*Available online at http://www.journalcra.com*

*International Journal of Current Research*
*Vol. 7, Issue, 12, pp.24642-24649, December, 2015*

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

# GERMINATION OF WEEDS AND SPECIES GROWN AND SUBMITTED TO THE GROWING OF SUNN HEMP AND ITS EXTRACT

[1,*]Dana Katia Meschede, [2]Gabriele do Prado Borges, [1]Eli Carlos de Oliveira, [1]Marli de Moraes Gomes and [1]José Roberto Pinto de Souza

[1]Universidade Estadual de Londrina - UEL, Departamento de agronomia, Tel (43) 3371-5981, cx postal 1011, CEP 87057970, Londrina-PR
[2]Departamento de Agronomia, Rua Pref. Jairo Monteiro, CEP 19700.000

**ARTICLE INFO**

***Article History:***
Received 05th September, 2015
Received in revised form
08th October, 2015
Accepted 27th November, 2015
Published online 30th December, 2015

***Key words:***
*Crotalaria juncea*,
Allelopathic,
Cover crops,
Soybean,
Stress.

**ABSTRACT**

Sunn hemp (*Crotalaria juncea* L.) is a tropical legume that could be an important summer cover crop, it has the potential for suppressing both crops and weeds. The objective of this study was to evaluate the allelopathic effect of sunn hemp in different spacing intervals and densities, in the germination of corn, beans, rice, soybeans and weeds. The study was conducted in Cáceres/MT and Paraguaçu Paulista/SP. Sunn hemp was planted to obtain matter for the extraction of allele chemical compounds and the suppressive effect from growing sunn hemp on the weeds on the crops in the field. The corn, bean, rice, soybean and bitter grass seeds were the bio-indicators. There were two spacing intervals (0.25 m and 0.50 m) and three densities (25, 40 and 50 plants $m^{-1}$) evaluated the sunn hemp height, density, dry weight of weeds ($g/m^2$) and the germination and root length of the planted specie seedlings. The reduction of sunn hemp plant spacing reduces the growth of weeds in the field that directly interfere in the germination and growth of seedlings. The crops display different sensitivity to the concentration of sunn hemp extracts, bean extract displays the greatest sensitivity to the extract, even at the lowest concentration, when compared to corn and rice, as it also affects the root. No significant interference was present in soybean extracts. Bitter grass has reduced germination from the extracts and increased numbers of abnormal plants.



***Citation*****: Dana Katia Meschede, Gabriele do Prado Borges, Eli Carlos de Oliveira, Marli de Moraes Gomes and José Roberto Pinto de Souza, 2015.** "Germination of weeds and species grown and submitted to the growing of sunn hemp and its extract", *International Journal of Current Research,* 7, (12), 24642-24649.

## INTRODUCTION

Every issue regarding agriculture nowadays, has directly or indirectly defined as its essence, contrary to the need for reducing production cost, the reconciliation of growing concerns on environmental issues, regarding the extreme importance of finding and adapting management methods and cultural practices, which adhere to these issues. Based on these concerns, research and the literature suggest that there are multiple objectives for plant growing; for example: the production of material for covering the soil; increased organic soil content matter; harnessing the allelochemical potential; and after all, several other aspects for serving these needs. Green cover crops serve these purposes to some extent, as well as reduce the usage of herbicides for controlling weeds, and they help to improve the physical, chemical and biological qualities of the soil. The *Crotalaria juncea* is a Magnoliophyte plant (angiosperm), Magnoliopside (dicotyledon), from the Fabales order and the Fabaceae family (Pascualide and Panchuelo, 2007). It is an alternative for managing coverage, due to its symbiotic affinity and C/N ratio. According to Kiehl (1985), this also summarizes several allelopathic compounds, which may be a series of suppressors for weed species. The growing problem in weed management resistant to glyphosate brings about a need to manage the crop in order to control these resistant infestations.

In this process, the study and understanding of plants with potential vegetation coverage linked to the production of allopathic compounds is extremely important scientifically and economical (Siveira *et al*., 2010; Cerdeira *et al*., 2012). The green fertilizer can cause changes in the population of native plants due to allelopathic effects and competition for light, water, oxygen and nutrients, leading to the disappearance of some of them (Mateus *et al*., 2004; Carreras *et al*., 2001;

***Corresponding author: Dana Katia Meschede,***
*Universidade Estadual de Londrina - UEL, Departamento de agronomia, tel (43) 3371-5981, cx postal 1011, CEP 87057970, Londrina-PR.*

Favero *et al.,* 2001; Adler and Chase, 2007). Studying the composition of the seed bank of weeds in soil cultivated by green fertilizer, Severino and Christoffoleti (2001) found that sunn hemp promoted greater control over the native vegetation than other species of green fertilizer, significantly reducing weed infestation. Meschede *et al*. (2007) also found the effect of different green vegetation coverage on the population of weeds, and noted that the crotalaria promotes good ground vegetation coverage, reducing the number of weed species in the growing area.

Thus, sunn hemp, can be a good alternative in managing the fallow season and it can be grown in order to produce straw for preparing the direct seeding system, providing improvements in physical, chemical and biological characteristics of the soil and contributing to the reduction of weeds and seed banks in the soil, resulting in reduced usage of herbicides. However, Souza Filho and Alves (2002) point out that the allelopathic effect may range to and interfere in any plant community. Thus, interference may occur in crop plants, in the germinal appearance and/or growth processes/development, resulting from chlorosis and withering, until the plants die or substantial reduction occurs in the production thereof (Pires *et al*. 2001).

Thus, this study aimed to study the allelopathic effect of sunn hemp planted in different spacing intervals and densities, the germination of corn, beans, rice, soybean, weeds of different species.

## MATERIALS AND METHODS

The field study was conducted in two locations, the first in EMPAER-MT/Cáceres-MT, the geographic coordinates were 16º11'42” southern latitude and 57°40'51" western longitude, situated at an altitude average of 118 m in 2006. The second area was a model farm in Paraguaçu Paulista, in 2013, latitude 22º24'46"south and longitude 50º34'33". The experimental design was randomized blocks with four replications and six treatments. The treatments consisted of two row spacing intervals (25 cm and 50 cm) and three densities (25, 40, and 50 plants per meter) of sunn hemp arranged in factorial 2x3. Each plot consisted of 15 $m^2$, considering the useful area of the central part of the field but excluding 1 m on each side. The soil preparation was carried out in a conventional system.

Sowing was done in September 2006 (Cáceres/MT) and December 2013 (Paraguaçu Paulista/SP) and the harvest was carried out after 70 days (during the reproductive step). Five plants are harvested from within each plot (floor area). The plants were cut along the soil surface by collecting all the shoots (leaves and stems). The weeds were identified and quantified (number of plants/$m^2$). The height of the crotalaria plants was also measured only at the experimental model farm in Paraguaçu Paulista and the weight of the weeds in the harvest area and inserted in an oven for 72 hours in order to weigh the dry matter. The laboratory step was carried out at Mato Grosso State University - UNEMAT/Cáceres-MT and Gamonn Paraguaçu Paulista College. And it was carried out in separate phases and varied treatments based on the concentration. The first stage of the research was performed in Caceres, whereas the treatments were subjected to different concentrations, applying a factorial scheme of 2 spacing intervals x 3 densities x 4 concentrations, totaling 24 treatments, plus the control treatment (no extract just water): T1: 0.25 m between rows x 25 plants/m, 25% concentration; T2: 0.25 m between rows x 25 plants/m, concentration 50%; T3: 0.25 m between rows x 25 plants/m, 75% concentration; T4: 0.25 m between rows x 25 plants/m, 100% concentration; T5: 0.25 m between rows x 50 plants/m, 25% concentration; T6: 0.25 m between rows x 50 plants/m, 50% concentration; T7: 0.25 m between rows x 50 plants/m, 75% concentration; T8: 0.25 m between rows x 50 plants/m, 100% concentration; T9: 0.40 m between rows x 25 plants/m, 25% concentration; T10: 0.40 m between rows x 25 plants/m, 50% concentration; T11: 0.40 m between rows x 25 plants/m, 75% concentration; T12: 0.40 m between rows x 25 plants/m, concentration 100%; T13: 0.40 m between rows x 50 plants/m, 25% concentration; T14: 0.40 m between rows x 50 plants/m, 50% concentration; T15: 0.40 m between rows x 50 plants/m, 75% concentration; T16: 0.40 m between rows x 50 plants/m, 100% concentration; T17: 0.50 m between rows x 25 plants/m, 25% concentration; T18: 0.50 m between rows x 25 plants/m 50% concentration; T19: 0.50 m between rows x 25 plants/m 75% concentration; T20: 0.50 m between rows x 25 plants/m, concentration 100%; T21: 0.50 m between rows x 50 plants/m, 25% concentration; T22: 0.50 m between rows x 50 plants/m, 50% concentration; T23: 0.50 m between rows x 50 plants/m, 75% concentration; T24: 0.50 m between rows x 50 plants/m, 100% concentration and T25: control (without extract).

For the experiment conducted in Paraguaçu Paulista, the concentration was maintained at 100%, and the extracts were applied: T1: 0.25 m between rows x 25 plants/m; T2: 0.25 m spacing between rows x 40 plants/m; T3: 0.25 m between rows x 50 plants/m; T4: 0.50 m between rows x 25 plants/m; T5: 0.50 m between rows x 40 plants/m; T6: 0.50 m between rows x 50 plants/m; T7: control (without extract).

**Extract preparation**

Drying sunn hemp was performed in natural conditions (in the shade), until achieving constant weight conditions; then it was shredded manually into approximately pieces of 2.0 cm and crushed separately (for each treatment) in a blender (3 cycles 15 seconds) with 300 ml of distilled water at 80 °C; and then another 700 ml of water was added at the same temperature to prevent degradation of allelochemicals, filtering the crude extract through filter paper, thus the concentration reached 12% (w/v); and infusion for 4 minutes. On day 7; subsequent to infusion, a final filtration was performed again for extract obtainment; They were cooled, stored at 10 ° C for 24 hours; and stirred 2 to 3 times (Leather and Einhellig, 1986).

**The preparation of different concentrations**

The first experiment was conducted in Caceres to try to understand the effect of different concentrations of the matrix extract; the extract was diluted to 25, 50, 75 and 100%, by adding distilled water to achieve the desired proportions. In the second experiment, only the undiluted extract was decided on.

**Bioassays**

The bioassay used "blotter test" (Brasil, 2009) 20 seeds were used for each biomarker for constituting the treatments. The experimental design was completely causal and included four replications. The treatments consisted of four doses of sunn hemp extracts grown in two spacing intervals and three densities (scheme 2x3x4), performed for each bio-indicator (corn, beans, rice) Caceres and (soy, corn and bitter grass) in Paraguaçu São Paulo/SP. The soybean and corn seeds were purchased at retailers and, and the bitter grass were harvested in areas proven to be resistant to glyphosate. The seeds were incubated for 7 days in a growth chamber at room temperature and a reciprocating cycle of 12 hours of light and 12 hours of darkness. And the evaluations were performed 7 days after applying the substrates for crop species and 21 days for the bitter grass. On the last day, all the shoots and roots of the germinated seeds were measured.

The non-germinated seeds were submitted to tetrazolium to verify if they were either dead or dormant. The data were submitted to the Shapiro-Wilk test, $p < 0,05$, in order to test the adherence of wastes to the normal distribution and the Bartlett test ($p < 0,05$) to identify the condition of homogeneity of variances. The normality and homogeneity conditions were identified. Then the variance analysis was performed and the Scott-Knott test, at a 5% probability level for comparison between treatments. Data values corresponding to the plant density factor were submitted to regression analysis, prioritizing the explanatory models of each characteristic, considered as a function of plant density and displayed when the regression adjustment was significant.

## RESULTS AND DISCUSSION

### The data was evaluated was performed in Cáceres/MT

Table 1 presents the data on the germination of corn, rice and bean seeds seven days after sowing. It shows that all species studied displayed effects from the interference of extracts applied in different concentrations and seeding densities. The corn seed were analyzed, when grown in the sunn hemp extract in a 0.25 meter space interval between plants, which brought about the lowest germination interference, however, in the lowest plant density (25 plants $m^{-1}$) at a 40 $m^{-1}$ density of plants brought about death of the embryo plants, leading to 0% of germinated seeds, but when the spacing interval between plants increased to 0.50, an inhibitory effect was registered only when sunn hemp were grown in higher density (50 plants $m^{-1}$), with a reduction of up to 70% (the highest concentration).

This result clearly demonstrates the greater accumulation of allopathic compound due to the stress factor (higher density with smaller spacing intervals) probably promoted by the competition of the intra-specific sunn hemp. For the rice plants grown in a spacing interval of 0.25 m between plants, interference only occurred from the extract when it was applied and the sunn hemp was grown 40 plants $mt.^{-1}$, in different dilutions, and the restrictions in germination percentage exceeded 80% content. When the spacing was increased to 0.50 m between plants, the interference density occurred only above 50 plants $m^{-1}$ in different dilutions. This result shows there is a higher tolerance level in rice when compared to corn and beans in the allopathic compounds released by sunn hemp.

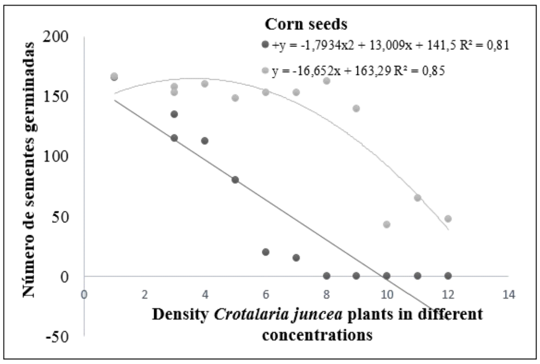
The bean plant proved to be more susceptible to the extract and since the density of 25 plants $m^{-1}$ dramatically reduced the germination, reaching 0% when the density increased to 40 plants $m^{-1}$ row spacings in the two space intervals studied and in the more diluted extract concentration. Figure 1 displays the germination of different species at different densities and spacing intervals to demonstrate adaptation to the linear and polynomial behavior. The trend showed the number of germinated seeds reduced in all the seeds studied due to the application of the extract, whereas the sunn hemp were grown in greater density and in smaller spacing intervals. When the seeds were exposed to the extract, sunn hemp developed in a 0.25 m spacing interval; there was a linear equation adjustment. But there was a polynomial adjustment in the 0.50 mt. spacing interval between rows. This shows a clear-cut trend that an increase in seeding density was linked to the reduced sunn hemp spacing interval, which brought about a reduction in germination.

**Table 1. Number of seeds germinated 7 days after sowing (DAS) and length of root and shoot of corn seedlings, rice and beans submitted to *Crotalaria juncea* extract cultivated in two spacings (0.25 m/plants and 0.50 m/plants) and three densities (25, 40 and 50 plants/$m^2$)**

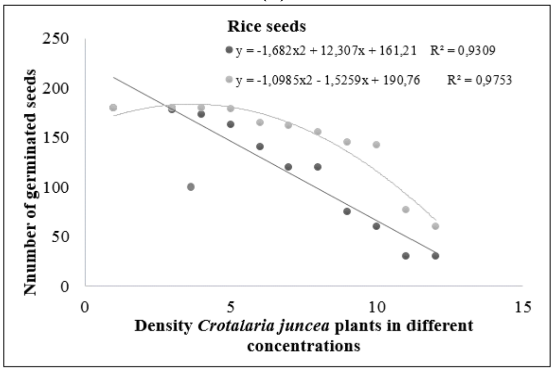
| Trat | Corn seed | | Rice seed | | Bean seed | |
|---|---|---|---|---|---|---|
| | Esp.0,25m | Esp.0,50m | Esp.0,25m | Esp.0,50m | Esp.0,25m | Esp.0,50m |
| Control | 166 A | 167 A | 180 A | 180 A | 180 A | 180 A |
| Dens. 25 ptas/25% | 135 B | 158 A | 180 A | 180 A | 65 B | 70 B |
| Dens. 25 ptas/50% | 115 C | 153 A | 178 A | 180 A | 45 C | 70 B |
| Dens. 25 ptas/75% | 113 D | 160 A | 173 A | 180 A | 1 D | 40 D |
| Dens. 25 ptas/100% | 80 D | 148 A | 163 A | 179 A | 0 D | 0 D |
| Dens. 40 ptas/25% | 20 D | 153 A | 140 B | 165 A | 0 D | 0 D |
| Dens. 40 ptas/50% | 15 D | 153 A | 120 B | 155 B | 0 D | 0 D |
| Dens. 40 ptas/75% | 0 D | 153 A | 120 B | 145 B | 0 D | 0 D |
| Dens. 40 ptas/100% | 0 D | 153 A | 75 C | 142 B | 0 D | 0 D |
| Dens. 50 ptas/25% | 0 D | 140 B | 60 C | 142 B | 0 D | 0 D |
| Dens. 50 ptas/50% | 0 D | 93 B | 30 D | 60 C | 0 D | 0 D |
| Dens. 50 ptas/75% | 0 D | 65 C | 30 D | 70 C | 0 D | 0 D |
| Dens. 50 ptas/100% | 0 D | 48 C | 30 D | 50 D | 0 D | 0 D |
| F | 42,43 | 105,8 | 129 | 1,17 | 5,58 | 109,4 |
| CV (%) | 17 | 11 | 24,4 | 12,19 | 6,6 | 22 |

Legend *Dens= density; ptas=plants; esp=spacing.
Means followed by the same capital letter in each column belong to the same group, according to the grouping criterion Scott-Knott, 5% probability.

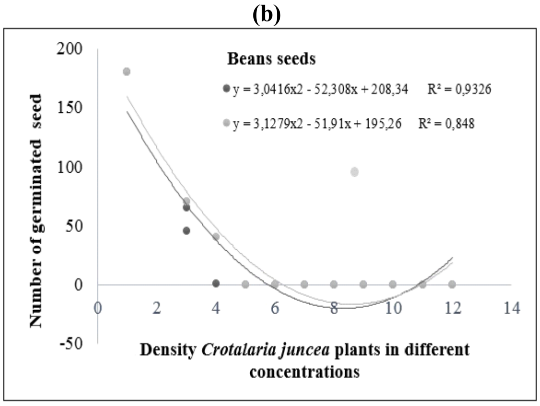
This was probably due to the increase of the respective allelopathic compounds produced by it, in a stressed condition, brought about by the intra-specific competition.




(a)




(b)




(c)

**Figure 1.** ***Crotalaria juncea*** **extract effect on germination of corn, rice and beans, grown in spacings, and 0.25 and 0.50 m densities of 25, 40 and 50 plants/m. Cáceres/MT**

This trend was also observed in bean seeds, as the curve quickly tends to approach zero. Adler and Chase (2007), observed the potential use of the sunn hemp cover, and some other legumes in the suppression of different species, emphasizing their allopathic effects. Observing the effects of the sunn hemp extract in the root and shoot growth characteristics thus, the lower density of sunn hemp (25 plants linear $m^{-1}$) thus, it can be inferred that interference in corn plants occurs when the extract is concentrated (above 75%), while lower concentrations do not vary from the control, indicating that low $mt.^{-1}$ plant density compared to high density, behaves with lower stress and therefore producing fewer allelopathic compounds will promote interference in the plant (Holether *et al.* 2008; Santos *et al.* 2010; Rani *et al.* 2011). However, for densities above 40 plants $mt.^{-1}$, even the lowest concentrations negatively influence the characteristics evaluated. The increase in planting density reductions promoted growth independent shoots if there was an increase in the extract concentration (Figure 2). Looking at the data on corn root, rice and bean growth submitted to sunn hemp extract it can be confirmed that the sunn hemp interferes significantly in the development of the roots in the studied plants (Table 2) and only in the lowest diluted density in the sunn hemp crop, there was no difference from the control, the others caused reduction, the greater the concentration and the plant density were, the greater were the restraining growth effects causing the germination rates to be zero.

**Table 2. Means of corn root length, rice and beans 7 days after sowing (DAS), submitted to the *Crotalaria juncea* extract in different concentrations (25%, 50%, 75% and 100%), cultivated in two spacings (0.25 and 0.50 plants/m) and three densities (25, 40 and 50 plants/$m^2$)**

| Trat | Corn root | | Rice root | | Bean root | |
|---|---|---|---|---|---|---|
| | Esp.0,25m | Esp.0,50m | Esp.0,25m | Esp.0,50m | Esp.0,25m | Esp.0,50m |
| Control | 60 A | 60 A | 65 A | 65 A | 5,5 A | 5,5 A |
| Dens. 25 ptas/25% | 58 A | 58 A | 60 A | 60 A | 2,5 A | 3,5 A |
| Dens. 25 ptas/50% | 50 B | 53 B | 50 A | 50 B | 2,0 A | 2,7 B |
| Dens. 25 ptas/75% | 47 B | 50 B | 37 C | 38 C | 0 C | 2,3 B |
| Dens. 25 ptas/100% | 45 B | 50 B | 37 C | 38 C | 0 C | 0 C |
| Dens. 40 ptas/25% | 40 B | 45 C | 37 C | 38 C | 0 C | 0 C |
| Dens. 40 ptas/50% | 30 C | 43 C | 32 C | 33 C | 0 C | 0 C |
| Dens. 40 ptas/75% | 23 D | 45 C | 30 C | 30 C | 0 C | 0 C |
| Dens. 40 ptas/100% | 20 D | 43 C | 30 C | 30 C | 0 C | 0 C |
| Dens. 50 ptas/25% | 0 E | 40 C | 27 C | 28 C | 0 C | 0 C |
| Dens. 50 ptas/50% | 0 E | 38 D | 27 C | 25 D | 0 C | 0 C |
| Dens. 50 ptas/75% | 0 E | 33 E | 25 C | 20 D | 0 C | 0 C |
| Dens. 50 ptas/100% | 0 E | 28 E | 25 C | 20 D | 0 C | 0 C |
| F | | 9,73 | 129,00 | 21,46 | 65,00 | 12,00 |
| CV (%) | | 9,00 | 24,40 | 13,74 | 30,00 | 29,00 |

Legend *Dens= density; ptas=plants; esp=spacing
Means followed by the same capital letter in each column belong to the same group, according to the grouping criterion Scott-Knott, 5% probability.

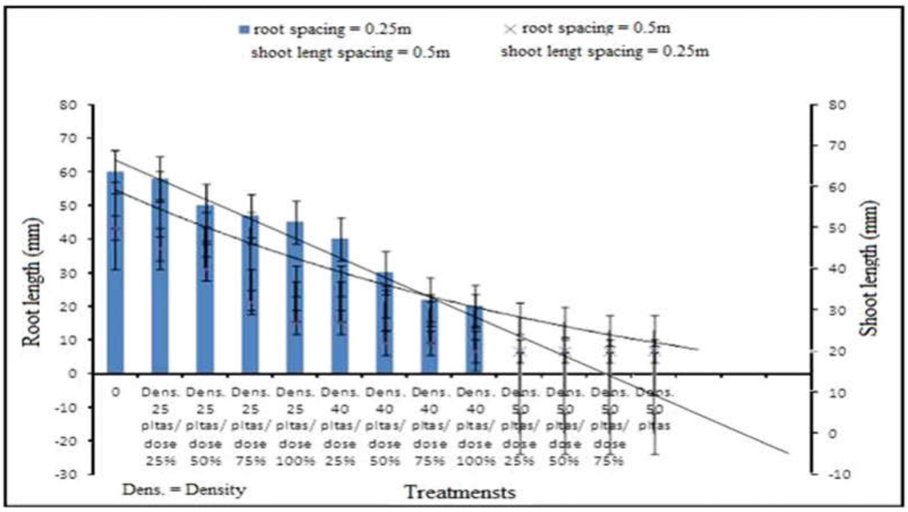



**Figure 2.** ***Crotalaria juncea*** **extract effect on the length of root and shoot of the corn grown in the spacing of and 0.25 and 0.50 m density of 25, 40 and 50 plants/m at concentrations (25%, 50%, 75% and 100%). Cáceres/MT**

**Data from evaluations conducted in Paraguaçu Paulista/SP**

For the experiment conducted in Sao Paulo State, the data were evaluated in field conditions and the laboratory phase. The data from sunn hemp final density and weed weight in the fields were adjusted by regression and is shown in Figure 3.

It is possible to see that the regression adjustments are contrary as based on spacing intervals. When the plant density is increased from 40 to 50 plants/m in 0.25 m spacing intervals between plants, the amount of weed species undergoes reduction, which is an expected result in most soil coverage due to the increased number of sunn hemp plants. However, when the density increases, from 40 to 50 plants $m^{-1}$, the number of weeds also increases.

This behavior must be based on specific increased intra-competition, which delays the initial growth of sunn hemp and consequently causes weed germination. The trend has been observed when there is an increase from 25 to 40 plants/linear meter density in 0.50 m spacing intervals between plants, the number of weeds in the area increase in the area; however, above the above mentioned density, there is a trend for weed reduction. This process probably took place because of the increased spacing intervals, as in the case of 0.50 m between rows, there is a need for more plants for the closing between the rows, or more blockage of the crop, thus, there are fewer germinated weed species (Figure 3). The evaluation of the dry weed matter is based on the spacing and density. The higher the sunn hemp density is the lower weed weight is present in the spacing area between 0.25 m rows has been observed (Figure 4).

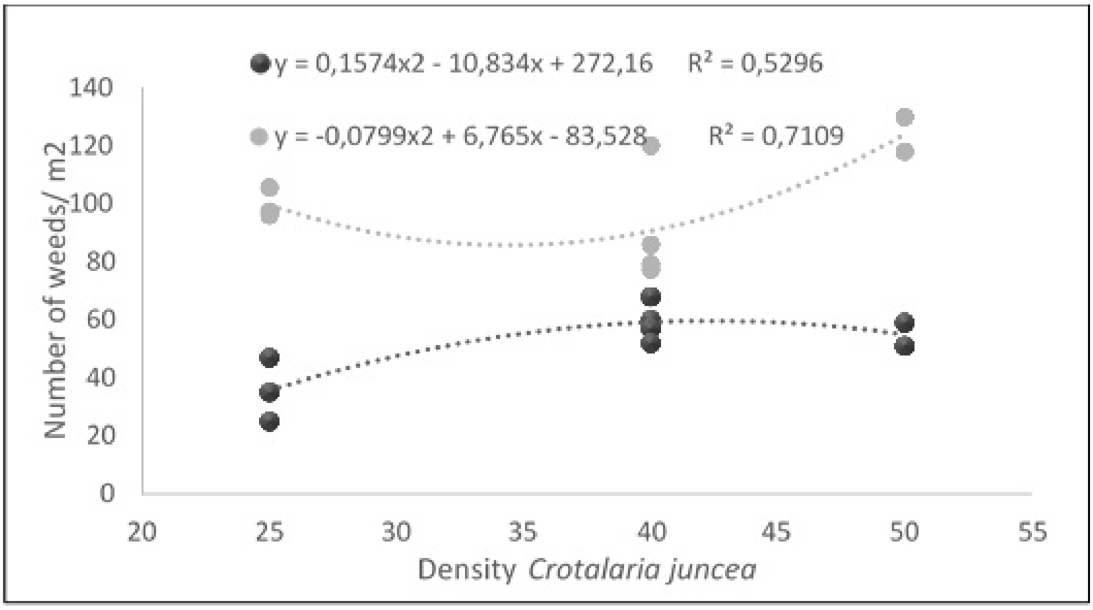



**Figure 3. Density of weeds (plants/m²numbers) in pre-harvest conditions for plants grown with *C. juncea* grown in row widths of 0.25 m 0, 50 m in thickness 25, 40 and 50 plants/m. paraguaçu paulista/sp**

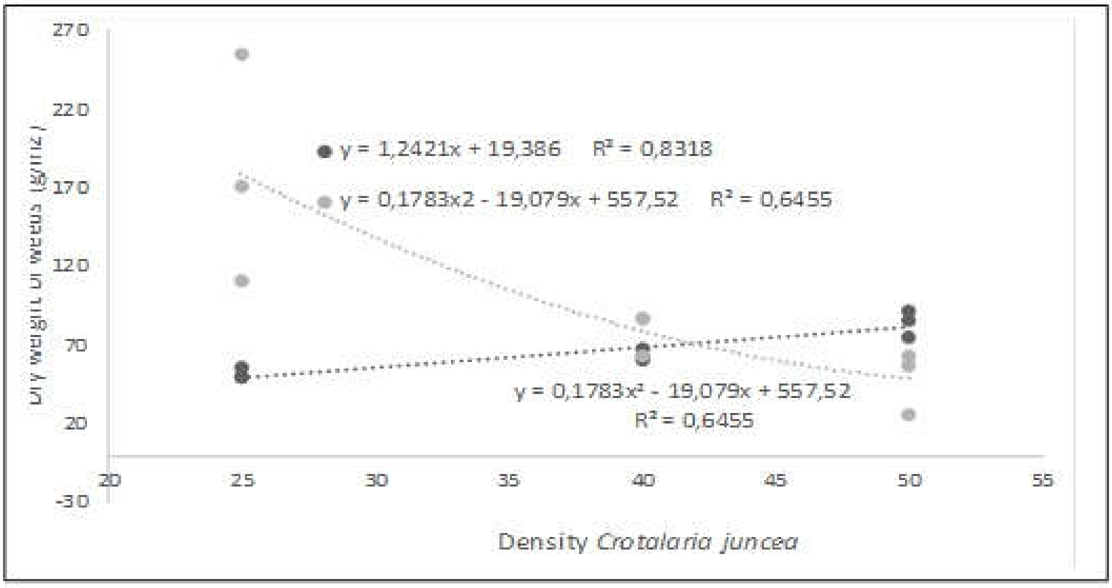



**Figure 4. Weight (g/m²) end of weeds in pre-harvest conditions for plants grown with *C. juncea* grown in row widths of 0.25 m 0.50 m in thickness 25, 40 and 50 plants/m. Paraguaçu Paulista/SP**

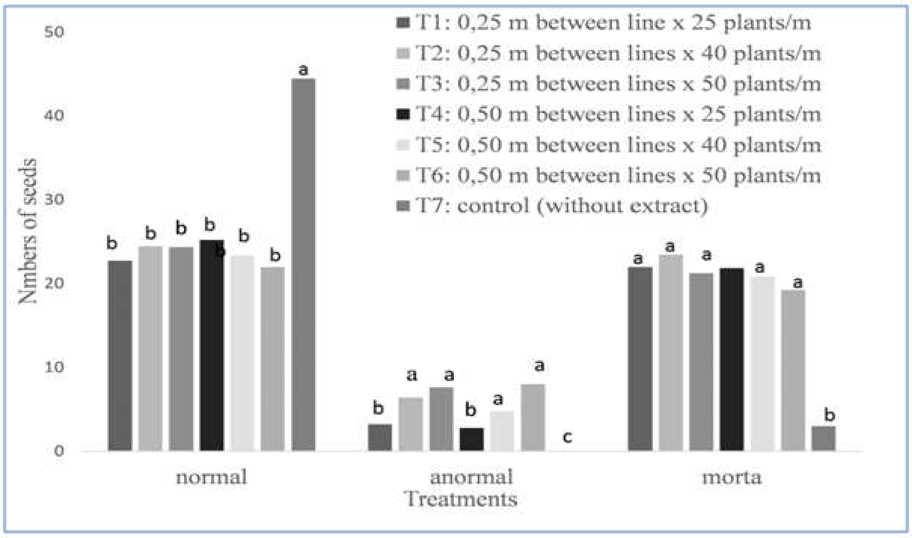



**Figure 5. Strength of corn seed submitted to sunn hemp extracts grown under different spacing and density. The treatments were: T1: 0.25 m between rows x 25 plants/m; T2: 0.25 m between rows x 40 plants/m; T3: 0.25 m between rows x 50 plants/m; T4: 0.50 m between rows x 25 plants/m; T5: 0.50 m between rows x 40 plants/m; T6: 0.50 m between rows x 50 plants/m; T7: Witness. Paraguaçu Paulista/SP**

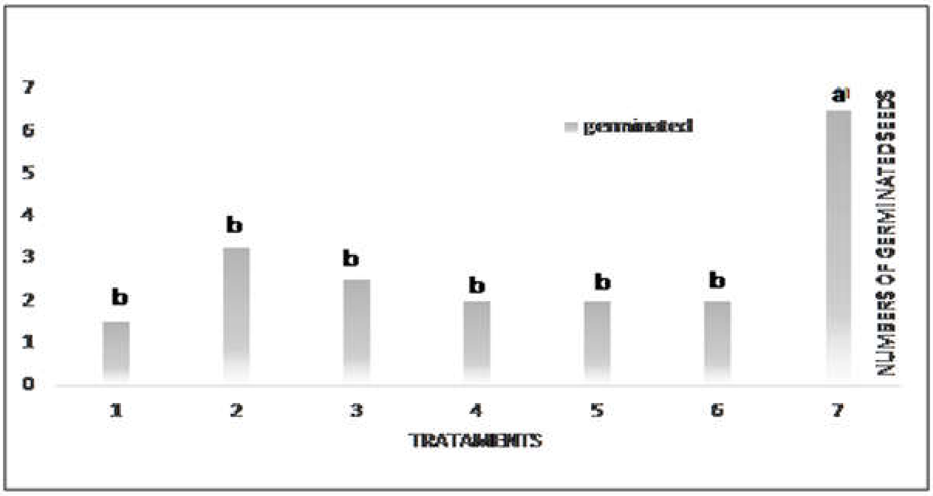



**Figure 6. Germination of bitter grass submitted to sunn hemp extracts grown under different spacing and density. The treatments were: T1: 0.25 m between rows x 25 plants/m; T2: 0.25 m between rows x 40 plants/m; T3: 0.25 m between rows x 50 plants/m; T4: 0.50 m between rows x 25 plants/m; T5: 0.50 m between rows x 40 plants/m; T6: 0.50 m between rows x 50 plants/m; T7: Witness. Paraguaçu Paulista/SP**

This lower weed weight is related to better control of sunn hemp in the weed species and it may correspond to higher concentrations of certain allelopathic compounds produced by sunn hemp when subjected to a stressful condition (higher density). The greater availability of allelopathic compounds in the environment might promote greater interference on the germination and early growth of weeds, promoting their respective death or even reducing their capacity for growth (Theadwell and Alligool, 2008). According to Paulino (1992) the increase in the concentration of secondary plant metabolites as a type of survival mechanism, which is one of the factors for establishing the plant in a stressed condition. When the spacing intervals increased from 0.25 m to 0.50 m in different densities of sunn hemp, it revealed that an increase in higher density spacing intervals can make it possible for more dry matter accumulation by the weeds. This result is related to the greater number of weed germination, and due to the availability of more physical space for development, and the dilution of the released allelopathic compounds. The 0.50 m spacing intervals between rows allows for doubled plant growing area in 0.25 m. This allows for greater light infiltration and dilution of released allelopathic compounds, which is only effective in higher concentrations. Although, there is another usage condition reported in several scientific papers, especially green fertilizer, sunn hemp is considered as an alternative plant by many farmers grown for mulching purposes, especially for establishing the direct sowing system. Since, it also maintains a symbiotic relationship with organisms capable of fixing atmospheric nitrogen. It also provides a composition related to the relatively interesting C/N ratio, as this makes it possible to understand the Kiehl's approach (1985), and it has allelopathic principles in its chemical composition (alkali: pirrolizydina recognized as the primary) suppressing a number of weed species.

The data collected on the weed population in the area revealed the presence of the following species: blue morning glory (*Ipomoea acuminata*), burr grass (*Cenchrus echinatus*), burr ram (*Acanthospermum hispidum*), breaking stone (*Phyllanthus niruri*), mallow (*Malva sylvestris*), spiderwort (*Fuscata siderasis*) and standing grass chicken (*Eleusine indica*), are present in different densities in each plot, however, there were not any predominant species and there was an average density of 150 plants/$m^2$. The evaluation of sunn hemp plant height showed no significant differences in the treatments. Analyzing the effects of the extracts on the corn seed germination, and regarding the characteristics and dead and germinated seeds, there were significant comparative differences observed in the control and treated seeds. The number of abnormal seeds (indicating low strength) was significantly affected by the increased sunn hemp density (Figure 4).

Carreras *et al*. (2001) was working on different concentrations of sunn hemp and noted that the unn hemp grown in low density (25 plants linear $mt^{-1}$), the root length almost did not differ from the control group, due to the fact that the metabolite concentration produced by sunn hemp was not sufficient to cause interference, proving that the low density $mt.^{-1}$ plants compared to the linear high density plants behave are less stressed and therefore produce fewer allelopathic compounds (Skiner *et al*. 2012), then when the increased root growth density was reduced by approximately 40%. This information adheres with Skiner *et al*. (2012) who also noted the suppressive effect of sunn hemp on various species of vegetables and weeds.

In Figure 5, the effect of the sunn hemp extract was observed in the number of germinated bitter seeds. It is possible to infer that sunn hemp due to this inhibitory effect on germination of weed species at any density they may be subjected to (the significance level was 1%). This probably occurred due to an increase in density (stress condition) that promotes (Paulino, 1992) an increase in the concentration of secondary plant metabolites as sort of a survival mechanism. These results adhere to Teixeira *et al*. (2004) who found that inhibition of germination beggar tick by the aqueous extract from sunn hemp.

**Conclusions**

For the experimental conditions, it can be concluded that:

- The increased density and/or decrease in the crop spacing of *Crotalária juncea*, can promote increased production of secondary metabolites, which will provide a better allelopathic effect on weeds, making it possible to recommend crop rotation management for this species.
- The level of phytotoxicity or inhibition provoked by *Crotalária juncea* extract depends on the crop species or weeds, as well as the crop density and extract concentration. Knowledge on the species and adequate concentrations will make it possible to insert this species in the system without any interference in the main crop.
- The usage of crotalaria as a ground cover plant also provides an excellent tool for control weeds resistant to glyphosate, such as for example: *Digitaria insularis* causes serious losses for Brazilian agribusinesses, by increasing production costs and reducing crop productivity.

## REFERENCES

Adler, M.J., Chase, C.A. 2007. Comparison of the allelopathic potential of leguminous summer cover crops: Cowpea, sunn hemp, and velvetbean. *Hort Science*, 42:289-293.

Brasil, Manual de Análise Sanitária de Sementes. 2009. 200p. Anexo do Capitulo 9 (teste de Sanidade de Sementes das Regras de Análise de Sementes). 3695p. In: Regras para análise de sementes. Ministério da Agricultura e Reforma Agrária, Brasília, BR.

Carreras, M.E., Pascualides, A.L., Planchuelo, A.M. 2001. Comportamiento germinativo de las semillas de *Crotalaria incana* L. (Leguminosae) en relación a la permeabilidad de la cubierta seminal. *Agri Scientia*, 18:45-50.

Cerdeira, A.L., Cantrell, C.L., Dayan, F.E., Byrd, J.D., Duk, E.S.O. 2012. Tabanone, a new phytotoxic constituent of cogongrass (*Imperata cylindrica*). *Weed Science*, 60:212–218.

Favero, C., Jucksch, I., Alvarenga, R.C., Costa, L.M. 2001. Modificações na população de plantas espontâneas na presença de adubos verdes. Pesquisa Agropecuária Brasileira 36:1355-1362.

Holethi, P., Lan, P., Chin, D.V., Noguchi, H.K. 2008. Allelopathic potential of cucumber on barnyardgrass (*Echinochloa crussgalli*). *Weed Bio*, 2:30-39.

Kiehl, E.J. 1985. Fertilizantes Orgânicos. Editora Agronômica Ceres Ltda. São Paulo, BR, 492 p.

Leather, G.R., Einhellig, F.A. 1986. Bioassays in the study of allelopathy. In: A.R. Putnam and C.S. Tang. The Science of Allelopathy. John Wiley and Sons, New York, USA, p 133-145.

Mateus, G.P., Crusciol, C.A.C., Negrisoli, E. 2004. Palhada do sorgo de guiné gigante no es elecimento de plantas daninhas em área de plantio direto. Pesquisa Agropecuária Brasileira 39 (6):539-542.

Meschede, D.K.., Ferreira, A.B., Ribeiro, J.R. CC. 2007. Avaliação de diferentes coberturas na supressão de plantas daninhas no cerrado. Plantas daninhas 25 (3):465-471.

Pascualides, A.L., Planchuelo, A.M. 2007. Seed morphology and imbibition pattern of *Crotalaria juncea* L. (Fabaceae). *Seed Science and Technology* 35:760-764.

Paulino, W.R. 1992. Ecologia atual. Atica Ed. Cap 7. pp.115-125.

Pires, N.M., Prates, H.T., Pereira, Filho, I.A., Oliveira Júnior R.S., de, Faria TCL de. 2001. Atividade alelopática da leucena sobre espécies de plantas daninhas. Scientia Agrícola 58 (1):61-65.

Rani, P.U., Sekharreddy, P., Nagaiah, K. 2011. Allelopathic effects of *Sterculia foetida* (L.) against four major weeds. *Allelopathy Journal*, 28:179-188.

Santos, I.L.V.L., Silva, P.G., Lima, Júnior, S.F., Souza, P.R.E., Tabosa, J.N., Maia, M.M.D. 2010. Utilização de RAPD na caracterização molecular de acessos de sorgo (*Sorghum bicolor* L. Moench) recomendados para o semi-árido de

Pernambuco. Revista Brasileira de Ciências Agrárias 5 (1):60-66.

Severino, F.J. and Christoffoleti, P.J., 2001. Banco de sementes de plantas daninhas em solo cultivado com adubos verdes. *Bragantia*, 60 (3):201- 204.

Silveira, H.R.O., Ferraz, E.O., Matos, C.C., Alvarenga, I.C.A., Guilherme, D.O., Tuffi Santos, L.D., Martins, E. R. 2010. Alelopatia e homeopatia no manejo da tiririca (Cyperus rotundus). *Planta daninha,* 28 (3):499-506.

Skinner, E.M., Diaz Perez, J.C., Phatak, S.C., Schomberg, H.H., Vencill, W. 2012. Allelopathic effects of sunnhemp (*Crotalaria juncea* L.) on germination of vegetables and weeds. HortScience 47:138-142.

Souza Filho, A.P., Alves, S.M. 2002. Alelopatia: princípios básicos e aspectos gerais. 260 p. Embrapa Amazônia Ocidental, Amazônia, BR.

Teixeira, C.M., Araujo, J.B.S., Carvalho, G.J. de. 2004. Potencial alelopático de plantas de cobertura no controle de picão-preto (*Bidens pilosa* L.). *Ciência Agrotecnologia*, 28 (3):691-695.

Treadwell, D., Alligood, M. 2008. Sunn hemp (*Crotalaria juncea* L.): A summer cover crop for Florida vegetable producers. Horticultural Sciences Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, USA.

*******