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Evaluation of Production Lines of Lima Beans (*Phaseolus lunatus*), Grown in Home Gardens

José Luis Céspedes Cansino[1] & Deisy Rodríguez Sosa[2]

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ABSTRACT
This study was made to evaluate the behavior of P. lunatus grown in home gardens for family consumption, in areas of the Local Administrative Council, in Senado, Camaguey, Cuba. The areas used belong to the Noel Fernández Agricultural Company, in the municipality of Minas, on brown carbonated soils. Six varieties of *Phaseolus lunatus* were evaluated. Variety "bola roja" (red ball) was the most affected variety (3.21 t/ha). P. lunatus Caballero rojo aplanado was not affected by pests.

KEY WORDS/: home gardens, lima beans, *Phaseolus lunatus*, urban agriculture

INTRODUCTION
Lima beans (*Phaseolus lunatus*) usually climb endlessly (group IV), though there are also determinate climbers in the group. It is a non-commercial crop, commonly grown in home gardens in the countryside, with a broad diversity that comprises the wild types through the three crops reported for the species (Castiñeiras *et al*., 2007). The *Phaseolus* genus has highly nutritious beans with an important source of calories (Ballesteros *et al*., 2010); hence it is a suitable alternative for everyday human nutrition in urban and rural areas in Cuba.
INIFAT keeps a crop collection with more than 80 accessions from of material gathered by farmers, and as a result of foreign germplasm introduction. Preliminary characterization and evaluation of the collection enabled identification of accessions with relevant traits, especially high yields. Breeding was made through negative selection, between 2000 and 2006, and it resulted in the release of four varieties: Bayito 2321, Bola Roja 3187, Nieve and Ameliá. The beans from these varieties can be consumed dry or green, though the first two varieties (rojo jaspeado and rojo, respectively) are best dry. Nieve and Ameliá (white beans) can be eaten both as greens (green seeds) and beans (dry seeds).
The purpose of this paper is to evaluate the response of productive lines of *Phaseolus lunatus* grown in home gardens for family consumption, in Senado Administrative Zone, Minas, province of Camaguey.

[1]M Sc., Bachelor in Education, Major in Agronomy. Assistant Professor. Ignacio Agramonte Loynaz University of Camaguey: jose.cespedes@reduc.edu.cu
[2]Eng., Major in Agronomy. Instructor. Ignacio Agramonte Loynaz University of Camaguey: CUM Minas. deisy.rodriguez@reduc.edu.cu

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MATERIALS AND METHODS

The study was made at Senado Administrative Zone, municipality of Minas, between September 2013 and April 2014.
The predominant soil is mid-loam, brown carbonated, with thin blocks. It also has roots, anthropic inclusions, macro animals (soil worms, tiny coleopteran, ants and cochineal insects).
The prevailing climate during the experiment included the lowest mean temperatures in December and January (14.7 ºC), and the highest in April (33.5 ºC). The highest precipitation values occurred in October (255 mm), and the least rainy day was January (23 mm).
The study was designed for 25 m^2 lots, tilled with a MTZ-80 tractor pulling an ADI-3 plow. The experiment had 3 replicas and 7 variants (7 lines) for analysis of their behavior, along with a randomized block design.
Below are the response variables chosen, according to the methodology established for each case.

Phenology

-Days before blossoming
-Days to harvest
-Growth habit
Also included was,
-The appearance of the first pests in the different lines of the species studied, based on the observation method, and frequent sampling in the research area.

Yield indicators

- Pod average per plant (10 plants taken at random).
- Bean average per pod (10 pods from each species taken at random).
- Mass of 100 beans.
- The average yield per hectare was estimated, based on the yields of 25m^2. The proportional method was used to estimate the possible result for 100 000 m^2 within the hectare.

Statistical processing

To process observations and measurements, SPSS 21, for Windows, was used, with single-factor variance analysis. The Duncan´s test was used to compare the means. Additionally, the effect percent of the most and least commonly observed pests on the *Phaseolus* lines was calculated by dividing the total of productive lines affected by the total of cultivated lines.

RESULTS AND DISCUSSION

Pest effects on the crop at different stages of phenological development.

Damages in beans, as in all Cuban crops, are to a greater or lesser extent caused by pests of different species that can hinder yields in the crops. Therefore, it is important to evaluate the field behavior of the 7 species of genus *Phaseolus*. In that sense, table 1 shows the behavior analysis of the element in the varieties studied. The caballero rojo aplanado jaspeado (*Phaseolus lunatus*) did not have any affectations during the cycle. However, all the other varieties were attacked by approximately 2.54 pests at some point along the crop´s cycle. The most commonly observed

pest was the potato leafhopper (*Empoasca kraemeri*), in 6 of the 7 varieties, accounting for an 85.71% index. A tiny snail (*Praticolella griseola*) was observed in the lower leaves, causing skeletonization. The same pests are common in countries with large productions of the beans (Arnold, 1986) (CIDICCO, 2004), and are also present in Cuba. However their incidence is minor, especially when compared to the common commercial beans with more technical care. It indicates adaptation of traditional varieties to the specific environments where they grow.

Table I: Pests observed, and time of occurrence (days after germination), in *Phaseolus lunatus* varieties.

	Varieties	1	2	3
	Phaseolus lunatus			
1	Caballero bayito globoso.	16	19	35
2	Caballero bola roja	10		10
3	Caballero bayo aplanado	7		7
4	Caballero determinate Jaspeado.	19	19	
5	Caballero bola negra	11	11	
6	Caballero rojo aplanado			

Notice: Empoasca kraemeri Ross y Moore[1] , Acheta assimilis[2] , Praticolella griseola[3]

Table 3 shows the evaluation results of analysis of three phenological traits of *Phaseolus lunatus* (lime beans). In the days before blossoming the bean with the determinate growth was the earlier (39 days), whereas caballero rojo moteado negro was second (59 days), with significant differences among them and the rest.

The latest accession was observed in caballero negro globoso (80 days), with the most significant value way above the rest. The bayito globoso with small beans, caballero bola roja, and caballero grano blanco, took 65 days to blossom, without statistical differences among them, but significantly different from the other lines studied. The blossoming days coincided with the reports made by Castiñeiras *et al*. (2007), who determined the blossoming date between 56 and 102 days after germination. However, these values did not coincide with the determinate growth variety (*Phaseolus lunatus*).

The variable days to harvest showed the earliest accession observed in determinate caballero (69 days), significantly different from the rest.

The latest accessions were observed in caballero grano negro globoso (113 days), significantly different from the rest. Besides, the caballero rojo jaspeado negro, harvested on day 95th, had significantly different values from the rest.

These results coincided with Castiñeiras *et al*. (2007), who said that production begins between 105 and 160 days after germination. Moreover, depending on the variety and the harvest cycle, it can extend to 131 and 209 days. Nevertheless, the accession found in the determinate beans did not coincide with the values previously reported with greater earliness than the determinate variety.

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The same table also shows that concerning the growth habit, type IV was predominant in five of the accessions; only one had determinate growth. These data were important for accession planting and tutor establishment, which occurred in most cases.

Table 3. Evaluation of phenological traits of *Phaseolus lunatus* accessions

Lines studied	Days to Blossoming	Harvest (days)	Growth habit
Caballero Bayito globoso	65 b	93 c	Type IV
Caballero bola roja	65 b	93 c	Type IV
Caballero blanco crema	65 b	93 c	Type IV
Caballero with determinate growth	39 d	69 d	Type I
Caballero negro globoso	80 a	113 a	Type IV
Caballero rojo moteado negro	59 c	95 b	Type IV
ESx	2.2660	2.4099	

Results of variable analysis of Phaseolus lunatus accessions

Table 5 shows the results of analysis of four yielding variables, in lima beans. The number of pods per plant in caballero bola roja (28 pods per plant), had the most remarkable results, with significant differences from the rest. The other caballero with outstanding results was the one with determinate growth, significantly higher than the other lines of its genus, considering the exception previously mentioned. The lowest results were observed in white caballero crema (5 pods per plant), significantly different from the rest. The other three were in-between (9-12 pods per plant). Regarding the number of beans per pod, all the lines studied were observed to average 2 beans per pod, with the only exception of caballero rojo jaspeado negro (3). No significant differences were observed among the genus lines studied.

The weight of 100 seeds (g), and the yields (t/ha) for the first indicator are shown in the table. The line of determinate growth had significantly heavier beans, with larger beans and yields of 2.35 t/ha.

Although bola roja was less heavy, the yields (t/ha) were significantly higher (3.21 t/ha), thanks to a higher number of pods per plant.

Caballero negro globoso (0.95 t/ha), and white crema aplanado (0.45 t/ha), were significantly lower than the rest, but no differences were observed between them. Rojo jaspeado negro grano aplanado (1.72 t/ha) had an average behavior with lower results in comparison to the reports by Castiñeiras *et al.* (2007), and Ballesteros *et al.* (2010), who achieved 8-12 t/ha.

Based on these results, caballero bola roja, the determinate growth beans, and particularly, rojo jaspeado should be planted in home gardens. Caballero bayito globoso with the small beans should be used in a lower proportion. The other two with the lowest yields would be evaluated only for the purpose of maintaining the phytogenetics and biodiversity of the species.

Table 5 Yield components of *P. lunatus* varieties

Lines analyzed	Pod per plant	Beans per pod	Weight of 100 seeds (g)	Yields (t/ha)
Caballero bayito globoso	10c d	2 a	34.93 d	0.91 d
Caballero bola roja	28 a	2 a	43 b	3.21 a
Caballero blanco crema	5 d	2 a	35.94 d	0.45 e
Caballero determinate	20 b	2 a	46.34 a	2.35 b
Caballero negro globoso	9 c d	2 a	28.3 e	0.65 e
Caballero rojo jaspeado negro	12 c b	3 a	37.95 c	1.72 c
ESx	1.4007	0.1072	1.0839	0.1845

CONCLUSIONS

-The best anti-pest behavior was observed in caballero grano rojo jaspeado negro, with no affectations by any organism along their cycle.

-The highest earliness observed among caballero accessions occurred in the determinate growth line.

-The most productive lines were bola roja and bayito globoso.

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