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Green and sweet corn grown under different cover crops and phases of the no-tillage system[1]

Milhos verde e doce cultivados sob diferentes coberturas e estádios do sistema de plantio direto

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HIGHLIGHTS:

Sunn hemp is the cover crop that produces the largest dry matter in all phases of the no-tillage system.
Considering adequate amounts of dry matter, the type of cover crop does not affect the yield of sweet and green corn.
No-tillage system in transition or consolidation phases promotes better yields in green and sweet corn production.

ABSTRACT: Special corn is cultivated all year conventionally round; however, its productivity increases when grown under a no-tillage system (NTS). This study aimed to evaluate the agronomic performance of sweet and green corn cultivated under residues of different cover crops and the NTS implantation stages. Two experiments were carried out in the randomized block design, with four replications, in each of the three areas. The experiments consisted of evaluating the sweet and green corn, simultaneously, in three areas at different stages of development of NTS: initial (1 year), transition (7 years), and consolidation (19 years) with six types of cover crops: Signal grass (SG), Pearl millet (PM), Sunn hemp (SH), a mixture of SG + SH, SG + PM, and PM + SH. The dry matter (DM) production of the cover crops, the productivity of husked and unhusked ears, straw, and grain yield were evaluated. The SH had the highest dry mass production among the studied cover crops in all phases of the NTS. The phase of the NTS did not influence the productivity of ears with or without husk in green corn. The cultivation of sweet corn in transition and consolidation areas of the NTS showed better yields when compared to the initial phase of the system.

Key words: *Zea mays*, Cerrado, cover plants, yield

RESUMO: Os milhos especiais são cultivados o ano todo e de forma convencional, contudo, quando cultivados sob sistema de plantio direto (SPD) pode aumentar a produtividade das culturas. O objetivo deste estudo foi avaliar o desempenho agronômico do milho doce e verde cultivados sob resíduos de diferentes coberturas e estádios de implantação do SPD. Dois experimentos foram conduzidos em delineamento de blocos casualizados, com quatro repetições, em cada uma das três áreas. Os experimentos consistiram da avaliação do milho doce e verde, simultaneamente, nas três áreas em diferentes estádios de desenvolvimento do SPD: inicial (1 ano), transição (7 anos) e consolidação (19 anos); Seis tipos de cobertura: braquiária (B), milheto (M), crotalária (C), mistura de B + C, B + M e M + C. Avaliou-se a produção de massa seca (MS) das coberturas, as produtividades de espigas empalhadas e despalhadas, de palha e rendimento de grãos. A crotalária teve a maior produção de MS entre as coberturas estudadas, em todas as fases do SPD. A produtividade de espigas com ou sem casca no milho verde não foi influenciada pela fase do SPD. O cultivo de milho doce em áreas de transição e consolidação do SPD apresentou melhores rendimentos quando comparado à fase inicial do sistema.

Palavras-chave: *Zea mays*, Cerrado, plantas de cobertura, produtividade

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Introduction

Brazil occupies the second position in corn production (*Zea mays* L.), in the world scenario, cultivated for the production of dry grains (CONAB, 2020). This corn, considered common, gave rise to special types of corn, all those grown for other purposes (Pereira Filho et al., 2018). Among these specials, green and sweet corn have the largest cultivated area in the country (Cardoso et al., 2021).

Among these special ones, green and sweet corn have the largest cultivated area, with 36 thousand hectares of sweet corn being cultivated in the country, with average productivity of 13 Mg ha^{-1} (Luz et al., 2014). There is no official record for green corn in the country; however, it is known that in 2018, 9.1 million tons were produced in the world, with an average yield of 8.1 Mg ha^{-1} (Silva et al., 2021).

These special corns are cultivated intensively and conventionally (Miranda et al., 2020), causing degradation of soil attributes (Silva et al., 2020). However, when they are cultivated under a no-tillage system (NTS), the sustainability of production increases (Oliveira et al., 2017), as the system provides the improvement of physical (Torres et al., 2019), chemical (Soratto et al., 2012), and biological properties of soils (Ferreira et al., 2019), soil attributes, which can increase crop yield (Pedrotti et al., 2015).

In the Brazilian Cerrado, pearl millet, signal grass, and sunn hemp are the cover crops most used in isolated or mixed cultivation, as they have high straw production and nutrient cycling, thus improving soil quality (Pacheco et al., 2017; Mazetto Júnior et al., 2019; Torres et al., 2021).

The NTS goes through different phases until it reaches its last stage of development. According to Sá et al. (2009), the initial phase occurs in the first five years, transition (between 5 and 10 years), consolidation (10 to 20 years), and maintenance (over 20 years), when the NTS expresses its full potential of benefits. However, NTS is still little used to produce special corns and needs to be better evaluated. In this context, the objective of this study was to assess the development of sweet and green corn cultivated under the residues of different coverings and stages of the NTS.

Material and Methods

During the 2018/2019 harvest, the study was conducted in three areas under the no-tillage system (NTS) in Uberaba-MG. The areas used were in different phases, depending on the time of the NTS implantation. The first of them had been implemented one year ago (NTS1) and was in an initial stage; the second was implemented seven years ago (NTS7), being in the transition phase; and the third implemented 19 years ago (NTS19), characterizing the consolidation phase. Table 1 shows the dimensions and location of the areas used in the study.

The predominant soil in the three different areas studied was Oxisol (Soil Survey Staff, 2014), with a clayey-sand texture, with the following physical characteristics in the 0-0.40 m layer: 210 g kg^{-1} clay 80 g kg^{-1} silt, and 710 g kg^{-1} sand. The soil chemical analyses in the studied areas (Table 2) were carried out according to the methodologies of EMBRAPA (1997).

The climate of the region is classified as Aw-type, hot tropical, according to the updated Köppen classification (Beck et al., 2018), with hot and rainy summer and cold, dry winter. The region has an annual historical rainfall average of 1600 mm and an average temperature of 22.6 °C (INMET, 2019). The rainfall in November and December/2018 and January/2019 was 370, 314, and 70 mm, respectively, during which the cover crops were cultivated. When green and sweet corn was grown, in February, March, April, and May 2019, rainfall was 91, 585, 69, 51 mm, respectively, accumulating 796 mm in that period.

Simultaneously, experiments with sweet and green corn were carried out in three areas at different stages of implantation

Table 1. Dimension and location of the study areas

Areas	Description
NTS1	Total area of 0.30 ha, at 19º 45' 27" S, 47º 55' 36" W, and 795 m of altitude, in an area under the initial phase of the no - tillage system (NTS), with one year of implantation (NTS1).
NTS7	Total area of 0.21 ha, at 19º 39' 22.69" S, 47º 57' 25.86" W, and 797 m of altitude, in an area under transition phase to the NTS, with seven years of implantation (NTS7).
NTS19	Total area of 0.21 ha, at 19º 39' 21.81" S, 47º 57' 26.82" W, and 798 m of altitude, in an area under consolidation ph ase of NTS, with 19 years of implementation (NTS19).

Table 2. Chemical attributes of the soil in the 0-0.40 m layer of the areas with different implantation times of the no-tillage system (NTS) in Uberaba, MG

System	pH $CaCl_2$	P-av (mg kg^{-1})	Ca^{2+}	Mg^{2+}	Na^+	Al^{3+}	H + Al	K^+	OM (g kg^{-1})
			(cmol$_c$ dm^{-3})						
					0-0.05 m				
NTS1	5.0	26.41	1.70	1.42	0.03	0.32	3,55	0.25	12.60
NTS7	5.0	21.72	1.45	1.32	0.03	0.35	4,50	0.21	14.14
NTS19	5.0	17.60	1.72	1.10	0.04	0.27	4,62	0.28	15.21
					0.05-0.10 m				
NTS1	5.0	27.43	1.57	1.40	0.03	0.22	3,42	0.10	12.71
NTS7	4.7	14.97	0.92	1.25	0.03	0.50	5,12	0.14	11.81
NTS19	4.7	12.09	1.02	1.00	0.04	0.42	5,20	0.15	13.24
					0.10-0.20 m				
NTS1	4.9	9.31	1.32	0.97	0.03	0.32	3,46	0.07	10.38
NTS7	4.5	9.52	0.65	1.22	0.03	0.50	4,54	0.12	11.71
NTS19	4.6	9.29	0.87	1.25	0.04	0.27	5,16	0.14	10.64
					0.20-0.40 m				
NTS1	4.9	2.45	1.22	1.15	0.03	0.40	3,39	0.06	8.45
NTS7	4.6	2.36	0.42	0.97	0.04	0.27	3,72	0.10	7.93
NTS19	4.5	2.10	0.62	0.97	0.03	0.43	4,70	0.11	7.76

NTS1 - No-tillage system for one year; NTS7 - No-tillage system for seven years; NTS19 - No-till system for 19 years; P-av - Available phosphorus of the no-tillage system (NTS), as follows: 1 - NTS implanted one year ago (NTS1); 2 - NTS for seven years (NTS7) and: 3 - NTS for 19 years (NTS19). Green corn (*Zea mays* L.) and two sweet corn (*Zea mays* var. Saccharata), being cultivated after the management (desiccation) of these coverings.

The experimental design used in all areas and experiments was in randomized blocks, with four replications, and the treatments consisted of the use of six different types of coverage: 1 - Signal grass (SG) (*Urochloa brizantha* cv. Marandú); 2 - ADR 500 Pearl millet (*Pennisetum glaucum* L.) (PM); 3 - Sunn hemp (*Crotalaria juncea*) (SH); 4 - Mixture of SG + SH; 5 - SH + PM, and 6 - PM + SG.

The cover crops isolated or in mixtures were cultivated in November/2018, December/2018, and January/2019, in a mechanized way, in 28 plots each with a 30 m^2 area (5 x 6 m), where 30 rows of seeds were sown. Plants were spaced 0.20 m apart without any form of fertilization in the sowing and topdressing, with 15 (SH), 50 (SG), and 60 (PM) seeds distributed per meter, respectively grown individually. In the mixtures SG + SH, SH + PM, and SG + PM, half of these amounts of seed per meter of each crop were used for sowing.

When approximately 50% of the sown species reached maximum flowering, about 90 days after sowing, samples were collected in an area of 2 m^2 from the central part of each plot, with subsequent drying in an oven with forced-air circulation at 65 °C for 72 hours, to quantify the dry matter (DM) of cover crops, in Mg ha^{-1}. After determining the DM, the plant material was returned to its respective area. It is noteworthy that at the time of these evaluations, the SG was still beginning to flower.

After the cover crops sampling, crop management was performed, desiccating the total area using 2 kg ha^{-1} of a commercial herbicide (Roundup WG^R) whose active ingredient is 792.5 g kg^{-1} of N-(phosphonomethyl)glycine.

Special corn was sown at the end of February 2019, using the sweet corn hybrid Thunder Attribute from Syngenta and the green corn hybrid Agroceres VT PRO2™ from Biomatrix, both recommended for cultivation in the region with a population of 62,000 plants ha^{-1}. These hybrids are genetically modified, resistant to the main pests in corn and glyphosate, with an early cycle between 90 and 105 days.

For the cultivation of sweet and green corn, the cultivation areas of the cover plants (30 m^2) were divided in half, giving rise to each experimental unit of each evaluated cover, with an area of 15 m^2 for each type of corn.

In each plot, green and sweet corn seeds were sown in 6 rows spaced 0.50 m apart, with 3.0 seeds distributed per meter, considering the four central rows as useful area, totaling 8.0 m^2.

The mineral fertilization carried out in the sowing was defined according to the chemical characteristics of the soils and the recommendations proposed by Ribeiro et al. (1999) using 400 kg ha^{-1} of the formulated 08-28-16 (N-P_2O_5-K_2O) at sowing to provide about 32 kg ha^{-1} of N, 112 kg ha^{-1} of P_2O_5, and 64 kg ha^{-1} of K_2O.

At 20 days after sowing, the first topdressing fertilization was carried out, applying 155.0 kg ha^{-1} of urea (45% N) to provide 70 kg ha^{-1} of N; and 125.0 kg ha^{-1} of potassium chloride (KCl - 56% K_2O) to supply 70 kg ha^{-1} K_2O. At 40 days after sowing, the second topdressing fertilization was carried out, with the application of 70 kg ha^{-1} of N, aiming to reach the maximum yield potential of the hybrid.

As for weed management, herbicide was applied 20 days after crop emergence, with glyphosate ammonium salt of 792.5 g kg^{-1} (Roundup WG®) at a dose of 2 kg ha^{-1} and Tembotrione (Soberan®) 240 mL ha^{-1}. The application (200 L ha^{-1} of spray volume) was carried out with a Jacto 2000® sprayer, equipped with flat jet type tips.

As for pests and diseases arising in the region, they were monitored weekly since the beginning of the crop cycle. During the cycle, the first application was 30 days after sowing, with Imidacloprid 100 g L^{-1} + Beta-cyfluthrin 12.5 g L^{-1} (Connect®) with 1 L ha^{-1}, and the foliar fertilizer Vitaphol GR in the dose of 2 L ha^{-1}. At 45 days after sowing, the second application was carried out with Tiametoxam 141.0 g L^{-1} + Lambda-cyhalothrin 106.0 g L^{-1} (Engeo Pleno™ S®) at a dose of 250 mL ha^{-1}, Bifenthrin 50, 0 g L^{-1} + Carbosulfan 150.0 g L^{-1} (Talisman®) at a dose of 700 mL ha^{-1}, Trifloxystrobin 100 g + Tebuconazole 200 g L^{-1} (Nativo®) with 750 mL ha^{-1}, and foliar fertilizer Vitaphol GR with 2 L ha^{-1}. Both applications were carried out with a Jacto 2000® sprayer, equipped with empty conical jet tips ("empty cone"), and to apply 200 L ha^{-1} of spray solution.

The harvest was carried out manually, at a time when the sweet corn was in the R4 stage and the grains on average with 73% moisture. Green corn was harvested at the R3 phenological stage, with an average humidity of 80%. Twenty-four ears with a size equal to or greater than 15 cm were sampled in the useful area of the plots in both types of corn. Then, the ears were packed in nylon bags and transported to the laboratory, where they were weighed, thus obtaining the ear+husk yield (EHY) per hectare in Mg ha^{-1}.

In the laboratory, 12 ears of each harvested corn were randomly chosen, and the husks were removed. Then, the husks were weighed to determine husk yield (HY, expressed in Mg ha^{-1}) and ear yield (EY, expressed in Mg ha^{-1}). Subsequently, with the aid of a knife, the grain was threshed and weighed to determine the grain yield. Since they are corn with different purposes and forms of commercialization, green corn has the percentage of grain yield per ear (GYPE), and sweet corn, the grain yield per hectare (GY, expressed in Mg ha^{-1}) was determined.

The data were subjected to the tests of normality and homogeneity of the variances and additivity of the blocks through the Shapiro-Wilk and Bartlett tests, respectively. Then, the three experimental areas were subjected to joint analysis of variance, applying the F-test. When a significant effect was found, the means were compared by Scott & Knott test at 0.05 probability, with the aid of the Agroestat Software.

Results and Discussion

The sunn hemp (SH) was the cover crop that presented the highest dry mass (DM) production among the species studied at the three areas evaluated, which are at different stages of implementation of the no-tillage system (NTS). At the same time, the signal grass (SG) was the one that presented the lowest DM production in all the areas (Figure 1). It is also observed in Figure 1 that the area with seven years of implementation of the NTS (transition) was the one that presented the highest DM production performance, regardless of the type of cover crop used.

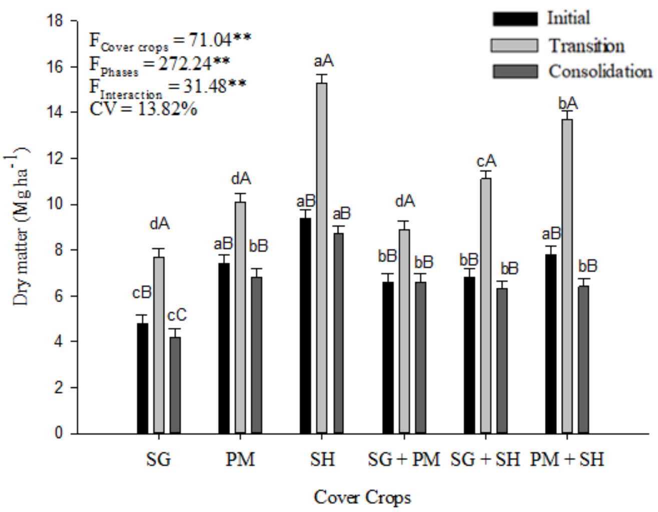
This SH performance may be related to its pivoting root system, which assists in soil decompression, penetrating deeper layers in search of water and nutrients (Bertollo et al., 2021), its rapid growth, and the ability to establish a symbiosis with bacteria of the genus *Rhizobium* sp. and perform biological nitrogen fixation (BNF), which the plant can use during formation process (Loss et al., 2014).

The lower production of DM of the signal grass is probably related to the fact that the plant has a longer vegetative cycle than the SH and PM (Collier et al., 2018), which was evident when managed, SH and PM were in full bloom, while the SG was still at the beginning of flowering.

In this same region of the Cerrado of Minas Gerais, the SG has produced DM ranging from 6.0 to 13.0 Mg ha^{-1}, as observed by Ceballos et al. (2018), Torres et al. (2019), Miranda et al. (2020). Similarly, these authors justify the lower DM yield of the SG concerning other cover crops due to the time that the SG was managed, because in general, in these studies, it had not reached the maximum flowering (Mazetto Júnior et al., 2019), as it has a longer cycle than the other plants used in the studies.

When comparing the implantation phases of the system, the transition phase stood out concerning the others, with the highest DM production (Figure 1). The production of DM from SG, PM, and SH in isolated cultivation in this study ranged, respectively, from 4.2 to 7.7 Mg ha^{-1}, 6.8 to 10.1 Mg ha^{-1}, and 8.7 to 15, 3 Mg ha^{-1}, which are close to the ranges of 6.0 and 11.0 Mg ha^{-1} for SG, 7.0 and 12.0 Mg ha^{-1} for PM, and 4.0 and 9.0 Mg ha^{-1} for SH reported in other studies conducted in the Cerrado(Collier et al., 2018; Mazetto Júnior et al., 2019; Torres et al ., 2021).

The quantity and quality of dry matter produced by cover crops are essential parameters to be considered when producing straw in the Cerrado, as the decomposition and nutrient cycling of plant residues is more accelerated in this region (Pacheco et al., 2017; Ceballos et al., 2018; Torres et al., 2021). According to Lal & Logan (1995), the decomposition rate of waste is up to 10 times faster than temperate climate regions.



** - Significant at < 0.01 by Scott-Knott test. Lowercase letters compare cover crops within the same NTS stage and uppercase letters compare NTS phases within each cover plant

Figure 1. Dry matter yield of signal grass (SG), pearl millet (PM), sunn hemp (SH), and mixtures SG + PM, SG + SH, and PM + SH, in three phases of NTS

The PM + SH presented DM production similar to SH in the implantation phase and the second-largest DM production in the transition phase (Figure 1). Considering that the mixture of cover plants with different root systems provides advantages to the soil-plant system, the composition of PM + SH (Poaceae + Fabaceae) is a promising mixture to be used in the edaphoclimatic conditions of the Cerrado (Soratto et al., 2012).

The cover crops did not influence any of the agronomic parameters evaluated in green corn, either in isolated cultivation or in mixtures (Table 3). The harvest of fresh green corn can explain this behavior. At the same time, the grains are soft, with about 70 to 80% moisture, and before the total conversion of sugar into starch, which occurred approximately 90 days after planting (Luz et al., 2014).

The husk yield and the grain yield per hectare were influenced by phases of the no-tillage system (Table 3). The highest GYH was obtained in the transition area (7 years). However, green corn is sold in ears with and without husk, and the phase of the no-tillage system did not influence these parameters.

These results obtained with green corn are divergent from those verified when this same corn completes its cycle to be harvested for dry grain, as it is a crop that significantly increases its productivity when it is cultivated on plant residues from the Fabaceae family in isolated cultivation or when these plants are present in mixtures (Soratto et al., 2012; Torres et al., 2015; Pacheco et al., 2017). This increase in production is justified by the improvement of physical, chemical, and biological attributes that occur in areas under no-tillage, which continue to improve soil quality as the area moves into the system maintenance phase, as highlighted by Sá et al. (2009), Silva et al. (2020).

The cover crops did not influence the straw yield, however,

Table 3. Agronomic attributes of green corn grown on residues of different cover crops in areas under the no-tillage system in the initial (1 year), transition (7 years), and consolidation (19 years) phases, in the 2018/2019 harvest, in Uberaba-MG

Coverings	Agronomic attributes			
	EY	HY	EHY	GYH
	(Mg ha^{-1})			
Coverings				
Signal grass (SG)	6.99	3.56	10.55	66.22
Pearl millet (PM)	7.13	3.59	10.72	66.11
Sunn hemp (SH)	6.85	3.52	10.37	66.22
SG + SH	7.09	3.47	10.64	67.14
SG + PM	7.15	3.61	10.77	66.48
PM + SH	6.89	3.60	10.50	65.77
Phases of the no-tillage system				
Initial	6.96	3.54 b	10.51	66.32 b
Transition	7.16	3.40 b	10.56	67.88 a
Consolidation	6.93	3.74 a	10.51	66.02 c
$F_{coverings (C)}$	1.42^{NS}	0.47^{NS}	0.73^{NS}	0.88^{NS}
$F_{area (A)}$	2.62^{NS}	8.90**	0.69^{NS}	17.18**
$F_{Int. CxA}$	0.73^{NS}	0.38^{NS}	0.70^{NS}	0.43^{NS}
CV%	6.13	12.62	6.84	3.90

NS - Not significant; ** - Significant (p < 0.01). Means followed by the same lowercase letter in the column do not differ from each other by the Scott-Knott test (p < 0.05). EY - Ear yield; HY - Husk yield; EHY - Ear+husk yield; GYH - Grain yield per hectare in all treatments, the ears produced presented good husks, and the husk yield (HY) ranged from 3.47 to 3.61 Mg ha^{-1}. This is an essential characteristic for green corn, as the consumer market requires good ear coverage, as it favors the maintenance of grain moisture and conservation of ears (Pereira Filho et al., 2018).

The EHY of the present study was 10.60 Mg ha^{-1}, being within the range from 9.0 to 15.0 Mg ha^{-1} recommended as a suitable yield for the cultivation of green corn by Albuquerque et al. (2008). The present study results are still close to those observed by Santos et al. (2009), who evaluated the cultivation of green corn in NTS and obtained an ear yield of 13.3 Mg ha^{-1} when cultivated in succession to sunn hemp.

Assessing the green corn yield, Silveira et al. (2021) also did not observe the effects of cover crops on the yield attributes of green corn in NTS. These authors observed EHY values ranging from 10.06 to 10.91 Mg ha^{-1}, HY from 3.26 to 4.53 Mg ha^{-1}, and EY from 6.70 to 7.20 Mg ha$^{-1,}$ similar to those obtained in this study. It is noteworthy that in both studies, the dry matter yield of cover crops was considered adequate in all species used (Soratto et al., 2012; Pacheco et al., 2017; Collier et al., 2018; Mazetto Júnior et al., 2019), making green corn yield not influenced by the type of cover plant, since they all produced sufficient amounts of DM to promote one or more of the beneficial effects of NTS, for example, providing nutrients and improving the chemical, physical, and biological attributes of the soil.

Evaluating the production of green corn grown under conventional cultivation system, minimum cultivation system, and no-tillage system, Oliveira et al. (2017) observed that conventional cultivation had the lowest content of Ca^{2+}, Mg^{2+}, and soil organic matter and crop yield when compared to the conservation cultivation systems. These authors found that the predecessor cover crops influenced the green corn yield differently, higher with sunn hemp in the NTS and pearl millet and sunflower in the minimum cultivation system.

It was observed that there were no significant differences between parameters evaluated when the crop was grown on any of the cover crops for sweet corn (Table 4). However, the EY, EHY, and GYH were influenced by the phase of the no-tillage system and the highest means of these parameters were observed in the Transition and Consolidation areas. (Table 4).

When evaluating the yield of sweet corn grown in an area under a no-tillage system (NTS) in the initial phase, on sunn hemp, pigeon pea, beans, and peanut residues, Pedrotti et al. (2015) observed the effects of cover crops on sweet corn productivity, where sunn hemp was the cover crop that provided the highest productivity (9.4 Mg ha^{-1}). These values are likely related to the adequate amounts of DM produced by this coverage. Still, in NTS, the productive efficiency of commercial ears reached 95% of the plants, while in the minimum and conventional cultivation, it was 88 and 85%, respectively.

This behavior can be justified by the improvements in the physical, chemical, and biological attributes of NTS. As the areas mature, system stabilization occurs, providing better conditions for the development of cultivated plants, as highlighted by Sá et al. (2009), Soratto et al. (2012), Pacheco

Table 4. Agronomic attributes of sweet corn grown on residues of different cover crops in areas under the no-tillage system in the initial (1 year), transition (7 years), and consolidation (19 years) phases, in the 2018/2019 harvest, in Uberaba-MG

Coverings	Agronomic attributes			
	EY	HY	EHY	GYH
	(Mg ha^{-1})			
Coverings				
Signal grass (SG)	5.92	2.50	8.44	3.40
Pearl millet (PM)	63.5	2.68	8.92	3.79
Sunn hemp (SH)	6.22	2.60	8.83	3.62
SG + SH	6.25	2.55	8.77	3.84
SG + PM	6.10	2.63	8.78	3.76
PM + SH	6.05	2.59	8.66	3.54
Phases of the no-tillage system				
Initial	5.32 b	2.42	7.77 b	2.88 b
Transition	6.72 a	2.73	9.40 a	4.16 a
Consolidation	6.41 a	2.63	9,02 a	3,94 a
$F_{coverings\ (C)}$	0.70^{NS}	0.28^{NS}	0.43^{NS}	1.10^{NS}
$F_{area\ (A)}$	32.14**	3.28^{NS}	22.38**	36.42**
$F_{Int.\ CxA}$	1.56^{NS}	1.77^{NS}	1.69^{NS}	1.74^{NS}
CV%	8.23	11.62	7.78	7.45

^{NS} - Not significant; ** - Significant (p < 0.01). Means followed by the same lowercase letter in the column do not differ from each other by the Scott-Knott test (p < 0.05). EY - Ear yield; HY - Husk yield; EHY - Ear+husk yield; GYH - Grain yield per hectare

et al. (2017), Collier et al. (2018), and Torres et al. (2019), which favored the development of sweet corn, which is a more sensitive and demanding crop in terms of soil fertility when compared to green corn.

In NTS areas in the transition stage, the improvement of some soil physical attributes can already be evidenced, since the restructuring and stabilization of the particles are already visible, with this, there is a decrease in macroporosity, an increase in soil density, microporosity, and total porosity, with the maintenance of greater soil moisture (Torres et al., 2015; Mazetto Júnior et al., 2019), still without problems with compaction, as can occur in the following stages (Torres et al., 2019).

In addition, the consecutive contributions of organic matter on the surface and subsurface that occur in areas in NTS provide greater availability of nutrients for plants, which tend to develop better, as highlighted by Collier et al. (2018) and Silva et al. (2020), a behavior that can be evidenced in areas in the transition and consolidation phases where sweet corn was cultivated.

Studies evaluating the development of vegetables in the different stages of NTS implementation are still scarce; however, with the results observed in the present study, it is possible to state that sweet and green corn demand soil characteristics and nutrient availability. Thus, higher yields of these crops are obtained in mature NTS.

The influence of the predecessor crop on sweet and green corn, combined with the DM yields considered adequate for the NTS, allow us to infer that even for these crops with a faster cycle grown in an irrigated area, the amount of DM provided by the predecessor crops is of high importance, since the process of decomposition of organic matter and availability of nutrients is more accelerated under these conditions (Pacheco et al., 2017, Mazetto Júnior et al., 2019), with this there will be greater inputs of nutrients in the soil for these corns to have better performance when they are harvested at immature stages, that is, with a shorter crop cycle (Pedrotti et al., 2015; Oliveira et al., 2017; Silveira et al., 2021). However, this is a topic that needs to be better elucidated in future studies.

In this sense, the results of the present study open up possibilities for new research in this area, especially regarding: 1- Crop responses to the effects of compaction and physical characteristics of the soil of the NTS according to the different implantation phases; 2- Effects of DM quantity and quality in shorter cycle species; 3- Effects of availability and fertilization of nutrients with less mobility in the soil, in NTS with different maturity stages; among others.

Conclusions

1. Sunn hemp had the largest dry mass production among the studied cover crops in all phases of the no-tillage system.
2. Cover crops did not influence the parameters evaluated in green and sweet corn.
3. The productivity of ears with or without husk in green corn was not influenced by the phase of the no-tillage system.
4. The cultivation of sweet corn in transition and consolidation areas of the no-tillage system showed better yields when compared to the initial phase of the system.

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