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CULTIVAR RELEASE

‘UNEMAT Pavoro’ and ‘UNEMAT Implacável’: New malagueta pepper varieties with high productive and functional properties

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Abstract: *The cultivars ‘UNEMAT Implacável’ and ‘UNEMAT Pavoro’ exhibit high yield (7,610.30 kg ha^{-1} and 5,435.74 kg ha^{-1}, respectively) and elevated polyphenol content (307.92 mg 100g^{-1} and 310.87 mg 100g^{-1}, respectively). These traits support the sustainable production of functional foods, meeting the demands of competitive and high-value tropical markets.*

Keywords: Capsicum frutescens*, hybrids, genetic improvement, polyphenols*

INTRODUCTION

The genus *Capsicum*, originating from the Americas and belonging to the Solanaceae family, includes various species of peppers and bell peppers widely cultivated worldwide. These plants are valued not only for their culinary use but also for their medicinal and nutritional properties (Lal et al. 2023). Since ancient times, peppers have been integral to human culture, used as amulets, decorations, food additives, and in phytotherapies (Veiga Jr et al. 2022).

The genus includes a diversity of species with varying shapes, colors, sizes, and pungency levels, with some of the most well-known being *C. annuum*, *C. frutescens*, *C. chinense*, *C. baccatum*, and *C. pubescens* (Barboza et al. 2019, Lee 2019). The genetic variability within this genus has allowed the selection and development of cultivars adapted to different environmental conditions and market demands (Santo et al. 2022).

Capsicum frutescens, one of the most important species in the genus, plays a crucial role in agriculture and the food industry due to its versatility and high commercial value. The species is also important in agriculture, exhibiting considerable resistance to pests and diseases, and adapting well to various climatic and soil conditions, which makes it a popular choice among farmers (Santos et al. 2023). Tabasco and Malagueta peppers, the most well-known varieties, have distinct markets and are widely cultivated in tropical and subtropical regions (Alonso-Villegas et al. 2023, Santos et al. 2023).

In Brazil, there is an increasing demand for pepper cultivars. The cultivation of Malagueta peppers not only diversifies agricultural production but also contributes to the economic stability of farmers in the region. The state of Mato

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Grosso has significant potential to become a major pepper production hub, favored by favorable climatic conditions and the involvement of small local farmers. Recent studies highlight the importance of genetic improvement to meet market demands, promoting more productive cultivars with higher bioactive compound content and disease resistance (Soares et al. 2020).

The aim of this study was to evaluate *Capsicum frutescens* hybrids in terms of yield, resistance to anthracnose, and bioactive compound content, with the goal of generating information that contributes to increasing production efficiency and the competitiveness of Brazilian agriculture.

BREEDING METHOD

The hybrids 'UNEMAT Pavoro' and 'UNEMAT Implacável' were obtained through the crossbreeding of parental lines UNEMAT 44 x UNEMAT 52 and UNEMAT 115, respectively (Amorim et al. 2021) (Figure 1). These pure lines were developed by the breeding program of the Genetic Plant Breeding Laboratory (LMGV) and belong to the Active Germplasm Bank (BAG) of UNEMAT. The parental lines are of *C. frutescens* species and underwent five cycles of mass selection, selected based on their resistance to the fungus *Colletotrichum gloeosporioides* (Maracahipes et al. 2016), yield (Araújo et al. 2019, Amorim et al. 2024), and antioxidant potential.

The hybrids underwent rigorous performance evaluations, in accordance with the standards and minimum requirements established by the Ministry of Agriculture and Livestock (*Ministério da Agricultura e Pecuária* - MAPA) with a view to including the cultivars in the National Cultivar Registry (*Registro Nacional de Cultivares* - RNC).

The experiment was conducted from August 2019 to April 2020 at the experimental field of the LMGV/UNEMAT Jane Vanini Campus in Cáceres, MT, Brazil. The geographical area is located at lat 15º 27' and 17º 37' S, long 57º 00' and 58º 48' W, alt of 118 m asl. The region has a hot and humid tropical climate, with a dry winter as described by Neves et al. (2011).

To obtain the seedlings, hybrid seeds were sown in polyethylene tubes, using Vivatto® substrate. Each container received three seeds, and the seedlings were kept in a greenhouse with controlled temperature for 36 days. During this time, the plants were irrigated twice a day and received foliar fertilization weekly. After this period, the seedlings underwent an acclimatization process before being transferred to the field. The transplant was carried out 57 days after sowing, when the plants had two pairs of mature leaves. The experiment used a randomized block design with four blocks, six treatments, and ten plants per plot. A commercial Malagueta pepper cultivar (Blue line Topseed Garden) was used as a control. The spacing between plants and rows was 1 x 1 m. The irrigation system used was drip irrigation.

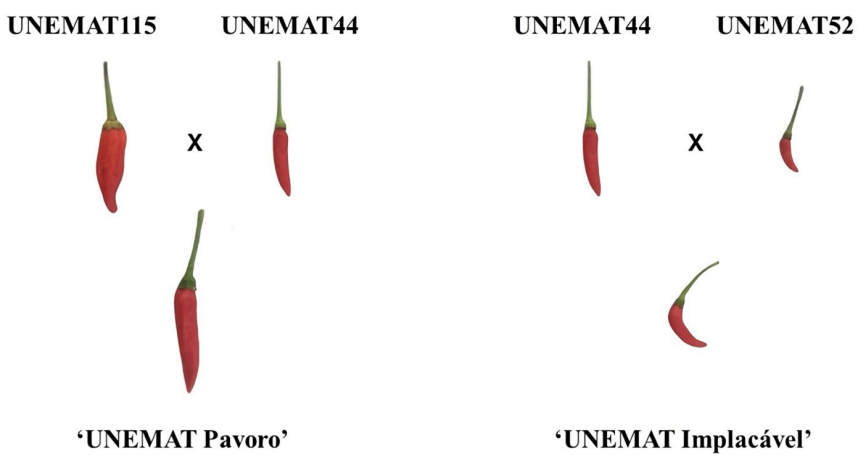

Figure 1. Parental lines UNEMAT44, UNEMAT52, and UNEMAT115 used to obtain the hybrids 'UNEMAT Pavoro' and 'UNEMAT Implacável'.

To quantify total polyphenols (TP), mature fruits were collected 45 days after anthesis, mashed in liquid nitrogen, and stored in an ultra-freezer (-80°C). The analysis followed the method of Morais et al. (2019), with some modifications. Extraction was performed using ethanol, methanol, and a refined methanol solution containing 1% HCl. The supernatants were combined to form the extract, which was evaluated at concentrations of 3, 6, and 9 mg mL^{-1}. For the analysis, an aliquot of the extract (100 µL) was mixed with 900 µL of distilled water, 500 µL of 10% Folin-Ciocalteu reagent, and 2.5 mL of 20% sodium carbonate. The mixture was homogenized and left to rest in the dark for 60 minutes. Absorbance was measured at 750 nm using a spectrophotometer. To calibrate this analysis, a gallic acid curve was generated, and the results were expressed in gallic acid equivalents (GAE mg $100g^{-1}$).

For the morpho-agronomic evaluation of pepper cultivars, 48 minimum descriptors proposed by the MAPA were used (Brasil 2006). Additionally, for evaluating production performance, the following characteristics were estimated: Number of fruits per plot (NFP): total number of fruits in the plot (harvested biweekly); Average fresh fruit weight (AFFW): average weight in grams (g) of twenty fresh fruits (calculated as the total fruit weight per plant divided by the number of fruits per plant); Dry fruit weight (DFW): average weight in grams (g) after drying 100g of fresh fruits without peduncle from each plant in the plot; Fruit length (FL): measured in centimeters; Fruit diameter (FD): measured in centimeters; Yield (Y): expressed in kg ha^{-1}. Data were analyzed by ANOVA and Tukey's test ($p < 0.05$) using the Genes software (Cruz et al. 2016).

PERFORMANCE AND AGRONOMIC PROFILE

The cultivar 'UNEMAT Implacável' is a vigorous and quite spicy hybrid with a relatively short cycle of 96 days. Its fruits are elongated, green before maturation, and acquire an orange-red hue upon maturation. The cultivar 'UNEMAT Pavoro' has a semi-perennial cycle, with the harvest beginning 96 days after transplanting. Its fruits are spicy and differ from typical Malagueta peppers, especially in size, being significantly larger than those found in the market. Before maturing, the fruits are light green, and after ripening, they turn red.

The hybrids 'UNEMAT Pavoro' and 'UNEMAT Implacável' showed significantly superior agronomic performance compared to the commercial Malagueta cultivar and the parental lines, highlighting the advances made by the UNEMAT breeding program (Table 1). These results emphasize the impact of mass selection and hybrid vigor in improving production efficiency and enhancing nutritional and morpho-agronomic traits.

The total polyphenol content was significantly higher in 'UNEMAT Pavoro' (310.87 mg $100g^{-1}$) and 'UNEMAT Implacável' (307.92 mg $100g^{-1}$), surpassing 'Malagueta' (192.15 mg $100g^{-1}$). These compounds are associated with antioxidant and therapeutic properties, increasing the market value of these peppers as functional foods (Santos et al. 2023, Bogusz Jr et al. 2018).

'UNEMAT Pavoro' (2.43 g) and UNEMAT 115 (2.48 g) stood out for their higher fresh mass, while the highest dry mass was observed in 'UNEMAT Pavoro' (3.04 g) and UNEMAT 115 (3.10 g). These results indicate potential for industrial use and higher yield in drying processes. The fruits of 'UNEMAT Pavoro' (3.57 cm) and UNEMAT 115 (3.12 cm) are longer and wider, favoring commercial acceptance and processing. Larger fruits are valued by the food industry and consumers (Soares et al. 2020).

Table 1. Averages of the characteristics evaluated in *Capsicum frutescens* L. peppers: parental lines UNEMAT44, UNEMAT52, and UNEMAT115, hybrid cultivars 'UNEMAT Pavoro' and 'UNEMAT Implacável', and the control cultivar Malagueta

Treatments	Traits						
	TP	AFFW	DFW	FL	FD	NFP	Y
UNEMAT Implacável	307.92 ab	1.75 c	1.55 b	2.10 b	0.62 d	170 a	7610.30 a
UNEMAT Pavoro	310.87 a	2.43 a	3.04 a	3.57 a	1.04 b	130 b	5435.74 b
Malagueta	192.15 b	1.82 c	1.48 b	2.19 b	0.83 c	75 c	1548.16 d
UNEMAT44	239.87 ab	2.05 b	1.67 b	3.12 a	0.82 c	100 d	4368.12 c
UNEMAT115	190.93 b	2.48 a	3.10 a	3.12 a	1.20 a	68 e	1502.11 d
UNEMAT52	235.20 ab	1.77 c	1.47 b	1.94 b	0.56 d	57 e	1499.85 d

TP: Total polyphenols (GAE mg $100g^{-1}$); AFFW: Average fresh fruit weight (g); DFW: Dry fruit weight (g); FL: Fruit length (cm); FD: Fruit diameter (cm); NFP: Number of fruits per plot; Y: Yield (kg ha^{-1}). Means followed by the same letter within columns do not differ significantly by Tukey's test ($p < 0.05$).

'UNEMAT Implacável' had the highest number of fruits per plot (170 fruits), followed by 'UNEMAT Pavoro' (130 fruits). This high NFP directly contributed to the high yield: 'UNEMAT Implacável' reached 7610.30 kg ha^{-1} and 'UNEMAT Pavoro' 5435.74 kg ha^{-1}, values far superior to that of the Malagueta cultivar (1548.16 kg ha^{-1}). These data corroborate studies by Naves et al. (2022), which highlight the efficiency of hybrid vigor in improving nutrient use and resistance to abiotic stresses.

The high yield of the cultivars 'UNEMAT Pavoro' and 'UNEMAT Implacável' represents a significant increase in the profitability of pepper production, providing a higher economic return per cultivated area compared to the commercial Malagueta cultivar. This can be especially advantageous in a competitive market. Moreover, traits like red fruits may be more accepted by consumers due to the perception of greater maturity and sensory quality, positively influencing sales and product appreciation. Larger fruits are also important as they may offer higher yield per unit of weight, making them more attractive for industrial processing and for consumers seeking larger peppers.

These results underscore the robustness and characteristics of the cultivars developed by UNEMAT, showing their potential to promote sustainability and competitiveness in the Brazilian agricultural sector, aligning with the market's demand for more nutritious and functional foods.

OTHER CHARACTERISTICS

The hybrid 'UNEMAT Pavoro' is notable for its remarkable resistance to anthracnose (Amorim et al. 2021), a fungal disease that severely affects the crop. This resistance not only minimizes economic damage to farmers by reducing the need for fungicide applications but also ensures more stable and predictable production. Resistance to anthracnose reduces pesticide costs and guarantees greater production stability, as observed by Maracahipes et al. (2020).

Pungency presence is another important trait of these hybrids, meeting the specific demands of consumers who prefer hotter peppers, thus expanding the potential market for these cultivars. Additionally, the adaptability to the climate of Mato Grosso further strengthens these cultivars' potential for tropical systems (Pramanik et al. 2020).

SEED PRODUCTION

The production of hybrid seeds is both viable and economical. The average seed yield per plant is 25 g. The cultivars 'UNEMAT Implacável' and 'UNEMAT Pavoro' are registered in the National Cultivar Registry (RNC) under numbers 49186 and 49189. UNEMAT is responsible for the production and maintenance of genetic materials.

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DATA AVAILABILITY

The datasets generated and/or analyzed during the current research are available from the corresponding author upon reasonable request.

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