CHARACTERIZATION OF A WIDE COLLECTION OF BEANS AND RESULTS FROM FARMER SELECTION

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ABSTRACT. A collection of 51 bean varieties were seeded on a private farm in "La Palma", Pinar del Río, with the aim of organizing the I Agrodiversity Fair on this crop in the community. It was celebrated with plenty of men and women on February 28, 2002 within pod-filling stage. Everyone had the opportunity of visiting the area and selecting up to five varieties to take them later to their farms. After recording the information of their selection and the data from yield as well as its components concerning both replicates, then selection differential was calculated. A variance analysis was performed on the whole population, also studying the main associations between variables and the most important stadigraphs per character. The high variability was notable in this fair and red grain coloration was also remarkable. Thus, farmers proved their ability for observation and selection.

Key words: *Phaseolus vulgaris*, agronomic characters, selection, peasantry, diversification

RESUMEN. Una colección de 51 variedades de frijol fue sembrada en la finca de un campesino en La Palma, Pinar del Río, con el objetivo de organizar entre los miembros de la comunidad la I Feria de Agrodiversidad en este cultivo en ese municipio. El 28 de febrero del 2002, hallándose en fase de llenado de las vainas, se efectuó la feria, contándose con una amplia participación de hombres y mujeres. Todos tuvieron la oportunidad de visitar el área y seleccionar como máximo las cinco variedades de su preferencia, para posteriormente llevarlas a sus fincas. Con la información recogida de la selección de los participantes y los datos de rendimiento y componentes de las dos réplicas empleadas, se posibilitó calcular el diferencial de selección. De la población total se realizó un análisis de varianza, se estudiaron las principales asociaciones entre las variables y estadígrafos más importantes por caracteres. Como resultado más notorio, se destaca la alta variabilidad presentada en esta feria, en la población de granos de color rojo. Se demuestra la alta capacidad de observación-selección de los campesinos.

Palabras clave: *Phaseolus vulgaris*, características agronómicas, selección, campesinado, diversificación

INTRODUCTION

In Cuba, the common bean (*Phaseolus vulgaris* L.) consumption and production are very popular; however, the whole national production does not satisfy people's demands and even now, thousand tons have to be imported every year (1). According to investigations and farmers' experience, several factors affect this crop production, mainly the lack of varieties adapted per location.

Conventional plant breeding in Cuba has priorized seeds from improved varieties, but the lack of resources has not allowed enough production; so the local farmer does not have free access to it. Besides, such varieties are generally prone to specific adaptation under different agroecosystems; thus, it is very important to give farmers free access to diversity, so that they can select varieties for their own farms (2, 3, 4). Specifically-adapted varieties are obtained by directly selecting under target environments, then either cultivars or crops are adapted to biophysical and socioeconomic environments, besides confirming how significant domesticated local varieties are for plant breeding (2).

In April 2001, a bean fair was celebrated at the National Institute of Agricultural Sciences (INCA), located in San José de las Lajas, Havana, with a broad diversity of bean color, size and shape as well as different plant structures, biological cycles and different tolerance levels to biotic/abiotic stresses (5). Farmers from service and credit cooperatives (CSC) of La Palma, Pinar del Río, participated among others. A whole day observing, exchanging, evaluating and selecting in the field encouraged the participants and a private farmer asked the project (Participatory plant breeding as a complementary strategy in Cuba) to develop a similar fair on his farm. The process

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for selecting and adopting varieties is very efficient with the help of farmers and plant breeders in local diversity fairs (3, 4).

The objectives of this paper was to evaluate the general behavior and the behavior per color of a bean grain population on the farm as well as the most important stadigraphs to know farmers' varietal selection capacity.

MATERIALS AND METHODS

Fair assembly and celebration. On December 25, 2001, 51 bean varieties were seeded on Coco's farm located in La Palma, from which black, red and white colors corresponded to bean 25, 17 and 9 respecively. They included commercial, precommercial and local varieties and were derived from different origin. Seeding and some cultural practices followed Bean Technical Pattern (6) whereas others were closely related to farmers' possibilities; particularly this time, their possibilities provoked all varieties developed a normal biological cycle.

A group of encouraged neighbors actively helped farm assembly. Seeding was accurately performed in plots with four 4-m long rows separated 0.5 m. Each block was 1 m apart to let guests' observation, perform evaluations and harvests without mixing varieties, which were seeded and repeated twice, so there were 102 plots on the farm and the surrounding field strips with local varieties.

On February 28, 2002, the fair was celebrated with farmers from this location and the neighboring ones. Once they were on the farm, men and women had the same right to select up to five varieties preferably. To avoid men's influencing women or viceversa, they select their varieties individually.

Harvest and evaluation. The farmer together with his family gradually harvested as they were drying.

Plants were tied up in cufflinks; later, they were identified by varietal numbers and placed in tobacco-drying warehouses. After harvesting, all varieties were threshed in jute sacks and clobbered with a stick; then, samples were cleaned and dried. 10 plants/replicate were taken; branch number/plant, grains/plant (100-seed-grams) and yield (g/plant and kg/plot) were determined in every sample.

Evaluations were randomly processed through a Two-Way Classification Variance Analysis (within and between varieties) and broad-sense heritability was estimated to each varietal color and the whole population (7, 8, 9). A correlation analysis was performed among variables and the main stadigraphs were determined. Having recorded the average yield of the existing population of the fair (51 varieties) as well as yield from five selected varieties per farmer, the selective differential was determined per each case. The selective efficiency through the calculated effective differential is represented as follows:

$$(Fair - X) = D_E$$

Fair: average yield of 51 varieties participating on the fair
D_E: Effective selection differential as farmer selective efficiency
X: Average yield of five varieties selected per each farmer

RESULTS AND DISCUSSION

In general, the analysis proved the existence of a wide variability at the bean varietal collection presented in the fair through significant differences recorded in each variable evaluated, except yield (g) per plant, which did not present any significant differences among varieties. As a result of this analysis, grains/plant and 100-seed-weight were notable variables, since they showed the most pronounced differences among variables. These results confirm a wide diversity of materials exposed in the fair, which helped farmers select the most adequate varieties for consumption and commercialization in a participatory manner, according to their criteria and particular needs.

On the other hand, some authors have stated (2, 3) that when variability is locally exposed, varietal selection is more effective and it has more specific adaptation.

Table II presents the most important stadigraphic values corresponding to each character, which allowed to distinghish white grain varieties as the most remarkable ones concerning pod number/plant, its mean and variance surpassing the other two groups of colors. Correspondingly to the former result, white grain varieties were distinguished by the mean value of grain number/plant, a determining characteristic of the group tending to reach mean yield/plant, which surpasses black and red grain varietal groups.

On the other hand, regarding the recorded values on 100-seed-weight variable, either the mean or variable from the red grain varietal group confirms wide differences from the grain size point of view. As a more distinctive characteristic of the black grain varietal group, there is a low variance recorded in 100-seed weight and a very similar value to the white grain group, which are in agreement with the above results and backed up by previous studies highlighting the most pronounced differences on red grain weight.

Table I. Mean square estimates per population character

Variation sources	DF	Pods/plant	Grains/plant	100-seed-weight (g)	Yield/plant (g)	Yield/plot (kg)
Replicate	1	9.0019*	70.0156 NS	2.9115 NS	3.0068 NS	0.1414 NS
Varieties	50	6.6424 **	342.0116***	132.1072***	5.2386 NS	0.1330*
Error	50	3.0196	110.2338	3.7827	5.2361	0.0759

DF-Degrees of freedom

Table II. Most important stadigraphs for all characters evaluated

Stadigraphs	Pods/plant	Grains/ plant	100-seed weight (g)	Yield/plant (g)	Yield/plot (kg)
			Full population		
Mean	8.0	36.5	23.0	7.6	1.4
Variance	4.8	228.7	70.3	5.7	0.1
Maximum	17.1	82.3	53.1	15.0	2.4
Minimum	4.7	11.2	15.1	3.8	0.6
Range	12.0	71.1	38.0	11.2	1.8
			Black population		
Mean	7.8	40.4	19.4	7.7	1.5
Variance	3.1	136.2	3.3	4.6	0.1
Maximum	12.3	73.8	22.7	15.0	2.4
Minimum	4.9	23.6	15.1	3.9	0.8
Range	7.4	50.2	7.6	11.1	1.6
			Red population		
Mean	7.3	26.3	26.5	6.9	1.3
Variance	3.1	187.8	116.8	6.0	0.1
Maximum	12.1	60.8	53.1	13.4	2.2
Minimum	4.7	11.2	15.9	3.8	0.6
Range	7.4	49.6	37.2	9.6	1.6
			White population		
Mean	10.0	48.2	18.2	8.7	1.5
Variance	8.5	182.6	2.6	6.3	0.1
Maximum	17.1	82.3	21.8	15.0	2.0
Minimum	6.4	30.1	15.9	5.1	1.0
Range	10.7	52.2	5.9	9.9	1.0

As a result from correlation analysis (Table III), associations existing among very similar variables was confirmed, independently of the grain group evaluated, so the highest positive associations were those existing between pod number/plant with grain number/plant as well as pod and grain number/plant with yield/plant and yield/plot. Such associations coincide with other studies conducted with bean crop (10).

Table III. Associations among variables

	Grains/plant				100-seed weight			
Variables	Black	Red	White	Total	Black	Red	White	Total
Pods/plant	0.87	0.75	0.96	0.82	-0.21	-0.25	-0.09	-0.28
Grains/plant					-0.20	-0.64	-0.07	-0.61
	Yield/plant				Yield/plot			
Variables	Black	Red	White	Total	Black	Red	White	Total
Pods/plant	0.78	0.59	0.92	0.75	0.35	0.46	0.59	0.44
Grains/plant	0.92	0.59	0.96	0.78	0.41	0.27	0.52	0.46
100-seed weight	0.15	-0.13	0.20	-0.18	0.37	0.19	-0.06	-0.9
Yield/plant					0.55	0.53	0.48	0.55

Significant correlation at 0.05

Likewise, the association existing between yield/plant and yield/plots was distinguished.

The analysis proved the nonexistence of associations between grains/plant and 100-seed weight, in case of black and white beans, whereas in red beans, an important and negative association was observed, basically determined by a wide variability existing in terms of 100-seed weight, differently from black and white grain varieties, which were notable for presenting very similar grain sizes, therefore, very similar weights.

Table IV shows heritability values corresponding to every variable evaluated, which are differentiated per varietal group according to grain color. In general, either the case of the complete collection or of each varietal group/color, 100-seed weight was the highest heritable variance, with values of 0.60-0.93, the latter value pertaining to the red color. As a selection criteria, pod number/plant was notable with important values of h^2 (0.36-0.52), which makes evident its possible use in the indirect yield selection. As it is observed, yield/plant and yield/plot have low values, so confirming these results (10).

Table IV. Character heritability

	Pods/ plant	Grains/ plant	100-seed weight (g)	Yield/ plant (g)	Yield/ plot (kg)
Total population	0.38	0.51	0.94	0.00	0.27
Black grain population	0.52	0.26	0.72	0.19	0.16
Red grain population	0.42	0.62	0.93	0.58	0.32
White grain population	0.36	0.46	0.60	0.29	0.19

When representing the selective efficiency by means of the effective differential estimate of each farmer (men and women individually), it was observed that 9 out of 55 men did not reach positive differentials; therefore, 84 % men selected varieties with satisfactory yields (Figure 1).

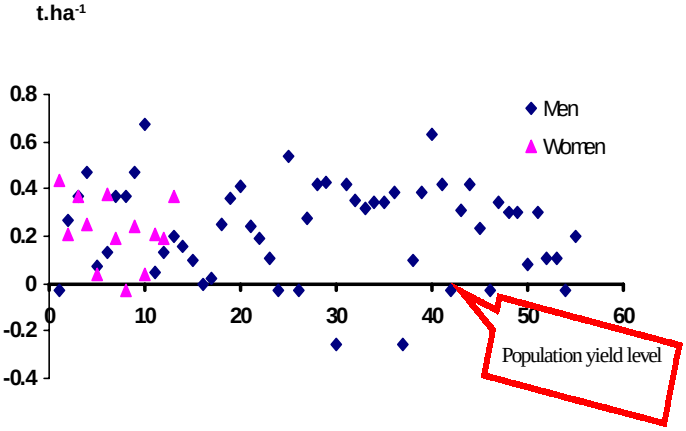

Figure 1. Selective differential reached by each farmer

Among 13 women selecting in the fair, just one did not reach positive differential; therefore, 94 % women could select varieties with satisfactory yields.

However, 12 participants achieved higher yields than 400 kg.ha^{-1} grains, where mean population value was 1.4 kg.ha^{-1} (Table II). These farmers attained more than 29 % upon the mean value, which suppose positive results with participatory selection, coinciding with more recent results from participatory selection in this locality (11, 12).

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