Participative evaluation and agroclimatic conditions in the cultivation system of organic common beans

Marciel Lelis Duarte [1*], **Jose Arcanjo Nunes** [2], **Sebastião Martins Filho** [3]

[1] Departamento de Engenharia Agrícola Universidade Federal de Viçosa, Avenida Peter Henry Rolfs, s/nº, Campus Universitário, 36.570-900 Viçosa, MG, Brazil.
[2] Secretaria Municipal de Desenvolvimento Rural, Centro Cultural e Esportivo. "Scarpão", 29.490-000, Atílio Vivácqua - ES, Brazil
[3] Departamento de Estatística, Universidade Federal de Viçosa, Avenida Peter Henry Rolfs, s/nº, Campus Universitário, 36.570-900 Viçosa, MG, Brazil.

**Corresponding author. E-mail: marciellelis@gmail.com*

ABSTRACT. The present study aimed at the participatory evaluation of local and improved bean genotypes associated with agroclimatic conditions in organic farming systems. Joint work between the formal and informal sectors, generally represented by rural communities, can contribute to the use and conservation of germplasm adapted to the agroecosystems of agricultural communities. Furthermore, participatory improvement is undoubtedly an excellent strategy for the sustainable development of family farmer communities. Farmers happen to be co-responsible for the research ceasing to be a passive element within the process. The experiments were conducted under field conditions, under organic cultivation, in the agricultural community of Fortaleza, located in Muqui-ES. A total of 39 genotypes were used between cultivars grown in the region and local genotypes in the years 2006, 2007, and 2008. The experimental design was a randomized block design with four replications. It was verified that years of 2006, 2007, and 2008 there were few differences between the genotypes in the characteristics evaluated, except for grain production. The low rainfall in the year 2006 and the high temperatures in the year of 2008 influenced the low production of grains of the genotypes.

Keywords: Climate elements, Landrace, improved genotypes, *Phaseolus vulgaris*.

DOI: https://doi.org/10.33837/msj.v3i3.1260

Received June 26, 2020. Accepted August 8, 2020.
Associate editor: Ana Paula Silva Siqueira

INTRODUCTION

In the south of the state of Espírito Santo, the predominant form of agriculture is familiar, where beans are grown for the livelihood of families, with the surplus traded in the region itself (Ferrão et al., 2016).

According to data from Conab (2019), the average productivity of Brazil in the 2017/2018 harvest was 1019 kg ha^{-1}, which is considered low. In conventional systems with high technology, the productivity of the common bean manages to surpass a mark of 3000 kg ha^{-1}. However, most Brazilian beans are produced in family farming with little technology, without knowledge of the ideal agroclimatic conditions for each genotype and generally fertilization and deficient pest control (Vieira et al., 2013).

Knowledge of the agroclimatic requirements of crops is a tool that helps agricultural planning, aiming at greater productivity, profitability, and reduction of losses due to climatic factors (Pereira et al., 2014). There are countless factors that influence the performance of beans, especially temperature and rainfall. Temperature is one factor that directly affects the development of culture at different physiological stages, mainly flowering and fruiting (Hoffmann Junior et al., 2007, Vieira et al., 2013, Pereira et al., 2014).

In the context of current agriculture, when new cultivars are adopted in a given region, they replace traditional ones and can lead to the total elimination of the old ones. The preservation of existing genetic variability in a species and related species can be done in several ways. However, recently there has been recognition of the role of agricultural communities in the management and conservation of genetic resources at the local level, appearing as a complement to the system of existing conservation (Machado, 2014, Nodaria and Guerra, 2015).

Thus, the joint work between the formal and the informal sectors (represented by rural communities), in the management of agrobiodiversity in a short period of time, can contribute to the use and conservation of germplasm adapted to the agroecosystems of agricultural communities. Also, participatory breeding is undoubtedly an excellent strategy for the sustainable development of family farming communities. Still, in this case, the farmer becomes co-responsible for the research, ceasing to be a passive element in the process (Ceccarelli, 2012, Fonseca, 2014).

In view of the above, the objective was to evaluate local and improved bean genotypes associated with agroclimatic conditions in an organic cultivation system with the participatory evaluation of farmers.

MATERIAL AND METHODS

The experiments were carried out under field conditions, in an organic system, within a participatory research approach, in the agricultural community of Fortaleza, located in the municipality of Muqui-ES, at an altitude of 240 m, with the prevailing climate hot and humid in the summer with dry winter, with an average annual temperature of 22ºC, with a daily maximum of 28ºC and minimum of 17ºC (Ramos et al., 2016).

Plantings were carried out in 2006 (sowing on 05/06/2006), 2007 (sowing on 05/02/2007), and 2008 (sowing on 03/14/2008). Thirty-nine genotypes were used between improved cultivars grown in the region and local genotypes, using a dosage of 16 t ha^{-1} of cattle manure. These genotypes are conserved in PET bottles, in a dry and cool place on the farmers' properties, who use them for cultivating the next harvest, for the family's consumption and, when there is a surplus, they are sold. Throughout the development of the work, the choice of area, planting, conducting the trial, harvesting, and evaluating the experiment, were carried out with the participation of farmers in the community.

The experimental design used was randomized blocks, with four replications. The experimental unit consisted of four rows of five meters in length spaced between lines by 0.5 m. The two central lines where the evaluations were carried out were considered useful area. The following agronomic characteristics were evaluated: **1) Growth habit** - as described by Oliveira et al. (2018), **2) Flower color**, **3) Grain color**, **4) Number of days to flowering** - Counting the number of days planted until when 50% of the plants in the experimental unit were in bloom, **5) Number of days for maturation -** Counting the number of days of planting until 50% of the plants in the experimental unit had mature pods**, 6) Number of pods per plant -** Ten plants were collected at random in the useful area, counting the total number of pods and estimating the average, **7) Number of grains per pod** - Obtained by counting the total number of grains from ten plants and dividing the result by the total number of pods, **8) Grain productivity -** Carried out using the weight of grains in the useful area in kilograms, with a correction for 13% humidity, transforming the data to kg ha^{-1}, **9) Mass of one hundred grains (g)** - Determined by weighing one hundred grains from the useful area and subsequently corrected to 13% humidity, **10) Height of the first pod (cm) -** Determined by collecting ten plants at random in the useful area of each experimental unit, measuring from the plant's collar to the height of insertion of the first pod, **11) Height of plants (cm) -** Were evaluated by taking ten plants at random in the useful area and measuring from the plant's collar to the end of the main stem and **12) Final stand** - Were counted the number of plants in the useful area.

At the end of the experiment, individual variance analyzes were performed for each year of planting, and the genotypes were compared using the Scott-Knot procedure ($p \leq 5\%$). In the interest of verifying the behavior over these years, a joint analysis of the data was also carried out for all years.

RESULTS AND DISCUSSION

For all evaluated characteristics, it was verified that the genotype x years interaction was significant ($p < 0.05$).

It can be seen in Table 1 that most of the evaluated genotypes showed determined growth, with an average number of 45 days until flowering. For maturation, an average of 98 days was observed, with few genotypes exceeding 100 days.

When the behavior of the genotypes in the years 2006, 2007, and 2008 was observed, it was noted that there were few differences in the evaluated characteristics, except for grain productivity (Tables 2 and 3). 2006 was the year with the lowest production, which probably occurred due to low rainfall after planting, which lasted up to 40 days (Figure 1). For high productivity, the bean requires an amount of water in the soil available that is sufficient for its development and maintenance, especially in the fundamental stages such as germination, emergence, flowering, and grain filling (Rosales et al., 2012; Ardakani et al., 2013, Beebe et al., 2014, Pereira et al., 2014, Polania et al., 2016).

Another probable cause was that the average temperature was 21.2ºC in 2006, lower than in other years (Figure 2). Vieira et al (2013) report that low temperatures during the plant's growth phase can impair vegetative growth, generating small plants, abortion of flowers, and seeds.

In the other years, 2007 was the year in which the production was greater, with few differences compared to 2008. These few differences for the year 2008 probably occurred due to the air temperature. This year the average temperature was around 27ºC (Figure 2), between the sowing and flowering period, since the ideal would be for flowering to coincide with temperatures close to 21ºC (Vieira et al., 2013).

Table 1. Growth habit characteristics, flower color, grain color, the average number of days for flowering ± standard deviation, the average number of days for maturation ± standard deviation, evaluated in common bean genotypes grown in organic systems in the municipality of Muqui-ES.

Genotype	Growth habit	Flower color	Grain color	Number of days to flower	Number of days to mature
Amarelinho	Determined	White	Dark brown	46 ± 2	97 ± 6
Amendoim vermelho	Determined	Purple	Pink streaked with dark red	43 ± 4	100 ± 2
Baetão	Determined	Purple	Streaked purple	47 ± 5	97 ± 6
Bate estrada	Determined	Purple	Light red streaked to black	50 ± 5	97 ± 6
BATT-477	Determined	Purple	Light Beige	44 ± 3	97 ± 6
Caeté Pé Curto	Determined	Purple	Black	47 ± 4	97 ± 5
Campinho	Determined	White	White /Red	41 ± 3	100 ± 2
Capixaba precoce	Determined	Purple	Black	43 ± 2	100 ± 2
Carioca	Determined	White	Type carioca	45 ± 4	97 ± 6
Córrego Alto	Determined	White	White with red spots in the hilum region	41 ± 2	100 ± 2
EL-22	Determined	Purple	Light Beige	44 ± 3	97 ± 5
Enxofre	Determined	Purple	Yellow	38 ± 5	95 ± 9
Fortuna	Indetermined	Purple	Black	53 ± 4	106 ± 8
IAPAR 81	Determined	White	Type carioca	48 ± 5	98 ± 3
Imperial	Determined	Purple	Black	45 ± 3	97 ± 5
Levanta hipoteca	Indetermined	Purple	Black	54 ± 6	106 ± 8
Macuquinho	Determined	White	Dark brown	47 ± 3	97 ± 6
Macuquinho verdadeiro	Determined	White	Dark brown	46 ± 3	97 ± 6
Mamona	Determined	Purple	Streaked purple	47 ± 2	97 ± 5
Manteigão	Determined	White	Brown	41 ± 3	100 ± 2
Manteigão 2	Determined	Purple	Light Beige	43 ± 3	100 ± 2
Monte Alegre	Determined	White	Red	43 ± 4	100 ± 2
Morgado	Determined	Purple	Pink/ Brown	50 ± 5	97 ± 6
Mulatinho	Determined	White	Light brown	45 ± 2	97 ± 6
Paina	Determined	Purple	Black	46 ± 4	97 ± 6
Perola	Determined	White	Type carioca	48 ± 4	100 ± 2
Preto meia lua	Determined	Purple	Black	40 ± 3	100 ± 2
Rio doce	Determined	Purple	Black	45 ± 2	97 ± 6
Rosinha	Determined	Purple	Light wine	52 ± 8	96 ± 7
Sangue de boi	Determined	White	Wine	39 ± 2	100 ± 2
Santa Maria	Determined	Purple	Black	46 ± 2	99 ± 2
Serrano	Determined	Purple	Black	49 ± 5	100 ± 2
Sumidouro	Determined	Purple	Black	46 ± 4	100 ± 2
Terrinha-1	Determined	White	Light grey	49 ± 4	97 ± 6
Terrinha-2	Determined	White	Dark brown	45 ± 3	97 ± 5
Uirapuru	Determined	Purple	Black	47 ± 5	97 ± 5
Vagem riscada	Determined	Purple	Black	47 ± 4	97 ± 6
Vermelho	Determined	White	Red	47 ± 5	97 ± 6
Vermelho e branco	Determined	White	Red streaked with white	31 ± 2	80 ± 0

Table 2. Joint analysis of the characteristics number of pods per plant (NPP), number of grains per pod (NGP), and grain yield in kg ha^{-1} (Yield) evaluated in common bean genotypes grown in an organic system in the municipality of Muqui-ES, in the years of 2006, 2007 and 2008[1/]

Genotype	NPP			NGP			Yield		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Amarelinho	13.6 a A[2/]	12.3 b A	7.1 d B	5.0 a B	7.0 a A	5.8 a B	763.7 a B	1107.3 b A	1146.7 a A
Amendoim vermelho	7.8 c A	8.4 c A	6.8 d A	4.1 b A	4.4 c A	4.3 b A	732.7 a B	1365.7 a A	696.7 b B
Baetão	7.6 c A	9.4 c A	5.4 d A	4.5 a A	5.2 b A	5.5 a A	256.0 c B	713.3 c A	520.0 c A
Bate estrada	4.7 d A	8.4 c A	6.3 d A	3.6 b B	5.2 b A	5.8 a A	102.0 c B	416.0 d A	500.0 c A
BATT-477	8.0 c A	10.4 c A	9.8 c A	5.6 a A	6.4 a A	6.5 a A	404.3 b B	763.0 c A	905.0 b A
Caeté Pé Curto	6.9 c B	13.2 b A	8.1 c B	5.1 a A	5.8 b A	6.2 a A	296.3 b B	705.0 c A	836.7 b A
Campinho	5.7 c A	7.3 c A	6.6 d A	2.9 b A	3.9 c A	3.1 b A	634.3 a A	676.3 c A	546.7 c A
Capixaba precoce	10.5 b B	13.9 b A	7.3 d B	5.1 a A	5.3 b A	5.6 a A	727.7 a A	641.3 c A	450.0 c B
Carioca	6.8 c A	8.2 c A	8.6 c A	5.1 a A	5.3 b A	6.0 a A	377.0 b B	755.7 c A	686.7 b A
Córrego alto	6.2 c A	8.6 c A	6.6 d A	3.5 b A	4.0 c A	3.2 b A	639.7 a A	852.0 c A	753.3 b A
EL-22	9.7 b A	9.1 c A	9.2 c A	5.4 a A	6.2 a A	6.3 a A	560.0 a B	791.7 c A	965.0 a A
Enxofre	6.5 c A	7.9 c A	5.8 d A	3.7 b A	4.3 c A	3.1 b A	390.7 b B	737.0 c A	361.7 c B
IAPAR 81	9.9 b B	17.0 a A	17.8 a A	4.8 a A	4.8 c A	5.7 a A	705.7 a B	1184.7 b A	1143.3 a A
Imperial	10.7 b B	14.6 b A	9.2 c B	5.9 a A	6.3 a A	6.4 a A	566.3 a C	1128.3 b A	811.7 b B
Macuquinho	8.7 b A	10.8 c A	11.0 b A	5.9 a A	5.7 b A	6.1 a A	589.7 a A	720.3 c A	796.7 b A
Macuquinho verdadeiro	12.6 a B	19.0 a A	11.4 b B	4.6 a B	5.9 a A	5.8 a A	632.0 a B	1035.7 b A	1030.0 a A
Mamona	6.7 c A	7.7 c A	8.7 c A	4.0 b B	4.9 c A	5.3 a A	430.7 b B	694.7 c A	858.3 b A
Manteigão	4.6 d A	6.3 c A	4.5 d A	3.7 b A	4.7 a A	3.9 b A	373.3 b B	726.0 c A	460.0 c B
Manteigão-2	5.4 d A	6.6 c A	7.8 c A	3.7 b A	4.7 a A	4.3 b A	472.3 a C	1099.0 b A	706.7 b B
Monte Alegre	3.6 d A	6.5 c A	5.3 d A	2.8 b B	4.4 a A	3.5 b B	179.3 c B	663.3 c A	320.0 c B
Morgado	3.7 d B	7.2 c A	8.5 c A	3.1 b B	5.2 b A	5.8 a A	118.7 c B	473.7 d A	415.0 c A
Mulatinho	13.7 a B	17.4 a A	11.4 b B	5.3 a A	6.1 a A	6.4 a A	768.0 a A	821.3 c A	755.0 b A
Paina	9.3 b A	8.1 c A	9.5 c A	5.8 a A	6.0 a A	6.3 a A	635.0 a B	854.7 c A	1005.0 a A
Perola	7.2 c A	8.3 c A	6.5 d A	4.2 b A	5.4 b A	5.1 a A	610.7 a B	881.3 c A	661.7 b B
Preto meia lua	4.6 d B	7.6 c A	8.4 c A	3.2 b B	4.6 c A	3.7 b B	346.3 b B	771.7 c A	783.3 b A
Rio Doce	9.9 b A	9.4 c A	7.4 d A	5.7 a A	5.6 b A	6.1 a A	593.0 a B	926.7 b A	828.3 b A
Rosinha	5.7 c A	6.8 c A	6.8 d A	3.8 b B	4.0 c B	5.2 a A	175.0 c A	368.3 d A	358.3 c A
Sangue de boi	4.8 d A	5.8 c A	6.1 d A	2.8 b B	4.4 c A	3.5 b B	523.7 a B	1337.0 a A	628.3 c B
Serrano	7.6 c A	8.5 c A	9.2 c A	5.4 a A	5.2 b A	6.0 a A	414.3 b B	650.3 c A	858.3 b A
Sumidouro	8.5 b A	7.5 c A	7.0 d A	5.3 a A	5.8 b A	6.0 a A	611.0 a A	674.7 c A	740.0 b A
Terrinha 1	2.3 d B	6.1 c A	6.2 d A	3.3 b B	5.4 b A	5.8 a A	117.0 c C	465.7 d B	692.0 b A
Terrinha 2	10.4 b B	15.6 a A	12.3 b B	5.4 a A	6.1 a A	5.8 a A	625.3 a C	1334.7 a A	863.3 b B
Uirapuru	10.3 b B	14.4 b A	7.2 d B	5.2 a A	5.4 b A	6.0 a A	856.0 a A	963.3 b A	411.7 c B
Vagem riscada	11.7 a B	16.1 a A	8.4 c C	5.5 a B	6.9 a A	6.0 a B	637.0 a B	1022.3 b A	805.0 b B
Vermelho	4.8 d B	7.3 c B	12.3 b A	4.1 b A	4.3 c A	5.2 a A	196.7 c B	571.0 d A	656.7 b A

[1/] Sowing carried out on 05/06/2006, 05/02/2007 and 03/14/2008;

[2/] Means followed by the same lowercase letter in the column and uppercase in the row do not differ at 5% significance by the Scott-Knott procedure.

Table 3. Joint analysis of the mass characteristics of one hundred grains (MHG), the height of the first pod (AFP), and final stand (STAND) evaluated in common bean genotypes grown in an organic system in the municipality of Muqui-ES, in the years 2006, 2007, and 2008[1/]

Genotype	MHG			AFP			STAND		
	2006	2007	2008	2006	2007	2008	2006	2007	2008
Amarelinho	15.7 f A[2/]	16.3 g A	16.8 e A	12.0 a B	15.0 b B	24.5 b A	126.0 b A	122.3 a A	106.7 a B
Amendoim vermelho	45.0 b A	46.7 b A	31.3 b B	14.7 a B	18.7 a A	22.1 b A	131.7 b A	116.0 a B	102.7 a B
Baetão	14.7 f A	16.3 g A	18.2 e A	14.3 a A	14.0 b A	18.3 c A	142.0 a A	117.0 a B	103.7 a B
Bate estrada	13.8 f A	16.0 g A	16.2 e A	12.3 a B	18.0 a A	20.8 b A	125.7 b A	109.3 a B	102.3 a B
BATT-477	14.2 f A	14.0 h A	16.7 e B	13.3 a A	17.0 a A	19.0 c A	143.3 a A	114.3 a B	110.3 a B
Caeté Pé Curto	12.9 f A	12.3 h A	15.2 e A	12.7 a B	18.7 a A	21.3 b A	131.7 b A	118.0 a B	111.3 a B
Campinho	42.5 b A	41.0 c A	31.5 b B	14.3 a A	17.3 a A	15.5 c A	142.3 a A	114.3 a B	75.7 c C
Capixaba precoce	17.0 e A	17.0 g A	16.5 e A	14.0 a A	14.7 b A	15.8 c A	136.0 a A	118.0 a B	112.7 a B
Carioca	16.8 e A	16.7 g A	19.3 e A	15.0 a A	18.7 a A	16.6 c A	123.3 b A	120.7 a A	106.7 a B
Córrego alto	49.7 a A	47.7 b A	43.7 a B	18.7 a A	21.3 a A	24.6 b A	132.0 b A	110.0 a B	103.7 a B
EL-22	14.3 f A	16.0 g A	15.8 e A	12.7 a A	15.0 b A	18.2 c A	143.3 a A	118.0 a B	110.7 a B
Enxofre	36.3 c A	39.7 c A	32.2 b B	12.7 a A	14.0 b A	17.4 c A	137.0 a A	89.0 b B	96.7 b B
IAPAR 81	19.5 e A	15.3 g B	21.3 d A	14.0 a A	15.3 b A	18.4 c A	140.0 a A	118.7 a B	109.7 a B
Imperial	14.2 f B	19.0 f A	15.0 e B	16.7 a A	17.0 a A	19.9 c A	135.7 a A	125.0 a A	116.7 a A
Macuquinho	15.2 f A	16.0 g A	16.3 e A	15.7 a A	16.0 a A	15.9 c A	138.0 a A	112.7 a B	102.7 a B
Macuquinho verdadeiro	14.6 f A	14.0 h A	16.3 e A	15.7 a A	17.3 a A	15.7 c A	135.7 a A	111.3 a B	109.0 a B
Mamona	17.2 e A	17.7 g A	17.8 e A	13.0 a B	17.3 a B	21.7 b A	143.0 a A	118.7 a B	103.7 a C
Manteigão	30.0 d B	34.0 d A	23.5 c C	13.0 a B	22.3 a A	13.5 c B	139.0 a A	125.7 a A	83.3 c B
Manteigão-2	37.8 c A	32.0 d B	39.8 a A	15.7 a B	19.0 a B	23.5 b A	120.3 b A	125.3 a A	102.7 a B
Monte Alegre	32.2 d B	36.0 d A	21.3 d C	13.7 a A	20.0 a A	16.7 c A	131.7 b A	113.7 a B	89.0 b C
Morgado	12.7 f B	17.7 g A	14.7 e B	16.0 a A	16.0 b A	17.3 c A	136.7 a A	110.3 a B	94.3 b C
Mulatinho	16.7 e A	19.3 f A	15.2 e A	12.3 a A	18.0 a A	13.9 c A	136.0 a A	117.7 a B	92.7 b C
Paina	14.8 f A	17.7 g A	15.8 e A	13.3 a A	13.0 b A	17.9 c A	138.0 a A	122.0 a B	110.0 a B
Perola	18.0 e B	15.3 g B	23.8 c A	14.0 a B	12.0 b B	19.5 c A	137.7 a A	114.3 a B	108.0 a B
Preto meia lua	28.3 d B	33.3 d A	26.8 c B	14.7 a A	19.3 a A	18.5 c A	131.0 b A	122.0 a A	109.7 a B
Rio Doce	15.7 f B	21.0 f A	15.5 e B	15.0 a B	13.7 a B	20.7 b A	141.3 a A	118.0 a B	107.0 a B
Rosinha	13.8 f A	13.0 h A	15.8 e A	13.0 a B	17.7 a B	31.1 a A	126.0 b A	90.0 b B	115.0 a A
Sangue de boi	51.2 a A	53.0 a A	43.2 a B	15.7 a A	17.0 a A	13.4 c A	131.7 b A	118.7 a A	104.3 a B
Serrano	13.8 f A	15.3 g A	12.8 e A	14.7 a A	14.7 b A	19.3 c A	146.3 a A	118.3 a B	110.0 a B
Sumidouro	13.8 f A	15.3 g A	12.2 e A	16.7 a A	16.7 a A	16.8 c A	132.3 b A	120.0 a A	122.3 a A
Terrinha 1	18.0 e A	16.3 g A	20.8 d A	14.0 a B	14.0 b B	21.4 b A	143.0 a A	110.3 a B	112.0 a B
Terrinha 2	15.5 f A	13.0 h A	15.2 e A	12.7 a B	19.0 a A	17.2 c A	139.3 a A	117.0 a B	115.0 a B
Uirapuru	18.7 e B	31.0 d A	18.0 e B	13.3 a A	18.7 a A	16.8 c A	146.7 a A	124.0 a B	102.3 a C
Vagem riscada	14.3 f A	13.0 h A	14.7 e A	18.0 a B	19.7 a B	25.1 b A	139.3 a A	117.3 a B	111.3 a B
Vermelho	15.0 f B	24.3 e A	24.5 c A	14.7 a B	20.0 a A	22.1 b A	132.0 b A	106.3 a B	98.7 b B

[1/] Sowing carried out on 05/06/2006, 05/02/2007 and 03/14/2008;

[2/] Means followed by the same lowercase letter in the column and uppercase in the row do not differ at 5% significance by the Scott-Knott procedure.

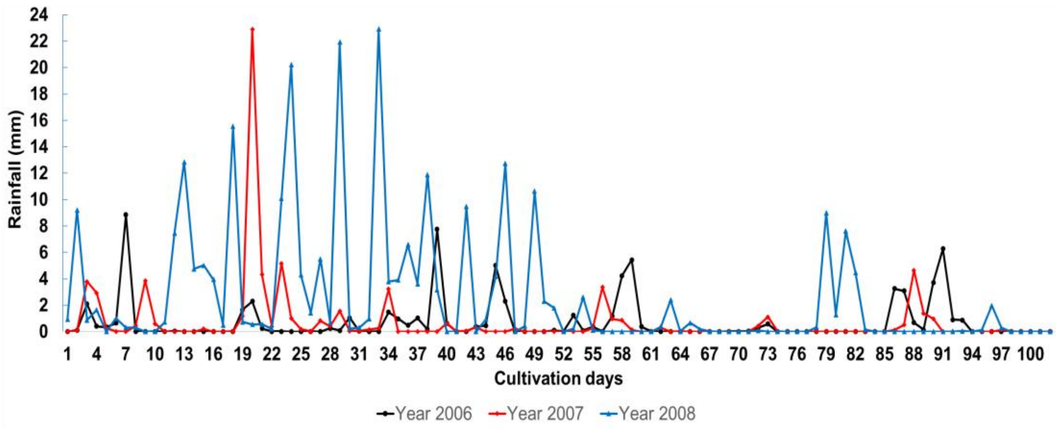

Figure 1. Rainfall during the planting of bean genotypes in 2006, 2007, and 2008, Muqui-ES.

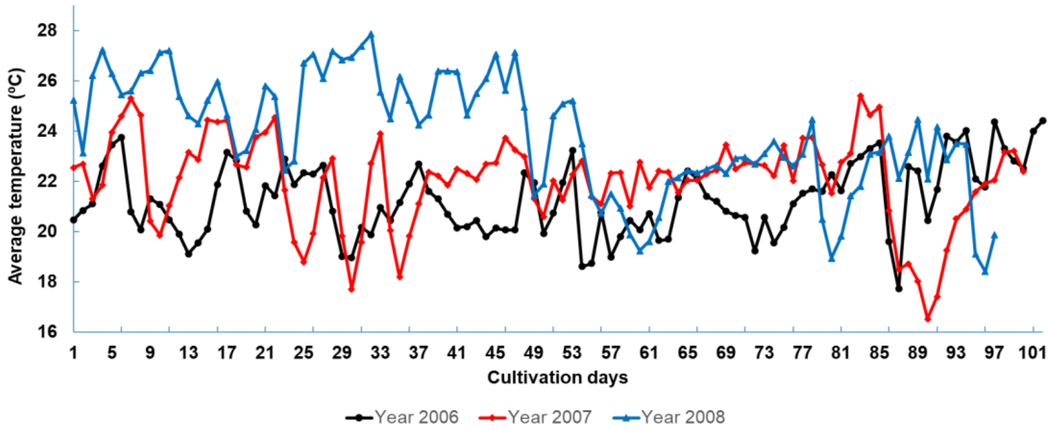

Figure 2. Average temperature during the planting of bean genotypes in 2006, 2007, and 2008, Muqui-ES.

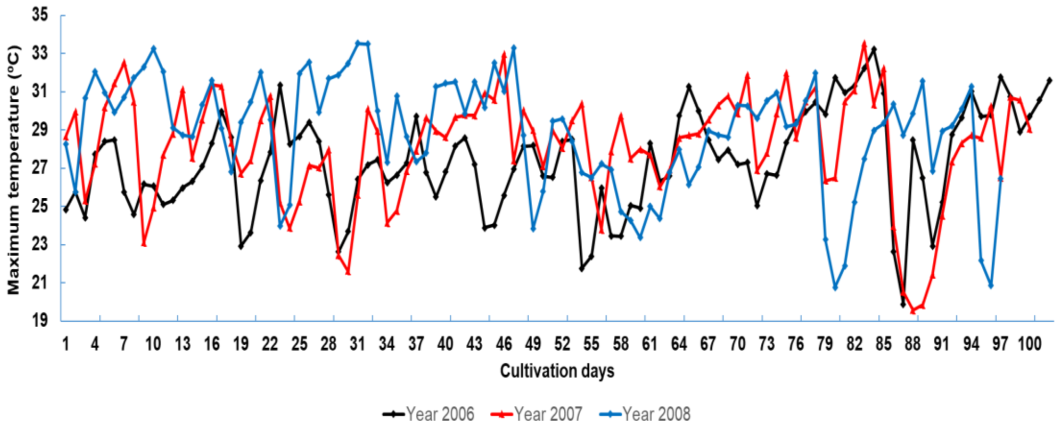

Figure 3. Maximum temperatures during the planting of bean genotypes in 2006, 2007, and 2008, Muqui-ES.

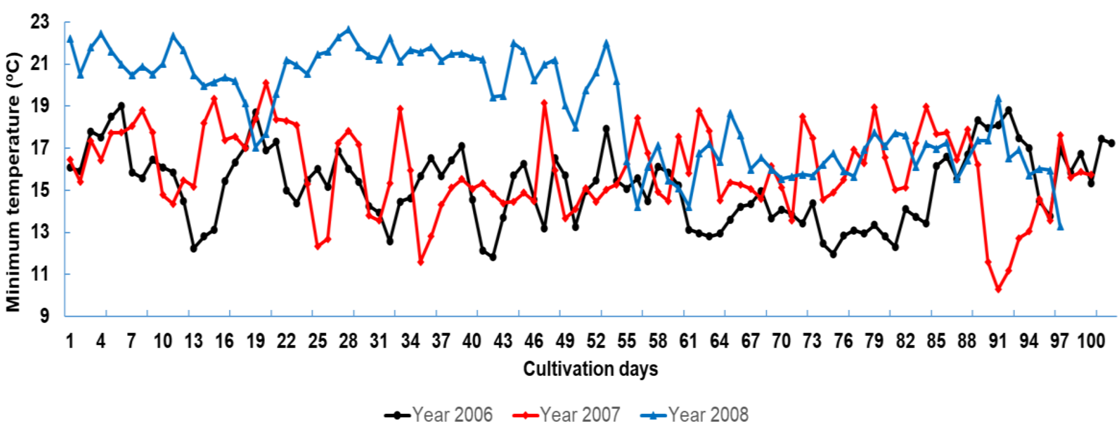

Figure 4. Minimum temperature during the planting of bean genotypes in 2006, 2007, and 2008, Muqui-ES.

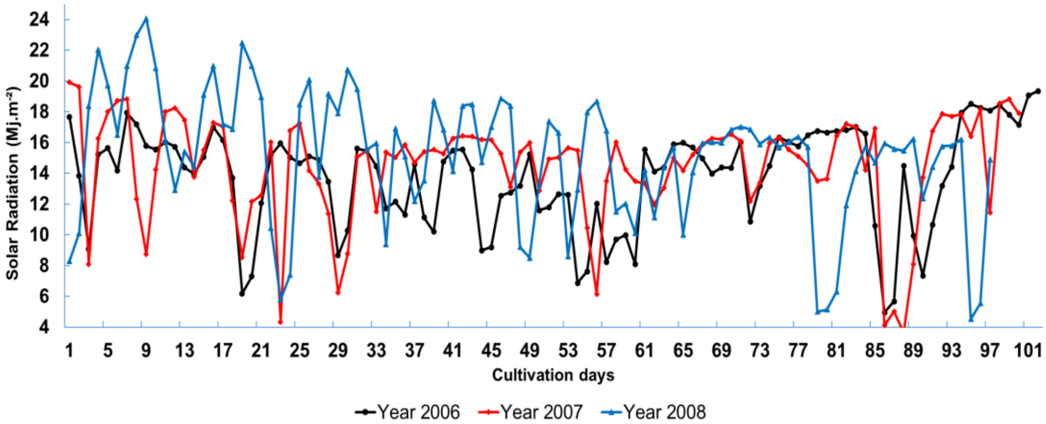

Figure 5. Solar radiation during the planting of bean genotypes in 2006, 2007 and 2008, Muqui-ES

In the pre-flowering and pod filling stages, beans are most affected by high temperatures (Hoffmann Junior et al., 2007, Vieira et al., 2013; Pereira et al., 2014). When this happens, the rate of abscission of organs reproductive can reach 50 to 70% of the total open flowers (Massignam et al., 1998).

In 2008, consecutive days with maximum air temperature values equal to or higher than 30º C, between this same period (Figure 4). The occurrence of temperatures above 32º C during the day results in losses to the establishment, growth, and development of the culture (Massignam et al., 1998, Hoffmann Junior et al., 2007, Pereira et al., 2014). Depending on the time the temperature remains above 30º C, the maximum value reached, and the number of consecutive days in which this condition occurs, the damage observed can be more serious (Massignam et al., 1998). Thus, under high air temperature conditions, reductions between 30,7 and 75,5% in bean grain yield have been observed (Hoffmann Junior et al., 2007).

The high air temperature exerts a great influence on the abscission of flowers and pods, impairing the filling of the grains the setting and the final retention of pods in beans, also responsible for the reduction of the number of grains per pod and their lower weight (Hoffmann Junior et al., 2007, Vieira et al., 2013, Pereira et al., 2014).

Solar radiation is another climatic factor that influences on the growth and development of bean culture, since it is directly related to plant's photosynthesis rate, having direct effects on biomass production (Teixeira et al., 2015). In this study, it can be seen that the solar radiation was lower for 2006 when compared to the other years (Figure 5).

According to Beebe et al. (2014), when there is low availability of solar radiation associated with low water availability, the photosynthetic rate is compromised with losses in productivity.

Considering the years 2007 and 2008, when production was highest, the following genotypes can be highlighted: Amendoim Vermelho, Sangue de Boi, and Terrinha 2, in the year 2007. In the year 2008, Amarelinho, Macuquinho Verdadeiro, Paina did not differ from the improved genotypes EL-22, IAPAR-81 (Table 2). These genotypes were the ones that showed to be more adapted to the organic cultivation system. Singh et al. (2009) report that the adoption of organic systems for the production of common bean demands the identification of cultivars more adapted to this management, due to the great variations observed in the productive performance between genotypes.

In the evaluation of agronomic characteristics of different bean cultivars produced in an organic system, Prezzi et al. (2014) found that the local cultivars of Feijão Preto were as productive as the improved cultivar IAPAR-81.

CONCLUSION

Regarding the conditions in which the experiment was carried out, it was concluded that organic planting with the participatory evaluation of farmers is viable for the cultivation of beans and that there was influence of agroclimatic conditions in the development of the evaluated genotypes.

The genotypes: Amendoim Vermelho, Sangue de Boi, Terrinha 2, Amarelinho, Macuquinho Verdadeiro, Paina, EL-22 e IAPAR-81 were the ones that showed higher productivity according to the agroclimatic conditions of the region and more adapted to the organic cultivation system.

ACKNOWLEDGMENT

To the National Council for Scientific and Technological Development (CNPq), process 507033/2004-3.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Ardakani, L. G, Farajee, H., Kelidari, A. (2013). The effect of water stress on grain yield and protein of spotted bean (*Phaseolus vulgaris* L.), cultivar Talash. *International journal of Advanced Biological and Biomedical Research*, 1(9), 940-949.

Beebe, S., Rao, I. M., Devi, M., and Polania, J. (2014). Common beans, biodiversity, and multiple stress: challenges of drought resistance in tropical soils. *Crop Pasture Science*, 65, 667–675. DOI: http://dx.doi.org/10.1071/CP13303

Ceccarelli, S. (2012). Plant breeding with farmers – a technical manual. ICARDA. 126p. Available from: < http://www.growseed.org/Salvatore.pdf>. Accessed on: 26-06-2020.

CONAB – Companhia Nacional de Abastecimento. (2019). Indicadores da Agropecuária. Brasília, ano XXVIII, n. 1. Available from: <https://www.conab.gov.br/info-agro/precos/revista-indicadores-da-agropecuaria/item/10717-indicadores-da-agropecuaria-n-01-2019>. Accessed on: 26-06-2020.

Ferrão, R. G., Moreira, S. O., Ferrão, M. A. G., Riva, E. M., Arantes, L. O. et al. (2016). Genética e melhoramento: desenvolvimento e recomendação de cultivares com tolerância à seca para o espírito santo. *Incaper em Revista*, 6(4), 51-71.

Fonseca, M. A. J. (2014). Recursos genéticos e melhoramento de hortaliças para e com a agricultura familiar. *Horticultura Brasileira*, 32(4), 508-508. DOI: http://dx.doi.org/10.1590/S0102-053620140000400023

Hoffmann Junior, L., Ribeiro, N. D., Rosa, S. S., Jost, E., Poersch, N. L., Medeiros, S. L. P. (2007). Resposta de cultivares de feijão à alta temperatura do ar no período reprodutivo. *Ciência Rural*, Santa Maria, 37(6), 1543-1548.

Machado, A. T. (2014). Construção histórica do melhoramento genético de plantas: do convencional ao participativo. *Revista Brasileira de Agroecologia*. 9(1), 35-50.

Massignam, A. M., Vieira, H. J, Hemp, S., Flesch, R. D. (1998). Ecofisiologia do feijoeiro. II – Redução do rendimento pela ocorrência de altas temperaturas no florescimento. *Revista Brasileira de Agrometeorologia*, 6(1), 41-45.

Nodari, R. O; Guerra, M. P. (2015). A agroecologia: estratégias de pesquisa e valores. *Estudos avançados*, 29(83), 183-207. DOI: http://dx.doi.org/10.1590/S0103-40142015000100010.

Oliveira, M. G. C., Oliveira, L. F. C., Wendland. A., Guimarães, C. M., Quintela, E. D., Barbosa, F. R., Carvalho, M. C. S., Lobo Junior, M., Silveira, P. M. (2018). Conhecendo a fenologia do feijoeiro e seus aspectos fitotécnicos. Brasília: Embrapa. 59p.

Pereira, V. G. C., Gris, D. J., Marangoni, T., Frigo, J. P., Azevedo, K. D, Grzesiuck, A. E. (2014). Exigências Agroclimáticas para a Cultura do Feijão (*Phaseolus vulgaris* L.). *Revista Brasileira de Energias Renováveis*, 3(1), 32-42.

Polania, J. A., Poschenrieder, C., Beebe, S., Rao, I. M. (2016). Effective use of water and Increased dry matter partitioned to grain contribute to yield of common bean improved for drought resistance. *Frontier Plant Science*. 7, 1-10. DOI: <http://dx.doi.org/10.3389/fpls.2016.00660.

Prezzi, H. A., Coelho, C. M. M., Heberle, I., Parizotto, C., Souza, C. A. (2014). Potencial de uso de cultivares crioulas de feijoeiro no sistema de cultivo orgânico. *Revista Brasileira de Ciências Agrárias*, 9(3), 394-400. DOI: <http:// dx.doi.org/10.5039/agraria.v9i3a4408

Ramos, H. E. A., Silva, B. F. P., Brito, T. T., Silva, J. G. F., Pantoja, P. H. B. et al. (2016). A estiagem no ano hidrológico 2014-2015 no Espírito Santo. *Incaper em Revista*, 6(4), 6-25.

Rosales, M. A., Ocampo, E., Rodríguez-Valentín, R., Olvera-Carrillo, Y., Acosta-Gallegos, J., Covarrubias, A. A. (2012). Physiological analysis of common bean (*Phaseolus vulgaris* L.) cultivars uncovers characteristics related to terminal drought resistance. *Plant Physiology and Biochemistry*. 56, 24-34. DOI: https://doi.org/10.1016/j.plaphy.2012.04.007.

Singh, S.P., Terán, H., Muñoz-Perea, C.G., Lema, M., Dennis, M., Hayes, R., Parrott, R., Mulberry, K., Fullmer, D., Smith, J. (2009). Dry bean landrace and cultivar performance in stressed and nonstressed organic and conventional production systems. *Crop Science*, v.49, p.1859-1866. DOI: https://doi.org/10.2135/cropsci2008.10.0578

Teixeira, G. C. S., Stone, L. F., Heinemann, A. B. (2015). Eficiência do uso da radiação solar e índices morfofisiológicos em cultivares de feijoeiro. *Pesquisa Agropecuária Tropical*, Goiânia, 45(1), 9-17.

Vieira, C., Paula Junior, T. J., Borem, A. (2013). Feijão. 2ed. Viçosa: UFV – Universidade Federal de Viçosa. 600p.

To cite this paper:

Duarte, M. L., Nunes, J. A., & Martins Filho, S. (2020). Participative evaluation and agroclimatic conditions in the cultivation system of organic common beans. *Multi-Science Journal*, 3(3), 29-36. DOI: https://doi.org/10.33837/msj.v3i3.1260