Selection of active plant extracts against the coffee leaf miner *Leucoptera coffeella* (Lepidoptera: Lyonetiidae)

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ABSTRACT: Aiming to contribute to the development of alternative control methods of the coffee leaf miner, *Leucoptera coffeella* (Guérin-Mèneville & Perrottet, 1842) (Lepidoptera: Lyonetiidae), a search for plants able to produce active substances against this insect was carried out, with species collected during different periods of time in the Alto Rio Grande region, (Lavras, Minas Gerais, Brazil). Coffee leaves containing *L. coffeella* mines were joined with 106 extracts from 77 plant species and, after 48 hours, the dead and alive caterpillars were counted. The extracts from *Achillea millefolium*, *Citrus limon*, *Glechoma hederacea*, *Malva sylvestris*, *Mangifera indica*, *Mentha spicata*, *Mirabilis jalapa*, *Musa sapientum*, *Ocimum basiculum*, *Petiveria alliaceae*, *Porophyllum ruderale*, *Psidium guajava*, *Rosmarinus officinalis*, *Roupala montana*, *Sambucus nigra* and *Tropaeolum majus* showed the highest mortality rates.

Keywords: *Leucoptera coffeella*, natural products, botanical insecticide, alternative control

RESUMO: Seleção de extratos de plantas ativos contra o bicho-mineiro-do-cafeeiro *Leucoptera coffeella* (Lepidoptera: Lyonetiidae). Visando contribuir para o desenvolvimento de métodos alternativos de controle do bicho-mineiro-do-cafeeiro, *Leucoptera coffeella* (Lepidoptera: Lyonetiidae), buscou-se selecionar plantas coletadas em diferentes épocas na região do Alto Rio Grande, (Lavras, Minas Gerais, Brasil) que contenham substâncias ativas contra este inseto. Folhas de cafeeiro com minas intactas de *L. coffeella* foram colocadas em contato com 106 extratos provenientes de 78 espécies vegetais e, após 48 horas, contaram-se as lagartas vivas e mortas. Os extratos de *Achillea millefolium*, *Citrus limon*, *Glechoma hederacea*, *Malva sylvestris*, *Mangifera indica*, *Mentha spicata*, *Mirabilis jalapa*, *Musa sapientum*, *Ocimum basiculum*, *Petiveria alliaceae*, *Porophyllum ruderale*, *Psidium guajava*, *Rosmarinus officinalis*, *Roupala montana*, *Sambucus nigra* e *Tropaeolum majus*, provocaram os maiores índices de mortalidade.

Palavras-chave: *Leucoptera coffeella*, produtos naturais, inseticida botânico, controle alternativo

INTRODUCTION

The coffee leaf miner, *Leucoptera coffeella* (Guérin-Mèneville & Perrottet, 1842) (Lepidoptera: Lyonetiidae), is considered to be one of the main coffee pests, since the corresponding larvae feed on mesophyllic leaf tissues, resulting in plantation defoliation that may account for an 80% loss in coffee production (Reis, 1990; Gallo et al., 2002). The most employed methods to control this insect are based on the use of synthetic insecticides, which have not been as efficient as desired to reduce *L. coffeella* population. Furthermore, these products have favored biological imbalances such as the development of secondary pests and have contaminated human beings and the environment with harmful substances (Souza et al., 1998).

A promising alternative to circumvent the previously mentioned problem comprises the use of products from plant sources, since many reports on the activity of plants against insects can be found in the literature (Damarla et al., 2002). An example is

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the effect of the neem seed extract, *Azadiracta indica* A. Juss on *L. coffeella*, this product has affected the development of larvae and adult emergence of this insect (Venzon et al., 2005). Another example is larvicidal, antifeedant and oviposition deterrent effects of aqueous extract of *Argemone mexicana* L., *Vetiveria zizanioides* L. Nash, *Annona murricata* L., *Murraya koenigii* (L.) Spreng and *Lantana camara* L. on the mining insect *Plutella xylostella* L. (Lepidoptera: Plutellidae) under laboratory and field conditions (Facknath, 2006).

Despite the high potential to produce a great variety of biologically active substances (Taiz & Zeiger, 2004), most of the plant species found in the Alto Rio Grande region, Minas Gerais State, Brazil have not been submitted to any study aimed to render their biological properties useful for human beings (Rodrigues & Carvalho, 2001). Consequently, in order to contribute to the development of new methods to control *L. coffeella*, this work aimed at identifying native and exotic plants from that region able to produce substances active against such insect.

MATERIAL AND METHOD

Plant extracts

Parts of the plant species (Table 1), collected in the Alto Rio Grande region (Lavras, MG), between October/2001 and May/2005, have been identified by Prof. Douglas A. Carvalho and exsiccata deposited in Herbarium ESAL, at the Biology Department/Federal University of Lavras, Minas Gerais State, Brazil. Considering the lack of studies with plants from the Alto do Rio Grande region the work aimed to utilize species with known insecticidal activity and also with which studies are lacking, in order to provide greater insight into the biological potential of the region. They were cut into small pieces with scissors and submitted to extraction with methanol at room temperature, for 48 hours. The resulting mixtures were filtered through cotton and residues were extracted with methanol once more. The liquids from both extractions were combined, concentrated to dryness in a rotatory evaporator and freeze-dried. For 13 plant species collected between May/2004 and June/2004 (Table 1), no freeze-drying was carried out to avoid a loss of volatiles (Bos et al., 2002).

Test with the coffee leaf miner

To perform the experiment with *L. coffeella*, an aloquot (0.070 g) of each freeze-dried plant extract was dissolved in 8.0 mL of an aqueous 1.0% (g mL^{-1}) Tween 80 solution. Regarding plant extracts not submitted to the freeze-drying process, the volume (mL) of Tween 80 solution was ten times the mass (g) of fresh plant used. Coffee plant leaves (*Coffea arabica* L. cv. Topázio) from a *L. coffeella* containing greenhouse, with intact mines of the insect, were dipped (10 seconds) into the extracts solution and maintained in a chamber at 25 ± 1°C, with 70% RH, and 14 h photoperiod, for 48 hours. Then, mines were opened to count dead and live larvae. Aqueous 1.0% (g mL^{-1}) Tween 80 and 0.2% (g mL^{-1}) Sumithion® 500 CE solutions were employed as negative and positive controls, respectively. The experiments were carried out in a randomized design, with four replicates per treatment, each composed of five mines. Values were transformed into percentages before statistical procedures, which comprised analyses of variances (ANOVA) and comparison of means in accordance with the Scott & Knott (1974) test at 5%. The software SISVAR was used to do so (SISVAR, 2000).

TABLE 1. Plant species collected in the Alto Rio Grande region (Lavras-MG) and used for the extract preparation.

Family/Scientific name	Common name: Portuguese	Common name: English	Date of collection (dd/mm/yy)	Part collected	Voucher number
Anacardiaceae					
Schinus molle L.	Arueira	Pepper tree	25/06/02	Leaves	14800
Mangifera indica L.	Manga	Mango	03/01/05	Leaves	1945
Annonaceae					
Annona cacans Warm.	Araticum-cagão	-	12/03/02	Leaves	12787
Apiaceae					
Foeniculum vulgare Mill.	Funcho	Fennel	18/10/01	Leaves	5319
Asteraceae					
Achillea millefolium L.	Mil-folhas	Milfoil	02/10/01	Inflorescences	17618
Achillea millefolium L.	Mil-folhas	Milfoil	02/10/01	Leaves	17618
Achillea millefolium L.	Mil-folhas	Milfoil	09/11/04	Leaves	17618

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TABLE 1. Plant species collected in the Alto Rio Grande region (Lavras-MG) and used for the extract preparation.

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Family/Scientific name	Common name Portuguese	English	Date of collection (dd/mm/yy)	Part collected	Voucher number
Arctium lappa L.	Barbana	Burdock	10/07/02	Leaves	19826
Artemisia vulgaris L.	Artemísia	Mugwort	16/08/02	Leaves	19817
Baccharis dracunculifolia D.C.	Alecrim-do-campo	Baccharis	09/08/02	Leaves	15866
Calea hispida Baker	Erva-de-lagarto	-	12/03/02	Leaves	11517
Calendula officinalis L.	Calendula	-	01/11/04	Leaves	9449
Chenopodium ambrosiodes L.	Erva-de-santa-maria	Epazote	12/09/02	Leaves	9747
[1]*Chenopodium ambrosioides* L.	Erva-de-santa-maria	Epazote	20/05/04	Leaves	9747
Cynara scolymus L.	Cinarina	Artichoke	18/10/01	Leaves	9736
Gochnatia barrosil Cabrera	-	-	26/10/01	Leaves	12075
Porophyllum ruderale (Jacq.) Cass.	Arnica –paulista	Poreleaf	19/09/02	Leaves	13441
[1]*Porophyllum ruderale* (Jacq.) Cass.	Arnica-paulista	Poreleaf	20/05/04	Leaves	13441
Tagetes sp.	-	-	22/02/05	Leaves	16070
Taraxacum officinale Wiggers	Dente-de-leão	Dandelion	22/10/02	Leaves	7316
Tithonia diversifolia (Hemsl) Gray	Girasol	Mexican sunflower	26/09/02	Leaves	10027
Burseraceae					
Protium heptaphyllum (Aubl.) March	Protium	Protium	26/10/01	Leaves	13602
Caprifoliaceae					
Sambucus nigra L.	Sabugueiro	Black lace	05/07/02	Leaves	4605
[1]*Sambucus nigra* L.	Sabugueiro	Black lace	20/05/04	Leaves	4605
Clethraceae					
Clethra scabra Pers.	Caujuja	Clethra	26/10/01	Leaves	17453
Clusiaceae					
Kielmeyera coriacea Mart. ex Saddi.	Pau-Santo	-	12/03/02	Leaves	7975
Curcubitaceae					
Curcuma longa L.	Açafrão	Tumeric	16/12/02	Leaves	19814
Momordica charantia L.	Melão-de-são-caetano	Bitter gourd	12/09/02	Leaves	8856
Momordica charantia L.	Melão-de-são-caetano	Bitter gourd	22/05/04	Leaves	8856
Dilleniaceae					
Davilla elliptica St. Hill	Lixinha	Cofferaria	23/11/01	Leaves	9725
Ebenaceae					
Diospyros hispida D. C.	Bacupari bravo	-	12/03/02	Leaves	8930
Equisetaceae					
Equisetum arvense L.	Cavalinha	-	16/02/05	Stems	2028
Erythroxylaceae					
Erythroxylum suberosum St.-Hill.	Mercúrio-do-campo	-	26/10/01	Leaves	8631
Euphorbiaceae					
Croton antisyphiliticus Mart.	Canela-de-perdiz	-	26/10/01	Leaves	13382
Euphorbiaceae					
Phyllanthus tenellus Roxb.	Quebra-pedra	Long-stalk	28/06/02	Leaves	12620
Fabaceae					
Andira anthelmia (Vell.) JF Macbr.	Angelim-de- morcego	Cabbage tree	12/03/02	Leaves	7790
Mimosa pudica L.	Dormideira	-	16/02/05	Flowers	6190
Senna obtusifolia (L.) Irwin & Barneby	Fedegoso	Java bean	16/12/02	Leaves	8072

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TABLE 1. Plant species collected in the Alto Rio Grande region (Lavras-MG) and used for the extract preparation.

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Family/Scientific name	Common name Portuguese	English	Date of collection (dd/mm/yy)	Part collected	Voucher number
Senna rugosa (G. Don.) H. S. Irwin & Barneby	Senna	-	03/04/02	Flowers	13914
Senna rugosa (G. Don.) H. S. Irwin & Barneby	Senna	-	03/04/02	Leaves	13914
Lamiaceae					
Glechoma hederacea L.	Hera-terrestre	Ground ivy	11/10/01	Leaves	6886
[1]*Glechoma hederacea* L.	Hera-terrestre	Ground ivy	20/05/04	Leaves	6886
Leonorus sibiricus L.	Erva macaé	Mother wort	16/08/02	Leaves	4345
Mentha spicata L.	Hortelã-peluda	Spearmint	10/07/02	Leaves	11666
Mentha spicata L.	Hortelã-peluda	Spearmint	02/10/01	Leaves	11666
[1]*Mentha spicata* L.	Hortelã-peluda	Spearmint	28/06/04	Leaves	11666
Mentha spicata L.	Hortelã-peluda	Spearmint	16/02/05	Leaves	11666
Ocimum basiculum L.	Basilicão	-	16/02/05	Leaves	17890
Ocimum gratissimum L.	Alfavaca	-	16/02/05	Leaves	10807
Peltodon tomentosus Pohl.	Hortelã-do-mato	-	03/04/02	Inflorescences	6168
Peltodon tomentosus Pohl.	Hortelã-do-mato	-	03/04/02	Leaves	6168
Rosmarinus officinalis L.	Alecrim	Rosemary	02/10/01	Leaves	3130
Tetradenia riparia (Hochst.) Codd	Mirra	Misty plume Bush	22/10/02	Leaves/Stems	19811
Thymus vulgaris L.	Tomilho	-	22/02/05	Leaves	17057
Liliaceae					
Allium cepa L.	Cebola	Onion	19/09/02	Leaves	930
Allium sativum L.	Alho	Garlic	22/10/02	Leaves	19824
Aloe vera L.	Babosa	True aloe	02/08/02	Leaves without slime	19820
[1]*Aloe vera* L.	Babosa	True aloe	08/06/04	Leaves without slime	19820
Lythraceae					
Diplusodon virgatus Pohl.	Cai-cai	-	19/10/01	Leaves	10601
Malpighiaceae					
Banisteriopsis campestris (A. Juss.) Little.	-	-	12/03/02	Leaves	14436
Malvaceae					
Malva sylvestris L.	Malva	Common mallow	25/06/02	Leaves	19815
Malva sylvestris L.	Malva	Common mallow	02/10/01	Branches	19815
[1]*Malva sylvestris* L.	Malva	Common mallow	28/06/04	Leaves	19815
Peltaea polymorpha St. Hil. Krap.	-	-	23/11/01	Leaves	13940
Melastomataceae					
Marcetia taxifolia (A. St.-Hil.) DC.	Marcetia	-	26/10/01	Leaves	14416
Miconia albicans (Sw.) Triana.	Quaresmeira-branca	-	26/10/01	Leaves	18045
Meliaceae					
Cabralea canjerana (Vellozo) Martius.	Canjerana	-	26/10/01	Leaves	18048
Moraceae					
Ficus carica L.	Figueira	-	19/11/04	Leaves	2146

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TABLE 1. Plant species collected in the Alto Rio Grande region (Lavras-MG) and used for the extract preparation.

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Family/Scientific name	Common name		Date of collection	Part	Voucher
	Portuguese	English	(dd/mm/yy)	collected	number
Musaceae					
Musa sapientum	Bananeira	Banana	18/07/02	Leaves	14727
Musa sapientum	Bananeira	Banana	14/05/05	Leaves	14727
Myrtaceae					
Campomanesia pubescens (DC.)					
O. Berg	Guabiroba	-	26/10/01	Leaves	14043
Myrcia fallax (Rich.) DC	Guamarim-do-preto	-	12/03/02	Leaves	17857
Psidium guajava L.	Goiabeira	Guava	03/01/05	Leaves	2129
Nictaginaceae					
Mirabilis jalapa L.	Maravilha	Clavillia	18/10/01	Leaves	8333
[1]*Mirabilis jalapa* L.	Maravilha	Clavillia	20/05/04	Leaves	8333
Ochnaceae					
Ouratea spectabilis (Mart.) Engl.	Folha-de-serra	-	26/10/01	Leaves	8632
Phytolaccaceae					
Petiveria alliaceae L.	Guiné	Anamu	04/10/02	Leaves	5127
[1]*Petiveria alliacea* L.	Guiné	Anamu	28/06/04	Leaves	5127
Petiveria sp.	-	-	16/12/02	Leaves	10302
Plantaginacea					
Plantago tomentosa L.	Tanchagem	-	02/08/02	Leaves	7756
Poaceae					
Coix-lacrima jobi L.	Capim-rosário	Job's tears	19/10/01	Leaves	5994
Coix- lacrima jobi L.	Capim-rosário	Job's tears	22/02/05	Leaves	5994
Echinolaena inflexa (Poir.) Chase	Capim-flexa	-	12/03/02	Branches	14449
[1]*Echinolaena inflexa* (Poir.) Chase	Capim-flexa	-	04/06/04	Branches	14449
Polygalaceae					
Polygala angulata DC. Brasil	-	-	12/03/02	Leaves	13603
Proteaceae					
Roupala montana Aubl.	Carne-de-vaca	Grilled meat	26/10/01	Leaves	8786
[1]*Roupala montana* Aubl.	Carne-de-vaca	Grilled meat	04/06/04	Leaves	8786
Punicaceae					
Punica granatum L.	Romã	Pomegranate	11/10/01	Leaves	2182
[1]*Punica granatum* L.	Romã	-	28/06/04	Leaves	2182
Punica granatum L.	Romã	-	03/01/05	Leaves	2182
Rubiaceae					
Alibertia sessilis (Vell.) K. Schum.	Marmelinho	-	26/10/01	Leaves	15275
Rudgea virbunoides Benth	Chá-de-bugre	-	26/10/01	Leaves	14001
Rutaceae					
Citrus aurantium L.	Laranja-amarga	-	28/03/05	Leaves	2248
Citrus limon (L.) Burm. F.	Limão	-	03/01/05	Leaves	19825
Citrus sp.	-	-	18/07/02	Leaves	20763
Ruta graveolens L.	Arruda	Rue	02/10/01	Leaves	3133
Salicaceae		-			
Casearia sylvestris Sw.	Guaçatonga	Wild coffee	26/10/01	Leaves	17461

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TABLE 1. Plant species collected in the Alto Rio Grande region (Lavras-MG) and used for the extract preparation.

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Family/Scientific name	Common name Portuguese	English	Date of collection (dd/mm/yy)	Part collected	Voucher number
Sapindaceae					
Serjania erecta Raldlk	Timbó	-	26/10/01	Leaves	7591
[1]*Serjania erecta* Raldlk	Timbó	-	28/05/04	Leaves	7591
Solanaceae					
Nicotiana tabacum L.	Tabaco	Tobacco	07/11/02	Leaves	6343
Tropaeolaceae					
Tropaeolum majus L.	Capuchinha	Garden nasturtium	18/10/01	Leaves	8853
Tropaeolum majus L.	Capuchinha	Garden nasturtium	18/10/01	Flowers	8853
Tropaeolum majus L.	Capuchinha	Garden nasturtium	02/08/02	Leaves	8853
[1]*Tropaeolum majus* L.	Capuchinha	Garden nasturtium	20/05/04	Leaves	8853
Tropaeolum majus L.	Capuchinha	Garden nasturtium	14/02/05	Flowers	8853
Zingiberaceae					
Zingiber officinale Roscoe	Gengibre	-	19/11/04	Leaves	2297

[1]Plant species whose extracts were not submitted to the freeze-drying process.

RESULT AND DISCUSSION

Among the freeze-dried extracts from plants collected between October/2001 and December/2002, those from *Achillea millefolium*, *Allium cepa*, *Allium sativum*, *Aloe vera*, *Arctium lappa, Artemisia vulgaris*, *Banisteriopsis campestris*, *Chenopodium ambrosioides*, *Citrus* sp., *Croton antisiphyliticus*, *Curcuma longa*, *Foeniculum vulgare*, *Mentha spicata*, *Momordica charantia*, *Nicotiana tabacum*, *Petiveria* sp., *Punica granatum*, *Ruta graveolens*, *Schinus molle* and *Tithonia diversifolia*, did not affect the *L. coffella* survival, though these plants were reported as active against other insects (Alexander et al., 1991; Dutta et al., 1993; Franzios et al., 1997; Adedire & Lajide, 1999; Larocque et al., 1999; Botha & Mccrindle, 2000; Hadis et al. 2003; Fuchs & Bowers, 2004; Khattak et al., 2004; Moshi et al., 2004; Jaenson et al., 2005; Pavela, 2005; Traboulsi et al., 2005; Yildirim et al., 2005; Ferrero, 2006; Gökce et al., 2006; Han et al., 2006; Kathuria & Kaushik, 2006; Mao et al., 2006; Mitchell & Ahmad, 2006; Zong & Wang, 2007).

Perhaps the results were different because the plants show variation in the production of secondary metabolites, according to the climatic conditions in which they were grown (Gobbo-Neto & Lopes, 2007). Moreover, different species of insects have different mechanisms for detoxification against the same substance, caffeine, for example, blocks the development of *Aedes aegypti* (Diptera: Culicidae), but does not have an adverse effect on *Perileucoptera :coffeella* (Lepidoptera: Lyonetiidae) (Guerreiro Filho & Mazzafera, 2000; Laranja et al., 2006). One must also consider the conditions of extraction, given the fact that secondary plant metabolites include several classes of substances. For example, for the extraction of polar compounds it is common to use methanol, ethanol or water an extractor. For nonpolar substances, hexane is a good extractor. In this sense, the results found in this study can be partly attributed to the different extraction conditions. Ferrero et al. (2006), for example, working with the hexane extract of *S. molle*, characterized by solubilizing nonpolar substances, while in the present study methanol extract was worked with. The mode of application of plant extract is also another factor that influences the results, Pascual-Villalobos & Fernández (1999) found that extracts of squill bulbs (*Urginea maritima* (L.) Baker) topically applied caused greater mortality than when compared with those that were mixed in the diet.

The freeze-dried extracts of the following plants were also inactive against *L. coffeella*: *Alibertia sessilis*, *Andira anthelmia*, *Annona cacans*, *Baccharis dracunculifolia*, *Cabralea canjerana*, *Calea hispida*, *Campomanesia pubescens*, *Casearia sylvestris*, *Clethra scabra*, *Coix-lacrima jobi*, *Cynara scolymus*, *Davilla elliptica*, *Diospyros hispida*, *Diplusodon virgatus*, *Echinolaena inflexa*, *Erythroxylum suberosum*, *Gochnatia barrosil*, *Kielmeyera coriacea*, *Leonorus sibiricus*, *Marcetia taxifolia*, *Miconia albicans*,, *Myrcia fallax*, *Ouratea spectabilis*, *Peltaea polymorpha,*, *Peltodon tomentosus*, *Phyllanthus tenellus*, *Plantago tomentosa*, *Polygala angulata*, *Protium heptaphyllum*, *Rudgea virbunoides*, *Senna obtusifolia*, *Senna rugosa*, *Serjania erecta*, *Taraxacum officinale* and *Tetradenia riparia*. Such a result seemed reasonable, since no report about the insecticidal properties of these plants could be found in the literature.

Differently from the previously mentioned results, the freeze-dried extracts of *Glechoma hederacea*, *Malva sylvestris*, *Mirabilis jalapa*, *Petiveria alliaceae*, *Porophyllum ruderale*, *Rosmarinus officinalis*, *Sambucus nigra* and *Tropaeolum majus*, increased *L. coffeella* larvae mortality (Table 2), corroborate the activity of such plants against other insects (Cammue et al., 1992; Huang & Renwick, 1995; Manea, 1995; Guillet el al., 1998; Chariandy et al., 1999; Guarrera, 2005; Jaenson et al., 2005; Miresmailli & Isman, 2006; Singh et al., 2006). Some of these plants have insecticidal activity against other insects of the order Lepidoptera. The essential oil of *R. officinalis* affects the survival of *Pseudaletia unipuncta* Haworth (Noctuidae) and *Trichoplusia ni* Hübner (Noctuidae), the terpenoid group of compounds were attributed to the deleterious activity of this plant against these insects (Isman et al., 2008). Another example is the feeding deterrent activity of *T. majus* on *Pieris rapae*, attributed mainly due to the presence of chlorogenic acid (Huang & Renwick, 1995). Regarding *Roupala montana*, the extract of which presented activity against *L. coffeella*, no report was found in the literature about the insecticidal activity of such plant. There are few studies with *R. montana*, but in plants belonging to the family Proteaceae, the presence of substances active against insects of the order Lepidoptera, such as, bisresorcinol derivatives, polyphenolic compounds and coumarins is reported in the literature (Hadaek et al, 1994; Erazo et al., 1997; Verotta et al., 1999; Koppera et al., 2002; Wang et al., 2009).

Despite of the increase in *L. coffeella* larvae mortality by freeze-dried extracts from *G. hederacea*, *M. jalapa, M. sylvestris., T. majus* (flowers), *P. alliaceae*, *R. montana*, *P. ruderale* and *S. nigra* colleted during the years of 2001 and 2002, extracts from the same plants collected between November/2004 and May/2005, prepared without employing the freeze-drying process, were all inactive. Since the freeze-dried extracts should be less active due to loss of volatiles, metabolic variations caused by environmental changes (Beppu et. al, 2004; Kofidis et al., 2004) probably accounted for the absence of insecticidal properties.

Among those plants whose freeze-dried extracts from parts collected during the years of 2001 and 2002 were inactive, *A. millefolium* e *M. spicata* were randomly selected for a new collection and preparation of freeze-dried extracts, which increased *L. coffeella* larvae mortality (Table 3). Conversely, *S. nigra* and *T. majus* (Table 3), lost their activity

TABLE 2. Effect of freeze-dried extracts from plants collected in the Alto Rio Grande region (Lavras-MG), between October/2001 and December/2002, on *Leucoptera coffeela* larvae mortality.

Plant species	Part collected	Larvae mortality (%)[1]
Experiment 1		
Foeniculum vulgare	leaves	24.8 a
Glechoma hederacea	leaves	44.8 b
Mirabilis jalapa	leaves	49.2 b
Ruta graveolens	leaves	9.5 a
Tropaeolum majus	flowers	44.4 b
Sumithion 500 CE (control)		100.0 c
Tween 80 (control)		5.56 a
Experiment 2		
Malva sylvestris	branches	62.7 b
Punica granatum	leaves	34.4 a
Tween 80 (control)		14.3 a
Sumithion 500 CE (control)		100.0 c
Experiment 3		
Marcetia taxifolia	leaves	10.5 a
Peltaea polymorpha	leaves	8.8 a
Rosmarinus officinalis	leaves	27.9 b
Tween 80 (control)		7.7 a
Sumithion 500 CE (control)		100.0 c
Experiment 4		
Arctium lappa	leaves	16.2 a
Baccharis dracunculifolia	leaves	14.6 a
Echinolaena inflexa	branches	34.0 a
Gochnatia barrosil	leaves	14.2 a
Petiveria alliaceae	leaves	58.7 b
Tween 80 (control)		14.6 a
Sumithion 500 CE (control)		100.0 c
Experiment 5		
Leonorus sibiricus	leaves	17.7 a
Phyllanthus tenellus	leaves	8.1 a
Roupala montana	leaves	30.2 b
Tween 80 (control)		13.3 a
Sumithion 500 CE (control)		100.0 c
Experiment 6		
Davilla elliptica	leaves	7.1 a
Kielmeyera coriacea	leaves	6.7 a
Porophyllum ruderale	leaves	42.4 b
Sambucus nigra	leaves	35.8 b
Tropaeolum majus	leaves	17.7 a
Tween 80 (control)		8.6 a
Sumithion 500 CE (control)		100.0 c

(1) Means followed by the same letter in each experiment do not differ significantly ($P \leq 0.05$).

when a new plant collection and extract preparation was carried out. Once more, variations in metabolic production by plants due to environmental changes may account for these results (Gobbo-Neto & Lopes, 2007; Vila-Verde et al., 2005). *P. lanceotata* can be used to exemplify such behavior. According to Bowers et al. (1992), only during the summer can aucubin and catalpol, which are the insecticides produced by that plant, be detected in the leaves.

Among the freeze-dried extracts from plants collected between October/2004 and May/2005, the one from *Citrus limon* was active (Table 3). This result corroborates the activity against *Atta sexdens rubropilosa* Forel, 1908 (Hymenoptera: Formicidae) reported by Fernandes et al. (2002). Analogously, the freeze-dried extracts from *Mangifera indica*, *Musa sapientum*, *Ocimum basiculum* and *Psidium guajava* also increased *L. coffeella* larvae mortality (Table 3), though no report on their insecticidal properties could be found.

TABLE 3. Effect of freeze-dried extracts from plants collected in the Alto Rio Grande Region (Lavras-MG), between November/2004 and May/2005, on *Leucoptera coffeella* larvae mortality.

Plant species	**Part collected**	**Larvae mortality (%)[1]**
Experiment 1		
Achillea millefolium	flowers	26.3 b
Aloe vera	leaves	8.5 a
Citrus limon	leaves	38.6 b
Glechoma hederacea	leaves	14.1 a
Mangifera indica	leaves	27.4 b
Mentha spicata	leaves	31.0 b
Musa sapientum	leaves	37.7 b
Ocimum basiculum	leaves	43.2 b
Psidium guajava	leaves	23.5 b
Zingiber officinale	leaves	12.3 a
Tween 80 (control)		8.5 a
Sumithion 500 CE (control)		99.7 c
Experiment 2		
Equisetum arvense	leaves	0.0 a
Malva sylvestris	leaves	0.0 a
Mirabilis jalapa	leaves	7.1 a
Ocimum gratissimum	leaves	0.0 a
Petiveria alliaceae	leaves	13.7 a
Roupala montana	leaves	5.8 a
Sambucus nigra	leaves	0.0 a
Tagetes sp.	leaves	0.0 a
Thymus vulgaris	leaves	2.8 a
Tropaeolum majus	leaves	0.0 a
Tween 80 (control)		0.0 a
Sumithion 500 CE (control)		100.0 c

(1) Means followed by the same letter in each experiment do not differ significantly ($P \leq 0.05$).

Despite of the reports on the ability to produce insecticidal substances by *Calendula officinalis*, *Mimosa pudica*, *Ocimum gratissimum*, *Punica granatum*, *Tagetes* sp., *Thymus vulgaris* and *Zingiber officinale* (Regnaultroger & Hamraoui, 1993; Williams & Mansingh, 1993; Huang & Renwick, 1995; Larocque et al. 1999; Navickiene et al., 2003; Aslan et al., 2004; Sarin, 2004; Seri-Kouassi et al., 2004; Aslan et al., 2005; Guarrera, 2005, Prajapati el at., 2005; Traboulsi et al., 2005), no effect on *L. coffeella* was observed for the freeze-dried extract from parts of these plants collected between October/2004 and May/2005.

Regarding the freeze-dried extracts of *Citrus aurantium*, *Coix-lacrima jobi*, *Equisetum arvense* and *Ficus carica*, also collected between October/2004 and May/2005, no influence on *L. coffeella* could be observed, which is in accordance with the absence of reports in the literature on the insecticidal activity of such plants.

As the presence of chemical groups in plants that have proven active against *L. coffeella* in this work, amides isolated from *A. millefolium* with high insecticidal activity against *Aedes triseriatus* (Say) larvae (LaLonde et al., 1980) stand out. *C. limon* is reported to have a high proportion of limonene and in lower quantities p-menthane molecules and pinenes in its composition, that are active against insects such as *Culex pipiens* (Diptera: Culicidae) (Michaelakis et al., 2009). *G. hederacea* has lecithin in its leaves that has insecticidal activity against *Leptinotarsa decemlineata* (Wang et al., 2003). *M. sylvestris* produces, among other secondary metabolites, terpenoids and derivatives and phenol, which in turn, are classes of substances known to have insecticidal activity (Cutillo et al., 2005; Geris et al., 2008). Although no reports were found for the insecticidal activity of *M. indica*, the presence of compounds with known insecticidal activity, such as saponins, steroids, tannis, flavonoids, reducing sugars, cardiac glycosides and anthraquinone have already been detected (Aiyelaagbe & Osamudiamen, 2009). Among the main compounds found in *M. spicata,* carvone deserves mention, which also has insecticidal activity (Tripathi et al., 2003; Chauhana et al., 2009). While trypsin inhibitors have been isolated *from M. jalapa* , such compounds may cause negative effects on the survival of insects (Kowalska et al., 2007; Kansal et al., 2008). In the case of *P. alliaceae*, the essential oil obtained from the roots of this plant proved to be active against *Bemicia* *tabaci.* The major constituent isolated from the oil, benzaldehyde, was also active against this insect (Bezerra, 2006). The mono and sesquiterpenes and fatty acid derivatives of *P. ruderale* active against *Ostrinia nubilalis* (Lepidoptera: Pyralidae may also be cited. In this context, insecticidal activity of *R. officinalis* on *Pseudaletia unipuncta.* Haworth (Noctuidae) and the *Trichoplusia ni.* Hübner (Noctuidae) was attributed to the terpenoid constituents. Regarding *S. nigra*, the activity against Hemipteran insect species was attributed to protein agglutinin I (SNA-I). It is a Type-2 ribosome-inactivating proteins (RIPs) (Shahidi-Noghabi et al, 2009). It is also possible to mention that the leaves of *T. majus* contain high amounts of the glucosinolate glucotropaeolin, this substance is known to have an insecticidal effect (Kleinwchter et al., 2008; Peterson et al., 1998).

Concluding, in this work the activity against *L. coffeella* larvae was detected for the freeze-dried extracts from *A. millefolium*, *C. limon*, *G. hederacea*, *M. sylvestris*, *M. indica*, *M. spicata*, *M. jalapa*, *M. sapientum*, *O. basiculum*, *P. alliaceae*, *P. ruderale*, *P. guajava*, *R. officinalis*, *R. montana*, *S. nigra* and *T. majus*. Nevertheless, the production of substances active against the insect by such plants during the whole year can not be guaranteed, since environmental conditions may affect metabolic production by plant species.

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