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Agronomic performance of cowpea genotypes in southwestern Brazilian Amazon

Abstract – The objective of this work was to evaluate the agronomic performance of cowpea (*Vigna unguiculata*) genotypes over three crop years, in the ecosystem of Rio Branco, in the state of Acre, Brazil. The experiments were carried out in the 2016, 2017, and 2018 crop seasons, in a randomized complete block design, with four replicates. Eight agronomic traits were evaluated in 14 cowpea genotypes, which included: 12 lines (BDO 1-5-11, BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-26, PDO 1-5-4, PDO 1-5-5, PDO 1-5-7, PDO 1-5-8, PDO 1-5-10, PDO 1-5-11, and PDO 1-5-14) and two cultivars (BRS Tumucumaque and BRS Imponente). A significant difference was observed in the genotype x crop year interaction, for most traits. Although there was no statistical difference between genotypes in the studied crop years, dry seed productivity was higher than the national average. All cowpea lines and cultivars from the genetic breeding program show equivalent and favorable agronomic performances in the environmental conditions of Rio Branco. Therefore, these genotypes can be selected for incorporation into the production system of Rio Branco.

Index terms: *Vigna unguiculata*, breeding, BRS Imponente, BRS Tumucumaque, family farming.

Desempenho agronômico de genótipos de feijão-caupi no sudoeste da Amazônia brasileira

Resumo – O objetivo deste trabalho foi avaliar o desempenho agronômico de genótipos de feijão-caupi (*Vigna unguiculata*) em três anos agrícolas, no ecossistema de Rio Branco, no estado do Acre, Brasil. Os experimentos foram conduzidos nos anos agrícolas de 2016, 2017 e 2018, em delineamento de blocos ao acaso, com quatro repetições. Foram avaliados oito caracteres agronômicos, em 14 genótipos de feijão-caupi, que incluíram: 12 linhagens (BDO 1-5-11, BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-26, PDO 1-5-4, PDO 1-5-5, PDO 1-5-7, PDO 1-5-8, PDO 1-5-10, PDO 1-5-11 e PDO 1-5-14) e duas cultivares (BRS Tumucumaque e BRS Imponente). Observou-se diferença significativa na interação genótipo x safra, para a maioria das características. Embora não tenha havido diferença estatística entre os genótipos nas safras estudadas, a produtividade de grãos secos foi superior à da média nacional. Todas as linhagens e as cultivares de feijão-caupi do programa de melhoramento genético apresentam desempenho agronômico equivalente e favorável nas condições ambientais de Rio Branco. Portanto, esses genótipos podem ser selecionados para incorporação ao sistema produtivo de Rio Branco.

Termos para indexação: *Vigna unguiculata*, melhoramento, BRS Imponente, BRS Tumucumaque, agricultura familiar.

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Introduction

Cowpea [*Vigna unguiculata* (L.) Walp.] is one of the most important sources of human food in tropical and subtropical regions of the world (Lopes et al., 2018). In Brazil, cowpea is marketed as both immature and dry grains, “acarajé” flour, and seed (Silva et al., 2018).

The world planted area is approximately 12.6 million hectares, and Nigeria ranks as the largest producer, with 3.4 million metric tons (FAO, 2019). In Brazil, the area planted in the 2019/2020 agricultural year, was 1.3 million ha, and the average yield was 545 kg ha^{-1} (Acompanhamento…, 2020).

In the Northern and Northeastern Brazil, cowpea is still grown as a secondary crop (Medeiros et al., 2017) mainly by small farmers. However, the easiness of adaptation to different Brazilian ecosystems has allowed the crop to spread to other regions, notably the Midwest (Freire Filho, 2011).

In Acre state, cowpea is an important source of income for traditional populations and family farmers (Mendonça et al., 2018). The crop is locally known as “feijão-de-corda” (string bean) or “feijão-de-praia” (beach bean) because of the cultivation in the floodplains of the state’s rivers. The crop, also known as the “dry-season bean”, is planted during the dry season or the Amazonian summer (between May and October). According to some authors (Oliveira et al., 2015; Mendonça et al., 2018), cowpea, together with common bean, makes up the main source of income and protein available throughout the year for a great variety of communities.

Although cowpea is an important crop for human food in various ways, its productive potential is little explored. According to Valeriano et al. (2019), cowpea is a subsistence crop and still lacks research on the management and recommendation of cultivars. Dutra et al. (2012) point out that the average Brazilian yield does not reflect this crop potential. The main reasons for the low cowpea yield are the lack of knowledge on the genotype x environment interactions and traditional cultivars with low yield capacity (Públio Júnior et al., 2017; Silva et al., 2018).

In view of this scenario, some universities and research centers have developed several genetic breeding programs, mainly the Embrapa’s cowpea breeding program. As result, there was the launch and recommendation of several cultivars adapted to the most varied edaphoclimatic conditions in Brazil, such as cowpea BRS Tumucumaque and BRS Imponente that stood out among crops in some Brazilian states (Cavalcante et al., 2014; Rocha et al., 2017).

According to Teixeira et al. (2010), the correct cultivar selection for a given environment and production system is crucial for achieving good yields. However, it is not sufficient to achieve success with the crop. Aspects related to cycle, plant architecture, seed quality, and resistance to diseases are highly relevant. Públio Júnior et al. (2017) emphasize that cowpea cultivars respond differently to the soil and climate conditions of the production regions. Therefore, preliminary studies aiming to evaluate the yield potential of new genotypes derived from breeding programs are essential for the recommendation of new cultivars.

In the state of Acre, the cultivars used by farmers are creole-based and mixed with seed provided by the government since a long time ago (Mendonça et al., 2018). Thus, due to the importance of cowpea crop in the state, studies are required to introduce, evaluate, and select genotypes that combine adaptation to the local ecosystem and high yields, besides taking into account the demands of consumers.

The objective of this work was to evaluate the agronomic performance of cowpea genotypes over three crop years, in the ecosystem of Rio Branco, in the state of Acre, Brazil.

Materials and Methods

The experiments were installed, conducted, and evaluated between April and July in three crop years (2016, 2017, and 2018), in the Embrapa Acre experimental field, in the municipality of Rio Branco, in the state of Acre, Brazil, located at 9º58'29"S, 67º49'44"W, at 160 m altitude. The predominant climate in the region is the Awi type (tropical hot and humid), according to the Köppen-Geiger’s classification, with 31ºC and 21ºC average maximum and minimum temperatures, respectively, 1,700 mm accumulated annual rainfall, and 83% relative humidity. Data on rainfall and average maximum and minimum temperatures for 2016, 2017, and 2018 are presented in Figure 1.

The soil of the experimental area was classified as a Argissolo Vermelho distrófico típico, medium-clay texture, according to Brazilian soil classification system (Santos et al., 2018). The soil chemical properties in the 0.0–0.2 m layer were: P_{resin}, 23.57 mg dm^{-3}; $P_{Mehlich-1}$, 6.10 mg dm^{-3}; pH, 6.18; H+Al, 2.71 $cmol_c$ dm^{-3}; Ca, 2.81 $cmol_c$ dm^{-3}; Mg, 0.93 $cmol_c$ dm^{-3}; K, 0.37 $cmol_c$ dm^{-3}; CEC, 6.82 $cmol_c$ dm^{-3}; sum of bases (SB), 4.11 $cmol_c$ dm^{-3}; C_{org}, 9.64 g kg^{-1}; OM, 16.58 g kg^{-1}; and base saturation (V), 60.26%.

Soil preparation followed the recommendations for conventional planting, consisting of one plowing and two harrowing operations to field level. Soil correction and fertilization were based on soil analysis according to Melo & Cardoso (2017).

The experiments were carried out between April and July of the three crop years, with 14 cowpea genotypes that consisted of 12 lines (BDO 1-5-11, BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-26, PDO 1-5-4, PDO 1-5-5, PDO 1-5-7, PDO 1-5-8, PDO 1-5-10, PDO 1-5-11, and PDO 1-5-14), and two cultivars (BRS Tumucumaque and BRS Imponente), belonging to the commercial subclasses evergreen, “canapu”, mulatto, smooth white, and rough white, from the genetic breeding program of Embrapa Meio-Norte. The lines BDO (“Bico-de-Ouro”) and PDO (“Pingo-de-Ouro”), are individual selections of plants with progeny test from plants collected in the states of Mato Grosso and Piauí (in the semiarid region), respectively.

The experiments in each crop year were arranged in a randomized complete block design with four replicates. The size of plots of each genotype was 2.0x5.0 m. Planting was carried out in 0.50 m spacing between rows, with 10 seed per linear meter, reaching 160,000 plants ha^{-1} population. The two central rows of each plot were considered as net plot for data collection.

The following traits were evaluated: seed number per pod (NSP); seed weight per pod (SWP, g); 100-seed weight (HSW, g); seed index (SID, %); dry seed yield (DSY, kg ha^{-1}); plant growth habit (PGH), according to the score ranking as 1 – erect, 2 – semi-erect, 3 – semiprostrate, and 4 – prostrate; cultivation value (CV), according to the score ranking as 1 – line/cultivar without characteristics suitable for commercial cultivation, 2 – line/cultivar with few characteristics suitable for commercial cultivation, 3 – line/cultivar with good deal of the characteristics suitable for commercial cultivation, 4 – line/cultivar with most characteristics suitable for commercial cultivation, and 5 – line/cultivar with almost all characteristics suitable

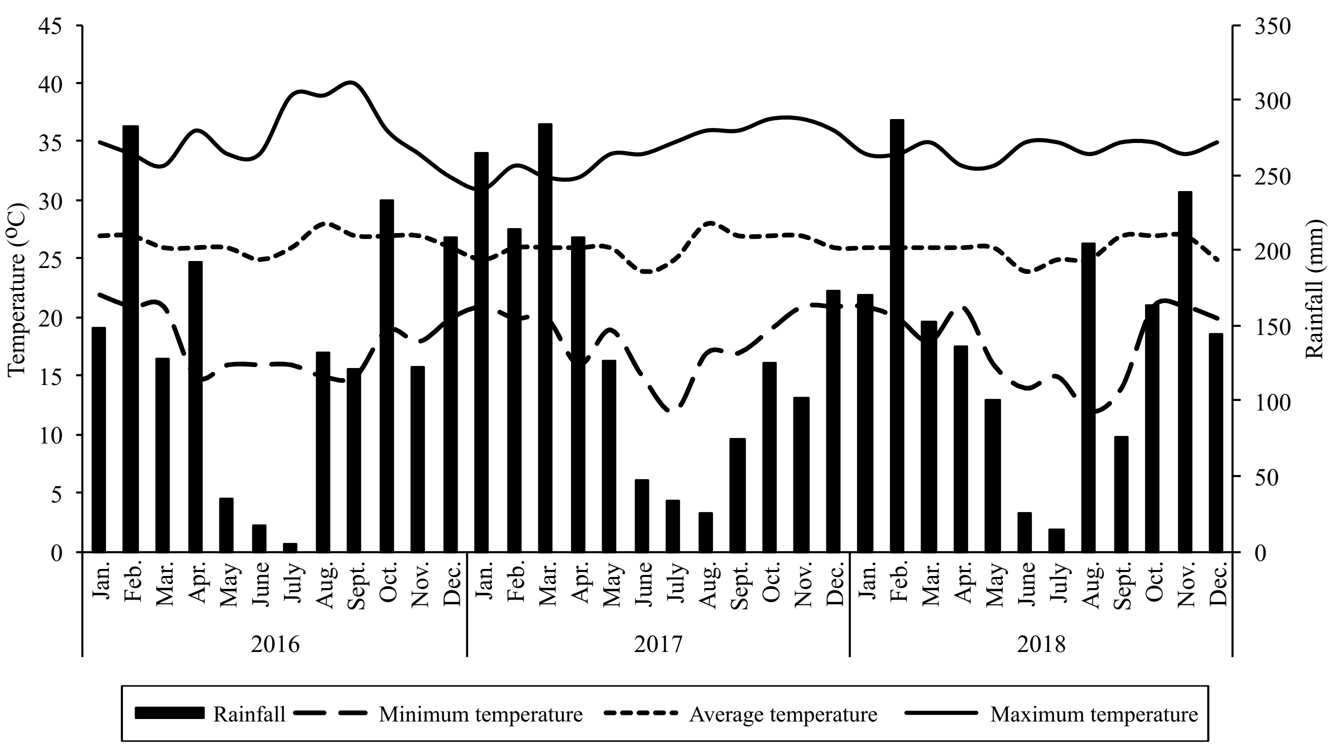

Figure 1. Rainfall and maximum, average, and minimum temperatures, in the municipality of Rio Branco, in the state of Acre, Brazil, in the 2016, 2017, and 2018 crop years (Agritempo, 2020).

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for commercial cultivation; and lodging (LOD), according to the score ranking as 1 – no lodged plant or main branch unbroken, 2 – 1% to 5% lodged plants or main branch broken, 3 – 6% to 10% lodged plants or main branch broken, 4 – 11% to 20% lodged plants or main branch broken, and 5 – above 20% lodged plants or main branch broken. The score ranking for the trait plant growth habit, cultivation value, and lodging were based on scoring tables described and used by Embrapa Meio-Norte, in the breeding and selection of genotypes according to Silva et al. (2018).

Data were analyzed by the joint analysis of variance for experiments of equal size with the data at the plot level, considering the crop year as a different environment, using the statistical program Sisvar (Ferreira, 2014), as recommended by Banzatto & Kronka (2006). The means of genotypes were compared by the Scott-Knott's test, and the means of years by the Tukey's test, at 5% probability each. In order to meet the assumptions of the analysis of variance, the data were subjected to transformation using the equations $(x + 1)^{0.5}$ for the variable NSP, and $(x)^{0.5}$ for PGH, CV, and LOD. Unfolding of the significant genotype x year interactions were carried out.

Results and Discussion

The joint analysis of variance showed that the effect of genotype (G) x crop year (Y) interaction was significant for NSP, SWP, DSY, PGH, CV, and LOD (Table 1). The variable HSW showed a significant effect only among genotypes. A significant difference was also observed among crop years for most yield traits (NSP, SWP, and DSY). Seed index showed no difference in the G x Y interaction nor in isolated factors. Sousa et al. (2015) evaluated different cowpea genotypes in two environments and found significant differences for most of the yield traits, in relation to the tested environments. The difference among crop years observed in this work indicates that there were variations in the crop years evaluated, notably the rainfall distribution (Figure 1), since the experiments were not irrigated, aiming to replicate the cropping system of local farmers who depend entirely on rain water for their farming.

The coefficients of variation ranged from 6.94% (NSP) to 19.38% (LOD) and are consistent with the findings in the literature (Teixeira et al., 2010; Locatelli et al., 2014; Pinto et al., 2017; Camara et al., 2018; Silva et al., 2018; Souza et al., 2018).

The analysis of the genotype performance in the crop years for NSP (Table 2), a component of yield in cowpea, showed that two groups were formed in 2016, in which the BDO 1-5-11, BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-7, PDO 1-5-8, PDO 1-5-10, and PDO 1-5-14 lines were superior. In 2017, only PDO1-5-26 was superior to the others. In 2018, most of the genotypes showed no difference for NSP, except for the genotypes PDO 1-5-14 and 'BRS Imponente' that formed the group of the least productive genotypes (Table 2). The fact that the crop year was present in different groups may be related to the variation of the rainfall regime that occurred during the period of experimental conduction in the crop years studied (Figure 1). According to Lopes et al. (2011) and Valeriano et al. (2019), this trait is greatly affected by climatic variations, mainly water deficiency. Rainfall levels ranging among 250 and 500 mm are suitable for the cultivation of cowpea (Andrade Júnior et al., 2017).

Teixeira et al. (2010) and Públio Júnior et al. (2017) recorded means ranging from 10 to 11 seed per pod, which is in good agreement with the means found in the present study.

The BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-4, PDO 1-5-7, and PDO 1-5-11 lines, and BRS Tumucumaque and BRS Imponente cultivars did not differ in relation to the crop year, showing, thus, a tendency to stabilization (Table 2). Therefore, the stabilization of genotypes for NSP is essential, as it is directly related to the crop yield.

The SWP is a trait evaluated in cowpea trials (Torres et al., 2015), but no difference was found among genotypes for each crop year, in the present work (Table 3). The BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-26, PDO 1-5-4, PDO 1-5-7, and PDO 1-5-11 lines, as well as BRS Tumucumaque and BRS Imponente cultivars did not differ for the different crop years, showing stability for SWP in the conditions of the present study. The stabilization of this trait together with the number of seed per plant has a great significance, as they directly influence production.

The lack of a significant interaction in HSW indicates that the genotypes kept the same ranking order over the three crop years (Table 3). However, when compared with the general mean of the genotypes, BRS Imponente cultivar showed the highest HSW. No significant difference was found among crop years. We point out, however, that all lines showed averages statistically equal to those of BRS Tumucumaque cultivar. As stated by Locatelli et al. (2014), this trait has a greater resistance to changes induced by environmental conditions, which suggests that the variation among genotypes found in the present study are probably derived from genotype.

Although no difference was found among the genotypes for DSY, in the crop years (Table 4), the means of this trait varied from 975 kg ha^{-1} (PDO 1-5-11) to 1,523 kg ha^{-1} (PDO 1-5-26), from 720 kg ha^{-1} ('BRS Tumucumaque') to 1,357 kg ha^{-1} (BDO 1-5-15), and from 1,093 kg ha^{-1} (PDO 1-5-8) to 1,164 kg ha^{-1} (PDO 1-5-7) in 2016, 2017, and 2018, respectively. The BDO 1-5-11, BDO 1-5-15, BDO 1-5-19, BDO 1-5-24, PDO 1-5-4, PDO 1-5-5, PDO 1-5-10, PDO 1-5-11, and PDO 1-5-14 lines, and the BRS Imponente cultivar show stability for the trait seed yield, since no significant difference was found among crop years.

Table 1. Analysis of variance of traits, plant growth habit, cultivation value and lodging of 14 cowpea (*Vigna unguiculata*) genotypes, in the municipality of Rio Branco, in the state of Acre, Brazil, in the 2016, 2017, and 2018 crop years(1).

Source of Variation	DF(2)	Mean square(3)							
		NSP	SWP (g)	HSW (g)	SID (%)	DSY (kg ha^{-1})	PGH	CV	LOD
Block (year)	9	2.43ns	0.11ns	2.80ns	104.91ns	98023.55**	0.45ns	1.030*	1.34*
Year (Y)	2	58.21**	2.96**	2.52ns	88.63ns	451366.46**	0.05ns	0.005ns	1.16ns
Genotype (G)	13	15.43**	0.20*	153.79**	80.67ns	72333.13**	1.60**	1.544**	1.31**
G x Y	26	4.58*	0.17*	7.71ns	113.37ns	56601.90**	0.75*	1.422**	1.17**
Error	112	2.49	0.09	6.71	74.48	29027.52	0.46	0.438	0.55
Coefficient of variation (%)		6.94	13.78	11.84	10.95	14.33	18.81	11.13	19.38
Overall mean		10.63	2.26	21.88	78.83	1188.68	1.92	3.08	1.93

(1)*, **Significant at 5% and 1%, respectively, by the F-test. (2)DF, degree of freedom. (3)Mean square for: NSP, number of seed per pod; SWP, seed weight per pod; HSW, 100-seed weight; SID, seed index; DSY, dry seed yield; PGH, plant growth habit; CV, cultivation value; and LOD, lodging. nsNonsignificant.

Table 2. Means of number of seed per pod of 14 cowpea (*Vigna unguiculata*) genotypes, in the 2016, 2017, and 2018 crop years, in the municipality of Rio Branco, in the state of Acre, Brazil(1).

Genotype(2)	Number of seed per pod		
	2016	2017	2018
BDO 1-5-11	13.25aA	10.35bB	10.25aB
BDO 1-5-15	12.60aA	11.00bA	10.05aA
BDO 1-5-19	12.60aA	10.30bA	10.42aA
BDO 1-5-24	12.00aA	9.85cA	10.12aA
PDO 1-5-26	10.70bB	13.80aA	10.35aB
PDO 1-5-4	11.20bA	10.75bA	10.20aA
PDO 1-5-5	13.95aA	10.50bB	10.32aB
PDO 1-5-7	11.75aA	10.90bA	10.15aA
PDO 1-5-8	13.40aA	9.10cB	11.25aAB
PDO 1-5-10	12.86aA	10.50bAB	9.70aB
PDO 1-5-11	12.80aA	11.30bA	11.10aA
PDO 1-5-14	11.75aA	10.10bAB	8.15bB
BRS Tumucumaque	9.65bA	8.05cA	10.20aA
BRS Imponente	8.80bA	6.15dA	7.05bA
Overall mean		10.63	

(1)Means followed by equal letters, uppercases in the rows, and lowercases in the columns, do not differ by the Tukey's and the Scott-Knott's tests, at 5% probability each. (2)BDO, "Bico-de-Ouro" lines; PDO, "Pingo-de-Ouro" lines; and BRS Tumucumaque and BRS Imponente cultivars.

It is noteworthy that the overall mean of dry seed yield recorded in the present study (1,188 kg ha^{-1}) is higher than the national average yield of 545 kg ha^{-1} (Acompanhamento…, 2020), which suggests the good productive capacity of the genotypes evaluated, mainly that of the studied lines.

Means of dry seed yields as those obtained in the present work have been reported in other studies (Silva et al., 2016; Souza et al., 2018; Araújo et al., 2019). According to Matos Filho et al. (2009), differences for yield in the same genotype, across different environments, can occur because of biotic factors and

Table 3. Means of seed weight per pod and 100-seed weight of 14 cowpea (*Vigna unguiculata*) genotypes, in the 2016, 2017, and 2018 crop years, in the municipality of Rio Branco, in the state of Acre, Brazil[(1)].

Genotype[(2)]	Seed weight per pod (g)			100-seed weight (g)			Mean
	2016	2017	2018	2016	2017	2018	
BDO 1-5-11	2.68aA	2.12aB	2.19aAB	20.25	20.50	21.37	20.70b
BDO 1-5-15	2.56aA	2.39aA	2.09aA	20.87	26.75	20.87	22.83b
BDO 1-5-19	2.56aA	2.17aA	2.13aA	20.37	21.12	20.43	20.64b
BDO 1-5-24	2.41aA	1.91aA	2.11aA	20.12	19.62	20.81	20.18b
PDO 1-5-26	2.31aA	2.66aA	2.16aA	23.62	19.25	20.93	21.27b
PDO 1-5-4	2.53aA	2.23aA	2.11aA	22.83	20.75	20.68	21.29b
PDO 1-5-5	2.97aA	2.05aB	2.13aB	21.25	19.75	20.68	20.56b
PDO 1-5-7	2.56aA	2.24aA	2.07aA	21.75	20.62	20.37	20.91b
PDO 1-5-8	2.66aA	1.80aB	2.22aAB	20.37	19.75	19.75	19.95b
PDO 1-5-10	2.81aA	2.29aAB	2.01aB	21.83	21.75	20.70	21.39b
PDO 1-5-11	2.50aA	2.29aA	2.18aA	19.50	20.37	19.62	19.94b
PDO 1-5-14	2.54aA	2.25aA	1.71aB	21.62	22.37	21.01	21.67b
BRS Tumucumaque	1.99aA	1.61aA	2.09aA	20.62	20.00	20.63	20.42b
BRS Imponente	2.58aA	2.17aA	2.47aA	31.50	35.50	35.10	34.03a
Overall mean		-	-	22.01A	22.00A	21.64A	-

[(1)]Means followed by equal letters, uppercases in the rows and lowercases in the columns, do not differ by the Tukey's and the Scott-Knott's tests, at 5% probability each. [(2)]BDO, "Bico-de-Ouro" lines; PDO, "Pingo-de-Ouro" lines; and BRS Tumucumaque and BRS Imponente cultivars.

Table 4. Means of dry seed yield and seed index of 14 cowpea (*Vigna unguiculata*) genotypes, in the 2016, 2017, and 2018 crop years, in the municipality of Rio Branco, in the state of Acre, Brazil[(1)].

Genotype[(2)]	Dry seed yield (kg ha^{-1})			Seed index (%)			Mean
	2016	2017	2018	2016	2017	2018	
BDO 1-5-11	1192.00aA	1063.60aA	1147.95aA	76.78	78.20	78.57	77.85a
BDO 1-5-15	1385.75aA	1357.45aA	1157.15aA	73.36	83.91	78.91	78.73a
BDO 1-5-19	1113.00aA	1187.00aA	1138.87aA	65.51	77.54	82.18	75.08a
BDO 1-5-24	1243.40aA	1233.45aA	1114.27aA	80.90	79.67	73.52	78.03a
PDO[2] 1-5-26	1523.00aA	1276.85aAB	1096.40aB	80.15	84.11	79.89	81.38a
PDO 1-5-4	1297.00aA	1225.60aA	1157.60aA	76.01	82.77	81.77	80.56a
PDO 1-5-5	1377.00aA	1160.60aA	1156.07aA	80.86	80.04	82.71	81.20a
PDO 1-5-7	1401.75aA	1030.40aB	1164.05aAB	81.98	78.74	76.87	79.20a
PDO 1-5-8	1484.25aA	1089.95aB	1093.12aB	82.59	72.17	78.84	77.87a
PDO 1-5-10	1338.67aA	1349.30aA	1162.00aA	85.11	86.35	79.92	83.67a
PDO 1-5-11	975.00aA	1078.00aA	1145.80aA	86.67	81.32	76.37	79.71a
PDO 1-5-14	1146.50aA	1228.90aA	1134.82aA	75.94	84.43	61.96	74.11a
BRS Tumucumaque	1287.95aA	720.25aB	1112.47aA	90.92	78.50	79.00	76.14a
BRS Imponente	1186.75aA	946.55aA	1148.80aA	79.18	75.10	88.31	80.86a
Mean	-	-	-	77.70A	80.20A	78.79A	-

[(1)]Means followed by equal letters, uppercases in the rows, and lowercases in the columns, do not differ by the Tukey's and the Scott-Knott's tests, at 5% probability each.[(2)]BDO, "Bico-de-Ouro" lines; PDO, "Pingo-de-Ouro" lines; and BRS Tumucumaque and BRS Imponente cultivars.

the genetic response of the genotype to environmental variation.

The SID, which indicates the efficiency of each genotype in the grain production (Silva et al., 2018), showed no significant difference in the G x Y interaction and in the means; however, values varying from 75.08% (BDO 1-5-19) to 83.77% (RFQ 1-5-10) were recorded (Table 4).

Sousa et al. (2015) evaluated different cowpea genotypes and found means of 62% and 64% for the trait SID. Silva et al. (2018) reported means of 73.02% in 2014, and 86.33% in 2015; and Públio Júnior et al. (2017) recorded an overall mean of 78%. Therefore, the means found in the present study for this trait can be considered adequate and suggest a good efficiency in grain production (Table 4), similarly to the results for agronomic performance of cowpea in two crop years reported by Silva et al. (2018).

The PGH in most genotypes varied from erect to semi-erect in all crop years, with means varying from 1 (erect plant) to 2 (semi-erect plant) (Table 5). The PDO 1-5-26, PDO 1-5-5, PDO 1-5-8, and PDO 1-5-11 lines, and the BRS Tumucumaque cultivar had PGH tending to semiprostrate in the first and second crop years, 2016 and 2017, respectively. However, in 2018, all genotypes varied from erect to semi-erect (Table 5). Farmers who aim to use mechanized agriculture prefer plants with growth tending to erect growth.

The criteria for the cultivation value include the general aspect of the plants, vigor, pod distribution, seed commercial characteristics, and resistance to diseases and pests of the genotypes. For cowpea genotypes, those considered acceptable should score 3 or above (Silva et al., 2018). In the present work, the BDO 1-5-11, BDO 1-5-15, BDO 1-5-24, and PDO 1-5-4 lines, and the BRS Imponente cultivar showed a tendency for a good deal of the characteristics suitable for commercial cultivation in the three crop years.

Most genotypes showed good LOD resistance, with means ranging from 1 (with no lodged plant or main branch unbroken) to 2 (with 1 to 5% lodged plants or main branch broken) (Table 5). The PDO 1-5-4 and PDO 1-5-10 lines, in 2016, and PDO 1-5-5, in 2017, showed from 6% to 10% lodged plants or with the main branch broken (scored 3). According to Guerra et al. (2017), farmers prefer erect plants with a low LOD degree, since they allow of mechanization in the area.

BRS Tumucumaque and BRS Imponente cultivars, in addition to their good production performance, have white grain teguments, which is a characteristic predominantly accepted by cowpea consumers in Acre state. The results show that the tested genotypes have favorable characteristics for the selection for cultivation and incorporation into the production system of Rio Branco, Acre state, Brazil.

Table 5. Means of growth habit, cultivation value, and lodging of 14 cowpea (*Vigna unguiculata*) genotypes, in the 2016, 2017, and 2018 crop years, in the municipality of Rio Branco, in the state of Acre, Brazil(1).

Genotype(2)	Growth habit			Value of cultivation			Lodging		
	2016	2017	2018	2016	2017	2018	2016	2017	2018
BDO 1-5-11	1.50bA	1.50bA	2.00aA	3.25aA	3.25bA	3.00aA	1.50aA	1.75aA	2.12aA
BDO 1-5-15	1.25bA	1.50bA	2.00aA	3.50aA	4.00aA	3.00aA	2.00aA	2.25aA	2.25aA
BDO 1-5-19	1.50bA	1.50bA	2.50aA	4.00aA	4.25aA	2.50aB	1.25aA	1.50aA	2.37aA
BDO 1-5-24	1.75bA	1.75bA	1.87aA	3.50aAB	4.25aA	3.00aB	1.75aA	2.00aA	2.12aA
PDO 1-5-26	2.50aAB	3.00aA	1.50aB	3.75aA	2.00bB	3.00aA	1.25aA	1.75aA	2.00aA
PDO 1-5-4	1.00bA	1.25bA	2.00aA	3.66aA	3.75aA	3.00aA	3.33aA	2.00aB	1.75aB
PDO 1-5-5	2.75aA	2.75aA	1.75aA	2.50aA	2.00bA	3.00aA	2.25aAB	3.50aA	1.87aB
PDO 1-5-7	1.75bA	1.75bA	1.87aA	3.25aAB	4.00aA	2.75aB	2.00aA	2.00aA	1.62aA
PDO 1-5-8	2.50aA	2.50aA	2.12aA	2.75aA	2.25bA	2.75aA	1.75aA	2.25aA	1.75aA
PDO 1-5-10	2.00bA	2.25aA	1.62aA	2.66aA	2.75bA	3.50aA	3.33aA	2.50aA	1.12aB
PDO 1-5-11	3.00aA	2.00bA	1.87aA	2.00aA	2.25bA	3.50aA	1.00aA	2.25aA	1.75aA
PDO 1-5-14	1.75bA	2.00bA	1.75aA	2.50aA	2.75bA	3.12aA	2.25aA	2.25aA	1.62aA
BRS Tumucumaque	2.75aA	2.50aA	2.25aA	2.25aB	2.75bAB	3.62aA	2.75aA	2.00aAB	1.25aB
BRS Imponente	1.00bA	1.00bA	2.00aA	2.75aA	3.00bA	3.37aA	1.00aA	1.00aA	1.37aA

(1)Means followed by equal letters, uppercases in the rows and lowercases letters in the columns, do not differ by the Tukey's and the Scott-Knott's tests, at 5% probability each. (2)BDO, "Bico-de-Ouro" lines; PDO, "Pingo-de-Ouro" lines; and BRS Tumucumaque and BRS Imponente cultivars.

Conclusion

The evaluated cowpea (*Vigna unguiculata*) lines and the BRS Tumucumaque and BRS Imponente cultivars show equivalent and favorable agronomic performances in the environmental conditions of the municipality of Rio Branco, in the southwestern Brazilian Amazon, and, therefore, these genotypes can be selected for incorporation into the production system of the region.

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