Cultivos Tropicales, 2021, vol. 42, no. 3, e09
ISSN impreso: 0258-5936
ISSN digital: 1819-4087

julio-septiembre
Ministerio de Educación Superior. Cuba
Instituto Nacional de Ciencias Agrícolas
http://ediciones.inca.edu.cu

Original article

'Odile' new cultivar of common bean (*Phaseolus vulgaris* L.), yield, the adaptability between seasons and peasant acceptance

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ABSTRACT

The common bean (*Phaseolus vulgaris* L.) is a crop of great importance in Cuba, but it is necessary to implement strategies to increase its yields, since production is well below national demand. The selection of varieties adapted to the product context plays an important role. The objective of this work was to evaluate the yield, the adaptability between seasons and the peasant acceptance of red bean 'Odile' new cultivar. Four experiments were carried out in the period between September 2015 and April 2017 in two areas, farm "El Mulato" and the experimental area of the National Institute of Agricultural Sciences (INCA), where five commercial varieties were included. In turn, in September 2015, January 2016 and November 2017, the cultivar 'Odile' was sown in experimental plots with other experimental lines and commercial varieties, to carry out the participatory selection carried out by farmers. The analysis of variance of the yield and the reaction to diseases indicated that the cultivar 'Odile' showed yields higher than 2000 kg ha^{-1} and resistance to common bacteriosis, BGYMV and rust, as well as an interaction between planting seasons. The AMMI analysis showed the stability of the cultivar 'Odile' yield and the analysis of proportions showed that black beans are more accepted by farmers, but cultivar 'Odile' showed high peasant acceptance with percentages higher than 96 %.

Key words: diseases, genotype-environment interaction, yield, phytopathogens, resistance

INTRODUCTION

The common bean (*Phaseolus vulgaris* L.) constitutes one of the fundamental dishes in the diet of Cuban population, where it is consumed almost daily with an estimated per capita consumption of 9 kg per year. This legume constitutes one of the typical dishes of the population [(1)]. In addition, this grain is considered a strategic crop, due to its nutritional properties (significant source of proteins, vitamins, minerals and dietary fiber), its presence in the five continents and its importance in the development of the peasant economy, among other attributes, in addition to being an alternative source of protein cheaper than meat and an essential component of a healthy diet [(2,3)].

The edaphoclimatic conditions in Cuba are favorable for its cultivation, but the latest national reports indicate that 272,728 tons were produced in 2016, distributed mainly in two production forms (state sector and non-state sector), which does not satisfy the national demand and the average yields achieved do not exceed 1.3 t ha^{-1} [(4)], figures lower than the potentials reached by commercial cultivars that do not satisfy national demand, so it is necessary to resort to imports, which puts the population food security.

For these reasons, in January 2012, during the VI Congress of PCC (Cuban Communist Party), a strategy was approved, within the Guidelines of the Economic and Social Policy, to ensure the increase in bean production, in order to gradually replace, imports of this grain. This development policy makes mention of various challenges that producers and researchers of this crop must face.

In Cuba, beans are planted throughout the national territory, with differences between the productive systems, in terms of soil type, access of producers to agricultural inputs, among other aspects. In addition to the regional contrast, there is an environmental genotype interaction, since, within the period considered for sowing this species, which varies between the months of September to January [(1)], there are differences in the behavior of climatic variables (temperature and rainfall, fundamentally), which determine the agronomic response of each cultivar and the final grain yield, for which cultivars adapted to this productive scenario are required.

Among commercial cultivars of red grain stands out, due to its use in production, 'Velasco Largo', large grain (mass of 100 grains greater than 40 g), erect bearing (type I) and short cycle, so it is preferred in many regions of the country, but it is very susceptible to most of the phytopathogenic diseases that affect crops in Cuba. Likewise, ‘Guama 23’ and ‘Rubí’, have a large grain size and type I and II growth habit, respectively, but they are less known and susceptible to the golden bean mosaic virus. Among the small grain cultivars, 'Cuba Cueto 25-9R', 'Buena Ventura' and 'Delicia 364' stand out, the first, susceptible to main pathogens that crop presents and the other two with the best response in field to diseases, but of small grain and intermediate reaction to rust, a disease of great importance for late plantings. The cultivar 'CIFIG 110' is the most recent release, still little known, although it seems the most promising due to its agronomic characterization, as reported in the technical guide for bean production, but it appears with an intermediate response to rust [(1)]. Therefore, adapted cultivars with good agronomic response are required in different production scenarios and that have peasant acceptance.

The objective of this work was to evaluate yield, the adaptation between planting seasons and the peasant acceptance of red bean ‘Odile’ new cultivar.

MATERIALS AND METHODS

Vegetal material

The plant material used in different tests was variable. Only results of two commercial cultivars of red grain color that are widely distributed in the national territory are shown, one of beige color and two of black grain color that were the ones that coincided in all the tests. Thus, the new cultivar 'Odile', with a red grain color, was also included (Table 1).

Table 1. Cultivars used for the stability analysis between sowing sreasons of the new cultivar 'Odile'

Cultivar	Grain color	Growth habit	Origin
‘Velasco Largo’	Red	I	IIGranos
‘Delicia 364’	Red	III	IIGranos
‘Engañador’ (BAT 93)	Beige	III	IIGranos
‘Cuba Cueto 25-9N’	Black	III	INIFAT
‘ICA PIJAO’	Black	II	IIGranos
‘Odile’	Red	III	INCA

IIGranos (Grain Research Institute); INIFAT (“Alejandro de Humboldt” Institute of Fundamental Research in Tropical Agriculture), INCA (National Institute of Agricultural Sciences)

Yield stability analysis of 'Odile' new cultivar bean

For the yield stability analysis of the new cultivar of bean 'Odile', four experiments were developed at different sowing times, September 8, 2016, considered as early season, November 11, 2016, time that is considered as optimal time, January 20, 2017 considered late. These experiments were carried out on the farm in the central area of the National Institute of Agricultural Sciences (INCA) and on January 23, 2017 another trial was set up in the production area of "El Mulato" farm, belonging to the Credit Cooperative and Fortified Services (CCSF) "Orlando Cuellar". The latter is shown on average with that of January 20.

Both areas where experiments were developed are located in Tapaste locality, San José de las Lajas municipality, in Mayabeque province, with an altitude of 122 m a.s.l and a soil classified as Lixic Ferrallitic Nitisol (5). Figure 1 shows the historical behavior of rainfall and temperature in the region (6).

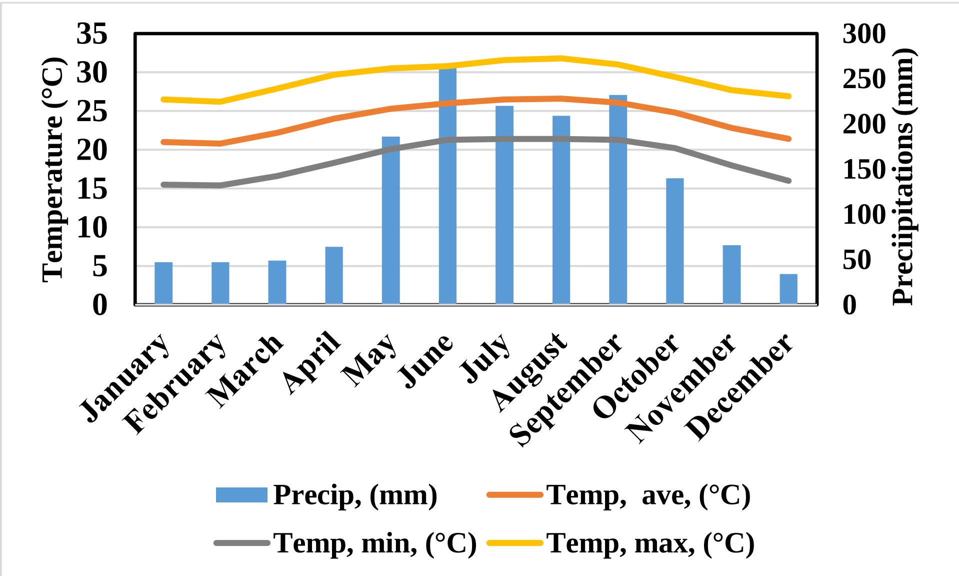

Figure 1. Pluviometric regime and historical temperatures in the region where the study was conducted

Soil preparation and cultural attentions in both areas were carried out according to what is established in the technical guide for bean cultivation in Cuba (1), with the particularity that it was mechanized at INCA and on the farm "El Mulato" rows (furrows) were made with animal traction.

The sowing distance in INCA was 0.75 cm between rows and in the "El Mulato" farm it was 0.60 m. The distance between plants was 0.08 m for an average of 12 seeds per linear meter in "El Mulato" and 0.06 m, for an average of 16.6 seeds per linear meter in INCA.

Evaluated variables

The variables that were taken into account were: the response to the natural incidence of the bean golden yellow mosaic virus (BGYMV), for its acronym in English *Bean golden yellow mosaic* virus; common bacteriosis (*Xanthomonas axonopodis* pv. *phaseoli*) and bean rust (*Uromyces appendiculatus*) (diseases that occurred during the development of the experiments) and the yield at 13 % humidity (kg ha^{-1}). To determine the yield, a linear meter was taken from the central row of the plot and the edges were left. The response to diseases was evaluated by nine-degree scales, for each disease, proposed by the International Center for Tropical Agriculture (CIAT according its acronyms in Spanish) [(7)], whose values are: 1 to 3 is resistant, 4 to 6 is intermediate and 7 to 9, susceptible.

Experimental design and statistical analysis

In both cases, a randomized complete block experimental design with three replications was used and the experimental unit consisted of plots of five rows and five meters in length. After checking the theoretical assumptions of normality and homogeneity of variance, to the data of the reaction to the natural incidence of diseases identified during the experiments, a double classification analysis of variance was applied, with the performance, a combined analysis was performed (season-genotypes) to know the interaction between factors. Both analyzes with the use of the statistical program SPSS, version 19 on Windows. When significant differences ($P \leq 0.05$) were detected between treatments (genotypes), the comparison of means based on the Tukey 0.05 multiple range test was applied.

Yield stability analysis

For yield stability analysis, the Model of additive main effects and multiplicative interaction (Model AMMI) was used. From the first main component and the rest of the components, in case of representing an acceptable percentage of the interaction (60 %) with the Excel biplot01 program, a Figure (biplot) was generated to represent the similarities of genotypes or environments.

The AMMI model is represented by the following equation [(8)]:

$$Y_{ij} = \mu + G_i + a_j + \sum_{i=1}^{k} \lambda_k \alpha_{ik} \gamma_{jk} + \varepsilon_{ij}$$

where:

Y_{ij} = Yield of the i-th genotype in the j-th environment (season)

The additive parameters are:

μ = general mean

G_i = Effect of the i-th genotype

σ_j = Effect of the j-th environment

λ_k = Eigenvalue of principal component K

$\alpha_{ij} * \gamma_{jk}$ = Value of the principal component k of genotype and season

ε_{ij} = Experimental error

Y_{ij} = Rendimiento del i-ésimo genotipo en el j-ésimo ambiente (época)

Peasant Acceptance. Results of the participatory selection of varieties

To verify the peasant acceptance of the bean cultivar 'Odile', three diversity fairs were held, using the methodology described [9], where they exhibited different genotypes. All the fairs were held at the "El Mulato" production farm.

For the first fair, a planting was carried out in September 2015, the second in January 2016 and the third planting was done in November 2017. All the plantings were in experimental plots formed by five rows separated by 0.60 m, at five meters long, for a total of 15 m^2 for each material to be selected.

The plant material varied in each one of the sowings. In the first one it consisted of seven commercial cultivars, one pre-commercial ('Velasco Largo', 'Cuba Cueto 25-9N', Engajador '(BAT 93), 'Chevere', 'ICA PIAJAO ',' M 112 'and' CUT 53 ') and six experimental lines from the International Center for Tropical Agriculture (CIAT) and the bean research program (PIF, according its acronyms in Spanish) in Honduras ('SCR 16', 'SCR 21', 'SCR15', 'SCR 3', from CIAT and ' X0104-45-5-1-4 ',' X069157-14-4-5-5 ',' X0104-52-5-5-3 'from the PIF). In the second fair, the materials used were 'SEN 81', 'SEN 74', 'SCR 5', 'SEN 95', selection of 'SCR 15' ('Odile') from CIAT; 'SURU', 'RBF 15-70', 'XRAV 40-4', 'MHN 322-49' from PIF and 'Cuba Cueto 25-9N', 'ICA PIJAO' and 'BAT 93' commercial cultivars. In the third sowing, the plant material was 23 cultivars that are in commercial production in Cuba, which included the cultivar 'Odile' [10].

When the genotypes were in the R8 stage (physiological maturity), farmers from agricultural cooperatives in the territory were invited to participate in a diversity fair. 13, 28 and 26 farmers participated, for the September, November and January sowings, respectively.

The genotypes only had one number and each farmer was given a ballot to select up to five materials from those exhibited at the fair. Each material had a sample of the seeds so that the color, size and shape of grains could be observed.

The selection percentage of different genotypes was determined and the existing relationship with the color of the grain was verified, since this is an important criterion in the bean trade in Cuba. This study was done through an analysis of X^2 proportions of the different materials shown with the statistical package SPSS version 19, on Windows.

RESULTS AND DISCUSSION

Table 2 shows the result of the yield variance analysis of genotypes studied throughout the early, optimal and late sowing seasons. Statistical differences between the environments could be appreciated, represented in this study by sowing seasons, also between the genotypes and the interaction of the two factors (genotype*environment). This indicates that these times constitute different environments for the planting of beans in Cuba, which shows the existence of genotypic interaction due to the environmental variability between the planting moments under study.

Table 2. Yield variance analysis of six common bean genotypes at different planting times (September 8, 2016, November 11, 2016, January 20, 2017 and January 23, 2017)

Origin	Sum of squares type III	gl	Quadratic mean	Significance
Season (environment)	4723322,559	2	2361661,280	0,000***
Genotype	20552536,802	5	4110507,360	0,000***
Replica	1364310,519	2	682155,260	0,245ns
Season * Genotype	5881234,546	10	588123,455	0,000***
Error	20664845,989	44	469655,591	

*** (significant at 0.001 probability respectively), ns (not significant for p≤0.05)

Such variability is mainly attributed to the differences in rainfall that occurred during bean development and temperatures, which are higher at the time of sowing in September, which is the second month, after June, of higher rainfall in this region locality (Figure 1). This result indicates that in the genetic improvement program, this aspect should be taken into account to obtain varieties adapted to the recommended period (September-January) for planting beans or with specific adaptation to each of the recommended moments. In this sense, several authors have identified a different agronomic response between bean cultivars, as they are planted in different environments where the water regime is different

[11], this aspect determines the yield in many producing regions of this species and determines the incidence of other factors such as pests [12].

That is why, for the formation of new genotypes, it is necessary to evaluate genetic materials in different environments and measure their genotype-environment interaction (GxA), which gives an idea of the phenotypic stability of genotypes in the face of environmental fluctuations and it is necessary for the development of a genetic improvement program [13].

The differences in yield for the seasons (Table 3), corroborated that the optimum moment for sowing beans is November, where the best yields were obtained, which differ significantly from those obtained with the sowings of September and January. This information is in accordance with what was previously reported by other authors [1], who have divided the early, optimal and late sowing period, as well as the recommendations of each of them based on the access that farmers have to irrigation.

Table 3. Average yield per planting season of six common bean genotypes

Season	Yield
September	1501,15 b
November	2165,28 a
January	1582,59 b
p	0,011*

Means with the same letters are not statistically different (Tukey, 0.05)

These results justify the evaluation of each new cultivar, at different times, as is the case of the cultivar 'Odile', of which it must be known whether it is broadly adaptable or of specific adaptation within the September-January period.

Table 4 shows the average yields obtained by each of genotypes used in the comparative test. It can be seen that the yield ranged between 605.7 and 2643.1 kg ha^{-1}. The cultivar 'Odile' was the one that produced the highest average yield (2643.1 kg ha^{-1}) without statistical differences with 'Delicia 364' (1938.7 kg ha^{-1}), 'CC25-9N' (1695.8 kg ha^{-1}) and 'BAT-93' (2063.6 kg ha^{-1}). This agronomic response justifies its introduction into production, since its yield is superior to cultivars that are currently highly demanded, fundamentally given its high yield potential, adaptability and resistance to pests [1,14,15], as well as it is valid to highlight that in previous evaluations [14], where the cultivar 'Odile' was included and some of these commercial cultivars used in this study, the existence of variability was evidenced, which constitutes an important aspect in genetic improvement programs [16,17].

Table 4. Average yield of six cultivars of common bean in three planting seasons and two environments of a comparative trial of adaptation and yield between planting seasons

Cultivars	Yield (kg ha^{-1})
'Delicia'	1938,7 a
'Velasco Largo'	605,7 c
'Cuba Cueto' 25-9N'	1695,8 ab
'Engañador (BAT 93)'	2063,6 ab
'Odile'	2643,1 a
'ICA PIJAO'	1550,9bc
CV	44,68
p	0,000***

Different letters mean significant differences for Tukey's test p≤0.05; *** significant for p≤0.0001

Disease response

The response to diseases of different cultivars compared in this study is shown in Table 5. It could be seen that the pathogenic systems that manifested themselves during the different planting moments were: Common bacteria (*Xanthomonas axonopodis* pv. *Phaseoli*), the virus BGYMV (Bean golden yellow mosaic virus) and rust (*Uromyces appendiculatus*). These pathogens are of great importance in the production of this grain in the region where this study was carried out [14,18,19] and their implications can be catastrophic, with significant losses in production, since different genetic sources are identified every day within these pathogens, which can be more aggressive on the crop [18], which derives the importance of obtaining resistance as an economically, socially and environmentally viable alternative for integrated pest management.

Table 5. Response to the natural incidence of diseases manifested by six common bean cultivars during three planting moments

Cultivars	BGYMV			Cb			Rust		
	September	November	January	September	November	January	September	November	January
'Delicia 364'	1,0a	1,0a	1,0a	4,0b	2,7ab	2,0ac	0	0	3,3b
'Velasco Largo'	6,3c	3,7bc	4,3bc	5,0b	4,3b	3,0c	0	0	6,7c
'CC 25-9N'	5,7c	5,7cd	4,0b	4,3b	2,3a	2,7bc	0	0	6,3c
'BAT 93'	3,7b	2,0ab	1,7a	2,0a	2,3a	2,0ab	0	0	1,0a
'Odile'	1,3a	1,7 ab	1,3a	2,3a	1,7a	1,7a	0	0	1,0a
'ICA PIJAO'	6,7c	6,0d	6,0d	4,3b	4,3b	3,3bc	0	0	7,3c
Average for the time	4,1	3,3	3,1	3,6	2,9	2,4	0	0	4,2
CV	58,4	62,9	64	35	39,4	28,8	0	0	64,1
p	***	***	***	***	***	***	-	-	***

BGYMV = bean golden yellow mosaic virus. Bc = Common bacteriosis. Different letters mean significant differences for Tukey's test p≤0.05. *** Significant at 0.001

Average results of the evaluation are shown by means of the nine-degree scales, for each disease, proposed by CIAT [7] whose values are: 1 to 3 is resistant, 4 to 6 is intermediate and 7 to 9, susceptible

The disease with the greatest severity was rust (average 4.2) in January sowings, followed by BGYMV in September sowing (4.1 average) and common bacteriosis (Cb), in September sowing (average 3.6). Likewise, it was detected that both BGYMV and Cb were manifested at all sowing moments; however, rust only appeared in January sowings, apparently this is related to the climatic conditions that this pathogen requires to develop, which persist at this time as can be seen in Figure 1.

'Odile' cultivar showed a very good response to the pathogens that were manifested, where it stood out for its resistant reaction to rust, as no visible symptoms of the disease were detected in the plantings that were carried out in January, as did the cultivar 'BAT 93' which is frequently used as a control resistant to this pathogen (14). Likewise, before the BGYMV, it had a good response, according to the CIAT scale (7), with a resistant reaction (between 1.3 and 1.7 value of the 9-degree scale) without statistical differences with 'Delicia 364', a cultivar that has been reported as resistant and with the presence of the *bgm-1* gene (10) that confers resistance to this pest.

The cultivar 'Odile' was the one that showed the lowest incidence against Cb among all cultivars that were in the comparative trial, which shows its good response to these systems that affect both the production of this legume in Cuba and the humid tropics in general (11) .

Figure 2 shows the biplot representation of the variance analysis for the AMMI model, of the yield variable, in the six genotypes evaluated in the comparative test. In the first component 78.8 % of the total variance is explained and the second component showed 21.11 %. The three environments are well differentiated and it is appreciated that there was specific adaptation of genotypes in these environments.

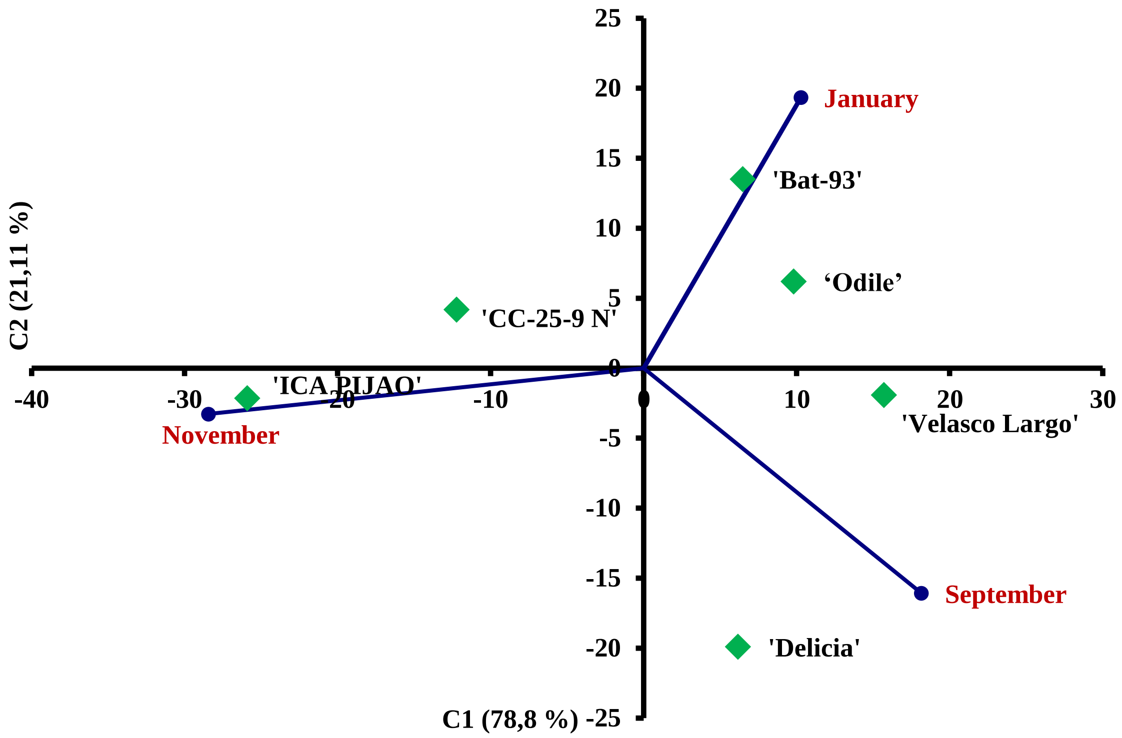

Figure 2. Biplot representation of six common bean cultivar association with particular planting seasons, with respect to the first two axes of main components of the yield AMMI analysis evaluated in three planting seasons

The cultivar 'BAT-93' stood out with high adaptability to the sowing season of January (late), which is in accordance with the response shown by this cultivar to rust (Table 5), which is the disease that is most commonly manifested at this time. The cultivar 'ICA PIJAO' shows greater adaptation to the optimal season (November sowings) and the cultivar 'Delicia 364' for the September season, being in agreement with the reaction to BGYMV. However, cultivars 'Odile' and 'CC25-9N' showed greater stability of the yield between seasons, which corroborates the use of these genotypes in Tapaste locality, at any of the recommended sowing times for this crop.

Acceptance of the cultivar 'Odile' in the production scenario of Tapaste, San José de las Lajas

Tables 6, 7 and 8 show the results of the participatory selection that was carried out in materials that were planted in September 2015, January 2016 and November 2017. A high acceptance of the diversity shown in the three fairs. The effective diversity (percentage of selected genotypes) was 92.85, 83.33 and 82.60 % for the sowings that were carried out in September 2015, January 2016 and November 2017; respectively.

Table 6. Percentage of selection made by farmers of common bean cultivars planted in September 2015

No	Cultivars	Color	NA	% selection	Average selection per color
1	'ICA PIJAO'	N	8	61,54	
2	'CUT 53'	N	4	30,77	63,63
3	'Cuba Cueto 25-9N'	N	13	100	
4	SCR 16	R	1	7,69	
5	SCR 21	R	1	7,69	
6	SCR 15 ('Odile')	R	13	100	
7	X0104-45-5-1-4	R	12	92,31	
8	X069157-14-4-5-5	R	12	92,31	
9	X0104-52-5-5-3	R	10	76,92	36,74
10	SCR 30	R	2	15,38	
11	'Velasco Largo'	R	0	0	
12	M 112	R	1	7,69	
13	'Chévere'	B	1	7,69	
14	'BAT 93'	C	1	7,69	
Percentage of selected materials				92,85	p=0,12 ns

NA (number of farmers), R (red), B (white); C (beige); N (black); ns: not significant for p≤0.05

Table 7. Percentage of selection made by farmers of common bean cultivars planted in November 2017

No	Cultivars	Color	NA	% selection	Average selection per color
1	CUFIG 145	B	1	3,57	
2	CC 25,9B	B	1	3,57	
3	Chévere	B	0	0	3,57
4	Lewa	B	0	0	
5	Quivican	B	3	10,71	
6	Bat-93	C	1	3,57	
7	Cubabana 23	N	4	14,29	
8	CUFIG-48	N	0	0	
9	CUL-156	N	27	96,43	
10	Cuba Cueto 25-9N	N	27	96,43	
11	Tomeguin-93	N	6	21,43	38,49
12	Liliana	N	9	32,14	
13	Guina-89	N	5	17,86	
14	Milagro Villareño	N	7	25	
15	Triunfo-70	N	12	42,86	
16	Delicia 364	R	7	25	
17	Cufig-110	R	1	3,57	
18	'Odile'	R	27	96,43	
20	Velasco Largo	R	3	10,71	21,43
21	CC-25-9 C	R	0	0	
22	Wacuto	R	4	14,29	
23	Lagrima Rojas	R	1	3,57	
Percentage of selected materials				82,60	p=0,52 ns

NA (number of farmers), R (red), B (white); C (beige); N (black) ns: not significant for p≤0.05

Cultivos Tropicales, 2021, vol. 42, no. 3, e09
ISSN impreso: 0258-5936
ISSN digital: 1819-4087

Table 8. Percentage of selection of bean genotypes planted in January 2016

No	Cultivars	color	NA	% Selection	Average selection per color
1	SURU	B	21	80,77	58
2	BAT 93	C	14	53,85	
3	SCR 5	R	23	88,46	
4	SCR 15 (Odile)	R	25	96,15	
5	SEN 81	N	3	11,54	79
6	SEN 74	N	25	96,15	
7	RBF 15-70	N	0	0	
8	SEN 95	N	24	92,31	
9	XRAV 40-4	N	18	69,23	
10	MHN 322-49	N	26	100	
11	CC 25-9N	N	26	100	
12	ICA PIJAO	N	0	0	
Percentage of selected materials				83,33	p=0,28ns

NA (number of farmers), R (red), B (white); C (beige); N (black)

Likewise, it was possible to appreciate, when analyzing the acceptance by the selectors according to the grain color, that at the fair that took place in September 2015, cultivars of black grain color were more selected with 63.33 % and red, white and beige ones by 36.74 %, without statistical differences between them (Table 6), a criterion that agrees with the culinary tastes of Cuban population [(15)], who mostly consume, to a greater extent, grain beans black and they are more adjusted to the access of ingredients necessary for its preparation.

At the fair held in November 2017, black cultivars were selected by 38.49 %, the red ones 21.43 % and the whites and beiges 3.57 % without statistical differences between them and with the same trend of genotypes sown in September (Table 7).

However, at the fair held in January 2016, white and red grain colored cultivars were the most selected with 79.0 %, compared to black ones (58 %), with no statistical differences between both groups (Table 8).

Even though the trend was for higher selection for black grain beans, among the genotypes sown in September and November, the new cultivar 'Odile' was highly selected with 100 and 96.43 %, respectively, in those fairs. Likewise, in the January sowings, the selection was 96.31 %. These results show the high acceptance by farmers given that, in general, more than 96 % of the breeders prefer this new cultivar 'Odile'.

With this criterion it becomes evident that this new cultivar can be successful in the producing area of Tapaste, given its greater stability of the yield compared to the other commercial cultivars with which it was compared in the different seasons in which beans are planted in Cuba as well as the criteria of farmers who represent the non-state sector, where this grain of high presence in Cuban culinary culture is most produced.

CONCLUSIONS

- The new cultivar ‘Odile’ presented good agronomic response, expressing a yield greater than 2000 kg ha^{-1} and stability between seasons, which justifies its extension/generalization.
- The cultivar ‘Odile’ presented high peasant acceptance, with a selection percentage higher than 96 % associated with its agronomic response.

BIBLIOGRAPHY

1. Faure Alvarez B, Benítez González R, Rodríguez Acosta E, Grande Morales O, Torres Martínez M, Pérez Rodríguez P. Guía técnica para la producción de frijol común y maíz. La Habana, Cuba; 2014 p. 34.
2. Tryphone GM, Nchimbi-Msolla S. Diversity of common bean (*Phaseolus vulgaris* L.) genotypes in iron and zinc contents under screenhouse conditions. African Journal of Agricultural Research. 2010;5(8):738-47.
3. Dipp CC, Marchese JA, Woyann LG, Bosse MA, Roman MH, Gobatto DR, et al. Drought stress tolerance in common bean: what about highly cultivated Brazilian genotypes? Euphytica. 2017;213(102):1-16.
4. de Cuba AE. Oficina Nacional de Estadística e Información. La Habana [Internet]. 2017; Available from: http://www.one.cu/aec2011/esp/09_Tabla_cuadro.htm
5. Hernández JA, Pérez JJM, Bosch ID, Castro SN. Clasificación de los suelos de Cuba 2015. Mayabeque, Cuba: Ediciones INCA. 2015;93:91.
6. Climate-Data.org. Clima San José de las Lajas: Temperatura, Climograma y Tabla climática para San José de las Lajas [Internet]. [cited 29/04/2021]. Available from: https://es.climate-data.org/america-del-norte/cuba/mayabeque/san-jose-de-las-lajas-26601/
7. Zobel RW, Wright MJ, Gauch Jr HG. Statistical analysis of a yield trial. Agronomy journal. 1988;80(3):388-93.
8. Centro Internacional de Agricultura Tropical. Sistema estándar para la evaluación de germoplasma de frijol. 2.ª ed. Cali, Colombia: CIAT; 1991. 56 p.

9. De La Fé CF, Ríos H, Ortiz R, Martínez M, Acosta R, Ponce M, et al. Las ferias de agrobiodiversidad. Guía metodológica para su organización y desarrollo en Cuba. Cultivos Tropicales. 2003;24(4):95-106.
10. Puldón V, Faure B, Cantillo P, Toledo D. Catálogo de variedades del Instituto de Investigaciones de Granos, Arroz, Maíz, Frijol, Soya. 1st ed. Artemisa, Cuba: Instituto de Investigaciones de Granos; 2018 p. 93.
11. Tosquy-Valle OH, López-Salinas E, Acosta-Gallegos JA, Villar-Sánchez B. Detección de líneas de frijol negro con adaptación en el trópico húmedo del sureste de México. Revista mexicana de ciencias agrícolas. 2014;5(6):911-21.
12. Osuna-Ceja ES, Reyes-Murov L, Padilla-Ramírez JS, Rosales-Serna R, Martínez-Gamiño MA, Acosta-Gallegos JA, et al. Rendimiento de genotipos de frijol con diferentes métodos de siembra y riego-sequía en Aguascalientes. Revista mexicana de ciencias agrícolas. 2013;4(8):1209-21.
13. Sánchez-Aspeytia D, Borrego-Escalante F, Zamora-Villa VM, Sánchez-Chaparro JD, Castillo-Reyes F. Estimación de la interacción genotipo-ambiente en tomate (*Solanum lycopersicum* L.) con el modelo AMMI. Revista mexicana de ciencias agrícolas. 2015;6(4):763-78.
14. Lamz-Piedra A, Cárdenas-Travieso RM, Ortiz-Pérez R, Montero-Tavera V, Martínez-Coca B, de la Fé-Montenegro CF, et al. Evaluación del comportamiento agro-morfológico a partir de la caracterización de la variabilidad en líneas de frijol común (*Phaseolus vulgaris* L.) sembradas en época tardía. Cultivos Tropicales. 2016;37(2):108-14.
15. Lamz-Piedra A, Cárdenas-Travieso RM, Ortiz-Pérez R, Hernandez-Gallardo Y, Alfonso-Duque LE. Efecto de la selección participativa de variedades en la identificación de genotipos sobresalientes de frijol común (*Phaseolus vulgaris* L.). Centro Agrícola. 2017;44(4):65-74.
16. Fernandes de-Sousa F, Lopes do-Carmo D, de Souza-Carneiro JE, Urquiaga S, Silva-Santos RH. Legumes as green manure for common bean cultivated in two growing seasons at southeast Brazil. African Journal of Agricultural Research. 2016;11(49):4953-8. doi:10.5897/AJAR2016.11689
17. Alves FAL, Andrade AP de, Bruno R de LA, Santos DC dos. Study of the variability, correlation and importance of chemical and nutritional characteristics in

cactus pear (Opuntia and Nopalea). African Journal of Agricultural Research. 2016;11(31):2882-92. doi:10.5897/AJAR2016.11025

18. Corzo-López M, Rivero-González D, Zamora-Gutiérrez L, Martínez-Zubiaur Y, Martínez-Coca B. Detección e identificación de nuevos aislados de Xanthomonas axonopodis pv. phaseoli en cultivares de frijol común (*Phaseolus vulgaris* L.) en la provincia Mayabeque, Cuba. Revista de Protección Vegetal. 2015;30(2):97-103.
19. Chang-Sidorchuk L, González-Alvarez H, Martínez-Zubiaur Y. Begomoviruses infecting common beans (*Phaseolus vulgaris* L.) in production areas in Cuba. Spanish journal of agricultural research. 2018;16(2):1-17.