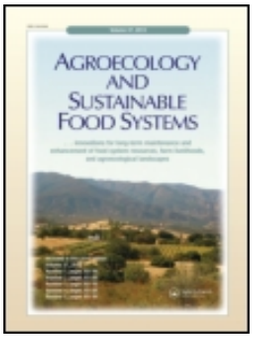

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No-residual baits and farmer perception to manage leaf-cutting ants

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ABSTRACT
The objective of this work was to study the perception of farmers facing the occurrence of leaf-cutting ants of *Acromyrmex* and *Atta* and to evaluate the efficacy of neem oil and sesame seed baits in reducing forage activity of ants under farmer conditions. The interviewed farmers were highly receptive to use environment-friendly techniques in both situations, organic and conventional systems. The neem baits reduced 75.5 and 83.5% of ant foraging, respectively, of *Atta* sp. e *Acromyrmex* spp. after 9 daily applications. Sesame bait reduced 55.9 and 67.6% foraging of *Atta* sp. and *Acromyrmex* spp., respectively.

KEYWORDS
Ant cutter; *Azadirachta indica*; neem; *Sesamum indicum*; sesame

Introduction

Family farming is a predominant practice in Latin America and a valuable cultural heritage that provides families with a source of information for the management of crops and livestock (Schneider 2010). The constant interaction between farmers and natural ecosystems, particularly during reconstruction and management of agroecosystems, enables such farmers to reflect upon natural processes and biological services. Moreover, it is a source of information that is stored in their personal repertoire of knowledge. This referential knowledge is biocultural, as it arises from the interaction between cultural values of a community that interacts with the local biodiversity. The biocultural heritage becomes referential knowledge available for farmers to overcome the daily challenges of agricultural activities, and it can be systematized into ethnoknowledge (Carli et al. 2013). However, the intense industrialization of agriculture in the latter half of the twentieth century imposed deep changes in agricultural systems, because the major inputs turned out to be produced outside farms instead of being built on ecological capital and, hence, farming has become dependent on industrial and financial capital (Van Der Ploeg 2010). Such marketing pressure weakened

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the farmer-×-nature relationships and made farmers dependent on knowledge produced by the academia or embedded in inputs purchased in the market (Moreira 2002). Market wise, society considers that food safety and environmental responsibility generated by scientists, professors, and professionals are the only ones with valid scientific knowledge. Gradually, farmers exclude themselves completely from the referential knowledge that was their natural domain and begin to accept the idea that hand labor is the only valid value they can exchange with industrial society. The latter embeds knowledge into inputs, machinery and biodiversity produced without the contribution of farmers (Moreira 2002).

Despite the profound changes left by the model of the Green Revolution in the Brazilian and international agricultural scenario, there are farming families in southern Brazil that are not completely conventionalized. They use native seeds, mixed animal breeds, and a small amount of industrial inputs (Schneider 2010). It is likely that many of the farming families, while managing crops and animal rearing, merge the cultural reference inherited from their ancestors with knowledge directly or indirectly provided by research centers, universities, and technical assistants. Such influence, according to Boff (2008), makes farmers use analogies and adopt phytosanitary measures similar to those they use to treat their families or domestic animals reared on their farms. This would be the reason why, nowadays, many conventional farmers, when switching to organic food production systems, continue to buy inputs produced outside their farms. In other words, they raise animals and grow crops in a similar way as they treat their family, that is, they seek chemical pharmacies as a source of healing. The redesign of production systems as a whole, at a stage following the replacement of synthetic inputs with organic ones, requires an educational process that could be favored by the recovery of traditional knowledge; therapeutic practices are considered as an immediate resource for overcoming phytosanitary problems while treating plants and animals or their own family (Rupp et al. 2006).

The case discussed in this article is the management of leaf-cutting ants of the genera *Atta* and *Acromyrmex* (Hölldobler and Wilson 1990) in Brazil's Southern Plateau. This region has subtropical climate, and the *Araucaria* forest and natural altitude fields and savanas are the two ecosystems associated with the Atlantic Forest biome. These ecosystems have a wide variety of plant species, which allows leaf-cutting ants to maintain their biological activity during the entire year (Giesel, Boff, and Boff 2013). Although leaf-cutting ants have always posed a threat to crops, farmers have been dealing with this challenge for a long time before the advent of synthetic insecticides in Brazil, which took place in 1960–1970s (Della Lucia, Folwer, and Araújo 1993). The slogan widely used in the 1970s—"Either Brazil cuts out the leaf-cutting ants or the leaf-cutting ants will cut up Brazil"—subliminally led to

the systematic chemical control of leaf-cutting ants from north to south of Brazil in an obsessive chase of leaf-cutting ants species (Fowler et al. 1989). Therefore, the metaphor that leaf-cutting ants are "destroyers of Brazil" has created a concept of irreconcilable coexistence of men and ants and the disharmonic association of the latter with any plant species. In this same period, the intensification of agricultural production took place in Brazil and other Latin American countries with the use of agrochemicals. This modern, intensive agriculture reduces agricultural biodiversity and can accelerate the ecological imbalance that causes frequent outbreaks of pests and diseases in agriculture (Frison, Cherfas, and Hodgkin 2011). Ever since, the control of leaf-cutting ants in the tropics and subtropics has been done almost exclusively through the application of toxic baits derived from conventional insecticides, including permethrin and bifenthrin(pyrethroid), sulfluramid (fluoroaliphatic sulfonamide), fipronil (phenylpyrazole), fenitrothion, and chlorpyrifos (organophosphate) (MAPA 2014). Although the synthetic pesticides were considered to be effective at first, their application has resulted in disastrous residual impacts on the environment because they are not selective; thus, they eliminate many beneficial organisms, substantially altering food chains (Boff 2008).

Monoculture and reduced diversity practices in areas surrounding crops make crops even more vulnerable, because they restrict leaf-cutting ant foraging options, thus, putting pressure on crops (Giesel, Boff, and Boff 2013). As a result, there has been a reduction of predators and antagonists, increasing the selection pressure of leaf-cutting ants and the damage they cause to cultivated plants (Peres Filho and Dorval 2003).

Family farmers feel constantly frustrated by applying synthetic insecticides, which are nonselective and cannot control ants for very long. Therefore, they have begun resuming the use of homemade management methods used by their ancestors, including the use of natural substances. Khater (2012) reported that the use of tropical plants with insecticidal or insect-repellent properties are excellent opportunities for integrated pest management. Peres Filho and Dorval (2003) reported that the use of sesame seed baits reduced the foraging activity of *Atta sedenx rubropilosa* ants, although the best effect was observed over the long term.

In the tropical region of Brazil, the cultivation of sesame, *Sesamum indicum* L., has been adapted for grain production aimed at human consumption purposes. It has been observed that sesame plants are attractive to ants while also being toxic. Hebling-Beraldo et al. (1991) reported that sesame leaves exerted deleterious effects on ants and increased the respiratory rate in nests of *Atta sexdens rubropilosa* so much that they became exhausted. Fatty acids obtained from leaves of *S. indicum* also inhibited the development of symbiotic fungi cultivated by the leaf-cutting ant *Atta sexdens* L., (Ribeiro et al. 1998). However, cultivation of sesame is restricted in southern Brazil

because of the subtropical climate with intense cold in winters. Accordingly, the use of sesame seeds as baits may be a real possibility for the management of leaf-cutting ants.

Neem, *Azadirachta indica* L., is another tropical species widely used in the management of insect pests. It contains the active ingredient azadirachtin, reported to act on several orders of insects, including Coleoptera, Diptera, and Hymenoptera (Peres Filho and Dorval 2003). Fernandes et al. (2007) reported that neem and its compounds can have multiple effects, including repellence, reduced fertility and fecundity, changes in behavior and death in several pests. The same authors observed that ants of *A. rugosus* carried significantly more neem baits than citrus pulp baits with subsequent negative effects. Brugger et al. (2008) found that baits containing neem seeds were attractive to worker ants of *Acromyrmex rugosus* and the average number of dead ants was significantly higher when the ants came into contact with paste made with hexane extract of neem. Workers of leaf-cutting ant *Atta sexdens rubropilosa* showed some changes in behavior when they contacted diets containing neem seed oil and showed symptoms of intoxication, such as slow movements, disorientation, and prostration (Santos-Oliveira et al. 2006). Aqueous extract of neem leaves also showed deleterious effects on *Leucoagaricus gongylophorus* Singer, the symbiotic fungus of leaf-cutting ants (Dias Souza, Peres Filho, and Dorval 2011).

Farmers' receptiveness to the use of environmentally friendly methods in the management of leaf-cutting ants depends on the sociocultural context and the degree of industrialization of their production systems. Therefore, it is necessary to rescue the empirical knowledge of farmers so that other techniques can be added as a complement to existing management techniques. The proposed ecological transition of agriculture offers a conciliatory and challenging way for local knowledge to be recognized and enhanced by scientific knowledge.

This work aimed to study the perception and local knowledge of farmers on the management of leaf-cutting ants and to evaluate the effect of neem and sesame baits on the reduction of the forage activity of leaf-cutting ants of the genera *Atta* and *Acromyrmex* in the Southern Plateau of Santa Catarina State, Brazil.

Materials and methods

Experimental setup

The research was conducted between March 2006 and January 2008 in the micro region of Campos de Lages, Southern Brazil, situated between the geographical coordinates 27°43′ to 28°02′S and 50°14′ to 50°32′W. The work consisted in recording the knowledge associated with leaf-cutting ants and

evaluating the effectiveness of homemade baits prepared with neem oil and sesame seeds in experiments conducted on farms with the collaboration of farmers. In the places where the experiments with baits were carried out, there were nests of the species *Acromyrmex laticeps* Emery (1905), *Acromyrmex heyeri* Forel (1909), and *Atta sexdens piriventris* Santschi (1919). The nests were separated by genus, *Acromyrmex* and *Atta*, in different experiments. Each located nest was geo-referenced (Garmin Etrex GPS), and measured in two dimensions, the largest diameter against the lowest, with the aid of a topographic tape.

Farmers' perception of leaf-cutting ants

Data were collected through interviews with farmers previously referred by extension practitioners of Epagri (Agricultural Research and Rural Extension Company of the State of Santa Catarina). The respondents' consent was previously granted. Fifty farmers were interviewed in 18 municipalities. Farmers were sampled to cover different levels of organization and production systems. Their production system was considered to be organic when farmers managed their crops and livestock following the standards proposed by the Brazilian Organic Law (Brasil 2007). Farmers were considered to be conventional when they used pesticides for plant protection purposes on their farms. Farmers were also considered as organic when they used inputs not covered by the standards of organic certification, but were homemade and compatible with ecological management.

A semistructured questionnaire was applied. It was composed of simple open or multiple choice questions based on the arguments/comments of respondents. The questions were related to sociocultural characteristics of rural families, and information about farmers' knowledge and awareness of leaf-cutting ants. The questionnaire covered the following topics: a) how farmers perceive the presence of leaf-cutting ants and what problems they face with such ants, b) how they perform the control, c) how they report the occurrence of nests and identify them, d) which control methods they use and if they are aware of the importance of such methods, and e) when they make the decision to control leaf-cutting ants.

Evaluation of nonresidual baits

Neem and sesame seed baits were evaluated as treatments in leaf-cutting anthills located at eight different family farms. Each anthill was an experimental plot. The treatments were grouped into blocks, separated by time and place, with five replicates for leaf-cutting of the genus *Atta* (experiment 1) and six replicates for the genus *Acromyrmex* (experiment 2). On each farm, with the participation of the respective farmer, the anthills were

located and identified by worker ants' morphology, whereby *Acromyrmex* ants have four pairs of thoracic spines while ants of the genus *Atta* have three pairs of thoracic spines easily visible to the naked eye. The characterization of anthill shape was considered additional information provided to identify the genus and species when possible, with assistance from farmers themselves, who reported similar information with those described in the relevant literature. To summarize, *Atta* anthills have multiple pans with concave appearance of mounds of loose earth. *Acromyrmex* anthills are shaped as half cones and have plant debris around them. The treatments consisted of granulated baits containing: a) wheat flour and Neem oil, b) wheat flour and sesame seeds, c) placebo bait-wheat flour, and d) without intervention, as control. The baits were prepared in the Laboratory of Homeopathy and Plant Health of Epagri, Lages, Santa Catarina State.

Bait preparation

The neem bait (*Azadirachta indica*) was obtained from the mixture of whole wheat flour, grain size of 1 mm, neem oil (Global Nim, Itajaí, BR) and water, respectively, in the weight ratio of 2:2:1. The sesame bait (*Sesamum indicum*) was also prepared with whole wheat flour, grain size of 1 mm, ground black sesame seeds (1 mm), and water, respectively, in the weight ratio 2:2:1. The placebo bait was prepared by mixing whole wheat flour, grain size of 1 mm and water, respectively, in a weight ratio of 2.5:1. The ingredients were manually mixed in a china bowl to form a homogeneous and smooth batter, and then passed through a manual pasta maker with a sieve with 1.5 mm holes. The "spaghetti" was oven dried at a temperature of 55 ± 1 °C for 18 hours. After drying, the spaghetti of each treatment was sectioned into pieces of approximately 5 mm in length, packed in paper bags and stored at a temperature of 18–20°C and 50–60% RH.

Implementation and evaluation of baits

In each previously selected anthill, always with the participation of farmers, the baits were applied in the three trails that had the highest number of ants moving. The baits were applied into bamboo tubes in an amount of 50 g per demarcated trail, 1 m away from the nest. The application of the baits took place daily in the morning period from 0700 to 9:00 h, and lasted for a period of 10 days. Baits were always replaced, that is, the remains of baits applied the day before were collected when new baits were applied. The evaluations, also carried out with the cooperation of farmers, consisted of counting the number of ants on the move, with or without load, for 1 min, at a certain point of the trail located 1 m from the nest, near the point of bait release. The evaluations were performed every day, just before the bait replacement.

Twenty-nine days after the first application, the last evaluation was performed to assess the effect of prolonged treatments.

Data analysis

Data were tabulated and underwent analysis of variance with the aid of WinStat (Ver. 2007) software package. Interviews were organized by descriptive statistics. Farmers who did not meet 100% of the organic legislation (Brasil 2007), but whose techniques were in accordance with ecological principles and transitioning to organic systems were categorized as organic for the purpose of analysis of the information provided.

Results and discussion

Farmer's perception

The average area of the farms where the study was conducted was 30 ha (organic/transitional) and 50 ha (conventional), both meeting the family farming criteria of Brazil's Ministry of Agrarian Development (MAD). Most of them (98%) were traditional farmers, who learned the cultivation practices and animal husbandry ("field chores") from their family, that is, they are part of the group of farmers whose knowledge is transferred from generation to generation and carriers a certain cultural heritage of Santa Catarina's family farming practices (Moreira 2002). Farmers clearly recognize that there are two groups of ants, those from the genus *Atta* and those from the genus *Acromyrmex*, which can be told apart by forage behavior, adult size, and colony formation.

Most farmers interviewed (81%) who managed their properties as organic and transitional systems mentioned that *Acromyrmex* ants are the biggest problem in their crops, while farmers in the conventional system refer to both genera as a threat to crops. This can be explained by the production method adopted. The organic and transitional systems tend to be diversified, maintaining the characteristics of natural ecosystems in their cultivation (Shennan et al. 1991). The organic system may favor *Acromyrmex* ants (various species) by providing increased diversification of the species susceptible to foraging by ants compared to the conventional system; hence, *Acromyrmex* ants are more likely to be found than *Atta* ones. Plant diversity also allows greater wealth of material to build the external surface of the nests forming the mounds of earth that are typical of *Acromyrmex* ants. However, ants of the genus *Atta* require soils that are shaped and stabilized physically in order to establish their nests. Such soils usually have a high level of clay (Hernández and Jaffé 1995). Typically, soils prone to compaction are avoided or improved by farmers, especially those who grow crops under an

organic system, which hampers the presence of the genus *Atta*, according to the farmers interviewed. Under conventional systems, the occurrence of ants of both genera, *Atta* and *Acromyrmex*, may be due to the reduction of predators and restriction of plant diversity for foraging.

Farmers categorized as organic showed a high diversity of techniques used in plant cultivation and similarly for the management of leaf-cutting ants (data not shown). Interviewed farmers expressed a certain tolerance to the presence of leaf-cutting ants, although organic farmers had greater responsiveness to immediate control. This is possibly due to the fact that there are few ecological techniques available for direct intervention in organic production systems (Table 1). Therefore, it can be observed that excessive concern for occasional risk offered by leaf-cutting ants induces unnecessary interventions, even in organic crops. Leaf-cutting ants were referred to as a problem to be solved by 94% of respondents (Table 1). Only 3 farmers stated that they never control leaf-cutting ants while 10 use controls when they think that ants are already causing damage.

The presence of leaf-cutting ants is most feared by farmers growing crops under organic/transitional systems, probably because of their orientation as to the need of preserving the nests. This explains why immediate action to eliminate the nests is more important to organic farmers (65%) than conventional ones (53%). Both farmers, organic and conventional, ignore any ecological services of leaf-cutting ants for the ecosystem and their possible benefits in agriculture, recognizing them as pests only (Araújo et al. 2002). This result is attributed to the fact that most farmers identified as organic were still at a recent transition; thus, they still required conventional practices, or the ecological techniques available for ant management were not appropriate. In fact, over 50% of respondents using the organic/transition systems reported having knowledge of natural methods for control of leaf-cutting ants although they did not actually use them (Table 1). During the interviews, it was found that, due to shortage of supply of inputs for organic systems, some farmers chose to use conventional

Table 1. Farmers' perception of leaf-cutting ants and subsequent intervention, given in percentage and number of respondents, Santa Catarina State, BR, 2006–2007.

	Aware of natural control methods)		Action for elimination of ant nests (% and number of respondents)			
Production systems*	Yes	No	When they see ant nests	When they see the damage	When they feel bothered	Never
Organic/ transition	53% (17)	47% (15)	25% (8)	50% (16)	19% (6)	6% (2)
Conventional	6% (1)	94% (17)	11% (2)	61% (11)	22% (4)	6% (1)

*Organic production system are farmers using inputs classified as organic to perform phytosanitary controls; production in transition, farmers who did not use pesticides, but had some practices that were at odds with the Brazilian legislation for organic produce or ecological principles as a result of lack of awareness; conventional production by farmers using pesticides as well as other conventional cultivation techniques.

practices for ant management even though they disapproved of them. Farmers under conventional cultivation (80%) use synthetic toxic commercial products (toxic baits or spray formulations) to control leaf-cutting ants (data not shown). In this category of farmers using the conventional system, only 5% were familiar with natural methods, that is, they had no knowledge of environment-friendly techniques for the management of leaf-cutting ants. The study showed that some control practices adopted by farmers under organic and transitional system, such as pouring diesel or oil on or into the nests, are incompatible with agroecology.

All the interviewed farmers from both production systems were favorable to the implementation of natural or environment-friendly methods in response to the risk posed by synthetic insecticides to their family, their animals and the environment. Therefore, there is awareness that plant health interventions through the use of synthetic insecticides incur serious risks to the health of living beings and the environment. Such awareness was more evident in farmers under organic/transitional systems because the answers are more informed and they are willing to change management measures that are contrary to the principles of agroecology and the Organic Law (Brasil 2007). This receptiveness facilitates the educational process as regards ecology and the environment, the possibility of coexistence among crops and leaf-cutting ants, and ecological management for both systems, by means of a pedagogical process of participatory research and FAO's Farm Business School Method.

Effectiveness of neem and sesame baits

The species identified in the study anthills were *Atta sexdens piriventris* (experiment one) and *Acromyrmex laticeps* and *Acromyrmex heyeri* (experiment two). The anthills of *A. laticeps* showed 0.56 ± 0.18 m^2 surface area, while *A. heyeri* nests measured 0.55 ± 0.15 m2. There was no significant difference between the size of anthills of the two *Acromyrmex* species by the *t* test ($n = 24$; $p > 0.94$). Therefore, all anthills identified as *Acromyrmex* were considered in the same experiment design.

There was no significant interaction between the factors Treatment and Time of Application for the variables, total activity ($r = 0.92$) and foraging activity ($r = 0.97$). Total activity was highly correlated with forage activity for all treatments, with no intervention ($r = 0.95$, $p < 0.001$), neem bait ($r = 0.98$, $p < 0.001$), sesame bait ($r = 0.98$, $p < 0.001$) and placebo bait ($r = 0.76$, $p < 0.001$).

The neem and sesame baits decreased the total passing ants and the forage activities of both species, *A. sexdens piriventris, A. laticeps and A. heyeri*

compared with control, and maintaining this effect 20 days after the last application (Figures 1 and 2).

Link and Link (2001) observed that baits with sesame seeds disrupted the forage activity of three different species of leaf-cutting ants of the genus *Acromyrmex*. Castro Faria, Ukan, and Sousa (2010) found that sesame seeds inhibited the growth of Basidiomycetae fungi cultivated by *Acromyrmex* ants. In a study conducted by Peres Filho and Dorval (2003), it was found that baits made of sesame leaves controlled satisfactorily the specie of *Atta sexdens rubropilosa*.

Total and forage activities of ants of both genera were significantly reduced after the ninth day and this effect remained for more than 20 days after the application of neem and sesame baits (Tables 2). The placebo bait only had an effect on the total activity of *Acromyrmex* spp compared to no-

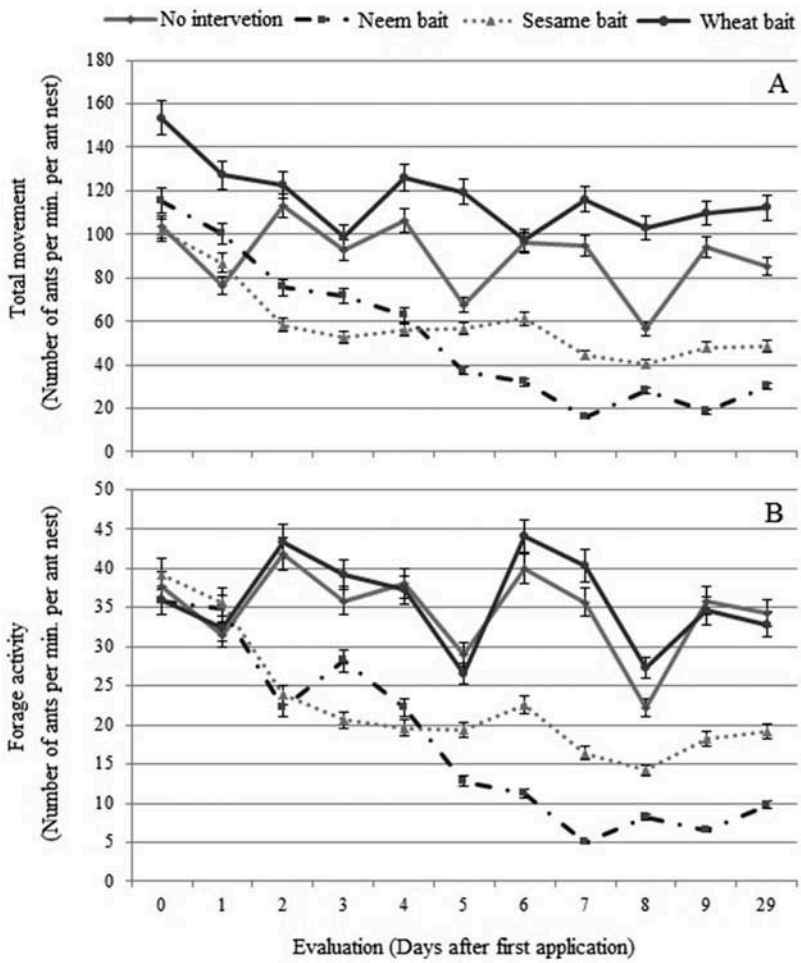

Figure 1. Activity of leaf-cutting ants *Atta sexdens piriventris* depending on the daily bait application. Total ants in movement (A), total foraging ants (B), Santa Catarina State, BR, 2007. Data are means of five replicates, considering the sum of three trails by nest.

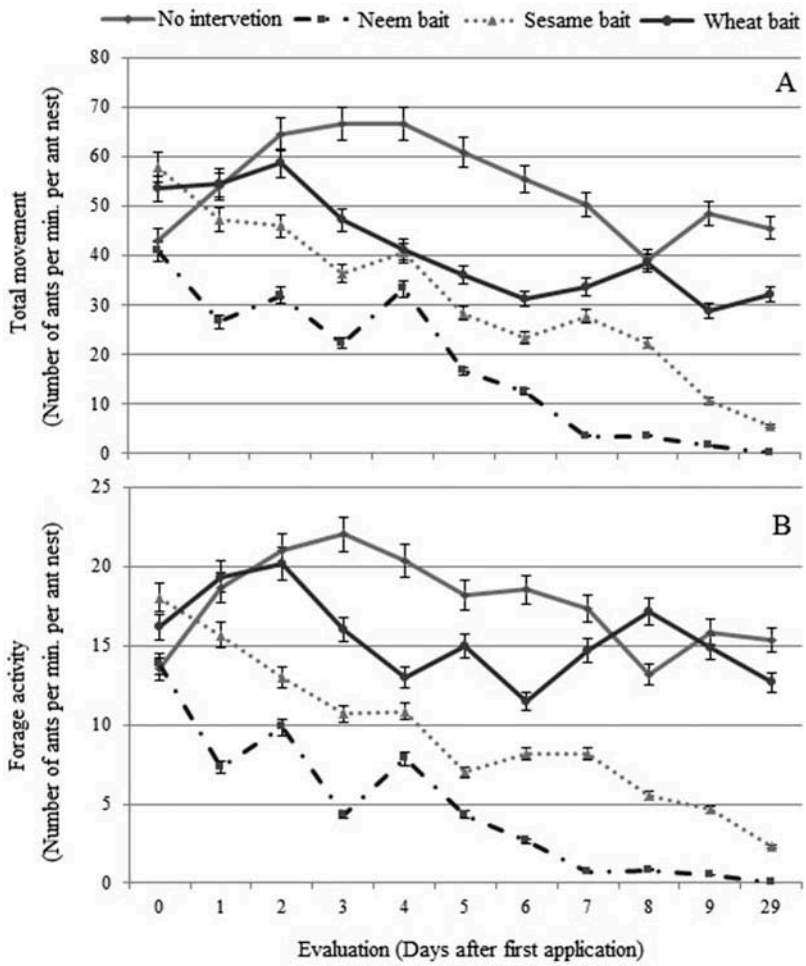

Figure 2. Activity of leaf-cutting ants (*Acromyrmex* spp.) depending on the daily bait application. Total ants in movement (A), total foraging ants (B), Santa Catarina State, BR, 2007. Data are means of six replicates, considering the sum of three trails by nest.

intervention. The neem oil bait decreased by 76.54% the forage activity of *Atta sexdens piriventris* ants 9 days after onset of application and remained at 58.86% reduction 20 days after the last application (Table 2). The use of the sesame bait caused a smaller reduction in foraging 9 days after the start of the evaluation (55.89%), but it equaled to neem at 29 days after the start of the application (56.77%), which corresponds to 20 days after the last application.

The neem oil bait, *Azadirachta indica*, had the greatest effect in reducing the forage activity of *Acromyrmex*, at 9 days after the start of daily applications (83.46%) among treatments, keeping this effect up to 20 days after the last application (Table 2).

According to Vendramim and Gastiglioni (2000), extracts from neem have a high impact on insect behavior, even at low concentrations. This effect was

Table 2. Reduction of foraging activity and total movement of leaf-cutting ants under treatments with neem and sesame baits at nine and 29 days after the start of applications, Santa Catarina State, BR, 2007.

	Atta sexdens piriventris				Acromyrmex spp			
	Reduction of foraging activity (%)		Reduction of total activity (%)		Reduction of foraging activity (%)		Reduction of total activity (%)	
Bait	At 9 days	At 29 days	At 9 days	At 29 days	At 9 days	At 29 days	At 9 days	At 29 days
Neem	76.54a	58.86a	82.75a	69.62a	83.46a	90.96a	86.98a	96.50a
Sesame	55.89b	56.77a	55.83b	57.75b	67.56b	78.99b	51.31b	68.07b
Placebo wheat	22.70c	24.18b	26.26c	27.75c	19.61c	26.89c	23.56c	26.57c
No intervention	23.01c	25.42b	23.68c	30.62c	12.09c	16.14c	4.38d	12.33d

*Values followed by the same letter in the same column do not differ at the level of 5% probability by Tukey's test.

evidenced in the present study, given the reduction in the forage activity of *A. sexdens piriventris, A. laticeps*, and *A. heyeri* ant species. Studies conducted by Santos et al. (2004) showed that neem extracts showed high toxicity to worker ants in *Acromyrmex* spp. Viana and Prates (2003) also observed the toxic action of neem oil with the aqueous extract of neem leaves for control of *Spodoptera frugiperda* (Lepidoptera: Noctuidae).

The sesame bait, *Sesamum indicum*, showed a lesser effect, but not unlike neem in the reduction of the forage activity and the total activity of both studied genera of leaf-cutting ants, *Atta* and *Acromyrmex*. The sesame seed bait reduced the forage activity of *A. laticeps* and *A. heyeri* ants compared with the placebo and no intervention. It is observed that the placebo bait also affected the total activity of the two *Acromyrmex* species tested compared with no intervention (Table 2). Sesame seeds were used by Souza, Corrêa, and Marques (1997) who obtained high mortality of *Acromyrmex* spp. ants when applying 40 g of sesame seeds per nest. According to Morini et al. (2005), sesame seeds also have an inhibitory effect on the fungus *Leucoagaricus longigophorus*, the main food source of the colony. On the other hand, Link and Link (2001) found that, although sesame caused disruption in the forage activity of *Acromyrmex* spp. ants, such activity was back to normal after the application was suspended. In the present study, the effect of reduced foraging extended to 20 days after the last application.

The frequency of application of botanical substance-based baits can be of great importance for successful management of leaf-cutting ants by using neem and sesame baits. For nests of *Atta sexdens piriventris*, the baits were distinguished from the placebo from the second to third consecutive days of application for both total and foraging activities. For nests of *Acromyrmex* spp. significant effects were found in the reduction of both total and foraging activities from the fourth to fifth consecutive days of application.

Conclusion

Family farmers in Santa Catarina's Plateau are highly receptive to ecological techniques for the management of leaf-cutting ants. Herbal ant baits containing neem oil and sesame seeds may offer a viable alternative in reducing the total and foraging activities of both genera of leaf-cutting ants, *Atta* and *Acromyrmex*. Reducing foraging of leaf-cutting ants by applying the neem and sesame baits is evidenced from the third and fifth applications, with prolonged effect for 20 additional days, after 10 daily applications.

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