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PLANT PARTS STRUCTURE AND YIELDING OF SORGHUM INTERCROPPED WITH MAIZE AND SPACED ALTERNATELY IN EVERY TWO ROWS

Summary

The studies were conducted in the years 2010-2012, at the Agricultural Experimental Station in Swadzim (52°26'20"N, 16°44'58"E), belonging to the Poznań University of Life Sciences, Poland. The reaction of two cultivars of sorghum (GK Aron mid-early and late Sucrosorgo 506) the intercrop with corn, compared to pure sorghum seed was evaluated. Corn was represented by a variety of medium-late, with high potential for biomass production: Absolut and Vitras. Compared to crops in pure sowing, companion crop of sorghum with corn resulted in a decrease in yield. The yields of sorghum fresh weight were reduced by over 15%, while in the dry matter reduction amounted to approx. 10%. The earlier and lower GK Aron cultivar showed a stronger negative reaction than the high, later Sucrosorgo 506 cultivar. The GK Aron cultivar compared to pure sowing gave s. m. yields lower by 17%, while the losses of yield of Sucrosorgo 506 did not exceed 4% and they were insignificant. No significant impact of maize cultivars on the yield and structure of sown plants of intercropped sorghum appeared. The sorghum sown as intercrop with corn was characterized by a lower share of leaves and the higher share of panicles compared to pure sowing.
Key words*: sorghum, intercropping and pure sowing, sorghum 2 rows/maize 2 rows, cultivars*

STRUKTURA ROŚLIN I PLONOWANIE SORGA UPRAWIANEGO WSPÓŁRZĘDNIE Z KUKURYDZĄ, PRZEMIENNIE CO DWA RZĘDY

Streszczenie

Badania przeprowadzono w latach 2010-2012 w Swadzimiu (52°26'20"N, 16°44'58"E), stacji należącej do Uniwersytetu Przyrodniczego w Poznaniu. Oceniano reakcji dwóch odmian sorga (średniowczesnej GK Aron i późnej Sucrosorgo 506) na uprawę współrzędną z kukurydzą, w porównaniu do siewu czystego sorga. Kukurydza reprezentowaną była przez odmiany średnio-późne, o dużym potencjale produkcji biomasy: Absolut i Vitras. W porównaniu do uprawy w siewie czystym, współrzędna uprawa sorga z kukurydzą skutkowała zmniejszeniem plonowania. Plony świeżej masy sorga były mniejsze o ponad 15%, natomiast w suchej masie obniżka wynosiła ok. 10%. Wcześniejsza i niższa odmiana GK Aron wykazała silniejszą ujemną reakcję niż wysoka, późniejsza odmiana Sucrosorgo 506. Odmiana GK Aron w porównaniu do siewu czystego dała plony s.m. niższe o 17%, podczas gdy ubytki plonu Sucrosorgo 506 nie przekraczały 4%. i były nieistotne. Nie wykazano istotnego wpływu odmiany kukurydzy na plonowanie i strukturę roślin sianego współrzędnie sorga. Sorgo siane współrzędnie z kukurydzą charakteryzowało się mniejszym udziałem liści i większym udziałem wiech w porównaniu do siewu czystego.
Słowa kluczowe*: sorgo, uprawa współrzędna a siew czysty, 2 rzędy sorga/ 2 rzędy kukurydzy, odmiany*

1. Introduction

Corn silage in modern cattle breeding is the basis of nutrition, acting 50-80% by weight of the feed. A large percentage of light soils in Poland and increasing number of summer droughts occurring make that the cultivation of silage maize has not always appropriate production effects [14, 15, 23, 24, 25]. Therefore the solutions are searched which in the case of water shortages ensure yield of an adequate amount and quality. Sorghum (*Sorghum bicolor (L.) Moench*) is an annual grass of C4 type, with high possibilities of biomass production per unit area and versatile [12, 13, 17]. It is considered that sorghum yield potential is higher than maize but in central Europe under sufficient soil moisture it usually resolves maize, both by yields and nutritional value of biomass [3, 5, 15, 18, 19, 20, 25].

Sorghum has a strong root system and is more resistant to drought than maize. It has a low transpiration rate and during the periods of drought it collects water from the deeper soil layers more effectively than other grasses [1, 3, 13, 15, 17].

Sorghum fodder crop makes silage well to the high content of sugars, but too much moisture is associated with considerable losses during ensiling and a small concentration of energy. Silage also contains two times more crude fiber and about 1/3 less nitrogen-free exhaust compounds than corn silage. The low dry matter content and a low concentration of the nutrients is connected to a lack of early varieties and consequently, a small share of fruitification in the crop [1, 4, 25]. With the development of the cultivation of sorghum in Europe, the farmer has at his disposal more and more varieties with high yield potential (hybrids) and an intermediate type between form and fodder grain, a higher content of s.m. and greater involvement of generative parts in yield [4, 14, 15, 24, 25].

To provide effective use of the advantages of both plants, the intercrop of sorghum with corn may be used. It consists in alternating (strip) corn and sorghum sowing. It allows to use the potential yield-forming sorghum and high energy value of corn. The technology is often referred to as "mixed cropping" [2, 5]. The advantages of such crops include among others: (1) higher yields and more efficient use of water and nutrients on light soils; (2) the risk reduction of low yields in years of poor rainfall and dry areas; (3) better health of the crop - sorghum plants are not infected by the blade or damaged by corn borer; (4) possibility to improve the quality parameters (s.m. content, sugar, starch) by the selection and proportions of suitable varieties seeding; (5) better silage - sorghum plants contain more sugars and remain longer green and the simultaneous yield of both substrates gives a uniform silage material [3, 4, 6].

In intercrop of sorghum and corn the interaction of plants must be taken into consideration. Although the two species photosynthesis of C4 type takes place but the rhythm of development is slightly different, different plant height as well and expiration date for harvest. Specific competition for water, nutrients and space for the development of roots and aerial parts in intercrop often causes a decrease in the yield component of lower competitiveness and changing the proportions of the plants as compared to the crop in pure. Impairment and morphological changes may be the result of shadowing by maize, particularly in the initial stages of growth. The effect of intercrop of bean maize is less than the number of pods formed [9]. A similar phenomenon is observed in the cultivation of cereal mixtures and cereal-legume. The agronomic factors such as mineral fertilizer, seed density, and the proportion or selection of variants [5, 7, 8, 10, 11, 21, 23, 24] affect the development of plants and competition between the species as a result.

The aim of the study was to evaluate the reaction of the two varieties of sorghum to intercrop of corn in a strip of two rows of both species. The test hypothesis is assumed that the companion crop of sorghum sown with maize plants differs in structure and performance of the unit area from sorghum grown in pure and that the selection of varieties of sorghum and maize affects the magnitude of these changes.

2. Material and methods

The study was conducted in the years 2010-2012 at the Agricultural Experimental Station in Swadzim (52° 26'20 "N, 16° 44'58" E) belonging to the University of Life Sciences in Poznan. The experiment was conducted by split-plot method, where the I-row factor included a way of sorghum sowing: a - in pure, b - in intercrop sowing with corn Absolut (Limagrain) varieties and c - the intercrop sowing with corn Vitras (HR Smolice) varieties. The varieties of sorghum constituted the second factor: mid-early GK Aron (GabonaKutato) and late: Sucrosorgo 506 (Syngenta Seeds). Both varieties have a high potential for the production of green matter, good tolerance to drought and high sugar content in the plant. Maize varieties belong to the group of medium late (FAO 250-260) with high potential for biomass production.

Experiment was carried out in four replications, on fallow soil, class IVa-b, with an average abundance of phosphorus and potassium and pH_{KCL} 5.5-6.0. Maize was sown in the last days of April at ½ plot, leaving 2 rows sown to sorghum. Sowing sorghum followed approx. 3 weeks later, in the second decade of May (Table 1). The size of the plots for harvest was 12,25 m^2 (2 rows x 0,7 x 8,750m). Corn and sorghum were sown with pneumatic seed drill at a density of 90000 grains of corn and 20400 grains of sorghum per 1 ha. During the test, the measurements of plant height, yield of fresh and dry weight and the share of stems, leaves and panicles of sorghum crop were made. Sorghum and corn were harvested late in the third decade of October. Corn during this period was in the late-maturity wax. Yields of biomass sorghum defined on the whole plot; height of the sprout of 25 plants, and the yield structure of the sample was evaluated on another 10 plants from the row. The significance of differences on average based on the synthesis of 3-year study were evaluated by analysis of variance and Tukey's test, at the significance level of $p \leq 0.05$. LSD for interacting process for sowing and variations (AxB) specified in the tables was calculated to compare three values - in the same cultivar of sorghum. Hydrothermal factor, where the limit is the digit „1”; 1-2 illustrate the sufficient moistening, and less than 0,5 - drought, calculated according to the Selianinow method [7] with the formula:

$$K = \frac{\textit{Total rainfall x10}}{\textit{Average temperature x number of days}}$$

Table 1. Weather conditions w years 2010-2012 at Swadzim
Tab. 1. Warunki pogodowe w latach 2010-2012 w Swadzimiu

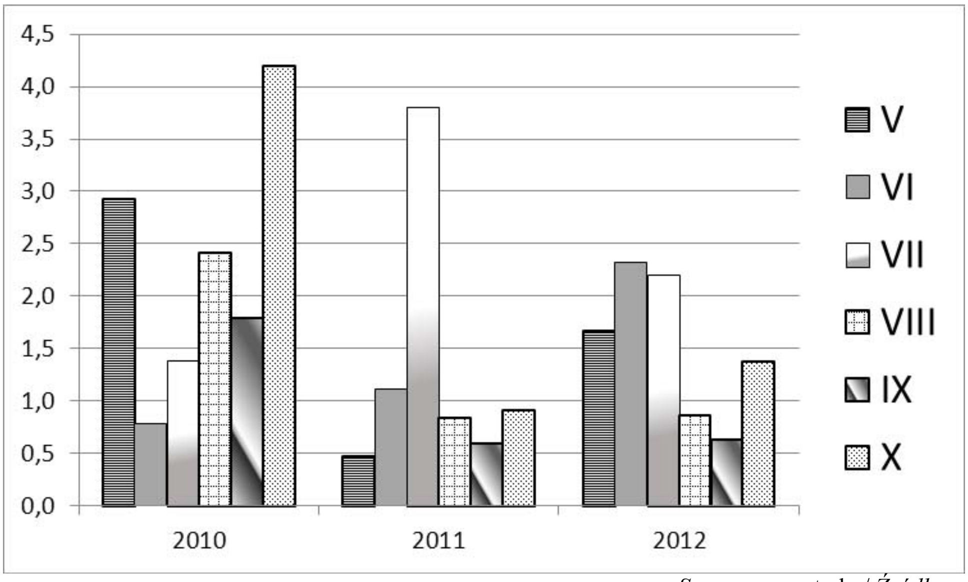
Month	2010	2011	2012	**1951-2009**
Terms of sorghum and maize sowing and harvesting				
Sowing time – maize – sorghum	29..04. 14.V.	29.04. 19.V.	28.04. 18.V.	-
Harvest time (sorghum + maize)	26.X.	21.X.	22.X.	-
Mean air temperature oC				
V	12,2	15,5	16,3	**13,4**
VI	18,4	19,9	17	**16,7**
VII	22,6	18,5	20	**18,5**
VIII	19,2	19,5	19,8	**17,9**
IX	13,0	15,9	15	**13,6**
X	7,0	9,8	8,6	**8,8**
V-X	**15,4**	**16,5**	**16,1**	14,8
Rainfall in mm				
V	110,5	22,5	84,4	**52,3**
VI	43,4	66,5	118,1	**57**
VII	97,5	218,7	136,2	**72,2**
VIII	143,5	50,4	52,7	**56,9**
IX	69,9	28,5	28,4	**43,2**
X	91,0	27,7	36,4	**38,4**
V-X	**555,8**	**414,3**	**419,8**	**320**

Source: own study / *Źródło*: opracowanie własne

3. Results and discussion

Weather conditions in the years of the study were quite favorable for sorghum and maize and the temperature of the growing season exceeded the average for multiplicity. Relatively the coldest year was 2010 when the average temperature from May to October was 15,4°C, which however was a higher value than the long-term average of 0,6 degrees (Table 1). Temperature differences however, were relatively high: a very hot summer and relatively cold spring and autumn. In the years 2011 and 2012, temperatures were more even and higher than the average long-term, so that the temperature of the growing season exceeded by 1,7 and 1,3°C the average of the years 1951-2009.

Sorghum and accompanying corn are among the thermophilic plants but to demonstrate the full potential of yielding they need more water in conditions of high temperatures [13, 16]. Total rainfalls for the period of six months however were high and above the sum of long-term rainfall of 95 mm in 2011; 136 mm in 2012 and up to 236 mm in an exceptionally wet 2010 year. Despite the high rainfall, the distribution was not uniform and in some periods there were gaps in soil moisture. A hydrothermal coefficient of less than "1" (Fig. 1) indicates such a condition. In 2010 these gaps were evident in June; in 2011 - in May, August, September and October, while in 2012 - in August and September.



Source: own study / *Źródło*: opracowanie własne

Fig. 1. Month hydrothermal coefficients in the growing seasons 2010-2012
Rys. 1. Miesięczne współczynniki hydrotermiczne w sezonach wegetacyjnych 2010-2012

Table 2. Number of sorgum plants in pice 1 m^{-2} depending on sowing mode and cultivar (2010-2012)
Tab. 2. Obsada roślin sorga na powierzchni 1 m^{2} w zależności od metody siewu i odmiany (2010-2012)

A: Sowing mode:	B: Sorghum cultivars		Mean:
	GK Aron	Sucrosorgo 506	
Pure sowing of sorghum	15,3	15,1	**15,2**
Mix-cropping with ‘Absolut’ maize	13,7	15,3	**14,5**
Mix-cropping with ‘Vitras’ maize	13,9	15,5	**14,7**
Mean:	**14,3**	**15,3**	-
LSD 0,05	A = d.i.*; B = 0,64; A*B = 1,24		

* differences insignificant

Source: own study / *Źródło*: opracowanie własne

Table 3. Plant high of sorghum [cm] depending on sowing mode and cultivar (2011-2012)
Tab. 3. Wysokość roślin sorga [cm] w zależności od rodzaju siewu i odmiany (2011-2012)

A: Sowing mode:	B: Sorghum cultivars		Mean:
	GK Aron	Sucrosorgo 506	
Pure sowing of sorghum	298,5	342,2 a	**320,4 a**
Catch-cropping - ‘Absolut’	298,5	310,1 b	**304,3 b**
Catch-cropping -‘Vitras’	295,9	335,1 a	**315,5 a**
Mean:	**297,6 b**	**329,1 a**	
LSD 0,05	A = 7,09; B = 7,90; A*B = 13,33		

Source: own study / *Źródło*: opracowanie własne

So in 2011 moisture conditions were at average level but in terms of yields of sorghum, last year was even slightly better than the others (Tab. 6). It confirms the high tolerance of sorghum to periodic shortages of water and the ability to download large water stored in the preceding months [2, 14, 16, 24]. The average number of sorghum plants after emergence was approx. 15 pieces · m^{-2}, it was close to 30% lower than the planned 20.4 pcs (Tab. 2). It was found that a variety GK Aron was characterized by slightly worse rising and was manifested only in intercrop growing conditions but it was not noticeable in pure sowing. Sowiński et al [21, 22] indicate also the large defects in the phase of germination of sorghum. The amount of sorghum plants tested only in 2011 and 2012 depended on the interaction of the method of sowing and cultivar. Among those cultivars GK Aron was lower but its height was independent of the way of sowing: in pure and companion crop with corn (Tab. 3). In turn, the Sucrosorgo 506 Hay cultivar sown as companion crop with corn variety Absolut was significantly lower than on other sites. The relatively low dry matter content of sorghum is one of the factors limiting the possibility of its maintenance. To reduce losses during the pickling, the contents of s.m. should approach the 30% [14, 16, 19, 20], whereas there is achieved most commonly 20-25% of s.m. [5, 6, 9, 12, 19]. Analysis of the dry matter content in our own experience shows, that despite the late harvest (the third decade of October) only in the driest 2011 it could exceed 30%, while in 2010 and 2012 it reached approx. 25% of s.m. (Tab. 4). It is worth noting that stems and leaves and most panicles include the least of s.m. The high content of s.m. in the leaves is the result of a late harvest. In terms of synthetic, the intercropping maize does not affect the contents of s.m. in sorghum but it indicated a trend for a higher proportion of s.m. at intercrop of the Vitras cultivar. It applies to entire plants, as well as the stems, leaves and tassels. Despite the relatively large differences in earliness of both tested cultivars of sorghum, the differences in content of s.m. in whole plants were not statistically significant. An earlier cultivar of GK Aron had a significantly higher dry weight in tassels, and less in the leaves and stems (Tab. 5). The obtained yields of sorghum were relatively high. In all the years of tests, cultivar Sucrosorgo 506 yielded significantly higher, giving a yield of forage of 780,6 dt, ie. almost higher by 180 dt than the GK Aron cultivar (Tab. 6). After conversion the yield on a dry weight there were the yields: 163,4 dt of cultivars GK Aron and 213 dt of Sucrosorgo 506. The differences in each period ranged from 10 to 80dt for the benefit of a cultivar Sucrosorgo 506. By Brabanti et al. [1] in terms of Italy, it can be achieved yields of sorghum of 180-250 dt·ha-1 s.m. [1], and in our climate zone there is usually achieved the yields of 150-170 dt of s.m. [7, 8]. In most studies, a Sucrosorgo 506 cultivar is distinguished by high yields, while other cultivars bring often lower crops, at 90-110 dt·ha^{-1} of s.m. [12, 22]. Catch-cropping of sorghum resulted in a significant reduction in the yield of fresh and dry weight as compared to the pure seed, regardless of the sown maize cultivars (Tab. 7-8). The reduction in yield amounted to 110-120 dt of fresh weight and approx. 20 dt of dry matter. The interaction between the way of seeding and cultivar of sorghum appeared. To visualize the relative differences there were calculated intercrops of sorghum sown, as compared to the pure seed, that was taken as 100. It was found that the negative impact of crop concerned only intercrop of GK Aron, which reacted by significant declines in fresh and dry weight crop, but for Sucrosorgo 506 there was not such a reaction. Limiting the harvest of sorghum in intercrop is probably related to increased competition for light, nutrients and water from the pre-hay corn. Large declines in intercrop of 1: 1 and 1: 2 were watched by Machul and Księżak [11], and in research of Kozłowski et al. [6], yields in the intercrop did not differ from the weighted average of pure sowing. Other studies also show that sorghum react negatively to the increased density, both per unit area and at a wider spacing and plant density in the range [11, 12, 24]. In the conditions of intercrop, a final yield depends on two components, ie. sorghum and corn. An average share of sorghum and maize in fresh weight of yield of three years of tests was similar, but based on the dry weight of sorghum a part in all three years was below 50% (Fig. 2). It means that so sorghum gave lower yields than maize. Sorghum highest proportion in the yield was found in humid and cooler 2010 - dry weight amounted to about 50, and in the fresh mass - even more than 60%. It indicates that sorghum can be more competitive in dry terms, but also with an excess of precipitation. In studies of Machula and Księżak [11] there was demonstrated that the proportion of sorghum depends on the level of nitrogen – it surpassed corn share at lower doses of N and was lower by the more abundant nitrogen fertilization. The working hypothesis assumed that the corn cultivar accompanying sorghum may also have an impact on its development. As shown in Figure 2, there were some differences in sorghum yielding depending on the cultivars of maize: Absolut or Vitras, but it wasn't proven to be statistically; there were neither repeated in years. Analyzing the percentage share of each part of the sprout in the harvested biomass, there was found that the main component of sorghum plant was a stalk acting weight of close to 80% of the yield of green fodder and approx. 70% of the weight of plant dry matter (Tab. 9 and 10). Our results thus confirm the thesis that in panicle sorghum the leading body sprout mass is the stalk [6, 7, 21, 23]. Sowing sorghum alternately every two rows of corn had quite small but clear impact on the plant habit and the proportions between its parts. Intercrop reduced the share of leaves in the fresh mass, inducing a tendency to increase the share of panicles (Tab. 9). It was clearly evident in leaves and tassels participation in the dry matter of yield. Kruczek et al. [7] and Szumiło et al. [24] indicate the drop in the share of leaves caused by changing conditions in the canopy, eg. due to a change of row spacing. The tested cultivars of sorghum were characterized by varying structure of plants. An earlier version of GK Aron was characterized by a lower share of stems and leaves, and a higher share of panicles in the yield of fresh and dry matter (Tab. 9 and 10). Share of panicles of GK Aron cultivar amounted to 12,4% in fresh weight yield and 20,9% in the yield of dry matter. Share of panicles in crop of Sucrosorgo 506 cultivar was nearly 3 times lower. The differences between cultivars also depended on the years. In subsequent years the share of panicle dry weight for the GK Aron cultivar was 8,6 – 33,4 – 20,8%, and for a Sucrosorgo 506 cultivar these values amounted to 2,2 – 10,8 – 10,9%. In the relatively coldest 2010 year many of the Sucrosorga 506 plants did not produce panicles at all and the share of panicle dry matter of yield in both cultivars was the lowest. On the other hand, in warm and relatively dry 2011 year, the GK Aron cultivar produced a relatively large panicles of nearly mature grain

Table 4. Dry matter content in plant of sorghum sown in pure stand and catch-cropping with maize depending on the years [%]
Tab. 4. Zawartość suchej masy w roślinach sorga uprawianych w siewie czystym i współrzędnie z kukurydzą w zależności od lat [%]

	Sowing mode:	2010	2011	2012	2010-12
Whole plant	Pure sowing of sorghum	24,7	28,6	25,0	26,1
	Catch-cropping with 'Absolut' maize	25,6	31,0	25,7	27,4
	Catch-cropping with 'Vitras' maize	26,4	31,3	26,9	28,2
	Mean:	25,6	30,3	25,9	
	LSD 0,05	d.i.	d.i.	1,60	d.i.
Stalks	Pure sowing of sorghum	21,4	24,3	23,7	23,1
	Catch-cropping with 'Absolut' maize	23,0	26,0	24,4	24,3
	Catch-cropping with 'Vitras' maize	23,3	26,9	24,1	24,8
	Mean:	22,6	25,7	24,1	
	LSD 0,05	1,76	d.i.	d.i.	d.i.
Leaves	Pure sowing of sorghum	44,0	34,0	26,2	35,0
	Catch-cropping with 'Absolut' maize	41,1	38,4	26,8	35,6
	Catch-cropping with 'Vitras' maize	44,6	38,6	27,4	36,9
	Mean:	43,5	37,0	26,8	-
	LSD 0,05	d.i.	d.i.	d.i.	d.i.
Panicles	Pure sowing of sorghum	48,6	46,7	32,8	42,7
	Catch-cropping with 'Absolut' maize	34,5	49,4	35,3	39,7
	Catch-cropping with 'Vitras' maize	45,0	48,2	37,9	43,7
	Mean:	42,7	48,1	35,3	
	LSD 0,05	d.i.	d.i.	2,37	d.i.

Source: own study / *Źródło*: opracowanie własne

Table 5. Dry matter content in plant of sorghum depending on cultivars and years [%]
Tab. 5. Zawartość suchej masy w roślinach sorga w zależności od odmian i lat [%]

	Cultivar	2010	2011	2012	2010-12
Whole plant	GK Aron	26,7	29,3	26,0	27,3
	Socrosorgo 506	24,4	31,4	25,7	27,1
	Mean:	25,6	30,3	25,9	
	LSD 0,05	1,50	1,50	d.i.	d.i.
Stalks	GK Aron	23,6	22,2	23,8	23,2
	Socrosorgo 506	21,6	29,2	24,3	25,1
	Mean:	22,6	25,7	24,1	
	LSD 0,05	d.i.	1,86	d.i.	0,86
Leaves	GK Aron	42,2	36,1	25,6	34,6
	Socrosorgo 506	44,8	37,9	28,3	37,0
	Mean:	43,5	37,0	26,8	-
	LSD 0,05	d.i.	d.i.	d.i.	1,63
Panicles	GK Aron	52,3	53,1	36,9	47,4
	Socrosorgo 506	33,0	43,1	33,8	36,6
	Mean:	42,7	48,1	35,3	
	LSD 0,05	15,7	3,10	d.i.	4,95

Source: own study / *Źródło*: opracowanie własne

Table 6. Yields of tested cultivars of sorghum depending on years [%]
Tab. 6. Plony badanych odmian sorga w zależności od lat [%]

	Cultivars	2010	2011	2012	2010-12
Fresh matter field [dt·ha^{-1}]	GK Aron	651,6	572,5	583,4	602,5
	Socrosorgo 506	758,2	789,9	793,5	780,6
	Mean:	704,9	681,2	688,5	
Dry matter field [dt·ha^{-1}]	GK Aron	173,0	167,1	150,1	163,4
	Socrosorgo 506	184,8	247,6	206,2	212,9
	Mean:	178,9	207,4	178,2	

Source: own study / *Źródło*: opracowanie własne

Table 7. Fresh matter yields of sorghum cultivars in pure sowing and catch-cropping in dt·ha^{-1} (2010-2012)
Tab. 7. Plony świeżej masy badanych odmian sorgo w siewie czystym i współrzędnym (2010-2012)

	A: Sowing mode:	B: Sorghum cultivars		Mean:
		GK Aron	Sucrosorgo 506	
Yield in dt·ha^{-1}	Pure sowing of sorghum	718,7 a	820,6 a	**769,7 a**
	Catch-cropping with 'Absolut' maize	533,2 b	776,2 ab	**654,7 b**
	Catch-cropping with 'Vitras' maize	555,6 b	744,9 b	**650,2 b**
	Mean:	**602,5 b**	**780,6 a**	-
	LSD 0,05	A = 40,47; B = 32,56 A*B = 71,71		
Pure sown = 100	Pure sowing of sorghum	100 a	100	**100,0 a**
	Catch-cropping with 'Absolut' maize	75,0 b	94,8	**84,9 b**
	Catch-cropping with 'Vitras' maize	75,8 b	91,2	**83,5 b**
	Mean:	**83,6 b**	**95,3 a**	-
	LSD 0,05	A = 6,49; B = 4,48; A*B = 9,15		

Source: own study / *Źródło*: opracowanie własne

Table 8. Dry matter yields of sorghum cultivars in pure sowing and catch-cropping in dt·ha^{-1} (2010-2012)
Tab. 8. Plony suchej masy badanych odmian sorgo w siewie czystym i współrzędnym (2010-2012)

	A: Sowing mode:	B: Sorghum cultivars		Mean:
		GK Aron	Sucrosorgo 506	
Yield in dt·ha^{-1}	Pure sowing of sorghum	190,4 a	215,7	**203,0 a**
	Catch-cropping with 'Absolut' maize	146,0 b	214,1	**180,0 b**
	Catch-cropping with 'Vitras' maize	153,9 b	208,9	**181,4 b**
	Mean:	**163,4 b**	**212,9 a**	-
	LSD 0,05	A = 17,92; B = 10,65; A*B = 22,39		
Pure sown = 100	Pure sowing of sorghum	100 a	100	**100,0 a**
	Catch-cropping with 'Absolut' maize	79,3 b	98,8	**89,1 b**
	Catch-cropping with 'Vitras' maize	85,7 b	96,5	**91,1 b**
	Mean:	**88,3b**	**98,4a**	-
	LSD 0,05	A = 8,31; B = 4,77; A*B = 10,73		

Source: own study / *Źródło*: opracowanie własne

Table 9. Plant structure in fresh matter [%]
Tab. 9. Struktura roślin sorga w świeżej masie [%]

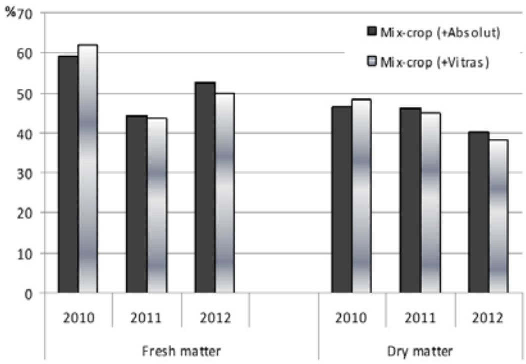
Plant elements	A: Sowing mode:	B: Sorghum cultivars		Mean:
		GK Aron	Sucrosorgo 506	
Stalk	Pure sowing of sorghum	77,5	81,3	**79,4**
	Catch-cropping - 'Absolut'	77,0	82,0	**79,5**
	Catch-cropping -'Vitras'	76,6	82,1	**79,4**
	Mean:	**77,0**	**81,8**	-
	LSD 0,05	A = d.i.; B = 1,29; A*B = d.i.		
Leaves	Pure sowing of sorghum	11,0	13,8 a	**12,4 a**
	Catch-cropping - 'Absolut'	10,5	11,7 b	**11,1 b**
	Catch-cropping -'Vitras'	10,0	11,8 b	**10,9 b**
	Mean:	**10,5 b**	**12,4 a**	-
	LSD 0,05	A = 0,87; B = 0.69; A*B = 1,33		
Panicle	Pure sowing of sorghum	11,5	4,9	**8,2**
	Catch-cropping - 'Absolut'	12,5	6,3	**9,4**
	Catch-cropping -'Vitras'	13,3	6,1	**9,7**
	Mean:	**12,4**	**5,7**	-
	LSD 0,05	A = d.i.; B = 1,25; A*B = d.i.		

Source: own study / *Źródło*: opracowanie własne

Table 10. Plant structure in dry matter [%]
Tab. 10. Struktura roślin sorga w suchej masie [%]

Plant elements	A: Sowing mode:	B: Sorghum cultivars		Mean:
		GK Aron	Sucrosorgo 506	
Stalk	Pure sowing of sorghum	66,7	74,4	**70,5**
	Catch-cropping - 'Absolut'	65,8	75,9	**70,9**
	Catch-cropping -'Vitras'	65,2	75,6	**70,4**
	Mean:	**65,9**	**75,3**	-
	LSD 0,05	A = d.i.; B = 2,20; A*B = d.i.		
Leaves	Pure sowing of sorghum	13,9	18,5	**16,2 a**
	Catch-cropping - 'Absolut'	12,9	15,7	**14,3 b**
	Catch-cropping -'Vitras'	12,6	16,1	**14,4 b**
	Mean:	**13,1 b**	**16,8 a**	-
	LSD 0,05	A = 1,40; B = 1.03; A*B = d.i.		
Panicle	Pure sowing of sorghum	19,3	7,1	**13,2**
	Catch-cropping - 'Absolut'	21,3	8,5	**14,9**
	Catch-cropping -'Vitras'	22,2	8,3	**15,3**
	Mean:	**20,9 a**	**8,0 b**	-
	LSD 0,05	A = d.i.; B = 2,27; A*B = d.i.;		

Source: own study / *Źródło*: opracowanie własne



Source: own study / *Źródło*: opracowanie własne

Fig. 2. Sorghum share in the total yield of biomass (Sorghum + maize) depending on the year and the variety of maize
Rys. 2. Udział sorga w ogólnym plonie biomasy (sorgo + kukurydza) w zależności od lat i odmiany kukurydzy

and panicles amounted to 1/3 of the weight of the plant. The relatively high dry matter content and a large share of panicles in 2011 and GK Aron cultivar indicate the possibility of a significant improvement in the quality of sorghum for food provided to implement the cultivars sufficiently early with a large share of grain in yield. Many authors indicate that for the development of the cultivation of sorghum high yields of green are not enough but it needs to improve its silage and feeding value so that at least on weak soils it can fully compete with corn [4, 14, 18, 22, 24, 25].

4. Conclusions

1. The content of dry matter in yield of sorghum was approx. 26% in 2010 and 2012 and over 30% in 2011. In terms of late October harvest the differences in content of s.m. between cultivars were small and statistically insignificant.
2. Intercrop with corn resulted in a decrease in sorghum harvesting compared to pure cultivation. Fresh weight yields were lower by 15%, whereas in case of the reduction in dry weight the decrease was approx. 10%.
3. Early and lower sorghum GK Aron cultivar indicated a stronger negative reaction on intercrop sowing of maize than high, later Sucrosorgo 506 cultivar. Compared to pure sowing, the GK Aron cultivar gave s.m. yields lower by 17%, while the yield decrease of Sucrosorgo 506 was insignificant and did not exceed 4%.
4. Sorghum sown as intercrop with corn was characterized by a lower share of leaves and higher share of panicles compared to pure sowing.
5. No significant impact of maize cultivars on the yield and structure of companion sowing plants of sorghum.

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