

## PRODUCTION OF BRS ITAIM COWPEA CULTIVAR BASED ON PLANT POPULATION DENSITY

Laerte Gustavo Pivetta<sup>1\*</sup>, Dácio Olibone<sup>1</sup>, Edvan Costa da Silva<sup>2</sup>, Ana Paula Encide Olibone<sup>1</sup>,  
Gilberto Keres<sup>3</sup>, José Ângelo Nogueira de Menezes Júnior<sup>4</sup>

SAP 22100 Received: 04/04/2019 Accepted: 06/04/2019  
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 18, n. 4, oct./dec., p. 377-382, 2019

**ABSTRACT** - Cowpea has great potential for cultivation and rotation in Mato Grosso State and in Brazilian Cerrado due to the large area available in these locations in the off-season. The aim of the current study is to analyze the yield of cowpea (BRS Itaim cultivar) grown in non-irrigated soil in Sorriso County-MT, based on plant population density. The experiment was carried out in commercial area, on March 8, 2015; it followed a randomized block design, with six population densities and four replicates. Population densities comprising 80, 120, 160, 200, 240, and 280 thousand plants per hectare were used in the experiment. Experimental plots encompassed four 5-meter-long rows with 0.45-meter spacing between them. Final plant stand (plants ha<sup>-1</sup>), number of pods per plant, number of grains per pod, pod length (cm), weight of one hundred grains (g) and grain yield (kg ha<sup>-1</sup>) in the useful plot were evaluated at harvest time. The number of pods per plant has linearly decreased as population density increased. The number of seeds per pod, pod length and weight of one hundred grains did not change due to population density. Population density of 230 thousand plants ha<sup>-1</sup> has enabled the highest grain yield under the tested conditions.

**Keywords:** *Vigna unguiculata* (L.) Walp., spatial arrangement, Cerrado, off-season.

## PRODUÇÃO DE FEIJÃO-CAUPI CULTIVAR BRS ITAIM EM FUNÇÃO DA DENSIDADE POPULACIONAL DE PLANTAS

**RESUMO** - O feijão-caupi apresenta grande potencial de cultivo e rotação no Mato Grosso e no Cerrado em função da grande área disponível no período da segunda safra. Objetivou-se com este trabalho avaliar a produtividade da cultura do feijão-caupi de sequeiro, cultivar BRS Itaim no município de Sorriso-MT em função da densidade populacional de plantas. O experimento foi implantado em área comercial no dia 08 de março de 2015, delineado em blocos inteiramente casualizados, contendo seis densidades populacionais e quatro repetições. As densidades populacionais utilizadas foram: 80, 120, 160, 200, 240 e 280 mil plantas ha<sup>-1</sup>. As parcelas experimentais continham quatro linhas de 5 m de comprimento com espaçamento de 0,45 m entre si. Na parcela útil, no momento da colheita avaliaram-se o stand final de plantas (plantas ha<sup>-1</sup>), número de vagens por planta, número de grãos por vagem, comprimento de vagens (cm), massa de cem grãos (g) e produtividade dos grãos (kg ha<sup>-1</sup>). O número de vagens por planta diminuiu de forma linear com o aumento da densidade populacional. O número de grãos por vagem, o comprimento de vagens e o peso de cem grãos não foram alterados em função da densidade populacional. A densidade populacional de 230 mil plantas ha<sup>-1</sup> proporcionou a maior produtividade de grãos nas condições testadas.

**Palavras-chave:** *Vigna unguiculata* (L.) Walp., arranjo espacial, cerrado, segunda safra.

### INTRODUCTION

Although African-native Cowpea (*Vigna unguiculata* (L.) Walp.) was first introduced in Brazil (Bahia State) in the 16<sup>th</sup> century, it remains little known in the country, except for the Brazilian Northern and Northeastern regions (FREIRE FILHO, 2005). The intense genetic improvement applied to this crop, in association with increased internal and external demands for this product, allowed cowpea to be introduced in Brazilian

agribusiness as an alternative for growing off-season crops in Cerrado areas (FREIRE FILHO et al., 2011).

Brazilian Cerrado has dry winter; soybean cultivation prevails in its grain-production areas during crop season, whereas corn cultivation prevails in the off-season. Off-season corn crop sowing window ends close to February 20<sup>th</sup>, depending on the region; therefore, cowpea has potential to be sown in areas where corn is not grown due to short cycles. Studies conducted by Embrapa Meio-

<sup>1</sup>Docente do Curso de Engenharia Agrônoma, Instituto Federal de Educação, Ciência e Tecnologia de Mato Grosso (IFMT), Campus Sorriso, Avenida dos Universitários, 799, Bairro Santa Clara, Sorriso, Mato Grosso, Brasil. E-mail: [laerte.pivetta@srs.ifmt.edu.br](mailto:laerte.pivetta@srs.ifmt.edu.br), [dacio.olibone@srs.ifmt.edu.br](mailto:dacio.olibone@srs.ifmt.edu.br), [ana.olibone@srs.ifmt.edu.br](mailto:ana.olibone@srs.ifmt.edu.br). \*Autor para correspondência.

<sup>2</sup>Doutorando em Agronomia, Universidade Estadual do Oeste do Paraná (Unioeste), Rua Pernambuco, 1777, Centro, Campus Marechal Cândido Rondon, Paraná, Brasil. E-mail: [edvan\\_costa@outlook.com](mailto:edvan_costa@outlook.com).

<sup>3</sup>Tecnólogo em Produção de Grãos, Instrutor Senar, Mato Grosso, Brasil. E-mail: [gilbertokeres85@gmail.com](mailto:gilbertokeres85@gmail.com).

<sup>4</sup>Pesquisador em Genética e Melhoramento de feijão-caupi, Empresa Brasileira de Pesquisa Agropecuária (Embrapa Meio-Norte). Av. Duque de Caxias, 5650, Buenos Aires, Teresina, Piauí. Email: [jose-angelo.junior@embrapa.br](mailto:jose-angelo.junior@embrapa.br).

Norte recorded BRS Itaim cultivar yield of 2.655 kg ha<sup>-1</sup> in Primavera do Leste County-MT (FREIRE FILHO, 2009), whereas the mean national yield is lower than 400 kg ha<sup>-1</sup> (FREIRE FILHO et al., 2011).

Good management strategies maximize the amount of solar radiation intercepted by leaves, without making excessive investment in vegetative parts (GIFFORD et al., 1984). Plant spatial arrangement is a technique used to maximize root interception and production (HALL, 2003). Optimum planting density is defined as the number of plants capable of more efficiently and fully exploring a given soil area; it can change depending on soil, climate, cultivar and crop conditions (FREIRE FILHO et al., 2005).

Cowpea genetic materials can present size variation from prostrate-sized cultivars used for manual harvesting to erect cultivar used for mechanized harvesting, given the different ways to grow it. According to Cardoso et al. (2013), optimum density changes depending on the size of the genetic material; the more upright, the greater the ideal density. They recorded the highest yields for cultivars BRS Itaim (erect), BRS Tumucumaque (semi-erect) and BRS Pajeú (semi-prostrate) at densities of 18.2, 16.9 and 11.3 plants per meter, respectively, whereas Santos et al. (2013) recorded optimum density of 9.6 plants per meter for prostrate-sized cultivar BRS Marataoã.

Thus, the aim of the current study was to analyze the yield of BRS Itaim cultivars grown in Sorriso County-MT, based on plant population density.

## MATERIALS AND METHODS

The experiment was conducted in a region whose climate is classified as Aw type (humid tropical climate), based on Köppen's classification. The experimental region presents well-defined dry season (from April to September). The mean temperature in the hottest month (October) is approximately 25.76°C, whereas in the coldest month (June) it reaches approximately 22.96°C; mean annual temperature is 24.70°C, mean relative humidity is 80%, mean annual rainfall (1,974.47 mm) is concentrated between October and April (SOUZA et al, 2013). Soil in the experimental area presented granulometric composition of 272 g kg<sup>-1</sup> of sand, 143 g kg<sup>-1</sup> of silt and 585 g kg<sup>-1</sup> of clay, on average, as well as the following chemical attributes in the 0-20 cm layer: pH (CaCl) = 5.0; organic matter = 39 g kg<sup>-1</sup>; phosphorus (Mehlich) = 8.3 mg dm<sup>-3</sup>; potassium = 0.12 cmol<sub>c</sub> dm<sup>-3</sup>; calcium = 3.9 cmol<sub>c</sub> dm<sup>-3</sup>; magnesium = 0.7 cmol<sub>c</sub> dm<sup>-3</sup>; aluminum (Al) = 0.0 cmol<sub>c</sub> dm<sup>-3</sup>; H + Al = 4.0 cmol<sub>c</sub> dm<sup>-3</sup>; cation exchange capacity (CEC) = 4.66 cmol<sub>c</sub> dm<sup>-3</sup>; and base saturation = 53.8%.

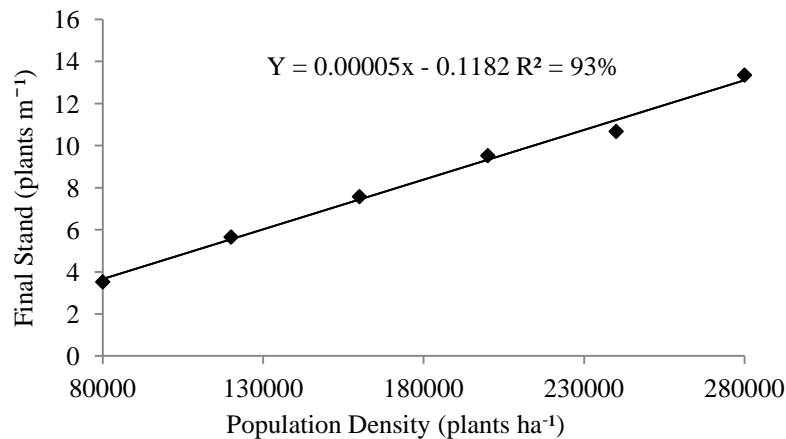
Six BRS Itaim cultivar population densities were evaluated based on a randomized block design with four replications - this cultivar presents well-defined erect growth habit (FREIRE FILHO, 2009). The experimental units comprised four 5-m-long rows with 0.45 m spacing between them. The useful area comprised the two central rows in the plot, although 0.25 m in each extremity of them was not taken into consideration. According to Vilarinho et al. (2010), BRS Itaim cultivar should be planted in rows spaced 0.50 m apart from each other at population density of 200 thousand plants per hectare, which corresponds to 10 seeds per linear meter. Thus, densities of 80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup> were defined to enable assessing the cultivar under local conditions.

The investigated area was desiccated with imazethapyr (0.5 L ha<sup>-1</sup> of commercial product) and glyphosate (3.0 L ha<sup>-1</sup> of commercial product) six days before the experiment; sowing took place on March 8<sup>th</sup>, 2015. A tractor-seeder set was used to mark the sowing rows where seeds were later manually deposited with the aid of a bazooka-type seed planter, which was specifically used in this experiment. Seeds were treated with fungicide based on carboxin + thiram (300 mL of commercial product /100 kg of seeds). On March 21<sup>st</sup>, plants were thinned in order to be adjusted to the corresponding densities. Topdressing fertilization was carried out on March 27<sup>th</sup> using 300 kg ha<sup>-1</sup> of Mono Ammonium Phosphate {MAP [10% of Nitrogen (N) + 50% of Phosphorus Pentoxide (P<sub>2</sub>O<sub>5</sub>)]}, which totaled 30 kg ha<sup>-1</sup> of N and 150 kg ha<sup>-1</sup> of P<sub>2</sub>O<sub>5</sub>.

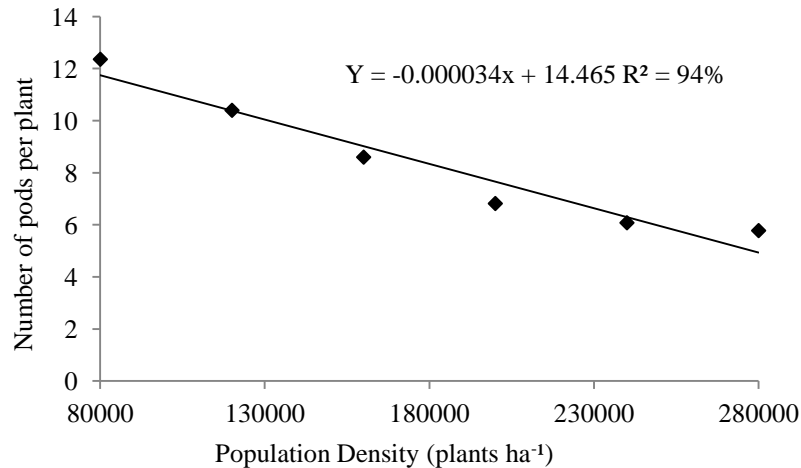
Harvest was manually done on June 6<sup>th</sup>, 2015, when all plants grown in the useful area were removed, accounted for and placed in raffia bags for further evaluation. The evaluated traits comprised final stand, number of pods per plant, number of grains per pod, pod length, weight of 100 grains and yield. Data were subjected to analysis of variance through F test, at 5% probability of error; means were subjected to regression analysis in the Sisvar statistical software, at 5% probability of error (FERREIRA, 2011).

## RESULTS AND DISCUSSION

Population density simulation was successful, since final plant stand presented linear adjustment at determination coefficient higher than 99% (Figure 1). Decreasing linear effects were observed in the number of pods per plant in comparison to population density, i.e., the larger the population, the smaller the number of pods produced by plants (Figure 2).



**FIGURE 1** - Final cowpea stand (BRS Itaim cultivar) based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>). \*\* significant at 1%.



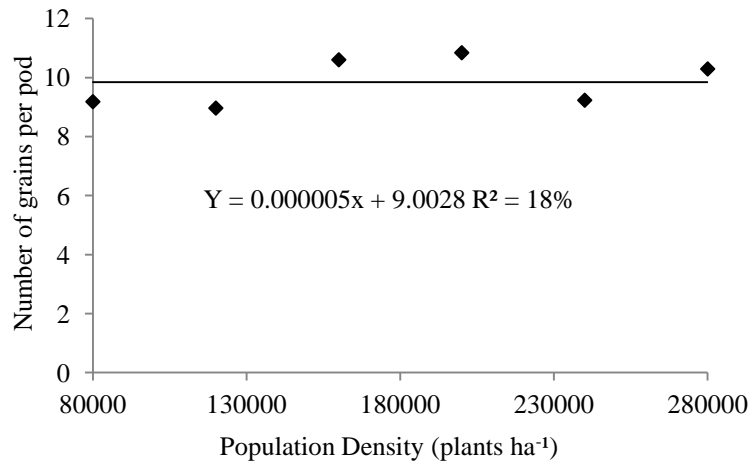
**FIGURE 2** - Number of pods per cowpea plant (BRS Itaim cultivar) based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>).

According to Naim and Jabereldar (2010), the number of pods per plant reduced as the number of plants increased from 30 thousand to 120 thousand plants per hectare for three cultivars in two cultivation years. According to Smith and Porter (1989), cowpea plants are more sensitive to variations in population density than to changes in nutrient levels. Based on ionic strength in the nutrient solution ranging from 100% to 5%, the aforementioned authors have found 44% variation in plant biomass. On the other hand, plant biomass decreased by 77% when plant density changed from one to five plants per pot.

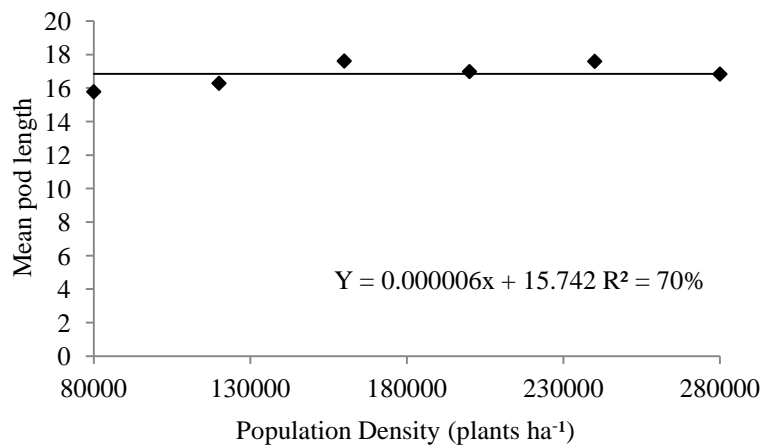
Intraspecific competition leads to reduced plant growth (SMITH and PORTER, 1989), as well as to decreased number of nodes in the main branch, number of side branches (BEZERRA et al., 2009) and number of

flowers (CARVALHO et al., 2000). These factors lead to decreased number of pods per plant, which concerns the production component mostly influenced by the environment. Overall, the number of pods per plant and grain yield per plant often decrease as population density increases (TÁVORA et al., 2000; CARDOSO and RIBEIRO, 2006; LEMMA et al., 2009; BEZERRA et al., 2009). Producers should pay special attention to this variable due to positive correlation between number of pods per plant and yield (TEIXEIRA et al., 2007; OLIVEIRA et al., 2013).

Population densities assessed in the current study did not influence pod development in cowpea BRS Itaim cultivar; all treatments enabled approximately 10 grains per pod (Figure 3) and 17-cm-long pods (Figure 4), on average.



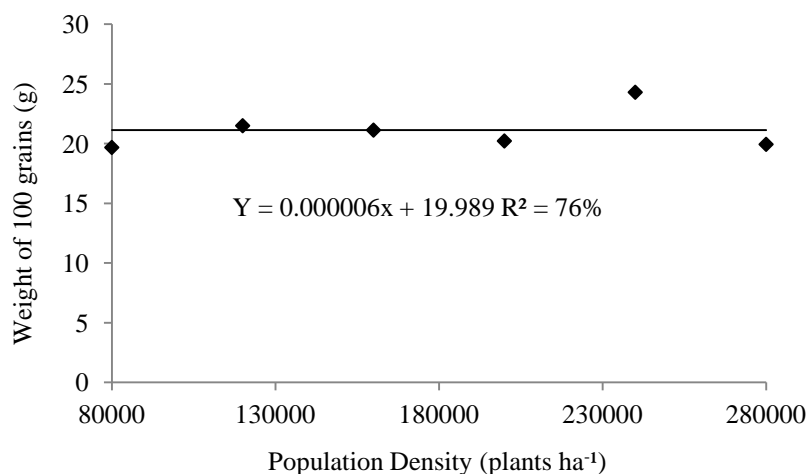
**FIGURE 3** - Number of grains per pod observed for cowpea BRS Itaim cultivar, based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>).



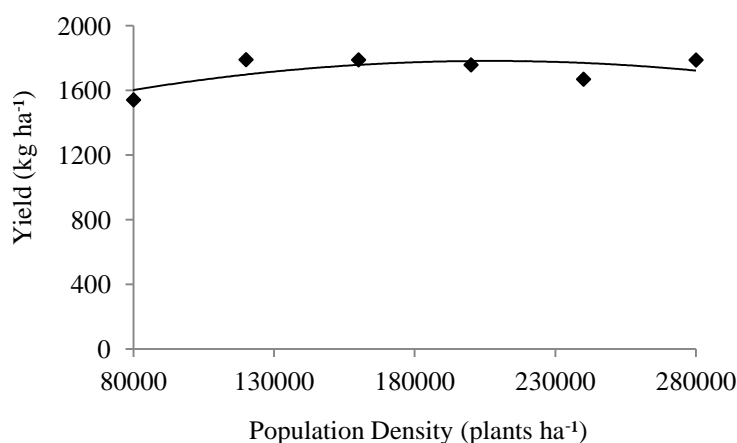
**FIGURE 4** - Mean pod length observed for cowpea BRS Itaim cultivar, based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>).

The number of grains per pod is a yield component of great genetic control; therefore, it is less influenced by the environment than the number of pods per plant. Similar results were observed by other authors (BEZERRA et al., 2009; CARDOSO and RIBEIRO, 2006; TÁVORA et al., 2000). The mean weight of one hundred grains was 21.12 g in all population densities assessed in the current study (Figure 5). These data corroborate the study by Cardoso and Ribeiro (2006), who did not observe significant difference in the weight of 100 grains (24.9 g, on average). This trait has great genetic influence and is the production component least influenced by the environment – according to reports, population density does not affect the weight of one hundred grains

(BEZERRA et al., 2009; CARDOSO and RIBEIRO, 2006; LEMMA et al., 2009; TÁVORA et al., 2000). Variable 'yield' has shown quadratic performance. It was possible finding yield peak of approximately 1,830 kg ha<sup>-1</sup> at population density of 230 thousand plants ha<sup>-1</sup> by calculating the maximum point by derivative in the equation (Figure 6). According to Henderson et al. (2000), it is essential finding the most appropriate plant arrangement in order to develop effective production systems to be applied to new crops. Information deriving from tests carried out in Mato Grosso State play a key role in the establishment of productive practices adapted to the region.



**FIGURE 5** - Weight of one hundred grains (g) observed for cowpea BRS Itaim cultivar, based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>).



**FIGURE 6** - Yield (kg ha<sup>-1</sup>) observed for cowpea BRS Itaim cultivar, based on six plant population densities (80, 120, 160, 200, 240 and 280 thousand plants ha<sup>-1</sup>).

Cowpea BRS Itaim cultivar has upright growth habit, which allowed greater sowing density; however, the number of pods per plant decreased as population density increased (Figure 2) - the other production components were not affected by population density (Figures 3 and 5). Thus, besides yield, it is essential taking into consideration the cost with seeds at the time to select the population density to be adopted; the recommended sowing rate is close to 230 thousand plants per hectare.

Bezerra et al. (2009) have observed quadratic behavior with maximum yield of approximately 1,700 kg ha<sup>-1</sup> at population density of approximately 490 thousand plants per hectare in an upright breeding line with well-define cycle provided by the International Institute of Tropical Agriculture (IITA); such breeding line is specific for Mechanized Harvests. This outcome explains the better performance observed at high population density. Cardoso and Ribeiro (2006) observed quadratic behavior with maximum yield of 1,670 kg ha<sup>-1</sup> at population density of approximately 110 thousand plants per hectare for semi-erect Rouxinal cultivar.

Increased population density has reduced the number of pods per plant; however, it has not affected the

number of grains per pod, pod length and the weight of one hundred grains. Thus, it is recommended using the maximum population density of 230 thousand plants ha<sup>-1</sup>.

## CONCLUSIONS

The number of pods per plant has linearly decreased as population density increased.

The number of grains per pod, pod length and the weight of one hundred grains did not change regardless of the population density.

Population density of 230 thousand plants ha<sup>-1</sup> enabled the highest grain yield under the tested conditions.

## REFERENCES

BEZERRA, A.A.C.; TÁVORA, F.J.A.F.; FREIRE FILHO, F.R.; RIBEIRO, V.Q. Características de dossel e de rendimento em feijão-caupi ereto em diferentes densidades populacionais. *Pesquisa Agropecuária Brasileira*, v.44, n.10, p.1239-1245, 2009.

- CARDOSO, M.J.; RIBEIRO, V.Q. Desempenho agrônomico do feijão-caupi, cv. Rouxinol, em função de espaçamento entre linhas e densidade de plantas sob regime de sequeiro. **Revista Ciência Agronômica**, v.37, n.1, p.102-105, 2006.
- CARDOSO, M.J.; RIBEIRO, V.Q.; MELO, F.B. Performance da densidade de plantas em cultivares comerciais de feijão-caupi nos cerrados do leste maranhense. In: CONGRESSO NACIONAL DE FEIJÃO-CAUPI, 3., 2013, Recife. **Anais...** Recife: Embrapa Meio-Norte, 2013. 1 CD-ROM.
- FERREIRA, D.F. Sisvar: a computer statistical analysis system. **Ciência e Agrotecnologia**, v.35, n.6, p.1039-1042, 2011.
- FREIRE FILHO, F.R.; ROCHA, M.M.; RIBEIRO, V.Q.; SILVA, K.J.D.; CARVALHO, H.W.L.; CRAVO, M. S.; LOPES, A.M.; VILARINHO, A.A.; SABOYA, R.C.C.; CAVALCANTE, E.S.; COSTA, A.F.; ALCÂNTARA, J.P.; SITTOLIN, I.M. **BRS Itaim**: cultivar de feijão-caupi com grãos tipo fradinho. Teresina, PI: EMBRAPA Meio-Norte, 2009. 2p.
- EMBRAPA. EMPRESA BRASILEIRA DE PESQUISA AGROPECUÁRIA. Centro de Pesquisa Agropecuária do Meio-Norte.
- FREIRE FILHO, F.R.; LIMA, J.A.A.; RIBEIRO, V.Q. **Feijão-caupi**: avanços tecnológicos. Brasília, DF: EMBRAPA Informação Tecnológica, 2005. 519p.
- FREIRE FILHO, F.R.; RIBEIRO, V.Q.; ROCHA, M.M.; SILVA, K.J.D.; NOGUEIRA, M.S.R.; RODRIGUES, E.V. **Feijão-caupi no Brasil**: produção, melhoramento genético, avanços e desafios. Teresina, PI: EMBRAPA Meio-Norte, 2011. 84p.
- GIFFORD, R.M.; THORNE, J.H.; HITZ, W.D.; GIAQUINTA, R.T. Crop productivity and photoassimilate partitioning. **Science**, v.225, n.1, p.801-808, 1984.
- HALL, A.E. Future directions of bean/cowpea collaborative research support program. **Field Crops Research**, v.82, n.2, p.233-240, 2003.
- HENDERSON, T.L.; JOHNSON, B.L.; SCHNEITER, A.A. Row spacing, plant population, and cultivar effects on grain amaranth in the northern Great Plains. **Agronomy Journal**, v.92, n.2, p.329-336, 2000.
- KÖPPEN, W. **Climatologia**: con un estudio de los climas de la tierra. México, Buenos Aires: Fondo de Cultura Económica, 1948. 479p.
- LEMMA, G.; WORKU, W.; WOLDEMICHAEL, A. Moisture and planting density interactions affect productivity in cowpea (*Vigna unguiculata*). **Journal of Agronomy**, v.8, n.4, p.117-123, 2009.
- MIRANDA, L.; AMORIM, L. **Atlas Geográfico**. Cuiabá, MT: Entrelinhas, 2001. 40p.
- NAIM, A.M.; JABERELDAR, A.A. Effect of plant density and cultivar on growth and yield of cowpea (*L. Walp*). **Australian Journal of Basic and Applied Sciences**, v.4, n.8, p.3148-3153, 2010.
- OLIVEIRA, S.R.M. **Densidade populacional do feijão-caupi sob níveis de irrigação**. 2013. 103p. Tese (Doutorado em Irrigação e Drenagem) - Universidade Federal do Ceará, Fortaleza, 2013.
- SANTOS, J.F.; BASTOS, E.A.; CARDOSO, M.J. Efeito de densidades de planta sobre a produtividade de grãos do feijão-caupi. In: CONGRESSO NACIONAL DE FEIJÃO-CAUPI, 3., 2013, Recife. **Anais...** Recife: Embrapa Meio-Norte, 2013. 1 CD-ROM.
- SMITH, R.A.; PORTER, J.R. Response of cowpea to variations in planting density and nutrient level. **Plant and Soil, The Hague**, v.116, n.2, p.183-190, 1989.
- SOUZA, A.P.; MOTA, L.L.; ZAMADEI, T.; MARTIM, C.C.; ALMEIDA, F.T.; PAULINO, J. Classificação climática e balanço hídrico climatológico no estado de mato grosso. **Nativa**, v.1, n.1, p.34-43, 2013.
- TÁVORA, F.J.A.F.; CARVALHO, W.P.; PINHO, J.L.N.; PITOMBEIRA, J.B. Densidade de plantio na cultura do feijão de corda irrigada. II. Componentes de produção e rendimento de grãos. **Ciência Agronômica**, v.31, n.1, p.20-26, 2000.
- TEIXEIRA, N.J.P.; MACHADO, C.F.; FREIRE FILHO, F.R.; ROCHA, M.M.; GOMES, R.L.F. Produção, componentes de produção e suas inter-relações em genótipos de feijão-caupi (*Vigna unguiculata* (L.) Walp.) de porte ereto. **Revista Ceres**, v.54, n.314, p.374-382, 2007.
- VILARINHO, A.A.; ROCHA, M.M.; FREIRE FILHO, F.R.; COELHO, G. **BRS Itaim - cultivar de feijão-caupi com grãos tipo fradinho**. Teresina, PI: EMBRAPA Meio-Norte, Comunicado Técnico 58, 2010. 4p.