Appendix No. 3

AUTO-PRESENTATION
Summary of professional achievements

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1. Personal details

- Full name: **Laurencja Szała**
- Place of employment:

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2. Diplomas, scientific degrees

2.1. Master engineer of agriculture sciences

Thesis title: The usefulness of three maize varieties for the Corn Cob Mix production in three harvest dates "

- Date of defence: March 18, 1984
- Place: Faculty of Agriculture, the August Cieszkowski Agricultural University of Poznań (since 2008 the Poznań University of Life Sciences)
- Name of supervisor: Dr. Tadeusz Michalski

2.2. Doctor (PhD) of agricultural sciences with specialization on agronomy

Thesis title: "Phenotypic and genetic variability of the doubled haploid populations of winter oilseed rape (*Brassica napus* L.)"

- Date of defence: June 6, 2013
- Place: Plant Breeding and Acclimatization Institute, Poznań
- Name of supervisor: Prof. dr hab. Teresa Cegielska-Taras

3. Information on employment in scientific organizations

From 1nd of November 1994 at present – Plant Breeding and Acclimatization Institute – National Research Institute, Research Division in Poznań

- 01.11.1994 – 31.05.2005 – specialist
- 01.06.2005 – 30.09.2013 – senior specialist

- 01.10.2013 at present – adjunct /assistant professor

4. Indication of professional scientific accomplishment with criteria defined in to art. 16 (2) of the Act of 14 March 2003 on academic degrees and titles and on arts degrees and titles (Journal of Laws no. 65 item 595, as amended)

4.1. The title of scientific achievement:

A series of four original and homogenous experimental papers under the title:

„Evaluation of genetic and interaction effect of doubled haploid lines of winter oilseed rape (*Brassica napus* L.)"

4.2. The achievement – list of papers:

The author/authors, title/titles of publications, year of publication, publisher
(IF and minister points MNiSW are given according to the updated list in 2015)

H1. **Szała L**., Cegielska-Taras T., Adamska E., Kaczmarek Z. 2018. Assessment of genetic effects on important breeding traits in reciprocal DH populations of winter oilseed rape (*Brassica napus* L.). Journal of Integrative Agriculture: 17(1): 76-85 [**IF_{2017}=1.042; IF_5=1.190; $MNiSW_{2016=}$25 pkt.**]
My contribution was: research concept and design, development of plant material, result interpretation and preparation of manuscript. I estimate my contribution to be 70%.

H2. Cegielska-Taras T., Nogala-Kałucka M., **Szala L**., A. Siger. 2016. Study of variation of tocochromanol and phytosterol contents in black and yellow seeds of *Brassica napus* L. doubled haploid populations. Acta Scientiarum Polonorum Alimentaria 15 (3): 321-332. [**IF=0; $MNiSW_{2016}$=15 pkt.**]
My contribution was: DH population development for an experiment, planning a field experiment, acquisition of data, data analyses and interpretation, results interpretation and manuscript co-preparation. I estimate my contribution to be 40%.

H3. Siger A., Michalak M., Cegielska-Taras T., **Szała L**., Lembicz J., Nogala-Kałucka M. 2015. Genotype and environment effects on tocopherol and plastochromanol-8 contents of winter oilseed rape doubled haploid lines derived from F1 plants of the cross between yellow and black seeds. Industrial Crops and Products 65: 134-141. [**IF_{2015}=3.449; IF_5=4.072; $MNiSW_{2016=}$40 pkt.**]
My contribution was: DH population development for an experiment, planning a field experiment, preparation of plant material for biochemical analysis, interpretation of data, critical revision of the article. I estimate my contribution to be 30%.

H4. Szała L., Sosnowska K., Popławska W., Liersch A., Olejnik A., Kozłowska K., Bocianowski J., Cegielska-Taras T. 2016. Development of new restorer lines for CMS *ogura* system with the use of resynthesized oilseed rape (*Brassica napus* L.). Breeding Science 66(4): 516-521. [**IF_{2016}=1.792; IF_5=1.952; $MNiSW_{2016=}$30 pkt.**]
My contribution was: research concept and design, development of plant material from resynthesis of oilseed rape to semi-RS seed collection, data acquisition and interpretation. I estimate my contribution to be 35%.

Total IF/IF_5 of papers mentioned above is 6.283/7.214 and 110 Ministry of Science and Higher Education points. IF is given according to the year of paper publication in the Journal Citation Reports and points of the Ministry of Science and Higher Education according to the List of Scientific Journals published on 9.12.2016.

4.3. The aim of the study and achieved results, together with discussion of their possible use

Introduction

After cereals, oilseeds are the second most important source of energy contained in food consumed by human and used as feed for farm animals. They are also a valuable raw material in many industries. Oilseed rape is a particularly important plant in the temperate climate zone, and its world production in 2016/2017 amounted to 76.2 million tons of grain. In Poland, the area of winter oilseed rape cultivation covers approximately 900,000 hectares, and its harvest in 2017 amounted to 2.7 million tons (FAOSTAT 2018, http://www.fao.org/faostat/en/#data/QC).

The production of new sources of genetic variability is a prerequisite for the development of winter oilseed rape (*Brassica napus* L.), a classic example of a species with a very narrow gene pool. Geographical limitation of the range of cultivation and intensive breeding work in the last few decades have led to a narrowing of the genetic base of modern breeding materials. All currently cultivated double improved cultivars with a low glucosinolate content and non-erucic oil derive these quality characteristics from only two genetic sources. The low glucosinolate content comes from the Polish spring oilseed rape cv. Bronowski, and the oil devoid of erucic acid - from the Canadian line derived from the cv. Liho, selected from the Polish local spring oilseed rape cultivars (Krzymański 2000). The high requirements imposed on breeders, related to the diverse composition of fatty acids in oil and high productivity, lead to further reduction of genetic variability of this species.

Doubled haploid (DH) lines are one of the most valued sources of genetic variability by breeders and are an excellent starting material for creative breeding of linear and hybrid varieties. In the breeding of open pollinated cultivars, they help to shorten the period devoted to material inbreeding, and in hybrid breeding, homozygosity of parental components allows to achieve 100% heterozygosity in the hybrid F_1, causing that all individuals in this generation are genetically identical. Doubled haploids are also used in basic research(Cegielska-Taras et al. 2015), especially on genetic determination of quantitative traits. The homozygous nature of DH line contributes to the development of genomics and genome marker maps defining regions responsible for quantitative traits (QTL), which include traits as important for oilseed rape breeding as yield and its components, fat content and fatty acids profile, protein content and resistance to pathogens. In recent years many studies have been devoted to increasing the content of natural biologically active compounds in food, as well as mapping genes and QTLs that control their synthesis. The most important bioactive compounds contained in oilseed rape oil are tocopherols and phytosterols. Tocopherols are lipophilic components of vegetable oils showing vitamin E activity (Minkowski et al., 2011). Together with 6 tocotrienols they constitute a group of 10 native substances called tocochromanols. The compound similar in structure to tocotrienols is 8-plastochromanol (PC-8), which is a derivative of γ-T3 (Nogala-

Kałucka and Siger, 2011). The E vitamin active compounds are among the most important natural antioxidants. The antioxidant activity of tocopherols *in vivo* is shaped in the following order: α-T > β-T > γ-T > δ-T, while PC-8 has an activity about 1.5 times higher than α-T (Olejnik et al., 1997). Two homologues of tocopherol: α-T and γ-T, are the most common in plants. The dominant form is the α-T homologue, which protects the photosynthetic organ against reactive oxygen species and free radicals. In turn, γ–T is predominant in seeds, and it acts as an antioxidant of polyunsaturated fatty acids (Bramley et al. 2000, Eitenmiller and Lee 2004, Szymańska and Kruk 2007). The role of vitamin E for the human body cannot be overestimated. It protects the body against oxidative stress and damage to cell membranes caused by free radicals. It slows down the oxidation of polyene fatty acids, both in living organisms and in food. Vitamin E is also involved in the synthesis of anticoagulants, maintaining appropriate cell membrane permeability and reducing platelet aggregation, and thus - prevents thrombosis. In addition, it participates in the protection of red blood cells, gene expression and transmission of nerve signals throughout the body, and also supports the proper functioning of the eyesight. On the other hand, biological properties of phytosterols are related to lowering blood cholesterol level by an inhibition of its absorption. Phytosterols also play an increasingly important role in the prevention and treatment of ischemic heart disease (Rudzińska et al. 2005).

The development and improvement of the process of *in vitro* androgenesis of winter oilseed rape made it possible to obtain a population of doubled haploids on a large scale. It was then possible to use DH lines in genetic analysis of quantitative traits and for research on environment influence on quality traits and seeds yield. Due to its homozygosity, a single DH line produces only one type of gametes and as a result of controlled propagation reproduces its genotype. This means that multiple experiments can be carried out with the same genotypes, in different locations and years, which is not possible in case of hybrids of the segregating generations. Moreover, in the case of an examination of poligenically conditioned traits inheritance, DH technology requires significantly fewer genotypes compared to hybrids of early generations of classical breeding. There are no heterozygotes, so there are no effects of domination and non-allelic interaction of heterozygous *loci*. Therefore, it is easier to find an interesting genotype in DH line populations than in segregating populations, since the frequency of its occurrence among doubled haploids is higher. This applies mainly to addictively conditioned traits, especially these controlled by recessive genes.

The lines of resynthesized oilseed rape (RS) are also doubled haploids. Unlike traditional DH lines formed as a result of splitting genetic information contained in heterozygote and then doubling the number of chromosomes in the haploids obtained, RS lines are formed by synthesis of genetic material of ancestral species i.e., *B. rapa* and *B. oleracea* and doubling the number of chromosomes in the obtained inter-species hybrid. Unlike *B. napus, B. rapa* and *B. oleracea* are highly polymorphous and offer a much wider genetic variability that can be used to increase the genetic diversity of oilseed rape. Resynthesized *B. napus* can be used to enrich heterotic genetic pools for future parental components, which is one of the requirements for successful hybrid breeding programs. The large number and diversity of representatives of both parental species collected from gene banks (Boukema and van Hintum 1999) constitutes a significant potential for the creation of oilseed rape with new properties. However, the resynthesized forms obtained from crossbreeding of *B. rapa* ssp. and *B. oleracea* ssp. have many undesirable agronomic features such as: low yield and low fat content in seeds, high erucic acid level in oil and high glucosinolate content in meal (Girke et al., 2012a, 2012b, Jesske et al., 2013). Moreover, like both parental species, RS oilseed rape is self-incompatible (Beschorner et al. 1995). Therefore, resynthesized oilseed rape should be improved by crossbreeding with natural double improved oilseed rape and selecting of double improved semi-RS lines, and only then introduced it into breeding programs.

The publications included in my scientific achievement concern an evaluation of genetic effects in DH populations of winter oilseed rape and the selection of genotypes with beneficial performance characteristics using uni- and multidimensional methods of quantitative genetics and mathematical methods. Proper planning of research experiments and selection of appropriate statistical methods allowed to observe and evaluate genetic phenomena occurring in the analyzed populations. In the first of these publications, the populations of DH line obtained from hybrids from reciprocal crossing between cv. Californium and DH W-15 line from cv. Wotan became a research material to determine an effect of crossbreeding direction on the characteristics of yield structure and seed quality (**H1**). Two further papers were devoted to the research on the content of biologically active compounds (**H2**) and the influence of environment on their content (**H3**) in seeds of DH line originating from the hybrid between the yellow and black seed line. The series of publications ends with an article about DH lines based on resynthesized oilseed rape as a source of completely new variability, which can be used in hybrid breeding. It concerns the development and the multi-stage selection of double improved semi-RS lines with the *Rfo* restorer gene for the Ogura CMS system **(H4)**.

In the breeding of new cultivars, special attention is paid to the selection of parental components for crossbreeding. By crossing parental forms that are genetically distant but have a high breeding value for important productivity traits, the effectiveness of obtaining valuable hybrids of F_1 or population of progeny can be significantly increased (Mądry et al. 2004). In many cases, the main criterion for the successful selection of parents to create productive populations of progeny is the breeding value of parental cultivars. The right choice of crossbreeding direction can also help breeders to develop an effective breeding strategy for new oilseed rape cultivars development. Determination of the effect of cytoplasmic and genetic (nuclear) effects of a mother or embryo on a given trait using unidimensional and multidimensional statistical methods was the main aim of the first publication (**H1**). Two reciprocal populations of doubled haploids designated as CW and WC, derived using the method of isolated microspores culture from hybrids of F_1 generation from the crossbreeding between Californium cultivar and DH W-15 line, were used as research material. Evaluation of the influence of crossbreeding direction on a given trait was based on significant differences in parental forms in this trait, and the basis for concluding about the influence of maternal or paternal effects were statistically significant differences between mean values of CW population and WC population, each of which consisted of 25 DH lines. In the studied parental pair, significant differences were found in the yield, the number of seeds in the pod and the thousand seed weight, as well as in the content of fat and linolenic acid, however, maternal effects were found only for the number of seeds in the pods and a clear influence of the paternal form on the content of linolenic acid was observed. In order to find the transgression lines, contrasts were used to test comparisons of average traits between each DH line and the “better” parent. It turned out that the frequency of transgression effects in some traits was related to the direction of crossbreeding. DH lines with positive transgression effects in terms of number of seeds in the pods were observed only in the population which mother form contained more seeds in the pods.

An influence of maternal effects was also observed in relation to the weight of one thousand seeds. Of the seven transgression lines in terms of this feature, as many as five belonged to a population which maternal form was characterized by larger seeds. Multidimensional statistical methods were also used to evaluate the populations. DH lines of both populations were characterized in terms of two sets of traits: yield and its structure, fat and three fatty acids content, assuming Mahalanobis distances as a measure of phenotypic similarity between DH lines in terms of the examined traits together. The graphical representation of DH lines distribution in the first two canonical variates showed a greater diversity of CW population than WC population both in terms of yield and its components, as well as fat and three fatty acids content.

Two further papers were devoted to the research on the content of biologically active compounds in oilseed rape oil and environment influence on the content of these compounds (**H2** and **H3**). Thanks to the high content of, inter alia, tocopherols (T) and sterols, oilseed rape oil becomes a functional food (probiotic, nutraceutical), the effect of which is not only nutrition, but also prophylactic and therapeutic (pro-health) effects. There should be a lot of natural bioactive compounds in seed oil, because in the subsequent stages of the refining process the oil is exhausted from valuable ingredients, such as tocopherols - up to 50%, and phytosterols - up to 20%. The first publication (**H2**) concerned the estimation of genetic variability of the content of four homologues of tocopherols (α-T, β-T, γ-T, δ-T), plastrochromanol-8 (PC-8), which, like tocopherols, is vitamin E active compound and five phytosterols in a unique plant material, i.e., two DH line populations of winter oilseed rape. The populations designated as HZ and ZH were derived from hybrids F_1 from reciprocal crossing between the black seed line DH H226 and the yellow seed line DH Z114. The range of variability in both populations of DH line exceeded the values of parental components for the examined traits with the exception of α-T content (in HZ population) and α-T/γ-T ratio (in both populations). This ratio is very important and should be balanced because α-T has the strongest antioxidant effect and increases the nutritional value of oil, while γ-T stabilizes double bonds in polyunsaturated fatty acids to prevent oil rancidity. In both populations, the range of variability was similar, as evidenced by similar coefficients of variability. No significant differences were found between the two populations in terms of total tocopherols content, which indicates that there are no maternal effects with regard to this trait. As far as the phytosterols content is concerned, the range of variability in both populations of the DH line of all analyzed phytosterols content and their sum exceeded the values of parental components. The correlation between the traits was determined by calculating correlation coefficients. There was a significant positive correlation between the yellow color of seeds and α-T content and a negative correlation between the yellow color of seeds and γ-T content. Yellow seed lines were also characterized by a much higher α-T/γ-T ratio, inheriting this trait from the yellow seed parental line DH Z114. However, the total content of tocopherols, the total content of phytosterols and the individual content of five phytosterols were not correlated with the color of the seeds. The analysis of main components (PCA) confirmed high variability in the analyzed DH line populations of winter oilseed rape indicating at the same time that DH lines with high content of tocopherols and phytosterols formed separate cluster groups. The use of doubled haploids in the breeding may increase the efficiency of the selection of initial materials for breeding with desired quality characteristics. In both populations of the DH line, a higher content of tocopherols, PC-8 and phytosterols than in the parental lines was obtained, which represent an added value in every edible oil. However, the variability in tocopherols content is also caused by environmental factors. According to Marwerde et al. (2004) apart from genetic variability, the main source of variability of tocopherols content are interactions of genotype and environment. Therefore, in order to determine the influence of genotype and environment on the content of four tocopherols (α-T, β-T, γ-T, δ-T) and plastochromanol-8 (PC-8) in winter rapeseed (*Brassica napus* L.), a study was carried out, in which the plant material were 25 DH lines obtained from hybrid F_1 derived from the crossing between the yellow seed DH line Z114 and the black seed DH line H226 (**H3**). An experiment conducted in the field for three years showed that the genotype as a source of variability had an effect on the α-T, γ-T content, their ratio, sum and PC-8 content. The other two sources of variability, the environment and the genotype-environment interaction, had an effect on all the examined traits. Estimated coefficients of inheritance in a broad sense (h2) indicated a higher share of genetic variability in the overall variability for α-T, PC-8 and total tocopherols content, and from the breeding point of view, high inheritance of traits guarantees effective selection and rapid biological progress. The analysis of genotype-environment interaction allowed to distinguish several stable lines in terms of the content of some of the examined biologically active compounds. The black seed line DH ZH91 turned out to be stable in terms of four traits: α-T, β-T, γ-T content and tocopherols sum, but its main effects were negative. However, the results of this study confirm the advisability of the search for new variability and increase in tocopherols and PC-8 content using DH line technology. High h2 coefficients for α-T, γ-T and PC-8 suggest the possibility of effective selection based on phenotype and obtaining genotypes with stable expression of traits.

The source of new variability and new traits is resynthesized oilseed rape (RS) formed by hybridization of *B. rapa* and *B. oleracea* subspecies. Due to its genetic diversity, RS oilseed rape can be a valuable component of hybrid breeding, however, having a number of unfavorable features, it cannot be directly included in breeding. The crossbreeding with double improved materials is one of the methods to improve the quality of seeds and other unfavorable traits. The development, selection and evaluation of semi-RS DH lines were the subject of next publication (**H4**). The RS line was crossed with two DH lines with the restorer gene (*Rfo*). A total of 801 androgenic plants were obtained from the resulting hybrids, of which only 281 had the *Rfo* gene restoring fertility, and of them only 4 lines met the criteria of double improved oilseed rape. Identification of plants with the *Rfo* gene was carried out with the use of isoenzymatic analysis in the PGI-2 system (Delourme and Eber 1992, Popławska et al. 2007). The presence of the *Rfo* gene in four double improved DH semi-RS lines was confirmed in an RAPD reaction using an OPC-2 primer (Delourme et al. 1994; Delourme et al. 1998). Genetic similarity analysis based on 344 markers obtained using 10 combinations of AFLP primers for 2 RS lines, 3 DH semi-RS lines and 96 lines of natural oilseed rape showed genetic distinction of DH RS and DH semi-RS lines from natural *B. napus*. In the dendrogram of genetic affinity, they formed a separate group of clusters located on the edge of the dendrogram. The genetic evaluation of DH RS and DH semi-RS lines was also based on the principal components analysis , which on the basis of 344 AFLP markers showed a clear separation of two DH RS lines, three DH semi-RS lines and six currently cultivated winter rapeseed cultivars. The DH semi-RS S1 line was used as a paternal component to develop the hybrid F_1 in order to investigate its yield potential. The results of the field experiment showed that two hybrids F_1 obtained on the basis of the same maternal component and with different paternal components: natural restorer and semi-RS restorer yielded at the same level, even though the semi-RS restorer yielded much lower than the natural restorer. However, the higher heterosis effect compensated for this difference. The obtained results formed the basis for further research on the participation of RS oilseed rape in hybrid breeding and on the effect of heterosis between components with high genetic diversity.

Summary

Four scientific publications constituting my scientific achievement include an assessment of the genetic and interactive effects observed in DH populations of winter rapeseed. The results of the presented studies are as follows:

- indication of an influence of maternal effects on the number of seeds in the pod and the weight of one thousand seeds
- selection of DH lines with increased content of biologically active compounds
- determination of the dominant effect of genetic factors on the content of the sum of tocopherols and α-tocopherol as well as plastrochromanol-8
- selection of double improved DH semi-RS lines with restorer gene as a source of new variability for hybrid breeding of winter rapeseed
- indication of a high heterosis effect between semi-RS restorer lines and CMS lines of natural oilseed rape

5. Other scientific and research achievements

After graduating from the Faculty of Agriculture of the Agricultural Academy in Poznań (now the University of Life Sciences) in 1983 in the field of “Cultivation of soil and plants,” I completed an internship at the Poznań Urban Green Enterprise, and then I took up a permanent job there. In November 1994 I started working in the Department of Genetics and Oilseed Plant Breeding IHAR in Poznań, in the Laboratory of Tissue Cultures, first as a specialist, and since June 2005 as a senior specialist. Since the beginning of my work in the Laboratory of Tissue Cultures under the direction of Prof. Teresa Cegielska-Taras, I have been dealing with doubled haploids of oilseed rape, initially focusing on methodological research on induced androgenesis, first in the culture of anthers and then in the culture of isolated microspores (Cegielska-Taras T. and Szała L., 1997, Cegielska-Taras T. and Szała L., 1998). The development of an effective procedure of *in vitro* microspores isolation and regeneration of androgenic plants from microspore embryos and high efficiency of doubling the number of chromosomes on the *in vitro* and *in vivo* conditions made DH line the main research material in my laboratory.

Doubled haploids have many advantages, which makes them a completely unique material, both for basic research and breeding work. For many years, as part of the Basic Research for Biological Progress in Plant Production, I participated in the production of the DH line for breeding purposes. At that time, the team of the Laboratory of Tissue Cultures served with its experience in organizing an *in vitro* laboratory in the Strzelce Plant Breeding Company, Borowo Branch and implemented the method and scheme of DH line production. This activity resulted in the registration in 2008 of the first in Poland Monolit winter oilseed rape cultivar, developed using doubled haploids (Cichy et al. 2005). This achievement as "Implementation of a new technology of winter oilseed rape breeding based on a doubled haploid line (DH) and development the first cultivar in Poland" was awarded with the Award of the Minister of Agriculture and Rural Development in 2009. Another DH line of winter oilseed rape in the Polish National List is the Brendy variety registered in 2013, of which I am a co-author.

Since 2000 the DH line populations have been used in genetic analysis of quantitative traits of winter oilseed rape (Szała et al. 2015). On the basis of several years of experience, genetic parameters controlling yield components, fat content and fatty acids profile in oil were evaluated and the number of genes needed to control the content of these acids was estimated. An influence of the environment on yield components and fatty acids profile in DH line populations was also evaluated. Uni- and multidimensional effects of GCA and SCA for yield components and fatty acids were also evaluated on the basis of the results obtained in the line × tester experiments. My interest in the analysis of quantitative traits in relation to yield, its components and seed quality traits was reflected in my doctoral thesis entitled: "Phenotypic and genetic variability of the population of doubled haploids of winter rapeseed (*Brassica napus* L.)," which I defended on June 6, 2013. On the basis of genetic and phenotypic differentiation of two pairs of populations of doubled haploids, it was found that genetic conditions had a significant influence on the expression of all examined traits in the analyzed populations of DH line. Only the number of seeds in the pods, fat content and neutral fiber content were not significantly affected by the environmental conditions. The analysis of yield structure in relation to seed yield showed that none of the traits of yield structure met the conditions of a reliable criterion on the basis of which an effective selection of doubled haploids per yield could be carried out. Soon after defending my doctoral thesis, I successfully passed the competition for the position of a research worker and since October 2013 I have been employed as an adjunct.

Another direction of research carried out in the Laboratory of Tissue Cultures was transgenesis. Experiments on the transformation of haploid embryos were carried out using *Agrobacterium tumefaciens* containing the binary vector pKGIB with the *uidA* gene encoding β-glucuronidase (GUS) and with the marker gene bar determining resistance to phosphinotricin (Cegielska-Taras et al. 2008). The method of foreign DNA introducing into microspore embryos of winter oilseed rape using *Agrobacterium tumefaciens* and then doubling the number of chromosomes with regenerated transformed haploids allows to obtain homozygous plants. This method is currently used for research in the NSC project (2016/23/B/NZ9/02175 OPUS Call for proposals No. 12), entitled "The plasticity of polyploids response to environmental stress: investigation of the ABI1/HB6 regulation under conditions of salt stress and drought in rapeseed (*Brassica napus* L.)," in which I am one of the participant

Research into the resynthesis of winter rapeseed is an important part of my scientific output. By crossing of parental species *Brassica rapa* and *Brassica oleracea*, which are a reservoir of many traits not found in rapeseed, it is possible to increase the overall genetic variability of this species and introduce new traits. Interspecies crossing was carried out for many years, but only the development of new biotechnological methods, including *in vitro* cultures, measurably increased the effectiveness of these treatments. Studies conducted in cooperation with the Laboratory of Heterosis showed a significant distinction of resynthesized (RS) and semi- resynthesized (semi-RS) oilseed rape from natural ones, which indicates the possibility of their use in hybrid cultivars breeding (Liersch et al. 2016, Sosnowska et al. 2017, Liersch et al. 2019). The first attempts in this respect are already being made in the 2015/16 season (Szała et al. 2019). The field experiments with 15 hybrids of F_1 and their parental forms: five CMS lines and three double improved DH semi-RS lines with restorer gene and two control cultivars: open pollinated Monolit and hybrid Arsenal were carried out in three localities. The assessment of the value of breeding materials based on multi-environmental experiments allows for the selection of genotypes best adapted to the majority of natural conditions of a given region, with a wide adaptive capacity, but also allows to separate genotypes with narrow adaptation, characterized by high productivity, but only in specific conditions. On the basis of the collected results, it was found that among the tested genotypes with a significantly higher or lower main effect, only one hybrid (M4S1) showed an interaction with the environment. Significant effects of genotype-environment interaction were observed in nine hybrids, two of CMS lines, two DH semi-RS lines and one control cultivar. Linear regression analysis allowed to determine the nature of genotype-environment interaction, and identified six hybrids, two DH semi-RS lines and one CMS line as intensive genotypes with the greatest adaptation to more favorable vegetation conditions. The remaining unstable genotypes, i.e., three hybrids, one CMS line and the control cultivar Arsenal showed the ability to adapt to less favorable conditions. Vegetation season 2015/16 was not favorable. In January there were severe frosts in snowless fields, and in summer frequent rains delayed the harvesting of seeds. All investigated genotypes yielded low, especially DH semi-RS lines, but also CMS lines. However, they caused high heterosis effect in some hybrids. Many reports indicate that RS lines can be used to develop semi-RS lines for hybrid breeding, but there are few publications on double improved lines and their evaluation under field conditions. Therefore, these studies are a valuable contribution to the assessment of the possibility of DH semi-RS lines using as paternal components for hybrid breeding. The proportion of 50% of RS rapeseed in the restoring lines is sufficient to ensure a high heterosis effect in hybrids. In the seasons 2017/18 and 2018/19, in cooperation with Breeding Company Strzelce, further experiments were established with the test hybrids to examined their yielding capacity under field conditions. In the nearest future it is planned to focus on the genetic nature of RS rapeseed. As part of the subject I am leading: "Genomic changes of resynthetic winter oilseed rape and their influence on gene expression and phenotype," cytogenetic characterization of RS rapeseed including identification of chromosomes in RS lines and detection of structural changes and chromosome rearrangements is carried out. Alloploids obtained from interspecies crossing have a set of non-homological chromosomes and even after doubling their number not all pairs of chromosomes are homologous. As a result, it leads to disorders during meiosis and gametophyte development, and thus to reduced fertility of the obtained hybrids. The condition for the use of resynthesized oilseed rape in hybrid breeding is its genetic stability and correct pollen formation. Cytogenetic studies will make it possible to identify chromosomes, their number and belonging to the A or C genome. Molecular analysis of RS line and natural oilseed rape lines with high phenotypic diversity (e.g. presence of restorer gene, yellow color of seeds, altered fatty acids profile) will also be carried out in order to select components to form F_1 hybrid and then DH line population to map RS oilseed rape and place new markers on the existing map.

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6. Summary of scientific achievements

6.1. Bibliometric indicators according to the particular citation databases. Status as of 20.03.2019**.**

Total points	
Total MNiSW points - before PhD (according to the list MNiSW published 9.12.2016)	318
Total MNiSW points - after PhD (according to the list MNiSW published 9.12.2016)	325
Total IF according to the JRC - before PhD	10.663
Total IF according to the JRC (year of publication) - after PhD	17.061
Total number of citations	
according Web of Science (WoS)	55/43
Hirsch index (h-index)	
according Web of Science (WoS)	5

6.2. List of journals, where original research papers were published before- and after PhD (points according to the list MNiSW published 9.12.2016) (including papers presented as scientific achievements)

Journal (alphabetical order)	Before PhD			After PhD			Total MNiSW[2] points
	N	IF_{2017}	MNiSW[2] points	N	IF[1]	MNiSW[2] points	
Acta Scientiarum Polonorum Alimentaria	-	-	-	1	-	15	**15**
Biological Bulletin of Poznań (obecnie Biological Letters)	1	-	13	-	-	-	**13**
BioTechnologia	1	-	13	2	-	26	**39**
Biuletyn IHAR	5	-	30	-	-	-	**30**
Brassicas	1	-	-	-	-	-	**-**
Breeding Science	-	-	-	1	1.792	30	**30**
Bulletin GCIRC	2	-	-	-	-	-	-
Crop Science	-	-	-	1	1.629	30	**30**
Euphytica	1	1.546	35	2	3.092	70	**105**
Frontiers in Plant Science	-	-	-	1	3.678	40	**40**
Industrial Crops and Products	1	3.849	40	1	3.449	40	**80**
Journal of Applied Genetics	3	5.268	60	-	-	-	**60**
Journal of Intergrative Agriculture	-	-	-	1	1.042	25	**25**
Journal of the Science of Food and Agriculture	-			1	2.379		**35**
Proceedings of International Rapeseed Congress	7	-	-	-	-	-	**-**
Rośliny Oleiste - Oilseed Crops	16	-	112	2	-	14	**126**
Zeszyty Naukowe AR w Krakowie	1	-	-	-	-	-	-
Chapter in monograph							
Advances in analysis and technology of rapeseed oil	3	-	15	-	-	-	**15**
Genetyka i genomika w doskonaleniu roślin uprawnych	1	-	-	-	-	-	**-**
Genetyka w ulepszaniu roślin użytkowych	1	-	-	-	-	-	**-**
Haploidy i linie podwojonych haploidów w genetyce i hodowli roślin	2	-	-	-	-	-	**-**
Total	**46**	**10.663**	**318**	**13**	**17.061**	**325**	**643**

1. N - No. of papers published in journal
2. [1]IF according to the year of publications, for publication IF_{2018} according to IF_{2017}
3. [2] according to the list MNiSW published 9.12.2016.