Original Article

EFFECTS OF SUGARCANE STRAW ON GRASS WEEDS EMERGENCE UNDER FIELD CONDITIONS

EFEITO DA COBERTURA DE PALHIÇO DE CANA-DE-AÇÚCAR NA EMERGÊNCIA DE GRAMINEAS INFESTANTES EM CONDIÇÕES DE CAMPO

Antonio Carlos da SILVA JUNIOR[1]; Cibele Chalita MARTINS[2]; Dagoberto MARTINS[3].

1. Engenheiro Agrônomo, Doutorando, Departamento de Produção Vegetal, Faculdade de Ciências Agrárias e Veterinárias - FCAV, Universidade Estadual Paulista - UNESP, Jaboticabal, SP, Brasil. acsjr_agro@hotmail.com; 2. Engenheira Agrônoma, Professora Livre-Docente, Departamento de Produção Vegetal - FCAV/UNESP, Jaboticabal, SP, Brasil; 3. Engenheiro Agrônomo, Professor Livre-Docente, Departamento de Produção Vegetal - FCAV/UNESP, Jaboticabal, SP, Brasil.

ABSTRACT: This study aimed to assess the effects of sugarcane straw soil cover on *Brachiaria plantaginea*, *Panicum maximum* and *Digitaria nuda* seedlings emergence. The experiment was carried out in a soil classified as Red Nitosol. Seven different amounts of sugarcane straw soil cover were assessed (0, 3, 6, 9, 12, 15 and 18 ha^{-1}). SP83-2847 variety straw was used. The experiment was arranged in a randomized blocks design, with four replications. Each experimental unit contained three species, which were allocated in the center of each plot, sown at 1 cm depth in a demarcated area. Different amounts of straw were distributed in this area. The sowing rate was used in order to obtain 1200 plant m^{-2}. Two phases comprised the study. In the first phase, weeds emerged in sugarcane straw cover soil were assessed at 9, 12, 19, 34 and 43 days after sowing (DAS) and the second phase assessed plant emergence after straw removal, at 89, 130, 175, 196, 217 and 234 DAS. Seedlings that had over 1 cm shoot and were visible in all assessments were considered emerged. Soil cover sugarcane straw amount influenced the different species germination dynamics. In the first phase, species differential response was observed regarding used straw amount. In the second phase, after straw removal, there was higher germination for *B. plantaginea* and *D. nuda*, while *P. maximum* showed lower emergency, regardless of the used straw amount.

KEYWORDS: *Panicum maximum. Brachiaria plantaginea. Digitaria nuda.* Unburned sugarcane. Seed bank.

INTRODUCTION

With the advent of sugarcane straw burning restrictions in Brazil due to environmental laws, mechanical harvesting without burning, popularly called unburned sugarcane system, showed a significant increase from the 2000s. The reduction of greenhouse gases emission and urban centers with characteristics similar to farming areas according to air quality were the intentions of these laws. Therefore, after crop mechanical harvesting, this material consisting of green leaves, straw, tips, stem and root fractions, which according to Ripoli and Ripoli (2009) is termed as straw, remain on the soil. However, these structures modify the environment for sugarcane regrowth, as well as for weeds germination, in relation to areas in which sugarcane is burned.

Weeds are among the problems that are found in unburned sugarcane harvest areas, as weed flora composition undergoes changes in relation to areas where sugarcane is burned. This is due to sugarcane straw presence over the soil, what requires new challenges to it’s control (AZANIA et al., 2002). Of the 79 most relevant weed species in different agricultural crops in very diverse regions of the world, 49 are present in the sugarcane agrosystem, directly or indirectly affecting productivity (HOLM et al., 1991).

Similar to agricultural crops no-tillage system, unburned sugarcane straw can affect weed emergence by three different processes: physical, biological and chemical, with interactions happening or not between them (PITELLI; DURIGAN, 2001). Straw cover physically -affects the emergence of small seed species, seedling development and survival, induces etiolation, thus making seedlings more susceptible to mechanical damage (CORREIA; DURIGAN, 2004).

Some biological effects can be improved by straw presence, as it creates conditions for development of microorganisms that play important roles in seeds deterioration and viability loss (PITELLI; DURIGAN, 2001). Chemical effects are related to allelochemicals release, changes in carbon/nitrogen ratio, nutrient immobilization and recycling (CORREIA et al., 2006).

The germination process can be changed by soil surface plant debris presence, as it can modify humidity, luminosity, soil temperature and oxygen amount. Quiescence and germination of weed are directly affected by these factors (CORREIA; DURIGAN, 2004; SALVADOR, 2007; TOMAZ et al., 2010).

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Common weeds of Sugarcane crop such as *Digitaria horizontalis* Willd. and *Acanthospermum hispidum* DC., have higher germination rates in the presence of light. Thus, they can no longer be problems in unburned sugarcane areas (KLEIN; FELIPPE, 1991); while for *Sida rhombifolia* L., light is not essential for germination (FLECK et al., 2001). Silva et al. (2003), while studying different sugarcane straw amounts on *Cyperus rotundus* L. tuber sprouting, observed that, regardless of straw quantity (up to 20 t ha^{-1}), these were no effects on plant emergence. Martins et al. (1999) report that amounts equal or higher than 6 t ha^{-1} of straw reduced eudicotyledon weed species presence.

However, the changes occurred in agricultural environment, imposed by straw deposition on soil surface due to mechanical harvesting of sugarcane and the subsequent straw removal to be used on energy generation, can affect the dynamics of weed community. Thus, this study aimed to evaluate the effects of different sugarcane straw amounts on *Brachiaria plantaginea* (Link) Hitchc., *Panicum maximum* Jacq. and *Digitaria nuda* (Schumacher) emergence, weeds that are commonly found in unburned sugarcane harvest areas.

MATERIAL AND METHODS

This study was carried out in an area with soil classified as clayey Red Nitosol (EMBRAPA, 2013). Fertilizers or lime were not used in the experimental area. The chemical characteristics of the soil are shown in Table 1. Soil texture was composed by sand (414 g kg^{-1}), silt (152 g kg^{-1}) and clay (434 g kg^{-1}).

Table 1. Chemical analysis results of a soil sample collected at 0-20 cm layer. Botucatu/ SP, Brazil, 2013/2014.

pH $CaCl_2$	M.O. g dm^{-3}	P_{resin} mg dm^{-3}	Al^{3+}	H+Al	K	Ca	Mg	SB	CTC	V %
			------	------	------	$mmol_c$ dm^{-3}	------	------	------	
5.1	28	25	---	42	3.0	36	17	55	97	57

The experimental area was prepared by plowing and harrowing, completely buffering the soil. After these operations, a bed former was used for making seedbeds and thus limiting experimental units, which measured 1.2 x 4.5 m. The experiment was arranged in a randomized blocks experimental design with four replications.

Different amounts of soil cover (0, 3, 6, 9, 12, 15 and 18 ha^{-1} sugarcane straw) were tested on three monocotyledonous weed species that are frequently found in sugarcane crops: *B. plantaginea*, *P. maximum* and *D. nuda*. The first variety used was SP83-2847 and the straws were collected from the field (commercial area) after mechanical harvesting and before any defensive application. The experimental area showed no infestation of the species under study.

Weeds were sown in the first half of September 2013, using 0.5m x 0.5m metal frames installed into the soil up to 10 cm depth in the central portion of each plot. In each square seeding of each species was performed. Sowing rate was determined so that there would be 300 viable seeds within each frame (1,200 plants m^{-2}), with seeds being manually incorporated at 1 cm from the soil surface.

After sowing, sugarcane straw was uniformly distributed in the amounts related to each treatment. The straws were previously dried in forced air circulation oven at 65 °C before distribution over the area. After sowing the area was irrigated (15 mm day^{-1}) every three days (except in rainy days). During the first study phase, site temperature and precipitation were measured (Table 2), as well as soil temperature at 5 cm depth in all treatments in the morning (7:30 a.m.) and afternoon (2:30 p.m.) (Figure 1).

The study was comprised of two distinct phases. The first phase assessed seedling emergence under sugarcane straw, and the second assessed seedling emergency after straw removal. Data were shown in number of emerged seedlings per square meter. The number of seedlings in sugarcane straw soil was assessed at 09, 12, 19, 34 and 43 days after sowing (DAS), with species identification being performed, as well as seedling counting and collection. Seedlings that had over 1 cm shoot and were visible in all assessments were considered emerged.

Following seedling emergence stabilization, which occurred after 43 DAS (last assessment) – although the experiment was carried out until 77 DAS to confirm that no new seedlings would emerge –surface sugarcane straw layer was removed. Straw weighing was carried out after drying in forced air ventilation oven, at 65 °C. With final (f) and initial (i) straw weight values, decomposed straw amount (d) was calculated using the formula: d = i - f; and decomposition rate (Td) was calculated by the formula: (%) = 100d/i. The second phase began with straw removal, and germination assessments were resumed at 89, 130, 175, 196, 217, 234 DAS, until seedling emergence ceased. The same assessment procedures conducted in the first phase were applied in the second phase. Assessments were closed when there was no weed emergence in the plots, at 234 DAS (157 days after straw removal).

Table 2. Accumulated rainfall and daily minimum, mean and maximum temperatures for each month during the study period. Botucatu/SP, Brazil, 2013/2014.

Month	Rainfall (mm)	Irrigation (mm)	Temperature Means (°C)		
			Minimum	Maximum	Mean
September	88	53	14.2	25.8	20.0
October	107	78	15.3	26.4	20.9
November	45	91	17.3	28.1	22.7
December	65	55	19.0	30.0	24.5
January	74	59	19.7	30.7	25.2
February	116	60	20.4	31.3	25.8
March	104	27	18.8	28.8	23.8
April	99	30	16.7	27.3	22.0

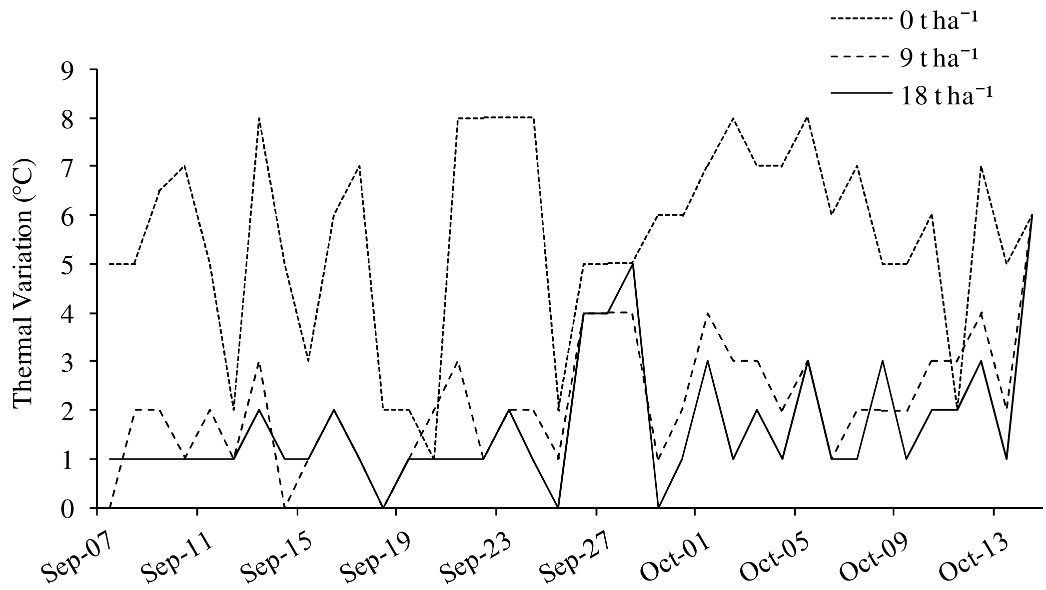

Figure 1. Soil temperature variation at 5 cm depth throughout the day with 0, 9 and 18 t ha^{-1} of straw during the first phase of the experiment.

The total number of emerged seedlings before straw cover removal was used to calculate field emergence starting period, emergence stabilization and mean germination time (t). Initial emergence period was considered when at least one seedling emerged in at least one of the repetitions, and emergence was stabilized when it was absent in all repetitions. Thus, the mean germination time (t) of each species was calculated using the formula proposed by Santana and Ranal (2004).

$t = (\Sigma^k n_i t_i)/(\Sigma^k n_i)$

Where:

t_i = time between experiment beginning and i-th observation; n_i = Number of seeds that germinate in t_i time (not the cumulative number, but the number reported for the i-th observation); and k = last seed germination time.

The total number of emerged seedlings in both phases and their sum were subjected to analysis of variance by F test, and their means were compared using the '**t**' test at 5% probability level.

RESULTS AND DISCUSSION

Straw decomposition

The amount of decomposed sugarcane straw, in absolute terms (Table 3), was inferior in the treatments that started with the lowest straw amounts (3 and 6 ha^{-1}). Higher thermal variation was probabily the cause, as soil decomposing microrganisms present higher activity with these variations (RODRIGUES et al., 2011). The rate of straw decomposition, when present in soil surface, has been adjusted to linear (CRUSCIOL et al., 2005), quadratic (PAL; BROADBENT, 1975) and exponential models (THOMAZ; ASAKAWA, 1993). Different sources and factors affecting this process are shown in these papers, in order to explain such diverse responses.

Table 3. Initial, final and decomposed sugarcane straw amount (SP 83-2847 variety) on the soil surface and decomposition rate. Botucatu/SP, Brazil, 2013/2014.

Straw amount (t ha^{-1})			Decomposition rate (%)
Initial	Final	Decomposed	
3	2.375	0.625	20.83
6	5.625	0.375	6.25
9	7.445	1.01	11.22
12	10.66	1.34	11.17
15	12.705	2.295	15.30
18	17.35	1.08	6.00

When considering the decomposition rate, the results showed that decomposition was higher under conditions with reduced quantities of sugarcane straw soil cover (3 t ha^{-1}). Higher contact area with soil surface and higher temperatures were probably the causes of this fast decomposition rate.

In treatments with 6 t ha^{-1} of initial straw amount, there was a low decomposition rate (6,25%) which can be explained by a lack of microorganism's establishment. In treatment with 18 t ha^{-1} of straw (maximum amount tested) it was also observed a reduced decomposition rate (6%) when compared to treatment with 9, 12 or 15 t ha^{-1} (Table 3). These differences in decomposition rate are common, once tissue degradation depends on humidity, temperature and area of soil contact between the straw and the soil. On treatments with 9, 12 and 18 t ha^{-1}, the amount of straw degraded was similar, indicating that the straw zone with highest soil contact presented degradation. Because the initial amount of straw was different, the decomposition rate (percentage in relation to total amount) was also different. The only exception was the treatment with 15 t ha^{-1} which had the smallest amount of decomposed straw, due probably to some particular condition not evaluated in this research. Faroni et al. (2003), who studied sugarcane straw degradation, observed reductions of around 58% of the initial quantity, which was of 15.8 t ha^{-1}, after one year of measurements. Oliveira et al. (1999) found that mass reduction was of approximately 22% after one year of unburned sugarcane residue permanence, what was primarily related to hemicellulose and cell content amount decrease.

Brachiaria plantaginea

Straw amount influenced *B. plantaginea* seedling emergence flow. At 3 t ha^{-1}, there was seedling emergence reduction, being more intense with increasing cover amount. There was also a complete emergence inhibition at the two highest straw amounts (Table 4). Velini et al. (2000) also observed the same behavior when studying this same species cover effect.

Salvador (2007) found that 10 t ha^{-1} of sugarcane straw was not sufficient to prevent *B. plantaginea* and *E. indica* germination. However, these species were not capable of breaking the barrier imposed by more than 10 t ha^{-1}straw amounts, probably due to the low starch reserve in the seeds. This hypothesis for the results seems to be the most probable in the conditions of this experiment.

With sugarcane straw cover withdrawal, *B. plantaginea* seedling emergence occurred randomly. With the removal of 9, 12 and 15 t ha^{-1} of straw mulch, there was a stimulation on emergence compared to the other studied amounts (Table 4), although there were no statistical differences between them Straw decomposition, which was similar for all three treatments, was probably the reason of this occurrence.

Table 4. *Brachiaria plantaginea* emerged seedlings number before and after sugarcane straw cover removal. Botucatu/SP, Brazil, 2013/2014.

Straw amount	Emerged seedlings (n° m^{-2})		
(t ha^{-1})	Before removal	After removal	Total
0	1409.0 a	31.0 bc	1440.0 a
3	1080.0 b	22.0 c	1102.0 b
6	403.0 c	43.0 bc	446.0 c
9	278.0 cd	79.0 abc	357.0 cd
12	79.0 de	96.0 ab	175.0 de
15	0.0 e	143.0 a	143.0 de
18	0.0 e	73.0 bc	73.0 e
F treatments	64.56 **	3.26 *	51.5 **
F blocks	0.77 ns	3.72 *	1.24 ns
C. V. (%)	30.1	67.1	27.6
d. m. s.	207.51	69.3	218.86

Means followed by the same letter do not differ by **t**. test (p > 0.05); ns: not significant; *significant at 5% level; ** significant at 1% .

In addition, organic compounds availability, such as humic acid, which caused seed dormancy to be overcome, and thus stimulated their emergence, may have occurred. Another factor that must be taken into consideration is related to the emergence peak that may have occurred under the straw and its subsequent death, as *B. plantaginea* can show emergence peaks of above 80% in October, regardless of soil management, with or without cultivation (BLANCO et al., 1994). For the lowest removed straw amount (3 t ha^{-1}) this effect was not similar, possibly due to seed bank depletion, which occurred before straw removal.

The beginning of *B. plantaginea* emergence in absence and at 3 t ha^{-1} straw treatment occurred 9 days after sowing (DAS). However, the mean germination time (MGT) for all straw amounts were different, as germination of most seeds at 0 t ha^{-1} straw occurred at 32 DAS (Table 5), what did not corroborate with the results found by Vidal and Theisen (1999), in which, after 5 days on bare soil, there were 50% viable seeds reduction. With 3 t ha^{-1} amounts, there was a 12 days decrease in MGT in relation to the treatment without cover, what can be due to increased nutrient release by faster decomposition rate (Table 3), thus favoring germination and seedling establishment (FELDMAN et al., 1994).

Table 5. Starting and stabilizing period of *Brachiaria plantaginea* seed germination after sowing under straw amounts. Botucatu/SP, Brazil, 2013/2014.

Straw amount	Seedlings emergence (DAS)		
(t ha^{-1})	Start	Stabilization	MGT
0	9	43	32
3	9	43	20
6	12	43	26
9	12	43	24
12	12	43	31
15	0	0	0
18	0	0	0

DAS: Days after Sowing; MGT: Mean Germination Time

For other quantities, *B. plantaginea* germination range was similar, with MGT being higher only in the treatment that had 12 t ha^{-1} compared to the other straw cover treatments.

Panicum maximum

Different straw amounts on soil modified *P. maximum* seed emergence. *P. maximum* seedlings emergence reduced along soil sugarcane straw amount increase (Table 6). Reductions on seedling emergence, compared to the treatment without straw was of 44, 71, 93, 93 and 100% for 6, 9, 12, 15 and 18 t ha^{-1}, respectively. Gravena et al. (2004) observed germination stimulus when low sugarcane straw amounts were used, such as 2 t ha^{-1} cover, and germination inhibition with 15 t ha^{-1}, what has not corroborated with the results found in this paper, as 3 t ha^{-1} has not stimulated emergence and 15 t ha^{-1} still provided plant emergence.

Table 6. *Panicum maximum* emerged seedlings number before and after sugarcane straw cover removal. Botucatu/SP, Brazil, 2013/2014.

Straw amount	Emerged seedlings (n° m^{-2})		
(t ha^{-1})	Before removal	After removal	Total
0	488.0 a	0.0	488.0 a
3	384.0 ab	2.0	386.0 b
6	273.0 b	10.0	283.0 c
9	142.0 c	7.0	149.0 cd
12	36.0 cd	2.0	38.0 de
15	36.0 cd	5.0	41.0 de
18	0.0 d	1.0	1.0 e
F treatments	20.43 **	0.76 ns	20.27 **
F blocks	1.16 ns	1.53 ns	1.2 ns
C. V. (%)	43.54	215.08	42.77
d. m. s.	125.57	12.32	125.8

Means followed by the same letter do not differ by **t**. test ($p > 0.05$); ns: not significant; *significant at 5% level; ** significant at 1% level.

After cover removal, there was no difference in the number of emerged seedlings, which were similar to all studied straw quantities. This fact may be related to *P. maximum* seed viability loss. This species may have seeds with indifferent photoblastism (KLEIN; FELIPPE, 1991), so that the effect is not physical. Thus, the possible cause of this viability decrease may be related to soil straw chemical or biological effects (TOLEDO; BEGLIOMINI, 2000).

The initiation of seedling emergence occurred later with increasing straw amounts of up to 15 t ha^{-1} (Table 7). Possibly, this was because temperature variations decrease with straw increasing straw amounts in the soil (Figure 1), as this species requires high alternating temperatures for germination (TOMAZ et al., 2010).

In straw presence, MGT was increased with increasing straw amount deposited on the soil (from 9 t ha^{-1}). It is noteworthy that, from 12 t ha^{-1} straw deposited on the soil, there was a need for a very long time to initiate *P. maximum* seedlings emergence, 34 days, what resulted in a higher MGT. With 18 t ha^{-1}, no plant emergence was recorded (Table 7), what can be related to lower temperature ranges found in soil (Figure 1).

Digitaria nuda

D. nuda seedlings emergence was reduced with increasing sugarcane straw amounts. (Table 8). In the treatment without straw, the recorded emergence was above the initial estimated quantity.. This fact may be due to a higher range of temperature on the soil (Figure 1), and direct light presence, what may have aided germination in face of what the laboratory germination test indicated. In the presence of light and alternating temperatures from 15 to 35 °C and from 20 to 35 °C, Mondo et al. (2010) verify an increase on *D. horizontalis* germination.

Table 7. Starting and stabilizing period of *Panicum maximum* seed germination after sowing under straw amounts. Botucatu/SP, Brazil, 2013/2014.

Straw amount	Seedlings emergence (DAS)		
(t ha^{-1})	Start	Stabilization	MGT
0	9	43	26
3	12	43	22
6	12	43	24
9	12	43	27
12	34	43	35
15	34	43	38
18	0	0	0

DAS: Days after Sowing; MGT: Mean Germination Time

Table 8. *Brachiaria plantaginea* emerged seedlings number before and after sugarcane straw cover removal. Botucatu/SP, Brazil, 2013/2014.

Straw amount	Emerged seedlings (n° m^{-2})		
(t ha^{-1})	Before removal	After removal	Total
0	1291.0 a	245.0 c	1536.0 a
3	497.0 b	463.0 bc	960.0 b
6	84.0 c	574.0 abc	658.0 b
9	19.0 c	774.0 ab	793.0 b
12	0.0 c	946.0 a	946.0 b
15	0.0 c	988.0 a	988.0 ab
18	0.0 c	893.0 ab	893.0 b
F treatments	54.99 **	2.94 *	2.19 ^{ns}
F blocks	0.95 ^{ns}	2.78 ^{ns}	2.33 ^{ns}
C. V. (%)	48.4	46.5	38.4
d. m. s.	194.23	482.08	552.48

Means followed by the same letter do not differ by **t**. test (p > 0.05); ns: not significant; *significant at 5% level; ** significant at 1% level.

The presence of straw over the soil reduced *D. nuda* seedlings emergence up to 77 DAS in 62, 93, 98, 100, 100 and 100%, for 3, 6, 9, 12, 15 and 18 t ha^{-1}, respectively. However, these results have not corroborated with Yamauti et al. (2011), as they recorded *D. nuda* total emergence inhibition at 8 t ha^{-1} straw amount.

Lorenzi (1993) noted that *D. horizontalis* control level proportionally increased with increasing straw amount on the soil from 6 t ha^{-1}. Emergence was zero for the same species with 10 t ha^{-1} straw. (VELINI et al., 2000). Correia and Durigan (2004) only recorded *D. horizontalis* seedling emergence and dry matter accumulation reduction when using 10 e 15 t ha^{-1} sugarcane straw cover. However, seedling emergence was totally inhibited at 12 t ha^{-1}.

After soil cover removal, there was a significant increase in the number of *D. nuda* emerged seedlings with increasing straw amounts (Table 8). In treatments with higher straw amounts, although germination in the presence of straw was totally inhibited, the rate of seedlings emerged after straw removal was higher than treatments with lower amounts of straw cover or in bare soil.

D. nuda must have special attention in sugarcane plantations, once the most used weed control method is the chemical. Some studies have shown is the occurrence of *Digitaria* genus selection. therein these cases a substitution of triazine and substituted urea susceptible species by tolerant species to these herbicides (DIAS et al., 2003; DIAS et al., 2005).

D. nuda emergence range decrease was observed until its stabilization by sugarcane straw amount increase on the soil. Seedling initial emergence was delayed as there was an increase on straw cover amount up to 9 t ha^{-1}, and there was no seedling emergence in the other straw amounts (Table 9). Despite the start of emergence period was delayed with straw presence, there was an emergence flow that reached stabilization. This is probably due to the physical impediment imposed by straw, because this physical effect reduces weed seedlings survival chances, with small reserve amounts for the embryo (PITELLI; DURIGAN, 2001), as is the case of *D. nuda*.

Table 9. Starting and stabilizing period of *Digitaria nuda* seed germination after sowing under straw amounts Botucatu/SP, Brazil, 2013/2014.

Straw amount	Seedlings emergence (DAS)		
(t ha^{-1})	Start	Stabilization	MGT
0	9	43	37
3	12	43	31
6	19	43	33
9	34	43	35
12	0	0	0
15	0	0	0
18	0	0	0

DAS: Days after Sowing; MGT: Mean Germination Time

CONCLUSIONS

Sugarcane straw over the soil proved to influence the germination of different weed species.

A differential response to straw presence was observed among the species evaluated. After sugarcane straw removal, seedling emergence of *B. plantaginea* and *D. nuda* was increased, while *P. maximum* had lower emergence, regardless of straw amount.

The presence and amount of sugarcane straw can promote weed shifting (species selection) on sugarcane production areas.

RESUMO: O presente estudo teve por objetivo avaliar os efeitos da cobertura do solo com palhiço de cana-de-açúcar sobre a emergência de *Brachiaria plantaginea*, *Panicum maximum* e *Digitaria nuda*. O experimento foi conduzido em um solo classificado como Nitossolo Vermelho. Foram avaliadas sete diferentes quantidades de coberturas do solo com palhiço de cana-de-açúcar (0, 3, 6, 9, 12, 15 e 18 t ha^{-1}). Utilizou-se o palhiço da variedade SP83-2847. O delineamento experimental utilizado foi de blocos casualizados com quatro repetições. Cada unidade experimental continha as três espécies e foram alocadas na região central das parcelas, semeadas a 1 cm de profundidade em uma área demarcada, que posteriormente foram cobertas pelas diferentes quantidades de palhiço distribuídas uniformemente. A taxa de semeadura utilizada foi para obter-se 1.200 planta m^{-2}. O estudo foi compreendido por duas fases. Na primeira fase foi avaliada a emergência das plantas daninhas sob cobertura de palhiço de cana aos 9, 12, 19, 34 e 43 dias após a semeadura (DAS) e a segunda, avaliou-se a emergência das plantas após a remoção do palhiço aos 89, 130, 175, 196, 217 e 234 DAS. Foram consideradas germinadas as plântulas visíveis em cada avaliação com mais de 1 cm de altura de parte aérea. A quantidade de palhiço de cana-de-açúcar utilizada como cobertura do solo influenciou a dinâmica de germinação das diferentes espécies. Na primeira fase observou-se uma resposta diferencial das espécies quanto a quantidade de palhiço utilizada. Na segunda fase, após a remoção do palhiço, verificou-se maior germinação para *B. plantaginea* e *D. nuda*, enquanto *P. maximum* apresentou menor emergência, independente da quantidade de palhiço utilizada.

PALAVRAS-CHAVE: *Panicum maximum*. *Brachiaria plantaginea*. *Digitaria nuda*. Cana-crua. Banco de sementes.

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