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The influence of cover crops on erva de touro (*Tridax procumbens*)

João Batista da Silva Oliveira[1]*, Adaniel Sousa dos Santos[1], Wéverson Lima Fonseca[1], Tiago de Oliveira Sousa[1], Leandro Pereira Pacheco[2], Aline Sousa dos Santos[3], Lisânia de Castro Medeiros[3] and Alan Mario Zuffo[4]

[1]Departament of Agriculture, Campus Professora Cinobelina Elvas, UFPI, 64900-000, Bom Jesus, PI, Brazil.
[2]Departament of Agriculture, Campus Universitário de Rondonópolis, UFMT, 78735-901, Rondonópolis, MT, Brazil.
[3]Departament of Biology, Campus Professora Cinobelina Elvas, UFPI, 64900-000, Bom Jesus, PI, Brazil.
[4]Departament of Agriculture, Campus Universitário, UFLA, 37200-000, Lavras, MG, Brazil.

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Tridax procumbens **is an herbaceous plant belonging to the Asteraceæ family and popularly known as erva-de-touro or margaridinha. The objective of this study is to investigate the effects of cover crops when incorporated or maintained on the soil surface at different levels of straw, on the emergence and initial development of erva de touro. The experiment was conducted in a greenhouse during the period of May to August 2014, in a (5 x 4 + 1) factorial scheme. Factor A consists of five species of cover crops: millet cv. ADR 300 (*Pennisetum glaucum*), Brachiaria (*Urochola brizantha*), sorghum (*Sorghum bicolor* L.), cowpea (*Vigna unguiculata* (L.) Walp.) and sunn hemp (*Crotalaria ocroleuca*), and factor B had four levels of dry mass (dry matter) of these plants (3, 6, 9 and 12 t ha^{-1}) on the soil surface. One treatment had no cover crops (control). The experiment involves a randomized block design with four replications. The analyzed variables were total number of emerged plants, shoot dry mass, leaf area, root dry mass and root volume. The cover crops at different levels of straw were efficient, giving greater prominence to the species, *P. glaucum* and *V. unguiculata* in suppressing the erva do touro (*T. procumbens*).**

Key words: Allelopathy, Brachiaria, millet, weed.

INTRODUCTION

Tridax procumbens L. is a herbaceous plant belonging to the Asteraceæ family and popularly known as erva de touro or margaridinha. It originates from Central America and spread to other regions such as South America and Africa (Kissmann and Groth, 1999), North America (Zimdahl, 1983) and Asia (Shetty et al., 1982). In Brazil, it has high incidence in the southeast and midwest, infesting pastures, roadside areas, vacant lands and

*Corresponding author. E-mail: joaobatistaagro@gmail.com.

urban areas (Lorenzi, 1991; Kissmann and Groth, 1999). This species showed very fast dissemination in the last 10 years in annual crops areas in the Cerrado of Central Brazil (Guimarães et al., 2000).

This species is reported to be one of the first to occur in field areas and Cerrado. Under favorable conditions such as good moisture and abundant lighting, it develops and spreads quickly (Kissmann and Groth, 1999; Lorenzi, 2000) and has been found in cotton crops (Albertoni and Almeida Neto, 1981), rice and soybeans (Albertoni and Almeida Neto, 1981). Nonetheless, weeds can reduce the quality and yield of a crop, make it difficult to harvest and, in extreme cases, make it unfeasible (Guglieri-Caporal et al., 2011). Also, weeds can enable the increase of grain moisture and drying costs, can encourage fermentation and increase the incidence of pests at storage (Vargas and Roman, 2005).

The use of cover crops in weed suppression is optimized on identification of more adaptable species to the region. To optimize the use of cover crops to suppress weeds, it is necessary to identify the most adaptable species to the region and adapt them to the best way of implementation and management (Ceretta et al., 2002). The production of dry mass and ground cover are factors that can assist in the control of weeds through chemical (allelopathy) and physical processes. The greater presence of microorganisms in the soil under no-tillage, as noted by Costa and Lovato (2004), which are capable of degrading the bank of the soil seed is important in integrated weed control in no-tillage.

Allelopathy is a process that occurs widely in plant communities, whereby certain plants interfere with the development of others. This behavior can therefore become important factor management cultures, in use of plants that exert control over certain undesired species, obtaining therefore, more productive culture systems (Goldfarb et al., 2009). The allelopathic compounds derived from the secondary metabolism of the plant are found distributed in different concentrations in different parts of the plant and during its life cycle. However, the main forms of release of these compounds into the environment are volatilization of the leaves, decomposition of plant residues, exuding of the roots and leaching through rain, fog and dew (Souza, 1988; Macias et al., 2007).

The allelochemicals in activities may suffer changes when designated under natural conditions, or when the substrate in the soil depends on the coverage to be maintained or incorporated into the soil surface (Ferreira and Áquila, 2000). Thus, the action of allelochemicals depends on the concentration, and incorporation leads to allelochemicals dilution. It is expected that residues placed on the soil surface are the most appropriate way to manage allelopathic action of cultures (Rezende et al., 2003).

T. procumbens is tolerant to diffused lighting, although the species prefer sunny areas (Kissmann and Groth, 1999). In contrast, there is no evidence about the effect of alternating temperatures on dormancy surpassing this species, provided that the studies have focused on constant temperatures. However, *T. procumbens* reaches more than 90% of germination at temperatures between 25 to 35°C (Guimarães et al., 2000). Through aggressive and difficult weed management in agricultural systems, its control has been sustained in the use of herbicides (Pacheco et al., 2013). However invasive, via an evolutionary phenomenon may develop herbicide resistance (Rizzardi et al., 2008). In analyzing this context, the adoption of cultivation methods, in the presence of biomass on the soil surface is critical to minimize the negative effects of chemicals on the environment and reduce the selection pressure caused by the intensive use of the same active ingredient.

In this sense, the objective of this study is to evaluate the effect of cover crops when kept on the soil surface at different levels of straw on the emergence and early development of bull's wort (*T. procumbens*).

MATERIALS AND METHODS

The experiment was conducted in a greenhouse from May to August 2014, on the campus of the Federal University of Piauí (UFPI/CPCE), Bom Jesus (Latitude 9° 16' 78"S, Longitude 44° 44' 25"W and altitude of 300 m), Piaui, Brazil.

The experiment was carried in a randomized block design with four replications, in a (5 x 4) + 1 factorial scheme, with factor A consisting of five species of cover crops: millet cv. ADR 300 (*Pennisetum glaucum*), Brachiaria (*Urochola brizantha*), sorghum (*Sorghum bicolor* L.), cowpea (*Vigna unguiculata* (L.) Walp.) and sunn hemp (*Crotalaria ocroleuca*); factor B having four levels of dry mass (dry matter) of those plants (3, 6, 9 and 12 t ha^{-1}) on the soil surface, and another treatment having no cover plants (control); giving a total of 64 experimental units.

The composition of each experimental unit was distributed in pots with capacity of 8 dm^3 of soil and diameter of 35 cm. The used substrates were soil samples taken from the layer of the Dystrophic Yellow. This depth was adopted in order to avoid larger weeds seed bank in the upper layers of the soil.

Twenty-five seeds from a single invasive species (*T. procumbens*) were randomly sown per pot in each experiment, and all residues were added to the surface. Fresh vegetation cover was added to the soil surface in amounts corresponding to different treatments (3, 6, 9 and 12 t ha^{-1}) in dry weight. The plant material was collected and fractionated on the day of the experiment installation to avoid possible allelochemicals loss.

To obtain the dry mass, the seeds of cover crops were sown by hand and grown in 5 m^2 beds and their shoots were collected when they were in the reproductive phase (beginning of the flowering stage ± 60 days), considering the culture cycle. The plant residues cover crops were segmented into sections of about 2 to 3 cm, weighed and fixed by a dry basis reference. Later, the plant samples were left in an oven at 65°C for 72 h and/or until constant weight was obtained. The wet material was adjusted according to the required dry matter per hectare, which was subsequently homogenized and kept on soil surface (pot) in accordance to the treatments. Irrigation was performed daily based on the plants' needs.

The variables were: total number of emerged plants (NEP), emergency speed index (ESI), leaf area (LA), shoot dry mass (SDM), root volume (RV) and root dry mass (RDM). The ESI was

Table 1. Variance analysis (F values) for number of emerged plants (NEP), leaf area (LA), shoot dry mass of aerial parts (SDM), root dry mass (RDM) and root volume (RV) for erva de touro.

Source of variation	Mean square				
	NEP	**LA**	**SDM**	**RDM**	**RV**
Cover crops (CC)	2.95**	163279.50**	13.22**	0.71**	16.49**
Residue level (RL)	121.11**	3349163.76**	151.03**	6.13**	447.30**
CC x RL	0.95*	53223.79*	4.66**	0.19*	10.29**
CV (%)	30.81	45.89	49.51	43.78	45.41

**Significant at 1%; *significant at 5%, CV – coefficient of variation .

calculated using the formula described by Maguire et al. (1962): ESI = [N1/1 + (N1-N2)/2 + (N3-N2) / 3 + ... (Nn-Nn-1)/n], where N1, N2, N3 ... Nn, correspond to the number of emerged seedlings and 1, 2, 3 ... n, are the number of days after sowing (DAS).

The leaf area (LA) was determined when weeds reached the stage of pre-flowering, with the assistance of LI-3100 equipment Area Meter (LI-COR, Inc., Lincoln, NE, USA), in which leaves were separated from the stem to make the measurement, expressed in cm^2 $vaso^{-1}$. Moreover, the roots were separated from the shoot, washed with water and removed from the soil and then subjected to root volume (RV) measurement expressed in cm^3 $vaso^{-1}$ using the method of the tubes (Basso, 1999). Both the shoot and root parts were subjected to drying in oven at 65°C until they had constant weight to obtain their dry mass.

Data were subjected to analysis of variance by test "F" ($p < 0.05$) with the help of Sisvar 4.2 software, and when significant, the treatment means were adjusted by regression equations with the help of the Sigma Plot 10.1 software.

RESULTS AND DISCUSSION

For the variables of number of emerged plants (NEP), leaf area (LA), shoot dry mass (SDM), root dry mass (RDM) and root volum (RV), a significant interaction was observed ($P<0.05$) between the management and the residue level only for NEP and RV (Table 1). At the same time, all the evaluated variables were different ($P<0.05$) for residue amount and cover crops.

All tested cover crops were efficient to reduce the NEP in erva de touro, with *P. glaucum* and *V*. *unguiculata* presenting higher reductions, mainly for the initial residue amount on the soil (Figure 1). The suppression of bull weed emergence in this study can be justified by the significant content of phenols group substances and flavonoids present in these kinds of toppings (Lisboa, 2009). In a survey conducted by Pacheco et al. (2013), it was observed that the soil cover reduced the number of emerged plants of Bidenspilosa. According to these authors, the reduction of seedling emergency is due to allelopathic action of cover crops.

The cover crops presented exponential decreasing behavior for the NEP of erva de touro (Figure 1). These results indicate that 3 t ha^{-1} of residue of *P. glaucum* and *V. unguculata* reduced the NEP in 78.99 and 76.30%, respectively, when compared to the control (0 t ha^{-1} of residue). The species *P. glaucum*, *C. ochroleuca*, *S. bicolore* and *U. ruziziensi*s were more efficient with the residue amount above 6 t ha^{-1}, with more than 78% of reduction, compared to control (0 t ha^{-1} of residue). Gimenes et al. (2011), analyzing the effect of *U. decumbens* on weed infestation, verified that the plant reduced the amount of *C. echinatus* from 30 to 2 plants m^{-2}, when compared to control.

For the variables LA and SDM of erva detouro, the lowest means of these variables were observed in pots seeded with *P. glaucum*, *S. bicolor* and *V. unguicuata* residue (Figure 1). These results can be explained due to the higher exponential decrease of the number of emerged plants caused by the cover crops. In this way, it is possible to observe that the reduction in SDM and LA became the weed plants less competitive with crops with economical potential. Correia et al. (2006) observed a potential use in the forage millet from 3 t ha^{-1} for the *B. pilosa* control, in a no-till system.

For the variables LA and SDM, the cover crops presented decreasing exponential behavior according to the residue amount, except for *U. ruziziensis* with a linear reduction for SDM (Figure 1). The highest reduction of LA was with 3 t ha^{-1} of *P. glaucum, S. bicolor* and *V. unguiculata* plants, with reductions of 80.78, 62.40 and 80.78%, respectively, compared to control (0 t ha^{-1} of residue). At the same time, the same cover crops reduced the SDM up to 80.22, 56.73 and 75.82%. Gimenes et al. (2011) demonstrated that 10 t ha^{-1} of dry mass from *Brachiaria decumbens* at 60 days after germination reduced more than 80% of the *Digitaria horizontalis* and *Cenchrus echinatus* weeds leaf area.

For root system variables, all tested cover crops were efficient to reduce RDM and RV (Figure 2), according to the exponential decrease of the emerged plants number (Figure 1). Thus, the lower development of the root system can result in a reduction of the competitive capacity of the weeds, because of the reduction and absorption capacity of water and nutrients, mainly in water stress conditions (Pacheco et al., 2013).

The cover crops *P. glaucum* and *V. unguiculata* were adjusted in the exponential regression model for RDM and RV of erva de touro, with higher reductions (more than 75%) when compared to control (0 t ha^{-1} of residue) (Figure 2). Fortes et al. (2009) verified that the use of the

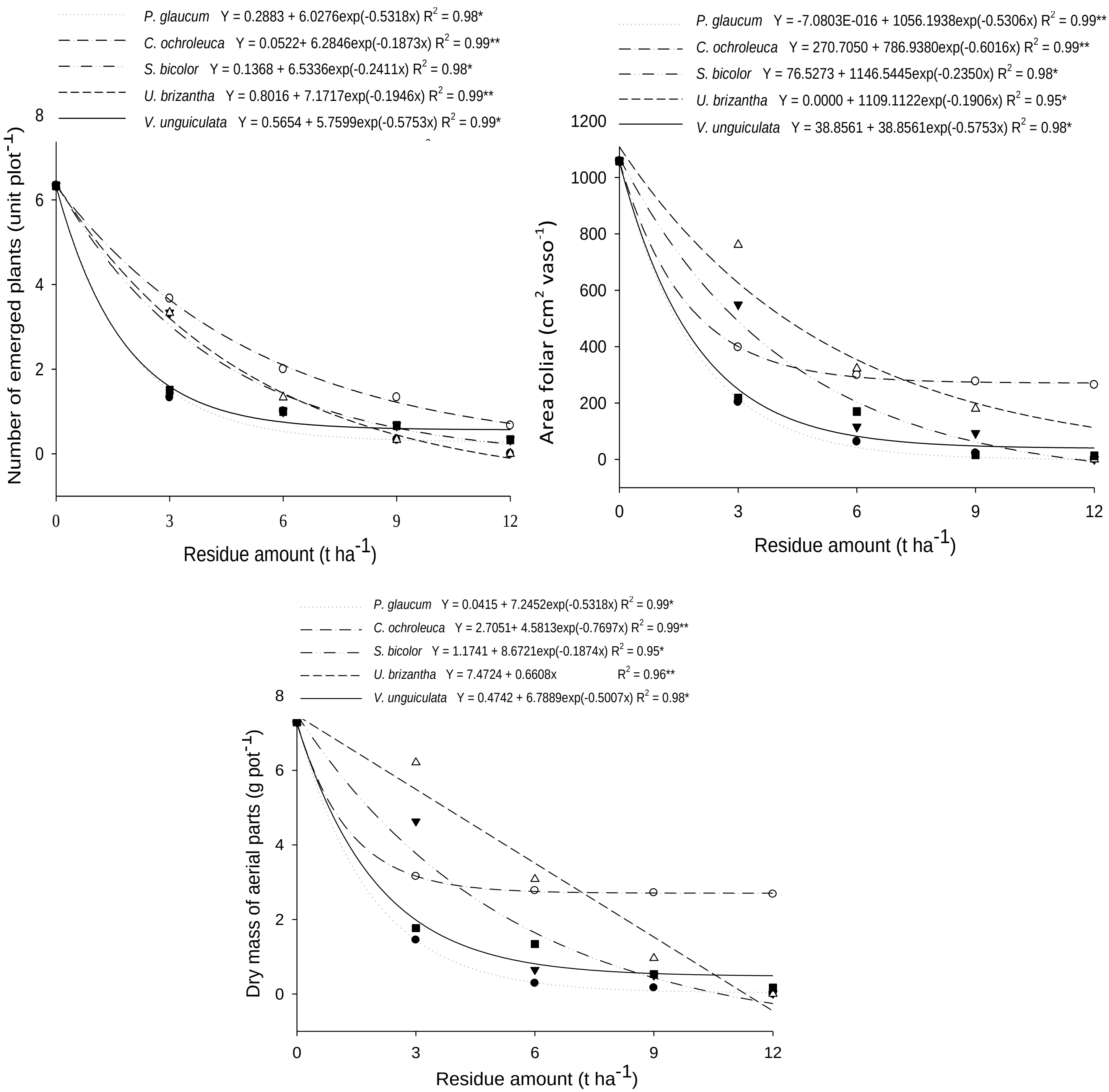

Figure 1. Number of emerged plants, leaf area and shoot dry mass of erva de touro according to crop residue amount of cover crops. ** and *: significant at 1 and 5%, respectively.

Sambucus australis and *Cymbopogon citratus* hot water extracts did interfere in the picão-preto (*Bidens subalternans*) average root length, with a higher effect when higher concentrations were used.

In conclusion, according to the results, all cover crops evaluated had potential to reduce erva de touro infestation. The species *P. glaucum* and *V. unguiculata* presented higher efficiency in erva de touro control, being the residue amount of 3 t ha^{-1} sufficient to promote a reduction in erva de touro germination. The cover crops *P. glaucum* and *V. unguiculata* presented higher reduction in root system parameters when 3 t ha^{-1} of

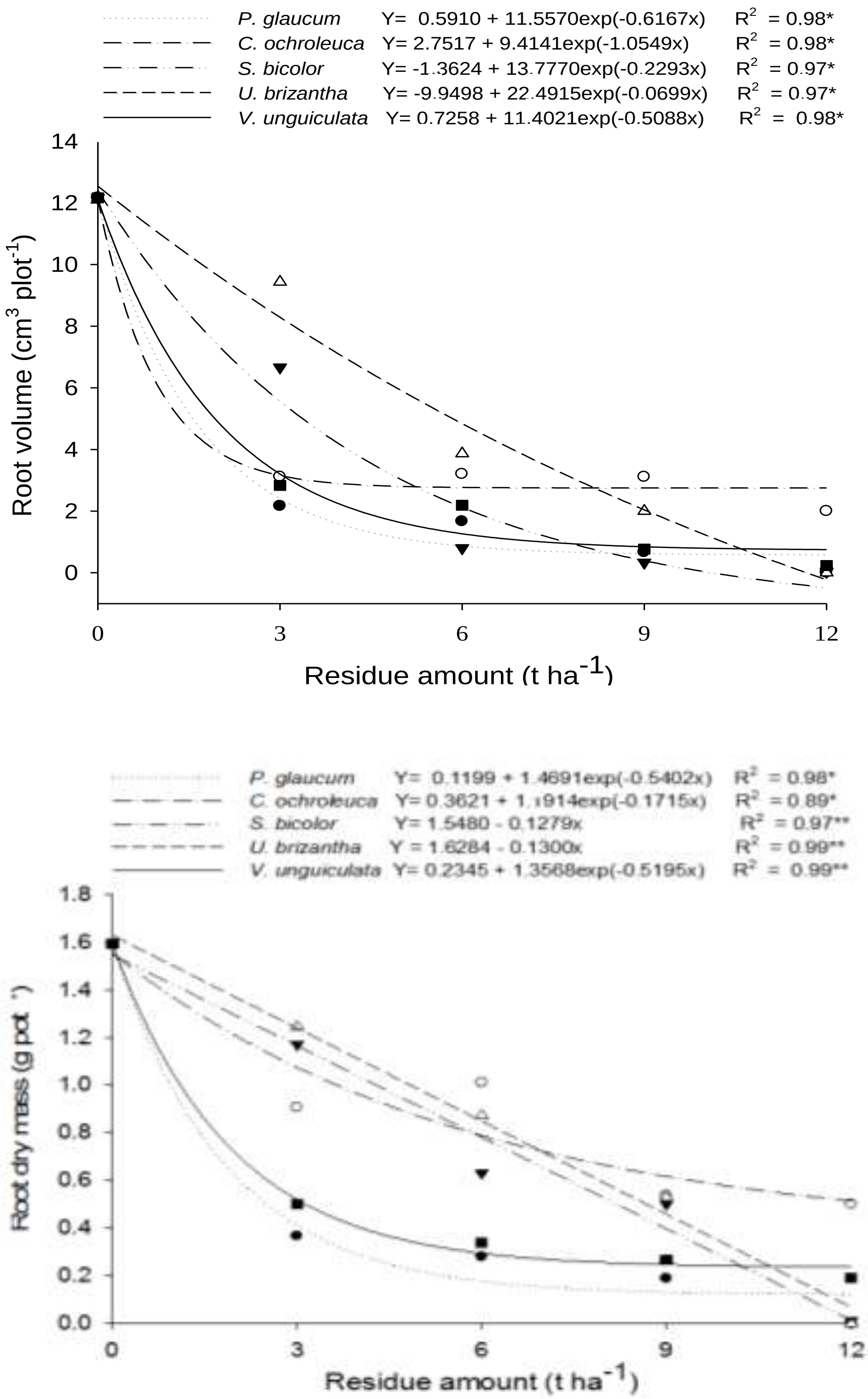

Figure 2. Root dry mass and root volume for erva de touro according to residue amount and cover crops. ** and *: significant at 1 and 5%, respectively.

residue was used.

Conflict of interests

The authors have not declared any conflict of interests.

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