

Agronomic performance of erect and semi-erect cowpea (*Vigna unguiculata* (L.) Walp.) genotypes in the Bragantina Region of Pará, Brazil

João Elias Lopes Fernandes Rodrigues^{*1}, Sônia Maria Botelho Araújo¹,
Maria Carolina Sarto Fernandes Rodrigues², Mauricio Willians de Lima³, Eraldo Ferreira Rodrigues¹

¹Embrapa Amazônia Oriental, Belém, Pará, Brazil

²Universidade Estadual Paulista (UNESP), São Paulo, Brazil

³Universidade Federal Rural da Amazônia (UFRA), Belém, Pará, Brazil

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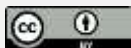
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Corresponding author:

João E. L. F. Rodrigues

Email: joao.rodrigues@embrapa.br



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ABSTRACT

Cowpea (*Vigna unguiculata* (L.) Walp.) is regarded as one of the most important and strategic food crops in the North and Northeast regions of Brazil, with a national average grain yield of 366 kg ha⁻¹ and approximately 1,000 kg ha⁻¹ in the state of Pará, particularly in the Bragantina region. In recent years, cowpea cultivars with high yield potential have been released. The introduction and evaluation of new lines and cultivars, aiming to identify superior genetic materials in terms of grain yield and market acceptance, have been widely adopted by cowpea producers. This study aimed to evaluate the agronomic performance of 12 lines and five cultivars of cowpea with erect and semi-erect growth habits, in order to identify genotypes suitable for recommendation for cultivation in the Bragantina region, in the state of Pará. The experiment was conducted using a randomized complete block design, comprising 17 treatments and four replications. Grain yield data were subjected to analysis of variance (ANOVA), and means were compared using Tukey's test at the 5% probability level. Statistical analyses were performed using Sisvar software, version 5.6 (2015). In the 2013 growing season, the line MNCO4-795f-153 stood out, with a grain yield of 1,523 kg ha⁻¹. In 2014, as well as in the combined analysis of both years, the line MNCO4-769f-62 exhibited superior performance, with mean yields of 1,295 and 1,401 kg ha⁻¹, respectively. Overall, the results indicate that the 17 evaluated cowpea genotypes exhibited high yield potential, exceeding 1,000 kg ha⁻¹, and can be recommended for cultivation under the edaphoclimatic conditions of the Bragança region, in the state of Pará.

Key words: Cowpea, Plant breeding, Grain yield

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.), also known as “feijão-da-colônia” or “feijão-de-corda,” was introduced from Africa along with enslaved people transported on slave ships. It is considered one of the most important and strategic food sources for tropical and subtropical regions worldwide and, in Brazil, particularly in the North and Northeast regions (Lemos, 1978).

Cowpea productivity in the state of Pará exceeds the national average of 366 kg ha⁻¹, reaching approximately 1,000 kg ha⁻¹ in 2005 in specific areas such as the cowpea production hub located in the Bragantina microregion. According to data from Conab, the state produced approximately 19 thousand tons of cowpea in 2022, out of a total of 21 thousand tons of beans (IBGE, 2025).

The crop has been expanding into other regions of the country (Freire Filho *et al.*, 2005); however, it still exhibits low grain yield, largely due to environmental conditions and the agricultural systems employed. The genotype × environment interaction was defined by Paiva *et al.* (2014) as the differential response of genotypes under varying environmental conditions, implying that the best-performing population or individuals in a given location may not exhibit superior grain yield when cultivated elsewhere. In other words, a given genotype responds differently depending on the environment in which it is grown. Therefore, estimated genetic parameters should ideally be free from environmental effects, which occur when no genotype × environment interaction is observed. To achieve this, genotypes must be tested across a range of environments, allowing for the reliable partitioning of genetic variance from genotype × environment interaction variance (Paiva *et al.*, 2014).

In Brazil, improved cowpea cultivars are already available, with grain yields exceeding 2,600 kg ha⁻¹ under irrigated conditions (Bezerra *et al.*, 1984). Furthermore, breeding programs have released new cultivars for the North, Northeast, and Central-West regions, exhibiting high yield potential, growth habits ranging from semi-prostrate to semi-erect, pod insertion

at or above the canopy level, early to medium-early physiological maturity, diverse commercial types, and resistance to pests and diseases (Freire Filho *et al.*, 2009). Nevertheless, cowpea is still predominantly cultivated by smallholder farmers, who often use traditional cultivars with low grain yield.

The introduction and evaluation of new lines and cultivars to identify superior genetic materials in terms of grain yield and market acceptance have been well received by cowpea producers, as they contribute to increased grain production, higher consumption, and improved household income through the commercialization of surplus production. However, these cultivars have often been released with limited information regarding the appropriate management practices required to fully express and maintain their genetic potential. Additionally, little is known about their performance under the diverse edaphoclimatic conditions of cowpea-producing regions in Pará. Therefore, the present study aimed to evaluate the performance of 12 lines and four cultivars of cowpea with erect and semi-erect growth habits, in order to identify genotypes suitable for recommendation for cultivation in the Bragantina region, in the state of Pará.

MATERIAL AND METHODS

Experimental area location

The trials were conducted in two areas in the municipality of Bragança, in the state of Pará, one in 2013 and the other in 2014. The geographic coordinates, soil types, and climate characteristics are presented in Table 1, 2, and 3.

Cowpea breeding lines and cultivars

Twelve cowpea breeding lines (MNCO4-769F-62, MNCO4-795F-154, MNCO4-782F-104, MNCO4-795F-159, MNCO4-762F-3, MNCO4-795F-155, MNCO4-792F-143, MNCO4-795F-168, MNCO4-792F-144, MNCO4-792F-148, and MNCO4-769F-48) and five cultivars (BRS Guariba, BRS Tumucumaque, BRS Nova Era, BRS Itaim, and BRS Cauamé), developed by the Embrapa breeding program, were evaluated in advanced trials for value for cultivation and use (VCU) of cowpea with erect and semi-erect growth habits.

Table 1. Geographic coordinates, soil type, and mean annual precipitation of the experimental areas in the municipality of Bragança, Pará State, Brazil

Municipality	Latitude	Longitude	Altitude (m)	Soil Type	Mean annual precipitation (mm year ⁻¹)
Bragança – PA	01° 02' 43" S	46° 46' 58" W	33	Dystrophic Oxisol (LA)	2,500

Source: INMET (2014)

Table 2. Chemical properties of the dystrophic Yellow Oxisol where the cowpea VCU trial was conducted, on a farmer's field in the municipality of Bragança, Pará State, Brazil, in 2013

Municipality	Depth cm	pH	OM	N	P	K	Na	Ca	Mg	Al	H+Al
			g dm ⁻³			mg dm ⁻³			cmolc dm ⁻³		
Bragança region	0–20	5.1	17.19	0.06	6	21	21	0.7	0.2	1.1	5.61

Source: Soil Laboratory of Embrapa Amazônia Oriental

Table 3. Chemical properties of the dystrophic Yellow Oxisol where the cowpea VCU trial was conducted at UDB/EMATER, in the municipality of Bragança, Pará State, Brazil, in 2014

Municipality	Depth	pH	OM	N	P	K	Na	Ca	Mg	Al	H+Al
	cm	g dm ⁻³			mg dm ⁻³			cmolc dm ⁻³			
Bragança region	0–20	4.9	15.83	0.05	4	28	2	0.8	1.2	0.7	3.80

Source: Soil Laboratory of Embrapa Amazônia Oriental

Soil preparation, sowing and fertilization

Soil preparation was carried out mechanically, consisting of leveling harrowing operations.

Sowing was performed manually using a dibble stick (a pointed wooden tool), placing four seeds per hill. Thinning was conducted 15 days after planting, leaving two plants per hill, in order to establish a plant population of approximately 100,000 plants ha⁻¹.

Fertilization was applied manually at a rate of 300 kg ha⁻¹ of the commercial N–P–K formulation (10:28:20), around the plants, 15 days after germination. Subsequently, hilling was performed to incorporate the fertilizer into the soil, thereby minimizing nutrient losses due to weathering processes.

Crop practices

During the experimental period, manual weeding was carried out, and the phytosanitary condition of the plants was monitored throughout the crop cycle to assess the occurrence of pests and diseases. Harvesting was performed in a single operation when the pods were completely dry, and all plots were harvested manually.

Grain yield data

Grain yield data for each genotype were estimated using the grain index. Five pods per plot were randomly

sampled, and the index was calculated according to the following expression (Embrapa, 2008):

$$IG (\%) = \left(\frac{\overline{PG}_{5v}}{P_{5v}} \right) \times 100$$

where:

IG(%) = grain index (%);

\overline{PG}_{5v} = mean grain weight of five pods (g);

P_{5v} = mean weight of five pods (g).

Experimental design

The experimental design was a randomized complete block design, consisting of 17 treatments (12 lines and 5 cultivars) with four replications. Each plot measured 2.0 m × 5.0 m and comprised four rows of 5.0 m in length, spaced 0.80 m apart, with 0.25 m between plants within rows. The two central rows were considered as the useful plot area for data collection and subsequent analysis.

Statistical Analysis

Grain yield data were subjected to analysis of variance (ANOVA), and means were compared using Tukey's test at the 5% probability level. All statistical analyses were performed using Sisvar software, version 5.6 (2015).

RESULT AND DISCUSSION

Table 4 presents the mean dry grain yield (kg ha⁻¹) of the 17 cowpea genotypes (12 breeding lines and 5 cultivars) with erect and semi-erect growth habits, developed by the Embrapa breeding program and evaluated at two locations in the municipality of Bragança over two consecutive growing seasons.

In Year 01, the line MNCO4-795F-153 (treatment 31) exhibited the highest grain yield (1,523 kg ha⁻¹), although it did not differ statistically from the other genotypes according to Tukey's test at the 5% probability level. This result suggests that environmental conditions were favorable for the expression of yield potential, but also indicates limited discrimination among genotypes under such conditions, a phenomenon commonly reported in cowpea trials under low environmental stress (Hall, 2012).

In Year 02, the line MNCO4-769F-62 (treatment 26) showed superior performance, reaching 1,295 kg ha⁻¹ and significantly outperforming the lines MNCO4-795F-154 and MNCO4-762F-3, as well as the cultivars

BRS Guariba, BRS Nova Era, and BRS Cauamé. However, it did not differ statistically from the remaining genotypes, indicating moderate variability in genotypic performance. According to Freire Filho *et al.* (2011), such variation is expected due to differences in environmental conditions and the differential response of genotypes.

In the combined analysis of Years 01 and 02, the line MNCO4-769F-62 again exhibited the highest mean yield (1,401 kg ha⁻¹), although no significant differences were observed among genotypes. Overall, all evaluated genotypes presented grain yields above 1,000 kg ha⁻¹, surpassing the average productivity reported for the state of Pará. These results demonstrate the high yield potential and adaptability of the evaluated genetic materials to the edaphoclimatic conditions of the Bragança region. The absence of significant differences among most genotypes suggests that several materials may be suitable for recommendation, allowing selection based on additional traits such as grain quality, market acceptance, and resistance to biotic stresses (Singh *et al.*, 2002).

Table 4. Mean dry grain yield (kg ha⁻¹) of 17 cowpea genotypes with erect and semi-erect growth habits, evaluated in 2013 and 2014, and in the combined analysis of both years, in the municipality of Bragança, Pará, Brazil

Treat.	Lines/Cultivars	Parentage/Origin	Mean grain yield (kg ha ⁻¹)		
			Year 01	Year 02	Combined seasons
31	MNCO4-795F-153	MNC99-518G-2 x IT92KD-279-3	1523a	743ab	1304ab
26	MNCO4-769F-62	CE-315 x 38E97-304G-12	1508 a	1295ab	1401a
32	MNCO4-795F-154	MNC99-518G-2 x IT92KD-279-3	1280a	672b	976ab
27	MNCO4-782F-104	(TE97-309G-24 x TE96-406-2E-28-2) x TE97-309G-24	1247a	792ab	1019ab
36	BRS Guariba	IT85F-2687 x TE87-98-8G	1235a	614b	924ab
34	MNCO4-795F-159	MNC99-518G-2xIT92KD-279-3	1224a	989ab	1106ab
37	BRS Tumucumaque	TE97-282-22G x IT87D-611-3	1182a	967ab	1074ab
38	BRS Nova era	TE97-404-1F x TE97-404-3F	1180a	594b	887ab
21	MNCO4-762F-3	TE96-282-22G x (TE96-282-22G x VITA7)	1178a	621b	899ab
33	MNCO4-795F-155	MNC99-518G-2xIT92KD-279-3	1175a	964ab	1070ab
39	BRS Itaim	MNC01-625E-10-1-2-5 x MNC99-544D-101-2-2	1141a	797ab	969ab
28	MNCO4-792F-143	MNC00-553D-8-1-2-3 x TVx5058-09C	1132a	988ab	1060ab
35	MNCO4-795F-168	MNC99-518G-2 x TVx-IT92KD-279-3	1073a	824ab	949ab
29	MNCO4-792F-144	MNCOO-553D-8-1-2-3 x TVx5058-09C	1063a	902ab	983ab
40	BRS Cauamé	TE93-210-13Fx TE96-282-22G	1037a	685b	861ab
30	MNCO4-792F-148	MNC00-553D-8-1-2-3 x TVx5058-09C	999a	868ab	933ab
24	MNCO4-769F-48	CE-315 x TE97-304G-12	927a	912ab	919ab
CV%	-	-	26	27	19
LSD	-	-	799	588	509

Furthermore, the relatively consistent performance across years reinforces the importance of multi-environment trials for identifying broadly adapted genotypes. Similar findings have been reported in cowpea breeding programs, where genotype \times environment interaction plays a crucial role in cultivar recommendation and selection strategies (Hall *et al.*, 2003; Rocha *et al.*, 2007).

CONCLUSION

The 17 cowpea genotypes, with erect and semi-erect growth habits, demonstrated high agronomic potential for cultivation in the Bragança region, in the state of Pará, as they exhibited mean grain yields exceeding the state average, estimated at 1000 kg ha⁻¹.

RECOMMENDATION(S)

Further studies should be conducted under multi-environment conditions, including other regions, to evaluate the stability and adaptability of the cowpea genotypes, with particular emphasis on genotype \times environment interactions. Additionally, the assessment of complementary traits, such as resistance to pests and diseases, tolerance to abiotic stresses, response to different rates of macro- and micronutrient fertilization, and grain quality, is recommended to support more accurate cultivar recommendations.

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