



Instytut Uprawy
Nawożenia i Gleboznawstwa
Państwowy Instytut Badawczy

Nr sprawy: NŻN.501.3.2020.WD

Principal:

WOODSTONE SP. z o.o.

ul. M. Curie Skłodowskiej 19/3

15-275 Białystok

Report on agricultural research conducted in 2020

Contract number: 500.414.24.2020

**The effect of the BOWERM TECHNO growth stimulator on the growth,
development and yield of corn**

Wykonawca:

Damian Wach
dr Damian Wach

dr Damian Wach

Kierownik Zakładu

A. Podleśna
prof. dr hab. Anna Podleśna

Jednostka organizacyjna IUNG-PIB: Zakład Żywienia Roślin i Nawożenia

Osoba do kontaktu: dr Damian Wach

Telefon: 814786836, 814786830

Adres e-mail: dwach@iung.pulawy.pl, nawozenie@iung.pulawy.pl

Puławy, wrzesień 2021 r.

ul. Czartoryskich 8, 24-100 Puławy
tel.: +48 81 47 86 700/800, fax: +48 81 47 86 900
www.iung.pulawy.pl, e-mail: iung@iung.pulawy.pl
NIP: 716-000-42-81

1. PURPOSE OF THE STUDY

The aim of the study was to determine the effect of the BioWerm Techno growth stimulator on the growth and development of LG 31-233 maize variety grown for silage.

2. RESEARCH METHODOLOGY

At the request of WOODSTONE Sp. z o.o., based in Białystok, ul. M. Curie-Skłodowskiej 19/3, 15-275 Białystok, a field experiment using the BioWerm Techno growth stimulator was conducted during the 2020 growing season with the aim of releasing it for commercial use. The experiment was conducted on the experimental fields of the Agricultural Experimental Station of the Institute of Soil Science and Plant Cultivation – National Research Institute in Grabów nad Wisłą, Masovian Voivodeship.

During the procedure for introducing the BioWerm Techno product to the market, there was a transfer of rights and assumption of obligations from Bud Drzew Sp. z o.o. with its registered office in Białystok, ul. M. Curie-Skłodowskiej 19/3, 15-275 Białystok to WOODSTONE Sp. z o.o. with its registered office in Białystok, ul. M. Curie-Skłodowskiej 19/3, 15-275 Białystok. The company requested a change of the entity responsible for introducing the product to the market in all documents prepared at IUNG-PIB in Puławy.

Samples of the preparation for agricultural research were collected by the sampler (Sylwester Czarkowski) from the District Chemical-Agricultural Station in Białystok on May 29, 2020 (sample collection protocol number 10 / 10/2020 of fertilizers and plant cultivation aids and substances intended for testing in order to be admitted to trading).

The experiment was conducted on lessive soil developed on light clay belonging to the good rye complex (class 3a). The soil under the corn was characterized by a slightly acidic reaction, with average phosphorus, potassium, and magnesium content. The experimental field was well-drained, and the soil had well-regulated water-air relations. Basic soil characteristics are provided in Table 1.

Plant	type and type of soil	agricultural suitability complex	mg in 100 g of soil			pH
			according to Egner		Mg	
			P ₂ O ₅	K ₂ O		
corn for silage	arable land made from light clay	good	17,0	15,0	7,2	5,7

Tables 2 and 3 summarize data on seed, pre-crops, and fertilization over the last three years.

Table 2. Seed evaluation

Plant / Variety	Sowing date	Origin	Sowing rate (kg/ha)	Spacing
Corn/ LG 31-233	04.05.2020	Limagrain	95.000	15,0 x 70,0

Table 3. Pre-emergence (over the last 3 years)

year	Forecrop	Yield t/ha	Organic fertilization per ha	Fertilization kg/ha				Chemical agent
				N	P ₂ O ₅	K ₂ O	CaO	
2016	winter triticale	4,92	-	150,0	60,0	90,0	-	Snajper
2017	spring barley	3,90	-	113,0	44,0	66,0	-	Gold450
2018	winter wheat	6,30	-	178,0	60,0	90,0	-	Bizon

The experiment tested the effect of the BioWerm Techno growth stimulator as a two-time topdressing at a dose of 2 liters per hectare against a control treatment according to the scheme:

A - control without spraying, standard NPK application;

B - BioWerm Techno stimulator sprayed at a dose of 2 liters per hectare, twice during the growing season, standard NPK application;

C - BioWerm Techno stimulator sprayed at a dose of 2 liters per hectare, twice during the growing season, NPK application reduced by 40%. According to the client's instructions, the BioWerm Techno stimulator was applied twice as a topdressing to plants in the fourth-leaf stage and the seventh-eighth-leaf stage of corn. In the control experiment, fertilization was applied in accordance with the silage maize cultivation technology adopted at the Agricultural Experimental Station in Grabów.

The field experiment was conducted using the long-stripe method. The harvested plot area was 22.4 m² (8 m long and 2.4 m wide).

The timing of application of the BioWerm Techno stimulator and the doses of mineral fertilizers are presented in Table 4, and the situational plan of the experiment is presented in Figure 1.

Table 4. Mineral fertilization and chemicals used in the experiment

object designation	type of chemical	% pure ingredient		dose kg / ha		
				of pure ingredient	active substance	
object A and B, 100% NPK	Polifoska 6	30	K ₂ O	84,0	-	30.04.2020
	Polifoska 6	20	P ₂ O ₅	56,0	-	30.04.2020
	Polifoska 6	6	N	16,8	-	30.04.2020
	Urea	46	N	92,0	-	30.04.2020
	Polidap	46	P ₂ O ₅	23,0	-	30.04.2020
	Polidap	18	N	9,0	-	30.04.2020
	Urea	46	N	50,0	-	18.06.2020
	sal de potasio	60	K ₂ O	90,0	-	30.04.2020
	Maister Power 42,5	-	-	-	1,5 L/ha	05.06.2020
	BioWerm Techno	-	-	-	2,0 L/ha	08.06.2020
	BioWerm Techno	-	-	-	2,0 L/ha	29.06.2020
object C, 60 % NPK	Polifoska 6	30	K ₂ O	50,4	-	30.04.2020
	Polifoska 6	20	P ₂ O ₅	33,6	-	30.04.2020
	Polifoska 6	6	N	10,0	-	30.04.2020
	Urea	46	N	55,2	-	30.04.2020
	Polidap	46	P ₂ O ₅	13,8	-	30.04.2020
	Polidap	18	N	5,4	-	30.04.2020
	Urea	46	N	30,0	-	18.06.2020
	sal de potasio	60	K ₂ O	54,0	-	30.04.2020
	Maister Power 42,5	-	-	-	1,5 L/ha	05.06.2020
	BioWerm Techno	-	-	-	2,0 L/ha	08.06.2020
	BioWerm Techno	-	-	-	2,0 L/ha	29.06.2020

3. Cultivation treatments during the growing season.

The experiment was conducted in accordance with the recommended technology for growing corn for silage. Chemical plant protection against weeds, diseases, and pests was applied according to corn protection recommendations. The results of the cultivation treatments are presented in Table 5, and the dates of selected plant development stages are presented in Table 6.

Table 5. Cultivation from the harvest of the previous crop and treatments during the vegetation period

10.09.2019	cultivating the field with a disc harrow after wheat harvest
21.10.2019	winter plowing with a reversible plough
17.04.2020	cultivating a field with a heavy harrow
30.04.2020	sowing of Polifoska6 multi-component fertilizer and 1 dose of nitrogen (N) in the form of urea with a fertilizer seeder
04.05.2020	field cultivation with a passive tillage set (spring harrow + tubular roller)

04.05.2020	Sowing of corn, variety LG 31-233, at a spacing of 70.0 x 15 cm with a precision seeder and the application of Polidar fertilizer
05.06.2020	spraying of corn with Maister Power herbicide at the rate of 1.5 L/ha + 250 L of water, using a mounted sprayer
08.06.2020	spraying corn with a plant growth stimulator - BioWerm Techno, 2 L/ha
18.06.2020	sowing 2 doses of nitrogen in the form of urea, 50 kg N/ha
29.06.2020	spraying corn with a plant growth stimulator - BioWerm Techno 2 L/ha
14.09.2020	green corn harvest

Table 6. Development stages of maize on the BBCH scale

BBCH code	Development phase	Date
00	dry grains	04.05.2020
01	beginning of swelling	07.05.2020
05	the radicle emerges	13.05.2020
07	coleoptile grows from a caryopsis	18.05.2020
09	coleoptiles above the ground	20.05.2020
10	beginning of development of the first leaf	23.05.2020
11	first leaf unfolded	26.05.2020
12	second leaf unfolded	26.05.2020
13	third leaf unfolded	02.06.2020
14	the fourth leaf unfolded	08.06.2020
15	fifth leaf unfolded	12.06.2020
16	sixth leaf unfolded	18.06.2020
17	the seventh leaf unfolded	23.06.2020
18	8-11 leaves unfolded	29.06.2020
19	12 or more leaves unfolded	11.07.2020
30	first node visible	14.07.2020
32	second node visible	16.07.2020
33	third node visible	20.07.2020
34	fourth node visible	22.07.2020
51	the beginning of panicle ejection	29.07.2020
53	visible top of the panicle	03.08.2020
55	fullness of panicle ejecting	08.08.2020
59	end of throwing out the panicles	15.08.2020
61	visible stamens in the spikelets of the central part	08.08.2020
63	the beginning of pollination	09.08.2020
65	flowering of the upper and lower parts of the panicle	10.08.2020
67	full bloom	13.08.2020
69	end of the flowering phase	28.08.2020
71	development of the first grains with a watery consistency, containing about 16% of dry matter	21.08.2020
73	the beginning of the milk ripeness of the kernels	25.08.2020
75	full milk ripeness of the kernels, they contain about 40% dry matter	29.08.2020
79	the grains reach their typical size	31.08.2020
83	beginning of waxy ripeness of kernels, kernels are soft, contain about 45% of dry matter	02.09.2020

85	full waxy maturity, kernels with typical color, contain about 55% dry matter	10.09.2020
87	physiological maturity, visible black spots at the base of the kernel, contains about 60% dry matter	14.09.2020
89	full maturity, hard and shiny kernels, contains about 65% dry matter	---
97	the plant dies and withers	---
99	harvested corn cobs, grain, dormancy period	---

4. WEATHER CONDITIONS

Corn sowing was carried out at the appropriate agrotechnical time. Weather conditions during the 2020 growing season were highly variable, with a lack of rainfall and periodic droughts. Thanks to relatively intense local rainfall during a period when plants demonstrated high water demand, quite satisfactory green corn yields were achieved.

The distribution of rainfall and temperature totals during the 2020 growing season are presented in Figures 2 and 3.

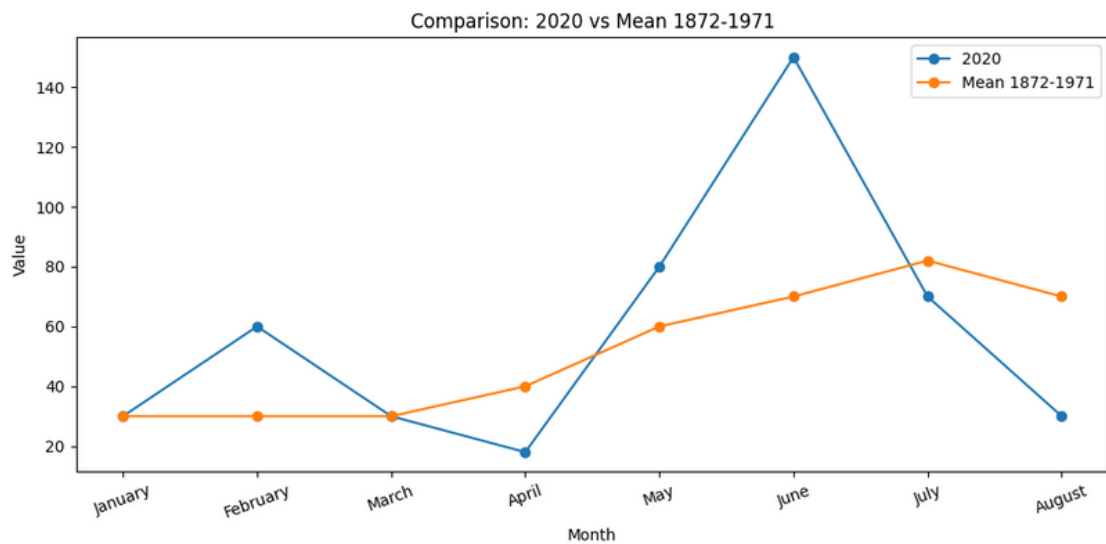


Figure 2. total rainfall in the 2020 growing season

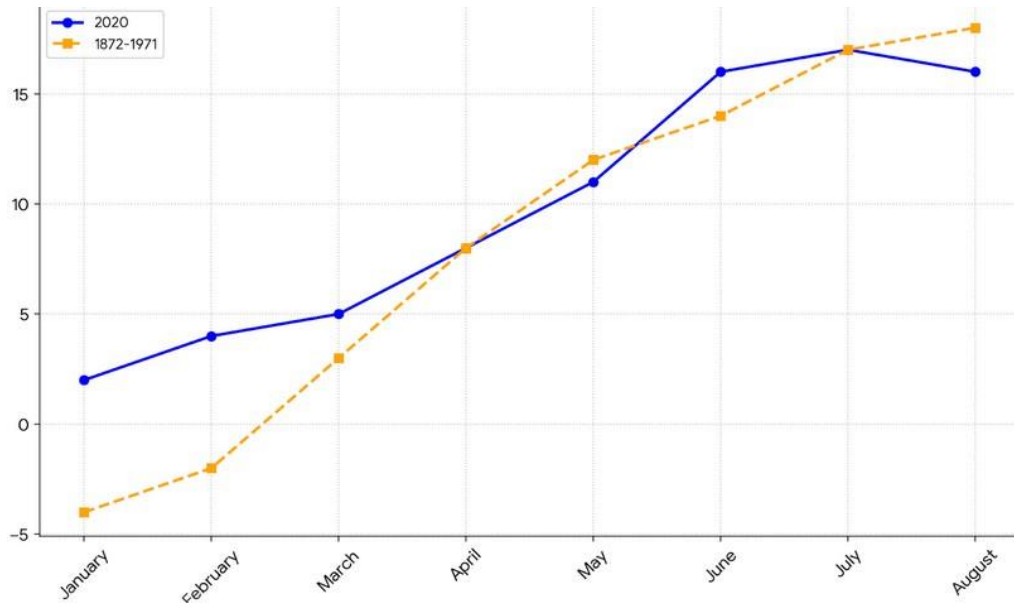


Figure 3. Temperature distribution during the 2020 growing season.

5. RESEARCH RESULTS

5.1. Biomass Accumulation and Root Development in Maize

According to the client's instructions, plant samples were collected from the maize field during the growing season to determine the dry weight of the aboveground parts and roots. Samples were collected three times on the following dates: June 17th (9 days after the first spray), July 9th (10 days after the first spray), and July 29th (at the panicle emergence stage). The plants were dried, and the dry weight of the aboveground parts and roots was determined. The results are presented in Figures 4 and 5.

The BioWerm Techno stimulator had a beneficial effect on both the growth of aboveground mass and the development of the corn root system (photos 1-5). At all sampling dates, the treatments using the tested stimulator achieved higher aboveground yields than the control. However, it should be noted that the yield increase was significant only in the treatment with the full NPK dose and stimulator application (Figure 4). The situation was slightly different for root dry matter; both the treatments with full and 40% reduced mineral fertilization observed a significant increase in root mass at all sampling dates compared to the control (Figure 5).

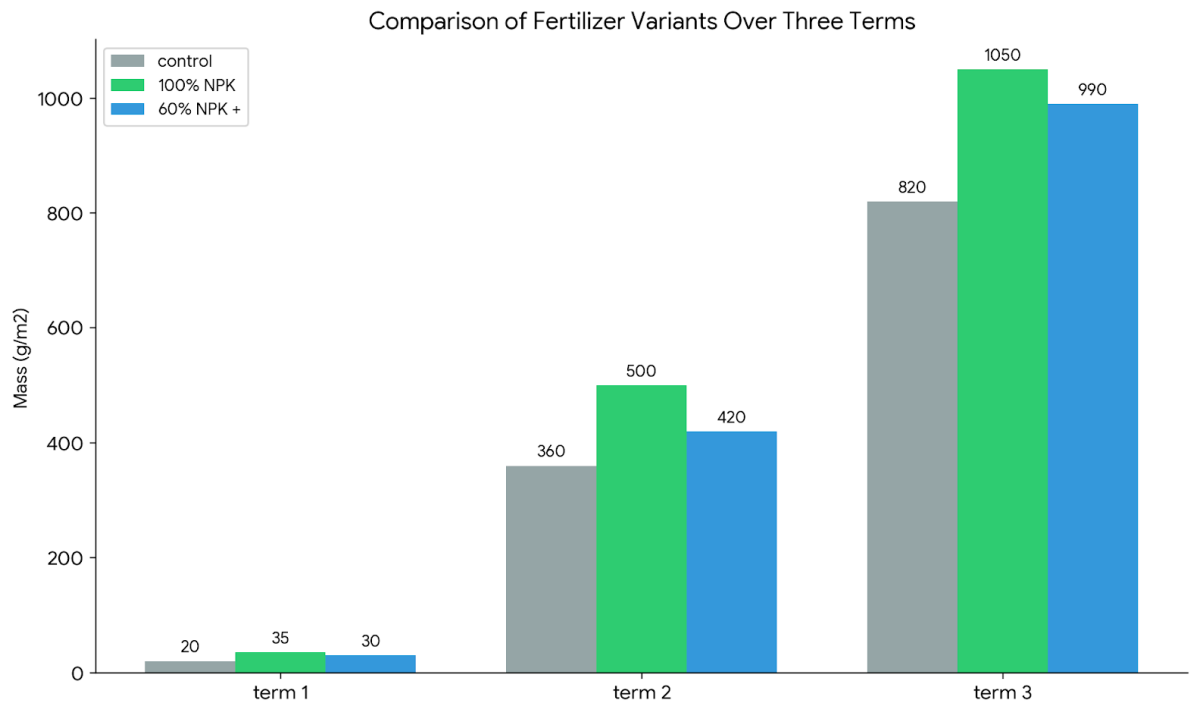


Figure 4. Effect of the BioWerm Techno growth stimulant on the accumulation of biomass (dry matter) of maize.

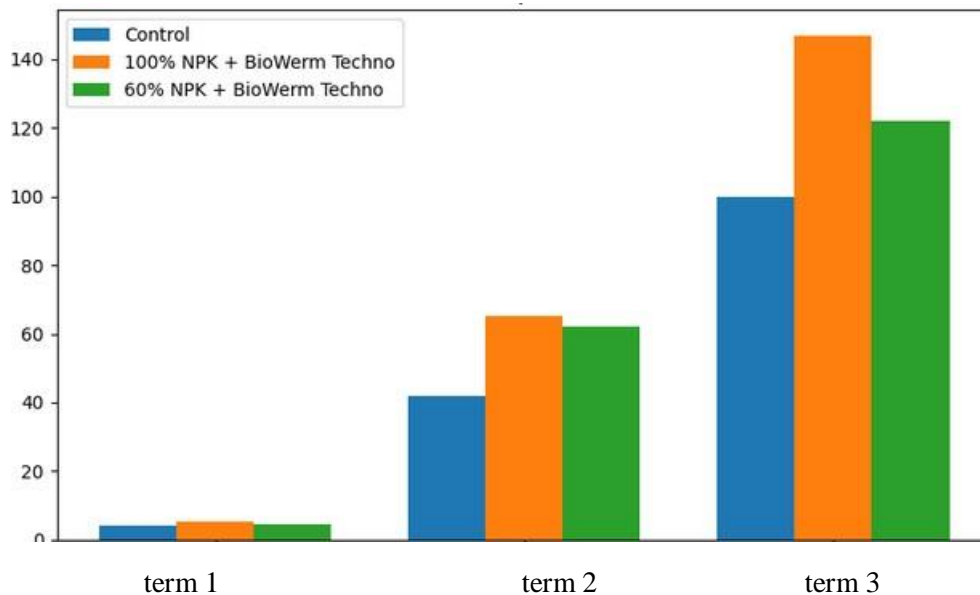


Figure 5. Effect of the growth stimulant BioWerm Techno on the root growth (dry weight) of maize.



Photo 1. The effect of the BioWerm Techno growth stimulator on corn development in the 16-17 phase (1 - control; 2. 100% NPK + BioWerm Techno; 3. 60% NPK + BioWerm Techno)



Photo 2. The effect of the BioWerm Techno growth stimulator on the development of corn in phase 32-33 (1 - control; 2. 100% NPK + BioWerm Techno; 3. 60% NPK + BioWerm Techno)



Photo 3. The effect of the BioWerm Techno growth stimulator on the development of corn roots in phase 32-33 (1 - control; 2. 100% NPK + BioWerm Techno; 3. 60% NPK + BioWerm Techno)



Photo 4. The effect of the BioWerm Techno growth stimulator on the development of corn in the 55-57 phase (1 - control; 2. 100% NPK + BioWerm Techno; 3. 60% NPK + BioWerm Techno)



Photo 5. The effect of the BioWerm Techno growth stimulator on the development of corn roots in the 55-57 phase (1 - control; 2. 100% NPK + BioWerm Techno; 3. 60% NPK + BioWerm Techno)

During the third sampling period, which occurred during the 55-57 stage and the final yield, the content of major mineral nutrients (NPK) in the dry mass of the above-ground plant parts was determined. Corn plants from the treatments sprayed with the BioWerm Techno stimulator accumulated more nutrients in the above-ground parts compared to the control treatment. The percentages of macronutrients in the above-ground biomass at the full panicle stage and in the final yield are summarized in Table 7.

Table 7. Nutrient content in the aboveground mass of maize in the full panicle phase and in the final yield

	N	P	K	N	P	K
	%			%		
control	1,765	0,235	2,26	1,021	0,245	1,465
100% NPK + BioWerm Techno	1,87	0,255	2,485	1,15	0,285	1,59
60% NPK + BioWerm Techno	1,735	0,24	2,31	1,04	0,255	1,54

5.2. Chlorophyll Content in Corn Leaves

At the time of plant sampling during the growing season, chlorophyll content in corn leaves was measured using a portable Hydro-N tester from Minolta. Measurements were taken intravitaly, on 30 fully expanded leaves. The averaged value from the 30 measurements was expressed in undimensioned SPAD units. A positive effect of the BioWerm Techno growth stimulator on chlorophyll accumulation in leaves was observed at each measurement time. On the third measurement time (at the peak emergence stage), the highest SPAD reading was obtained after application of the test product. On the second measurement time, significantly higher SPAD readings were obtained in the treatments sprayed with the test stimulator compared to the control treatment (Figure 6).

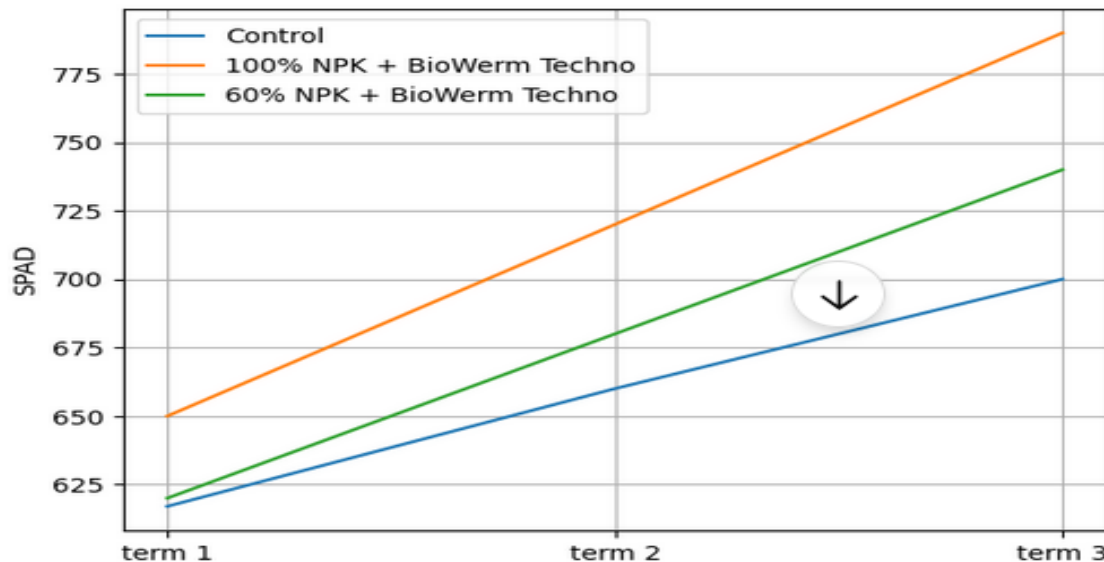
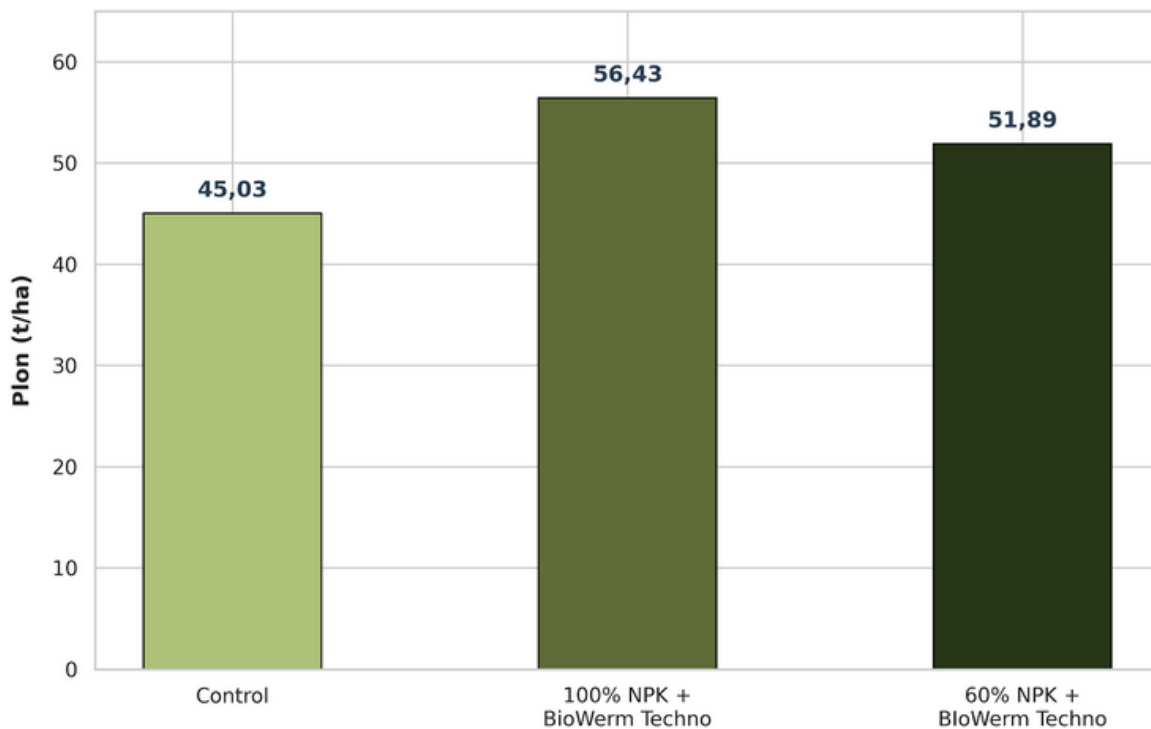


Figure 6. The effect of spraying with the BioWerm Techno growth stimulator on the SPAD chlorophyll content index readings in green leaves.

5.3. Green yield of silage-grown corn

Growth stimulator applications resulted in increased yield of silage-grown corn in both the full-fertilization and 40% reduced-fertilization treatments compared to the control (full NPK fertilization only). In both cases, the yield increase was statistically significant (Figure 6).



5.4. Nutrient Uptake in the Aboveground Corn Yield

Corn plants treated with the BioWerm Techno stimulator absorbed more of all analyzed macronutrients in the green matter yield. Thanks to the beneficial effect of the tested stimulator, the plants developed a larger root system, which allowed them to better utilize nutrients from the soil and applied mineral fertilizers. The uptake of nitrogen, phosphorus, and potassium in the green matter yield of corn is presented in Table 8.

Table 8. Nutrient uptake with the yield of green maize mass

	N	P	K
	Kg/ ha		
Control	201,9	46,2	276,4
100% NPK + BioWerm Techno	238,1	58,9	329,1
60% NPK + BioWerm Techno	204,5	51,1	308,7

6. Conclusions

1. The BioWerm Techno plant growth stimulator positively influenced the accumulation of aboveground biomass and the development of the root system of maize plants during the growing season.

2. A statistically significant increase in green maize yield was observed under the influence of the BioWerm Techno stimulator, both in the treatment with full NPK fertilization and with a 40% reduced dose of mineral fertilizers. This resulted in a significant increase in maize yield grown for silage.

3. Regardless of the level of mineral fertilization, plants treated with the test product absorbed a greater amount of nutrients from the soil and fertilizers compared to the control.

4. The BioWerm Techno plant growth stimulator is useful in the cultivation of field crops.