Cultivos Tropicales, 2019, vol. 40, no. 4, e02
ISSN impreso: 0258-5936
ISSN digital: 1819-4087

octubre-diciembre
Ministerio de Educación Superior. Cuba
Instituto Nacional de Ciencias Agrícolas

http://ediciones.inca.edu.cu

Original Article

Participatory varietal selection of soybean (Glycine max, (L.)) in Los Palacios, Pinar del Río, Cuba

Sandra H. Díaz-Solis[1*]
Rogelio Morejón-Rivera[1]
Lázaro Alberto Maqueira-López[1]
Anayza Echevarría-Hernández[1]
Ariel Cruz-Triana[1]
Osmany Roján-Herrera[1]

[1]Unidad Científico Tecnológica de Base "Los Palacios", Km 1½ carretera La Francia, Los Palacios, Pinar del Río, Cuba. CP 22900

[*]Author for correspondence. shdiaz@inca.edu.cu

ABSTRACT

Participatory selection is a simple, fast and efficient way to introduce a large cultivars number and its effectiveness in various crops is proven. Plant breeders develop more productive cultivars under ideal conditions but often do not adapt well to the specific conditions of farmers, this approach allows to increase yields, genetic diversity in the target environments and decision making of farmers in participating communities. The objective of the study was to identify the cultivars with the highest acceptance and the most taken into account agronomic criteria. In the present work the results of the participatory varietal selection of soybean are shown in a diversity fair developed in a farm in Los Palacios municipality. The most widely accepted cultivars were identified, the agronomic criteria most taken into account by the participants and the effective diversity percentage was determined. Cultivars D-2101, DT-26, DT-22 and DT-20 stand out with good behavior for the locality and the characters most taken into account at the moment of making the selection were number of grains per pod, number of pods per plant, grain size, yield, height and incidence of pests.

Key words: selection criteria, cultivars, yield, soja, cooperative, fair

INTRODUCTION

In the current context, with the impact of climate change on agriculture, a state of uncertainty about how to feed the population of the planet and guarantee the availability of species domesticated by different human groups is anticipated. To promote sustainable productivity growth, strategies that guarantee the increase in crop yields, the conservation of genetic resources and the adoption of innovative crop management practices that generate added value and increase rural incomes must be applied [(1)].

In Cuba, for some years, national grain production has been promoted and this line of action demands fostering the development of initiatives with the objective of introducing and/or validating new, more productive and tolerant cultivars of biotic and adverse abiotic factors. In this sense, primary importance is attributed to the selection of satisfactory genotypes, as a cultivar will be better when its plasticity is greater, that is, its ability to produce good crops both in different environments and in soils with different characteristics, and above all, in various campaigns and growing conditions.

In the case of soybeans (*Glycinemax*, (L.)), in the last 10 years it is imported from Brazil, Argentina and countries of Asia, which forces to allocate large resources to acquire the grain, which is an important component in the intensive production of poultry and pig meat, milk, yogurt, oil and other food production [(2,3)], this grain is among the most important in the world, due to its high protein and fat content; Although this crop has been known in the country since 1904, it has not been possible to stabilize its production.

In this sense, the Diversity Fairs are an effective alternative to facilitate the flow of seeds from the Research Institute towards the farmer and vice versa; they constitute an injection of genetic diversity with great community acceptance and broadening the demand spectrum of farmers. They also constitute a complement to the genetic improvement programs that are developed in numerous agricultural crop species, so that through the participatory selection of the new genetic materials, it is possible to minimize the time required for the extension of the new cultivars in addition to making a more effective selection of them for each specific condition. The participatory evaluation of varieties that is carried out in the context of the Diversity Fairs, has the objective of valuing the available germplasm, are Easy implementation and low cost, generate short-term results; that is, cultivars are quickly adopted by the participating farmers. For decision-making, the appreciation of farmers and agronomic results are complemented [(1)].

Carrying out the participatory selection of varieties (SPV) has become a motivating force for agricultural research and rural development, this approach allows us to consider the agroecological conditions and cultural practices of the target areas; local knowledge and preferences of producers in these areas; as well as the preferences and requirements of the other actors in the production chain. Programs in various countries have demonstrated the effectiveness of this method [4–11]. In Cuba it has been used successfully in crops such as rice, beans, tomatoes, cassava and chickpea among others [12–16].

Taking into account the aforementioned, the main objective of this study is to identify the cultivars with greater acceptance and the agronomic criteria most taken into account by the participants in the Participatory Selection of Varieties (SPV) spawns in the conditions of the Los Palacios municipality.

MATERIALS AND METHODS

General aspects for the assembly of the garden of cultivars

The soybean cultivation garden for the development of the Diversity Fair was located on the farm of the producer Jesús Rivera, belonging to the Credit and Services Cooperative (CCS) "Menelao Mora" of the Los Palacios municipality, Pinar del Río province. A surface was selected that allowed a conditioning in order to achieve the proper establishment of the same. For the assembly of the plots the uniformity of the soil was sought to avoid differences between the cultivars as a result of factors outside the characteristics of each of them. The cultural activities that were carried out during the crop cycle (soil preparation, planting, fertilization, irrigation and phytosanitary treatments) were carried out, as recommended by the Technical Manual of Soybean Cultivation [17].

Between the plots a minimum space was left to avoid the possible effect of competition among the cultivars that were identified through previously established keys to avoid the predisposition of the farmers in the participatory selection process. Ten cultivars that were planted in plots of 3 m^2 were put to the consideration of the participants and at the time of the election the survey carried out took into account 10 selection criteria (Table 1).

Table 1. Soy cultivars exposed in the fair and selection criteria that integrated the survey

Nu.	Cultivars	Nu.	Selection criteria
1	INCASOY 1	1	Grain color
2	INCASOY 24	2	Grain size
3	INCASOY 27	3	Plant architecture
4	WELLEAMS	4	Amount of grains per pod
5	DT-20	5	Number of pods per plant
6	DT-22	6	Overturning or flattening
7	DT-26	7	Growth habit
8	DT-84	8	Yield
9	D-2001	9	Incidence of pests
10	Traditional	10	Cycle

Conceptualization and characterization of the fair of diversity

The Diversity Fairs are defined as those meetings of farmers, plant breeders, decision makers, politicians, germplasm bank conservators and leaders of peasant organizations, among others, that carried out in fields previously prepared for such purposes, pursue the fundamental purpose of contributing through of the participatory selection of accessions to the maintenance and increase of the diversity of species and accessions of crops of economic interest for farmers, in a way that satisfies the needs of family consumption and marketing as sources of income for new resources [(18)].

Aspects that distinguished this diversity fair:

- Presentation of a wide variety of varieties that included commercial, introduced and traditional cultivars.
- The participants had the opportunity to appreciate the characteristics and behavior of the different exposed cultivars, select the five of their preference and the producers take them to their farms to evaluate them in their own production conditions.
- Participation of women in the process of selection and preservation of materials, exhibitions of products of innovation and rescue of traditions (preparation of canned food, handicrafts and other crafts).
- It turned out to be a space for training, exchange of experiences and horizontal interaction between producers, technicians and other key actors. A talk was made about the cultivation of soybeans and folded with relevant information.

- Explanation of the methodology for participatory selection of cultivars and delivery of ready forms that contained different criteria for the selection of cultivars; In addition, a space for participants to add someone else they consider important to take into account.

Participants

Producers of the Los Palacios municipality participated, both from the State Sector mainly linked to the Agroindustrial Grain Company, as well as the Cooperative and Farming Sector, belonging to various productive forms (Credit and Services Cooperatives, Agricultural Production Cooperatives and Basic Units of Cooperative Production). In addition, specialists, technicians, researchers and decision makers in the territory.

Analysis of the information

For the collection of information, the list of participants was used in which they were registered: name, sex, occupation, place of origin, work center or productive unit, address and telephone, as well as the forms prepared for this purpose, where both cultivars appeared selected as the selection criteria, based on the visual observation of the integral behavior of the cultivars. Descriptive statistics were used for the indicators evaluated, by counting and adding the number of votes cast by each one, to know the cultivars of greater interest for the participants and in the same way for the most important selection criteria.

The tabulation of all the information was done through *Microsoft Excel 2016*. At the time of 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 (% DE) was calculated using the formula:

$$\%\ \mathrm{DE} = \frac{\text{selected cultivars}}{\text{total of exposed cultivars}} * 100$$

RESULTS AND DISCUSSION

In the selection of soybean cultivars in the Diversity Fair 30 people participated (Table 2), which corresponds to the information about participants / fair in participation studies

registered in more than 200 Diversity Fairs of different crops carried out in several provinces of Cuba [19].

Table 2. Number of participants by groups in the participatory selection of soybean cultivars

Groups	Quantity		Percentage (%)	
Productors	17		57	
Technicians	9		30	
Decision makers	4		13	
Total	30		100	
	10 W	20 M	33 W	67 M

W: Women, M: Men

Female participation reached 33 %, which demonstrates the increasing incorporation of women into agricultural activities, although it is recognized that there is still a great deal of potential to be exploited to increase female presence in the sector, based on the application of the gender approach in local development. Which becomes more relevant if one takes into account that many women are responsible for the production, purchase, process and preparation of most of the food consumed. However, women in a condition of vulnerability often have limitations in accessing nutritional information and necessary resources (income, land, technology, services and others) to improve food security [20].

They were also exposed, as an initiative of the women, products made by them (canned food, handicrafts, items made from the recycling of disposable materials, arrangements with still life and other crafts (fabrics, seams, among others). 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. When the social and economic empowerment of women is achieved, they can become a powerful force for change. In rural areas of the developing world, women play a crucial role in the management of their homes and their contribution to agricultural production is essential, but inequalities between women and men make it difficult for women to fully realize [21].

Figure 1 shows the results of the participatory selection of soybean cultivars, the ones that received the most votes were D-2101, DT-26, DT-22 and DT-20. This indicates a good behavior of the new materials in these conditions, which becomes important considering that they have better characteristics and high performance potential.

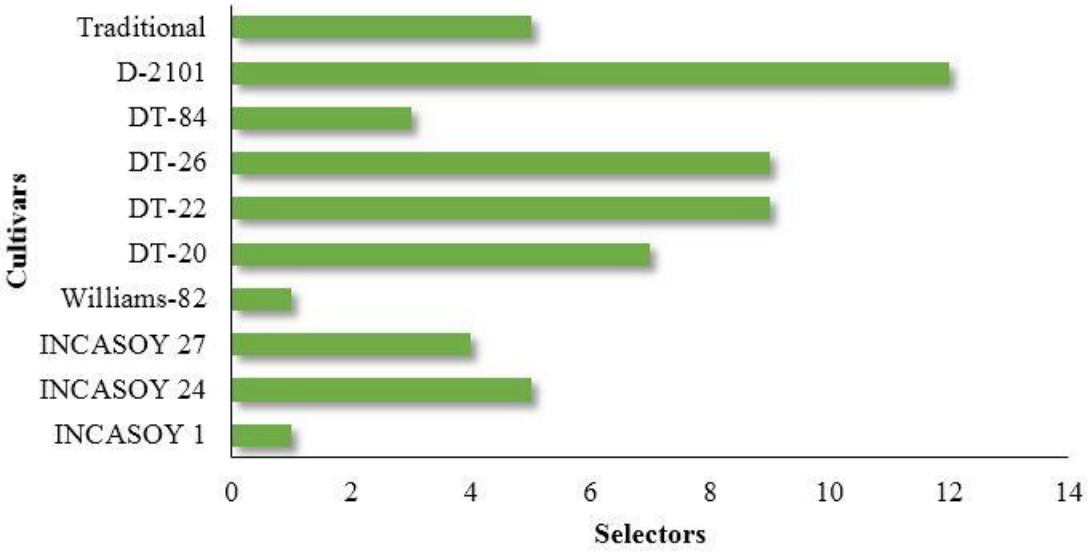

Figure 1. Cultivars selected by participants in the Soy Diversity Fair in Los Palacios municipality

In this context, it is significant to highlight that the traditional cultivar was selected, even more than four of the proposed ones, in this aspect it greatly influences that the materials are identified with a consecutive number and not with their real name. The name and origin of each cultivar are not informed until after the selection is made so that it does not influence the participants during this process as this could sometimes bias the results of it.

The breeders and the cultivar release committees increasingly recognize that the model of a "unique super variety widely adapted" is often incompatible with the real needs of small farmers that depend on climate, use, seasonality, among other aspects. In crop management there is no "one model for all" [22].

All cultivars were at least selected by one person and in the case of D-2101, DT-26, DT-22 and DT-20 reached percentages of 40, 30, 30 and 23, respectively. The effective diversity was 100 %, which confirms good adaptation to local edaphoclimatic conditions and great acceptance of the materials exhibited at the fair.

Other authors, when studying the response of the growth and yield of soybean cultivars, in an essay developed at the Los Palacios Base Technological Scientific Unit (UCTB), also reported the cultivars DT-20 and DT-26 as those with better behavior with the highest yields on the three planting dates evaluated [23].

For a few years, research centers and mainly plant breeders have paid more attention to farmers' priorities and improve their access to the materials that are generated, due to the

scope they have in genetic improvement strategies and extension of cultivars, since it allows to respond to the current challenges of agriculture. The search for soy cultivars with greater adaptation to the specific agroclimatic conditions of each locality, is considered in Cuba as an important strategy to achieve better productive results. The Network of Evaluation of Soybean Cultivars for the Argentine Northwest (NOA), which aims to assess the behavior of the different soybean cultivars available to the producer, evaluated during the 2012/2013 campaign, 33 cultivars in 12 locations [24].

Figure 2 shows the results of the surveys on the selection criteria, it can be seen that the most taken into account when selecting the cultivars were: number of grains per pod, number of pods per plant, grain size, yield, height and incidence of pests.

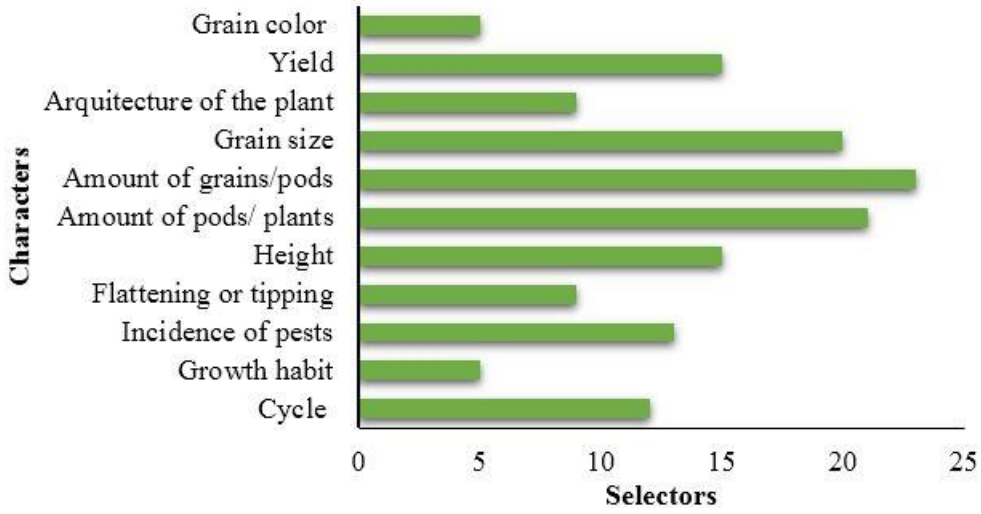

Figure 2. Selection criteria by participants in the Soy Diversity Fair in the Los Palacios municipality

It is proposed that the pods can contain between one and five grains, but that they generally have two or three and that the number of grains per pod depends on each cultivar, since it has a high heritability. In evaluations of soybean cultivars it has been found that in the pods per plant parameter there is a significant difference between the cultivars and that this character is among those that have the greatest influence on agricultural yield [25,26].

It is known that, in recent years, the great variability of yields is closely related to the role that weather conditions play in the behavior of a particular cultivar, an aspect that allows explaining how some cultivars respond better than others to the edaphoclimatic conditions of a given locality [27]. For example, there are cultivars that in the cold season or under certain circumstances, reach a smaller size, their leaves are smaller, among other characteristics [28].

Within the framework of the Diversity Fair, a workshop was held where a talk was given on: "Soybean cultivation and characteristics of the cultivars most adapted to the conditions of Los Palacios". In addition, aspects related to crop management, technology and seed conservation; Results of trials conducted under experimental conditions about the response of a group of cultivars were discussed, including those exposed. The participants had the opportunity to exchange experiences, highlighting the debate between producers and between them and the researchers of the UCTB and decision makers of the Municipal Delegation of Agriculture.

It is important to point out that numerous training programs in the agricultural sector have been designed and developed, with which different forms of production have benefited, with various objectives, among which are information on new technologies, prepare actors depending on their job skills and improve their professional performance; An example of this are the Local Agricultural Innovation Project (PIAL) of the National Institute of Agricultural Sciences (INCA), and the Agro-Ecological Movement of farmer to farmer (MACAC) of the National Association of Small Farmers (ANAP), to name a few. These projects have had during all their development as a fundamental premise, the participation of the producers that are accompanied, information is provided on the different crops, technologies, cultivars, seeds, among other results; but above all, enhancing their self-management, their critical capacity in the face of problems, their innovative power and the possibility of extending their own results, which has had good acceptance among the actors in rural areas; Therefore, these positive experiences can be incorporated into the training processes developed in the future [29].

CONCLUSIONS

- The genotypes with good behavior for the locality according to the participatory selection are D-2101, DT-26, DT-22 and DT-20, with a high level of adaptation in these conditions and more likely to be adopted.
- The characters quantity of grains per pod, number of pods per plant, grain size, yield, height and incidence of pests, are the most important at the time of making participatory selection of cultivars.

- The Diversity Fair is an excellent space for training in order to boost and strengthen the process of learning and interaction of various key actors, as well as to promote gender equality and empowerment of Cuban women.

BIBLIOGRAPHY

1. Caetano CM, Peña RD, Maigual JL, Vásquez LN, Nunes DC, Pazdiora BRC. Mejoramiento participativo: herramienta para la conservación de cultivos subutilizados y olvidados. Acta Agronómica. 2015;64:307–27.
2. Villalobos E, Camacho F. Desarrollo de variedades tropicales de soya para el consumo humano. Agronomía Mesoamericana. 2000;11(2):1–6.
3. Romero A, Ruz R, González M. Evaluación de siete cultivares de soya *Glycine max* en las condiciones edafoclimáticas del municipio Majibacoa, Las Tunas. Pastos y Forrajes. 2013;36(4):459–63.
4. Mudege NN, Mukewa E, Amele A. Workshop Report: Training on Gender Integrated Potato Participatory Varietal Selection (PVS) in Ethiopia. 2015.
5. Getahun A, Atnaf M, Abady S, Degu T, Dilnesaw Z. Participatory Variety Selection of Soybean *Glycine max*(L.) Merrill) Varieties Under Rain Fed Condition of Pawe District, North-Western Ethiopia. International Journal of Applied Science and Mathematics. 2016;3(1):40–3.
6. Horn LN, Ghebrehiwot HM, Sarsu F, Shimelis HA. Participatory varietal selection among elite cowpea genotypes in northern Namibia. Legume Research: An International Journal. 2017;40(6).
7. Goa Y, Ashamo M. Participatory approaches for varietal improvement, it's significances and challenges in Ethiopia and some other Countries: A Review. International Journal of Research Studies in Science, Engineering and Technology [IJRSSET]. 2017;4(1):25–40.
8. Diouf M, Gueye M, Samb PI. Participatory Varietal Selection and Agronomic Evaluation of African Eggplant and Roselle Varieties in Mali. European Scientific Journal, ESJ. 2017;13(30):327–40. doi:10.19044/esj.2017.v13n30p327
9. Sugiharto AN, Andajani TK, Baladina N. Effectiveness of Participatory Varietal Selection in Corn Cultivar Establishment. Journal of Advanced Agricultural Technologies Vol. 2017;4(4).

10. Wilkus EL, Francesconi GN, Jäger M. Rural seed sector development through participatory varietal selection: Synergies and trade-offs in seed provision services and market participation among household bean producers in Western Uganda. Journal of Agribusiness in Developing and Emerging Economies. 2017;7(2):174–96.
11. Hunde D, Tefera G. Participatory Varietal Selection and Evaluation of twelve Soybeans *Glycine max* (L.) Merrill] varieties for Lowland areas of North Western Ethiopia. International Journal of Plant Breeding and Crop Science. 2018;5(2):403/407.
12. Morejón R, Díaz SH, Díaz GS, Pérez N, Ipsán Pedrera D. Algunos aspectos del manejo de la semilla de arroz por productores del sector cooperativo campesino en dos localidades de pinar del río. Cultivos Tropicales. 2014;35(2):80–5.
13. 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 comun *Phaseolus vulgaris* L. Centro Agrícola. 2017;44(4):65–74.
14. Moya-López CC, Orozco-Crespo E, Mesa-Fleitas ME. Ferias de agro-biodiversidad cubanas: vía para la selección de variedades de tomate. Agronomía Mesoamericana. 2016;27(2):301–10.
15. Álvarez-Kile PM, Rodríguez-Montes W. Evaluación de 7 variedades de yuca mediante una feria de biodiversidad en condiciones de sequía en el municipio Jiguaní. Redel. Revista granmense de Desarrollo Local. 2018;2(1):80–9.
16. Cárdenas Travieso RM, de la Fé Montenegro CF, Echevarría Hernández A, Ortiz Pérez R, Lamz Piedra A. Selección participativa de cultivares de garbanzo *Cicer arietinum* L. En feria de diversidad de San Antonio de los Baños, Artemisa, Cuba. Cultivos Tropicales. 2016;37(2):134–40.
17. Esquivel M. El cultivo de la soya en Cuba. 1997.
18. Martínez-Cruz M, Ríos-Labrada H, Ortiz-Pérez R, Miranda-Lorigados S, Acosta-Roca R, Moreno-Moreno I, et al. Metodología del Fitomejoramiento Participativo (FP) en Cuba. Cultivos Tropicales. 2017;38(4):132–8.
19. Ortiz Pérez R, Angarica L, Guevara-Hernández F. Beneficios obtenidos en fincas participantes en el Programa de Innovación Agropecuaria Local (PIAL) en Cuba. Análisis costo/beneficio de la intervención. Cultivos Tropicales. 2014;35(3):107–12.

20. Polar V, Babini C, Flores P. Tecnología para hombres y mujeres: Recomendaciones para reforzar la temática de género en procesos de innovación tecnológica agrícola para la seguridad alimentaria. Centro Internacional de la Papa: International Potato Center; 2015. 48 p.
21. FIDA. La mujer y el desarrollo rural [Internet]. Fondo Internacional de Desarrollo Agrícola; 2018 [cited 10/05/2019]. Available from: https://www.ifad.org/es/web/knowledge/publication/asset/39555772
22. Haan S de, Salas E, Fonseca C, Gastelo M, Amaya N, Bastos C, et al. Selección participativa de variedades de papa (SPV) usando el diseño mamá y bebé: una guía para capacitadores con perspectiva de género. [Internet]. Centro Internacional de la Papa.: International Potato Center; 2017 [cited 10/05/2019]. 82 p. doi:http://dx.doi.org/10.4160/9789290604754
23. Maqueira-López LA, la-Noval WT de, Roján-Herrera O, Pérez-Mesa SA, Toledo D. Respuesta del crecimiento y rendimiento de cuatro cultivares de soya *Glycine max*. (L.) Merril) durante la época de frío en la localidad de Los Palacios. Cultivos Tropicales. 2016;37(4):98–104. doi:10.13140/RG.2.2.17255.65447
24. Devani MR, Ledesma F, Sanchez JR, Gonzalez V, Ploper LD, Moa D, et al. Red de evaluación de cultivares de soja para el noroeste argentino: campaña 2012/2013. Estación Experimental Agroindustrial Obispo Colombres. 2013;15–45.
25. Salas DM, Santiesteban R, Fonseca R. Título: Evaluación de algunos componente del rendimiento en variedades de soya *Glycine max* L. Merri) en suelo Fluvisol de la provincia Granma. Granma Ciencia. 2015;19(2):1–6.
26. Ávila Concepción JM, Infante Miguel HR, Cabello Peña H. Evaluación de nuevos cultivares de soya en el municipio de Puerto Padre, Cuba. Investigación Agraria y Ambiental. 2014;5(2):31–9.
27. Akinbile CO. Assessment of the CERES-Rice model for rice production in Ibadan, Nigeria. Agricultural Engineering International: CIGR Journal. 2013;15(1):19–26.
28. Zonetti P da C, Suzuki LS, Bonini EA, Ferrarese MLL, Ferrarese-Filho O. Altas temperaturas, crecimiento y lignificación de soya transgénica resistente al glifosato. Agrociencia. 2012;46(6):557–65.
29. Vallejo Zamora Y, Pérez Castro T, del Pozo Núñez EM, Arozarena Daza N, López Labrada A. La capacitación agraria desde la visión del agricultor, en el municipio Boyeros, La Habana, Cuba. Cultivos Tropicales. 2016;37(2):149–54.