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Original article

Participatory varietal selection of chickpea in Los Palacios, Pinar del Río, Cuba

Selección participativa de cultivares de garbanzo en Los Palacios, Pinar del Río, Cuba

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ABSTRACT: The Participatory Selection of Cultivars has been shown to be effective in promoting the participation of different stake holder in the genetic improvement process and to know about the preferences of producers. The aim of the study was to identify cultivars with the greatest acceptance and the agronomic criteria of greatest consideration from participants' perspective. The participatory selection was carried out at the Agrodiversity Fair in the Scientific and Technological Unit de Base "Los Palacios", located in the Los Palacios Municipality, Pinar del Río province where growers, technicians and decision-makers of both sexes participated. The effective diversity percentage was determined, cultivars with the greatest acceptance and the most relevant agronomic criteria were identified. Female participation reached 44.8 % and effective diversity was 75 %. DI-77, DN-12 and DI-11 cultivars stood out for their good performance for the locality; the characters with the highest degree of acceptance at the time of selection were number of pods per plant, number of grains per pod, grain size and plant erection. Participatory cultivars selection in chickpea could be an excellent methodology to accelerate cultivars adoption, enrich genetic diversity of this crop and increase yields, also allow training, the interaction of various stake holders and promote gender equality.

Key words: selection criteria, grain, growers, production, agricultural fairs.

RESUMEN: La selección participativa de cultivares ha demostrado ser efectiva para promover la participación de los diferentes actores en el proceso de mejoramiento genético y para conocer las preferencias de los agricultores. El objetivo de este estudio fue identificar los cultivares con mayor aceptación y los criterios agronómicos de mayor consideración, desde la perspectiva de los/as participantes. La selección participativa se realizó en la Feria de Agro diversidad de cultivares de garbanzo que se desarrolló en la Unidad Científico Tecnológica de Base "Los Palacios", ubicada en el municipio Los Palacios, provincia Pinar del Río, donde participaron productores, técnicos y decisores, de ambos sexos. Se determinó el porcentaje de diversidad efectiva, se identificaron los cultivares con mayor aceptación y los criterios agronómicos de mayor relevancia. La participación femenina alcanzó el 44,8 % y la diversidad efectiva fue del 75 %. Se destacaron, por su buen comportamiento para la localidad, los cultivares de garbanzo DI-77, DN-12 y DI-11; los caracteres con mayor grado de aceptación, en el momento de realizar la selección fueron: cantidad de vainas por plantas, cantidad de granos por vaina, tamaño del grano y el porte de la planta. La selección participativa de cultivares en el garbanzo podría ser una excelente metodología para acelerar la adopción de cultivares, enriquecer la diversidad genética de este cultivo y aumentar los rendimientos, asimismo, permite la capacitación, la interacción de diversos actores y promover la equidad de género.

Palabras clave: criterios de selección, granos, agricultores, producción, ferias agrícolas.

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INTRODUCTION

Beans, peas and chickpeas account for about 70 % of the world's legume production and the latter represents about 17 % of the annual total (1). Chickpea is the common name of an annual plant, *Cicer arietinum*, of the Fabaceae or Leguminosae family, which is widely cultivated and is considered a good source of protein.

Despite its importance, chickpea crop yields are low, due to several production constraints, including: low yield potential of local varieties; lack of superior varieties; its susceptibility to biotic and abiotic stresses; poor cultural practices (2,3).

Chickpea production in Cuba until the 90's has not been of consideration and, consequently, there are no records in national or world statistics of its production (4); However, in recent years, its sowing has awakened greater interest, among other aspects, due to its preference, its high cost in the foreign exchange market and its low production costs, in relation to other species of grains, as well as to the increasing knowledge of the crop (5), becoming an attractive cultivar to expand its production, especially in the current conditions, where the country needs to substitute imports and achieve food security.

In this sense, it is urgent to introduce to farmers improved varieties with higher yields and better adaptation to the conditions in which this legume is grown in the country. For this process, the "Agrodiversity Fairs" and the participatory selection of cultivars have been very successful. This methodology has contributed to the introduction of new technologies and new diversity of different crops to farmers' farms (6-10).

Participatory variety selection (PVS) has proven to be successful in identifying cultivars preferred by farmers in a shorter time than the conventional system and, therefore, accelerates its dissemination (3). Programs in several countries have demonstrated the effectiveness of this method (11-15). In Cuba, it has been successfully used in crops such as rice, tomato, chickpea, beans and cassava, among others (6-9,16).

Considering this background, the main objective of this study is to identify the cultivars with greater acceptance and the agronomic criteria of greater consideration by the participants in the Participatory Variety Selection (PVS) of chickpea in the conditions of Los Palacios municipality.

MATERIALS AND METHODS

Location

The work was carried out in Los Palacios municipality, Pinar del Río province, Cuba. The garden of chickpea cultivars for the development of the Agrodiversity Fair was located in areas of the Los Palacios Scientific and Technological Base Unit, belonging to the National Institute of Agricultural Sciences (INCA), where the Participative Selection of Cultivars was subsequently carried out.

General aspects for the assembly of the Cultivation Garden

An area was selected that would allow for conditioning in order to achieve adequate establishment. Plots were set up with uniform soil to avoid differences between cultivars, as a consequence of factors unrelated to the characteristics of each one of them. The cultural tasks during the crop cycle (soil preparation, sowing, fertilization, irrigation and phytosanitary treatments) were carried out according to the technical instructions for chickpea cultivation (17).

Six foreign cultivars (DI-11, DI-18, DI-20, DI-64, DI-75, DI-77) from the germplasm bank of the International Center for Agricultural Research in Arid Zones (ICARDA) and two national cultivars (DN-12, 5 NHA) from the Institute for Fundamental Research in Tropical Agriculture (INIFAT) were used, which were identified with a consecutive number (1 to 8) and not with their code. The name and origin of each cultivar are informed after the selection is made, so that it does not influence the participants during this process, as it could bias the results of the selection.

Cultivars were planted in 60 m long furrows, the plots consisted of five furrows with a planting distance of 0.70 x 0.10 m and a minimum space was left between them to avoid the possible effect of competition between them. Cultivars subjected to evaluation and the selection criteria that made up the survey are listed (Table 1), as well as the survey applied during the participatory selection (Figure 1).

Encuestas para la SPV Surveys for the PVS

The methodology for the PVS was explained and the completed surveys were handed out, containing different criteria for the selection of these criteria, with a space for

Table 1. Chickpea cultivars exhibited at the fair and selection criteria used in the field survey

Number	Cultivars	Number	Selection criteria
1	DI-11	1	Grain size
2	DI-18	2	Grain weight
3	DI-20	3	Branching
4	DI-64	4	Number of grains per plant
5	DI-75	5	Number of grains per pod
6	DI-77	6	Number of pods per plant
7	DN-12	7	Growth habit
8	5NHA	8	Plant height

the participants to add any other data they considered important to take into account (Figure 1).

Participants

Producers from Los Palacios municipality participated, both from the State Sector, mainly linked to the Agroindustrial Grain Company (EAIG), and from the Cooperative and Farmer Sector, belonging to different productive forms (Credit and Service Cooperatives and Agricultural Production Cooperatives). In addition, specialists, technicians, researchers and decision-makers of the territory.

Exchange of experiences

Within the framework of the Agrodiversity Fair, a talk was given on "Chickpea cultivation, characteristics of the foreign and national cultivars exhibited, and opportunities for their dissemination". In addition, aspects related to the management of the crop and its technology were discussed; results of trials carried out under experimental conditions on the response of a group of cultivars, including some of those exhibited, were discussed. Participants had the opportunity to exchange experiences and discuss criteria among producers and between them and STBU (UCTB) researchers, decision makers and other actors in the production chain.

Information analysis

The list of participants was used to collect information, in which the following were recorded: name, sex, occupation, place of origin, work center or production unit, address and telephone number, as well as the surveys prepared for this purpose, which showed both the cultivars selected and the selection criteria, based on the visual observation of the overall behavior of the cultivars. Descriptive statistics were used for the indicators evaluated, by counting and summing the number of votes cast for each one, in order to know the cultivars of greatest interest to the participants and, likewise, for the most important selection criteria.

The tabulation of all the information was carried out using *Microsoft Excel* 2016. When analyzing the information, specialists, technicians, researchers and extensionists were included in the category of "technicians".

To measure the efficiency of the selection, the percentage of effective diversity (% ED) was calculated using the formula:

$$\% ED = \frac{selected\ cultivars}{total\ exposed\ cultivarss} * 100$$

RESULTS AND DISCUSSION

Twenty-nine people participated in the selection of chickpea cultivars at the Agrodiversity Fair and female participation reached 44.8 % (Table 2). Attendance at these activities corresponds to that reported on participants/fair in participation studies recorded in more than 200 Fairs of different crops, carried out in several provinces of Cuba (18).

The percentage of female participation demonstrated the growing incorporation of women in agricultural activities; similar results were obtained in a study of the same type in the province of Artemisa (7). Although it is recognized that there is still a great potential to increase the presence of women in the sector, based on the application of the gender

Chickpea Diversity Fair

Place_____ Date _____
Name _____ Age ____ Sex ____
Occupation _____
CPA _____
CCS _____
UBPC _____
Other _____

Select up to 5 cultivars of your preference and mark with an X the criteria for which you chose them

Selection Criteria	Var. #	Var. #	Var. #	Var. #	Var. #
Grain size					
Grain weight					
Ramifications					
Number of grains/plant					
Number of grains/pod					
Number of pods/plant					
Plant erection					
Height					
Other (its considerations)					

Figure 1. Field survey applied during the participatory selection of chickpea cultivars

Table 2. Number of participants per group in the participatory selection of chickpea cultivars

Groups	Quantity		Percentage (%)	
Productors	14		48.3	
Technicians	11		37.9	
Decision makers	4		13.8	
Total	29		100	
	13 W	16 M	44.8 W	55.2 M

W: Women, M: Men

approach in local development. This is even more relevant if one takes into account that gender inequalities profoundly undermine women's potential as engines of agricultural growth and prevent them from playing their prominent role as agents of family food security and well-being. One of the challenges will be to track changes in women's participation in different aspects of innovation systems, which, by nature, represent multiple stakeholders and go beyond the local level (19).

Also exhibited at the fair, as an initiative of the women, were products made by them (canned food, handicrafts, articles made from recycled disposable materials, still-life arrangements and other handicrafts (weaving, sewing, etc.). There was also an exchange of experiences and it was recognized that these actions contribute to the rescue of traditions and, in some cases, constitute sources of income for women.

The participatory selection of chickpea cultivars (Figure 2) revealed that the most selected were DI-77, DN-12 and DI-11 (Figure 3). Cultivar DI-77 is distinguished by its semi-erect growth habit, height greater than 50 cm, large number of branches and pods per plant, two grains per pod and high yields; characteristics that favored the preference for this cultivar and compensated for the small size of its grains.

It is interesting to note that cultivars DI-64 and 5 NHA were not selected during this process. This could be related, in the case of DI-64, to the type of growth habit, lower plant height and, therefore, fewer nodes, fewer branches, fewer pods per plant and also susceptible to fusariosis, aspects that place it at a disadvantage to achieve good yields. While for 5 NHA, it could be because there were difficulties with the handling of the seed and a good germination was not achieved, since this is a commercial cultivar with good behavior and widely used, mainly in the eastern region of Cuba. This suggests that it should be included in future studies at the local level to validate its performance.

The percentage of effective diversity was 75 % and most of the cultivars were selected by at least one of participants, which confirms good adaptation to the local edaphoclimatic conditions and great acceptance of the materials exhibited at the Los Palacios fair. It is suggested that the percentage of selection or effective diversity may be related to the variability of the species under study, since in a species with greater variability, local materials may be more important than in species with less variability (8).

Figure 2. Various actors at the Agrodiversity Fair during the participatory selection of chickpea cultivars

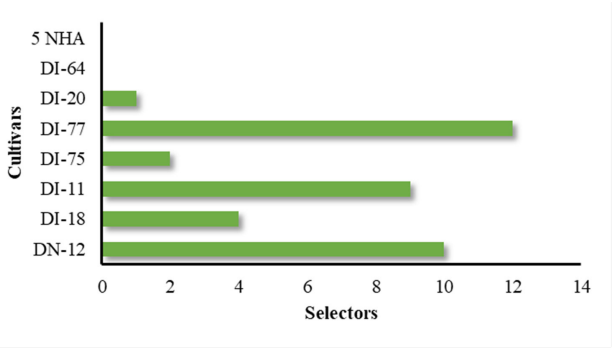

Figure 3. Crops selected by participants in the Chickpea Agrodiversity Fair in Los Palacios municipality

In a previous fair developed in San Antonio de los Baños, where the participatory selection of chickpea cultivars was carried out, also most of the cultivars (75 %) were selected, which coincides with the results obtained in this work and corroborates the high acceptance of this species by the selection actors (7).

The surveys on selection criteria indicated that the most important characters taken into account at the time of cultivar selection (Figure 4) were: number of pods per plant, number of grains per pod, grain size and plant size.

The final yield of any crop species depends on the relationship between source and site of consumption and on the different yield components, in this case, number of pods per plant, number of grains per pod and weight of 100 seeds (20). However, it is opportune to remember that the environmental factor and its interaction with the genotype determine; in general, more than half of the phenotypic effect, so that the selection of the materials in the environments of destination for its exploitation, allows having great advantages in adaptive terms (21).

The fact that cultivars had good behavior in the edaphoclimatic conditions of the municipality and achieved acceptance by the breeders becomes relevant if the low development of the crop in the country is attributed, among other causes, to the lack of cultivars that present high and stable yields adapted to the local conditions and the lack of culture to produce this grain (5). For some years, work has been carried out under experimental conditions in the evaluation of a group of chickpea genotypes, including national and introduced cultivars, to promote the development of the crop in Los Palacios municipality with those that achieve a better adaptation to the soil and climatic conditions.

Some authors report that the released chickpea varieties were released by several research centers, but that farmers do not have enough information about them because this process was carried out with little participation of farmers and these had not yet been tested in study areas (2). While in another research they suggest equipping farmers with knowledge about improved chickpea, strengthening seed production, building farmers' confidence in improved technologies through participatory cultivar selection, encouraging large-scale demonstration of farmer-selected varieties, and optimizing availability of improved seed through community-based seed production (22).

Breeders showed greater interest in criteria related to productivity and in this sense it is recognized that pods per plant is the most important yield component and, at the same time, the most affected by growth conditions, plant densities, soil moisture and weather conditions related to climatic variables (23). Likewise, some authors in works similar to this one, found that 50 % of cultivars were chosen for developing large grains, relating this quality with the quality for the commercialization of this crop and suggest taking into account this criterion in future studies, as an indicator for the access of new cultivars to the market (7), while in others it is reported that most of the farmers identified yield, tolerance to drought and uniform maturity as the main selection criteria (3). In previous studies conducted in the locality there are authors who report good results in the performance of some of these cultivars in terms of yield and resistance to Fusarium blight (4).

It is known that the selection criteria of growers and breeders often differ, so that sometimes the characteristics of the cultivars do not fit their interests. However, in some cases the researchers' selection coincides with farmers' preferences. In general, however, farmers have shown their own way of selecting a cultivar for their locations and have included parameters such as earliness, disease and pest resistance, seed color, branch number and length, and seed size. Therefore, taking farmers' preferences into account in a cultivar selection process is of utmost importance (2).

In Cuba, biodiversity fairs, where participatory cultivar selection and field days are generally carried out, are considered a good tool to obtain immediate feedback from farmers on any established intervention, the participatory approach has an important role in the adaptation and dissemination of technologies, in less time than the conventional way.

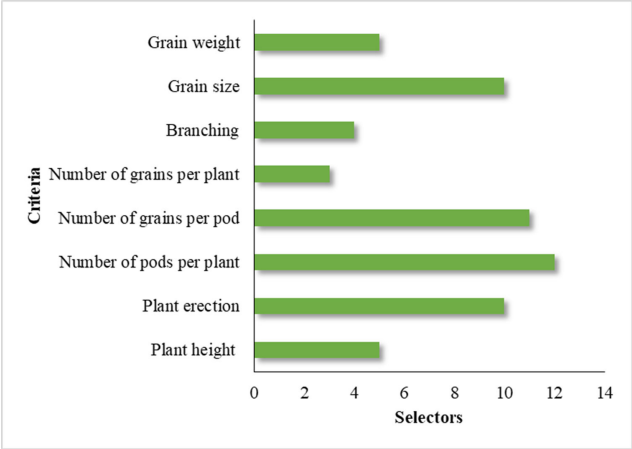

Figure 4. Chickpea cultivar selection criteria by participants in the Chickpea Agrodiversity Fair in Los Palacios municipality

Some projects implemented in the country have had, throughout their development, as a fundamental premise, the participation of the producers, who are accompanied and provided with information on the different crops, technologies, cultivars, seeds, among other results; but above all, empowering their self-management, their critical capacity to face problems, their innovative power and the possibility of extending their own results, which has been well accepted among the rural stakeholders; therefore, these positive experiences can be incorporated into the training processes developed in the future (24).

The results of the PVS are useful to obtain systematic feedback in the breeding program, based on key traits, characteristics and preferences required by the final users, as well as to obtain efficiency in the breeding process, increasing the probability of adoption and diffusion by producers and reducing the time required for the release of a cultivar (25). This methodology has been widely used in the chickpea cultivation, due to its advantages (2,3,7,22,26,27).

During the exchange workshop, after the lecture, the most important aspects of the phytotechnics of this crop were discussed and the results of trials carried out under experimental conditions on the behavior of a group of national and foreign cultivars, including those presented, were shared. This activity, which involved several key actors, was of great importance and usefulness, since it allowed the development of capacities and the expansion of the participants' knowledge on the crop in question, as well as a space to clarify doubts, identify new training needs, establish other goals and, in addition, use the information generated to obtain feedback for future research and, mainly, for the improvement of this crop. Numerous programs have been designed and developed to achieve these objectives (22,26).

CONCLUSIONS

- The genotypes with good performance for Los Palacios, according to the participatory selection, were DI-77, DN-12 and DI-11, with a high level of adaptation under these conditions and a higher probability of being adopted.
- Characters that are most important at the time of participatory selection of chickpea cultivars are: number of pods per plant, number of grains per pod, grain size and plant size.
- The Agrodiversity Fair is an excellent space for training in order to dynamize and strengthen the learning process and interaction of various key actors, as well as to promote gender equity in the Cuban agricultural context.
- The participatory selection of cultivars in chickpea is an excellent methodology to accelerate the adoption of cultivars, enrich and maintain the genetic diversity of this crop and, at the same time, increase yields.

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