CROP BREEDING AND APPLIED BIOTECHNOLOGY

CULTIVAR RELEASE

UNEMAT Pedro and UNEMAT Malagueta Pantaneira: New pepper cultivars with increased resistance to anthracnose

Ana Flávia Silva Amorim[1], Sabrina Cassaro[1*], Lourismar Martins Araújo[2], Isabela Vera dos Anjos[1], Antonio Marcos Chimello[1], Maria do Socorro Bezerra de Araújo[1], Thiago Alexandre Santana Gilio[3], Kelly Lana Araújo[1] and Leonarda Grillo Neves[1]

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Abstract: *The objective of this study was to introduce new cultivars of Capsicum frutescens L. (pepper) with resistance to anthracnose. 'UNEMAT Pedro' is characterized by its red fruits, while 'UNEMAT Malagueta Pantaneira' is hybrid with orange–red fruits. Both cultivars exhibit a semi-perennial growth cycle, a pungent fruit flavour, and high productivity.*

Keywords: Colletotrichum*, genetic breeding, disease resistance*

INTRODUCTION

The genus *Capsicum* comprises peppers and chilies, which can be consumed as vegetables (fresh), in sauces, in condiments, and/or as spices. The genus includes over 30 species, five of which have been domesticated (*C. annum*, *C. baccatum*, *C. chinense*, *C. frutescens*, and *C. pubescens*) (Tripodi and Kumar 2019). There is a wide variety of peppers, differing primarily in shape, size, pulp thickness (pericarp), and final colour during the maturation stages (Rasekh et al. 2022). Among the domesticated species, *C. frutescens* is the predominantly cultivated species in America, Asia, and Africa and is known for its pungent and highly pungent varieties (Tripodi and Kumar 2019). Nutritionally, *Capsicum* spp. are rich in vitamins and minerals. In the past two decades, there have been significant increases in the global demand and production of *Capsicum* (Devendran et al. 2022). However, *Capsicum* production faces limitations due to various types of abiotic and biotic stress (Parisi et al. 2020).

Anthracnose is a disease caused by fungi of the genus *Colletotrichum*, and its occurrence can lead to significant losses in large-scale production (Silva et al. 2020). This disease can affect all stages of production, from seeds to post-harvest fruits (Fisher et al. 2019). Due to its economic importance and scientific relevance, this genus has been included among the ten most important worldwide. To date, 218 species of *Colletotrichum* have been identified and classified into 12 species complexes, and others are recognized as individual species. These species infect over 30 plant genera, causing anthracnose and post-harvest diseases (Silva et al. 2020).

The species *C. gloeosporioides* is the most common cause of anthracnose in Brazil. Initial symptoms of anthracnose in plants and fruits appear as circular

***Corresponding author:**
E-mail: sabrina.cassaro@unemat.br
ORCID: 0000-0001-9440-1750

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[1] Universidade do Estado de Mato Grosso, Avenida São João, s/n, Cavalhada, 78200-000, Cáceres, MT, Brazil
[2] Instituto Federal de Mato Grosso, Avenida Senador Filinto Müller, 953, Quilombo, 78043-400, Cuiabá, MT, Brazil
[3] Universidade Federal de Mato Grosso, Departamento de Agronomia/Engenharia Florestal, Rua Quarenta e Nove, 2367, Boa Esperança, 78060-900, Cuiabá, MT, Brazil

lesions, which gradually darken and increase in size. The disease is most prevalent during the summer due to higher humidity. The pathogen spreads through water splashes and can be further dispersed by rain or irrigation (Moura et al. 2013).

Chemical control is the method most commonly used to manage anthracnose (Reis et al. 2009). However, alternative approaches such as the use of plant extracts for disease control have shown promising results, as chemical products can have significant environmental consequences (Casemiro et al. 2019). Nonetheless, genetic resistance is considered a more effective management strategy (Santos and Parreira 2022).

Considering the significance of anthracnose, the objective of this study was to introduce new anthracnose-resistant cultivars of *C. frutescens* L. (pepper), developed through the genetic improvement program at the Universidade do Estado de Mato Grosso (UNEMAT), along with their main morpho-agronomic traits.

HISTORY AND BREEDING METHOD

The UNEMAT Pedro cultivar is a line derived from the UNEMAT 44 accession, which was collected in the city of Cáceres, state of Mato Grosso (lat 16° 04' 14'' S, long 57° 40' 44'' W). After the resistance to anthracnose, fruit potential, and production of this cultivar were assessed (Amorim et al. 2021), two rounds of mass selection were conducted to further improve its desirable traits (Figure 1).

The UNEMAT Malagueta Pantaneira cultivar is a hybrid developed by crossing the parents UNEMAT 115 and UNEMAT 17 (Figure 1), which are part of the Active Germplasm Bank (AGB) of the Laboratório de Melhoramento Genético Vegetal (LMGV) of the UNEMAT. The selection of parental lines was based on their potential resistance to *C. gloeosporioides* (Maracahipes et al. 2016).

Prior to being registered by the Ministério da Agricultura, Pecuária e Abastecimento (MAPA), both the lineage and the hybrid underwent systematic evaluations following the standards and minimum requirements for determining the Value for Cultivation and Use (VCU) for *Capsicum*. These evaluations were performed to assess the suitability of the cultivars for inclusion in the National Registry of Cultivars (NRC).

The experiment was carried out at the field experimental site for *Capsicum* at LMGV/UNEMAT, located on the Jane Vanini Campus in Cáceres, Mato Grosso, Brazil. The geographic coordinates of the site are approximately between latitudes 15° 27' and 17° 37' S and longitudes 57° 00' and 58° 48' W. The site has an altitude of 118 m asl. The experiment was conducted from August 2019 to April 2020. According to the Köppen (1936) climate classification, the climate is tropical, classified as "Aw," with an average temperature of 26.6 °C and an average annual rainfall of 1158 mm.

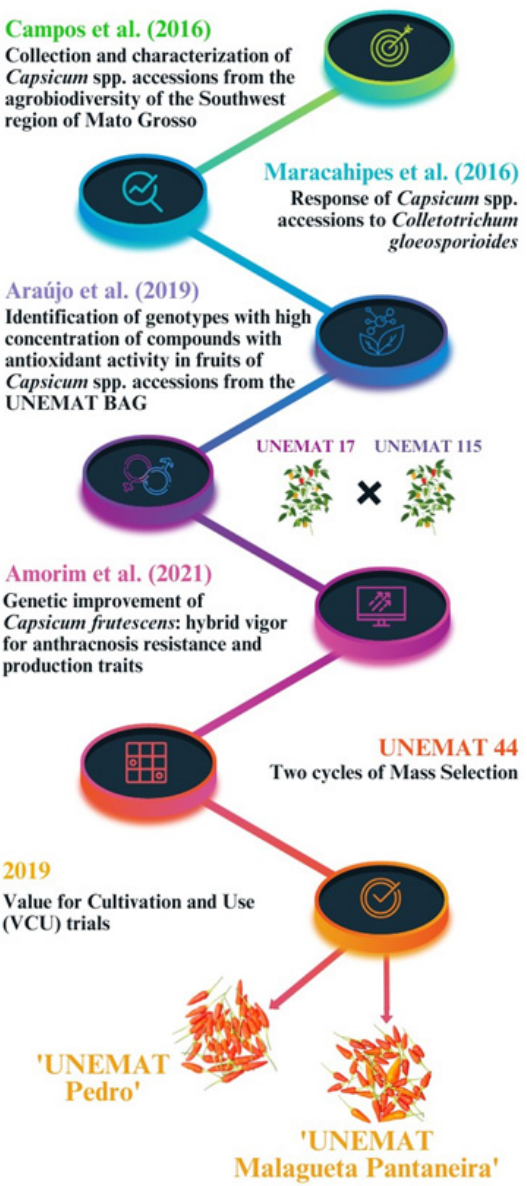

Figure 1. Flowchart of the breeding program used to obtain the cultivars UNEMAT Pedro and UNEMAT Malagueta Pantaneira.

Table 1. Morpho-agronomic descriptors of *Capsicum* showing polymorphism

Descriptor	New cultivars		Reference cultivar
	UNEMAT Malagueta Pantaneira	UNEMAT Pedro	Malagueta
Plant: stem position	semi-erect	semi-erect	upright
Plant: internode length	long	long	long
Flower: anther colouring	blue	violet	blue
Fruit: colouring before ripening	green	white–green	green
Fruit: colour intensity before maturation	clear	clear	average
Fruit: length	long	average	short
Fruit: diameter	average	average	small
Fruit: apex shape	rounded sharp	rounded	rounded
Peduncle: length	average	short	short
Cycle to flowering	47 days	38 days	38 days
Cycle to maturation	96 days	96 days	96 days

To obtain the seedlings, three seeds of each genotype were sown in polyethylene tubes filled with commercial substrate, with three seeds per container. Subsequently, the tubes were placed in a greenhouse under controlled temperature, irrigated twice per day, and treated with foliar fertilizer weekly for a duration of 36 days. Following this period, the seedlings were transferred to an acclimatization area prior to being transplanted into the field. The transplantation of the seedlings occurred 57 days after planting, when the plants had clearly developed two pairs of true leaves.

The experiment followed a randomized block design with four blocks, three treatments, and twenty plants per plot. The spacing between plants was set at 1x1 m, both within rows and between rows, resulting in a total effective area of 200 m². A drip irrigation system was utilized to water the plants.

For morpho-agronomic evaluation of the cultivars, a set of 48 minimum descriptors proposed by Brasil (2006) for *Capsicum* were utilized (Table 1). In terms of productive performance, the following traits were assessed: average fruit mass (AFM), the average weight of 100 fruits without the peduncle; fruit dry mass (FDM), the average mass of 100 fruits after drying (using a forced circulation oven at 60 °C for 72 hours); fruit length (FL) (in cm); fruit diameter (FD) (in cm); number of fruits (NF), the mean number of fruits collected across the eight harvests; and yield (P) (in kg ha^{-1}).

For anthracnose resistance evaluation, three immature fruits (at 35 days) from each treatment were harvested and brought to the laboratory. They were disinfected with 0.5% sodium hypochlorite and 70% alcohol and washed in sterilized distilled water, with one minute allocated to each step. Subsequently, they were placed in polystyrene trays lined with damp paper towels and covered with transparent plastic bags to create a humid chamber. For inoculation, a conidial suspension was prepared from a Petri dish containing the fungus *C. scovillei* (CS03) obtained from the LMGV Mycoteca and cultivated in potato-dextrose-agar (PDA) medium. Spore quantity was measured using a Neubauer chamber, and the suspension was adjusted to 10^6 conidia/ml. A wound was made in the middle region of each fruit using a sterilized needle, and a 20 µL drop of the spore suspension (10^6 conidia/ml) was deposited onto the wound. The trays were stored in a temperature-controlled environment at 24 °C ± 2, and evaluation was performed daily on all fruits up to 11 days after inoculation. The lesion area (LA) (mm²) was assessed at seven days (LA7) and 11 days (LA11) after inoculation by measuring the width (mm) and length (mm) of each lesion with digital callipers.

A commercial cultivar of Blueline chili pepper from Topseed Garden, considered susceptible to anthracnose, was used as the control. The data were subjected to the Jarque–Bera normality test, analysis of variance, and Tukey's mean comparison test at a 5% probability level using the Genes software (Cruz 2016).

PERFORMANCE AND AGRONOMIC PROFILE

In addition to the reasons provided earlier, the hybrid "UNEMAT Malagueta Pantaneira" also stands out because of its exceptional yield potential. During the VCU tests, its yield consistently surpassed that of the commercial cultivar (Table 2). This trait further emphasizes the superior agronomic performance of 'UNEMAT Malagueta Pantaneira' in terms of yield and overall yield.

Table 2. Means of productive performance traits and resistance to anthracnose evaluated in pepper (*Capsicum frutescens* L.) cultivars

Cultivars	Traits							
	AFM	FDM	FL	FW	NF	Y	LA7	LA11
UNEMAT Pedro	446.82 b	89.00 b	3.09 b	0.89 b	515 a	3574.60 b	1.43 b	1.83 b
UNEMAT Malagueta Pantaneira	679.46 a	202.73 a	4.2 a	1.3 a	443 b	5435.74 a	1.59 b	1.74 b
Malagueta	393.5 b	62.81 c	2.89 b	0.83 b	427 b	1548.16 c	104.55 a	114.22 a

AFM: average fruit mass; FDM: fruit dry mass; FL: fruit length; FW: fruit diameter; FN: number of fruits; Y: yield; LA7: lesion area on the seventh day; LA11: lesion area on the 11th day. Means followed by the same letter in each column do not differ according to Tukey's test ($p < 0.05$).

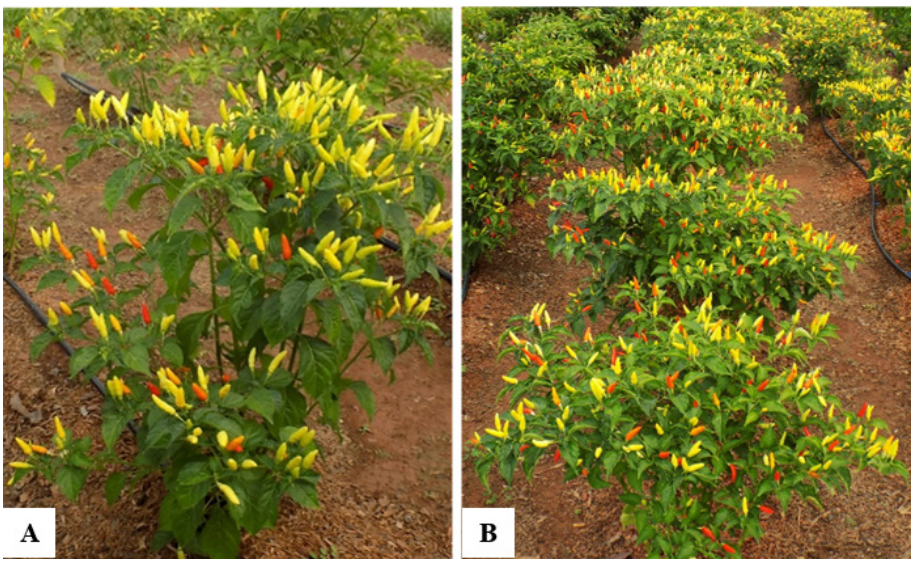

Figure 2. New pepper cultivars (*Capsicum frutescens)* UNEMAT Pedro (A) and UNEMAT Malagueta Pantaneira (B) developed by Universidade do Estado de Mato Grosso (UNEMAT).

The UNEMAT Pedro and UNEMAT Malagueta Pantaneira cultivars exhibited average yields of 3574.60 and 5435.74 kg ha^{-1}, respectively, which are two to four times higher than that of the commercial cultivar Malagueta (1548.16 kg ha^{-1}).

The cultivar UNEMAT Pedro has a semi-perennial cycle, with the onset of harvest occurring 96 days after transplanting the seedlings. Its fruits possess a distinct spicy flavour and are distinct from other chili peppers, particularly due to their average length (3.09 cm) and diameter (0.89 cm), which are significantly greater than those of peppers commonly found in the market. The fruits of UNEMAT Pedro start off as light green and turn red upon maturation (Figure 2). Additionally, this cultivar exhibits high levels of antioxidants (Araújo et al. 2019).

The cultivar UNEMAT Malagueta Pantaneira is a vigorous hybrid with a pungent taste and a relatively short growth cycle of 96 days. Its fruits are elongated, starting off green and turning orange–red upon maturation (Figure 3). On average, the fruits measure 4.2 cm in length and 1.3 cm in diameter.

OTHER TRAITS

Commercially available Malagueta pepper cultivars are susceptible to anthracnose. Due to the existence of multiple *Colletotrichum* species and pathotypes, developing and marketing an anthracnose-resistant cultivar are highly challenging tasks (Mishra et al. 2019). In this context, the key technological advantage of the UNEMAT Pedro and UNEMAT Malagueta Pantaneira cultivars is their increased resistance to anthracnose, the main post-harvest disease in this crop. This resistance is a significant advantage in disease management (Amorim et al. 2021). The intensity of anthracnose affecting the fruits of UNEMAT Pedro (1.83 mm^2) and UNEMAT Malagueta Pantaneira (1.74 mm^2) was significantly lower than that for the

fruits of susceptible commercial cultivars (114.22 mm²) (Table 2), demonstrating a high resistance, which, in turn, results in a longer shelf life for the fruits.

SEED PRODUCTION

The UNEMAT Pedro and UNEMAT Malagueta Pantaneira cultivars are registered in the NRC under the numbers 49190 and 49188, respectively, by the MAPA. The UNEMAT is responsible for the production and preservation of the genetic material of these cultivars.

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