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EFFECT OF TEMPERATURES IN THE PERFORMANCE OF POTATO VARIETY ROMANO (*Solanum uberosum* L.)

Efecto de las temperaturas en el rendimiento de la papa (*Solanum tuberosum* L.) Variedad romano

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ABSTRACT. The work was developed in the farm "Las Papas", belonging to the National Institute of Agricultural Sciences (INCA); located at the 23^0 00' north latitude and 82^0 12' west longitude, to a height of 138 m above sea level in San José de las Lajas, Mayabeque. With the objective of evaluating the responses elicited in performance, product variations of temperatures during the crop cycle, the Roman variety plantations were made during the years 2014 and 2015, respectively. The behavior of the minimum temperatures, average and maximum and the amplitude of these was assessed. The total and commercial yield in t ha^{-1} and the composition of the tuber size was estimated. Statistical processing was performed with the use of Statgraphycs v5.1 program and graphics were performed using the Sigma Plot v3.1 program.

Key words: environmental conditions, ambient temperature, crop yield

RESUMEN. El trabajo se desarrolló en la Finca "Las papas", perteneciente al Instituto Nacional de Ciencias Agrícolas (INCA); situada a los 23^0 00´ de latitud norte y 82^0 12´ de longitud oeste, a una altura aproximada de 138 m sobre el nivel del mar en San José de las Lajas, Mayabeque. Con el objetivo de evaluar las respuestas provocadas en el rendimiento producto de las variaciones de las temperaturas durante el ciclo del cultivo, se realizaron plantaciones de la variedad Romano, durante los años 2014 y 2015, respectivamente. Se evaluó el comportamiento de las temperaturas mínimas, medias y máximas así como la amplitud de estas. Se estimó el rendimiento total y comercial en t ha^{-1} y la composición del tubérculo por calibres. Todo el procesamiento estadístico se realizó con el empleo del programa Statgraphycs v5.1 y los gráficos se realizaron con el programa Sigma Plot v3.1.

Palabras clave: condiciones ambientales, temperatura ambiental, rendimiento de cultivos

INTRODUCTION

The potato (*Solanum tuberosum* L.) is the fourth food crop in order of importance, after wheat, rice and corn. Coupled with these cereals, it has great relevance in the diet of the world population. It is among the ten most important foods produced in developing countries (1). According to statistics from the Food and Agriculture Organization of the United Nations (FAO), they indicate that almost 17,8 million ha of potato (*Solanum tuberosum* L.) A production close to 352,4 million tons and an average yield of 19,81 t ha^{-1} in 2011 (2). In Cuba, the potato is the first place among the roots and tubers, being planted each year around 5 664,0 ha $year^{-1}$, with an average yield of 22,5 t ha^{-1} and an annual production of 127 554,5 tons in the 2014-2015[A] campaign. However, the Roman variety achieved yields below these, according to the same report. Although it is planted in many geographical areas due to its great ecological plasticity (3), the ideal conditions for its production in Cuba are presented in a short period of time, in which temperatures are lower coinciding with the period between the months of December-April. For this reason, the crop cycle is reduced taking into account its edaphoclimatic requirements,

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[A] MINAG. *Informe Técnico de campaña de papa 2014-2015*. 2015, La Habana, Cuba, 60 p.

an effect that is also counteracted to some extent by locating the production areas in those most productive soils and in the coldest times of the year.

In other regions where climatic conditions are favorable, obtaining high yields in the crop depends on the productive potential of the cultivated varieties and the agrotechnical treatment or management made to them. However, in Cuba the temperature is a determining factor in the physiological development of the crop; so that it is necessary to evaluate performance behavior more and more, taking into account the variations that occur in this variable each year, which is the objective of this work.

MATERIALS AND METHODS

The work was carried out during the years 2014 and 2015 in potato plantations (*Solanum tuberosum* L.), in the experimental areas of the National Institute of Agricultural Sciences. For the study, the variety Roman was used, with tubers seeds greater than 45 mm, planted at 0,30 x 0,90 m, by means of a sample design. The irrigation was applied by spraying in a mechanized way, by means of a Pivot Central machine, the rest of the cultural attentions were made according to the Technical Instructions for this crop (4).

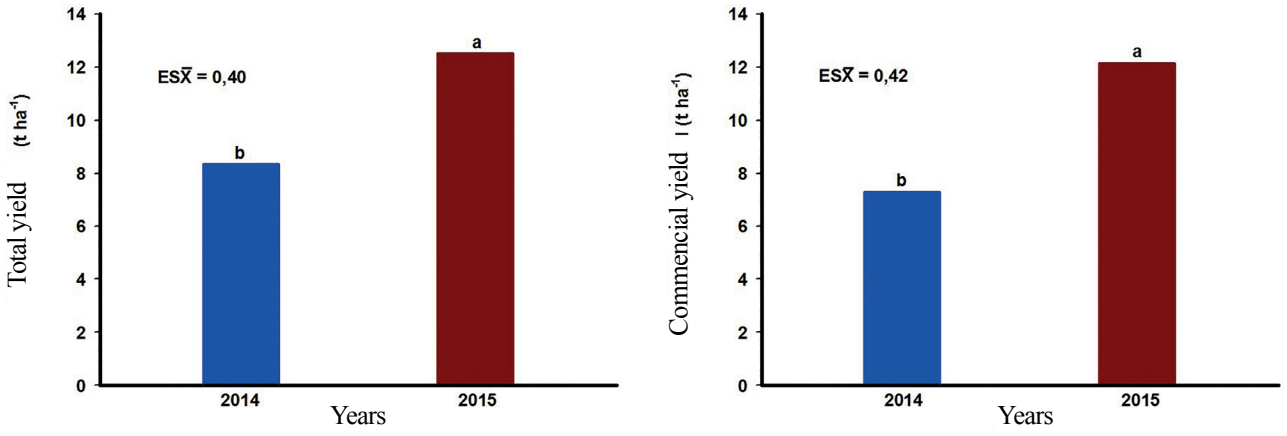
The data of the temperatures (minimum, average and maximum) were obtained from the records made in the Meteorological station near the experimental area (less than 1 km distance), with which the amplitude of the same were determined. The difference between the maximum and minimum daily from the means the effective temperature with which the phase by phase was calculated, considering Phase 1 from the planting to the beginning of the tuberization (30 DAP), Phase 2 from the beginning of the tuberization until the end Of foliage growth 70 DAP) and Phase 3 from this time to harvest. At the end of the harvest the total and commercial yield (> 55 millimeters) in t ha-1 was determined, as well as the composition of the same by the calibers, expressed in the percentage of the total mass, being these variables evaluated of the variables . All statistical processing was performed using the Statgraphy v5.1 (5) program and the graphs were performed using the Sigma Trama v3.1 program.

RESULTS AND DISCUSSION

Figure 1 shows the total and commercial yield during the evaluated years. In both cases, there were significant differences, with the year 2015 achieving the highest total and commercial yield (12,5 t ha^{-1}). Similar values have been achieved for this variety in previous studies (6).

Temperatures are an important factor within the present climatic conditions, with a great influence on the behavior of the yields, they exerted a smaller influence in the year 2015 to show the greater values, although for the region in which the Study, the variety used in this work, its yields averaged around 18 t (1).

[B] Aldabe, L. y Dogliotti, S. *Bases fisiológicas del crecimiento y desarrollo del cultivo de papa (Solanum tuberosum L.)*. Ed. Universidad de la República, 1996, Montevideo, Uruguay



Means with different letters above the bars represent significant differences among treatments, according to Duncan test at p <0.05

Figure 1. Behavior of Total and Commercial yield (t ha-1) during the study years

However, even when environmental conditions are adequate for the development of the crop, it is also possible to find low yields, which depends on the cultural attention (especially the nutrition) given to the crop[C].

As can be observed in Figure 2, in the year 2014 the maximum temperatures showed higher values, staying longer in that condition. The averages reported for both years surpass those established as optimal (15 - 20 ^{0}C), although some varieties yield the maximum with higher temperatures (7), which is not the case of the variety used, considering their behavior in the potato areas of the country.

On the other hand, it is argued that plants cannot escape the adverse conditions that may arise continuously, but adapt their growth and development to that changing environment (8, 9).

The high and low temperatures greatly influence the respiratory loss and the development of the initial foliage of the crop (10). Therefore, the phenological prediction based on the thermal time is an alternative to predict the different phenological stages of the potato crop with respect to the environmental conditions of the study area, which allows determining the application of agricultural inputs as well as the timely implementation of cultural work

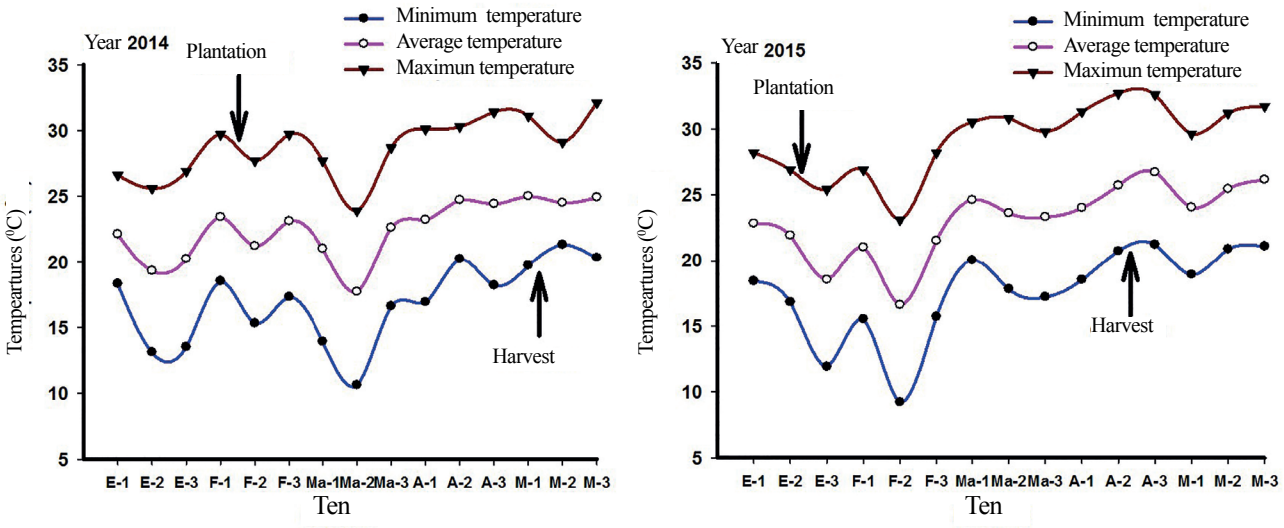
In addition, the temperature effect on crop development is evaluated with the thermal integral, also known as the day of development (11). This variable relates the ambient temperature to the phenological stages of the crop and allows predicting when one of them will occur.

It is proposed that the knowledge of the thermal requirements for each phenological stage represents practical and agronomic advantages that allow to optimize the use of inputs and to plan the potato crop under different climatic conditions (12).

The greatest influence of this meteorological variable on the crop lies in the range of amplitude that occurs between maximum and minimum temperatures (Figure 3). The evaluated years present a good behavior in this indicator, standing out the year 2015 since the fluctuations of amplitude between the minimum and the maximum were greater during the first stages of the growth and development of the tuber; which favors the yields achieved, unlike the year 2014 when at that time the fluctuations were lower, in this aspect stands out the year 2015 because the temperatures were also lower.

In addition, it can be inferred that greater amplitude of these in the period corresponding to the end of the crop cycle, allowed a greater translocation of dry matter to the tubers, which favored the increase of the yields in the year 2015, as it had been analyzed. It is important to note that biomass in crops such as potato is the sample of all the potential of photosynthesis and accumulation of assimilates of the plant (13), which ultimately is the element responsible for the yields reached.

[C] Punina, A. E. I. *Evaluación agronómica del cultivo de papa (Solanum tuberosum) C.V. Fripapa, a la aplicación de tres abonos completos* [en línea]. Tesis de Diploma, Universidad Técnica de Ambato, 2013, Ecuador, 70 p., [Consultado: 19 de diciembre de 2016], Disponible en: <http://repositorio.uta.edu.ec/bitstream/123456789/6532/1/Tesis-69%20%20%20Ingenier%c3%ada%20Agron%c3%b3mica%20-CD%20210.pdf>.



The arrows in the graph indicate the date of planting and harvesting of the crop

Figure 2. Behavior of maximum, average and minimum temperatures during the two years of study

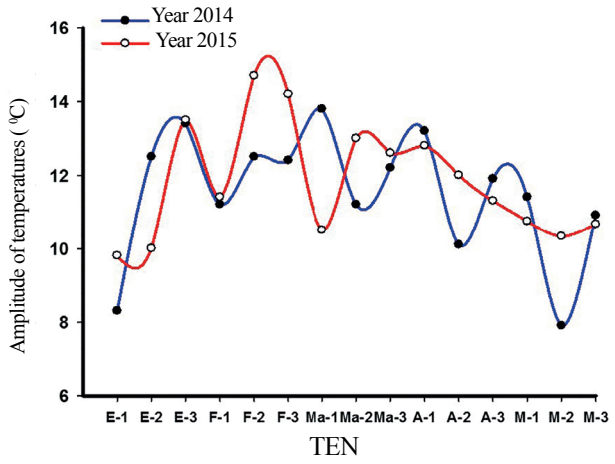
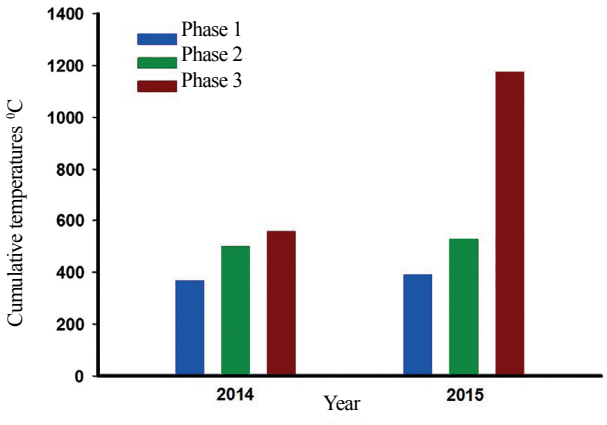


Figure 3. Thermal amplitude of the temperatures during the two years of study

In studies carried out in relation to climate change in Latin America and its influence on the agricultural sector and the production of potato crop in specific, it is expected that for the period 2010-2040, the productivity of this crop will be reduced between 10 and 19 %, if no adaptation measures are incorporated (14), which may be related to the use of varieties tolerant to high temperatures, in which work is currently being carried out with great intensity (15).

Assuming that each stage of development of a crop requires a minimum accumulation of temperature to reach its end and that the plant can move to the next phase, the accumulated temperature sums for each of the phenological phases are presented in Figure 4 (16) considered in the two years of study.



Phase 1 (from planting to 30 days (beginning of tuberization)), Phase 2 (from start of tuberization to end of foliage growth (70 days)) and Phase 3 (from this time to harvest)

Figure 4. Cumulative temperature per phase of the crop during the evaluated years

It is denoted in 2015 a similar behavior to the year 2014 in terms of the temperature magnitude accumulated in the first two phases, but not in the third, which corresponds to the end of foliage growth until the harvest, which had a longer duration in 2015, which led to higher yields.

The behavior observed in 2014 is no more than the effect of the environmental conditions that occurred that year in terms of the effect of temperatures, which caused the senescence of the foliage in a shorter time (17); So that the thermal requirements in that year did not meet the needs of the crop. The growth rate of tubers is affected even though in the early stages good development and considerable biomass accumulation has been achieved[D].

It is also known that the behavior of the biomass accumulation in potato, as in other plants, is sigmoidal reason why it is wanted that the tuberization stage is lengthened so that a greater mobilization of assimilates to the final sink, that are the tubers.

Figure 5 presents the percentage of yield with respect to the total in the different sizes of tubers considered. In the case of the year 2014 and in correspondence with the yield for that plantation no percentage was found in tubers of greater caliber (55 mm), which does not guarantee that the yields are superior to those found.

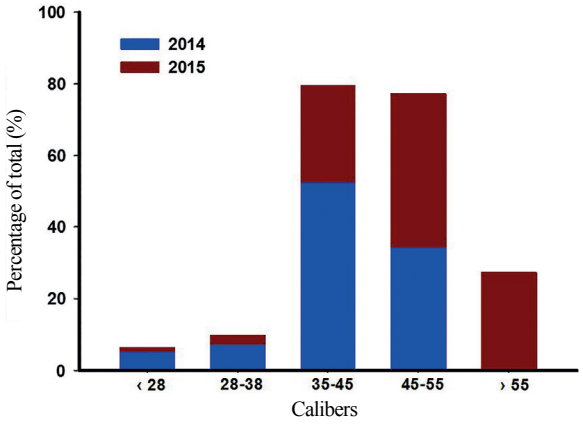


Figure 5. Percentage of the yield with respect to the total in the sizes considered during the two years

[D] Rojas, B. E. O. *Evaluación del desarrollo del cultivo de papa bajo escenarios de variabilidad climática interanual y cambio climático, en el sur oeste de la Sabana de Bogotá* [en línea]. Tesis de Maestría, Universidad Nacional de Colombia, 2011, Colombia, 158 p., [Consultado: 20 de octubre de 2015], Disponible en: <http://www.bdigital.unal.edu.co/5242/1/edwinoswaldorojasbarbosa.2011.pdf>

In contrast, in the year 2015 the highest percentage in terms of mass was found in gauges above 45 mm, being low in the first two sizes, all of which is a reflection of the yield that reached the plants in both plantations. The weight of commercial tubers was similar in both years, although not in the size of the tubers. It has been verified that this one has a high correlation with other variables related to the growth of the plant as it is the case of the height (18).

In the work it was verified that the date of sowing plays an important element due to the conditions of the prevailing environment, which modified the development of the crop.

Another important aspect is the study and behavior of the performance in different environments because of the importance it has to define selection criteria looking for clones that are more productive and of higher quality tolerant to high temperatures (19, 20). In another sense, temperature is the most important factor to take into account because it induces development through the different phases of the crop, from emergence to flowering and maturity.

CONCLUSION

According to the results, potato cultivation is shown to be extremely sensitive to environmental changes (with higher temperature effect). Therefore, in the presence of temperatures above the optimum, the growth patterns are modified in terms of the duration of the different phenological phases, greatly influencing the yields achieved, while reducing the number of tubers in the larger calibers.

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