Crop Breeding and Applied Biotechnology 15: 285-289, 2015
Brazilian Society of Plant Breeding. Printed in Brazil

CULTIVAR RELEASE

http://dx.doi.org/10.1590/1984-70332015v15n4c48

'Norine', a cinnamon-linalool hybrid cultivar of basil

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Received 02 December 2014

Accepted 30 July 2015

Abstract – 'Norine' is a hybrid cultivar of basil, adapted to the Northeastern Brazil, which is derived from the cultivars 'Cinnamon' and 'Maria Bonita'. It has essential oil content of 2.91% and yield of 2.37 mL plant^{-1}. The main chemical compounds of the essential oil are (E)-methyl cinnamate (41.93 %) and linalool (34.92 %). 'Norine' is characterized by presenting upright growth habit, rounded crown, mean height of 55 cm, mean crown diameter of 59 cm, mean leaf length of 8.4 cm, and mean leaf width of 4.5 cm

Key words: Ocimum basilicum *L., essential oil, methyl cinnamate, linalool.*

INTRODUCTION

Basil (*Ocimum basilicum* L. - Lamiaceae) is an annual or perennial plant, depending on where it is grown. It is an autogamous species with medicinal, aromatic, and spice potential. Although basil flower is hermaphrodite, there may be cross-pollination between different types or varieties, mainly by the activity of bees (Sobti and Pushpangadan 1982). Cross-pollination can vary between 32 and 66% (Krishnan 1981, Nation et al. 1992). Its essential oil can be extracted from the leaves and from apices with inflorescences.

It has a diversity of chemotypes, which have frequently been discovered. One of the main goals of basil genetic improvement programs is to identify and introduce new compounds in the essential oil which increase the chemical quality and impart properties of interest for the market, specifically for the pharmaceutical, cosmetic, and perfume industries.

(E)-methyl cinnamate is one of the components of the essential oil of basil, which produces a flavor similar to cinnamon (*Cinnamomum zeylanicum*) and can be used in "fine" perfumery, cosmetics, and other personal hygiene products, as well as in non-cosmetic products (Sharma and Kanwar 2012).

Linalool is another component, and it is the main target of basil genetic improvement programs due to its various properties, including sedative, anxiolytic, analgesic, anticonvulsant, anti-inflammatory, and anesthetic properties. In addition, it is used in perfumes, cosmetics, and flavorings (Beier et al. 2014, Aprotosoaie et al. 2014).

In this regard, the Universidade Federal de Sergipe (Federal University of Sergipe) has carried out experiments to evaluate the crop since 2000 in an effort to obtain cultivars adapted to the edapho-climatic conditions of the Northeastern Brazil, and which encompass the qualities required by the market. This study presents the hybrid cultivar 'Norine', which contains linalool and (E)-methyl cinnamate as its major compounds.

GENETIC ORIGIN AND DEVELOPMENT

Cultivar Norine was derived from the cultivars 'Cinnamon' and 'Maria Bonita', obtained from the company Johnny's Selected Seeds and the Universidade Federal de Sergipe, respectively. To produce basil cultivars, it is necessary to protect the plants or inflorescences with white screen, in order to avoid contamination with other pollen carried by bees, and to ensure the production of homozygous seeds.

To obtain 'Norine', the homozygous cultivars Cinnamon and Maria Bonita were crossed in 2009, in

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a greenhouse covered with white screen, located at the Research Farm Campus Rural da UFS, at the municipality of São Cristóvão, state of Sergipe, Brazil (Blank et al. 2012). The cross was carried out in the morning (7:00-9:00 am), and the cultivar Cinnamon was the genitor plant from which the inflorescences were selected and marked with wool yarn before the flower buds were emasculated at pre-anthesis. Flowers of the cultivar Maria Bonita were harvested to obtain the pollen (genitor). The harvested flowers (containing pollen) were rubbed against the stigmas of the emasculated flowers, and the inflorescences were protected with paper bags after manual pollination. Thus, a hybrid from the cross 'Cinnamon' x 'Maria Bonita' was obtained. Among 12 plants obtained from this cross, one plant was selected ('Cinnamon' x 'Maria Bonita' pl#08), which presented high linalool and (E)-methyl cinnamate content, and high essential oil yield (Blank et al. 2012) for vegetative propagation using cuttings.

PERFORMANCE CHARACTERISTICS

The hybrid 'Cinnamon' x 'Maria Bonita' was distinguishable as a new hybrid cultivar after the results of four competition trials between the hybrid, its parent cultivars and commercial cultivars during the 2009/2010, 2010/2011, 2011/2012, and 2012/2013 crop years at the Research Farm Campus Rural da UFS.

To implement these trials, seedlings were grown in an environment protected by 50% shadow screen, with irrigation in 162-cell polypropylene trays. The substrate comprised cattle manure, coconut powder, sand, and soil (1:1:1:2 ratio), with 1 g of lime and 6 g of Hortosafra® fertilizer (6 % N, 24 % P_2O_5, 12 % K_2O, 5.1 % Ca, 4.9 % S, 0.189 % Zn, 0.06 % B and 0.09 % Mn) added per liter of substrate. Seedlings were transplanted in December of the respective year when they presented three pairs of defined leaves.

At the experimental site, soil was prepared and 2 t ha^{-1} of lime was applied at 30 days before planting, according

Table 1. Dry weight of aerial part, essential oil content and yield of the basil hybrid cultivar Norine (*Ocimum basilicum* L.), the parent cultivars Cinnamon and Maria Bonita, and the commercial cultivars Sweet Dani and Genovese, for experiments carried out in the municipality of São Cristóvão, state of Sergipe, Brazil, during the crop years of 2009/2010, 2010/2011, 2011/2012 and 2012/2013

Cultivar	Crop years				Mean
	2009/2010	2010/2011	2011/2012	2012/2013	
Dry weight of aerial part (g $plant^{-1}$)					
Sweet Dani*	32.68 bB	51.27 dA	38.87 cB	32.68 bB	38.87 c
Genovese*	22.64 bC	69.81 cA	37.45 cB	19.91 cC	37.45 c
Cinnamon	25.14 bB	47.69 dA	34.03 cB	29.27 bB	34.03 c
Maria Bonita	41.33 aB	88.82 bA	49.94 bB	19.66 cC	49.94 b
Norine	30.25 bD	195.82 aA	90.72 aB	46.09 aC	90.72 a
Mean	30.41 C	90.68 A	50.20 B	29.52 C	50.20
CV (%)	18.54	6.61	8.47	35.25	14.07
Essential oil content (%)					
Sweet Dani*	1.22 cB	1.93 cA	1.46 cB	1.22 dB	1.46 d
Genovese*	1.45 cB	1.50 dB	1.71 cB	2.17 cA	1.71 c
Cinnamon	1.89 bB	1.00 eC	1.74 cB	2.33 cA	1.74 c
Maria Bonita	3.18 aC	5.00 aA	4.33 aB	4.80 aA	4.33 a
Norine	3.27 aA	2.47 bB	2.91 bA	3.00 bA	2.91 b
Mean	2.20 C	2.38 B	2.43 B	2.70 A	2.43
CV (%)	12.40	10.26	6.99	12.53	10.92
Essential oil yield (mL $plant^{-1}$)					
Sweet Dani*	0.39 cB	0.99 cA	0.59 bB	0.40 dB	0.59 c
Genovese*	0.30 cB	1.02 cA	0.58 bB	0.42 dB	0.58 c
Cinnamon	0.46 cA	0.48 dA	0.54 bA	0.67 cA	0.54 c
Maria Bonita	1.30 aC	4.44 bA	2.23 aB	0.95 bD	2.23 b
Norine	0.96 bD	4.83 aA	2.37 aB	1.33 aC	2.37 a
Mean	0.68 C	2.35 A	1.26 B	0.75 C	1.26
CV (%)	15.80	5.57	9.93	28.11	11.21

Means followed by the same lowercase letters in columns and uppercase letters in rows are not significantly different from each other, according to the Scott-Knott test ($p \leq 0.05$). CV: coefficient of variation.
*Commercial cultivar.

to prior soil analysis, in order to raise the base saturation to 70%. After liming and disking, 800 kg ha^{-1} of mono-ammonium-phosphate (MAP), 300 kg ha^{-1} of potassium chloride (KCl), and 5 t ha^{-1} of cattle manure were added to the soil.

The experiment was carried out in a randomized block

Table 2. Content of linalool, 1,8-cineol, geraniol, neral, geranial and methyl cinnamate in the essential oil of the basil hybrid cultivar Norine (*Ocimum basilicum* L.), the parent cultivars Cinnamon and Maria Bonita, and the commercial cultivars Sweet Dani and Genovese, for experiments carried out in the municipality of São Cristóvão, state of Sergipe, Brazil, during the crop years of 2009/2010, 2010/2011, 2011/2012 and 2012/2013

Cultivar	Crop years				Mean
	2009/2010	2010/2011	2011/2012	2012/2013	
			Linalool (%)		
Sweet Dani*	0.00 e	0.00 d	0.00 e	0.00 e	0.00 e
Genovese*	67.33 b	63.60 b	67.32 b	71.05 b	67.32 b
Cinnamon	27.25 d	27.38 c	25.99 d	23.34 d	25.99 d
Maria Bonita	75.40 a	73.33 a	75.51 a	75.18 a	74.85 a
Norine	32.19 c	28.16 c	34.92 c	44.42 c	34.92 c
CV (%)	5.97	2.94	1.85	2.74	3.70
			1,8-Cineol (%)		
Sweet Dani*	0.00 d	0.00 d	0.00 d	0.00 b	0.00 d
Genovese*	10.43 a	8.42 a	15.99 a	5.43 a	10.07 a
Cinnamon	3.49 c	1.69 c	4.34 c	6.44 a	3.99 c
Maria Bonita	5.24 b	4.82 b	4.28 c	5.15 a	4.87 b
Norine	5.38 b	4.20 b	6.85 b	5.13 a	5.39 b
CV (%)	8.69	14.55	11.76	28.05	17.08
			Geraniol (%)		
Sweet Dani*	1.92 b	1.90 b	1.96 b	1.98 b	1.94 b
Genovese*	0.00 c	0.00 c	0.00 c	0.00 c	0.00 c
Cinnamon	0.00 c	0.00 c	0.00 c	0.00 c	0.00 c
Maria Bonita	14.67 a	16.34 a	14.70 a	13.75 a	14.86 a
Norine	0.00 c	0.00 c	0.00 c	0.00 c	0.00 c
CV (%)	10.25	15.27	10.73	13.13	12.17
			Neral (%)		
Sweet Dani*	31.68 a	32.65 a	31.72 a	32.75 a	32.20 a
Genovese*	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Cinnamon	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Maria Bonita	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Norine	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
CV (%)	19.16	4.72	19.16	25.15	19.05
			Geranial (%)		
Sweet Dani*	41.40 a	43.11 a	42.00 a	41.48 a	42.00 a
Genovese*	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Cinnamon	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Maria Bonita	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
Norine	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
CV (%)	12.04	13.66	10.02	12.04	12.03
			Methyl cinnamate (%)		
Sweet Dani*	0.00 c	0.00 b	0.00 c	0.00 c	0.00 c
Genovese*	0.00 c	0.00 b	0.00 c	0.00 c	0.00 c
Cinnamon	51.94 a	47.17 a	44.87 a	46.70 a	47.67 a
Maria Bonita	0.00 c	0.00 b	0.00 c	0.00 c	0.00 c
Norine	47.36 b	47.16 a	41.93 b	31.27 b	41.93 b
CV (%)	3.70	5.80	3.09	6.36	4.79

Means followed by the same lowercase letters in columns and uppercase letters in rows are not significantly different from each other, according to the Scott-Knott test ($p \leq 0.05$). CV: coefficient of variation.
*Commercial cultivar.

design, with three replications. Each useful plot comprised two rows of three plants, totaling six plants, spaced 0.60 x 0.50 m apart.

The crop was managed according to Blank et al. (2004). Plants were drip irrigated according to the crop's water needs. The crop was harvested at 60 days after transplanting, in February of the respective year, during the full flowering of the plants from each plot. The six plants from each plot were cut at 20 cm above the soil, and then defoliated.

To obtain shoot dry weight, samples of leaves + inflorescences of each plot were weighed after being dried in a forced-air circulation drying oven at 40 ºC for five days, and the results were expressed in g plant^{-1}.

A 50 g sample of dry leaves + inflorescences from each plot was hydrodistilled for 140 minutes in a Clevenger distiller, collected in 3-liter flasks, in order to measure the essential oil content, which is expressed in %, based on mL 100 g^{-1} of dry matter weight (Ehlert et al. 2006). The essential oil yield (mL plant^{-1}) was obtained by multiplying the essential oil content by the shoot dry weight.

The chemical composition of the essential oils was analyzed via gas chromatography using a GC/MS-FID (QP2010 Ultra, Shimadzu Corporation) equipped with an AOC-20i automated sampler (Shimadzu). Essential oil components were identified by comparing the mass spectra in the found in the literature (Adams 2007) with spectra from the equipment's databases (NIST21, NIST107 and WILEY8), and also by comparing retention indices with those of the literature. The Kovats retention indices (KI) were determined using a homologous series of *n*-alkanes (C_9H_{20}–$C_{19}H_{40}$) injected under the same chromatographic conditions as the samples, using the equation by Van Den Dool and Kratz (Van Den Dool and Kratz 1963).

Based on the competition trials, the cultivar had an efficient agronomic performance, and it even had aerial part dry weight yield higher than its parents and other commercial cultivars (Table 1). Its aerial part dry weight was 90.72 g plant^{-1}, while the 'Cinnamon' and 'Maria Bonita' cultivars aerial part dry yield values were 34.03 g plant^{-1} and 49.94 g plant^{-1}, respectively. The hybrid cultivar had an essential oil content of 2.91%. Additionally, the new hybrid cultivar demonstrated the potential for a higher essential oil yield (2.37 mL plant^{-1}). This is because the yield was higher than that of the cultivar 'Cinnamon' (0.54 mL plant^{-1}), and of the cultivar 'Maria Bonita' (2.23 mL plant^{-1}), which is recognized for its high linalool and essential oil content and yield (Table 1). The new cultivar also presented higher means compared to the 'Cinnamon' parent for other characteristics, including linalool (Table 2). 'Norine' produces high contents of linalool (34.92 %) and (E)-methyl cinnamate (41.93 %), in addition to 5.39 % of 1,8-cineol, which are compounds of interest for the essential oil market (Table 2).

OTHER CHARACTERISTICS

The hybrid cultivar Norine is characterized by having upright growth habit, rounded crown, mean height of 55.41 cm, mean crown diameter of 59.58 cm, mean leaf length of 8.45 cm, and mean leaf width of 4.55 cm (Blank et al. 2012). The stem is dark purple, and the leaves and the ribs are intermediately tinted green. The inflorescences comprise flowers with rosy petals and purple sepals.

PLANT MAINTENANCE AND DISTRIBUTION

'Norine' is deposited in the herbarium of the UFS under the number ASE 31985, and will be registered by the Ministério da Agricultura, Pecuária e Abastecimento - MAPA (Ministry of Agriculture, Livestock and Supply). 'Norine' hybrid cultivar plants are maintained at the Research Farm "Campus Rural da UFS", in the municipality of São Cristóvão, state of Sergipe, Brazil, in a greenhouse covered with a 50% shade screen. They are propagated via vegetative propagation, and can be farmed in a protected environment or under field conditions. Information about the cultivar may be obtained through the Departamento de Engenharia Agronômica - Universidade Federal de Sergipe (Department of Agronomic Engeneering), Av. Marechal Rondon s/n, Jardim Rosa Elze, 49.100-000, São Cristóvão, SE, Brasil.

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