Sunflower and peanut emergence: initial development under sugarcane mulch

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ABSTRACT

The research aimed to evaluate the effect of residual sugarcane mulch on sunflower and peanut plant emergence and initial development. Containers of 4.0 L were disposed in a randomized experimental block design, with four replications, in a factorial arrangement of five mulch amounts and three cultivars of each crop. The mulch treatments consisted of four increasing amounts (5, 10, 15 and 20 t ha^{-1}) and a control with no mulch. The sunflower cultivars were the varieties IAC-iarama and Catissol and the hybrid H-358; the peanut cultivars were the runner-type varieties IAC-Caiapó and Runner 88, and the erect type Tatu. The speed emergence index and final emergence percentage, the plant height and shoot dry mass were evaluated. The presence of different levels of sugarcane mulch negatively influenced the emergence and initial plant development mainly in peanut but also in sunflower. The negative effects were particularly stronger for the runner-type cultivars of peanut, while cultivar Tatu was less influenced by the mulch thickness.

Key-words: *Arachis hypogaea* L. - *Helianthus annuus* L – mulch - oilcrops - seedling development.

INTRODUCTION

The sugarcane crop expansion is a reality in Brazil due mainly to the bio-energy or renewable energy concern. This expansion is now associated with the biodiesel agriculture chain, favored by the possibility of sugarcane rotation with oil crops. In Sao Paulo state, sugarcane rotation with peanut crop is a reality (Borsari Filho, 2006), but there is also a great potential for sunflower crop. There is increased interest in the oil crops that can be used for biodiesel production (MAPA, 2006). Thus, together with the sunflower rotation benefits on sugarcane of about 50% in the sugar yield (Ambrosano et al., 2005), the energetic benefits of fuel association are expected, due to the use of the biodiesel produced by the sugarcane chain in the agriculture and transportation vehicles from the sugar mills and farms.

With the implementation of laws that prohibited sugarcane burning, the harvest leaves a large amount of mulch on the soil surface. This presence of mulch can modify physical soil characteristics like water content and thermic extent (Vasconcelos, 2002), which contribute to soil conservation but, on the other hand, can cause problems to crop management (Furlani Neto et al., 1997).

The mulch layer in sugarcane areas can be as high as 10cm in thickness on the soil surface, which corresponds to 20 t ha^{-1} of residues; these form a physical barrier that reduces the light incidence and modifies the local climate conditions (Velini and Negrisoli, 2000). Those alterations are able to affect the emergence and plant development due to the influence on dormancy and seed emergence processes (Trezzi and Vidal, 2004). With the increased use of oilcrops in the sugarcane rotation, the study of the influence of mulch on different crops is a necessity. In this sense, the aim of the present research was to evaluate the influence of sugarcane residual mulch on the emergence and initial development of different sunflower and peanut cultivars.

MATERIALS AND METHODS

A greenhouse experiment was done at Ecophysiology and Biophysics Center of Instituto Agronômico (IAC), Campinas, SP, Brazil. Plastic containers of 4.0 L capacity, filled with 2.7 L of an argilous sieved soil, with the following chemical composition: pH ($CaCl_2$) = 5.2, organic matter = 25 g dm^{-3}, P (resin) = 1 mg dm^{-3}, K = 0.9, Ca = 23, Mg = 6, H+Al = 28, SB=29.9, CTC=57.7, expressed in $mmol_c$ dm^{-3} and V = 52% were used. The soil was amended according to Van Raij et al. (1997).

Before sowing, seeds of sunflower and peanut were physiologically characterized by determining the germination, emergence (MARA, 1992), and speed emergence index according to Maguire (1962).

The treatments were arranged in a factorial scheme (5 x 3), in a randomized block design, with four replications, combining five amounts of sugarcane mulch (0, 5, 10, 15 e 20 t ha^{-1}) and three cultivars of each crop, separately. For sunflower we used the open pollinated cultivars IAC-iarama and Catissol and the hybrid Helio-358, while for peanut the runner type varieties IAC-Caiapó and Runner 88, and the erect type Tatu were used.

In each pot, ten seeds previously treated with Thiram 0.2% were sown at 3cm deep, followed by the addition of the mulch of sugarcane cultivar SP 803280, which was cut into small pieces before scattering it on the soil surface. The layer thicknesses in the containers were 4, 6, 9, and 10 cm, which corresponded to 5, 10, 15, and 20 t ha^{-1}, respectively.

The final plant emergence (EM) was evaluated 15 days after sowing (MARA, 1992). For the speed emergence index (SEI), the number of normal seedling was counted daily up to a constant number, according to Maguire (1962). The initial plant development was evaluated 30 days after sowing by harvesting the plants and measuring the plant height (PH) and, after drying the aerial part in an oven at 65°C through constant mass, the shoot dry mass (SDM) was obtained.

The data were analyzed using the variance analysis with F test. The data in percentage were transformed to arc $\sin\sqrt{x/100}$ before the statistical analysis, although the original means are reported in the tables and figures. The Duncan test was used for the comparison of means among cultivars. For the mulch analysis, a regression analysis was utilized.

RESULTS AND DISCUSSION

The initial characterization of the physiological potential for sunflower and peanut cultivars (Table 1) showed that all cultivars fitted the commercialization patterns. The three sunflower cultivars presented the same physiological level while the peanut cultivar IAC-Caiapó showed a slightly lower level. Those results indicated the adequate physiological quality of all cultivars to be studied.

Table 1. Characterization of physiological potential for the seeds of sunflower and peanut cultivars in relation to initial germination level (G), final emergence (EM), and speed emergence index (SEI).

	G (%)	EM (%)	SEI
Sunflower			
IAC-iarama	99a[1]	100a	1.66a
Catissol	95a	100a	1.74a
Helio 358	98a	100a	1.51a
Peanut			
IAC-Caiapó	88b	86a	0.95a
Runner 886	92a	83a	0.87a
Tatu	97a	84a	1.04a

[1]Means followed by the same letter in column, for each specie, did not differ from Duncan ´s test at 5% probability

For sunflower there were significant interactions between mulch amount and cultivars only for shoot dry mass (SDM), while for peanut the interactions were significant only for seedling emergence (EM). There were almost no variations in the shoot dry mass of any of the sunflower cultivars with the increasing amount of mulch on soil surface (Table 2). The higher data presented by Helio-358 could be associated with the genetic vigour of the hybrid.

Table 2. Means of sunflower shoot dry mass affected by mulch (M) and cultivars (C). Campinas-SP, Brazil

Cultivars	Sugarcane mulch on the soil surface (t ha^{-1})					Adjustment equation and coefficient of determination (%)	
	0	5	10	15	20		
Sunflower –	Shoot dry mass – SDM (g)						
IAC-iarama	1.6b[1]	1.5b	1.6b	1.4b	1.4b	Y = 1.59 – 0.01x	r^2=69
Catissol	1.5b	1.4b	1.4b	1.4b	1.7b	Y = 1.51 – 0.03x + 0.002x^2	r^2=86
Helio-358	2.0a	2.1a	1.9a	2.0a	1.9a	not significant	
M x C	0.05*						

[1]Means followed by the same letter in column, for each species, did not differ from Duncan ´s test at 5% probability; *Significant at P=0.05.

The seedling emergence of all peanut cultivars was negatively affected by the mulch presence (Table 3). The cultivar Tatu was the least affected by the mulch on the soil surface, which indicates that this cultivar would be the one most indicated for the ploughed out sugarcane areas.

Table 3. Means of peanut seedling emergence affected by mulch (M) and cultivars (C). Campinas-SP, Brazil.

Cultivars	Sugarcane mulch on the soil surface (t ha^{-1})					Adjustment equation and coefficient of determination (%)	
	0	5	10	15	20		
Peanut -	Seedling emergence - EM (%)						
IAC-Caiapó	64.6a[1]	37.8b	23.2a	8.4b	2.6b	Y = 51.04 – 2.20x	r^2=99
Runner 886	60.8a	27.0b	16.5a	7.2b	7.3b	Y = 50.40 – 3.91x	r^2=99
Tatu	60.5a	57.1a	25.9a	48.4a	33,9a	Y = 51.22 . 0.97^x	r^2=68
M x C	442.11**						

[1]Means followed by the same letter in column, for each species, did not differ from Duncan ´s test at 5% probability
**Significant at P=0.01.

The isolated effect of mulch amount and cultivars interfered with the evaluated parameters both for sunflower and peanut. The sunflower seedling emergency percentage (EM) and the speed emergency index (SEI) were directly affected by the mulch increasing on the soil surface (Fig. 1). The greater seedling emergence reduction occurred with the introduction of 5 t ha^{-1} (4 cm) of mulch on soil surface in relation to the tester with no mulch at all; between 15 t ha^{-1} and 20 t ha^{-1} the values did not change. The SEI followed the same pattern of reduction presented by seedling emergence (Fig. 1B). According to Teasdale (1996), the mulch deposition on soil surface can cause chemical, physical and biological alterations in the environment and, depending on the plant species, it can affect the seedling emergence and plant development. Mulch deposition is responsible for delay in the soil heat absorption, which interferes in the thermic difference between day and night, leading to a delay in the speed emergence index, in same cases, like what happened in the present research.

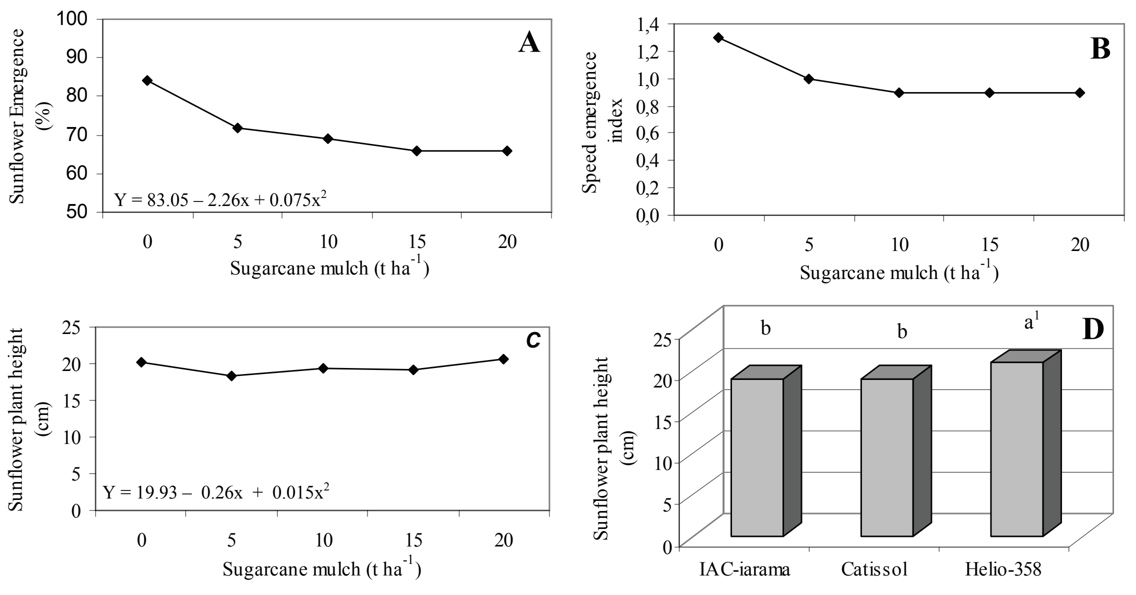

Fig. 1. Sunflower percentage of emergence (A), speed emergence index (B) and plant height (C) affected by the presence of sugarcane mulch on the soil. Sunflower plant height in the studied cultivars (D). Campinas-SP, Brazil.

Differently from other parameters, the plant height of sunflower (Fig. 1C) showed a small increase with the mulch thickness increase. This was an expected behavior since with the increasing of mulch thickness the seedling elongates in the sunlight direction (Carvalho and Nakagawa, 2000). In field conditions, plant shading leads to less biomass accumulation and the plants become more sensitive to lodging (Correia and Durigan, 2004). There were also differences between cultivars (Fig. 1D), with Helio-358 presenting the highest values for plant height in comparison to IAC-iarama and Catissol, which did not differ between each other. The better performance of Helio-358 could be related to its genetic vigour. Both seedling emergence and SEI did not vary between cultivars.

In relation to peanut crop (Fig. 2), there was a significant negative effect of the sugarcane mulch on SEI (Fig. 3A), plant height (Fig. 2C), and dry shoot mass (Fig. 2E). SEI was negatively influenced by the thickness of the mulch layer; with mulch 10-cm thick, the SEI was 78% lower. In peanut, the mulch negative effect was much more pronounced than in sunflower, probably due to the higher temperature necessary for seedling emergence because this is a tropical species whose center of origin is Brazil. Also, the DSM was reduced with the mulch layer increasing up to 10t ha^{-1}, being constant after this thickness. Like sunflower, the peanut plant height was positively influenced by increasing the mulch layer, with the elongation of the plants, already described by Carvalho and Nakagawa (2000) for seedlings under light deficits.

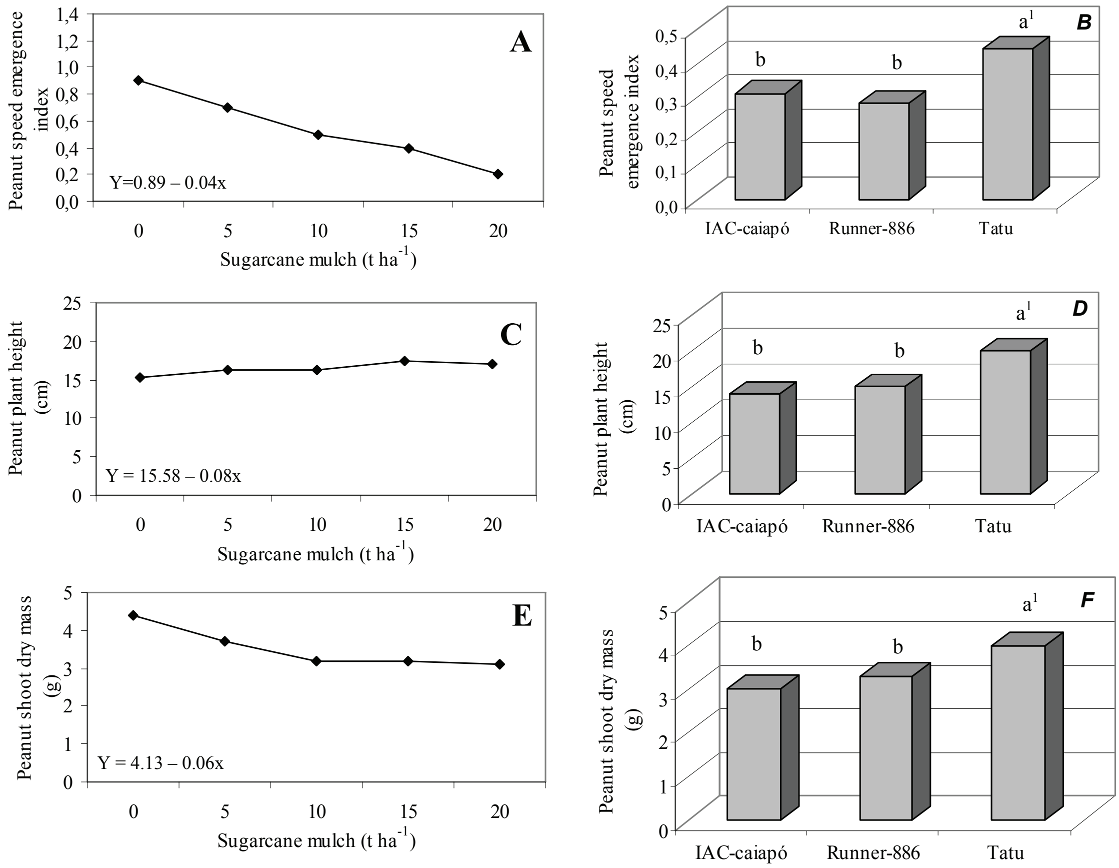

Fig. 2. Means of peanut speed emergence index (A and B), plant height (C and D) and shoot dry mass (E and F) affected respectively by sugarcane mulch (A, C and E) and cultivars (B, D, and F). Campinas-SP, Brazil.

The isolated effect of cultivars is also presented in Fig. 2. The cv. Tatu presented the best performance in comparison to IAC-caiapó and Runner-886 for SEI (Fig. 2B), HP (Fig. 2D), and DSM (Fig. 2F). This superiority could be related to its growing habit classified as erect, while IAC-Caiapó and Runner 886 are classified as runner type. The erect plants have a tendency to grow up faster than the runner type. In the present research work, cultivars with different growing habits were evaluated in order to verify if the erect cultivars would perform better initially in comparison to the runner type which has a tendency to be more productive than the erect cultivar. In the past, the erect type was the one most cultivated in Brazil and it will likely become an option for the ploughed out sugarcane areas with the mechanical harvest obligation.

The research showed that both emergence and initial sunflower development was less negatively influenced by the presence of sugarcane mulch than peanuts. So, in the first approach, sunflower seems to be under better conditions for giving a good performance in areas with high levels of sugarcane mulch. Otherwise, it would be of interest to carry out field evaluations in the future.

CONCLUSION

Under greenhouse conditions it is possible to conclude that the presence of different levels of sugarcane mulch on the soil surface can negatively influence both sunflower and peanut emergence and initial plant development. The negative effects are stronger for peanut cultivars, especially for the runner type; the cultivar Tatu was less influenced by the mulch thickness.

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