Crop Protection 63 (2014) 57–67

Contents lists available at ScienceDirect

Crop Protection

journal homepage: www.elsevier.com/locate/cropro

The control of isariopsis leaf spot and downy mildew in grapevine cv. Isabel with the essential oil of lemon grass and the activity of defensive enzymes in response to the essential oil

A.J. Maia [a,*], J.S.B. Oliveira [a], K.R.F. Schwan-Estrada [a], C.M.R. Faria [b], A.F. Batista [c], W.F. Costa [c], B.N. Batista [a]

[a] Agronomy Department, State University of Maringá – UEM, 85040080 Maringá, Brazil
[b] Agronomy Department, State University of West of Paraná-UNICENTRO, Guarapuava, Brazil
[c] Department of Chemistry, State University of Maringá – UEM, Maringá, Brazil

ARTICLE INFO

Article history:
Received 26 November 2013
Received in revised form
7 May 2014
Accepted 10 May 2014
Available online 11 June 2014

Keywords:
Vitis vinífera
Grapes
Induced resistance
Catalase
Chitinase

ABSTRACT

The aim of this study was to evaluate the potential of the essential oil of lemon grass (*Cymbopogon citratus*) for the control of isariopsis leaf spot (*Pseudocercospora vitis*) and downy mildew (*Plasmopara viticola*) in grapevine cv. Isabel, the effect of the essential oil on the productivity of the grapevines and the effect of the essential oil on the activity of the enzymes chitinase and catalase. The experiment was conducted in a commercial vineyard over two consecutive crop cycles. Each plant in the experiment was subjected to one of the following nine treatments: 0, 0.5, 1.0, 2.0 or 4.0 mL L^{-1} essential oil, Tween® 80%, Bordeaux mixture, Acibenzolar-S-methyl and mancozeb. An analysis of the area under the disease progress curve showed a quadratic response by both diseases to the doses of essential oil during the first and second crop cycles. The essential oil treatments also increased the number and mass of the clusters of fruit as well as the productivity and desirable chemical characteristics of the grape. The activity of chitinase increased as a result of the essential oil treatments, whereas the activity of catalase decreased. The essential oil at doses of 1.0 and 2.0 mL L^{-1} can serve as an alternative means of controlling isariopsis leaf spot and downy mildew and can also serve to improve the fruit quality of grapes cv. Isabel in tropical regions.

1. Introduction

Most cultivated grapevines are susceptible to various diseases, such as downy mildew (*Plasmopara viticola* (Berk. & M.A. Curtis) Berl. & De), anthracnose (*Elsinoe ampelina* Shear), isariopsis leaf spot (*Pseudocercospora vitis* (Lév.) Speg.), gray rot (*Botrytis cinerea* Pers) and ripe rot (*Glomerella cingulata* (Stoneman) Spauld & Schrenk). Thus, control methods for these diseases are necessary and of particular importance because they need to be effective and efficient and should still result in a competitive production cost in the market (Farjado, 2003).

The most widely used fungicide to control diseases of grapevine is Bordeaux mixture, a copper fungicide. However, like all copper compounds, this fungicide may produce symptoms of toxicity in young plant tissues, and the corrosive action of the fungicide may compromise the structure of the vine. Due to these characteristics, Bordeaux mixture is recommended for use only after fruiting. Other synthetic fungicides, such as metalaxyl, thiophanate-methyl and cymoxanil, are used on a large scale in the wine industry for the control of these diseases (Amorim and Kuniyuki, 2005).

The use of fungicides can increase production significantly. However, fungicide use can also cause serious damage to the environment and can result in the selection of pathogens that are resistant to certain active ingredients contained in the fungicides. Consumers of fresh fruit are increasingly concerned about the origin of the products that they purchase, the presence of toxic waste and the conservation of the fruit. For this reason, the consumption of organic products has increased steadily, causing changes in the production, storage, distribution and marketing of agricultural products (Flores-Cantillano et al., 2001). This ecological awareness has created opportunities for agriculture, enhancing trade in organic products and leading some growers to shift from

* Corresponding author. Tel.: +55 42 99535583.
E-mail address: alymaia2005@yahoo.com.br (A.J. Maia).

http://dx.doi.org/10.1016/j.cropro.2014.05.005
0261-2194/

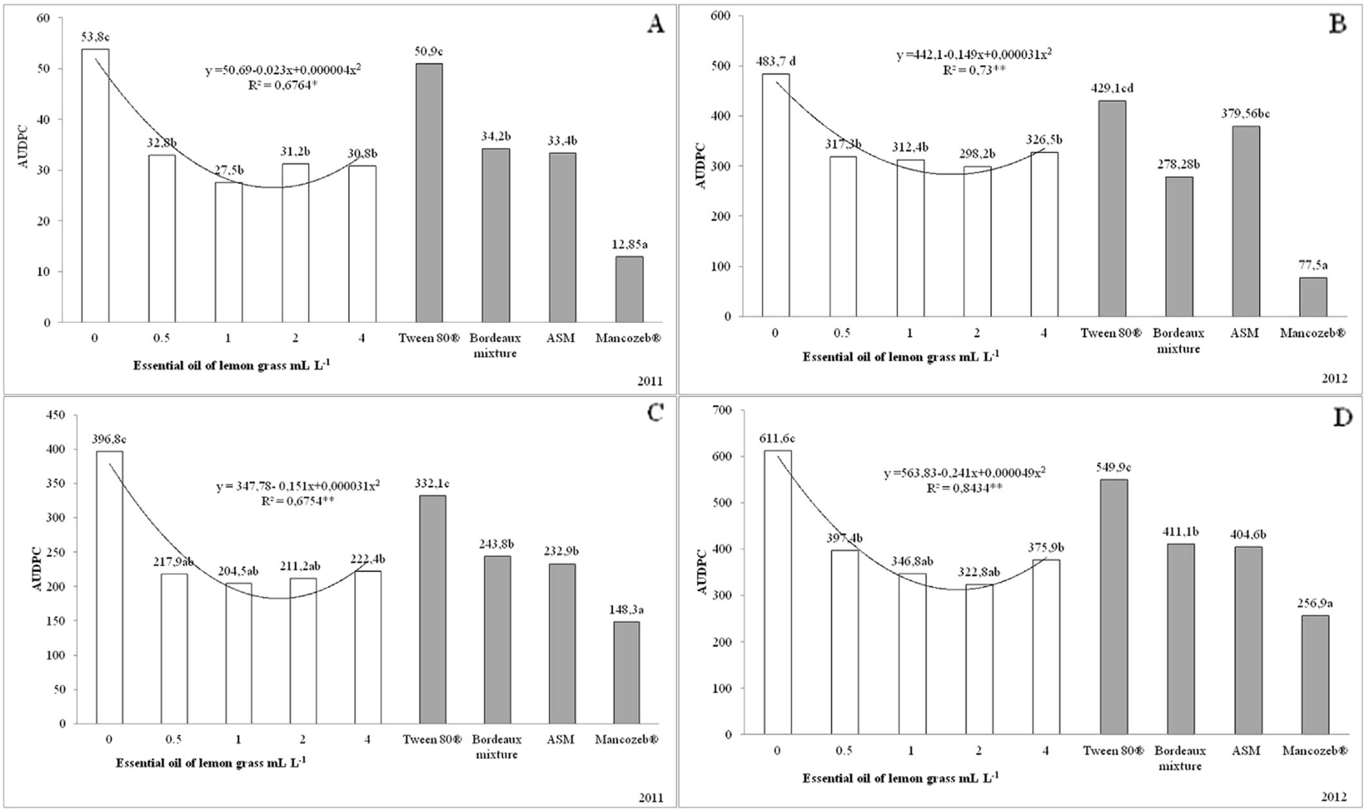

Fig. 1. Effects of doses of essential oil of lemon grass on the AUDPC, leaf spot (A and B) and mildew (C and D) on grapevine cv. Isabel in two consecutive years. **Significant ($p = 1\%$). Means followed by the same letter do not differ (Tukey test, $p = 5\%$).

conventional production to organic or integrated production (Detoni et al., 2005).

Accordingly, it is necessary to use alternative methods to control diseases that occur in organic agriculture. Among these alternative methods are the induction of resistance in plants (Bonaldo et al., 2005) and the use of natural bioactive substances with antimicrobial activity (Camili et al., 2007). In this context, the use of essential oils extracted from medicinal plants that contain secondary compounds can have both fungitoxic actions (antimicrobial action) and facilitate resistance by activating defense mechanisms in plants (indirect antimicrobial action). For these reasons, the use of these essential oils may represent a promising alternative in organic agriculture (Franzener et al., 2003).

Lemon grass (*Cymbopogon citratus* (DC) Stapf), a member of the family Poaceae, is a medicinal plant that contains compounds that can potentially control pathogen-caused plant disease and/or induce plant resistance to pathogens. This aromatic plant is cultivated for the commercial production of an essential oil that is widely used as a scenting agent in perfumery and cosmetics, in the preparation of colognes, soaps and deodorants and in the pharmaceutical industry (Costa et al., 2005). Its typical major constituents are citral monoterpenes (an isomeric mixture of neral and geranial) and myrcene (Guimarães et al., 2011). According to Souza et al. (1991), the citral monoterpenes show antimicrobial and antifungal activity, and these properties are currently attracting attention in agronomy.

Pereira et al. (2012) evaluated the activity of essential oils of *Cinnamomum zeylanicum* (cinnamon), *C. citratus* (lemon grass), *Syzygium aromaticum* (clove), *Melaleuca alternifolia* (tea tree), *Thymus vulgaris* (thyme), *Azadirachta indica* (neem), *Corymbia citriodora* (eucalyptus) and *Cymbopogon nardus* (citronella grass) to control rust (*Hemileia vastratrix* Berk. & Br) in coffee seedlings in a greenhouse. The essential oil of lemon grass was found to reduce the severity of the disease by 67% and 70% in Catuaí IAC62 and Catuaí 2SL, respectively, demonstrating the effectiveness of the essential oil in controlling this disease.

The effect of the essential oil of *C. citratus* on induced resistance has been verified by Balbi-Peña et al. (2007), who used the oil to treat tomato plants inoculated with *Alternaria solani*. In that study, increased peroxidase activity at 12 and 48 h after inoculation

Table 1
Total soluble solids (TSS), pH, and the weight of bunches of cv. Isabel grapes subjected to different doses of essential oil from lemon grass in crops 2011. Marialva-PR.[a]

Treatments	Total soluble solids (TSS)	pH	Weight of bunches (g)
Control	15.03bc[1]	3.1[ns;2]	60.94 [ns;3]
Essential oil lemon grass 0.5 mL L^{-1}	16.00ab	3.2	63.79
Essential oil lemon grass 1.0 mL L^{-1}	16.55a	3.1	60.98
Essential oil lemon grass 2.0 mL L^{-1}	13.63cd	3.0	52.72
Essential oil lemon grass 4.0 mL L^{-1}	15.73ab	3.1	52.37
Tween 80%	13.95cd	3.1	58.93
Bordeaux mixture (1:1:1)	14.40cd	2.9	57.52
S-methyl-Acibenzolar	14.27cd	3.1	57.33
Mancozeb	15.9 ab	4.9	64.98
CV%	4.36	40.2	14.03
Fc	13.36	1.15	0.22

Means followed by the same letter do not differ by Tukey test at 5% probability not significant for the average test. Tukey and polynomial regression at the level of 5%.
[1]$Pr > Fc_{regression} = 0.000/Pr > t = 0.0134/y = 15.43{-}0.00007x/R^2 = 0.011$.
[2]$Pr > Fc_{regression} = 1.737/CV\% = 2.83$. [3]$Pr > Fc_{regression} = 0.1681/CV\% = 14.96$.
[a] Marialva, city located in the state of Paraná (PR), Brazil.