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IMPACT OF ORGANIC AND CONVENTIONAL CULTIVATION ON SEED QUALITY OF TWO SOYA BEAN VARIETIES SOWN AT DIFFERENT ROW SPACINGS

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ABSTRACT

Soya bean (*Glycine max* (L.) Merr.) is a legume valued for, among other things, the high nutritional value of its seeds, which contain around 40% protein with an excellent amino acid composition and a significant fat content. The study aimed to evaluate the protein, fat, fibre and amino acids content of the seeds of two soya bean varieties sown at different row spacings under organic and conventional growing conditions. The study showed that the conventional method of production has a more favourable effect on the soya bean's protein content and the most amino acids, primarily essential amino acids. In organic cultivation, soya bean seeds were characterised by a higher content of fat and sulphur amino acids (methionine and cysteine). The research carried out indicates that the seeds of the Aldana variety, compared to the Merlin variety, have greater nutritional importance to humans due to a higher content of protein and almost all amino acids, including essential amino acids. Only a higher content of seed fat and tryptophan was evidenced in the Merlin variety. Row spacing did not significantly differentiate the assessed soya bean seed quality parameters. Only the amount of methionine was significantly higher when soya beans were grown at a narrower row spacing (22.5 cm).

Key words: soya bean, amino acids, protein, fat, cultivation

INTRODUCTION

Soya bean is a legume of exceptionally high nutritive value, as its seeds contain about 40% protein with excellent amino acid composition and 20% fat and are a source of many valuable minerals, including calcium, phosphorus and potassium [Abbasi Surki et al. 2010, Sharma et al. 2014, Biel et al. 2017, Saranraj et al. 2021]. Of a dozen soya bean species, the most popular is the farm soya bean, known as vegetable soya bean (*Glycine max* (L.) Merr), which in Poland occupies a vital position in the human diet. Soya protein has a high nutritional value and is well digested, and its amino acid composition primarily meets human requirements for individual amino acids. It is a better source of lysine than most plant proteins, although, like them, it is relatively poor in another amino acid that is exogenous to humans – methionine [Wilk 2017]. In addition, soya bean is a very valuable crop to grow in rotation. This is because it leaves a lot of nitrogen-rich crop residues. It is due to the coexistence of legumes with papillary bacteria of the genus Bradyrhizobium, which fix atmospheric nitrogen. However, due to the sparse distribution of soya beans

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in our country's soils, there is a need to inoculate the seeds with Bradyrhizobium strains before sowing in order to increase nitrogen fixing and subsequently better utilise the yield potential [Zimmer et al. 2016, Panasiewicz et al. 2023].

The two main limitations of organic field production are the availability of nitrogen in the soil and weed competition. Soya beans are, therefore, an excellent crop to grow in an organic system as they provide their own nitrogen, and mechanical tending provides satisfactory weed control in their case [Cox et al. 2018]. Through the use of natural inputs that are not technologically processed, organic farming aims to ensure sustainable soil fertility and high biological quality of agricultural products. On the other hand, conventional agricultural systems are often associated with negative environmental impacts from, among other things, nitrate leaching from the soil, groundwater and food and feed contamination with pesticide residues [Poudel et al. 2002].

Individual crop varieties differ not only in their functional type, earliness group, susceptibility to disease infestation, and competitiveness against weeds but also in seed quality, including the amino acids composition of the protein [Mohamed et al. 2018, Safina et al. 2018, Shawon et al. 2018, Abdel-Wahab and Abdel-Wahab 2020, Biletska et al. 2020, Marín 2021]. The quality of the seed, including the protein, oil and some amino acids content of individual soya bean varieties, can also be influenced by row spacing, including through its effect on competition between plants for water, nutrients and light access [Bellaloui et al. 2020].

Due to its high nutritional, fodder and fertiliser qualities, as well as its essential role in crop rotation, soya bean should be cultivated on a larger scale on both organic and conventional farms. Therefore, research aimed at determining the optimum agrotechnical conditions for obtaining favourable quality parameters for the seeds of this crop in different farming systems is crucial. For these reasons, a study was carried out to evaluate the protein, fat, fibre and amino acid content of the seeds of two soya bean varieties sown at different row spacings under organic and conventional growing conditions. The research hypothesis assumed that the seed quality of both soya bean varieties under organic cultivation conditions would be similar to that obtained in the conventional method, thanks to the coexistence of this plant with atmospheric nitrogen-fixing bacteria and its consequent independence from mineral nitrogen supply. It was further assumed that row spacing, due to its effect on competition between plants for environmental resources, could alter the quality characteristics of soya bean seeds.

MATERIAL AND METHOD

Experimental design and agronomic practices

A three-factor field experiment was set up in a split-plot design, in triplicate, in plots of 21.6 m^2. The experimental factors were: 1) cultivation method: conventional and organic, 2) soya bean variety: Aldana (early variety) and Merlin (mid-early variety), 3) row spacing: 22.5 cm and 35 cm. The varieties Aldana and Merlin were selected because they are adapted to the agroecological conditions of south-eastern Poland, especially the Lublin region. After harvesting the forecrop, which was spring wheat, the entire experiment was ploughed and harrowed twice, followed by pre-winter ploughing. In spring, harrowing, cultivation, harrowing, soya bean sowing and seed harrowing were carried out. Both soya bean varieties were sown annually in the first decade of May at a planned sowing density of 80 plants per 1 m^2. The sowing depth was 3 cm. In conventional cultivation, phosphorus-potassium fertilisation and the first nitrogen dose were applied pre-sowing, respectively: N – 30 kg ha^{-1} (ammonium nitrate 34.5%), P – 40 kg ha^{-1} (superphosphate 40%), K – 80 kg ha^{-1} (potassium salt 60%). At the beginning of flowering (BBCH 51), a second dose of nitrogen fertiliser was applied at a rate of 20 kg ha^{-1}. In organic cultivation, fertilisation consisted of a double application of organic fertiliser Bio-algeen S90 – a single dose of 200 ml per 100 l of water. The first dose of this fertiliser was applied at the soya bean germination stage (BBCH 09) and the second dose at the lateral shoots development stage (BBCH 21). Bio-algeen S90 is a natural fertiliser made from marine algae. This formulation contains 90 groups of chemical compounds, including amino acids, vitamins, alginic acid and other unexplored active components of marine algae, as well as elements, including nitrogen – 0.02%, phosphorus – 0.006%, potassium – 0.096%.

Table 1. Total precipitations (mm) and mean monthly air temperature (°C) during the experiment, recorded by the Meteorological Station in Czesławice

Months	2017		2018		2019		2020		LTA 1963–2010	
	mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
January	17.1	–5.9	20.7	–0.2	31.5	–3.4	14.1	1.2	30.3	–3.0
February	44.1	–0.6	12.9	–4.2	14.6	2.5	76.5	3.2	29.2	–1.7
March	31.8	5.1	16.0	3.2	27.1	5.5	26.0	4.6	31.3	1.8
April	59.1	6.9	27.1	12.7	39.0	10.3	19.0	8.6	42.4	7.7
May	33.7	12.8	59.1	15.5	87.0	14.4	111.4	11.2	63.5	13.6
June	43.2	17.6	74.8	16.3	11.2	22.9	170.3	17.4	72.7	16.5
July	147.7	18.7	91.2	16.8	46.3	20.0	67.8	18.8	80.0	18.3
August	75.1	19.7	55.5	20.1	52.0	21.9	59.3	20.4	69.5	17.7
September	103.3	13.3	54.7	14.7	33.5	16.3	128.5	15.7	59.5	13.1
October	104.9	8.7	41.3	9.2	37.0	12.6	93.4	10.9	45.6	7.9
November	37.0	3.8	15.2	3.9	56.3	6.6	17.4	5.2	41.0	2.9
December	39.4	2.1	70.8	–0.2	46.3	2.6	16.0	1.9	36.9	–1.3
Sum/Mean	736.4	8.5	539.3	9.0	481.8	11.0	799.7	9.9	601.9	7.8

LTA – Long term average

In the conventional method, soya bean seeds were treated before sowing with Nitragina (Bradyrhizobium japonicum bacteria) and Vitavax 200 FS (carboxin, thiram) at a rate of 400 ml 100 kg^{-1} of seed with 1 : 1 water added. Next, Afalon Dispersion 450 SC (linuron) + Dual Gold 960 EC (S-metolachlor) was applied at a rate of 1 l + 1.25 l ha^{-1} immediately after sowing to reduce weeds. In organic cultivation, soya bean seeds were treated only with Nitragina and weeds were controlled by harrowing three times: three days after sowing, at the stage of developed a three-leafed leaf at the second node (BBCH 12) and the stage of the developed three-leafed leaf at the third node (BBCH 13). Seeds of the Aldana variety were harvested annually in the first decade of September, while the Merlin variety was harvested in the second decade of September.

Seed quality analysis

The content of protein, fat and fibre in soya beans was determined using the NIR (near infra-red) technique, which utilises the phenomenon of light reflection from the analysed substance in the near infra-red range, with the use of a computerised whole-grain transmission analyser Omega G from Bruins Instruments (Germany) supplied by the Department of Herbology and Plant Cultivation Techniques at the University of Life Sciences in Lublin. Protein amino acid content was determined at the Central Research Laboratory of the University of Life Sciences in Lublin by ion exchange chromatography (INGOS amino acid analyser).

Statistical analysis

The results of the studies collected between 2017 and 2020 were subjected to analysis of variance (ANOVA), and the significance of differences was estimated using the Tukey test at a significance level of $p \leq 0.05$. The effects of cultivation method, soya bean variety, row spacing and their interactions on the protein, fat, fibre and amino acids content of the seeds were determined. All calculations were performed using Statistica 14.0.0 software.

RESULTS

Organic soya bean cultivation resulted in higher seed fat and lower seed protein content compared to conventional cultivation (Tab. 2). Seeds of the Merlin variety had a 4.6% higher seed fat content than Aldana. In contrast, higher protein content was found in the Aldana variety (by 1.8%). Row spacing did not significantly differentiate the protein, fat or fibre content of soya bean seeds.

Statistical analysis showed no significant effect of the interaction of experimental factors and weather conditions across growing seasons on the protein, fat or fibre content of soya beans. However, the interaction of cultivation method and variety modified protein and fat content (Figs. 1, 2). Higher protein content and lower fat content were characterised by seeds of the Aldana cultivar rather than Merlin, collected from both conventionally and organically grown plots. Indeed, the lowest protein content and the highest fat content were obtained in seeds of the Merlin cultivar grown using the organic method.

The experimental factors modified the protein amino acids content to different degrees (Tabs. 3, 4). In soya beans grown using the conventional method, the sum of all amino acids, both exogenous and endogenous, was higher than in the organic method – by a total of 17.00 g kg^{-1}. The organic method only significantly increased the content of sulphur-containing amino acids (methionine and cysteine) in soya bean seeds. The plots farmed using the conventional method showed a significantly higher content of almost all essential amino acids in soya bean seeds, with the exception of methionine and tryptophan, the amount of which was similar regardless of the farming method. Among endogenous amino acids, conventional cultivation, compared to organic cultivation, significantly increased the content of arginine, aspartic acid and glutamic acid in soya beans by 7.4, 7.7 and 6.0%, respectively.

In the seeds of both soya bean varieties, lysine and leucine had the highest quantitative share among the essential amino acids, and glutamic acid, aspartic acid and arginine among the endogenous ones. However, all these amino acids were present in significantly higher amounts in the Aldana variety than in Merlin (Tabs. 3, 4). The Merlin cultivar was characterised by a significantly higher density of only tryptophan compared to the Aldana cultivar, by 19.9%. The seeds of both varieties had similar contents of threonine, histidine, proline, glycine, alanine, cysteine and tyrosine. The other amino acids were present in significantly higher amounts in the seeds of the Aldana variety than in Merlin.

Row spacing had little effect on the amino acid composition of soya bean seeds (Tabs. 3, 4). The sum of essential and endogenous amino acids was found

Table 2. The protein, fat, and fibre content in soya bean seeds depending on the cultivation method, cultivar and row spacing (mean for 2017–2020)

Specification	Cultivation method		Cultivar		Row spacing	
	C	O	Aldana	Merlin	35 cm	22.5 cm
Protein content ($g\,kg^{-1}$ DM)	353.4 a	351.8 b	355.8 a	349.5 b	352.3 a	352.9 a
p	*		***		ns	
Fat content ($g\,kg^{-1}$ DM)	185.2 b	186.3 a	181.6 b	189.9 a	185.9 a	185.6 a
p	***		***		ns	
Fibre content ($g\,kg^{-1}$ DM)	47.8 a	47.9 a	47.9 a	47.8 a	47.9 a	47.8 a
p	ns		ns		ns	

C – conventional, O – organic, ns – not significant difference
* significance level at $p \leqslant 0.05$
** significance level at $p \leqslant 0.01$
*** significance level at $p \leqslant 0.001$
Different letters denote significant differences ($p \leqslant 0.05$) between the treatments. The same letter means not significantly different values ($p \leqslant 0.05$)

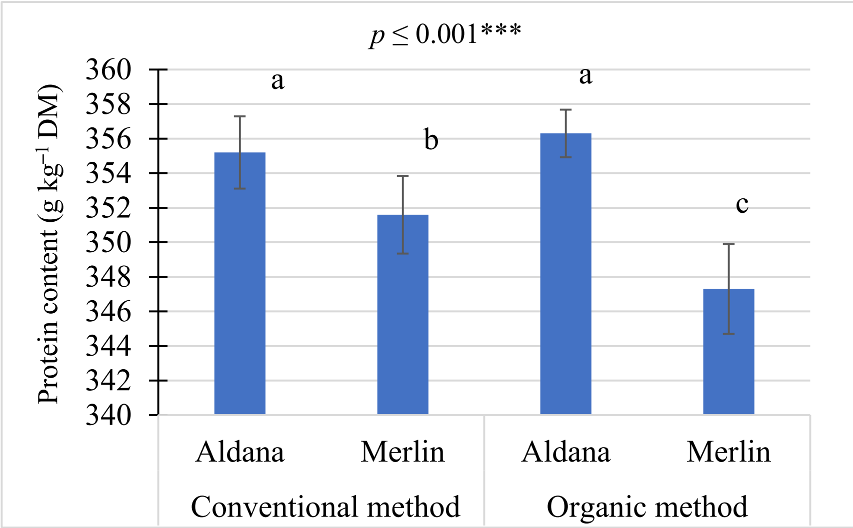

Fig. 1. The protein content in soya bean seeds depending on the interaction between the method of cultivation and soya bean cultivar (mean for 2017–2020). Explanation as in Table 2

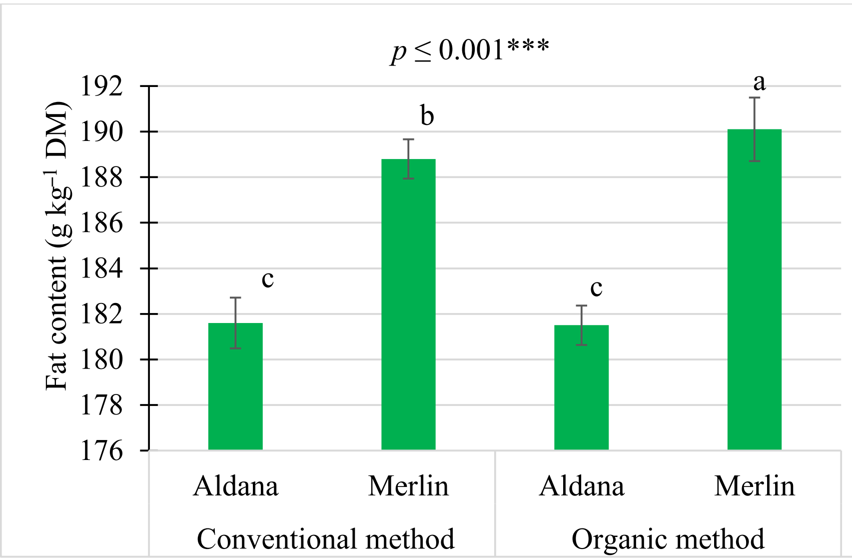

Fig. 2. The fat content in soya bean seeds depending on the interaction between the method of cultivation and soya bean cultivar (mean for 2017–2020). Explanation as in Table 2

to be similar on both sites. Seeds harvested from plots with a smaller row spacing (22.5 cm) were characterised by a significantly higher methionine density, respectively, by 15.8% compared to that found when soya bean was grown at a row spacing of 35 cm. There was no evidence of an effect of this factor on the density of the other amino acids in the seeds.

Statistical analysis showed no significant effect of the interaction of the experiment factors and weather conditions in the different growing seasons on the amino acid content of soya bean seeds. In contrast, the interaction of the experiment factors modified significantly the content of some amino acids, as shown in Tables 5–7 and Figure 3.

Table 3. Essential amino acids content (g kg^{-1} DM) in soya bean seeds depending on cultivation method, soya bean cultivar and row spacing (mean for 2017–2020)

Specification	Cultivation method		Cultivar		Row spacing	
	C	O	Aldana	Merlin	35 cm	22.5 cm
Lysine	23.34 a	21.91 b	23.23 a	22.02 b	22.57 a	22.68 a
p	*		*		ns	
Methionine	4.04 b	4.54 a	4.41 a	4.18 b	3.98 b	4.61 a
p	***		**		***	
Phenylalanine	17.73 a	16.68 b	17.68 a	16.73 b	17.17 a	17.23 a
p	**		**		ns	
Threonine	14.16 a	13.38 b	14.06 a	13.48 a	13.79 a	13.74 a
p	*		ns		ns	
Leucine	25.94 a	24.62 b	26.06 a	24.51 b	25.26 a	25.31 a
p	*		*		ns	
Isoleucine	15.37 a	14.45 b	15.39 a	14.43 b	14.91 a	14.91 a
p	*		*		ns	
Valine	16.49 a	15.38 b	16.41 a	15.47 b	15.96 a	15.91 a
p	*		*		ns	
Histidine	9.75 a	9.02 b	9.71 a	9.07 a	9.39 a	9.39 a
p	*		ns		ns	
Tryptophan	4.58 a	5.05 a	4.38 b	5.25 a	4.64 a	4.99 a
p	ns		***		ns	
Total of aminoacids	131.4	125.0	131.3	125.1	127.7	128.8

Explanation as in Table 2

Table 5 shows only those amino acids, the content of which was significantly differentiated by the interaction of cultivation method and variety. Of the essential amino acids, the seeds of the organically-grown Merlin variety showed a lower content of lysine, phenylalanine, threonine, leucine, isoleucine and valine than on the other experimental sites. Methionine content was significantly higher in the organically grown Aldana variety. The seeds of the organically grown Merlin variety also had significantly the lowest content of arginine, aspartic acid, glutamic acid and proline. The seeds obtained from this object were also characterised by the lowest alanine content, which was, however, not significantly different from that obtained from the Aldana variety grown using both conventional and organic methods. Indeed, the highest cysteine content was shown in the Aldana variety grown using the organic method.

Of all the amino acids, the interaction of cultivation method and row spacing significantly differentiated only the content of methionine and tryptophan in soya bean seeds (Tab. 6). Indeed, soya bean seeds sown at a row spacing of 22.5 cm grown using the organic method contained the most methionine. The lowest tryptophan content was found in soya bean seeds sown at a wider row spacing (35 cm) grown using the conventional method. Compared to this, a significantly higher tryptophan content of 23.9% was found in seeds collected from plots with a row spacing of 35 cm grown using the organic method.

Methionine and tryptophan content also depended significantly on the interaction between cultivar and row spacing (Tab. 7). The highest methionine content was found in the seeds of both soya bean varieties sown at a narrower row spacing (22.5 cm). The seeds of the

Table 4. Endogenous amino acids content (g kg^{-1} DM) in soya bean seeds depending on cultivation method, soya bean cultivar and row spacing (mean for 2017–2020)

Specification	Cultivation method		Cultivar		Row spacing	
	C	O	Aldana	Merlin	35 cm	22.5 cm
Arginine	25.12 a	23.40 b	25.03 a	23.49 b	24.21 a	24.31 a
p	**		*		ns	
Asparagine	39.40 a	36.58 b	39.21 a	36.77 b	38.04 a	37.94 a
p	**		*		ns	
Serine	17.44 a	16.83 a	17.78 a	16.50 b	17.34 a	16.93 a
p	ns		*		ns	
Glutamine	65.53 a	61.83 b	66.04 a	61.31 b	63.70 a	63.65 a
p	***		***		ns	
Proline	17.62 a	17.22 a	17.89 a	16.95 a	17.46 a	17.38 a
p	ns		ns		ns	
Glycine	14.64 a	13.83 a	14.65 a	13.81 a	14.14 a	14.32 a
p	ns		ns		ns	
Alanine	15.25 a	14.43 a	15.24 a	14.44 a	14.78 a	14.90 a
p	ns		ns		ns	
Cysteine	3.57 b	4.24 a	4.12 a	3,69 a	3.71 a	4.10 a
p	*		ns		ns	
Tyrosine	11.53 a	11.17 a	11.46 a	11.23 a	11.54 a	11.16 a
p	ns		ns		ns	
Total of aminoacids	210.1	199.5	211.4	198.2	204.9	204.7

Explanation as in Table 2

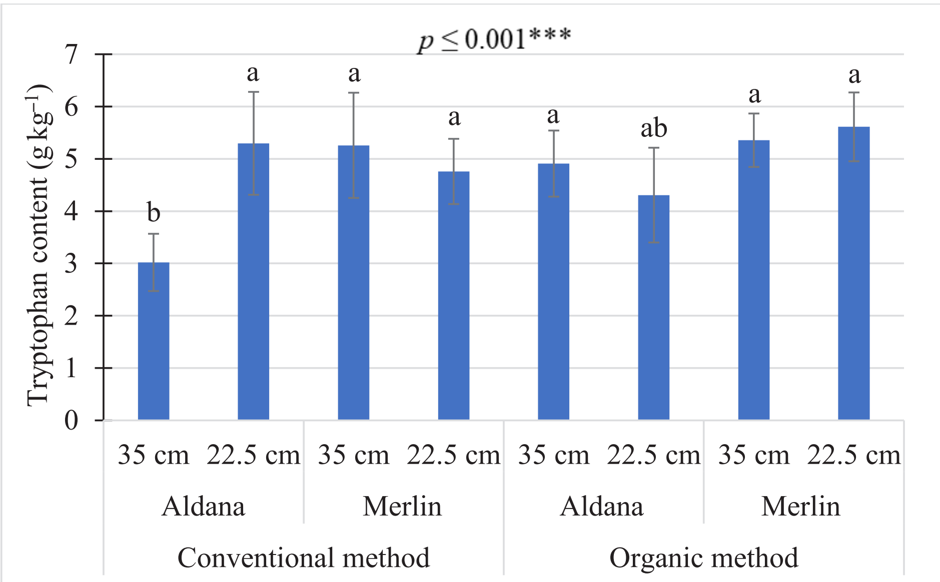

Fig. 3. The tryptophan content in soya bean seeds (g kg^{-1} DM) depending on the interaction between the cultivation method, soya bean cultivar and row spacing (mean for 2017–2020). Explanation as in Table 2

Table 5. The amino acids content (g kg^{-1} DM) in soya bean seeds depending on the interaction between the method of cultivation and soya bean cultivar (mean for 2017–2020)

Specification	Conventional method		Organic method	
	Cultivar Aldana	Cultivar Merlin	Cultivar Aldana	Cultivar Merlin
Lysine	23.13 a	23.55 a	23.33 a	20.49 b
p	**			
Methionine	3.87 b	4.22 b	4.94 a	4.14 b
p	***			
Phenylalanine	17.54 a	17.91 a	17.81 a	15.54 b
p	***			
Threonine	13.98 a	14.34 a	14.14 a	12.63 b
p	**			
Leucine	25.78 a	26.11 a	26.34 a	22.90 b
p	**			
Isoleucine	15.34 a	15.40 a	15.45 a	13.45 b
p	*			
Valine	16.38 a	16.61 a	16.44 a	14.33 b
p	*			
Arginine	24.96 a	25.27 a	25.10 a	21.70 b
p	**			
Asparagine	39.14 a	39.66 a	39.28 a	33.88 b
p	**			
Glutamine	65.28 a	65.78 a	66.80 a	56.85 b
p	***			
Proline	17.40 a	17.84 a	18.38 a	16.06 b
p	**			
Alanine	15.11 ab	15.39 a	15.36 ab	13.49 b
p	*			
Cysteine	2.96 c	4.18 b	5.27 a	3.21 c
p	***			

Explanation as in Table 2

Merlin cultivar sown at 35 cm row spacing had the lowest content of this amino acid. Seeds of the Aldana cultivar sown at 35 cm row spacing had significantly lower tryptophan content compared to the Merlin cultivar sown at 35 cm and 22.5 cm spacing, by 25.4 and 23.7%, respectively.

Statistical analysis confirmed the effect of the interaction of cultivation method, smothering and row spacing on tryptophan content in soya bean seeds (Fig. 3). The lowest content of this amino acid was found in the Aldana cultivar grown using the conventional method at a row spacing of 35 cm. Compared to this object,

Table 6. The methionine and tryptophan content in soya bean seeds (g kg^{-1} DM) depending on the interaction between the method of cultivation and row spacing (mean for 2017–2020)

Specification	Conventional method		Organic method	
	Row spacing			
	35 cm	22.5 cm	35 cm	22.5 cm
Methionine	3.99 b	4.10 b	3.97 b	5.11 a
p	***			
Tryptophan	4.14 b	5.03 ab	5.13 a	4.96 ab
p	*			

Explanation as in Table 2

Table 7. The methionine and tryptophan content in soya bean seeds (g kg^{-1} DM) depending on the interaction between the soya bean cultivar and row spacing (mean for 2017–2020)

Specification	Cultivar Aldana		Cultivar Merlin	
	Row spacing			
	35 cm	22.5 cm	35 cm	22.5 cm
Methionine	4.21 b	4.61 a	3.75 c	4.61 a
p	**			
Tryptophan	3.96 b	4.80 ab	5.31 a	5.19 a
p	*			

Explanation as in Table 2

seeds of the Aldana cultivar grown using the organic method at a row spacing of 22.5 cm were characterised by a similar tryptophan content.

DISCUSSION

Soya bean is a rich source of protein and essential amino acids while containing low amounts of raw fibre and anti-nutrients [Reis et al. 2020, Guo et al. 2022]. In-house studies have shown higher protein and lower fat content in soya beans under conventional growing conditions. Fat content is a trait most often negatively correlated with protein content [Guo et al. 2022]. In contrast, the lower protein content of organically grown soya beans is probably due to the lack of mineral fertilisation, including nitrogen fertilisation, on the site. In our experiment, only seaweed manure (with a nitrogen content of 0.02%) was applied to the organically grown plots. The beneficial effect of nitrogen fertilisation and inoculation of *B. japonicum* seeds on the crude protein content of soya bean seeds is indicated by the study of Panasiewicz et al. [2023]. Similarly, the results of the experiment by Kraski et al. [2022] indicate that mineral fertilisation influences the nutrient content of soya bean seeds. In the study by these authors, the application of a higher dose of fertiliser resulted in a significant increase in the total protein content and a decrease in the crude fibre content of soya bean seeds. Our study and that by Jarecki and Bobrecka-Jamro [2015] did not confirm the effect of mineral fertilisation and seed inoculation with Nitragina used in different cultivation methods on the fibre content of the seeds. Research by Jarecki and Bobrecka-Jamro [2015] further indicates that nitrogen fertilisation increases glutamic acid and methionine content in soya beans while causing a decrease in cysteine content. However, the content of the other amino acids in the soya bean protein was slightly modified by the application of nitrogen fertiliser and Nitragin. Also, our study confirms the positive effect of nitrogen fertilisation applied in conventional cultivation on the glutamic acid content of soya beans. However, the content of methionine and cysteine was higher in soya beans grown without mineral fertilisation when only seaweed manure was applied. In contrast, the content of most amino acids, both exogenous and endogenous, was higher in conventionally cultivated soya beans. The study by Ćustić et al. [2002] indicates that there is a significant decrease ($P < 0.05$) in methionine, valine and lysine content after the application of nitrogen fertiliser, compared to the control (without N fertilisation). A relative decrease, compared to the control, was significantly higher in protein than in dry matter, mainly when a higher dose of nitrogen fertiliser was applied. The negative effect of nitrogen fertilisers was most evident in methionine content. Our study confirms such a relationship for methionine, but valine and lysine contents were higher after mineral fertilisation, including nitrogen.

In the study presented here, row spacing made little difference in soya bean seed quality traits. Also, Acikgoz et al. [2009] showed that crude protein and oil content of forage soya beans were not significantly affected by varying row spacing (20, 40, 60 and 80 cm). According to Bellaloui et al. [2020], row spacing influences competition between plants for available water, nutrients and light interception during seed setting and, therefore, can alter the quality traits of soya bean seeds (protein and oil content, fatty acids, sugars and amino acids). It is confirmed by a study by Jaureguy et al. [2013], which showed that oil and protein content are influenced by row spacing and weather conditions in each year of the experiment, with row spacing of 70 cm having the most beneficial effect on protein content, followed by 60, 40 and 50 cm respectively.

In researching diverse soya bean varieties, it is crucial to identify those with favourable seed quality parameters, including the highest protein and essential amino acids content or oil content, among others. Selecting soya bean varieties with high protein content and high yield to ensure sustainable protein production is one of the difficulties in soybean breeding [Guo et al. 2022]. The advantage of soya protein, among other plant proteins, is the optimal amino acid ratio. These are mainly essential amino acids, of which animal proteins are the primary source. This is confirmed by a study by Jaureguy et al. [2013], which showed that oil and protein content are influenced by row spacing and weather conditions in each year of the experiment, with row spacing of 70 cm having the most beneficial effect on protein content, followed by 60, 40 and 50 cm respectively. Only significantly higher tryptophan content was found in the Merlin variety. The amino acid composition of protein can vary according to the soya bean growing region. Other factors, e.g. weather conditions, the characteristics of soya bean varieties and agro-technical practices, can affect the nutritional values of the seeds [Goldflus et al. 2006]. Soya bean protein content is a quantitative trait usually negatively correlated with agronomic traits such as oil content [Guo et al. 2022]. It was also confirmed in our study that seeds of the Merlin variety, characterised by significantly lower protein content than those of the Aldana variety, contained higher fat content.

CONCLUSIONS

Organic soya bean cultivation had significantly higher fat content and lower protein content in the seeds. Conventional cultivation had a more favourable effect on the amino acid content of soya bean seeds. The plots cultivated with this method showed a higher content of almost all amino acids, primarily essential (exogenous) amino acids. Only a significantly higher content of sulphur amino acids (methionine and cysteine) was found in soya beans cultivated using the organic method).

The Merlin variety had a higher seed fat content. The seeds of the Aldana variety, however, had a higher content of protein and almost all amino acids compared to the Merlin variety. Only a significantly higher tryptophan content was found in the Merlin variety. The seeds of both varieties showed similar contents of threonine, histidine, proline, glycine, alanine, cysteine and tyrosine.

The row spacing did not significantly differentiate protein, fat and fibre content and had little effect on the amino acids content of the seeds. Only the amount of methionine was significantly higher when soya bean was grown at a narrower row spacing (22.5 cm).

Studies have shown that soya bean seeds should remain an essential component of the human diet. Their value is determined by their high protein compactness and favourable amino acid composition, especially under conditions of conventional soya bean cultivation.

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