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THE EFFECT OF SUNFLOWER (*Helianthus annuus* L.) CATCH CROP ON CONTENT OF SELECTED COMPONENTS OF NUTRITIVE VALUE OF SWEET CORN (*Zea mays* L. var. *saccharata* (Sturtev.) L.H. Bailey)

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Abstract. Organic manuring have significant influence on the sweet corn growth. Important element of sweet corn agrotechny can be catch crops cultivated on the ploughing down. A field experiment was carried out at the Zawady Experimental Farm near Siedlce. There was investigated the effect of green manures applied as sunflower catch crops on changes in the content of dry matter, ascorbic acid, total sugars and monosaccharides in sweet corn . The sunflower was sown at three dates: the 21st of July, 4th of August and 18th of August. The effects of catch crop green manures was compared to the effect of farmyard manure (40 $t \cdot ha^{-1}$) and the control. Sweet corn cultivated in control and after catch crops sown on the 18th of August content more dry matter in kernels then cultivated after farmyard manure. Catch crops sown on the 21st of July and 18th of August reduced ascorbic acid content in corn compared to farmyard manure and the catch crop sown on the 4th of August. Sweet corn cultivated following farmyard manure and catch crops sown on the 21st of July and 4th of August had a higher content of total sugars compared with corn following the sunflower catch crop sown on the 18th of August. An average content of monosaccharides in sweet corn after sunflower catch crop sown on the 21st of July was higher than in corn cultivated following farmyard manure.

Key words: organic manuring, green manure, dry matter, ascorbic acid, sugars

INTRODUCTION

More and more Polish farmers are interested in sweet corn cultivation and in the last years the area under sweet corn amounted to 3.5 th hectares. Soil and climatic conditions of Poland are favourable for sweet corn cultivation. Moreover, its profitability is very high [Wierzbicka 1998, Waligóra and Kruczek 2003].

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Sweet corn is a valuable crop plant with many uses in human nutrition. The quality of corn grain depends on many factors including fertilization and weather conditions. Organic manuring is the factor which compensates both shortages and excess of nutrients in soil. A special role in improving soil fertility is ascribed to catch crop plants when they are incorporated into the soil [Creamer 1996, Hruszka 1996, Jabłońska-Ceglarek et al. 2004, Clark et al. 2007, Elfstrand et al. 2007, Tejada et al. 2008]. Studies on an application of green manure catch crops in vegetable growing focus mainly on their influence on soil physical and chemical properties, reduction of nutrient leaching into ground waters (nitrogen in particular), weed control and yield increase. There is a paucity of literature on the subject of secondary effect of incorporated green manures on the nutritive value of vegetables, especially sweet corn. It seems necessary to carry out studies examining this problem.

It is not always possible to sow plants grown for green manure purposes at an optimal date due to the fact that the main crop has not been harvested yet. In the present study different sowing dates of sunflower were chosen to determine how delayed sunflower sowing influences its secondary effect. Sunflower applied as a catch crop plant using as a green manure it is in Poland very small. Sunflower it is a species gives in a short time a lot of green mass. What is more it is not related with most vegetables species cultivated in our country. Additionally, showing strong allopathic affect [Gniazdowska 2007].

The present work is an attempt to determine the effect of sunflower catch crop, sown at three dates and incorporated as a green manure on the content of dry matter, ascorbic acid and sugars in sweet corn.

MATERIALS AND METHODS

Data analysed in the current paper were obtained from a field experiment carried out in 2004–2007 in central-eastern Poland. The experiment was located at the Experimental Farm in Zawady, 25 km east of Siedlce (52°06'N, 22°55'E).

The trial was set up on the soil representing grey brown podzolic soils characterized by the average organic carbon content (C_{org}) of 0.95%, the humus layer reaching the depth of 30–40 cm, and pH_{H2O} of 5.8. The soil had a sufficient quantity of $N\text{-}NO_3$ and average available phosphorus, potassium, calcium and magnesium contents. According to the international system of FAO classification, the soil was classified as a Luvisol (LV) [WRB 1998].

The experiment was established in a split-block design with four replications. The secondary effect of sunflower (*Helianthus annuus* L.) catch crop on the yield level and quality of sweet corn (*Zea mays* L. var. *saccharata*) was investigated. Seeds of sunflower (30 kg·ha^{-1}) were sown as a summer catch crop in 2004–2006 at three dates: the 21st of July (A1), 4th of August (A2) and 18th of August (A3). Before sowing mineral fertilization was applied at the following rates: 80 kg N·ha^{-1}, 60 kg P_2O_5·ha^{-1} and 80 kg K_2O·ha^{-1}. The green mass of sunflower was ploughed down in the thrd 10-daysOctober. The growing season of sunflower sown at the successive dates was: A1 – 92 days, A2 – 78 days, A3 – 64 days, respectively. Directly before catch crop incorporation,

representative samples of plant material were taken (above-ground parts and roots) to assess fresh and dry matter yields and perform chemical analyses to determine macro-element contents.

The effect on corn yield of sunflower catch crop was compared to the effect of farmyard manure (FYM) at a rate of 40 t·ha^{-1} and the control without organic manuring (NOM).

The effect of sunflower catch crop on the nutritive value of two corn cultivars: 'Challenger F_1' and 'Sweet Wonder F_1' were tested. Sweet corn was cultivated in 2005–2007, in the first year after the incorporation of green manures and farmyard manure. The seeds were sown in mid-May at the spacing of 65 × 20 cm. The seeding rate of 'Challenger F_1' was 10 kg·ha^{-1} and 'Sweet Wonder F_1' 6 kg·ha^{-1}. Sowing was preceded by an application of mineral fertilization to all the plots at the following rates: 110 kg N, 110 kg P_2O_5, and 180 kg K_2O per 1 ha. Mineral fertilizers for the catch crops and corn were in the form of ammonium nitrate, granular superphosphate and 60% potassium salt. Cobs were harvested at the stage of milk maturity of kernels, which was at the end of August and the beginning of September. The whole plot area was 56 m^2. The whole experimental area was 0.26 ha.

During the harvest representative samples of marketable cobs were taken in the aim of making chemical analyses for the content in kernels:

– dry matter – oven-drying gravimetric method,

– ascorbic acid – Pijanowski method,

– total sugars and monosaccharides – Luff Schoorl method.

The results of the experiment were statistically analyzed by means of the analysis of variance following the mathematical model for the split-block design. Significance of differences was determined by the Tukey test at the significance level of $p = 0.05$.

Table 1. Weather conditions in the period of study
Tabela 1. Warunki pogodowe w okresie prowadzenia badań

Factor Czynnik	Years – Lata	Vegatation period – Okres wegetacji		
		catch crops międzyplonów		sweet corn kukurydzy cukrowej
		VII–X	VIII–X	V–VIII
Air temperature Temperatura powietrza °C	1951–1990	13.8	12.5	16.0
	2004	14.7	13.8	-
	2005	15.3	13.7	16.7
	2006	16.4	14.4	17.8
	2007	-	-	17.7
Precipitation Opady atmosferyczne mm	1951–1990	210.6	140.0	254.0
	2004	164.7	115.7	-
	2005	147.7	61.2	240.7
	2006	286.7	270.5	307.4
	2007	-	-	219.4

In table 1 showed the mean air temperatures and precipitation in the cultivation period of sunflower catch crop and sweet corn.

RESULTS AND DISCUSSION

The amount of organic mass and macroelements incorporated with farmyard manure and sunflower catch crop are showed in table 2. The rate of 40 t·ha^{-1} FYM supplied 10.3 t·ha^{-1} dry matter and a total of 552.5 kg·ha^{-1} macroelements (N + P + K + Ca + Mg) into the soil (tab. 2). Sunflower sown on the 21st of July (A1) produced most fresh and dry matter (40.5 t·ha^{-1} and 7.4 t·ha^{-1}, respectively). Incorporation of sunflower sown on the 4th of August (A2) supplied less fresh and dry matter (by 6.8 and 1.5 t·ha^{-1}, respectively). Sunflower planted on the 18th of August (A3) supplied by 19.4 and 3.8 t·ha^{-1} less fresh and dry matter, respectively. Schmid and Klay [1984] report that the quantity of organic matter introduced into the soil with green manures correspond to the quantity incorporated with farmyard manure applied at a rate of 22–32 t·ha^{-1}, the amount of incorporated dry matter ranging between 4.5 and 5.5 t·ha^{-1}. The quantity of dry matter incorporated with catch crop A1, A2 and A3 supplied the quantity which contains 28.7, 22.9 and 14.0 tonn farmyard manure, respectively.

Table 2. The quantity of organic matter and the amount of macroelements incorporated with farmyard manure and sunflower catch crop (mean for years 2004–2006)

Tabela 2. Ilość przyoranej masy organicznej oraz makroskładników z obornikiem i międzyplonem słonecznika (średnie z lat 2004–2006)

Specification Wyszczególnienie	Organic matter Materia organiczna t·ha^{-1}		Macroelements – Makroskładniki, kg·ha^{-1}					
	FM**	DM**	N	P	K	Ca	Mg	total łącznie
Farmyard manure Obornik	40.0 c***	10.3 d	143.0 d	67.4 d	203.1 b	87.0 bc	52.0 d	552.5 c
Sunflower Słonecznik (A1)*	40.5 c	7.4 c	117.5 c	19.5 c	239.4 c	96.1 c	41.0 c	513.5 c
Sunflower Słonecznik (A2)	33.7 b	5.9 b	91.9 b	15.9 b	192.8 b	77.4 b	32.6 b	410.6 b
Sunflower Słonecznik (A3)	21.1 a	3.6 a	56.0 a	9.4 a	117.1 a	47.1 a	19.8 a	249.4 a

* The date of sowing of sunflower catch crop: A1 – 21 July, A2 – 4 August, A3 – 18 August – Termin wysiewu nasion międzyplonu słonecznika: A1 – 21 lipca, A2 – 4 sierpnia, A3 – 18 sierpnia

** FM – Fresh matter – Świeża masa, DM – Dry matter – Sucha masa

*** Values followed by the same letters do not differ significantly at p = 0.05 – Wartości oznaczone tą samą literą nie różnią się istotnie przy p = 0,05

Forty tonnes of farmyard manure per 1 ha supplied the same total amount of macroelements as the sunflower catch crop sown on the 21st of July (A1). It contented less nitrogen, phosphorus and magnesium but more potassium or calcium than farmyard manure. The total amount of macroelements incorporated with this catch crops equalled 513.5 kg per 1 ha. The quantity of macroelements incorporated with sunflower A2 and A3 was, respectively, by 26 and 54% lower compared with the farmyard manure.

The average dry matter content in kernels amounted to 26.94% (tab. 3). It differed significantly in the consecutive study years. The kernels of corn cultivated in 2005 and

2007, which were characterized by lower participation, contained significantly more dry matter than in 2006 when the precipitation in the growing period of corn was by 27 and 40% higher than in 2005 and 2007, respectively. In their earlier studies, Jabłońska-Ceglarek et al. [2005] reported as similar tendency. In turn, Michałojć et al. [1996] found that increased soil moisture is followed by increased dry matter content of sweet corn kernels. Borowiecki [1988] reported that soil water shortages negatively influenced grain formation, number of grains per cob as well as dry matter content.

Table 3. The dry matter contents in sweet corn kernels
Tabela 3. Zawartość suchej masy w ziarniakach kukurydzy cukrowej

Organic manuring Nawożenie organiczne	Dry matter – Sucha masa, %					
	years – lata			$\bar{x}$	cultivar – odmiana	
	2005	2006	2007		B1**	B2
Control (NOM) Kontrola	28.02 ab***	25.40 b	28.93 b	27.45 b	26.92 ab	27.98 b
Farmyard manure Obornik	27.33 a	24.87 ab	26.86 a	26.35 a	26.29 a	26.42 a
Sunflower Słonecznik (A1)*	27.63 ab	24.51 ab	28.40 b	26.85 ab	26.02 a	27.67 b
Sunflower Słonecznik (A2)	27.92 ab	24.18 a	28.14 b	26.75 ab	26.50 ab	26.99 ab
Sunflower Słonecznik (A3)	28.72 b	24.63 ab	28.61 b	27.32 b	27.40 b	27.23 ab
Mean – Średnio	27.92 B	24.72 A	28.19 B	26.94	26.63 A	27.26 A

* The date of sowing of sunflower catch crop: A1 – 21 July, A2 – 4 August, A3 – 18 August – Termin wysiewu nasion międzyplonu słonecznika: A1 – 21 lipca, A2 – 4 sierpnia, A3 – 18 sierpnia
** Cultivar – Odmiana: B1 – Challenger F1; B2 – Sweet Wonder F1
*** Values followed by the same letters do not differ significantly at p = 0.05 – Wartości oznaczone tą samą literą nie różnią się istotnie przy p = 0,05

The highest average dry matter content was determined in sweet corn cultivated in the control without organic manuring (NOM) (27.45%) and after sunflower catch crop sown on the 18th of August (A3) (27.32%). A similar quantity of dry matter was found in the kernels of corn following the sunflower catch crop sown on the 21st of July (A1) and 4th of August. The dry matter content in corn following farmyard manure was significantly lower than in the control NOM and the corn following catch crop A3 (26.35%).

Compared with farmyard manure, dry matter content in kernels was significantly higher after sunflower A3 in 2005, and after A1, A2, A3 and in NOM in 2007. In 2006, which received the greatest precipitation during the sweet corn growing period, the kind of organic manuring did not change the dry matter content in kernels.

The cultivars investigated responded differently to the organic manuring applied in the study. Most dry matter (27.40%) was accumulated by 'Challenger F_1' after sunflower catch crop A3, significantly less after farmyard manure (26.02%) and sunflower catch crop A1 (26.02%). 'Sweet Wonder F_1' accumulated most dry matter when cultivated in the control NOM (27.98%) and after catch crop A1 (27.67%), the accumulation being significantly lower after farmyard manure (26.42%).

Despite differences in the dry matter contents in corn kernels determined for individual combinations, they fell within the range of optimal values. The nutritive value of sweet corn grain is highest when it contains from 24 to 29% dry matter. The unique taste of sweet corn is associated with a high grain content of water-soluble polysaccharides. It is well established that an increased dry matter content, e. g. in maturing kernels, is followed by unfavourable changes in carbohydrates. The taste, quality and appearance of kernels deteriorates [Douglass and Juvik 1993, Michałojć et al. 1996, Marshall and Tracy 2003, Szymanek et al. 2004, Niedziółka and Szymanek 2005].

In the studies regarding an application green manures as previous crops (oat, field pea, spring vetch) in sweet corn cultivation, Jabłońska-Ceglarek et al. [2005] found that the effect of the previous crops on grain content of dry matter was similar to the influence of farmyard manure. Vetch, which produced least biomass, was an exception as the grain dry matter content of maize following this legume was lower than after farmyard manure.

The amount of ascorbic acid in sweet corn kernels differed significantly in the successive study years (tab. 4). Significantly most and least ascorbic acid was accumulated by corn in 2005 (9.39 mg·100^{-1} g f.m.) and 2006 (8.07 mg·100^{-1} g f.m.), respectively. The ascorbic acid content in the corn following catch crop, irrespective of the sowing date, was similar to the content determined after farmyard manure application and ranged from 8.64 to 8.83 mg·100-1 g f.m. Compared with mineral fertilization-based corn cultivation, sweet corn following sunflower catch crop A2 and A3 was characterized by a significantly higher ascorbic acid content. According to Warman and Havard [1998], it is difficult to indicate which cultivation system, that is mineral fertilizer – or organic manure-based system, more favourably influences vitamin C content in sweet corn.

Table 4. The ascorbic acid contents in sweet corn kernels
Tabela 4. Zawartość kwasu askorbinowego w ziarniakach kukurydzy cukrowej

Differentiating factors Czynniki różnicujące		Ascorbic acid, mg·100^{-1} g f.m. Kwas askorbinowy, mg·100^{-1} g św.m.		
		cultivar – odmiana		$\bar{x}$
		Challenger F_1	Sweet Wonder F_1	
Years Lata	2005	9.33 a**	9.46 a	9.39 c
	2006	8.07 a	8.06 a	8.07 a
	2007	8.52 a	8.66 a	8.59 b
Organic manuring Nawożenie organiczne	Control (NOM) – Kontrola	8.57 a	8.47 a	8.52 a
	Farmyard manure – Obornik	8.50 a	8.91 a	8.70 ab
	Sunflower – Słonecznik (A1)*	8.77 a	8.52 a	8.64 ab
	Sunflower – Słonecznik (A2)	8.69 a	8.98 a	8.83 b
	Sunflower – Słonecznik (A3)	8.68 a	8.77 a	8.73 b
Mean – Średnio		8.64 A	8.73 A	8.68

* The date of sowing of sunflower catch crop: A1 – 21 July, A2 – 4 August, A3 – 18 August – Termin wysiewu nasion międzyplonu słonecznika: A1 – 21 lipca, A2 – 4 sierpnia, A3 – 18 sierpnia
** Values followed by the same letters do not differ significantly at p = 0.05 – Wartości oznaczone tą samą literą nie różnią się istotnie przy p = 0,05

The total sugar content in sweet corn differed significantly in the consecutive study years (tab. 5). It was found that corn cultivated in 2006 and 2005 contained, respectively, most (9.02% f.m.) and least (5.61% f.m.) total sugars. In 2005 and 2006 organic manuring did not significantly affect the parameters investigated. In 2007 the corn cultivated after farmyard manure and sunflower catch crop sown on the 21st of July (A1) and 4th of August (A2) contained significantly more total sugars compared with both the control NOM and sweet corn cultivated following sunflower catch crop sown on the 18th of August (A3).

Table 5. The total sugars contents in sweet corn kernels
Tabela 5. Zawartość cukrów ogółem w ziarniakach kukurydzy cukrowej

Organic manuring Nawożenie organiczne	Total segars, % f.m. – Cukry ogółem, % św.m.					
	years – lata			$\bar{x}$	cultivar – odmiana	
	2005	2006	2007		B1**	B2
Control (NOM) Kontrola	5.58 a***	9.11 a	6.39 a	7.03 a	6.87 bc	7.18 a
Farmyard manure Obornik	5.59 a	9.00 a	7.33 b	7.30 a	6.79 bc	7.82 c
Sunflower Słonecznik (A1)*	5.53 a	8.98 a	7.24 b	7.25 a	6.49 a	8.01 c
Sunflower Słonecznik (A2)	5.58 a	8.86 a	7.44 b	7.29 a	7.04 c	7.55 b
Sunflower Słonecznik (A3)	5.75 a	9.17 a	6.39 a	7.10 a	6.68 ab	7.52 b
Mean – Średnio	5.61 A	9.02 C	6.96 B	7.19	6.77 A	7.62 B

* The date of sowing of sunflower catch crop: A1 – 21 July, A2 – 4 August, A3 – 18 August – Termin wysiewu nasion międzyplonu słonecznika: A1 – 21 lipca, A2 – 4 sierpnia, A3 – 18 sierpnia
** Cultivar – Odmiana: B1 – Challenger F_1; B2 – Sweet Wonder F_1
*** Values followed by the same letters do not differ significantly at p = 0.05 – Wartości oznaczone tą samą literą nie różnią się istotnie przy p = 0,05

The sweet corn cultivars examined had different contents of total sugars depending on the organic manuring applied. 'Challenger F_1' after catch crop A2, farmyard manure and in the control NOM contained significantly more total sugars (7.04, 6.79 and 6.87% f.m., respectively) compared with the crop cultivated after sunflower A1 (6.49% f.m.). Significantly more total sugars were determined in the kernels of 'Sweet Wonder F_1' following catch crop A1 (8.01% f.m) and farmyard manure (7.82% f.m.) as compared to corn harvested from treatments where sunflower catch crops A2 and A3 had been grown (respectively, 7.55 and 7.52% f.m.).

An average content of monosaccharides in the sweet corn cultivars examined amounted to 2.37% f.m. (tab. 6). It amounted to 2.68, 2.23 and 2.19% f.m. in 2006, 2007 and 2005, respectively, the differences being significant.

Sweet corn following sunflower catch crop A1 accumulated significantly more monosaccharides (2.68% f.m.) compared with the corn after farmyard manure (2.27% f.m.). Moreover, 'Challenger F_1' contained more monosaccharides.

Table 6. The monosaccharides contents in sweet corn kernels
Tabela 6. Zawartość cukrów redukujących w ziarniakach kukurydzy cukrowej

Organic manuring Nawożenie organiczne	Monosaccharides, % f.m.– Cukry redukujące, % św.m.					
	years – lata			$\bar{x}$	cultivar – odmiana	
	2005	2006	2007		B1**	B2
Control (NOM) Kontrola	2,1 a***	2,7 a	2,2 a	2.32 ab	2.33 a	2.32 a
Farmyard manure Obornik	2,1 a	2,5 a	2,2 a	2.27 a	2.25 a	2.29 a
Sunflower Słonecznik (A1)*	2,5 a	2,7 a	2,2 a	2.49 b	2.55 a	2.42 a
Sunflower Słonecznik (A2)	2,1 a	2,8 a	2,4 a	2.42 ab	2.41 a	2.43 a
Sunflower Słonecznik (A3)	2,2 a	2,7 a	2,2 a	2.34 ab	2.36 a	2.32 a
Mean – Średnio	2.19 A	2.68 C	2.23 B	2.37	2.38 B	2.36 A

* The date of sowing of sunflower catch crop: A1 – 21 July, A2 – 4 August, A3 – 18 August – Termin wysiewu nasion międzyplonu słonecznika: A1 – 21 lipca, A2 – 4 sierpnia, A3 – 18 sierpnia
** Cultivar – Odmiana: B1 – Challenger F_1; B2 – Sweet Wonder F_1
*** Values followed by the same letters do not differ significantly at p = 0.05 – Wartości oznaczone tą samą literą nie różnią się istotnie przy p = 0,05

Jabłońska-Ceglarek et al. [2005] reported insignificant differences in sugar contents of sweet corn cultivated following previous crops used as green manures and farmyard manure. The authors did not find an influence of the quantity of catch crop mass incorporated on the accumulation of sugars by corn. However, it was found that an application of green manures beneficially affected dry matter, vitamin C and sugar content in other vegetables species [Jabłońska-Ceglarek et al. 1994, Franczuk et al. 1999, Jabłońska-Ceglarek et al. 2000, 2002]. Kołota and Adamczewska-Sowińska [2004] found that the content of minerals in vegetables cultivated following green manures was similar to the content in vegetables following farmyard manure.

CONCLUSIONS

1. The quantity of biomass and the amount of macroelements incorporated with sunflower catch crop sown on the 21st of July was similar to the quantity incorporated with farmyard manure applied at the rate of 40 $t \cdot ha^{-1}$. Delaying the sowing date of sunflower resulted in a decrease in the quantity of organic mass produced and amount of macroelements accumulated.

2. Increased precipitation in the growing period was followed by reduced dry matter contents in sweet corn kernels in the study years. In 2006, which was most favourable for sweet corn growing in terms of moisture conditions, dry matter contents in corn cultivated after catch crop and farmyard manure were similar. In 2007, which received the least rainfall over the growing period, the dry matter content of sweet corn following catch crop was significantly higher compared with farmyard manure.

3. The effect of sunflower catch crop and farmyard manure on ascorbic acid content was similar. Corn following the catch crop sown on the 4th and 18th of August had higher ascorbic acid contents compared with mineral fertilization-based cultivation.

4. Sweet corn following sunflower catch crop sown on the 21st of July significantly increased monosaccharides content as compared to farmyard manure-based cultivation.

5. The cultivars investigated in the study responded differently to an application of sunflower catch crop. The catch crop sown on the 21st of July produced much organic mass which increased and reduced dry matter and total sugars contents in the grains of 'Sweet Wonder F_1' and 'Challenger F_1', respectively.

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WPŁYW MIĘDZYPLONU SŁONECZNIKA (*Helianthus annuus* L.) NA ZAWARTOŚĆ W KUKURYDZY CUKROWEJ (*Zea mays* L. var. *saccharata* (Sturtev.) L.H. Bailey) WYBRANYCH ELEMENTÓW WARTOŚCI ODŻYWCZEJ

Streszczenie. Na wzrost kukurydzy cukrowej istotny wpływ ma nawożenie organiczne. Ważnym elementem jej agrotechniki mogą być rośliny międzyplonowe uprawiane na przyoranie. Eksperyment przeprowadzono w RSD w Zawadach k. Siedlec. Badano wpływ nawozów zielonych ze słonecznika wysiewanego 21 lipca, 4 i 18 sierpnia na zawartość suchej masy, kwasu askorbinowego, cukrów ogółem i redukujących w kukurydzy cukrowej. Efekty stosowania nawozów zielonych porównano z obornikiem (40 t·ha^{-1}) oraz obiektem kontrolnym. Kukurydza uprawiana w kontroli i po międzyplonie posianym 18 sierpnia charakteryzowała się wyższą zawartością suchej masy w ziarniakach od uprawianej po oborniku. Uprawa kukurydzy po międzyplonach posianych 21 lipca i 18 sierpnia wpłynęła na spadek ilości kwasu askorbinowego w ziarniakach w stosunku do uprawy po oborniku i międzyplonie posianym 4 sierpnia. Kukurydza uprawiana po oborniku oraz międzyplonach posianych 21 lipca i 4 sierpnia charakteryzowała się wyższą zawartością cukrów ogółem od uprawianej po międzyplonie posianym 18 sierpnia. Zawartość cukrów redukujących w kukurydzy po międzyplonie posianym 21 lipca była wyższa niż po oborniku.

Key words: nawożenie organiczne, nawozy zielone, sucha masa, kwas askorbinowy, cukry

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