

# REPORT

on the research carried out under the contract concluded on 03.06.2024  
between the University of Warmia and Mazury in Olsztyn  
and GoudenKorrel S.A., based in Kaliska

<b>RESEARCH TOPIC TITLE</b>	<b>Evaluation of the agricultural effectiveness of the application of Belenus fertilizer in the production of common corn and common soybeans</b>
<b>RESEARCH TOPIC NUMBER</b>	<b>30.690.101-500</b>
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<b>THEME MANAGER</b>	<b>Prof. dr hab. Bogdan Dubis</b>
<b>LOCATION OF THE EXPERIMENT</b>	<b>Production and Experimental Plant "Balcyny" Ltd. in Balcyny</b>

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## RESEARCH TASK 2

### *Evaluation of the agricultural effectiveness of the application of Belenus fertilizer in the production of soybeans*

#### 1. RESEARCH METHODS AND CONDITIONS

##### 1.1. Test methods

A single-factor, two-repeat field experiment in a completely randomized design with common soybean variety Adessa was conducted on the production fields of the Production and Experimental Plant in Balcyny near Ostroda during the 2024 growing season.

The experimental factor was the dose of Belenus fertilizer applied pre-sowing according to the scheme:

- A. Control (without Belenus fertilizer)
- B. Belenus at a rate of 400 kg ha<sup>-1</sup>
- C. Belenus at a dose of 800 kg ha<sup>-1</sup>

The experiment was conducted in a completely randomized design, in 2 replications on a flat soil, formed from light dust on light loam classified in the good rye complex (IVb rating class). The chemical composition of the soil before the establishment of the soybean experiment was as follows: **combination A:** P<sub>2</sub>O<sub>5</sub> – 86 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 220 mg·kg<sup>-1</sup>, Mg – 47 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 11,6 mg·kg<sup>-1</sup>, organic matter – 2,05% p.s.m., C-org. – 1,19% p.s.m., pH in KCL – 4,7, pH in H<sub>2</sub>O – 5,8, salinity NaCl 0,14 g dm<sup>3</sup>; **combination B:** P<sub>2</sub>O<sub>5</sub> – 112 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 190 mg·kg<sup>-1</sup>, Mg – 54 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 14,5 mg·kg<sup>-1</sup>, organic matter – 2,16% p.s.m., C-org. – 1,25% p.s.m., pH in KCL – 4,5, pH in H<sub>2</sub>O – 5,6, salinity NaCl 0,11 g dm<sup>3</sup>; **combination C:** P<sub>2</sub>O<sub>5</sub> – 118 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 190 mg·kg<sup>-1</sup>, Mg – 53 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 11,3 mg·kg<sup>-1</sup>, organic matter – 2,04% p.s.m., C-org. – 1,18% p.s.m., pH in KCL – 4,0, pH in H<sub>2</sub>O – 5,2, salinity NaCl 0,11g dm<sup>3</sup>. The chemical composition of the soil after harvesting common soybeans was: **combination A:** P<sub>2</sub>O<sub>5</sub> – 101 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 170 mg·kg<sup>-1</sup>, Mg – 47 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 13,3 mg·kg<sup>-1</sup>, organic matter – 2,81% p.s.m., C-org. – 1,63% p.s.m., pH in KCL – 4,4, pH in H<sub>2</sub>O – 5,3, salinity NaCl 0,10 g dm<sup>3</sup>; **combination B:** P<sub>2</sub>O<sub>5</sub> – 109 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 165 mg·kg<sup>-1</sup>, Mg – 58 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 19,5 mg·kg<sup>-1</sup>, organic matter – 2,63% p.s.m., C-org. – 1,52% p.s.m., pH in KCL – 4,5, pH in H<sub>2</sub>O – 5,4, salinity NaCl 0,16 g dm<sup>3</sup>; **combination C:** P<sub>2</sub>O<sub>5</sub> – 99 mg·kg<sup>-1</sup>, K<sub>2</sub>O – 190 mg·kg<sup>-1</sup>, Mg – 59 mg·kg<sup>-1</sup>, S-SO<sub>4</sub> – 26,8 mg·kg<sup>-1</sup>, organic matter – 2,54% p.s.m., C-org. – 1,47% p.s.m., pH in KCL – 4,3, pH in H<sub>2</sub>O – 5,1, salinity NaCl 0,20 g dm<sup>3</sup>.

The experiment was conducted on plots of 225m<sup>2</sup> (15x15 m) in a post-winter triticale stand. Tillage in autumn consisted of disking and winter plowing. In spring, pre-sowing tillage was carried out with a cultivating unit, and rolling after sowing. Soybeans were sown in rows, with a density of 80 germinating seeds/m<sup>2</sup>, at a spacing of 10 cm, 3-4 cm deep, in the first decade of May. Pre-sowing P fertilization was applied at a rate of 40 kgP<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> (granular triple superphosphate) and Belenus fertilizer according to the experimental scheme. In weed control, the following were applied: Stomp Aqua 455 CS at a rate of 1.5 dm<sup>3</sup> ha<sup>-1</sup> (immediately after sowing), Corum 502.4 SL at a rate of 1.25 dm<sup>3</sup> ha<sup>-1</sup> + Dash HC at a rate of 1.0 dm<sup>3</sup> ha<sup>-1</sup> at BBCH stage 25, Fusilade Forte 150 EC at a rate of 1.2 dm<sup>3</sup> ha<sup>-1</sup> at stage 50. In chemical insecticide protection (bean pod borer), Mospilan 20 SP was applied at a dose of 0.2 kg ha<sup>-1</sup>. Harvesting was done in one stage.

The types of agrotechnical treatments and their timing are shown in Table 1.

Table 1 Summary of agronomic treatments in common soybean (growing season 2024)

Type of agrotechnical treatment performed	Date
Pre-winter plowing	25.10.2024
Pre-sowing cultivation (cultivating unit)	22.04.2024
Pre-sowing fertilization (according to the experiment scheme)	25.04.2024
Cultivation unit	06.05.2024
Seed sowing	07.05.2024
Seed rolling	08.05.2024
	08.05.2024
Weed control	04.06.2024
	10.06.2024
Protection from pests	22.07.2024
Harvesting	24.09.2024

## 1.2. Scope of field and laboratory tests

The scope of the laboratory and field tests included: the chemical composition of the soil before the establishment of the experiment and after the harvest of the crop: including: pH in KCL, pH in H<sub>2</sub>O, salinity, content of bioavailable forms of P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, Mg, S-SO<sub>4</sub>, C-org., humus; monitoring of the occurrence of phenological phases - the beginning of panicle shedding and the end of panicle shedding; the pattern of weather conditions (average daily air temperature, precipitation); measurement of the leaf greenness index (SPAD) (10 plants) using a Minolta SPAD 502DL chlorophyll meter at two dates: beginning of flowering (BBCH 61), end of flowering (BBCH 69); biometric evaluation of plants: plant height (10 plants),

number of pods per plant (10 plants), length of root system (10 plants); soybean seed yield with determination of moisture content of each field sample; determination of protein and fat content of seeds; sampling of soybean seeds from each plot of 2.0 kg.

Table 2 Summary of developmental phenophases of common soybean

Phenophase	Date of occurrence
Beginning of emergence	20.05.2024
Full emergence	25.05.2024
Beginning of budding	12.06.2024
Full budding	20.06.2024
Beginning of flowering	27.06.2024
Full flowering	10.07.2024
Beginning of pod formation	18.07.2024
Full pod formation	26.07.2024
Maturity for harvesting	20.09.2024

## 2. RESEARCH RESULTS - TABULAR SUMMARY

Table 3. Leaf greenness index of common soybean (growing season 2024)

Combination	Repeat	SPAD Index	
		start of blowing out the panicles (BBCH 16)	end of throwing panicles (BBCH 69)
A – Control (without Belenus)	I	32,1	36,7
	II	35,5	35,3
	average	<b>33,8</b>	<b>36,0</b>
B – Belenus 400 kg	I	35,9	34,4
	II	38,5	35,9
	average	<b>37,2</b>	<b>35,2</b>
C – Belenus – 800 kg	a	40,7	38,0
	b	37,9	31,8
	average	<b>38,9</b>	<b>34,9</b>

Table 4. Morphological features of soybean plants before harvest (growing season 2024)

Combination	Repeat	Specification		
		Length of the tap root (cm)	Plant height (cm)	Number of pods (pcs.)
A – Control (without Belenus)	I	13,5	54,4	14,6
	II	12,7	55,3	14,8
	average	<b>13,1</b>	<b>54,9</b>	<b>14,7</b>
B – Belenus 400 kg	I	13,6	56,8	18,3
	II	13,7	63,9	17,7
	average	<b>13,6</b>	<b>60,4</b>	<b>18,0</b>
C – Belenus – 800 kg	a	13,9	58,8	18,7
	b	14,1	63,3	21,8
	average	<b>14,0</b>	<b>61,1</b>	<b>20,3</b>

Table 5. Seed yield of common soybean (2024 growing season)

Combination	Repeat	Seed moisture content (%)	Seed yield (t ha <sup>-1</sup> )	
			At harvest moisture	At 14% moisture content
A – Control (without Belenus)	I	11,0	4,40	4,55
	II	10,8	3,96	4,11
	average	<b>10,9</b>	<b>4,18</b>	<b>4,33</b>
B – Belenus 400 kg	I	11,0	5,04	5,22
	II	10,8	4,67	4,84
	average	<b>10,9</b>	<b>4,86</b>	<b>5,04</b>
C – Belenus – 800 kg	a	11,2	4,96	5,12
	b	10,9	5,39	5,58
	average	<b>11,1</b>	<b>5,18</b>	<b>5,35</b>

Table 8. Chemical composition of soybean seeds (2024 growing season)

Combination	Repeat	Specification		
		Dry matter (%)	Total protein (%)	Raw fat (%)
A – Control (without Belenus)	I	88,5	31,4	20,2
	II	89,2	31,0	19,5
	average	<b>88,8</b>	<b>31,2</b>	<b>19,9</b>
B – Belenus 400 kg	I	89,4	30,2	20,9
	II	89,2	30,0	20,8
	average	<b>89,3</b>	<b>30,1</b>	<b>20,9</b>
C – Belenus – 800 kg	a	88,7	30,5	20,2
	b	88,9	31,0	20,5
	average	<b>88,8</b>	<b>30,8</b>	<b>20,4</b>

### 3. SUMMARY (CONCLUSIONS)

The seed yield of common soybeans grown on soil of the good rye complex under 2024 climatic conditions averaged 4.91 t ha<sup>-1</sup>. The yield-forming efficiency of the application of Belenus biological fertilizer in soybean cultivation was high. The pre-sowing application of Belenus fertilizer at a rate of 400 kg ha<sup>-1</sup> resulted in a 16% increase in soybean seed yield, and the application of this fertilizer at a rate 2 times higher allowed to increase the yield level of this species by as much as about 24% compared to the control object without Belenus fertilizer. Under the conditions of application of Belenus fertilizer in the cultivation of common soybean, an increase in the leaf greenness index (stage 61 BBCH), the length of the tap root, plant height, the number of pods set per plant and the crude fat content of the seeds was recorded.

### 3. PHOTOGRAPHIC DOCUMENTATION (Balcyny 2024)



Photo 1. Common soybean (50-59 BBCH) (combination C), Balcyny 2024 (own photo).





Photo 2. Common soybeans (70-79 BBCH) (combination B), Balcyny 2024 (own photo).



Photo 3. Common soybean (90-99 BBCH) (from left, combination B and C), Balcyny 2024 (own photo).





Photo 4. common soybean (80-89 BBCH) (combination C), Balcyny 2024 (own photo).