the highest yields being achieved on wheat complexes. It belongs to plants of fertile soils it does not tolerate heavy and flooded soils. Careful preparation of the position should begin in the fall. If the forecrop was a cereal plant, 8-10 cm of stubble and winter plowing to a depth of 22-25 cm should be used. In the case of maize forecrop, it is advisable to disk and plow at a depth of 25-30 cm. Due to the reduction of the risk of soil depletion, spring treatments are limited to harnessing and harrowing (Filoda i Mrówczyński 2012, 7-8). The timing of sowing is correlated with the soil temperature, soybeans as the heat-loving plant best sprouts at temperatures above 10 ° C. Depending on the region, the optimum sowing date is from April 20 to May 5.

Soybean sowing is done using cereal or spot drills used for beet and maize. The recommended width of the interiors is between 15 and 75 cm (AgroYoumis) or exactly 25 cm (Information Bulletin 2015, pp. 2-30), depending on the individual farmers. Disproportions are due to individual varietal characteristics eg: tendency to branching.

Sowing standards depend on the degree of seediness of the variety, the weights of 1000 seeds and their germination capacity. Typically, soybeans are sown in the quantity of 50 to 100 pcs /m^2. The recommended sowing depth is 3-4 cm. Deep sowing is unfavorable as it hampers uniform growth (Jasińska i Kotecki, 2003, p. 122).

The seed is most often sold in 150,000 seed units, which at a seedling of 60-70 seeds per m^2 is 4.0-4.5 U / ha.

Looking at soybean cultivation, it should be mentioned that plants belonging to the butterfly family can only co-exist with a specific species of papillary bacteria. In the case of soya, they are Bradyrhizobium japonicum. It is recommended to use a vaccine containing live cultures of papillary bacteria. The preparation accelerates the time when warts are formed on the roots (Martyniuk 2012, pp. 17-22), it facilitates the process of symbiosis, which in turn leads to an increase in the amount of nitrogen remaining in the soil. The positive effect of the vaccine on the protein content is also demonstrated. If you have not cultivated legumes for a number of years, it is essential to use the vaccine. Fields where the frequency of legume crops was greater did not require the use of vaccines. Papillary bacteria can remain in the soil for many years (Vance 1998, pp. 872-877).

The vaccines available on the market are peat based (Rizobin, Nitrazon) and vaccines that are liquid (Optimize, Hi Stick). In case of liquid vaccines the treatment can be made up to 3 months before sowing. Wet mills are used to carry out the proper grafting process (seeds wetted with the slurry) or dry (recommended dose for seed preparation). Using a peat based treatment, the treatment is performed on the day of sowing. Due to the high sensitivity of papillary bacteria to sunlight, the treatment process should be carried out in darkened rooms (Vaccine Label 2015).

Company Saatbau Linz, in response to the needs of agricultural producers, has introduced FIX FERTIG system inoculation seeds to the market. Seeds are coated with papillae with glue, which is a function of a preservative and protection against sunlight. This process is performed 6-8 weeks before sowing (Information Bulletin 2015, pp. 2-30).

2. Fertilization of soybeans

Nitrogen-bearing symbiosis, which has the capacity to bind atmospheric nitrogen, reduces the demand for soybean for mineral fertilization with this mineral ingredient (Lorenc-Kozik and Pisiulewska 2003 pp.131–142; Martyniuk 2012, pp. 17-22). The abundant papilla can deliver 100 kg of nitrogen soya (Podleśny 2005, pp.213-224). According to Korsak-Adamowicz et al. (2007, pp. 232–237) drought affected the process of symbiosis of papillomania bacteria with arable crops. Hungria et al (2006, pp. 927–939) presents the economic and ecological benefits of replacing nitrogen fertilization with seed vaccination with papillary bacteria. Both in Brazil and in other countries, mineral fertilization is associated with an increase in production costs. Adamska et al (2016, pp. 9-13) argues that for legumes, the largest share of direct costs is the purchase of mineral fertilizers. In soybean cultivation, the expenses incurred to meet the fertilizer requirements amounted to 16% of direct costs. The calculation included fertilization with potassium salt and superphosphate. Seed sown with nodular soymilk containing soybean was used and the use of the starting dose of this root was not used, which, at the high cost of mineral fertilizers, contributed to the reduction of the expenditure incurred. For comparison, in the case of traditional cultivation (using the nitrogen take-up rate) of yellow lupine fertilization costs accounted for 57% of the direct costs incurred. Apart from economic issues, the ecological aspect is also important. With heavy papillae, papillary bacteria can deliver 100 kg N / ha, which affects the limitation of mineral fertilization. The cultivation of this plant with the reduced amount of applied nitrogen fertilizers is included in the recommendations of the Nitrates Directive (Filoda i Mrówczyński 2012, p. 5).

The experiments of Lorenc-Kozik and Pisulewska (2003, 131–142) concerning nitrogen fertilization in the dose of 30 and 60 kg resulted in significant increase of soybean yield. According to Bobrecka - Jamro and Pizlo (1996, pp. 31–44) the highest yields were obtained when using atmospheric and mineral nitrogen. In turn, the results of Schmitt et al. (2001, pp. 983–988) and Freeborn et al. (2001, pp. 1200–1209) did not show the effect of nitrogen fertilization on the increase in the yield of seeds. In case of nitrogen fertilization, it is important to remember that too high a dose can prolong the vegetative period and consequently delay maturation. Excessive dosage of this element negatively affects the formation of root warts (Grzebisz 2011, pp. 104-105). In case of less intensive typing, it is recommended to use 40-50 kg N / ha top of the flowering nitrogen at the beginning of flowering (Filoda i Mrówczyński 2012, pp. 3-5).

The industry press reports that the best level of fertilization may be calculated based on the results of soil tests and nutritional needs of the plant. For the production of 1 t seed, soya needs: 75 kg of nitrogen, 25 kg of phosphorus, 35 kg of potassium, 20 kg of calcium, 10 kg of magnesium and 4 kg of sulfur.

Potassium and phosphorus fertilization should be done in the fall, before plowing 60-80 kg P2O5 / ha and 80-120 kg K_2O / ha. Microelements, such as zinc, molybdenum and boron, can be applied in foliar form during the budding phase. Many experiences (Lorenc-Kozik and Pisulewska 2003 pp. 131–142, Mandić et al. 2015, pp. 133–143) confirm the effectiveness of the use of foliar fertilizers to increase soybean yield.

– Boron (B) is a deficient micronutrient, plays a particularly important role in the formation of beetles in leg pulses. In addition, it participates in the binding of pods and limits their ability to crack. The application of foliar spray is recommended before flowering of the plants.
– Molybdenum (Mo) is an essential component of the enzyme complex - nitrogenase. Plants with this ingredient are characterized by more root warts, which translates into more nitrogen binding.

- Fields with low boron and molybdenum content can be fertilized in solid form (B-superphosphate borated or borax, mo-molybdatesodium or ammonium) or in the form of foliar feeding.
- Zinc (Zn) is a contributing factor to the activity of plant hormones - auxins, which deficiency causes plant growth retardation. Zinc deficiency affects the reduction in the number of branches, leading to a reduction in the number of flowers and educated pods.

It is not recommended to use fertilizers containing copper and manganese, as these ingredients pose a great threat to developing root warts (Grzebisz 2011, 85-121).

3. Soya protection

The degree of profitability of soybean cultivation depends to a large extent on the elimination of weed infestation. Weeds are a big competition for soya in the first month after sunrise, because the development of the plant is slow then. The period from the beginning of sunrise to the time of covering the soil by developing plants lasts from 40 to 50 days. In the case of neglecting the weed control process, yields of several dozen may be reduced (Jędruszczak 1996, pp. 72-81).

The main threats are weeds such as white kombut, rdests, field violets, cuddly cuddles, rough raspberries, rape seedlings, field mustard and cereal broom, single-grain weed and barnyard. The perennial weed species in soybean plantations can be predominantly of field thistle and perch.

In 2016, the number of authorized measures in soybean has increased. All registered products are registered in the region of minor crops area.

For about two years in soybean cultivation you can use:

- Sencor Liquid 600 SC (active substance: metribuzin, triazinone compound) - 600 g in 1 liter (52.2%).
- Boxer 800 EC (active substance: prosulfocarb, carbamate compound) - 800 g/l (78.43%)).
- Afalon dispersion 450 SC (active substance: linuron, - urea derivative compound - 450 g/l).

In 2016 on the list of authorized preparations appeared:

- Corum 502,4 SL (active substances: bentazone (compound of diazin group) - 480 g / l (43.0%), imazamox (imidazolinone compound) - 22.4 g/l (2.0%))
- Plateen 41.5 WG (active substances: metribuzine (triazine compound) - 17.5% (175 g/kg), flufenacet (oxy acetamide group) - 24.0% (240 g/kg)).
- Proman 500 SC (active substance metobromuron compound from phenyl urea group) - 500 g/l (41.02%))
- Stomp Aqua 455 CS (pendimethalin).
- Dual Gold 960 EC (active substance: metolachlor-S)
- Focus Ultra 100 EC (active substance: Cycloxide)
- Fusilade Forte 150 EC (active substance: fluazifop-P-butyl),
- Trivko (active substance: fluivifop-P butyl) (MRiRW)

In addition to chemical methods, a farmer may also apply mechanical weed control, which consists in harrowing during the 3rd trimester. It is cost-effective to take precautionary measures, ie to choose a position with low weed potential and the use of certified seed. The proper variety will provide relatively quick and united growth, which may consequently contribute to the reduction of weed infestation (Filoda i Mrówczyński 2012, pp. 8-9).

4.2. Pests in soybean cultivation

Soybean, as a relatively new plant in Poland, is not much threatened by pests. However, potential threats can be caused by: Aphididae, Ostrinia nubilalis Hübner, Soybean meal, Delia florilega Zett., Sitona sp., Agrstis ssp., Lygus rugulipennis Popp.) (Filoda i Mrówczyński 2012, 13-22).

According to the recommendations of the integrated soybean protection method, correct agricultural policy principles should be followed:

- applying proper shifting;
- weeding of the plantation and removal of crop residues, which constitute the wintering place of pests;
- deep plowing and frequent soil loosening, leading to the reduction of soil pests;
- intercropping.

Only careful execution of the above agrotechnical treatments allows reducing the occurrence of pests in the area of cultivation.

In 2016, licenses for use in soybeans received the following formulas:

- Kobe 20 SP,
- Lanmos 20 SP,
- Mospilan 20 SP,
- Sekil 20 SP,
- Ceta 20 SP.

The active substance is acetamiprid (compound of neonicotinoid derivatives - 200 g/kg (20%)).

According to the information on the labels, all newly introduced means are insecticides in the form of water-soluble, contact-and-stomach-like insecticides. The preparations are designed to control sucking and biting pests. On the plant they work surface, deep and systematic.

The recommendations for the date of use, the number of treatments, the maximum allowable doses and the pests susceptible to the above formulations are the same because they are preparations containing the same active substance. The only difference is the trade name used by manufacturers.

Below is a brief description of the use of preparations depending on the type of pest:

- Sitona spp.
  - Maximum recommended dose for single use: 0.2 kg/ha.
  - Number of treatments: 1.
  - Term of application: the agent should be applied at the onset of the pest, from the first to the 9th leaf stage (BBCH 11-19).
  - The larval feeding sites are root warts - they disturb the process of nitrogen fixation. The large number of larvae translates into a decrease in the number of pods that have formed.
- Alfalfa, aphid
  - Maximum / recommended dose for single use: 0.2 kg/ha.
  - Number of treatments: 1.
  - Term of application: The preparation should be applied during the onset of the pest, from the beginning of the flowering phase (about 10% of the flowers open) to the beginning of pod and seed development phases.

  - In the case of aphids (Aphidoidea) the threshold of economic harmfulness was set at 250 individuals per plant.
- Bean legato
  - Maximum / recommended dose for single use: 0.2 kg/ha.
  - Number of treatments: 1.
  - Term of application: The preparation should be used in the pod and seed development phase with a grace period (the first pod has reached the right length) (BBCH 70).

There may be bacterial, fungal and viral diseases in the soybean area. Currently, this problem does not occur in Poland, however, according to the recommendations of the "Methodology of integrated soybean protection", observations should be made in order to detect the risk early.

Company AgroYoumis has developed a soybean disease publication on the website that can be observed:

- viral diseases: soy mosaic and yellow soy mosaic;
- bacterial disease: bacterial soybean soot, bacterial spotting of soy;
- fungal diseases;
- diseases occurring in the early stages of plant development: gangrene, seedling;
- diseases that may occur in all phases of plant development: Anthracnose (Colletotrichum sp.), Ascychyta sp., Septorrhizae - Septoria Glycines;
- Fusarium (Fusarium spp.): Fusaric root gangrene and stem base (fusariosis);

– diseases that occur in the flowering phase: fusaric wilting (Vascular Fusariosis), cerkosporiosis (soya bean sprouts), soybean meal;
– diseases occurring during pod formation: purple cerkosporiosis of soybeans, fuzzy browning of pods (Agroyoumis Poland).

SaatbauPolska, an agribusiness handbook, is quoted on the risk of these diseases (Information Bulletin, 2015 pp. 2-30).

Currently one fungicide is permitted for use in soybean crops ie; Topsin M 500 SC (active substance: thiophanate-methyl - 500 g)

In order to limit the occurrence of the above diseases, it is necessary to use certified seed with a bacterial vaccine, follow the rules of proper agrotechnics and grow the right soils corresponding to the needs of soy.

4. Soy Collection and yielding in Poland

Soybeans cultivated in Poland matured in the period from the third decade of August to mid-September. The date of harvest depends on the cultivar cultivated and on the course of the humidity and thermal conditions. In the case of too early harvesting, the seeds do not reach the full accumulation of nutrients. Harvesting during full maturity of seeds determines higher yields, which is influenced by prolonged accumulation of mineral nutrients and increased seed weight. Delayed harvest influences the significant decrease of yield obtained (Filoda i Mrówczyński 2012, pp.20-24).

The complete maturity of the collection is confirmed by the total fall of all leaves. The pods are yellowish-brown in their interior (inside). Ripe seeds are yellow with a characteristic brown stamp.

Soya harvest is done in one step with a combine harvester set at a shear height of 7-8 cm, in the afternoon. Because of the susceptibility of soy to mechanical damage, the drum rotation should be set to 400-600 rpm. The speed of the harvester should not be greater than 3-4 km / ha. The harvest of soybeans adapted to a combine harvester at a speed of up to 3 km / ha allows yield losses of up to 22% to be reduced (Šařec et al. 2006, pp. 255-262).

Modern combine harvesters, such as the Case IH Axial-Flow 7240, feature a 3020 series cutter, which stands out from other products with a flexible cutting edge. In addition to the fully adjustable suspension system, it allows for perfect adaptation to variable ground contours. Due to the fact that the lowest soybean pods are suspended at low altitudes, this avoids losses during harvest. Company Case IH conducted a comparative experiment to check the level of damage and losses during manual and machine harvest. Samples obtained by manual harvesting included 98% of normal seeds and 2% of non-standard seed. In the case of machine harvesting, 96% of normal seeds of full use value and 4% of non-compliant seeds were obtained (Case IH 2014).

Company CLAAS offers a large selection of combine harvesters and other means need for harvest. The MAXFLEX 1200, 1050, 930, 770, 620 and 560 harvesters are designed for harvesting low-growing plants such as soybeans. Equipment features a flexible beveled beam, cutting angles for various operating conditions, continuous feeder adjustment and optionally the anti-splash plate makes almost all pods (CLAAS) come to the machine.

Humidity of seed to be stored should not exceed 12%, in case of harvesting seeds with higher humidity, it is advisable to suppress them (Rudziński 2011, pp. 113-126).

Table 1. Results of the different soybean cultivars in 2011-2016.

Variety	Seed plant (t/ha)					
	2016*	2015	2014	2013	2012	2011
Abelina	3,6	2,1	3,5			
Mavka	3,1	2,1	3,2	3,0	3,0	2,8
Aligator	3,7	2,0	3,8	3,2		
Madlen	2,9	1,8	3,1	2,8		
Aldana	2,6	1,8	3,0	2,6	3,0	2,6
Augusta	2,7	1,7	2,7	2,4	2,4	2,3
Protina	3,3					
Sultana	3,5					

Own studies based of the results of the Post-Variety Experimental Variety (PDO)

** Results based on initial yields of varieties in post-registration experiments*
http://www.coboru.pl/DR/PublWynikowPDO/WWPO_Soja_2016.pdf

Table 1 presents the results of 2011-2016 soybean harvest in Poland. In 2015 soybean yield was lower than in the remaining years, the impact was insufficient rainfall. In literature, many studies (Bobrecka-Jamro and Pizlo 1996, Bury and Nawracała 2004 pp. 415–422, Kołodziej and Pisulewska 2000 pp.759–776, Lorenc-Kozik and Pisulewska 2003, pp. 131–142; Michałek and Borowski 2006 pp. 459–471) confirm that soybean yields are significantly dependent on the course of humidity-thermal.

Summary

Analysis of available literature shows that soybean cultivation in Poland is possible and profitable. Available soybean varieties are well suited for growing in Polish climatic conditions. In addition, agricultural producers, who decide to buy seed, can count on comprehensive help from breeders. On the market there are also more and more agrotechnical guides or articles in the professional press.

In recent years the number of plant protection products that can be used in soybean has increased. Particularly important is admission of 4 insecticidesin September 2016. There is also growing interest in soybean cultivation among farmers. The impact has many factors, including. Economic, related to the possibility of obtaining subsidies or relatively low demand for soybean for mineral fertilization thus clearly reduces the costs of growing it. Contemporary agricultural producers, when deciding to grow soybeans, are aware of its positive effect on succeeding plants. The mineral wealth of the crop residue helps to reduce the fertilizer demand in subsequent years.

The right soybean technology is still being improved, which can be seen in creating ministerial programs (for example, "Increasing the use of national feed protein for the production of high quality animal products under sustainable development"). Construction of modern combines that, thanks to appropriate, sometimes dedicated equipment with flexible beams of scythe or cutters can mow lower and more accurately, thereby reducing losses.

All these measures show that soybean cultivation has a lot of potential and in the coming years there will be a growing demand for professionals specializing in the comprehensive cultivation of this plant.

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