*Evaluation of seven soybean (*Glycine max*) cultivars under the edaphoclimatic conditions of the Majibacoa municipality, Las Tunas*

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ABSTRACT

The research was conducted in a cooperative of credits and services (CCS) of the Majibacoa municipality, Las Tunas province, in order to evaluate the productive performance of seven soybean (*Glycine max* (L.) Merrill) cultivars on a lixiviated Reddish Brown Fersialitic soil. The evaluated cultivars were: Jupiter, Conquista, BR-4, Canada, Inifat-382, Williams and Incasoy-1. A randomly block design was used, with four replications per treatment and 5 x 2-m plots with 1 m of distance between replications. Sowing was carried out at 4 cm of depth, with a distance of 0,50 m between rows and 0,10 m between plants. Two irrigations per week were applied and fertilization was used with a complete formula at the time of sowing, with doses of 80 and 100 kg of phosphorous and potassium/ha, respectively. Fifteen days after the emergence of plants, the maximum height was obtained in the cv. Jupiter and the lowest height in Canada. At 30, 45 and 60 days, Jupiter, Conquista and Inifat-382 were significantly higher than the other cultivars. The highest grain yield was obtained in cvs. Jupiter and Inifat-382 (2,11 and 2,19 t/ha, respectively) and the lowest, in Incasoy-1, which was in correspondence with its lowest number of pods per plant. It is concluded that the most outstanding cultivars were Jupiter and Inifat-382, because they achieved the highest plant height and the best grain yield; while the cv. Incasoy-1 was the one with the lowest yield.

Key words: evaluation, *Glycine max*, varieties

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is the main oil plant worldwide due to its high protein (35-50 %) and oil percentage (15-25 %), for which it constitutes a cheap and high-quality protein source, for livestock as well as for human feeding; from which the grain as well as the plant is used.

This crop is exploited in different parts of the world and it is a foodstuff that can contribute to the solution of nutritional problems in the tropical regions. The worldwide importance of soybean can be analyzed from its uses, production, quality, the protein cost and the favorable attributes it has. Overall, it has advantageously replaced different protein products, which include corn and fishmeal (Carrao and Gontojo, 1999).

Despite the multiple soybean uses, the industrialized world has not cared much for divulging or using this plant for feeding the billions of people who do not consume milk in Africa, Asia and a large part of Latin America (Morejón, 2008).

This crop occupied in 2007 a total production of 219,8 million tons of grain. United States is the biggest producer (32 % of the world production), followed by Brazil (28 %), Argentina (21 %), China (7 %), India (4 %) and other countries (8 %). In Cuba soybean is known since 1904; however, its production has not been stabilized. At present it is imported from Brazil, Argentina and some Asian countries, which forces to allocate numerous resources to acquire the grain and import large quantities –with the corresponding expenditure of foreign currency–, because it is an essential element for the intensive production of poultry and pork meat, and for milk, yogurt and oil production; as well as to complement other foodstuffs (Villalobar and Camacho, 2008). At these moments, the prices of this product in the market exceed US $565/ton.

The objective of this work was to evaluate the productive performance of seven soybean cultivars

(*G. max* (L.) Merrill), under the conditions of Majibacoa, Las Tunas, in order to search for new cultivars of higher grain productive potential and protein concentration.

MATERIALS Y METHODS

Location. The experiment was conducted in areas of the CCS Waldemar Díaz –in Los Guayos locality (Majibacoa municipality, Las Tunas province)–, during the period since November 28th, 2010 until March 5th, 2011, and under field conditions.

Climate and soil. During the research, the average temperature was around 23 °C; while rainfall was low, especially during the months from December to February, which contrasts with the high evaporation and relative humidity values found. Table 1 shows the principal climate indicators during the experimental stage.

The soil samples were taken before sowing at a depth of 20 cm. They were dried and sieved with a 2-mm net. The soil had a low organic matter content, slightly alkaline pH and adequate Ca/Mg + K ratio; while the phosphorous content was low and the cation exchange capacity reached moderate values (table 2).

Treatments and experimental design. Seven *G. max* cultivars were evaluated: Jupiter, Conquista, BR-4, Canada, Inifat-382, Williams-82 and Incasoy-1. A randomized block design was used, with four replications per treatment and 5 x 2 m plots were used with 1 m of distance between replications.

Procedure. The land preparation was carried out through the traditional method, using an oxteam with a moldboard plow and a creole plow to make the rows. For sowing seeds were used from the National Institute of Fundamental Research on Tropical Agriculture (INIFAT) and the National Institute of Agricultural Sciences (INCA), with 98 % of germination. This was manually done, at 4 cm of depth; with 0,50 m between rows and 0,10 m between plants.

The humidity conditions for the evaluated cultivars were maintained between 75 and 80 % of the field capacity, for which two irrigations were performed per week.

A whole fertilizer formula was manually applied on the bottom of the row, at the time of sowing. The used doses were: 80 and 100 kg of phosphorous and potassium/ha, respectively.

The harvest was manually carried out, during the maturity stage. The plants were exposed to sunlight to achieve good grain drying. The yield was determined from the total number of grains.

During the vegetative cycle the following measurements were made:

- Plant height (cm). It was measured 15, 30, 45 and 60 days after emergence, with a metric tape
- Number of pods per plant .The number of pods was counted in each plant.
- Number of grains per pod. The number of grains per pod was counted in 80 plants of each cultivar and the average was determined.
- Weight of 100 grains (g). The grains were weighed in an analytical scale.
- Yield per hectare. The yield obtained in each plot was taken into account and after that these data were transformed to yield in tons per hectare (t ha^{-1}).

Statistical Analysis. The obtained data were subject to a variance analysis of double classification and the means were compared through Duncan's

Table1. Average performance of the climate variables.

Variable/month	November	December	January	February
Temperature (°C)	25,00	21,10	23,40	24,10
Rainfall (mm)	7,50	1,30	2,50	2,70
Relative humidity (%)	95,00	94,00	96,00	94,00
Evaporation (mm)	165,16	145,27	161,18	191,52

Table 2. Chemical composition of the lixiviated Reddish Brown Fersialitic soil.

Depth (cm)	OM (%)	pH (KCl)	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	P_2O_5
			cmol (+) kg^{-1}				(ppm)
0-20	2,64	7,2	20,0	10,0	0,17	0,06	6,92

Source: Hernández, Pérez, Bosh and Rivero (1999).

test, for a 5 % probability error. The information was processed through the statistic software InfoStat, version 1.0 (Di Rienzo *et al.* 2001).

RESULTS AND DISCUSSION

Table 3 shows the plant height. Fifteen days after germination, the highest height was obtained in cv. Jupiter and the lowest one, in the Canada, which did not differ from cv. BR-4. The rest of the cultivars occupied intermediate positions in this indicator, although BR-4, Williams-82 and Incasoy-1 did not differ among themselves in this period. At 30, 45 and 60 days, Jupiter, Conquista and Inifat-382 were significantly higher than the other cultivars; BR-4 was significantly lower, although at 30 days it did not differ from Canada and Incasoy-1 or from Williams-82 cvs. after 45 days.

The obtained results could be related to the response of the different varieties to the photoperiod. According to Anwar *et al.* (2009), in the vegetative cycle of soybean plant height is one of the most affected indicators by day duration, and it varies according to the species, the latitude and season. In studies conducted by Ponce, Fé, Ortiz and Moya (2003), it was proven that in spring the plants can achieve a greater height. In tall cultivars height is a fundamental requisite, because it propitiates mechanized harvest and allows them to be more efficient to compete with weeds (FAO, 2011).

Regarding the yield components (table 4) it was observed that the lowest number of pods per plant corresponded to Incasoy-1 that differed statistically from the other cultivars, which did not differ among themselves. This cultivar also showed the lowest yield (1,30 t/ha), which coincides with the results

Table 3. Performance of the height in the evaluated cultivars.

Treatment	Plant height (cm)			
	15 days	30 days	45 days	60 days
Jupiter	13,82^{a}	26,86^{a}	43,25^{a}	47,88^{a}
Conquista	11,46^{c}	25,86^{a}	42,76^{a}	47,23^{a}
BR-4	8,53^{de}	12,56^{c}	18,26^{c}	21,26^{c}
Canada	7,71^{e}	13,50^{bc}	21,53^{bc}	26,47^{b}
Inifat-382	12,60^{b}	24,75^{a}	44,87^{a}	48,57^{a}
Williams-82	9,57^{d}	16,75^{b}	23,41^{bc}	26,40^{b}
Incasoy-1	8,84^{d}	16,30^{bc}	23,41^{bc}	27,62^{b}
CV (%)	6,50	12,30	15,20	9,30
ES ±	0,67	2,40	4,80	3,20

Means with unequal superscripts in a same column differ statistically at $p < 0,05$ (Duncan, 1955).

Table 4. Indicators of the reproductive phase of the soybean crop.

Treatment	Number of pods/plant	Number of grains/pod	Weight of 100 grains (g)	Yield t/ha
Jupiter	31,67^{a}	2,05^{bc}	17,45^{bc}	2,11^{a}
Conquista	31,70^{a}	2,20^{ab}	14,02^{ed}	1,77^{abc}
BR-4	25,87^{a}	2,05^{bc}	15,97^{cd}	1,52^{bc}
Canada	28,45^{a}	2,25^{a}	12,85^{e}	1,51^{bc}
Inifat 382	26,67^{a}	1,90^{c}	21,10^{a}	2,19^{a}
Williams-82	25,55^{a}	2,12^{ab}	18,87^{ab}	2,04^{ab}
Incasoy-1	17,00^{b}	2,07^{b}	18,20^{bc}	1,30^{c}
CV (%)	11,89	5,00	9,50	19,40
ES ±	5,68	0,10	1,60	0,35

Means with unequal superscripts, in a same column differ statistically at $p < 0,05$ (Duncan, 1955).

obtained by other authors (Díaz *et al*., 1985; Deulofeu, 1997; Ortiz *et al.,* 2004) who reported the existence of a relationship between the number of pods per plant and yield.

The studies conducted by Vega and Fuente (2008) proved that the fixation of the pods is delayed with temperatures lower than 22 ºC and ceases completely below 14 ºC. Thus, the favorable yields in cvs. Jupiter, INIFAT-382 and Williams-82 could be due to the fact that the temperatures had an optimum mean for the crop development (22,76 ºC). In this sense, Díaz, Medina, Ruiz and Serrano (2007) stated that those optimum means for soybean growth are between 20 and 30 ºC; and that the ones closer to 30 ºC are ideal for its development.

The number of grains per pod was higher in cvs. Canada, Conquista and Williams-82. These two last ones did not differ statistically from Jupiter, BR- 4 and Incasoy-1, and in all cases this number was higher than two. The lowest value corresponded to cv. Inifat-382 (1,90), without statistical differences with Jupiter and BR- 4.

Ortiz *et al.* (2008) stated that the number of grains per pod depends on each cultivar, because it shows high inheritability. On the other hand, Anon (2007) reported that the pods can contain between one and five grains, but they generally have two or three; which is in correspondence, in a certain way, with the results obtained in this research.

Regarding yield, significant differences were found among the cultivars. The best ones were Jupiter, Inifat-382 and Williams-82, with 2,11; 2,19 and 2,04 $t.ha^{-1}$, respectively; although this last one differed neither from cv. BR-4 nor from Canada. This result is related to the number of pods per plant and the weight of 100 grains, indicators that were not adequate in cultivar Incasoy-1, which caused a yield of only 1,30 t/ha. In the case of cv. Canada, the low weight of its grains (12,85 g) –which differed significantly from the other varieties– also determined it to have a relatively low yield. In this sense, Corbera and Núñez (2004) reported a range from one to 3 t/ha.

These results are lower than the ones informed by Linares (2009) in Guatemala. This author did not find statistic differences regarding the number of grains per pod and the weight of 100 grains, when evaluating different soybean cultivars in diverse places of the country; while the yield fluctuated between 2,9 and 3,7 t/ha. However, they are similar to the ones obtained by Díaz *et al*.; (cited by Alemán *et al*., 2005) and Zamora and Abdou (2007); in general, they coincide with the ones reported by Ortiz *et al*. (2004), who pointed out that in Cuba the weight of 100 soybean grains oscillates between 11,6 and 23,5 g and that there is a correspondence regarding weight of the grains and yield.

The low rainfall during the experimental period (14 mm in four months) had a high influence on crop growth and, thus, on the low yields obtained, together with other factors of the region climate (humidity and evaporation).

It is concluded that, for the soil and climate conditions of the region under study, the most outstanding cultivars were Jupiter and Inifat-382, because they achieved the highest plant height and the best grain yield; while cultivar Incasoy-1 had the lowest yield.

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