Article

Productivity of two Mexican potato genotypes in perlite and aggregates in hydroponics and greenhouse

Francisco Xavier Flores Gutiérrez[1]
Román Flores López[2§]
Martha Elena Mora Herrera[1]
Omar Franco Mora[3]

[1]University *Campus*-Tenancingo University Center-Autonomous University of the State of Mexico. Tenancingo-Villa Guerrero Road, Santa Ana Ixtlahuatzingo km 1.5, Tenancingo, State of Mexico CP. 52400. Tel. 714 1407724. (fxfloresg@uaemex.mx; marthaelenam@gmail.com). [2]Metepec-INIFAP Experimental Site. Toluca-Zitácuaro Highway km 4.5, Adolfo López Mateos Road, Col. San José Barbabosa, Zinacantepec, State of Mexico. CP. 51350. Tel. 55 38718700, ext. 85638. [3]Faculty of Agricultural Sciences-Autonomous University of the State of Mexico-*Campus* 'El Cerrillo' University. El Cerrillo Piedras Blancas, Toluca, State of Mexico. CP. 50200. Tel. 722 2965529. (ofrancom@uaemex.mx).

[§]Corresponding author: flores.roman@inifap.gob.mx.

Abstract

In order to determine the productive response of two Mexican potato genotypes in two substrates in the hydroponic cultivation system, three experiments were established with horticultural grade perlite and with the mixture of perlite with peat 1:1 v/v (aggregates), by what experiments were established in the autumn 2015, spring 2016 and summer 2016 cycles. With perlite, the Citlali variety and clone 99-39, produced on average 15.92 and 34.25 tubers per plant, respectively; in aggregates they produced 11.92 and 15.42 tubers per plant, respectively. Genotype 99-39 exceeded Citlali by up to 10.9 tubers per plant on average of the three crop cycles and produced 2.2 times more tubers in autumn than in spring, as well as 2.9 more tubers in autumn than in summer. Citlali produced 3.6 times more tubers in autumn than in summer and five times more in autumn than in spring. The most efficient substrate was horticultural grade perlite, clone 99-39 was more productive than the Citlali variety, the production of tubers in both genotypes was closely affected by the season of the year and the results will allow decisions on the management of the production of prebasic seed II in both genotypes.

Keywords: aggregates, perlite, prebasic seed II, tuber.

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Introduction

The production of potato mini-tubers in the greenhouse is aimed at increasing propagation material with high phytosanitary quality (Struik, 2008) and the formal scheme of potato seed production in Mexico considers a greenhouse multiplication stage, where the Pre-basic category II, described in Official Mexican Standard NOM-041-FITO-2002 (SENASICA, 2015) and corresponds to mini-tubers obtained from seedlings or mini-tubers free of pests and diseases, increased in appropriate conditions to preserve their degree of purity, quality phytosanitary and adequate physiological characteristics.

Peat is the main substrate used by farmers producing potato seed in the prebasic category II in Mexico (Arellano *et al*., 2010; Patron, 2014; Flores López *et al*., 2014); however, Flores López *et al*. (2016) mention other organic substrates in the production of mini-tubers, such as coconut fiber, rice husk and inorganic such as tezontle, perlite, sand and gravel; mixtures of organic and inorganic substrates are called aggregates (Resh, 2006).

Hydroponics is an alternative for the production of mini-tubers under controlled conditions (Lommen, 2008) and there are alternatives to land use (Wheeler *et al*., 1990; Farran and Mingo Castel, 2006; Corrêa *et al*., 2009; Chang *et al*., 2011; Chang *et al*., 2012; Mateus-Rodríguez *et al*., 2013.

The comparison of greenhouse mini-tuber production systems has been reported by Muro *et al*. (1997); Medeiros *et al*. (2002); Tierno *et al*. (2013); in addition, Lommen (2008) points out that hydroponic techniques for the production of mini-tubers have a lower risk of the presence of pathogens present in the soil or organic substrate such as peat, sawdust, coconut fiber, rice husk, among others; they can also be used alone or in mixtures (aggregates) in different volume/volume ratios (v:v).

Inert and organic substrates act as root anchors and as a reservoir of the nutrient solution; hydroponic agriculture is based on cultivation with or without soil, in different classifications (Urrestarazu, 2013); also, the varietal response to hydroponic systems and substrates is not consistent, quite the contrary, it is diverse and there are differences and interactions system-variety and substrate-cultivar (Muro *et al*., 1997; Corrêa *et al*., 2008; Tierno *et al*., 2013). Greenhouse crops also allow reducing the effect of pests and diseases (Adams, 2004), an essential requirement for the production of pre-basic potato seed II; however, it is necessary to consider the availability of substrates and the adequate sterilization of this resource.

In Mexico, organic substrate mixtures are used successfully in the production of potato mini-tubers (Rubio *et al*., 2000; Arellano *et al*., 2010). The open hydroponic system has been evaluated and used by Rolot and Seutin (1999); Ritter *et al*. (2001); Corrêa *et al*. (2008) with variable responses, compared to other closed systems.

Flores-López *et al*. (2016) reported the effect of nutrition on the production of mini-tubers of advanced clones of the potato program of the National Institute of Forestry, Agricultural and Livestock Research (INIFAP), in an open hydroponics system and with horticultural grade perlite and given the differential response of the potato cultivars in greenhouse hydroponic systems, the objective of the present work was to determine the productivity of two potato genotypes in the production of mini tubers with two substrates in the hydroponic system.

Materials and methods

Three experiments with two cultivation substrates and two Mexican potato genotypes were established in the autumn-winter cycles on November 10, 2015 (autumn), spring-summer on March 30, 2016 (spring) and in the summer-autumn cycle, on August 26, 2016 (summer), in greenhouses and facilities of the National Institute of Forestry, Agricultural and Livestock Research, located with geographical reference of 10° 17' 28'' north latitude and 99° 42' 51'' west longitude (SMN, 2017) and temperate climate with rains in summer, with precipitation between 800 and 1 000 mm, at an altitude of 2 726 meters above sea level (INEGI, 2009).

The substrates evaluated were horticultural grade perlite and the commercial control, a mixture of horticultural grade and peat perlite in a 1:1 v/v ratio, which will be called aggregates in this study; all in hydroponic system. 1.8 L pots were used, using a belt and drip irrigation system every 15 cm, to maintain moisture and distribute the nutrient solution. The population density was 36 plants per square meter and 10 irrigations per day were programmed in the perlite substrate and in aggregates the nutrient solution was supplied every two days, as is done commercially. During the development of the crop fungicides and insecticides were applied for the preventive control of pests.

The Mexican potato materials were clone 99-39 of white cuticle, oblong shape and cream pulp, semi-late cycle and Citlali variety, red cuticle, round shape and yellow pulp, early cycle. The nutritive solution used was N= 200, P= 80, K= 350, Ca= 100 mg L^{-1}, plus microelements (Flores-Gutiérrez *et al*., (2018) and Flores-López *et al*., 2016). The greenhouse temperature was recorded with a HANNA Data logger model HII4ICH CE IP67® thermometer, in the autumn-winter cycle the average temperature was 15 °C, with a maximum of 35 °C and a minimum of -2 °C; in the spring-summer cycle the average temperature was 22 °C, with a maximum of 46 °C and the minimum of 8 °C, while in the summer-autumn cycle the average was 20 °C, with a maximum of 40 °C and the minimum of 4 °C. The tubers used were selected with a diameter between 15 and 18 mm, disease-free and a single shoot, were seeded at a depth of 10 cm, on the same date, for both substrates.

The experiments were established under an experimental design of randomized complete blocks with four repetitions nested in the systems and the statistical analysis was carried out as a series of experiments in which the significance of the cycles, culture systems, clones of potato and the interaction between them; when the F test of the variance analysis showed statistical differences, the Tukey test (DMSH) was applied at a significance level of 0.05.

The study variables were: SPAD values, measurement that was performed with a Konica Minolta® SPAD-502, foliar area index (IAF), determination that was made with a Linear Ceptometer model LP-80AccuPAR® and plant height; These three measurements were made at 30, 60 and 90 days after sowing (dds).

At harvest, the number of tubers less than 15 mm in diameter per plant, the number of tubers equal to or greater than 15 mm in diameter per plant, the number and weight of total tubers per plant, the dry weight of tubers per plant were evaluated, the total dry weight per plant and the harvest index. To determine these values, eight plants with complete competence of each system and repetition were sampled and to estimate the dry weight a sample drying oven was used at a temperature of 75 °C, until constant weight was obtained (Flores-López *et al*., 2016). Statistical determinations were made with the statistical package InfoStat (Di Rienzo *et al*., 2015).

Results and discussion

SPAD values, leaf area index and plant height

The greenness index (SPAD) of the genotypes was relatively constant for each of the clones throughout the crop cycle and in the three planting seasons, in general, the Citlali variety had statistically higher SPAD values ($p \leq 0.05$) a those registered for clone 99-39, which is due to the phenotypic characteristics of both cultivars, Citlali has more intense green color in its foliage (46.25 [a], 46.96 [a] and 46.96 [a]) than the hue of clone 99-39 (44.68 [b], 44.85 [b] and 44.41 [b]), in the combined analysis.

In the Table 1 shows the values of the green index for the interaction cycle x substrate x genotype; while the combined analysis indicated higher SPAD values in the perlite substrate than, in aggregates, at 90 days after sowing, on average (Table 2), this result was probably due to the fact that the nutrient supply was constant in perlite, while in aggregates it was provided every two days, with values of 46.79 [a] for perlite and 43.48 [b] for aggregates.

Table 1. Averages of SPAD values in the interaction cycle x substrate x genotype at 30, 60 and 90 days after sowing. Two genotypes, two substrates and three growing seasons.

Cycle	Substratum	Genotype	Greenness index (SPAD)		
			30 dds	60 dds	90 dds
Autumn-Winter	Perlite	Clone 99-39	47 [bc*]	46.3 [abc]	47.4 [ab]
		Citlali	45.8 [bcd]	47.3 [ab]	47.4 [ab]
	Aggregates	Clone 99-39	47.4 [b]	47.5 [ab]	49.9 [abc]
		Citlali	52.5 [a]	50.7 [a]	51.5 [a]
Spring-Summer	Perlite	Clone 99-39	45.8 [bcd]	46.6 [abc]	44.7 [bcde]
		Citlali	47.5 [b]	47.5 [ab]	47.2 [ab]
	Aggregates	Clone 99-39	43 [cde]	43.7 [bc]	41.4 [cde]
		Citlali	42.7 [de]	43.5 [bc]	42.8 [bcde]
Summer-Autumn	Perlite	Clone 99-39	47.7 b	44.0 [bc]	46 [abcd]
		Citlali	47.9 [b]	50.1 [a]	48 [ab]
	Aggregates	Clone 99-39	37.3 [f]	41.1 [c]	40 [e]
		Citlali	51.2 [ef]	42.8 [bc]	40.7 [de]

[*]= Values with different letters are statistically different ($p < 0.05$) according to the Tukey test.

Table 2. Combined analysis. Average values ±standard error of the mean and statistical differences is shown for the main variables evaluated in two Mexican potato genotypes in two substrates and three crop cycles.

Variable	Average per plant ±standard error		Coefficient of variation (%)	Tukey (0.05)
	Perlite	Aggregates (peat + perlite)		
SPAD values 90 dds**	46.79 a* ±0.36	43.88 b ±0.96	4.73	0.94
IAF 90 dds	5.96 a ±5.88	4.67 b ±0.31	6.41	0.33
Plant height 90 dds	80.08 a ±0	55.96 b ±0	7.23	2.98
Tubers < 15 mm	3.88 a ±0.41	1.88 b ±0.24	32.28	0.55
Tubers ≥ 15 mm	25.08 a ±3.27	13.67 b ±2.18	11.23	1.56
Total tubers per plant	29 a ±3.47	15.46 b ±2.33	8.56	1.91
Fresh weight of tubers per plant	236.05 a ±21.6	169.58 b ±12	10.15	8.72
Dry weight of tubers per plant	31.36 a ±2.81	25.82 b ± 2.55	10.21	2.03
Total dry weight per plant	41.97 a ±4.11	33.73 b ±3.64	17.43	3.56
Harvest index	0.76 a ±0.01	0.77 a ±0.01	2.86	0.02

*= values with different letters are statistically different ($p < 0.05$) according to the Tukey test. **= days after sowing.

The average foliar area index of the two genotypes was not statistically different, in the combined analysis throughout the crop cycle; however, when the substrates evaluated were compared, the value of IAF in perlite was higher ($p \leq 0.05$) in perlite (5.96 a) than in aggregates (4.67 b), at 90 dds (Table 1).

In the Table 3 shows the response of genotypes in the three growing seasons, it is evident that spring-summer, when the average temperature was higher (22 °C) the plants of both genetic materials showed greater leaf area, especially when they were planted in perlite.

Table 3. Foliar area index averages in the interaction cycle x substrate x genotype at 30, 60 and 90 days after sowing. Two genotypes, two substrates and three growing seasons.

Cycle	Substrate	Genotype	Foliar area index		
			30 dds	60 dds	90 dds
Autumn-Winter	Perlite	Clone 99-39	2.57 bc*	4.7 abcd	5.79 bcd
		Citlali	1.82 c	3.66 de	5.61cd
	Aggregates	Clone 99-39	2.56 bc	3.99 cde	6.05 bc
		Citlali	1.82 c	3.52 de	5.58 cd
Spring-Summer	Perlite	Clone 99-39	3.1 b	4.58 abcd	6.53 b
		Citlali	2.85 bc	5.15 abc	7.65 a
	Aggregates	Clone 99-39	2.45 bc	4.25 bcde	5.38 cd
		Citlali	2.55 bc	4.55 abcd	5.7 bcd
Summer-Autumn	Perlite	Clone 99-39	4.63 a	5.63 a	5.13 d
		Citlali	2.63 bc	3.08 e	2.6 e

*= values with different letters are statistically different ($p < 0.05$) according to the Tukey test.

Plant height had a differential response for genotypes; clone 99-39 had an average height of 31 [a], 55 [a] and 72 [a] cm, against 28 [b], 50 [b] and 64 [b] cm, at 30, 60 and 90 days after sowing (Table 4); that length, in centimeters, was statistically greater ($p \leq 0.05$) when the culture was done in perlite (80 [a]) than when it was carried out in aggregates (56 [b]), according to the results of the combined analysis shown in Table 1. Both Foliar area index, such as plant height were statistically higher in perlite, compared to the values recorded in the substrate mix, probably due to the frequency of supply of the nutrient solution.

Table 4. Plant height averages in the interaction cycle x substrate x genotype at 30, 60 and 90 days after sowing. Two genotypes, two substrates and three growing seasons.

Cycle	Substrate	Genotype	Plant height (cm)		
			30 dds	60 dds	90 dds
Autumn-Winter	Perlite	Clone 99-39	32.5 [abc*]	48.3 [c]	66 [d]
		Citlali	35 [ab]	43 [cd]	53.8 [de]
	Aggregates	Clone 99-39	21.8 [cd]	41 [cde]	52.3 [e]
		Citlali	18 [d]	36.8 [de]	45.8 [e]
Spring-Summer	Perlite	Clone 99-39	37.3 [a]	85.5 [a]	133.8 [a]
		Citlali	31.5 [abc]	77 [ab]	120 [b]
	Aggregates	Clone 99-39	33 [ab]	77.3 [ab]	97 [c]
		Citlali	29 [abc]	71.5 [b]	85 [c]
Summer-Autumn	Perlite	Clone 99-39	38.3 [a]	46.8 [d]	53.8 [de]
		Citlali	29.5 [abc]	45.5 [cd]	43.3 [de]
	Aggregates	Clone 99-39	25.5 [bcd]	30.3 [ef]	29.8 [f]
		Citlali	24.5 [bcd]	23.8 [f]	26 [f]

[*]= values with different letters are statistically different ($p < 0.05$) according to the Tukey test.

Tuber production per plant

In general, there was greater potato production when it was grown in horticultural grade perlite for both cultivars (Table 2). The number of tubers smaller than 15 mm in diameter did not show statistical differences between production cycles, but there was a genotype effect, since clone 99-39 produced, on average, 3.8 [a] mini-tubers and the Citlali variety 2 [b]. In the cycle x substrate interaction, more small tubers were produced in perlite than in aggregates, considering the three cycles.

The fact that in perlite the plant produced more tubers with a diameter of less than 15 mm, was probably due to the availability of nutrients continuously, which was quantified with the number of total tubers per plant. The foregoing coincides with that indicated by Minhas *et al*. (2004), who report higher tuber production with greater availability of assimilates.

Genotypes grown in horticultural grade perlite, in the hydroponic system, produced an average of 25.08 tubers equal to or greater than 15 mm in diameter per plant, 83% higher than that recorded in the aggregate substrate (13.67 tubers), which coincides with as reported by Adams (2004), who reports that yields are lower in organic substrates than in inorganic substrates in hydroponics, in addition to considering the continuous supply of the nutrient solution in the pelite substrate and the supply of nutrients every two days in the substrate aggregates. Clone 99-39 had a productivity per plant of 24.83 minitubers larger than 15 mm in diameter, statistically superior yield ($p\leq 0.05$) to that obtained by the Citlali variety with 13.92 tubers per plant; all this, on average of the three cycles and two substrates.

On the other hand, there were more mini-tubers of size equal to or greater than 15 mm in diameter in the autumn-winter cycle 35.06 [a], compared to that obtained in spring-summer (12 [b]) and summer-autumn (11.06 [b]), on average of the two cultivars in the two substrates. The potato is known to have a higher yield when the difference between the maximum and minimum temperatures is high and the night temperature is less than 18 °C, which occurred in the autumn-winter cycle, with an average of 15 °C, a maximum from 35 °C and minimum of -2 °C as well as the night temperature is cool in November and December; which coincides with that indicated by Beukema and Van der Zaag (1990).

When comparing the tubers per plant produced by the genotypes included in this study, it was found that clone 99-39 produced statistically ($p\leq 0.05$) more tubers per plant than the Citlali variety, with 24.83 and 13.92, respectively. Likewise, the response of the genotypes in the three production cycles, it was found that clone 99-39 generated, on average per plant, 34 minitubers equal to or greater than 15 mm in diameter, with perlite; however, the productivity of that clone was significantly reduced ($p\leq 0.05$) when grown in aggregates, where it only produced 15.41 tubers per plant of the indicated dimensions (Figure 1), the Citlali variety produced 15.9 tubers of equal size per plant or greater than 15 mm in diameter, when cultured in perlite and 11.9 in aggregates; these figures, for the second clone were statistically different ($p\leq 0.05$).

It is important to indicate that tubers with a diameter equal to or greater than 15 mm are used for planting in the field, where between 60 and 80 thousand units are required to plant one hectare (Flores-López *et al*., 2014).

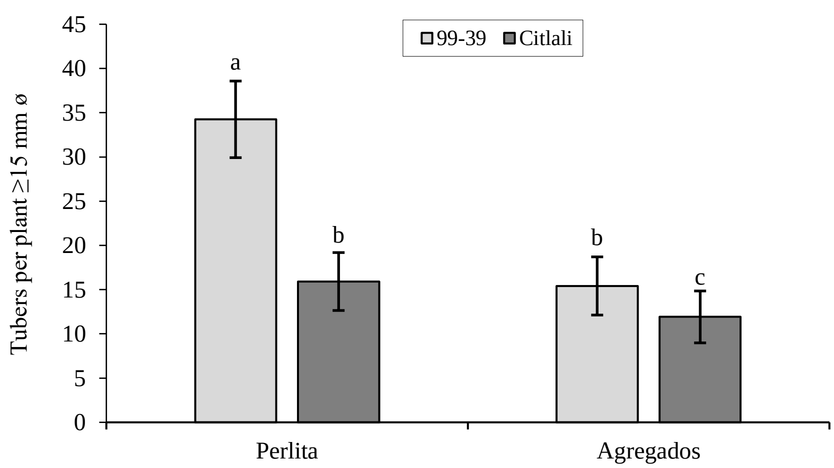

Figure 1. Average production of tubers equal to or greater than 15 mm in diameter in three growing cycles and two substrates for the Citlali variety and the mexican clone 99-39.

The cycle x system interaction was the one with the greatest impact, since the average response in the production of mini-tubers with a diameter equal to or greater than 15 mm was remarkable; thus, in the autumn and perlite cycle, genotypes produced 42.25 tubers per plant, a figure significantly higher than the rest of the combinations. The substrates added in the spring and summer cycles showed the lowest yields, with 6.75 and 6.38 tubers per plant, respectively; that is, 6.5 times less.

This response was evidenced by analyzing the interaction cycle x substrate x genotype (Figure 2) where clone 99-39 planted in the autumn-winter cycle yielded 10 times more than the Citlali variety planted in aggregates, both in spring and summer; however, clone 99-39 planted in aggregates, in spring and summer did not show high potential for tuber production, so it is possible to point out that the effect of temperature is fundamental in the productivity of the materials and coincides with what is mentioned by Beukema and Van der Zaag (1990) and it is also evident that the response of the cultivars was diverse in this work carried out in the hydroponic system and is consistent with that indicated by Muro *et al*. (1997); Corrêa *et al*. (2008); Tierno *et al*. (2013).

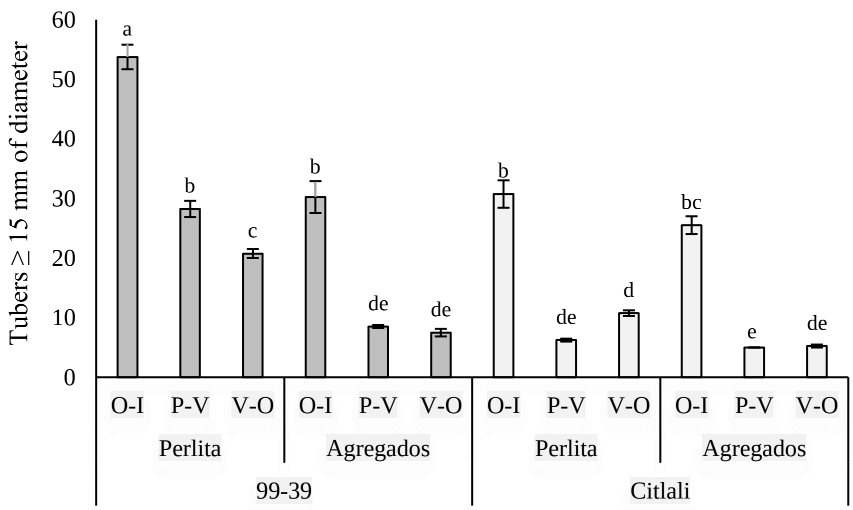

Figure 2. Effect of the interaction cycle x substrate x genotype on the production per plant of minitubers greater than or equal to 15 mm.

The high production of clone 99-39 in the greenhouse in both cultivation conditions compared to the Citlali variety, is consistent with what happened in field conditions, where this clone has a yield potential greater than the Citlali variety, indicated by (Rubio *et al*., 2017), who mention that clone 99-39 has an intermediate to late production cycle, under field conditions, with a potential yield of up to 80 t ha^{-1}, while the Citlali variety is an early genotype, with a potential yield in the field of 54 t ha^{-1}.

When the total production of tubers per plant (all sizes) was considered, clone 99-39 showed the best yield ($p \leq 0.05$) in the autumn-winter cycle, season in which the Citlali variety also obtained its best yield (34.5 tubers), although significantly less than that obtained by clone 99-39 (58 tubers); that is, 68% more tubers for 99-39 (Table 5).

Table 5. Average production of total tubers per plant in the interaction cycle x substrate x genotype.

Cycle	Substratum	Genotype	Tubers per plant
Autumn-Winter	Perlite	Clone 99-39	58.0 [a*] ± 2.48
		Citlali	34.5 [b] ± 2.96
	Aggregates	Clone 99-39	33.5 [b] ± 2.90
		Citlali	27.5 [c] ± 1.66
Spring-Summer	Perlite	Clone 99-39	34.3 [b] ± 1.65
		Citlali	8.0 [de] ± 0.41
	Aggregates	Clone 99-39	10.8 [de] ± 0.63
		Citlali	6.3 [e] ± 0.25
Summer-Autumn	Perlite	Clone 99-39	26.3 [c] ± 0.95
		Citlali	13.0 [d] ± 0.58
	Aggregates	Clone 99-39	8.5 [de] ± 0.65
		Citlali	6.3 [e] ± 0.25

[*]= Values with different letters are statistically different ($p< 0.05$) according to the Tukey test.

Genotype 99-39 in autumn and planted in perlite produced 58 tubers per plant, the same clone planted in spring with perlite obtained 34.3 and in 26.3. That clone planted in aggregates yielded 33.5 tubers per plant in autumn, however, its response in aggregates was 33.5 tubers per plant in autumn, but only 10.8 in spring and 8.5 in summer. The Citlali variety showed a production of 34.5 tubers per plant when cultivated in perlite, in the autumn-winter cycle, 8 in spring and 6.3 in summer, while in aggregates it yielded 27.5 tubers per plant, when it was grown in aggregates in autumn and 6.3 in spring and summer.

In this study, the most productive crop cycle was that of autumn-winter 2015-2016, the conditions of cold temperatures at night and the difference between the maximum and minimum daily favored the mobilization of photoassimilates towards the tubers, in accordance with the noted by Beukema and Van der Zaag (1990) and the largest production of stolons.

Tuber weight and harvest index

The fresh weight of tubers per plant showed contrasting results with respect to the number of tubers per plant, the value of Pearson’s correlation coefficient between these variables was 0.08 and without statistical significance. In that sense, the comparison of means for crop cycles showed that in spring-summer the highest weight of tubers per plant was obtained, with 283 [a] gram, in summer-autumn the average was 185 [b] g and in autumn-spring 141 [c] grams per plant. Among substrates the response was similar to that observed in the number of tubers with 236 [a] gram in perlite and 170 [b] grams in aggregates.

When considering the interaction cycle x genotype, the response in fresh weight was significantly ($p\leq 0.05$) higher for spring and clone 99-39 (325 [a] g), which surpassed the Citlali variety planted in the autumn cycle that obtained 119[d] grams. The interaction cycle x substrate x genotype (Figure 3) shows the differential behavior of the materials under study. With this, it is evident that the production of more tubers does not necessarily have a greater impact on them, a fact that contrasts with what was pointed out by Beukema and Van der Zaag (1990), but which apparently is related to the differential response of the genotypes of potato and its interactions in hydroponic cultivation (Muro *et al*., 1997; Corrêa *et al*., 2008; Tierno *et al*., 2013.

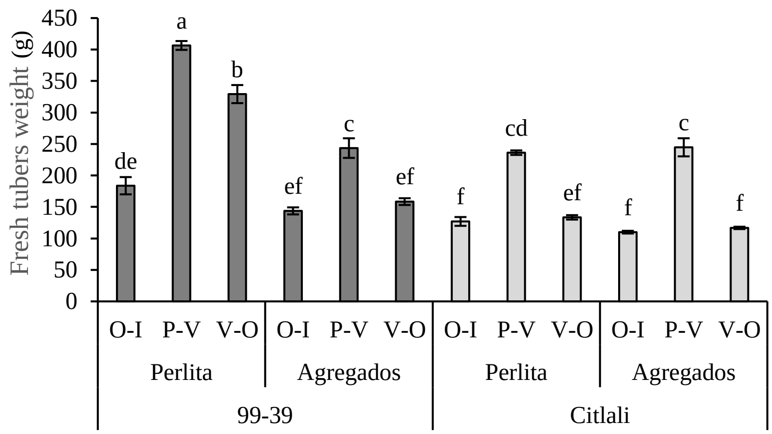

Figure 3. Effect of the interaction cycle x substrate x genotype on the fresh weight of tubers per plant of two potato genotypes.

In addition, it should be considered that the tubers of the Citlali variety are larger, due to the precocity of that cultivar. The weight of the tubers of clone 99-39, in general, was lower, probably because they were only grown for 90 days, when their cycle is at least 110 days, therefore, their tubers, although in good numbers, could still gain more weight; especially in the autumn-winter cycle, when plants tend to have a later cycle and this fact does coincide with what was reported by Beukema and Van der Zaag (1990).

Regarding the dry weight of tubers per plant, the combined analysis showed results similar to those of fresh tuber weight, therefore, Pearson's correlation coefficient between these variables was 0.94 (p< 0.0001). In relation to the harvest index, the greatest statistical differences were found when comparing the values obtained in the three production cycles (Figure 4). In the autumn-winter cycle, the highest harvest index (0.80) was obtained, followed by the summer-autumn cycle (0.76), and the lowest was the spring-summer cycle (0.73).

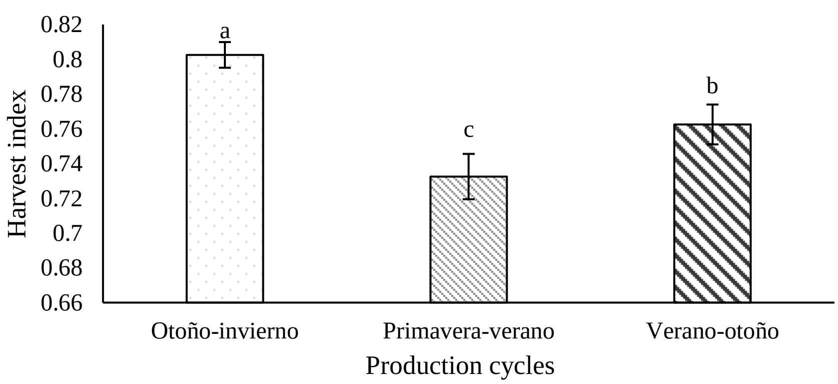

Figure 4. Average harvest index of two Mexican potato genotypes in three crop cycles and two substrates.

These values were closely associated with the temperatures recorded in the different production cycles; at a lower temperature, higher harvest rate; this corresponds to what was observed by Flores-Gutiérrez *et al*. (2018) and mentioned by Beukema and van der Zaag (1990). The harvest index values of the Citlali variety and clone 99-39 on two substrates and three crop cycles are presented in Figure 5. Although in the analysis of substrates and genotypes there was no statistical significance, if there was in the interaction indicated, so that the environment is probably the factor with the greatest effect on the accumulation of dry weight in the tubers.

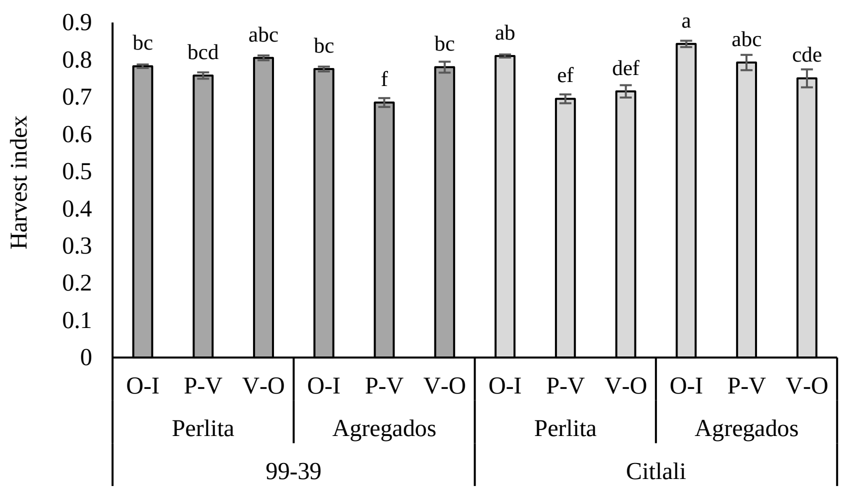

Figure 5. Crop index in the genotype x cycle per substrate interaction.

Conclusions

The production system in Perlite and hydroponics was more efficient with respect to the aggregate due to its inert condition, greater aeration and continuous nutrient disposal. The productive potential of each genotype was expressed in the greenhouse, where clone 99-39 was better than the Citlali variety.

The season of the year strongly affects the response in number of tubers per plant in potato in greenhouse and hydroponics. The results obtained here will allow decisions regarding the management of the production of seed tuber of the prebasic category II in both genotypes.

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