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Full Length Article

Mulching with Sugarcane Straw Reduces Weed Density in Sugarcane Field

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Abstract

Occurrence of weeds in sugarcane crop according to levels of straw over the soil was studied. Experiment was carried out during two annual cycles. Treatments were 0 % (no straw); 25, 50, 75 and 100% (i.e., 5, 10, 15 and 20 t/ha of straw, respectively); and straw burned over the soil. Floristic analysis of weed species was achieved. Percent area occupied by weeds was assessed visually and regression analysis between weeds and amount of straw mulch was performed. Floristic analysis characterized 19 weed species, from eight botanical families: Amaranthaceae, Asteraceae, Commelinaceae, Convolvulaceae, Euphorbiaceae, Poaceae, Portulacaceae and Solanaceae. Highest richness of species was observed for Asteraceae and Poaceae, with seven and four species, respectively. Higher frequency was found for *Amaranthus hybridus*, *A. viridis* and *Physalis angulata* (85% of samples) for first annual crop cycle; and *A. hybridus*, *Bidens pilosa* and *Cenchrus echinatus* predominated (83% of samples) in second cycle. *A. hybridus* was the most frequent species in both cycles. The highest density of weeds was observed in treatments with straw burned. Application of 75 and 100% straw showed highest suppression for low and high density of weeds, respectively. Increasing level of straw leads correspondent weed control. That information is vital to orientate decision which amount will deposit over the soil since in recent years the straw is also demanded for alternative sources of energy, as thermal or second generation bio-ethanol.

Keywords: Spontaneous plants; *Saccharum officinarum*; No-burn sugarcane; Weed control

Introduction

Mechanical harvest was recently introduced in sugarcane fields and presently is adopted by most fields. This practice is increasing both in traditional and expansion fields, restricting semi-mechanized harvesting to sloped areas (Braunbeck and Magalhães, 2010). Pre-cleaning by burning of straw must be completely abolished in the coming years (Braunbeck and Magalhães, 2010). As a result, huge amounts of straw will be available. In 2011-2012 season, production of 130 million ton. was estimated, which means about 8-30 t/ha of biomass over the soil (Christoffoletti *et al*., 2007).

Mulching can benefit sugarcane crop by increasing absorption of nutrients, such as phosphorous and nitrogen, which can improve yield by 30% (Ball-Coelho *et al.*, 1993). In addition, mulching reduce weed occurrence, a limiting factor for higher yield in sugarcane crop (Campligia *et al.*, 2010). Previous studies have showed that population of weed may be successfully reduced or have their emergency reduced by mulching (Braz *et al*., 2006; Correia *et al.*, 2006; Silva *et al.*, 2009). However, other studies demonstrated the opposite; in addition, increasing in amount of mulch over the soil can cause injuries in plants and consequently yield losses (Melander *et al.*, 2005; Mochizuki *et al.*, 2008; Leavitt *et al.*, 2011).

Due to huge amounts of straw resulted from harvest and industrial processing, it is necessary to find out the proper destination for this residue. Thus, effects on different factors of production such as weeds, pests, nutrient availability, have to be investigated and the optimum amount of straw would be used for mulching and other for energy generation. This study deals with weed occurrence, estimated by floristic analysis and determination of percent area occupied by weeds. Then, percentages of remaining straw: 0, 25 (5 t/ha), 50 (10 t/ha), 75 (15 t/ha) and 100% (20 t/ha); and burning of straw, were used as mulching in sugarcane crop, during two annual cycles.

Materials and Methods

Experiment was carried out at Usina de Açúcar e Álcool Bandeirantes - USIBAN (23º05'14" S, 50º20'44" W; altitude: 421 m.a.s.l.), in Bandeirantes – Paraná - Brazil. Local climate was classified as Cfa type (Köeppen climate classification) with annual rainfall of 1300 mm.

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Soil has a clay texture, classified as Eutroferric Red latosol (Embrapa, 2006). Cultivar SP 80-1816 was used, planted in August 2010 and conducted for two annual cycles. The harvest of plant cane (first cutting) occurred in September 2011. Treatments consisted of percentages of sugarcane straw: 0, 25 (5 t/ha), 50 (10 t/ha), 75 (15 t/ha) and 100% (20 t/ha); and the burning of straw. Straw was taken from adjacent area after mechanical harvesting and applied over the soil in August 2010. Randomized blocks with four replicates were used. Each plot contained 10 rows of plants (10 m length and 1.5 m between rows).

Floristic analysis of community of infesting weeds and visual record (percent area occupid by each species) was performed at 55 and 42 days after planting and first cutting, respectively. A frame of 0.50 × 0.50 m was used (four samples per plot). Weed plants were identified and quantified. Data were analyzed with software Anafau (Moraes *et al.,* 2003) to calculate abundance, frequency and constancy. Richness and diversity (estimated by the Shannon-Wiener) of species were also established by BioEstat 5.0 (Ayres, 2007).

Data of percent area occupied by weeds were analyzed for data homoscedasticity and normality, to verify assumptions for parametric analysis. Attended the assumptions, analysis of variance (ANOVA) were carried out and Tukey test ($p < 0.05$) was used to compare means. Regression analysis was performed for percent area occupied by weeds depending on the amount of remnant straw. Software Sisvar 5.3 (Ferreira, 2010) was used for the analysis of variance and regression.

Results

Analysis of the floristic composition characterized 19 weed species which belong to eight plant families: Amaranthaceae, Asteraceae, Commelinaceae, Convolvulaceae, Euphorbiaceae, Poaceae, Portulacaceae and Solanaceae. Highest specie richness occurred in Asteraceae and Poaceae, with seven and four species, respectively (Table 1).

During first crop cycle (2010), higher frequency was found for *Amaranthus hybridus* (Amaranthaceae)*, A. viridis* (Amaranthaceae) and *Physalis angulata* (Solanaceae) (85% of sampled specimens). During second crop cycle (2011), *A. hybridus, Bidens pilosa* (Asteraceae) and *Cenchrus echinatus* (Poaceae) predominated (83% of sampled specimens) (Table 1). *A. hybridus* was the most frequent in both cycles.

In both years, a linear decrease of weeds in function of increasing in amount of straw was observed (Fig. 2C and D). In 2010, treatments with 75% (15 t/ha) and 100% (20 t/ha) of the applied straw showed the lower amount of area occupied by weeds. Higher population of weeds was found in treatment with burned straw (Fig. 2A). In 2011, lower area occupied by weeds was recorded in treatment with 100% (20 t/ha) than burned straw and without straw (0%) (Fig. 2B).

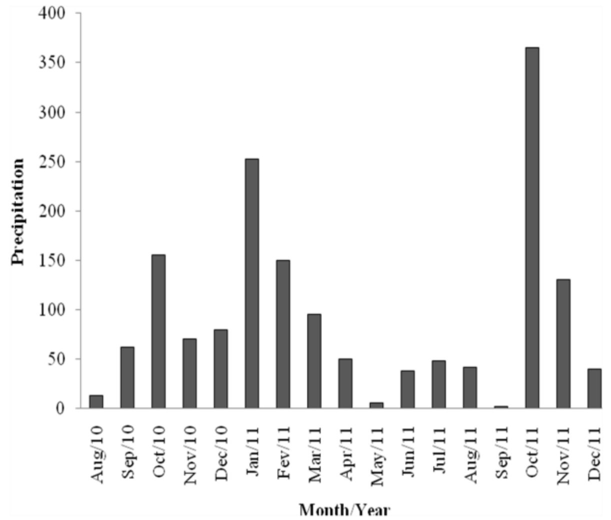

Fig. 1: Precipitation (mm) from August 2010 to December 2011, Estação Metereológica de Bandeirantes. Bandeirantes weather station, 2013

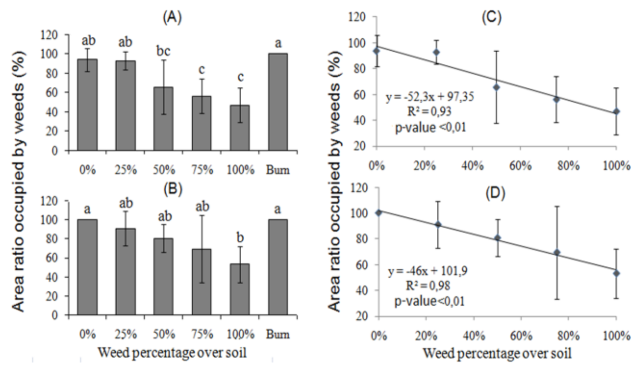

Fig. 2: Mean percentual (n=4) of occupied area of weeds under treatments (A and B), Linear regression of occupied area of weeds (y axis) and percentual of straw over the soil (x axis) (C and D). Means followed by the same letter are not significantly different (Tukey test: $P<0.01$). Bars represent standard error of mean. Letters A and C refers to year 2010, B and D, 2011

Discussion

Amaranthus genus is the most important as weed in sugarcane fields which has also been documented earlier (Kuva *et al.,* 2007). In previous studies, populations of *Brachiaria plantaginea* (Poaceae), *Panicum maximum* (Poaceae) and *A. hybridus* were suppressed by using just 10, 15 and 16 t/ha of straw over the soil surface, respectively (Silva *et al.,* 2003; Gravena *et al.,* 2004; Monquero *et al.,* 2009). Significant reduction of *Cyperus rotundus*

Table 1: Floristic analysis of weeds in sugarcane area, under different percentual of straw over the soil or total burn of straw. Data refer to sample of 24 m^2 (total area), realized in 2010 and 2011 at 55 and 42 days after planting and first harvest, respectively Bandeirantes – Paraná – Brazil

Species	2010						2011					
	Abundance		Frequency (%)		Constancy		Abundance		Frequency (%)		Constancy	
Amaranthus hybridus	409	a	44,70	sf	24	w	4203	sa	61,97	sf	23	w
Amaranthus viridis	212	a	23,17	sf	13	w	1	d	0,01	lf	1	z
Bidens pilosa	66	a	7,21	sf	10	w	836	sa	12,33	sf	21	w
Cenchrus echinatus	-		-		-		605	sa	8,92	sf	11	w
Commelina benghalensis	12	a	1,31	mf	5	y	522	sa	7,70	sf	12	w
Conyza bonariensis	-		-		-		1	d	0,01	lf	1	z
Digitaria horizontalis	12	a	1,31	mf	1	z	95	sa	1,40	sf	5	y
Digitaria insularis	2	d	0,22	lf	1	z	163	sa	2,40	sf	7	y
Emilia sonchifolia	11	c	1,20	f	6	y	13	ma	0,19	mf	9	y
Euphorbia heterophylla	-		-		-		2	c	0,03	f	2	z
Ipomoea grandifolia	1	r	0,11	lf	1	z	1	d	0,01	lf	1	z
Ipomoea nil	4	c	0,44	f	4	y	18	ma	0,27	mf	9	y
Parthenium hysterophorus	-		-		-		5	c	0,07	f	1	z
Physalis angulata	165	a	18,03	sf	6	y	1	d	0,01	lf	1	z
Portulaca oleracea	20	ma	2,19	mf	9	y	311	sa	4,59	sf	21	w
Solidago microglossa	-		-		-		2	c	0,03	f	1	z
Sonchus oleraceus	-		-		-		2	c	0,03	f	2	z
Sorghum halepense	1	r	0,11	lf	1	z	-		-		-	
Tridax procumbens	-		-		-		1	d	0,01	lf	1	z
Richness				12			18					
Diversity (Shannon-Wiener index)				0,65			0,57					
Equitability				0,60			0,45					

Dash "-" indicates no weed observation. sa - super abundant, ma - much abundant, a - abundant, c - common, d - dispersed, r - rare, sf - super frequent, mf – much frequent, f - frequent, lf - less frequent, w - constant, y - accessory, z – accidental

(Cyperaceae) was obtained by using 16 t/ha (Silva *et al.*, 2003). These previous results were obtained under controlled environments, in which seeds were sown in boxes containing soil or in the experimental fields. Environmental conditions in which experiments were conducted, infesting species, differences in methodology and the interactions between them may have influenced the amounts of straw to suppress weeds.

Increasing in specie richness and abundance of weeds was observed from 2010 to 2011. Higher abundance was found in 2011, probably due to higher rainfalls in the period before the weed assessment (360 mm, from September to October 2011) (Fig. 1). Under unfavorable conditions for weed infestation (as occurred in 2010), treatment with 75% of remaining straw was suitable to suppress weeds. However, under higher occurrence of weeds (as occurred in 2011) due to higher rainfalls, only treatment with 100% of straw suppressed them. Deposition of large amount of straw over the soil may cause reduction in yield and biomass production (Campos *et al.,* 2010). However, maintaining 50% or 75% of straw may improve yields (Aquino and Medina, 2014). That information is vital to orientate which amount will deposit over the soil since in recent years the straw is also demanded for alternative sources of energy, as thermal or second generation bioethanol (Soccol *et al.*, 2010; Canilha *et al.*, 2012).

Conclusion

In crux, in sugarcane field *A. hybridus, A. viridis, B. pilosa, C. echinatus* and *P. angulate* genus weeds were dominating. Weeds can be suppressed by increasing the amount of straw up to 20 t/ha.

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