Załącznik nr 4

Author's review of his own scientific and scholarly achievements

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1. PERSONAL DATA

Name and surname: Krystyna Zarzyńska

Date and place of birth: 9 March 1959, Młodzieszyn

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2. DIPLOMAS AND DEGREES

1983 Warsaw University of Life Science, Faculty of Agriculture (MSc)

1996 Institute For Potato Research in Bonin (PhD in agricultural science in agronomy)

OTHER FORMS OF EDUCATIONS

Completed English course preparing for the First Certificate, Warsaw 1998/1999

Completed training in statistics with the use of the Statistica program, Radzików , November 19-21,2002

3. PERSONAL LIFE

1983-1984	trainee	State Agricultural Farm in Leszno near Warsaw
1984-1989	technologist	Institute for Potato Research, Jadwisin Branch
1990-1996	assistant	Institute for Potato Research, Jadwisin Branch
12.1996	assistant professor	Plant Breeding and Acclimatization Institute, Jadwisin Branch
1985-2002	teacher	Agricultural High School in Serock (part-time)

4. DISCUSSION OF SCIETIFIC AND SCHOLARY ACHIEVEMENT

Pointing out the achievement following on from Article 16, Act 4, from 14th March 2003, concerning the degrees and titles in the arts (Dz U. Nr 65, poz 595 wit later changes)as well as regulation of the Minister of science and Higher Education dating back to 3 October 2014 concerning the details of mode and conditions of carring out activities in PhD, habilitation and full professorship award procedure (Dz.u.14.10.2014, poz 1389).

4.1. TITLE OF SCIENTIFIC ACHIEVEMENT

Environmental and agricultural conditions of yielding and quality of potato grown under the organic crop production system

4.2. PUBLICATIONS COMPRISING THE SCIENTIFIC AHIEVEMENT*:*

A. **Zarzyńska K**. 2006. Cechy odmian ziemniaka przydatne w produkcji ekologicznej. Problembooks on the Progress of Agricultural Sciences No. 511, part I. Potato food and industrial and its processing. Quality of Polish potato varieties: 73-81. (MNiSW=6 points)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 100%.

B. **Zarzyńska K. 2011**. Rola wybranych czynników agrotechnicznych w kształtowaniu jakości handlowej ziemniaków uprawianych w systemie ekologicznym. Bulletin IHAR 259: 243-250. (MNiSW=4 points)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 100%.

C. **Zarzyńska K.,** Szutkowska M. 2012. Rozwój chorób okresu wegetacji na ekologicznej i konwencjonalnej plantacji ziemniaka, a plon bulw. Journal of Research and Application in Agricultural Engineering Vol. 57 (4): 205-212. (MNiSW=5 points)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 70%.

D. **Zarzyńska K.** 2013. Chemical composition of potato tubers in relation to crop production system and environmental conditions. Journal of Agriculture Science and Technology B 3/10: 689-695. (MNiSW=7 points)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 100%

E. **Zarzyńska K.**, Pietraszko M. 2015. Influence of climatic conditions on development and yield of potato plants growing under organic and conventional systems in Poland. American Journal of Potato Research 92: 511-517 IF: 517. (IF=1,159, MNiSW=25 points)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 80%.

F. Grudzińska M., Czerko Z., **Zarzyńska K.**, Borowska-Komenda M. (2016) Bioactive Compounds in Potato Tubers: Effects of Farming System, Cooking Method, and Flesh Color. PLoS ONE 11(5): e0153980. doi:10.1371/journal.pone.0153980. (IF=2,806, MNiSW=35 points)
The own contribution included providing samples for analyzes, assistance in developing the results. I estimate my contribution to 10%.

G. **Zarzyńska K.**, Pietraszko M. 2017. Possibility to predict the yield of potatoes grown under different production systems on the basis of selected morphological plant development. Plant, Soil and Envinronment 4: 188-192. (IF=1,421, MNiSW= 30 points)

The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 80%.

H. **Zarzyńska K.**, Jończyk K. 2017. Yield and commercial tuber quality of potatoes grown under two crop production systems in different environmental conditions. Journal of Research and Applications in Agricultural Engineering Vol 62 (4). (MNiSW=12)
The own contribution included the development of the concept, methodology of research, participation in conducting experiments, data analysis, preparation of results and writing the publication. I estimate my participation at 80%.

Total amount of IF = 5,386
Total amount of The Ministry of Science and Higher Education Points = 124

4.3. DISCUSSION OF THE SCIENTIFIC ACHIEVEMENT

INRODUCTION

Organic farming means a way of farming with sustainable crop and animal production on the farm, based on biological and mineral raw materials not processed technologically. The basic principle of organic farming is the rejection of agricultural and food chemistry. Thanks to this, two basic goals are achieved, i.e.:

- environmental protection of agricultural production, soil, water and landscape, - high quality of agricultural products (primary) referring to the properties of products created naturally in nature without human intervention. The basic principles of organic farming are:
- the use of multilateral crop rotations with the participation of legumes (fabaceae) and saturated with poppies cultivated for green fertilizers
- selection for cultivation of species and varieties of plants adapted to the habitat, resistant to diseases and pests, with high competitive ability to weeds and frequent use of mixed crops,
- striving to increase the fertility and biological activity of the soil through the use of organic (natural) fertilization, multilateral crop rotation, appropriate soil cultivation, etc.,
- striving for closed circulation of organic matter and nutrients in the farm, understood as a whole (feed and fertilizer balance), in the protection of plants against diseases and pests, prevention (crop rotation, organic fertilization, selection of varieties) and the increase of the natural resistance of soil against pathogens due to its biological activity are of fundamental importance. It is allowed to use biological preparations (based on bacterial and fungal metabolites) and certain decoctions and plant extracts.

Global trends in agriculture are moving towards increasing organic and integrated cultivation. Poland has a very good basis for the development of organic farming. This is supported by the clean environment, unpolluted soils, the fragmented structure of our agriculture and the culture of agricultural production (not excessive intensification). In recent years, the development of organic farming in Poland is very dynamic. We are at the forefront of European countries both in terms of the number of farms and the area of cultivation. However, this increase is not even and does not affect all plants equally. One of the agricultural crops whose share in organic farming is small is potato, despite the fact that it still forms the basis for feeding a large number of Poles. The area of organic potato cultivation does not exceed 2 thousand ha and constitutes only 0.3% of total ecological arable land.

Potato belongs to difficult species in organic farming due to the high risk of pests, and the main ones are: weeds, potato blight and potato beetle. At every stage of cultivation, however, it is possible to protect plants by using non-chemical methods. They are less effective but it is possible to obtain yields at a profitable level.

The aim of the research was to show the basic problems of organic potato production, to refine the cultivation technology, to assess the yield and quality of the crop and to seek solutions to improve production. Research on organic potato cultivation was conducted in the Plant Breeding and acclimatization Institute, Department Jadwisin on the soil of the weak rye complex and in the Institute of Soil Science and Plant Cultivations, Osiny Experimental Station on the soil of the good rye complex.

I. Selection of potato varieties for organic farming.

The proper selection of varieties determines the success of organic potato production (Zarzyńska, Goliszewski 2006). One of the most important features of cultivars in organic farming is the high resistance to fungus *Phythophtora infestans* causing potato blight. The use of resistance to this disease is one of the elements of protection against the development of the disease. According to Kapsa (2005) varieties with the degree of resistance 7-8 (on a 9-point scale) may stay of unprotected in years with late appearance of blight, or limited protection may be sufficiently effective. Copper fungicides are allowed to protect potato plants from the late blight in organic crops, but their effectiveness is not as high as other fungicides. There are also limits on the use of copper, and in some countries a complete ban on its use. Therefore, in most countries where organic farming is more widespread, special breeding programs are being conducted in terms of their suitability for organic farming . In this respect, Poland has a slightly better situation. Our potato breeding was directed mainly at obtaining resistance to both viral and fungal diseases. Therefore, we have a large number of varieties with increased resistance to late blight, and recently the table Polish variety Gardena with immunity of 7 on a 9-point scale was predominantly used for organic production. In addition to resistance to late blight, the variety for organic farming should show a number of other features such as: high yield with nice tuber appearance and good taste and culinary values. In addition, it should quickly cover the soil to be competitive with weeds, have low soil and fertilizer requirements, and store well. Based on many years of experience in working on potato, two main criteria for selecting varieties for organic production have been established:

I. The growing season is so short that about 75% of the tuber yield is collected until the potato late blight.
II. Cultivation of varieties so resistant to late blight, so that chemical protection against this disease can be completely avoided or it would be sufficient to use permissible preparations mainly of copper to protect against large losses caused by this disease. In each of the criteria, slightly different characteristics are important. The developed criteria for the selection of varieties are given in the table 1.

Table 1. Features of varieties important in organic production

Selection according to the criterion:	
I (earliness)	II (resistance to *Phythophtora infestans*)
1. Fast rate of commercial yield creating	1. High resistance to late blight
2. Fast growth rate in the initial phase development	2. Fast growth rate in the initial development phase and a large overground mass
3. Good reaction to presprouting	3. Good quality
4. Good quality	4. High yielding potential
5. Small soil requirements	5. Small soil and fertilizing requirements
6. High resistance to viruses	6. High resistance to viruses
	7. Good storability

The selection of varieties according to the first criterion should be useful mainly for regions with favorable conditions for growing early varieties. In regions with less favorable conditions, the second criterion should prevail. In practice, it is difficult to find varieties that would have all the mentioned characteristics, but you should try to choose those that have as many desirable features as possible. The fast growth rate at the initial stage of development and the high overground mass of plants is closely related to the level of weeding (Zarzyńska 2006, Zarzyńska, Goliszewski 2007). From the point of view of the fight against weeds, the most varieties, with big mass of shoot preferably covering the soil, are most useful. No less important feature of varieties in organic crops is high- yielding potential. Low-yielding varieties in conventional production generally give low yields in organic production and the profitability level of growing such varieties is very small. From many years of research it appears that the yield of the same varieties grown in the organic system is about 20-50% lower compared to conventional cultivation (Gransedt and others 1997, Kuś, Stalenga 1998, Sawicka, Kuś 2000, Van Delden 2001). Even the most resistant and highly yielding varieties will not gain recognition in organic production unless they are characterized by high quality of tubers. Obtaining a very nice appearance of tubers is much more difficult here than in conventional cultivation. Prohibition of the use of chemical plant protection products often makes it impossible to obtain a crop completely free of symptoms of certain diseases, damage by pests, etc. Therefore, the greater importance is played by the selection of varieties, for example with increased resistance to common scab or rizoctonia (Stein-Bachinger and others 1997).

Criteria for the selection of potato varieties for organic farming are presented in the **publication A.**

II. The effect of environmental conditions on the development and yielding of potato plants cultivated in the organic system.

The factors that largely determine the size and quality of the potato yield grown in the organic system are the weather conditions prevailing during the growing season. Potato is a plant with relatively high water requirements and fertilizers (Baukema, Zaag Van der 1990, Millard, MacKerron 1986, Dzierżyce 1998, Trawczyński 2012). To obtain high yields, it is necessary not only the right amount of rainfall, but also their proper distribution. Water shortage or uneven supply of it inhibits the growth of plants, which has a direct impact on the tuber yield and its structure. The amount of potato water needs varies throughout the growing season. As the overgrowth of the plants grows, their water needs grow. The greatest demand for water comes from the period of establishing and further forming tubers. Calendar, for early varieties, this period is in June and early July, and for later varieties from the second decade of June to the end of August (Głuska 1998, Głuska 2004, Borówczak 2012). This period, called the critical one, determines mainly the amount of harvested crop. If we add restrictions on fertilizing to unfavorable water conditions, which is the case with organic production, we can expect an even stronger reaction of plants. When discussing the impact of the growing season conditions on plant development and the size of the crop, one can not overlook the impact of this factor on disease development, mainly potato blight, which causes the largest yield losses. So here, you can confirm the principle that the so-called "blight" years, i.e. years with high rainfall, are years of high potato yields. This is particularly true for conventional crops where it is possible to use pesticides and mineral fertilizers. In organic crops the situation is more complicated. As you know, the most fertile nutrient of plants is nitrogen. It should be noted, however, that the mineral forms of nitrogen are very labile in the soil and the occurrence of excessive rainfall during the growing season may help to rinse parts of this component to deeper soil layers, which may result in malnutrition of the plant and, consequently, the yield (Haverkot, Mac Kerron 2000, Goffart at al. 2008, Trawczyński 2009).

The influence of extremely different conditions of the growing season prevailing in 2012 and 2013 on plant development, the potato yield grown in two production systems, i.e. organic and conventional, is presented in the **publication E.** It was found that the values of all the studied morphological and physiological parameters of plants (plant height, LAI, SPAD, PAR) were significantly higher in the conventional system than in organic and significantly higher in favorable year 2012 compared to 2013 in both production systems. The largest differences concerned the aboveground mass and LAI, and the smallest degree of plant nutrition expressed in the SPAD indicator. Differences in the development of plants both between the production system and in the years of research were reflected in the tuber yield and its structure. Significantly higher yield was obtained in the conventional system, and compared years of research in 2012. Changes in the yield and tuber size distributions were, however, greater in the years of testing than in production systems. This concerned mainly a very large diminutive of yield, especially in the organic system. This confirms the view that in years with unfavorable weather conditions for the potato crop, higher yield losses are to be expected on organic plantations than conventional ones. The yield declines in the organic system in the literature relative to the conventional system range from 20 to 50%. In our research, in the year very unfavorable for yielding potatoes, the decline was almost 70%. The **publication G** assessed the possibility of predicting the yield of potato tubers cultivated in an organic and conventional system based on selected indicators of plant productivity. The significantly lower value of such plant development indexes as: LAI, SPAD and chlorophyll *a* fluorescence was also confirmed, and in plants growing in the organic system in comparison to the conventional system. It has been proven that the decrease in both chlorophyll content and chlorophyll *a* fluorescence was higher in the organic system than in the conventional one. The smaller assimilation area of leaves and lower photosynthetic activity of the leaves have contributed to a larger decrease in the yield of tubers grown in the organic production system. A positive correlation between the mentioned indicators and the yield in both production systems has been proven, but in the organic system these dependencies were slightly lower, which indicates a smaller possibility of predicting the tuber yield in this production system.

III. The development of fungal diseases during the growing season on an organic potato plantation.

Another, very important problem of potato cultivation in the organic system is the development of fungal diseases during the growing season, mainly potato blight and more and more often potato early blight. The disease that causes the greatest losses in potato cultivation is the late blight which is caused by the fungus-like organism of *Phytophthora infestans* (Oerke 1994, Erwin, Ribeiro 1996). In conventional crops, the fight against this disease is much easier than in organic ones due to the possibility of using a wide range of synthetic fungicides. In organic production, only copper preparations are allowed, but they can only be used in limited quantities. In most EU countries, including Poland, the applicable limit is 6 kg of pure copper per hectare, but in some countries there is a total ban on using these funds, eg Scandinavian countries, the Netherlands, or restrictions only up to 3-4 kg, eg Germany or Switzerland (IFOAM 2000, Tamm 2004). The loss of yield caused by the destruction of pathogens depends on the time and intensity of the infection. The earlier the infection of plants and better conditions for the development of the disease, the higher the loss. The way to avoid very large losses and obtain yield at an acceptable level is the use of agrotechnical methods such as: cultivating of varieties quickly harvesting, ie very early and early, use of sprouting and larger seed potatoes and cultivation of varieties with high resistance to this disease. The second disease of the growing season, which causes lower yield losses, is the so-called early blight caused by fungi from the Alternaria. In conventional crops, it does not play as much importance as in organic crops. This is due to the fact that the pathogen develops better on undernourished and physiologically older plants (Kapsa 2004, Kuczynska 1992, Osowski 2007). Nitrogen deficiency on the organic plantation and the use of sprouted seed potatoes therefore favors the development of the disease. The **C publication** assessed the rate of development of both diseases in 2010 and 2011 with different temperature and humidity conditions. In 2010, favorable conditions for the development of potato blight occurred only in August, and in 2011 already in mid-July. In the case of early blight, the opposite situation happened. Better conditions for the development of the disease were in 2010.The date of the onset of the first symptoms of late blight and early blight was also varied depending on the production system. In the organic system, the first symptoms of early blight occurred earlier than in the conventional system in both years of research. In the case of potato late blight, there were no such dependencies. The rate of spreading the late blight depended on the pressure of the pathogen. In the "non-blight" year, the development of the disease at the organic plantation was at a similar level as in the conventional system. In the "blight" year, these differences were much larger. The yield of tubers was closely related to the intensity of potato blight in individual production systems. The faster the rate of spreading the disease, the lower the yield. By conducting research on growing potatoes in the organic system for many years, it can be noticed that both the onset of infection and the development *of Phytophthora infestans* on the organic plantation is slightly slower than on the conventional one. This relationship is closely related to the development of aboveground parts of plants. Too strong development of the aboveground part (high supply of nitrogen) lengthens tuber initiation and plant maturation (Harris 1992, Marsher 1995, Millard 1986). It also prolongs the time of high humidity in the field, which promotes the development of potato blight (Ratke et al. 2000, Wright 2002). A slower rate of spread of the blight may be a positive effect of weaker plant development in the organic system. The development of the disease depends on the microclimate in the field (Lapwood, 1997). In an open, well-ventilated field, which is typical of lower plants, with less aboveground mass, the disease is slowed down, at least until it is shorted (Fry 1986). Confirmation of these dependencies was found in the so-called "non-blight", year i.e. 2010, when the rate of disease spread was similar, and in some cases even slower in the organic system than in the conventional one. In 2011, with strong pathogen pressure, the protection of potato with copper preparations was not sufficient and the rate of spreading the disease on the organic plantation was much faster than in the conventional one.

IV. Quality of potatoes from organic production

a) **Commercial tubers quality.**

The consumer interest in safer and better controlled methods of agricultural production, including organic and integrated farming, results from the loss of confidence in conventional food. The quality of potato yield consists of their commercial quality, i.e. the external appearance of tubers, the share of internal defects, chemical composition, nutritional properties, flavors, etc. From potatoes originating from organic production, we generally expect better tastiness and better nutritional values at a slightly worse a look (Rembiałkowska and others 2006).The use of natural fertilizers in the organic system, the use of crop rotation rich in perennial plants, and green manures contribute to the increase of some diseases, such as common scab or rhizoctonia and create better conditions for the development of soil pests (Gransed et al. 1997, Paffarth 2002, Stain et al. 1997). The yield from organic farming is generally characterized by poorer external quality, due to the greater diminution of tubers and their disease infestation due to the lack of complete chemical protection.

One of the most important skin defects, affecting the appearance of tubers is common scab. The tuber infestation depends to a large extent on the climatic and soil conditions prevailing during the growing season, especially the humidity conditions at the time of tuber formation. On lighter soils, infection is generally higher than on stronger soils but this is not the rule. The fertilization with manure also contributes to a greater infection of the tubers, hence it can be expected that on organic plantations the share of infected tubers will be larger.

Quite commonly occurring skin defect, although less affecting the appearance of tubers is black spot. The severity of this defect is related to the occurrence of *Rizoctonia solani* fungus. The fungus's development depends on the conditions prevailing during the growing season. Particularly wet and cool spring promotes the development of the disease. Black spot infection is not strictly related to the production system.

Another, most common defect of tubers are various types of defects. These include: deformations, secondary growth, cracks etc. These defects are most often caused by unfavorable plant growth conditions, mainly due to uneven water supply. The cultivation system itself does not determine in a fundamental way the number of such defects.

In organic crops, damage from pests is a common defect of tubers. It happens mainly when potatoes are grown on perennial plants, papilionaceous compounds with grasses, etc.

The share of green tubers depends to a large extent on their size. Large tubers are more exposed to light than small tubers. In the organic system, where a smaller and more diminutive yield is obtained, the share of tubers with this defect should therefore be smaller. On the other hand, in this system of cultivation, more mechanical treatments are made, often manually removing weeds, which exposes the tubers to exposure and the effect of light.When buying potatoes from both organic and conventional production, we can not assess them in terms of the share of internal defects. The basic ones are the rust spot and hallow hearts. These defects depend mainly on the genotype, but the quality of the soil and the weather conditions of the growing season have a large impact on their share. The production system itself is less important.

The commercial quality of tubers, i.e. the share of defects in the yield, was assessed in the **publication H**. It includes two production systems, i.e. organic and integrated, and two localities: Jadwisin and Osiny. For the majority of tuber defects, significant differences were found both between the production system and the place of cultivation. The climatic and varietal factor played a largest role. Such relationships are confirmed in the literature (Backinger and Werner 1997, Otto 2010, Zarzyńska, Wroniak 2007). In general, it was difficult to confirm better commercial quality in a particular production system in our work. The occurrence of some tuber defects was greater in the organic system, while others in the integrated system.

Summing up the research conducted over many years in two places in Poland, it can be concluded that the commercial quality of the crop, i.e. the share of tubers with various defects in it depends mainly on climatic and soil conditions and varietal characteristics, and less on the cultivation system.

b) Chemical composition of tubers.

Numerous studies conducted in the world and in Poland indicate that crops from organic production are more abundant in many bioactive antioxidant compounds that are valuable for health (Barański et al. 2014, Brown 2005, Hamouz et al. 2008 Lundegardh B., Prędka I Gronowska-Senger 2009, Wierzbicka A., Hallmann E. 2013, Wierzbicka A., Hallmann E. 2015). Antimutagenicity studies and animal studies also confirm that such products can have a positive effect on human health (Bradbury et al. 2014). It can therefore be said that organic farming allows us to obtain products with more favorable chemical composition, as a result we can assume (for which there is some evidence) that organic food has a beneficial effect on the health of farm animals and people (Średnicka-Tober and others 2015) The question arises what are the causes of qualitative differences between ecologically and conventionally grown plants. According to Worhington's most frequently cited theory (2001), the higher content of bioactive compounds in organic products results from the lower availability of mineral nitrogen for plants in the organic system in relation to the conventional one. When there is a lot of easily absorbed nitrogen in the soil, which takes place in a conventional system, they first produce compounds containing nitrogen, for example; proteins for normal growth and secondary nitrogen-containing metabolites, such as alkaloids. In the organic farming system, when the nitrogen content in the soil is lower, the metabolic processes in the plants change towards carbonaceous compounds, e.g. starch, cellulose and other secondary metabolites, such as polyphenols and terpenes (eg carotenoids) and other dyes or vitamins (e.g., vitamin C). In addition, organic production is activated by the natural mechanisms of the plant defense system due to the exclusion of the use of chemical protection. Plants then activate their natural defense system against diseases and pests, which is associated with greater synthesis of polyphenolic compounds. These compounds, including phenolic acids and flavonoids, play defense functions in plants, insight into allelopathic properties (in relation to other plants), and have the character of natural insecticides (in relation to pests attacking plants). In the soil, under the influence of organic fertilization, the activation of microflora and soil fauna takes place simultaneously, which helps to absorb certain metabolic compounds. Thanks to this, balanced ion pickup takes place, and this in turn, determines the beneficial composition of ecological raw materials.

Relevant requirements are imposed on the potato intended for direct consumption. It must be characterized by good sensory characteristics and have adequate nutritional value. This, in turn, depends primarily on their chemical composition. The components that determine their nutritional value are carbohydrate compounds, protein, vitamin C and minerals. A consumable potato should not contain or contain as little as possible substances harmful to health, ie glycoalkaloids, nitrates, heavy metals, pesticides (Leszczyński 2000). The main ingredient of the dry matter of potatoes is starch. Its quantity in table potatoes should not exceed 15-16% (Leszczyński 2000). The content of dry matter and starch in potatoes depends primarily on the variety, nitrogen fertilization and vegetation season (Zgórska, Frydecka-Mazurczyk 1985). Moderate mineral fertilization has no significant effect on the content of starch in tubers, while higher doses of fertilizer, especially nitrogen, reduce the content of this ingredient. Potato contains a large amount of vitamin C. It varies between 10-30 mg·100 g$^{1\cdot}$The importance of vitamin C in tubers is also influenced by the way of cultivation and fertilization. The use of high doses of nitrogen results in a lower content of this compound (Wyszkowski 1996). The content of nitrates in tubers is the basic feature according to which the quality of potatoes intended for direct consumption is assessed (Wierzbicka, 2008). The main factor influencing the accumulation of these harmful compounds is nitrogen fertilization. The climatic and soil conditions prevailing during the growing season and varietal properties also play a significant role. Glycoalkaloids (TGA) are naturally occurring substances in the entire Solanacea family. They are one of the elements of the multi-component immune mechanism of potato plants. TGA content above 100 mg · kg^{-1} in fresh tuber weight worsens taste, and concentrations above 200 mg·kg^{-1} can affect human health (Maga 1980, Friedman, Dao 1992, Friedman, Mc Donald 1997). The content of glycoalkaloids in tubers is determined by genetic and environmental factors (Frydecka-Mazurczyk, Zgórska 2002, Lachman et al. 2001, Nitihamyong et al. 1999, Zgórska et al 2006). Due to the high nitrogen fertilization, the content of glycoalkaloids may increase (Zrust 1997). The chemical composition of tubers depending on the production system, place of cultivation, climatic and varietal conditions was assessed in **paper D**. Among the studied factors, the climatic conditions of the growing season and varietal properties had the greatest influence on the chemical composition of tubers. These factors significantly differentiated the content of all tested components. The production system, ie organic and integrated, significantly differentiated the content of dry matter, starch, and vitamin C in potato tubers. However, it did not affect the content of nitrates and glycoalkaloids. The place of cultivation, i.e. mainly soil quality, was important in terms of dry matter content, vitamin C starch and nitrates. There was no significant effect of this factor on the content of glycoalkaloids. In **paper F** the influence of the potato growing system (organic, conventional), the color of the tuber flesh (white, cream, light-yellow and yellow) and the method of preparation (raw, boiling in water, microwave cooking and steaming) on the content of ascorbic acid, total polyphenols and antioxidant activity was investigated. It was found that the content of ascorbic acid depended mainly on the color of the flesh and the method of cooking. The highest amount of ascorbic acid was found in potatoes with yellow flesh cooked by steam. The yellow-flesh potato grown conventionally and baked in the microwave oven showed the largest loss of vitamin C. In potatoes from the organic system such losses were not observed. The dry cooking method (baking in the microwave) increased the content of phenolic compounds in potatoes by approx. 30% regardless of the color of the flesh and the production system. Antioxidant activity was significantly higher in organic potatoes (raw and steamed) than in potatoes from a conventional system. There was a significant correlation between the antioxidant activity and the content of ascorbic acid, but only in potatoes from the organic system. Such dependence did not apply to potatoes grown in a conventional production system. A positive correlation between antioxidant activity and polyphenol content was found regardless of the production system (conventional, organic). In conclusion, the highest content of bioactive compounds can be found in yellow-flesh potatoes grown in the organic system, steamed.

V. Possibility to improve the quality of the crop through agrotechnical treatments

The factors that limit the yield level and the quality of various agricultural plants in the organic system are the large restrictions on the use of pesticides, and the deficit of nutrients caused by the lack of use of mineral fertilizers. Therefore, one should look for other solutions that can contribute to the increase of both yield and its quality. The treatments that can largely compensate for these limitations are in the case of potato, for example, the proper preparation of seed potatoes, irrigation of plantations, or the use of organic soil fertilizers and effective microorganisms authorized in organic crops. Sprouting of seed potatoes is a particularly recommended treatment in organic production, because it speeds up emergence and initial plant development, which favors the so-called escape from the late blight, shifts the vegetation for a better period of sunshine, which increases photosynthesis efficiency and promotes higher yield. This allows better development of the root system, so better use of water and nutrients, increases plant resistance to virus infection and accelerates maturation, which in turn increases the resistance of tubers to mechanical damage and results in better tuber retention. The positive effect of the sprouting treatment on plant growth and crop yield in organic potato cultivation has been described by Zarzyńska (2002) and Zarzyńska and Goliszewskio (2007). A treatment that can help to improve the quality of tubers is irrigation of plantations. This treatment affects the increase in both the total and commercial yield of tubers. This irrigation operation is widely known in practice and confirmed by many authors (Głuska 1994, Gładysiak, Grześ 2006, Mazurczyk i inni 2007, Rębarz, Borówczak 2006, Zarzyńska 2006). The use of irrigation in organic potato cultivation can, however, have negative consequences. Irrigating increases the risk of potato blight and can cause leaching of nutrients from the rhizosphere to deeper soil layers. The ideal solution seems to be drip irrigation used in our research. Another factor that can improve the organic production of potato is the use of effective microorganisms. Most of the work on the impact of this factor in organic production concerns mainly the impact on the soil, improved yield and plant health. There are reports that the introduction of EM vaccine to the soil gives a number of positive effects, limiting digestive processes, accelerating metabolism, increasing the photosynthesis effect, increasing humus content, detoxifying soil contaminated with pesticides, inhibiting the development of plant pathogens, and raising the biological quality of plant yields (Kucharski, Jastrzębska 2007). The influence of this factor on the quality of potato tubers is reported, by Boligłowa (2005) who confirms the positive impact of EM on limiting the entry of potato blight and common scab. In the **publication B** the influence of such factors as: presprouting of seed potatoes, irrigation of plantations, application of effective microorganisms on the share of tuber defects in the yield from an organic plantation was assessed. The most important factor determining the commercial quality of tubers was the varietal factor. However, it was found that the commercial quality of tubers cultivated in the organic system can be improved by applying additional cultivation measures. The irrigation of the plantations proved the most effective treatment of tubers quality. The presprouting of seed potatoes and the use of effective microorganisms had a slight impact on the contribution of external and internal defects to tubers.

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The publications that make up my scientific achievement may contribute to the dissemination of organic potato production. The main problems of organic farming demonstrated in the achievement are often the subject of investigations of farmers cultivating potatoes in this production system. Providing tips such as: characteristics of varieties that should be taken into account in the selection for cultivation, problems of plantation protection, factors determining the quality of the crop can help in deciding whether to turn the crop into an organic one.

The developed scientific achievement may also contribute to raising public awareness of the health-promoting properties of potatoes cultivated in the organic system. Until recently, potatoes were treated as a low-grade vegetable. In recent years, thanks to the transfer of knowledge about their pro-health properties, this perception changes. Potatoes are still the basis of feeding a large group of society in Poland (mainly older people). Consumption of organic potatoes with increased health benefits may have a positive impact on their health. The benefits of environmental protection are also important. A very large limitation or complete absence of agricultural chemistry in organic crops undoubtedly contributes to the improvement of the world around us.

4.4. DISCUSSION OF OTHER RESEARCH ACHIEVEMENTS THE RUNNING OF SCIENTIFIC ACTIVITIES

Other publications related to organic potato cultivation

A. Publications concerning the evaluation of varieties

Research on organic potato cultivation has been carried out in the Jadwisin for 15 years. At that time, over 30 varieties were tested in the three-year cycle. Most publications on this subject therefore include a three-year period. The varieties were examined mainly for their suitability for cultivation in the organic system under different climatic and soil conditions but also other aspects such as: varietal differences in plant development and weeds' level, varietal variation in plant productivity indicators, variations in response to selected agronomic factors were assessed , variations in yield level and structure. The variety factor has always played a significant role. In many works it was emphasized that proper selection of a variety for cultivation in an organic system is an essential factor determining the success of production. One of the works compares the usefulness of Polish and foreign potato varieties from the same groups of earliness to organic farming. Most of the features that determine this usefulness are included in this assessment. The significance of the diversity of Polish and foreign varieties in terms of developmental features of plants has been proved. Polish varieties were characterized by a higher above-ground mass and a higher LAI index. In organic production, the Polish varieties yielded at a higher level and had a better yield structure, i.e. a higher commercial yield and a higher yield of large tubers compared to western varieties. No significant differences were found regarding the commercial quality of tubers, i.e. the share of external and internal defects of tubers depending on the origin of the varieties. It was found that in the climatic conditions of Poland, the best varieties for cultivation in the organic system are domestic varieties. One of the works summarizes the 12-year research period, in which 30 potato varieties cultivated in the organic system in two places were assessed. It was found that the yields depended mainly on atmospheric conditions in the study years and on the variety. The place of cultivation itself did not matter. The average yield obtained in both locations (Jadwisin, Osiny) was similar and amounted to 23.7 t/ha for Jadwisin, and 21.7 t/ha for Osiny. The yield stability was higher on the stronger soil.

A list of publications on issues related to the assessment and selection of varieties for organic production:

Zarzyńska K., Goliszewski W. 2006. Rola odmiany w ekologicznej uprawie ziemniaka Journal of Research and Applications in Agricultural Engineering, Vol.51(2): 214-219.

Zarzyńska K., Gliszewski W. 2007. Jak wybierać odmiany do ekologicznej uprawy ziemniaka. Ziemniak Polski 2: 11-14.

Zarzyńska K., Goliszewski W. 2008. Ocena przydatności kilku odmian ziemniaka do uprawy w systemie ekologicznym i integrowanym na różnych kompleksach glebowych. Journal of Research and Applications in Agricultural Engineering, Vol 53 (40): 148-153.

Zarzyńska K. 2011. Porównanie wybranych polskich i zagranicznych odmian ziemniaka w uprawie ekologicznej. Journal of Research and Applications in Agricultural Engineering. Vol 56 (4): 208-212.

Goliszewski W., **Zarzyńska K**. 2012. Znaczenie odporności odmian ziemniaka w ekologicznej produkcji sadzeniaków i praktyczne zaleczenia agrotechniczne. Ziemniak Polski 2: 16-19.

Zarzyńska K., Goliszewski W. 2013. Reakcja kilku odmian ziemniaka na uprawę w systemie ekologicznym. Journal of Research and Applications in Agricultural Engineering, Vol 58 (4): 146-151.

Zarzyńska K. 2013. Dobór odmian ziemniaka do uprawy ekologicznej- rozdział w książce pt. ,,Ekologiczna produkcja ziemniaka'' pod redakcją W. Nowackiego: 63-75. Wyd. popr.

Zarzyńska K., Goliszewski W. 2014. New potato cultivars under organic system- evaluation of suitability, Journal of Research and Applications in Agricultural Engineering, Poznań, vol 59(4):126-131.

Zarzyńska K., Goliszewski W. 2015. Odmianowe zróżnicowanie produktywności roślin ziemniaka uprawianych w systemie ekologicznym i integrowanym. Fragmenta Agronomica 32 (3): 113-120.

Zarzyńska K., Goliszewski W. 2015. Cultivar-environmental determinants of potato yielding under organic system. Journal of Research and Applications in Agricultural Engineering, Poznań, vol 60 (4): 135-140.

Zarzyńska K. 2017. Zmienność plonowania odmian ziemniaka w systemie ekologicznym w wybranych mezoregionach Polski. Ziemniak Polski 2: 9-15.

Zarzyńska K. 2018. Ocena przydatności nowych odmian ziemniaka do uprawy ekologicznej. Ziemniak Polski 1: 16-22.

B. Publications on agrotechnics, including potato plant protection in an organic production system

This group of issues dealt with such problems as: the role of seed potatoes preparation, disease development on organic plantations and methods of their control, evaluation of weed infestation and methods of weed control, the impact of agrotechnical treatments on the yield and its structure, healthiness of seed potatoes from organic production. In one of the works, the level of secondary weed infestation was assessed on organic and integrated plantations under different climatic and soil conditions. Significant differences in the level of secondary weed infestation depending on the potato production system and the soil complex have been proven. The largest mass of weeds and the greatest species diversity were found in the organic system on heavier soil. The lowest level of weed infestation was recorded in the integrated system. Significant differences in weedness were shown depending on both cultivar and environmental conditions. The least level of weeding was observed in later varieties with a large overground mass. It was found that despite the greater weed infestation in the organic system compared to the integrated system, the mechanical method of weeds control in an organic plantation proved to be sufficiently effective.

In one of the paper, the differences in the development of plants cultivated in the organic and conventional system and their impact on the rate of spread of the potato blight were assessed. It was found that plants cultivated in the organic system were characterized by lower ground mass and lower values of productivity indicators, which consequently affected lower yields. A positive consequence of this was the later appearance of the first symptoms of the late blight and the slower rate of its spread. Among the agrotechnical treatments, the biggest impact on the yield of tubers and its structure (as in the case of the quality of tubers) had an irrigation operation. This was confirmed in two works.
The healthiness of seed potatoes is a big problem in organic potato production. There is no certified seed material and it is common practice to use the so-called derogation that allows the use of organic seed potatoes from conventional production. In our research we evaluated the occurrence of aphids - vectors of viruses on organic and integrated potato plantation and their impact on the health of seed potatoes. Very large infestation of tubers with viruses has been shown. It was also found that in the 3rd hazard zone in which potatoes were cultivated, organic seed production of varieties with low resistance to viruses is practically impossible. In such difficult conditions, it is only possible to produce seed potatoes of varieties with a minimum resistance of 6.5 (on a 9-point scale) to leaf-roll virus and 7 to Y virus. List of publications on the issues discussed:

Zarzyńska K. 2002. Przygotowanie sadzeniaków ziemniaka uwzględnieniem produkcji ekologicznej. Zesz. Prob. Post. Nauk Rol. 489: 103-111.
Zarzyńska K., Goliszewski W. 2005. Porównanie skuteczności różnych metod zwalczania agrofagów ziemniaka na plantacjach ekologicznych. [W:] Monografia, tom 2. ,,Wybrane zagadnienia ekologiczne we współczesnym rolnictwie".PIMR, Poznań: 275-284.
Zarzyńska K., Goliszewski W. 2005. Rozwój roślin ziemniaka w zależności od systemu produkcji, jakości gleby i odmiany. Biul. IHAR 237/238: 133-141.
Zarzyńska K., Goliszewski W. 2006. Problemy zwalczania agrofagów ziemniaka na plantacjach ekologicznych. Ziem. Polski 2: 20-23.
Goliszewski W**., Zarzyńska K**. 2006. Zdrowotność sadzeniaków pochodzących z plantacji ekologicznej. Ziemniak Polski 4: 17-20.
Zarzyńska K., Goliszewski W. 2007. Wpływ sposobu przygotowania sadzeniaków na rozwój roślin i plon bulw ziemniaków uprawianych w systemie ekologicznym na różnej kategorii glebach. Journal of Research and Appications in Agricultural Engineering, Poznań, Vol.52 (4): 104-108.
Zarzyńska K., Goliszewski W. 2007. Zachwaszczenie plantacji ziemniaka w zależności od systemu uprawy i kompleksu glebowego. Biul. IHAR 246: 95-105.
Goliszewski W., **Zarzyńska K**. 2008. Występowanie mszyc - wektorów wirusów na ekologicznej i integrowanej plantacji ziemniaków a zdrowotność sadzeniaków. Journal of Research and Appications in Agricultural Engineering. Vol. 53 (4): 148-153.
Zarzyńska K. 2009. Problemy ekologicznej uprawy ziemniaków w Polsce i krajach UE. Ziemniak Polski 3: 28-32.
Zarzyńska K. 2009. Wpływ wybranych zabiegów agrotechnicznych na rozwój roślin i plonowanie ziemniaków w systemie ekologicznym. [W:] Wybrane zagadnienia ekologiczne we współczesnym rolnictwie. Monografia, tom 6 PIMR, Poznań: 27-32.
Zarzyńska K., Goliszewski W. 2011. Rola wybranych zabiegów agrotechnicznych w kształtowaniu wielkości i struktury plonu ziemniaków uprawianych w systemie ekologicznym. Ziemniak Polski 3: 16-20.

Nowacki W, Goliszewski W, **Zarzyńska K**, Trawczyński C, Wierzbicka A, Szutkowska M, Barbaś P. 2012. Ekologiczna produkcja ziemniaka pod red. W. Nowackiego. Warszawa, 168 ss.

Zarzyńska K. 2013. Plonowanie ekologicznych plantacji ziemniaka – rozdział w książce pt. „Ekologiczna produkcja ziemniaka" pod redakcją W. Nowackiego: 155-174. Wyd. popr.

Zarzyńska K., Szutkowska M. 2013. Developmental differences, yield and late blight (*Phytophthora infestans*) infection of potato plants grown under organic and conventional system. Journal of Agricultural Science and Technology A, vol.3/4: 281-290.

Zarzyńska K., Pietraszko M. 2014. Zaraza ziemniaka na plantacji ekologicznej i konwencjonalnej w latach o zróżnicowanej presji patogenu, a plon bulw. Ziemniak Polski 4: 8-15.

C. Publications on the yield quality

In the publications concerning the quality of the yield of tubers from organic production, both the commercial quality and chemical composition of tubers were compared in relation to other production systems, climatic and soil conditions, or agrotechnical factors. Most of the works showed better chemical composition of tubers coming from the organic system at the expense of worse appearance of tubers. However, a higher content of dry matter or starch was not always proved. Almost always, however, a higher content of bioactive compounds, including vitamin C, was found. Most works showed significantly lower content of nitrates. One of the paper in which it was shown that in the tubers coming from the organic system, the nitrate content may be very high. This is due to many factors. On heavier soils, in order to balance nitrogen in the whole crop rotation, a general saturation with fabaceous plants is generally used. Potato is the plant that comes in rotation immediately after manure or compost, so in such cases, the dose of organic nitrogen may turn out too large for this plant and it will not be able to convert it into a crop. So it stays in tubers in the form of nitrates. This applies mainly to early varieties with a short vegetation period. The problem becomes even more serious in years with low precipitation and high temperatures. This was the situation on the heavier soil in Osiny. Another anti-nutritional ingredient in potato tubers is glycoalkaloids. The content of glycoalkaloids in most cases was not strictly related to the production system, mainly with varietal properties and weather conditions prevailing during the growing season. List of papers on the issues discussed :

Zarzyńska K., Goliszewski W. 2005. Jakość plonu i problemy ekologicznej uprawy ziemniaków na różnych typach gleb. Ziemiak Polski 1: 25-27.

Rembiałkowska E., Świetlikowska B., Kazimierczak R., **Zarzyńska K.,** Goliszewski W. 2006. Ocena wybranych cech jakości ziemniaków pochodzących z produkcji konwencjonalnej, ekologicznej i integrowanej. Monografia, tom 3: Wybrane zagadnienia ekologiczne we współczesnym rolnictwie, PIMR, Poznań: 112-122.

Zarzyńska K., Goliszewski W. 2007. Uprawa ziemniaków w systemie ekologicznym i integrowanym a jakość plonu bulw. Pamiętnik Puławski 142:617-626.

Zarzyńska K., Wroniak J. 2007. Różnice w jakości plonu bulw ziemniaków uprawianych w systemie ekologicznym w zależności od niektórych czynników agrotechnicznych. Journal of Research and Applications in Agricultural Engineering, Poznań, Vol 52 (4): 108-114.

Rembiałkowska E., **Zarzyńska K**., Goliszewski W., Świetlikowska K., Kazimierczak R., Wasiak-Zys G. 2007. Porównanie jakości sensorycznej wybranych odmian ziemniaków jadalnych pochodzących z produkcji ekologicznej, konwencjonalnej i integrowanej. [W:] Wybrane zagadnienia ekologiczne we współczesnym rolnictwie. PIMR, Poznań, Monografia , tom 4: 148-158.

Zarzyńska K., Wroniak J. 2008. Różnice w składzie chemicznym bulw ziemniaka uprawianego w systemie ekologicznym i integrowanym w zróżnicowanych warunkach klimatyczno- glebowych. Zesz. Prob. Post. Nauk Rol., z. 530: 249-251.

Zarzyńska K. 2010. Struktura plonu bulw ziemniaków uprawianych w systemie ekologicznym i integrowanym w różnych warunkach środowiskowych. Journal of Research and Applications in Agricultural Engineering, Vol 55. (4): 181-185.

Rembiałkowska E., Kazimierczak R., **Zarzyńska K**., Hallman E., Świetlikowska K. 2010. Evaluation of the quality features of the potato cultivars from conventional, organic and integrated crop production systems: 179-194 In: The impact of organic production methods on vegetable product quality ss. 263.

Zarzyńska K., Goliszewski W. 2012. Zróżnicowanie jakości plonu bulw ziemniaków uprawianych w systemie ekologicznymi i integrowanym w zależności od odmiany i warunków glebowo-klimatycznych. Cz. I. Udział wad zewnętrznych i wewnętrznych bulw. Biul. IHAR 266: 73-81.

Zarzyńska K, Wierzbicka A., Grudzińska M. 2016. Ekologiczna produkcja ziemniaka, gwarancją jego cech prozdrowotnych. Biul. IHAR 279: 77-89.

Other scientific activity

My research interests are much wider than those mentioned above. I conducted and continue to conduct experiments on the physiological aspects of potato plant development, mainly the vigor of seed potatoes and issues related to the size of mother tubers and their impact on the size and structure of the daughter's yield. In recent years, I have participated in a project on the impact of abiotic stresses (drought, high temperature) on the development and yielding of potato plants, and in particular on changes in the size and architecture of the root system.

As part of the research, I determined the values of the indicators characterizing the various potato development phases, i.e. the length of the resting period, the length of the incubation period, the initial development of root and sprout, the development of the aboveground part. In addition, I developed a nine-point scale for determining the dormancy duration of potato tubers.

Based on the dependencies between the size of the seed potato and the number of stems produced and the yield structure of the tubers, I determined the optimal number of stems per unit area at which the maximum yield of a given tuber size is obtained and thus: the maximum yield of large tubers is obtained at 100-150 thousand stems per hectare, the maximum yield of tubers of the commercial fraction at 200-250 thousand, and the maximum yield of seed potatoes at 300- 350 thousand stems.

On the basis of this data, I developed and introduced the concept of the so-called shaping of the canopy architecture, i.e. controlling the size of the seed potato and planting density in such a way as to obtain the optimal number of stems per unit area for a given direction. A formula has been developed for this purpose:

$$G = \frac{10000\ m^2 \times ip}{ik \times l}$$

where :

G- recommended planting density in a row (m)
ip - number of stems in a plant (nb)
ik - recommended number of stems for a given production direction (nb per 1 ha)
l - inter-row spacing (m)

Thus, having a certain seed potato size and knowing the developed relationships, the farmer can plan the planting density in such a way as to obtain the optimal number of stems per unit area and the maximum yield of the desired tuber size. List of papers on the issues discussed :

Zarzyńska K. 1997. Analiza aktywności wzrostowej oczek odmian ziemniaków wyhodowanych w latach 1970-1995 w zależności od wielkości sadzeniaków. Biul. Inst. Ziemn. 48: 65-72.

Zarzyńska K.1999. Wartości wskaźników charakteryzujących stan fizjologiczny bulw i rozwój rośliny ziemniaka. Cz. I. Okres spoczynku bulw. Biul. IHAR, 209: 111- 123.

Zarzyńska K. 2000. Wartości wskaźników charakteryzujących stan fizjologiczny bulw i rozwój rośliny ziemniaka. Cz. II. Okres inkubacji bulw. Biul. IHAR, 212: 125-139.

Zarzyńska K. 2000.Wartości wskaźników charakteryzujących stan fizjologiczny bulw i rozwój rośliny ziemniaka. Cz. III. Początkowy rozwój kiełków i korzeni. Biul. IHAR, 213:19-30.

Zarzyńska K. 2000. Wartości wskaźników charakteryzujących stan fizjologiczny bulw i rozwój rośliny ziemniaka. Cz. IV. Liczba łodyg w roślinie i procent kiełkujących oczek u bulw matecznych różnej wielkości. Biul. IHAR, 214: 167-181.

Zarzyńska K., Gruczek T. 2000. Możliwość sterowania liczbą łodyg na jednostce powierzchni w zależności od kierunku produkcji. Ziemniak Polski, 2: 19-24.

Zarzyńska K. 2000. Masa a kształt bulw u odmian jadalnych ziemniaka. Biul. IHAR, 213: 31-36

Zarzyńska K., Gruczek T. 2000. Planowanie optymalnego zagęszczenia pędów na jednostce powierzchni na podstawie fizjologicznych cech bulw matecznych w uprawie ziemniaka jadalnego. Biul. IHAR, 213: 185-190.

Zarzyńska K. 2001. Wartości wskaźników charakteryzujące stan fizjologiczny bulw i rozwój rośliny ziemniaka. Cz. V. Rozwój części nadziemnej. Biul. IHAR, 217: 151-168.

Zarzyńska K. 2002. Znaczenie cech morfologicznych sadzeniaków w uprawie ziemniaka. Cz. I. Zależność między wielkością sadzeniaka a niektórymi cechami bulwy i rośliny potomnej. Fragmenta Agronomica 3: 60-73.

Zarzyńska K., Szutkowska M. 2002. Specyficzne elementy technologii uprawy na przetwory spożywcze. W: Produkcja i rynek ziemniaków jadalnych - pod red. J. Chotkowskiego. Warszawa ,Wieś Jutra: 121-128.

Zarzyńska K. 2003. Dziewięciostopniowa skala określania długości okresu spoczynku bulw różnych odmian ziemniaka. Biul. IHAR 228: 215-223.

Zarzyńska K. 2004. Długość okresu spoczynku bulw odmian ziemniaka. Biul. IHAR 232: 5-21.

Zarzyńska K. 2004. Analiza plonu potomnego bulw ziemniaka w zależności od wielkości bulwy matecznej. Biul. IHAR 232: 15-21.

Zarzyńska K. 2008. Wpływ sposobu przygotowania sadzeniaków na liczbę łodyg w roślinie, plon bulw i jego strukturę. Biul. IHAR, 248: 53-61.

Zarzyńska K. 2009. Porównanie potencjału rozwojowego polskich i zagranicznych odmian ziemniaka badanych w latach 2005-2008. Biul. IHAR 254: 153-158.

Zarzyńska K. 2010. Odmianowe zróżnicowanie długości okresu spoczynku bulw ziemniaka. Ziemniak Polski 3: 14-17.

Zarzyńska K. 2012. Wpływ wielkości sadzeniaka i gęstości sadzenia na liczbę pędów i plony ziemniaków. Ziemniak Polski 3: 19-23.

Zarzyńska K. 2012. Przygotowanie sadzeniaków i sadzenie w aspekcie kształtowania optymalnej architektury łanu. [W:] Produkcja i rynek ziemniaka pod red J. Chotkowskiego: 198-205.

Zarzyńska K. 2013. Wpływ szoku termicznego w okresie przygotowania sadzeniaków na plon bulw i jego strukturę. Ziemniak Polski 4: 14-18.

5. SUMMARY OF SCIENIFIC ACHIEVEMENTS

My publication achievements after obtaining a PhD degree include 192 items, including 8 papers on scientific achievement. Among them, 85 are original scientific studies, including in major foreign magazines (American Journal of Potato Reasearch, Plant, Soil and Envinroment, Plos One, Potato Research). A significant share in my output is popular science publications, thanks to which I can disseminate the results of my research directly to potato producers.

I actively participated in and continue to participate in scientific conferences, both domestic and foreign. I gave 34 papers, including 4 invitated, 6 at international conferences, and presented 30 posters, including 13 at international conferences.

I was a contractor in 10 ekological research projects founded by Polish Ministry of Agriculture and Rural Development and in 1 international.

My didactic achievements include work as a teacher of agricultural subjects at the Agricultural Schools Complex in Serock for 17 years (part time) as well as training for farmers and ODR advisers, active participation in potato dissemination events, direct and telephone advice to potato producers.

I have completed scientific internships at foreign leading scientific centers dealing with potato such as: Washington State University (USA), Swiss Federal Research Station (Switzerland), University of Udine (Italy), Potato Research Institute (Czech Republic)

Table 2. Presentation of scientific achievements before and after PHD obtained

Specification	Number of papers		
	before PHD	after PHD	total
Scientific achievement: ,,Environmental and agricultural conditions of yielding and quality of potato grown under the organic crop production system''	0	8	8
,in this in English		5	5
Other publications			
Orginal papers in Polish	8	54	62
Orginal papers in English	-	6	6
Chapters in monographs in Polish or English	-	17	17
TOTAL	**7**	**85**	**92**
Popular scientific papers	5	45	50
Summaries in conference materials	12	62	74
TOTAL	**32**	**192**	**224**
Reviews	-	13	13
Papers read in conferences	7	34	41
Papers read in trainings	2	10	12

Table 3. Points awarded for all the publications after the PHD obtained

Journal title	Number of publications	Impact Factor	Total amount of points	
			According to the year of publication	in 2018
Scientific achievement				
American Journal of Potato Research	1	1,159	25	25
Biuletyn Instytutu Hodowli i Aklimatyzacji Roślin	1		4	6
Journal of Research and Applications in Agricultural Engineering.	2		17	24
Plant, Soil and Envinroment	1	1,421	30	30
PloS One	1	2,806	35	40
Zeszyty Problemowe Postępów Nauk Rolniczych	1		6	13
Journal of Agicultural Science and Technology B	1		7	-
Other Reviewed Journals				
Biuletyn Instytutu Hodowli i Aklimatyzacji Roślin	18		74	108
Electronic Journal of Polish Agricultural Universities	2		24	24
Fragmenta Agronomica	3		28	36
Journal of Agicultural Science and Technology A	1		7	-
Journal of Research and Applications in Agricultural Engineering.	11		65	132
Pamiętnik Puławski	1		6	-
Plant, Soil and Envinroment	1	1,421	30	30
Roczniki Akademii Rolniczej w Poznaniu	1		2	-
Zeszyty Problemowe Postępów Nauk Rolniczych	2		12	26
Ziemniak Polski	22		53	110
Monografie lub rozdziały w monografiach w języku polskim i angielskim	17		82	82
TOTAL **Including those of the scientific achievement**	**85** **8**	**6,807** **5,386**	**507** **124**	**686** **138**
Popular scientific papers				
Agro - Serwis	4			
Agrochemia	1			
Agrotechnika	2			
Farmer	10			
Gromada Rolnik Polski	1			
Ogrodnik Polski	1			
Plon	1			
Poradnik Gospodarski	4			
Raport Rolny	3			
Rolnik Dzierżawca	3			
Technika Rolnicza	1			
Top Agrar	4			
Warzywa	4			
Wiadomości Rolnicze Polska	3			
Wieś Jutra	2			
Total	**45**			

Total Impact Factor of scientific papers: 6,807

Number of citations by Web of Science database: 11
Index Hirscha according to the Web of Science database: 3

The sum of points for publications according to the list of Ministry of Science and Higher Education: 507 by the year of issue; 686 by 2018

Works submitted for printing:

Boguszewska-Mańkowska D., **Zarzyńska K**, Nosalewicz A**.** Drought differentially affects root system size and architecture of potato cultivars with differing drought tolerance. American Potato Journal.

6. ORGANIZATIONAL ACTIVITIES

1. EAPR, Physiology Section Conference, Pułtusk, Poland 29 June - 3 July 1998- member of organizing committee.
2. International seminar on the EU project. Reduced pollution in crop systems (Improved organic fertilization in agricultural crop systems for high efficiency of nitrogen fertilization and irrigation in reducing environmental pollution) – FertOrgaNic, January 22-24 2005- organizer.
3. Seminar on the implementation of EU project results Improved organic fertilization in agricultural crop systems for high efficiency of nitrogen fertilization and irrigation in reducing environmental pollution) – FertOrgaNic, 22-23 March 2006- organizer, content manager.
4. National Scientific Conference: Tradition and Modernity in Potato Production, Jadwisin, 7-9 July 2010 - member of the organizing committee.
5. Post harvest Section Conference, Warszawa, 22-24 October- member of the organizing committee.
6. 6.Triennal EAPR Conference, Warsaw 2020 - during organization - member of the organizing committee.

7. DISTINCTIONS, PRIZES, AWARD

Badge of Merit for Agriculture awarded by the Minister of Agriculture and Rural Development, 2017

Dr Krystyna Zarzyńska