academicJournals

Vol. 8(49), pp. 6575-6578, 19 December, 2013
DOI: 10.5897/AJAR2013.7667
ISSN 1991-637X ©2013 Academic Journals
http://www.academicjournals.org/AJAR

African Journal of Agricultural Research

Full Length Research Paper

Allelopathic influence of the aqueous extract of *Jatropha curcas L.* leaves on wild *Cichorium intybus*

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Accepted 4 December, 2013

The communication presents an evaluation of the allelopathic effect of the aqueous extract of physic nut (*Jatropha curcas L.*) leaves on the early development of wild chicory (*Cichorium intybus*) seedlings. The experiment was performed in Palotina City, State of Paraná, Brazil. The physic nut leaves were harvested and then crushed in a blender using the proportion of 1 L of distilled water for each 200 g of leaves resulting in a crude extract of 100%. The experiments were conducted in 6 trials with 8 repetitions. The dilutions of 80, 40, 20, 10, 5 and 0% (only distilled water) were made using the crude extract. Data was subjected to statistical analysis (regression at 1% of probability). Aqueous extract of physic nut leaves showed an inhibitory allelopathic effect on the development of wild chicory (sugarloaf variety) which increased with enhanced concentration, presenting negative linear tendency, except for the variable fresh weight of shoots.

Key words: *Jatropha curcas* L., *Cichorium intybus,* allelopathy.

INTRODUCTION

The allelopathic effects can be observed on plants/microorganism however, it becomes more evident in vegetables. The allelopathic effect is a natural interference in which the plant produces substances and metabolites that may benefit or harm other plants/organisms when released (Corsato et al., 2010; Gliessman, 2000).

During the intense process of development of agriculture, synthetic herbicides have played a very important role in the control of weeds, however, due to the emergence of weeds that are resistant to herbicides, and due to its impact on the environment, it increases the pressure and study to reduce or eliminate these materials/products of the food production process (Duke et al., 2002).

In agriculture, the allelopathic effects may interfere in the productivity of cultivars, and they can also be used to control undesirable plants, reducing the production costs, resulting into less use of agrochemicals and safeguarding against the adverse impact it may cause environmentally (Silva et al., 2012).

The tolerance to metabolites is a characteristic of specific species, where some are more sensitive like *Lactuca sativa* L. (lettuce) and *Cucumis sativus* L. (cucumber). These plants are considered indicators of allelopathic activity due to their characteristics such as uniform and quick germination, and sensitivity to submit significant results by applying small concentrations of allelopathic substances (Ferreira and Áquila, 2000).

Physic nut (*Jatropha curcas* L.) belongs to the Euphorbiaceae, the family of cassava and castor beans, being a multiuse tree that is used as a living fence and in

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the production of soap, it also contains certain medicinal properties in the treatment of arthritis, gout and toothache. In addition, its oil is destined to biodiesel production (Openshaw, 2000; Van Valkenburg and Bunyapraphatsara, 2002). As pointed out by Beltrão et al. (2005), physic nut is a perennial and monoecious species, having high oil content in its seeds and low production cost, besides being resistant to water stress, so it is indicated to be used in the semiarid northeast. The oil content in seeds varies between 30 and 37% (He et al., 2009).

The cultivation of *Jatropha curcas* L. does not interfere in food security and it is considered as viable option in the field intercropped with other crops. This plant is used in Latin America and West Africa as medicinal herb, besides its extract is widely used as insecticide, because of its proven toxicity to some insects, with other control methods as consequence of its easy retrieval and application. Its cultivation appears as an additional option among the areas of renewable energy not only for their oil content, but also for their by-products: like glycerin and pie, be used as biofertilizers or in biogas production (Sousa et al., 2009; Servin et al., 2006; Fernandes, 2012; Achten et al., 2008).

Using the root extract of *Jatropha*, positive and negative allelopathic interferences can be obtained in several cultures, depending on the vegetal species being treated therewith. Usually, when these substances interfere negatively on other plants, this inhibition occurs at the stage of seedlings, being corn and turnip good examples of affected plants (Abugre and Sam, 2010; Silva et al., 2012).

The utilization of extract obtained from the leaf of *J. curcas* can cause different interference from what was observed with the extract of roots. According to the same author, in order to observe the allelopathic effect from the roots, it is required a significantly concentration of the extract, while in the case of the leaves, small concentrations are required. Lemos et al. (2009) confirm that a small concentration of leaf extract can cause negative allelopathic effects on vegetables such as lettuce, from the stage of germination (rate and speed), until reducing the roots of seedlings, directly interfering on their development. Applications of high concentrations of leaf extract of *Jatropha* in soil cause reduction in root length of *Tagetes erecta* L., however, low concentrations of extract are shown as stimulating for the plant (He et al., 2009).

C. intybus is a species of plant with diploid characteristics of the Asteraceae family, which has hundreds of species that are used as horticultural products for salads. Different varieties of this species have been cultivated especially in northwestern Europe, India, South Africa and Chile. Due to its high content of inulin and fructans, it is widely employed in the production of functional foods, providing health benefits (Bremer, 1994; Kaur and Gupta, 2002; Pool-Zobel, 2005). The presence of weeds in crops and vegetable gardens is one of the main problems faced by organic producers, greatly increasing the production costs (Ferreira et al., 2007).

Due to the importance of cultivation and easy perception of the allelopathic effect in vegetables, the aim of this study was to evaluate the positive or negative allelopathy of the application of different concentrations of aqueous extract of leaves of *Jatropha curcas* L. on the early development of seedlings of the chicory species (*Cichorium intybus*) of the sugarloaf variety.

MATERIALS AND METHODS

The experiment was performed in Palotina city, State of Paraná, Brazil. The region is geographically located at 24°29'4" south latitude, 53°84'2" west longitude (Greenwich), with humid subtropical climate. The experiments were conducted from February of 2013 to April of 2013. The extract of physic nut leaves was prepared with green and healthy leaves just harvested and then milled with a blender. Then, cleavage of the material was performed through a sieve of 1 mm, after that, the parts were soaked in water yielding a final concentration of 200 g L-1.

This extract was diluted in distilled water to lower concentrations of 80, 40, 20, 10, 5 and 0% (and only distilled water served as control group). The design was completely randomized where each treatment was applied with 3 repetitions using 16 plants of wide chicory (*C. intybus*) of sugarloaf variety. The seeds were sown at a depth of 0.2-0.4 mm in specific trays for the vegetable seedling production. The sprinkling was performed 4 times per day, with a manual sprinkler and a volume of 5 mL for each cell during the period of 30 days till the harvest. It was conducted in a manner that it was exposed to sunlight mainly in the morning, and not exposed to rain, nor to any other environmental conditions.

Data pertaining to different parameters of the plant like its length, number of leaves, fresh and dry weight of aerial portion was recorded. The statistical analysis (ANOVA) was performed by a statistical software known as ASSISTAT 7.5 and the comparison among the averages of the treatment was performed with the application of the Tukey test at 5% of probability and the regression at 1% of probability.

RESULTS AND DISCUSSION

Table 1 shows that the aqueous extract of *J. curcas* has not just influenced linearly the fresh matter of air portion ($p<0.05$) but also the air portion, the number of leaves the root system and the dry mass have decreased linearly with the increase in concentrations (Lemos et al., 2009; Sanderson et al., 2013).

Increasing concentration of the aqueous extract has led to a reduction of the air portion in plant, according to the adjusted linear regression equation ($Y = -0.0329x + 4.436$ $r^2 = 0.65$). Sanderson et al. (2013) observed that when the concentrations of the aqueous extract of *J. curcas* has gone from 0 to 20% there was no allelopathic effect on the air portion of the plant, however, it can be seen a declining propensity. Reichel et al. (2013) observed that the application of aqueous extract of unsterilized

Table 1. Effect of the aqueous extract of physic nut (*Jatropha curcas* L.) on evaluated variables of wild chicory (*Chicorium intybus* L.).

Treat. (%)	Air portion (cm)	Root lenght (cm)	Leaves	Fresh weight/ aerial portion (g)	Dry weight/ aerial portion (g)
0	3.9125[bc]	5.8000[ab]	5.2500[a]	0.1325[bc]	0.0183[a]
5	5.1045[a]	5.9125[a]	4.6250[abc]	0.0815[cd]	0.0128[abc]
10	4.8456[ab]	4.7825[b]	5.0000[ab]	0.1841[ab]	0.0139[ab]
20	2.6334[d]	3.0125[cd]	4.0000[cd]	0.0540[d]	0.0103[bc]
40	3.3918[c]	3.4500[c]	4.2500[bcd]	0.1991[a]	0.0073[bc]
80	1.8424[e]	2.1443[d]	3.3750[d]	0.0502[d]	0.0054[c]
L.R.	146.395**(1)	155.963**(2)	37.898**(3)	3.3370[n.s.]	32.2495**(4)
Q.R.	30.6733**	0.1173[n.s.]	0.7313[n.s.]	5.9480[n.s.]	0.0099[n.s.]
CV (%)	13.66	16.5	14.3	31.45	44.55
O. Average	3.58	4.14	4.42	0.12	0.0113

Averages followed by the same letter do not differ significantly between each other by the Tukey test, at 5% of probability. (**) = significant at 1% probability; (*) = significant at 5% probability; ([n.s.]) = not significant. VC (%) = Variation coefficient. L.R. Linear regression. Q.R. Quadratic regression. (1) $y = -0.0329x + 4.436$ $r^2 = 0.65$; (2) $y= -0.0446x + 5.3326$ $r^2 = 0.74$; (3) $y = -0.0202x + 4.94$ $r^2 = 0.78$; (4) $y= -0.0001 + 0.017$ $r^2 = 0.93$.

J. curcas has given a reduction of 73.3% in the length of the air portion of the wheat seedlings.

The aqueous extract of physic nut has shown a strong inhibitory effect on the root development of wild chicory seedlings (Table 1). A linear declining effect with the increase of the extract concentration is in agreement with Lemos et al. (2009), who worked with concentration going from 0 to 100% of aqueous extract of physic nut, and observed a negative effect, besides morphological changes on root with thickening and lack of absorption zone. Sanderson et al. (2013) did not find in their studies an inhibitory effect of the aqueous extract of physic nut on the root system of lettuce, but they used lower concentrations (0, 1, 5, 10 and 15%). Reichel et al. (2013) found the aqueous extract of *J. curcas* of 20, 25, 30 and 35% to stimulate the root growth in the wheat plantation CD104. Abugre and Sam (2010) found an inhibition of the growth of the *Zea mays* seedlings at high concentrations of *J. curcas* root extract. Bonamigo et al. (2009) have reported an allelopathic effect of the aqueous extract of the root in the early development of soy and canola.

Abugre and Sam (2010) have noticed a huge amount of phenolic compounds in the leaf extract of physic nut which are mainly responsible for the the allelopathic effect and their high concentrations can inhibit the growth of seedlings in beans (*Phaseolus vulgaris L*.), corn (*Z. mays L*.), tomato (*Solanum lycopersicum L*.) and okra crops.

The allopathic effect is also evident in the number of leaves per plant suffering negative interference due to the increased concentrations of aqueous extract. The fresh mass of the plantation was not adjusted by the tested model, showing no inhibitory effect for this variable. Several studies indicate that *J. curcas* root and stalk extract also showed allelopathic effects on some of the cultivated species (Abugre et al., 2011; Rejila and Vijayakumar, 2011).

Reichel et al. (2013) observed in a study with the extract of physic nut leaves (*J. curcas*) on early wheat development (*Triticum aestivum L*.), using concentrations of (5, 10, 15, 20, 25, 30 and 35%), a possible allelopathic action, however, the authors emphasize that alcoholic extracts of the physic nut leaves affect more the wheat seedling growth than the crude aqueous extract.

Conclusion

It was possible to conclude that the aqueous extract of physic nut showed an inhibitory allelopathic effect on the development of wild chicory sugarloaf variety, in all the analyzed variables, presenting negative linear tendency, except for the variable fresh weight of shoots.

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