

ECOLOGICAL POTATO IN POLAND

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Poland, owing to the clean environment on most of its territory and the relatively low chemicalization of agriculture, has favourable conditions for production of many crops in the ecological system, potato including. The share of potato in ecological plantations in Poland is about 16–18%, and the yield level is close to the country's average. Ecological farms are advised to produce profitably edible varieties of high quality and resistance to *Phytophthora infestans*. Potato cultivation in the ecological system should ensure good quality, including the sensoric assessment – size, taste and nutritional value – nitrate and heavy metal content, and also a good storage quality. Yields of potatoes produced in the ecological system are, however, characterised by a lower share of commercial tubers than those from conventional plantations.

potato; ecological system

In view of numerous hazards connected with food produced by conventional methods, there is a growing interest on the part of the consumer in food produced by ecological means. The production of ecological food offers a chance for the Polish agriculture in its competition with the EU agriculture. The ecological food market has been on the increase in many countries, e.g. in Germany ecological products constitute about 4% of the food industry's turnout.

The interest in ecological food in various EU countries is different. In those having worse natural conditions the importance of ecological agriculture is greater, about 8–9% in Austria, Sweden, Finland; and lower in countries with good climatic and soil conditions – France, Holland, Great Britain. The International Ecological Agriculture Organisation (IFOAM) is an international institution that integrates ecological organisations in the respective countries. In Poland the leading association is the Ecoland.

Poland has especially favourable conditions for ecological production due to the clean environment prevailing in the country, large labour force and low degree of chemicalization in agriculture at the present and in the past. In Poland, a great significance has devoted to been the establishment of the legal status of ecological agriculture by the 2001 regulation and introduction of subsidies to that kind of production. The first ecological farms came to being in 1990 and since then their number has been growing, most dynamically at the end of the 1990s. In 2002 the area of supervised crops in ecological farms, and those in transition to that kind of farming, amounted to about 54,000 ha. The most dynamic increase in ecological farms has been documented in the eastern provinces of Poland – Lubelskie and Podkarpackie, among others.

The problems of ecological production, potato including, meet with great interest of the scientific community, an example of that being the scientific conference “Perspectives of ecological production of potato in Poland” (Zesz. Probl. Post. Nauk Rol., 2002).

Potato is the main root plant among the species cultivated in the realm of the ecological system. Its production under the ecological system is supported by biological and economic reasons, because potato is a commercial crop in great demand on the market. In ecological farms in Germany the share of potato in cropping is three times that in conventional farms, and the economic estimation shows that the income from potato cropping in those farms is two or three times higher than that from corn cropping.

Potato produced in ecological farms, originally packaged and labelled, is characterised by high quality parameters, finds more and more consumers on the Polish market, and after EU accession, is expected to fill market niches in the Western countries as a product of special quality.

In Poland the share of potato in the crop structure in ecological farms, vegetables including, is about 16–18%, while the yield level is close to the country's average. Studies on potato cultivation in Polish ecological farms indicate that yields at the level of 25–35 t·ha⁻¹ are possible (Kus, 2003). A similar level of potato yielding in ecological cultivation is reported also by Siebeneicher (1997). The mean yielding of potato in ecological farms is, however, by about 10–40% lower than in conventional farms. The differences in potato yielding between ecological and conventional farms are greater and larger and more intensive is the conventional agriculture. The level of potato yielding in ecological farms shows, however, a greater variation in conven-

tional farms. It is mostly due to the use in conventional farms of mineral fertilisation and pesticides, which compensate to a large degree the negative effects of bad weather and mistakes in the agrotechnics. Lower differences in potato yielding between the two systems are observed when the conventional farm is less intensive or even an extensive one. The main factors causing lower potato yields in ecological farms are weed infestation and potato blight.

In eco-farms it is advisable and profitable to produce high-quality, edible potato varieties, of quality traits preferred by a consumer, of non-darkening flash and of, genetically established, broad resistance to diseases and pests. The varieties should also be characterised by good storage properties. One of the essential factors deciding on the variety choice for ecological production is resistance to potato blight. In the Polish set of early varieties there is a lack of varieties of high or improved resistance to that disease, although due to their short vegetation period the infestation by *Phytophthora infestans* (Mont.) de Bary does not cause significant losses in the yields (Chrzanowska, 2002) among the medium early varieties an increased resistance (above 4 in the 9 degree scale) possess the following varieties: Andromeda (4), Balbina (4), Tatra (4.5), Triada (4), Barycz (5), Baszta (5), Maryna (5), Mila (5), Oda (5.5). Of the medium late and late varieties predisposed are as follows: Ania (6), Anielka (6), Arkadia (5), Danusia (5.5), Salto (5.5), Beata (6), Zeus (6) and Wawrzyn (6). Other features that should be taken into account when selecting variety are: regular shape of tubers, depth of eyes, colour of flash, culinary type and share of commercial potato in total yield.

The basic aim of ecological agriculture, based on balanced plant and animal production, is to supply food products of the highest quality. The problem of agricultural products quality remains still open because is not fully defined. Here the difficulties stem also from methodical imperfections. The guarantee of an ecological product still remains a farm attest, which takes into account, among others, the farm location in a safe distance from emitters of pollution (industrial plants) and traffic routes, as well as the level of heavy metals concentration in the soil, in the range of natural contents. It is a principle of ecological farming that the way of production alone does not guarantee high quality of farm products. In the conditions at hand, a proper technology should ensure a good quality of potato, which includes a sensoric evaluation – size, taste, purity; and the nutritional and health value – nitrate and heavy metals content, as well as good storage properties. The rare publications of comparisons between the qualities of potato grown under ecological and conventional systems indicate advantages of the ecological cultivation as concerns storage losses, dry mass content, ascorbic acid and the biological value of protein, and also taste advantage. Lower content of nitrates and heavy metals, especially cadmium, in potato tubers from eco-farms is significant (Rembialska, 2000). Sawicka and Kus (2002), when

comparing the chemical composition of potatoes grown in ecological and integrated systems, did not find differences in the content of nitrates, but documented a lower level of nitrites in potato tubers from ecological production.

Potato tubers of the highest consumer value should be the aim of the agrotechnical treatments. One of the most essential agrotechnical factors deciding of yield level and tuber quality is fertilisation, the most of all amount of nitrogen available to plants as a result of organic substance mineralisation. In the ecological production system the high demand of potato for nutrients is met exclusively by organic fertilisation. The potato utilises organic fertilisers well, because they release nutrients slowly, making them available to plants throughout the vegetation season. The organic fertilisation applied to potato affects positively not only yielding and the development conditions of the plant, but also the whole crop rotation. The basic source of nutrients for potato in the ecological system is a well laid compost, manure or well mineralised biomass of green manure.

The organic fertiliser that contains the largest amounts of nitrogen and is commonly used in potato growing, no matter what the production system, is a well fermented manure. Multi-year investigations indicate that the optimum dose of manure can be assumed to be 25–35 t.ha⁻¹, taking into account potato demand and the fertiliser nutritional value. Depending on soil conditions and availability of nutrients, 25 t.ha⁻¹ manure on very light soils can ensure the yield in the range 16–20 t.ha⁻¹, and on more compact soils the same is enough for 25 t.ha⁻¹ tubers.

Aside of manure, the source of mineral components and organic substance can also be stubble catch crops. The efficiency of stubble catch crops, dependent on genetic traits of the varieties grown and length of the vegetation season, may vary from 2 to 8 t.ha⁻¹ of dry mass. The effect of catchcrops on potato yielding depends not only on genetic traits of the catchcrop plants but also on their chemical composition (Ceglarek et al., 1997). A markedly greater positive effect on yield is shown by papilionaceous plants – serradella, yellow lupine, vetch, horse bean and also mixtures of papilionacea with field pea, sunflower and phacelia. Successful stubble catchcrops applied in potato fertilisation allow to lower the manure dose to 10–15 t.ha⁻¹, especially on rich soils, and thus diminish the risk of tuber-quality worsening connected with increased concentration of mineral compounds of nitrogen, that may be caused by too high manure fertilisation. The yield-creating action of stubble catchcrops – serradella, ryegrass, phacelia, rape and mustard – combined with manure and compost was compared by Duer and Jonczyk (1998). Manure and compost, especially when combined with stubble catchcrop, favourably affected the level of potato yield. Among the catchcrops – serradella, ryegrass, phacelia, rape and mustard – distinctly higher yield-forming effects were exhibited by serradella. An especially favourable effect of catchcrops on potato yielding was ob-

tained, in the light of the studies mentioned, on light soils characterised by low level of yielding. In the system of ecological agriculture the combination of manure or compost with the organic mass of green fertilisers allows to cover the potato demand for nutrients and obtain yields in the range 20–35 t.ha⁻¹.

In ecological farms the basic organic fertiliser is compost. Mineral additives may be combined with compost. In the process of composting organic waste the content of ammonia nitrogen gradually decreases, and increases the content of nitrate nitrogen and soluble phosphorus. Composts are applied at 20–40 t.ha⁻¹ doses, without fear of overdosing. Fertilisation with nitrogen is advisable the most of all on the lightest soils, where the manure undergoes quick mineralisation. A ripe compost, aside of ploughing into soil, can be cast on ridges after emergence, after the last ridging. But compost applied before planting is more yield effective than that applied during vegetation (D u e r , J o n c z y k , 1998).

Potato, in order to develop properly and accumulate hydrocarbons well, requires ample supply of potassium, because it favourably affects the plant's health and storage properties of tubers. The soil potassium content can be increased by application of sulphate of potash magnesium and kainite.

The idea behind the ecological agriculture is the reproduction of planting material locally in the ecological farms. The overriding principle remains, however, like in conventional agriculture, a good quality of seed-potatoes. Therefore, the ecological farms should use healthy seed-potatoes, produced in attested plantations. A healthy seed-potato is the main element in protecting potato in this production system. The issue of seed-potato health as dependent on production system was in Poland investigated by S a d o w s k i et al. (2002). In the ecological production system the treatment of planting material with synthetic dressings is not allowed.

A factor that decides upon the yield level and commercial tuber yield is the time of planting. It depends on soil preparation and its good warming, as well as earliness of the varieties and the expected time of cropping. In regions with good climatic conditions, early varieties – also those for very early cropping, grown under plastic or agrofibre sheets – are planted as early as possible. The time of planting at the remaining varieties strictly depends on soil temperature. An obligatory treatment of potatoes for early cropping is the initial sprouting germination, and activation of those planted for later cropping. Planting density, the associated number of stems and architecture of the canopy are significant elements deciding on the share of commercial tubers in the yield. The number of stems per unit area depends, aside of planting density, on the size of the seed-potato and the number of eyes it has. Also on the genetic characteristic of the varieties. The number of eyes increases linearly with potato size, though various differences are important here. For the most edible varieties the best density for commercial tuber yield is about 200,000 stems/ha. Depending on the size of seed-potato (30–60 g) the planting density in a

row varies from 0.20 to 0.27 m. Studies conducted by Z a r z y n s k a and G r u c z e k (2000) indicate that planting smaller potatoes a bit denser decreases seed-potato consumption.

Plant density, which directly affects the yield level and structure of the tuber fraction, in the ecological agriculture system is also an essential element in weed control. Smaller inter-ridge distance and less plants in a ridge reduces the biomass of weeds and the amount of seeds they produce. Taking into account that aspect, and yield level and share of edible tubers, the transition to inter-ridges broader than 0.75 m, used in conventional cultivation, is not advisable for the ecological production system.

In ecological farms worthy of note is the plant bed culture, which consists in grouping of several ridges in a common plot, without necessary furrows between the ridges. This kind of cultivation preserves soil humidity and creates good conditions for tuber growth. In the yields from plant bed cultures the share of deformed and greenish tubers is lower, while the share of big (commercial) tubers is greater. However, the plant-bed culture system requires a special set of machinery.

Potato, owing to the initial slow rate of growth and cultivation in broad spaces of ridges, is exposed to strong weed infestation and for that reason requires careful cultivation. Cultivation treatments destroy the growing weeds and improve the physical properties of the soil, creating thus better conditions for the development of stolons and tubers. In the ecological cultivation of potato, weeds are controlled by preventive actions and direct mechanical weed destruction. The preventive weed control entails proper crop rotation, composting of organic materials, variety selection, supplementary catch crops, stubble catch crops and winter after crops, soil tillage and soil mulching and littering. The direct weed control in the ecological agriculture system is based on mechanical methods using the available cultivation tools – harrow, horse-comb, light harrow, spring-tooth harrow, with hoe and furrow plough after emergence. Weed control is the most effective in the seedling phase. Then the compact potato canopy prevents weed infestation. Scrupulous cultivation from planting to occlusion of rows diminishes the risk of secondary weed infestation. The secondary infestation can, however, occur, especially in plantations intensively fertilised with manure. Multiannual studies carried out in Poland (G r u c z e k , 2001) indicate that the mechanical way of potato cultivation, used in the ecological production system allows to obtain the general yield on the level of 22 t.ha⁻¹, with 18 t.ha⁻¹ for the commercial tuber share, though that kind of cultivation is very energy-consuming.

Another cultivation measure in potato growing is combating diseases and pests. One of the biggest potato pests is the potato beetle. In spite of numerous studies, no biological method, i.e. using natural enemy, for combating the pest has been found yet. Therefore, in ecological agriculture the use has been accepted of a preparation called Novodor, which contains resting spores and pro-

tein elements of the bacteria *Bacillus thuringensis* subsp. *Tenebrionis* (S o s n o w s k a, L i p a, 1999). This preparation is characterised by zero waiting and prevention period and does not pollute underground waters and soil, but its main drawback is the lack of effectiveness in fighting the older larva stages and cockchafers. The active substance in the preparation is the toxin produced by the bacteria.

A big problem in the ecological potato production is the potato blight. This pest should be fought with agrotechnical methods only, among others by selecting varieties of high resistance and short vegetation period, initial sprouting germination of potatoes and early planting term. The preparation Miedzian is signalled as admissible in ecological production.

The utilisation of the high yield-bearing potential of potato depends, among others, on meeting the potato water demands. In experiments carried out by B o r ó w c z a k et al. (1998) on watering potatoes, as dependent on fertilisation and protection, the potatoes grown without mineral fertilisation and plant pesticides gave a yield on the level of 32.08 t.ha⁻¹, while productivity of sprinkled water in this cultivation technique was 104.8 kg tubers/mm/ha, being about 6 kg higher than in the intensive techniques.

In the ecological cultivation of potato the cropping is carried out 3–4 weeks after the start of foliage wilting, which is connected with the process of natural ripening of the plants. During that period a layer of cork develops on the tubers. The foliage can, however, be totally destroyed by mechanical comminution. The process of potato gathering, independently of cultivation system, should avoid damaging the tubers and yield contamination. A great effect on yield quality has the temperature of tubers and the environment. The minimum temperature is 12 °C and optimum 15 °C. In this temperature range the mechanical damage index is the lowest.

Summing up the principles of the ecological cultivation of potato, one can state that it consists in keeping harmony between natural conditions and principles of correct agrotechnics without using mineral fertilisation and chemical plant pesticides.

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Ekologické brambory v Polsku.

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Polsko má díky čistému životnímu prostředí na většině svého území a relativně nízké chemizaci zemědělství příznivé podmínky pro ekologický systém pěstování řady plodin včetně brambor. Podíl brambor z ekologicky obhospodařovaných ploch v Polsku činí 16–18 % a jejich výnosová úroveň se blíží celostátnímu průměru. Ekologickým farmám je doporučováno pěstovat výkonné konzumní odrůdy s vysokou stolní hodnotou a odolností k plísni bramborové. Pěstování brambor ekologickým způsobem by mělo zajistit dobrou kvalitu včetně sensorických vlastností – velikosti, chuti a nutriční hodnoty – obsahu dusičnanů a těžkých kovů i dobrou skladovatelnost. Pro brambory z ekologického systému pěstování je charakteristický menší podíl tržních hlíz než u brambor z konvenčních ploch.

brambory; ekologický systém

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