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RESPONSE OF THE GROWTH AND YIELD OF FOUR SOYBEAN (*Glycine max*. L.) DURING THE COLD SEASON IN LOS PALACIOS TOWN

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

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ABSTRACT. In the Technological Unit Scientist of Base belonging to the National Institute of Agricultural Sciences of Cuba four soybean cultivation were sowed, in three sowing dates with the objective of evaluating the behavior of their growth and yield. The experimental design was random of blocks with four repetitions and they were evaluated the agricultural yield, number of grains for sheaths, number of grains plant, number of sheaths for plant, dry mass of the sheaths, dry mass of the grains, dry mass of the air part, dry mass of the stems and the crop index, The results showed the cultivatrs DT-20 and DT-26 with the best behavior and it was evident the influence of the sowing date in the obtaining yield in spite of being carried out these in the same period.

Key words: dry matter content, cultivate, grains, crop index

RESUMEN. En la Unidad Científico Tecnológica de Base, perteneciente al Instituto Nacional de Ciencias Agrícolas de Cuba, se sembraron cuatro cultivares de soya, en tres fechas de siembra, durante la época de frio, con el objetivo de evaluar el comportamiento de su crecimiento y rendimiento. El diseño experimental fue de bloques al azar con cuatro tratamientos y cuatro réplicas y se evaluaron el rendimiento agrícola, el número de granos por vainas, el número de granos planta, el número de vainas por planta, la masa seca de las vainas, la masa seca de los granos, la masa seca de la parte aérea, la masa seca de los tallos y el índice de cosecha. Los resultados mostraron a los cultivares DT-20 y DT-26 como los de mejor crecimiento y rendimiento en las condiciones de estudio. También resultó evidente la influencia de la fecha de siembra en la obtención del rendimiento, a pesar de realizarse estas dentro de una misma época.

Palabras clave: contenido de materia seca, cultivar, granos, índice de cosecha

INTRODUCTION

Soybean (*Glycine max* L.) is one of the oldest cultures of mankind and it is the source of oil and vegetable protein most important in the world currently. The content of the grains is between 18 and 21 % oil and 38-40 % vegetable protein (1). In Cuba, Soy has been known since 1904; however, the country has not stabilized production. In the last 10 years it has imported from Brazil, Argentina and Asia, forcing to devote substantial resources to acquire the grain, which is an important component in the intensive production of poultry and pigs, production of milk, yogurt, oil and other food (2, 3).

The answer of soy in different environmental conditions is an aspect to consider in choosing cultivars with better adaptation to production regions and the adjustment of crop management practices (4). This

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presents physiological characteristics, conditions of handling and use, differentiating it from the rest of the most widespread crops, among which may be mentioned: a major photoperiodic response, high reproductive plasticity and seed production with high protein contents and oil (5). Therefore, to achieve stable returns over time or increase them, it is necessary to analyze the main factors that help determine the final crop yield is. To determine the influence of these and make a proper handling of them, they will generate an environment of high production and sustain soybean cultivation.

It is for all the above, it is extremely important to study the behavior of the performance of different soybean cultivars, for certain environmental conditions, since in most cases not taken into account the physiological factors that limit performance and its relationship to the behavior of the climate, so this work was developed with the objective of evaluating the growth and yield of soybean cultivars in Los Palacios town.

MATERIALS AND METHODS

the work was carried out in areas of the Scientific and Technological Base Unit (UCTB) Los Palacios, Pinar del Río, belonging to the National Institute of Agricultural Sciences (INCA). To this end, four cultivars of soybean (DT-20, DT-26, DVN-5, DVN-6), from the Socialist Republic of Vietnam, which are part of the genebank Research Institute Grain in Cuba were used. These materials were planted at different dates (December 2011, January 2012, December 2012), corresponding to the cold season on a Ferruginous Nodular Gley Hydromorphic petroferric soil (6). Some of the soil characteristics are described in Table I.

Table I. Some properties of the surface soil (0-20 cm) that characterize soil fertility where the experiments were developed

pH H_2O	Ca^{++}	Mg^{+}	Na^{++}	K^{+}	P_2O_5	MO
		cmol kg^{-1} soil			mg 100 g^{-1} of soil	(%)
6,49	7,01	3,13	0,16	0,23	20,47	2,72

Direct seeding technology to distances of 0,70 m between rows and 0,07 m between plants was used, with a standard of 50 kg ha^{-1} seed, about 24 seeds were deposited per linear meter to ensure at least 40 plants per square meter.

The plant breeding activities were carried out as recommended by the Technical Manual Farming of Soy[A]. The experimental design was randomized blocks with four treatments (cultivars) and four replications, experimental plots of 25 m^2. The behavior of the climate of the town, during the period that lasted experiments in each planting date, is shown in Figure 1. These data were reported by the Agrometeorology Station from Paso Real de San Diego in Los Palacios.

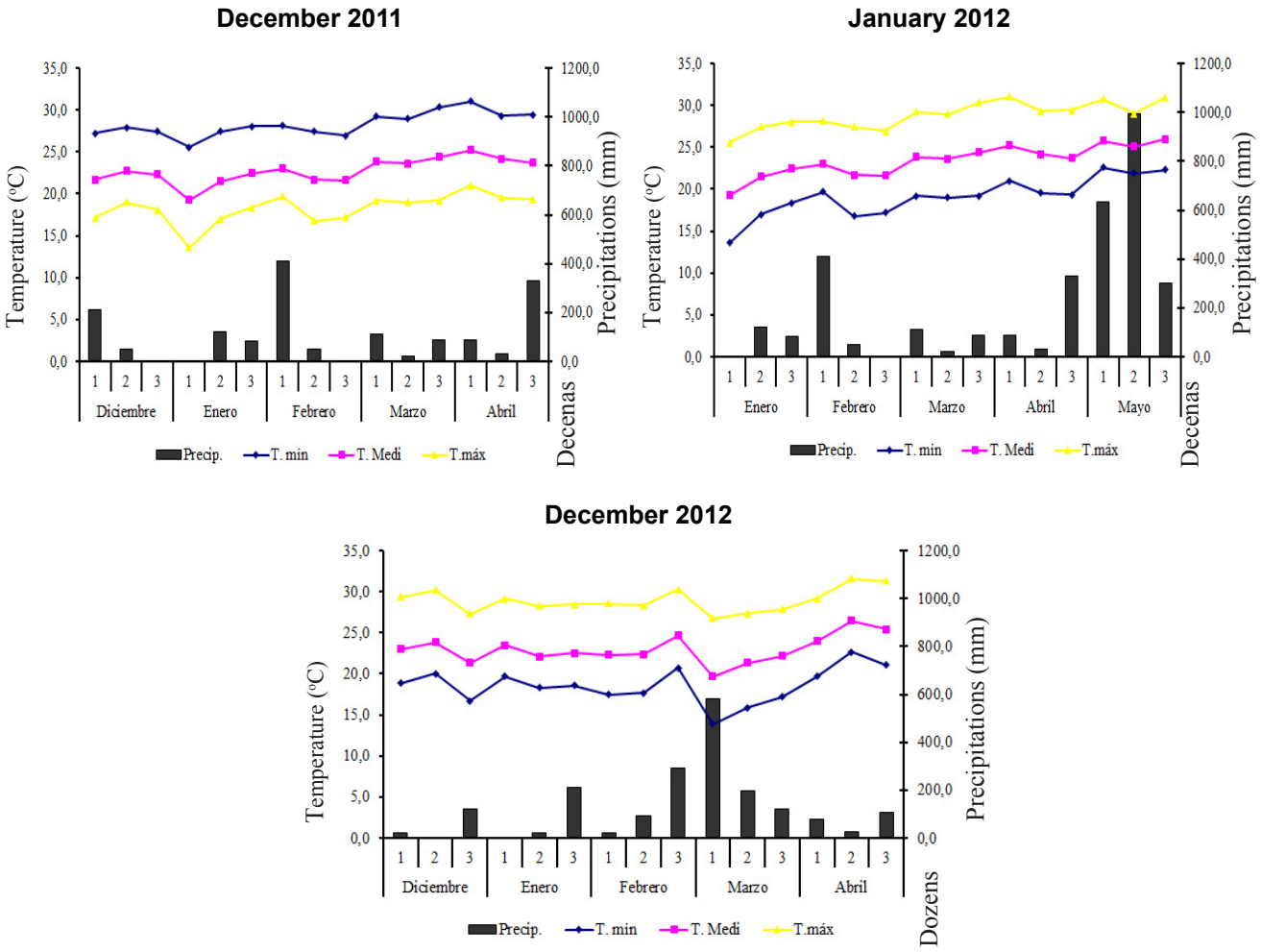
At the time of the harvest in each experimental plot agricultural yield (t ha^{-1}) to 14 % grain moisture (Yield P) in an area of 6 m^2 was determined. In addition ten representative plants were taken at random, always it took into account the border area and on each plant the following variables were evaluated:

- Dry mass of pods (M pods)
- Dry grain mass (M Grains)
- Dry mass total aerial part (total M)
- Dry mass of stems (M stalks (stems and dry leaves))
- Number of grains per pod (No Gr Pod)
- Number of grains per plant (No grains)
- Number of pods per plant (No pods)
- Mass of 100 grains (M mil)
- Harvest index (HI)

To determine crop yields were harvested 8 m^2 of the center in each plot, the plants are threshed and grains were dried to 14 % of moisture. As for the number of grains and number of pods, the value of each variable per plant and the number of grains per pod total grain between total was divided pods per plant was counted. For dry mass of parts of the plant (M pods, M beans, M stems and leaf), they separated each of the parties and kept in an oven for 72 hours at a temperature of 70 °C to constant weight.

The total mass (total M), was calculated by summing the dry mass of each individual organ. The HI was determined as the ratio of the dry mass of grains, between the dry mass of the aerial part of the plant at harvest time (dry mass of stems and leaves, pods dry mass). For the same planting date, each variable was performed an analysis of variance and significant differences between the means of the different treatments (cultivars) were compared by Tukey test at 95 % (7). In the case of yield and its components and Harvest Index confidence interval it was determined, taking into account the experimental error variance analysis and the statistical package Statgraphics 5.0 (8) was used.

[A] Esquivel, M. A. *El cultivo de la soya en Cuba. Manual Técnico*, 1997.



Data taken from the Agrometeorological Station of Paso Real de San Diego

Figure 1. Temperatures (maximum, average, minimum) and precipitation during the period of the experiments in the field

RESULTS AND DISCUSSION

The response of crop yield and its main components listed in Table II. Generally, these indicators varied among cultivars for the same sowing date and between dates. This variability may be related to the response of cultivars to the behavior of meteorological variables such as temperature and rainfall, which play a key role in crop productivity. On the date of January 2012 temperatures, typically, remained more stable during the cycle cultivars, planting in December 2011 and 2012 (Figure 1); something similar happened with precipitation to compare dates. Therefore, it became evident the influence of planting date on yield and its components, although plantings made within the same period.

In this sense, the literature highlights that the great variability of returns is closely related, in recent years the role of weather conditions in the definition of these indicators for a particular cultivar, something that helps explain how some cultivars respond better than others to the soil and climatic conditions of locality (9). Also developed research results indicate the influence of high temperatures (above 30 °C) in lower yields of some cultivars of soybean (10).

For agricultural yields are DT-20 and DT-26 cultivars of the best results, with respect to DVN DVN-5-6 and cultivars; generally, the highest values are reached in the sowing date of January 2012 (Table I). A similar response is observed in the number of pods per plant; however, the number of grains per pod is DT-26 cultivar the best result.

Table II. Range of performance components and crop yields (t ha^{-1}) at 14 % moisture content of grain, soybean cultivars (*Glycine max* L.) grown in the cold season

Cultivars	Number of pods	Number of grains per pod	Mass of 100 granos	Agricultural yield
December 2011				
Dt-20	34,4-41,5	2,0-2,5	20,1-24,7	3,3-4,7
Dvn-5	24,4-31,2	1,1-1,6	12,9-17,6	0,5-1,9
Dt-26	29,1-35,7	1,8-2,1	22,3-26,9	2,3-4,1
Dvn-6	20,7-27,4	1,1-1,6	21,6-26,3	0,9-2,3
Esx	1,7*	0,13*	11,86*	0,35*
January 2012				
Dt-20	50,7-65,5	1,7-2,0	19,2-22,2	4,0-5,5
Dvn-5	22,4-37,2	1,4-1,7	12,8-15,3	0,7-2,2
Dt-26	42,3-57,1	2,1-2,5	18,2-21,3	3,2-4,7
Dvn-6	24,7-39,5	1,8-2,1	18,3-21,4	1,8-3,3
Esx	3,8*	0,09*	7,70*	0,38*
December 2012				
Dt-20	37,8-46,8	1,7-2,5	17,0-19,8	2,9-3,9
Dvn-5	26,7-35,7	1,2-2,1	14,3-17,1	1,2-2,2
Dt-26	20,3-29,3	2,6-3,4	19,0-21,9	2,6-3,6
Dvn-6	21,2-30,3	1,0-1,8	19,3-22,1	0,9-1,9
Esx	2,31*	0,21*	7,18*	0,26*

Confidence interval at 95 % of probability calculated from the average taking into account the experimental error variance analysis

As for the mass of 100 grains, there are cultivars similar values, except the cultivation DVN-5 showing the lowest values.

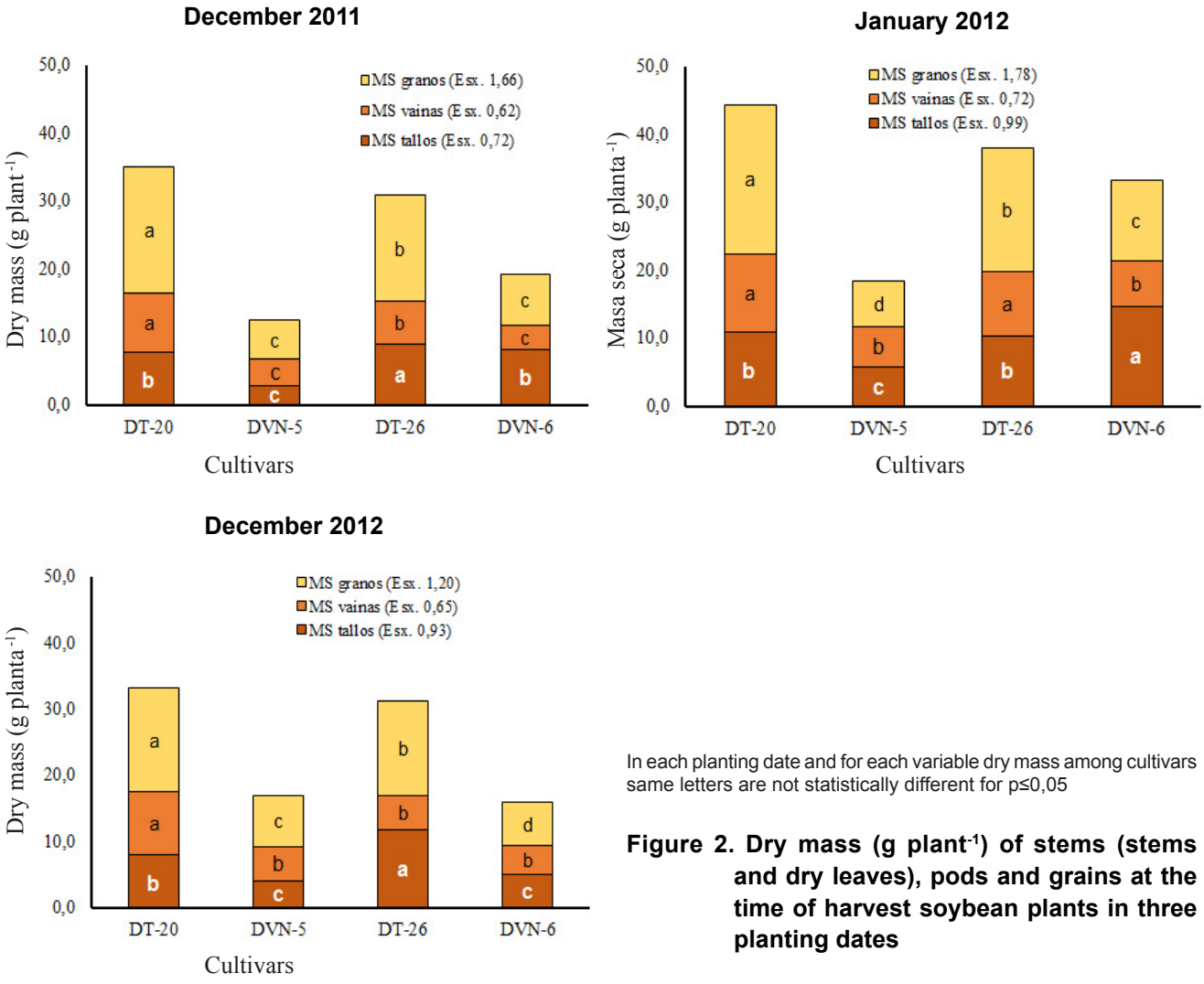
This variability that exists in cultivars that have higher values of a component and lower values on the other, for the same planting date, is given by the compensatory nature established among the components in crops where they have an important role cultivar characteristics, coupled with the growing conditions, elements which have also been highlighted by other authors (5, 11).

In Figure 2 the dry mass of stems, pods and grains at the time of harvest is shown. Generally, an influence of planting date on the values of dry mass that reached cultivars was found, as it is in January 2012 where it can see the highest values, something that is in line with the performance results analyzed previously. It also should be noted that in the three planting dates, cultivar DT-20 reaches the highest values of dry mass of grains and pods, followed by cultivating DT-26.

As for the dry mass of stems cultivar DT-26 is greatest dates in December 2011 and 2012; however, DVN-5 reaches the lowest values with statistically significant difference with the rest of cultivars in each planting date.

The differences observed among cultivars in planting dates, may be related to the characteristics of each cultivar, especially by the growth of plants under these conditions. There are cultivars that in the cold season or under certain circumstances, reach a smaller size, its leaves are smaller, among other features (10). These elements, coupled with a low photosynthetic activity, can bring lower production of dry mass (11).

In this sense, it is valid to note that the accumulation of biomass in a culture is given by the balance of carbon metabolism, considering that soy is a plant type C_3 where there are losses respiration and photorespiration mainly in the stages where increases air temperature (12). Moreover, while it is important to the production of total dry mass (biological productivity) of the plant, it is also necessary to ensure that part of the total production is destined for the economically useful plant (agricultural productivity) where the HI is a variable It indicates the difference between these two productions.

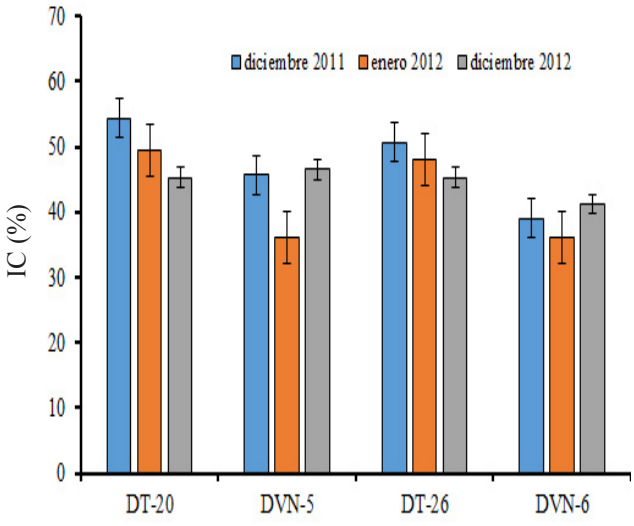


In each planting date and for each variable dry mass among cultivars same letters are not statistically different for p≤0,05

Figure 2. Dry mass (g plant^{-1}) of stems (stems and dry leaves), pods and grains at the time of harvest soybean plants in three planting dates

When analyzing the HI (Figure 3) can be seen that generally there are differences between cultivars and only the VN-5 and DT-20 show differences between planting dates. It is in January 2012 where DVN-5 reaches the lowest values, without differences with the cultivar DVN-6 in the same planting date.

In this sense, it is possible to note that there is a low efficiency in converting dry mass economically useful of these cultivars in these planting dates; aspect that may be related to genetic characteristics and response of the cultivar to conditions during its development, especially in the final stages of growth, where the date of January 2012 increased rainfall (Figure 1). In this regard, in the literature it is stated that the HI values vary between planting dates for the same cultivar and also stresses that may influence planting density and the prevailing weather conditions in the various stages of crop development (13).



The bars represent confidence intervals p≤0,05

Figure 3. Index crop soybean cultivars in three planting dates of the cold season

The importance of the HI to have a measure of the efficiency of the plant to certain weather conditions, especially in the use of light, water and nutrients in function of producing grains (14) are also highlighted. In studies in bean crops, the differences among cultivars evidence regarding the harvest index and how often, where higher value of this variable was achieved the highest yields (15) were found; aspect which is corroborated by the present study in soybean cultivation where, usually, cultivars lower yields, as shown in Table II (DVN-6 in all dates and DVN-5, mainly in January 2012) have the lowest values of HI. Moreover, other authors argue that to a certain date, the HI has an inverse relationship with the cycle length cultivars (16-18).

CONCLUSIONS

- From all the above we can conclude that there are variations mainly on the behavior of agricultural performance among cultivars and planting dates for the same period.
- The highest values of Harvest Index correspond to higher yields, something that can vary between cultivars and planting dates. In addition, DT-20 and DT-26 cultivars are the best growth and performance in the study conditions.

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