

Bordeaux mixture, plant-based oils and extracts evaluation on strawberry common leaf spot and fruit production

Evaluación de la mezcla de Burdeos, aceites y extractos vegetales sobre la mancha de fresa y la producción de frutos



<https://eqrcode.co/a/LDPqQe>

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ABSTRACT: Plant extracts and oils were assessed for strawberry leaf spot control in organic strawberry in the open field. For first cycle, treatments were extracts of rosemary (10 %) (*Rosmarinus officinalis* L.), garlic (*Allium sativum* L.) (0.01 %), rue (*Ruta graveolens* L.) (10 %), turmeric (*Curcuma longa* L.) (1 %), Bordeaux mixture (1 %), cotton (1.5 %) and canola oils (1 %), and water (control). For second cycle, Rosemary (20 %), rue (20 %), turmeric (2 %), canola oil (2 %), and water were used as treatments. A completely randomized block design with five replications was used. An analysis of variance was performed on the severity data, AUDPC and fruit production means were compared by the Scott-Knott and Tukey tests at 5 % probability for first and second cycles, respectively. Canola oil (1 and 2 %) reduced disease symptoms in both cycles. Rosemary and rue extracts reduced just when disease severity was low. Cotton and canola oils and rosemary, rue and turmeric extracts increased strawberry fruit production.

Keywords: *Mycosphaerella fragariae*, alternative control, rosemary, rue, canola oil, cottonseed oil.

RESUMEN: Se evaluaron extractos y aceites vegetales para el control de viruela en fresa orgánica en campo abierto. Los tratamientos en el primer ciclo fueron extractos de romero (*Rosmarinus officinalis* L.) (10 %), ajo (*Allium sativum* L.) (0,01 %), ruda (*Ruta graveolens* L.) (10 %), cúrcuma (*Curcuma longa* L.) (1 %), mezcla de Burdeos (1 %), aceites de algodón (1,5 %) y aceites de canola (1 %) y agua (control). En el segundo ciclo los tratamientos fueron romero (20 %), ruda (20 %), cúrcuma (2 %), canola aceite (2 %) y agua. El diseño experimental utilizado fue de bloques completamente al azar, con cinco repeticiones. Se realizó un análisis de varianza sobre los datos de severidad, el AUDPC y las medias de producción de frutos se compararon mediante la prueba de Scott-Knott y Tukey al 5 % de probabilidad para primer y segundo ciclos. El aceite de canola (1 y 2 %) redujo los síntomas de la enfermedad en los dos ciclos. Los extractos de romero y ruda se redujeron justo cuando la gravedad de la enfermedad era baja. Los aceites de algodón y canola y los extractos de romero, ruda y cúrcuma aumentaron la producción de frutos de fresa.

Palabras clave: *Mycosphaerella fragariae*, control alternativo, romero, ruda, aceite de canola, aceite de semilla de algodón.

Strawberry (*Fragaria × ananassa* Duch.) is affected by several leaf diseases and the common leaf spot (CLS) caused by *Mycosphaerella fragariae* (Tul. & C. Tul.) Lindau is one of the most economically important. Control is mostly performed with synthetic fungicides despite the risk of damage to health of farmers, consumers, and the environment that they may cause if improperly used. Previous studies showed that extracts of turmeric (*Curcuma longa*), garlic (*Allium sativum*), rue (*Ruta graveolens*), and wormwood (*Artemisia absinthium*) had fungicide effect (1,2) which may reduce or even substitute synthetic fungicides.

Looking for providing alternatives mostly to organic growers, the field efficiency of the extracts and plant oils for the CLS and their effects on organic strawberry fruit production was evaluated.

The experiments were carried out at Universidade Estadual de Londrina (Londrina-PR, Brazil) (23°19'44.5"S; 51°12'17.3"W; 585 m) for two cycles (2013 and 2015) in bed (1.2 m wide) with two cultiva-

tion lines (0.30 x 0.30 m) (experimental unit: 2.4 m x 1.2 m). Camarosa (transplanted on August 7, 2013) and Albion (transplanted on August 17, 2015) cultivars were used.

The evaluations were made with the natural incidence of the CLS. For disease severity, four central plants of each plot were used. In each plant, two leaves were randomly evaluated, and each of the leaves (average of the three leaflets) received a value according to a diagrammatic scale (3). Then the area under the disease progress curve (AUDPC) was calculated.

For the first cycle, the treatments were: rosemary extract (*Rosmarinus officinalis* L.) (10 %), garlic extract (0.01 %), rue extract (10 %), Bordeaux mixture (copper sulfate, hydrated lime and water in proportion 1:1:100) (1 %), turmeric extract (1 %), cottonseed oil (1.5 %), canola oil (1 %), and water (control). For the second cycle, the treatments were: rosemary extract (20 %), rue extract a 20 %, and turmeric extract (2 %), canola oil (2 %), and water (control).

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For the rosemary and rue extracts, 50g of leaves were separately crushed and blended with 100 mL of distilled water for 10 minutes. From these crude liquid extracts, aqueous extracts of each plant with 10 and 20 % concentrations were prepared for the first and second cycles, respectively (4).

The garlic extract was prepared by crushing 10g of garlic for 1 L of water and left to rest for twelve days. After this period, the extract was diluted to 1 % with water.

The turmeric extract at 1 % was prepared with crushed rhizomes in distilled water.

For the oil products, canola and cottonseed oils were emulsified in water at the desired concentrations [cottonseed (1.5 %); canola (1 and 2 %), first and second cycles, respectively] adding neutral detergent (1.0 %).

The strawberries were harvested twice a week. The fruits harvested were from the plants that were used for the disease evaluations (four plants per plot). Defective plants and diseased fruits were discarded.

A completely randomized block design with five replications was used. The data were transformed into the square root of (x + 1), and an analysis of variance was performed. AUDPC and fruit production means were compared by the Scott-Knott test for first cycle

and Tukey test were used for second cycle, both at 5 % probability.

In the first cycle, canola oil and the extracts of rue and rosemary showed lower AUDPC values than the control (Table 1). In a previous study, the 10 % rosemary extract provided satisfactory control of the mycelium growth of *Glomerella cingulata* (Stoneman) Spauld. & H. Schrenk, (1903) and *Colletotrichum gloeosporioides* (Penz.) (5). Canola oil controlled powdery mildew, *Sphaerotheca pannosa* var. *rosae*, on grapevine (6), and linseed and rapeseed oils were successfully used for *Uromyces appendiculatus* control (7). Although the lower AUDPC value presented by the turmeric extract was not significantly different from the value in the control, this extract provided a reduction in severity at 100 days after transplantation. In previous studies, *Alternaria solani* and *Botrytis cinerea* was observed to be controlled by curcumin and turmeric extract (2,8).

In the second cycle, the values of the CLS severity were higher than those observed during the first year (Table 1) since the plants were in their second production cycle. For both the first and the second cycles, there were reductions in severity between an evaluation date and the next one. This can be explained by the fact that the plant continues emitting new leaves.

Table 1. Common leaf spot severity at 86, 100 and 114 days after transplantation (DAT) (first cycle, Camarosa variety) and 39, 53, 67, 91, and 115 days after transplantation (DAT), for the second cycle, Albion variety, and area under the common leaf spot progress curve (AUDPC) in strawberry plants under different treatments. Londrina, Paraná, Brazil. / Severidad de la viruela de la fresa a los 86, 100 y 114 días después del trasplante (DAT) (primer ciclo, variedad Camarosa) y 39, 53, 67, 91, y 115 días después del trasplante (DAT) (para el segundo ciclo, variedad Albión) y área bajo la curva de desarrollo (AUDPC) de la viruela de la fresa de plantas bajo diferentes tratamientos. Londrina, Paraná, Brasil.

		Cycle 1					
Treatments and concentrations		Common leaf spot severity (%)					
(% m/v)		86 DAT	100 DAT	114 DAT	AUDPC		
Rosemary extract (10 %)		0.59 a	0.20 b	0.59 a	1.61 b		
Canola oil (1 %)		1.07 a	0.33 b	0.51 a	1.68 b		
Rue extract (10 %)		0.94 a	0.30 b	0.77 a	1.70 b		
Turmeric extract (1 %)		1.20 a	0.40 b	0.15 a	1.78 a		
Garlic extract (0.01 %)		1.58 a	0.70 a	1.27 a	1.90 a		
Cottonseed oil (1.5 %)		1.01 a	0.81 a	0.62 a	1.91 a		
Bordeaux mixture (1 %)		1.24 a	0.92 a	0.74 a	1.94 a		
Control		1.96 a	0.92 a	1.15 a	2.11 a		
C.V. (%)		18.41	11.67	21.57	15.66		
		Cycle 2					
Treatments and concentrations		Common leaf spot severity (%)					
(% m/v)		39 DAT	53 DAT	67 DAT	91 DAT	115 DAT	AUDPC
Canola oil (2 %)		0.83 ab	0.78 b	1.38 b	0.73 b	3.50 a	1.19 b
Rue extract (20 %)		0.89 ab	1.04 b	1.92 ab	1.25 ab	2.95 ab	1.44 ab
Rosemary extract (20 %)		0.48 b	1.11 b	1.53 b	1.68 ab	3.35 ab	1.70 ab
Control		1.19 a	1.55 a	2.36 a	1.68 ab	2.40 b	1.71 a
Turmeric extract (2 %)		0.83 ab	1.00 b	1.62 b	2.40 a	3.03 ab	1.91 a
C.V. (%)		29.39	19.80	17.19	42.72	14.94	14.98

Severity means in the same column followed by the same letter do not differ by the Scott-Knott and Tukey tests at the 5 % probability level for first and second cycles, respectively.

The treatments with rosemary (20 %) and canola oil (2 %) showed lower severity means than the control on three of the five evaluation dates. However, the AUDPC value was lower than the control only in the treatment with canola oil. Canola oil previously controlled powdery mildew in rose bush and rust (*Puccinia arachidis* Speg.) in peanuts (9, 10).

Fruit production was lower in the plants treated with garlic or Bordeaux mixture and in the control than in the plants with other treatments (Figure 1). Although no control was provided by the treatments with cotton oil or turmeric extract (their AUDPC values were similar to those in the control), the fruit production in these treatments did not differ from that in the treatments with the canola oil, rosemary or rue, which did control the disease. Bordeaux mixture neither controlled the disease and nor increased production. The use of plant extracts and oils to control plant diseases, despite the great potential they have for being used in plant protection, is still an emerging topic approached in researches (11-14). Some extracts may even have an effect on inducing plant resistance, promoting systemic resistance against pathogens (15). Therefore, future researches should study these biochemical chains that provide an effective control of diseases with a reduced use or none of chemical products.

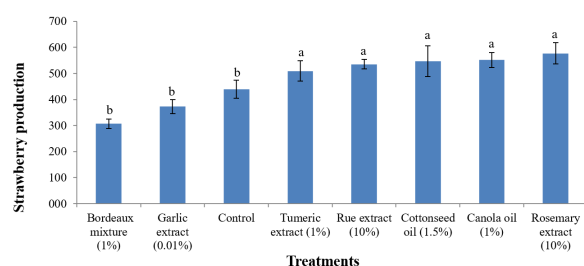


Figure 1. Total plant fruit production of strawberry (Camarosa cv.) under treatments for disease control (Mean+SE). Londrina, 2013. / *Producción total de plantas de fresa bajo tratamientos para el control de la enfermedad (Media+ES). Londrina, 2013.*

In summary, canola oil (1 and 2 %) decreased the incidence of common leaf spot in both years. Rosemary and rue extracts controlled only when the disease severity was low. Cotton and canola oils and the aqueous extracts of rosemary, rue and turmeric provided an increase of strawberry fruits.

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