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Growth parameters of golden berry (*Physalis peruviana* L.) at two altitudes in Huanuco, Peru

Parámetros de crecimiento del aguaymanto (*Physalis peruviana* L.) cultivado en dos altitudes geográficas en Huánuco, Perú

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Abstract

To evaluate the environmental effects at different altitudes on the vegetative growth of the "golden berry" crop (*Physalis peruviana* L.), two replicate experiments were conducted at Molino (2280 m a.s.l.) and Ichocan (2834 m a.s.l.) locations in the Huánuco region of Peru. Plant height, recorded at four intervals (34–182 days after transplanting – dat), was consistently taller at the lower altitude. In the final evaluation, plants from Molino were 32 % taller and had a main stem diameter and secondary stem length 40 % and 105 % larger than those from Ichocan. The higher temperatures at the lower-altitude location allowed plants to accumulate 42 % more degree-days and form 19 % more stem nodes. However, at the higher altitude site, the plants were more efficient at configuring nodes, as at the end of the evaluation, they formed 0.0280 nodes for each degree-day accumulated above the base temperature of 6.3 °C. In contrast, at lower altitudes, only 0.0235 nodes were formed per degree-day.

Key words: *Physalis, altitude, degree-days, stem node, base temperature*

Resumen

Con el objetivo de evaluar el efecto del medio ambiente a diferentes altitudes geográficas sobre el crecimiento vegetativo del cultivo de aguaymanto" (*Physalis peruviana* L.), se instalaron dos experimentos iguales en las localidades de Molino (2280 m.s.n.m.) e Ichocán (2834 m s.n.m.) en la región de Huánuco, Perú. La altura de las plantas registrada en cuatro intervalos (34 - 182 días después del trasplante-ddt) fue consistentemente mayor en la localidad de menor altitud. En la última evaluación, las plantas de Molino fueron 32 % más altas y con diámetro primario y longitud de tallo secundario 40 % y 105 % más grande que en Ichocán. Las temperaturas superiores registradas en Molino permitieron que las plantas acumulen 42 % más de grados-día y formen 19 % más de nudos. No obstante, en la mayor altitud de Ichocán, las plantas fueron más eficientes en la configuración de los nudos pues al final de las evaluaciones formaron 0.0280 nudos por cada grado-día acumulado sobre la temperatura base de 6.3 °C. En cambio, en la menor altitud, solo se alcanzó a formar 0.0235 nudos por grados-día.

Palabras clave: *Physalis, altitud, grados-día, nudos, temperatura base*

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Introduction

Physalis peruviana L., commonly known as "aguaymanto" in Peru and "golden berry" internationally, is an herbaceous species native to the South American Andes. However, some authors, such as Leggue (1974) and Fischer (2000), identify its center of origin more specifically as the region between Peru and Ecuador, where it grows wild in the high Andean areas. Currently, its cultivation has expanded to almost all tropical and subtropical regions of the world, including South Africa, Malaysia, and China. Numerous studies show that due to their chemical composition and biological activity, golden berry fruits are of great value in human health. Their protective mechanism would be related to the improvement of the antioxidant system in addition to the content of valuable antimicrobial and nutritive compounds (Bazalar Pereda et al., 2019; El-Beltagi et al., 2019; Guiné et al., 2020; Singh et al., 2019).

As with most crops, the growth and development of golden berry do not depend only on standard management practices but also on environmental factors, which strongly influence these processes, in addition to the genetic traits of the ecotypes or varieties. Such factors determine plant size, phenology, yield, ripening, and the internal and external quality of the fruits (Fischer & Orduz-Rodríguez, 2012; Panayotov & Kouzmova, 2022). Among environmental factors, temperature is perhaps the most complex in terms of its impact on plant physiology, influencing the dynamics of the biochemical processes and enzyme activity (Gariglio et al., 2007). When growing golden berry in both open field and greenhouse conditions, it was found that high temperatures inside the greenhouse accelerated phenological stages, resulting in increased vegetative growth and development, as well as earlier and higher production (Angulo, 2005; Zeist et al., 2020).

The number of stem nodes, whose intensity in their formation depends on the temperature (accumulation of degree-days), represents the developmental state of a plant, and the appearance of the same, together with the development rates of the leaves and flowers configure the development of the organs. The base physiological temperature for the appearance of nodes in the golden berry plants has been established at 6.3 °C (Salazar et al., 2008).

For instance, the optimal average temperatures for the cultivation of golden berry in Colombia are within a range of 13 to 16 ºC (Fischer & Melgarejo, 2020; Salazar et al., 2008). In Brazil, the ideal temperature conditions are between 15 and 25 ºC, according to Rufato et al. (2012) and Lima et al. (2021), while in Argentina, Quiroga and Kirschbaum (2021) generally estimate an optimal temperature of 21 ºC. Evaluating the phenological stages of golden berry, Weber et al. (2021) stated that under subtropical conditions in Brazil, the plant cycle from transplant to senescence was 174 days, with a total accumulation of 3843.6 degree-days.

A geographical component that modifies the climatic conditions of a given location in tropical climates, therefore considerably affecting the growth, vegetative growth, and other components of the plant cycle, is altitude, that is, its elevation above sea level. As important alterations, it could be highlighted, among others, that at higher altitudes, ultraviolet radiation increases, temperatures decrease, and senescence and leaf fall accelerate (Fischer et al., 2000). In Colombia, golden berry production takes place mainly in locations located between 1800 and 2700 m above sea level (m a.s.l.), an altitude range within which optimal temperature conditions (13 ºC -16 ºC) are estimated to be present for its cultivation (Miranda & Fischer, 2021). In India, it can be cultivated between 1 200 m.a.s.l. and 1 800 m.a.s.l. (Yamika et al., 2019).

The present study aimed to evaluate the effect of altitude on the vegetative growth of golden berry plants cultivated at two different elevations in the Andean region of Huanuco, Peru.

Materials and methods

The trials were conducted in Molino (2280 m a.s.l.) and Ichocan (2834 m a.s.l.), located in the Ambo province, Huanuco region. The temperature and relative humidity values, recorded by an Elitech Model RC-61 data logger, and the soil characteristics of both locations are presented in Tables 1 and 2, respectively.

Table 1. Mean temperatures and relative humidity at both locations during the trial (April 24th - October 22nd, 2018).

Place (m a.s.l.)	Maximum temperature (°C)	Minimum temperature (°C)	Average temperature (°C)	Relative humidity (%)
Molino (2280)	29.37	9.9	19.7	73.0
Ichocan (2834)	21.50	9.8	15.7	75.9

Table 2. Physicochemical characteristics of soils from both locations.

Parameter	Ichocan	Molino
pH	5.26	6.26
E.C. (1:1) dS/m	0.10	0.11
$CaCO_3$ (%)	0.00	0.00
O.M. (%)	3.08	1.67
P (ppm)	23.2	42.7
K (ppm)	268	245
Texture	FrAr	FrArA
CEC	16	15.2

E.C.: electronic conductivity. **O.M.:** organic matter. **CEC:** cation exchange capacity.

Source: Soil Analysis Laboratory-UNALM

The repeated experiment was set up at each location using a randomized complete block design (Calzada, 1970). Each experiment consisted of 4 blocks with 5 plots per block. Each plot contained 3 rows of 6 plants, resulting in a total of 90 plants per block. To avoid edge effects, only the 4 central plants from each plot were considered as sampling units, resulting in a total of 20 sampling units per block.

The plant material was golden berry plants of the "Colombian" ecotype, planted at a spacing of 2.2 x 1.5 m, 70 days after sowing, at the beginning of autumn (April 10th, 2018). The plants developed with a single main stem. Between 100 and 130 days after transplanting (dat), a support system with wire and wooden T-posts was installed. The irrigation system was drip irrigation with 4 $l.h^{-1}$ drippers. Between June and October 2018, N-P-K fertilization was applied at a dose of 193-183-160 $kg.ha^{-1}$. Additionally, foliar Calcium-Boron was applied between September 10th and December 3rd.

Growth parameters:

Plant height: the height of the main stem was measured from its base to the apex on four occasions (34, 64, 122, and 180 dat).

Main stem diameter: recorded once (180 dat) at approximately four centimeters below the branching zone.

Secondary stem length: recorded once (180 dat), in the third lateral stem, representing an average length from all lateral stems.

Number of stem nodes: counted directly on the plant, in pre-marked 20 plants per location.

The degree-days were calculated using the direct method, i.e., the difference between the average daily temperature and the base temperature of 6.3 ºC (Salazar et al., 2008), established for other conditions but widely used as a reference when there are no locally tested values.

The number of stem nodes formed per cumulated degree-day was determined by dividing the total number of stem nodes formed until 182 dat by the total degree-days cumulated until that day. Consequently, the number of degree-days necessary for stem node formation was obtained inversely.

Data analysis

For the plant height, main stem diameter, and secondary stem length, a combined analysis of variance was performed, and the mean values were compared later with a Tukey test. Additionally, the degree-days accumulation was determined by the difference between daily temperature and base temperature previously mentioned, and the number of stem nodes was obtained from 20 plants per location. In both cases, the T-test was used to assess mean values

Results and discussion

Growth and vegetative development indicators of plants

The results show a marked altitudinal effect in the three growth parameters assessed, with statistically significant differences (Tukey test at 5 %) favorable to the plantation in the Molino location (2280 m.a.s.l.) in all cases. In the first evaluation of plant height, 34 days after transplant (dat), the plants from Molino were 38% higher than those from Ichocan (2834 m.a.s.l.). This superiority was maintained throughout the evaluation period, concluding 182 dat with plants 32.3 % taller (Figure 1). Additionally, on the final evaluation day, the main stem diameter and the secondary stem length were 40 % and 105 % greater in Molino than in Ichocan, respectively (Figure 2).

During the trial time, the maximum and average temperatures at the lower altitude location (Molino) were higher than in Ichocan (Table 1). This could partially explain the results obtained in primary and

secondary vegetative growth, since temperature directly influences the growth and development of plants in general (Gariglio et al., 2007; Liu et al., 2020). Yamika et al. (2019) specifically indicated that geographic altitude affects the growth of golden berry plants by modifying climatic components, especially temperature. Similarly, Fischer (1995) and Fischer & Lüdders (2002) reported that in Colombia, during the first 32 weeks, golden berry plants grown at 2690 m.a.s.l. and an average temperature of 12.5 °C, showed smaller stem sizes compared to those grown at 2300 m.a.s.l. where the average temperature was 17.4 °C.

The root zone temperature could also be an important factor since the abovementioned paper considered that lower soil temperature at higher altitudes reduced root growth. More recently, Fischer and Melgarejo (2014) reported that soil temperature between 15 °C and 22 °C favored root growth, whereas at 8 °C, plant development was reduced.

Other climatic parameters affected by geographical altitude may also be involved in our results besides temperature, since no single environmental factor affects solely the plant's physiology and yield (Fischer et al., 2016; 2018). For instance, the high UV-B radiation at higher

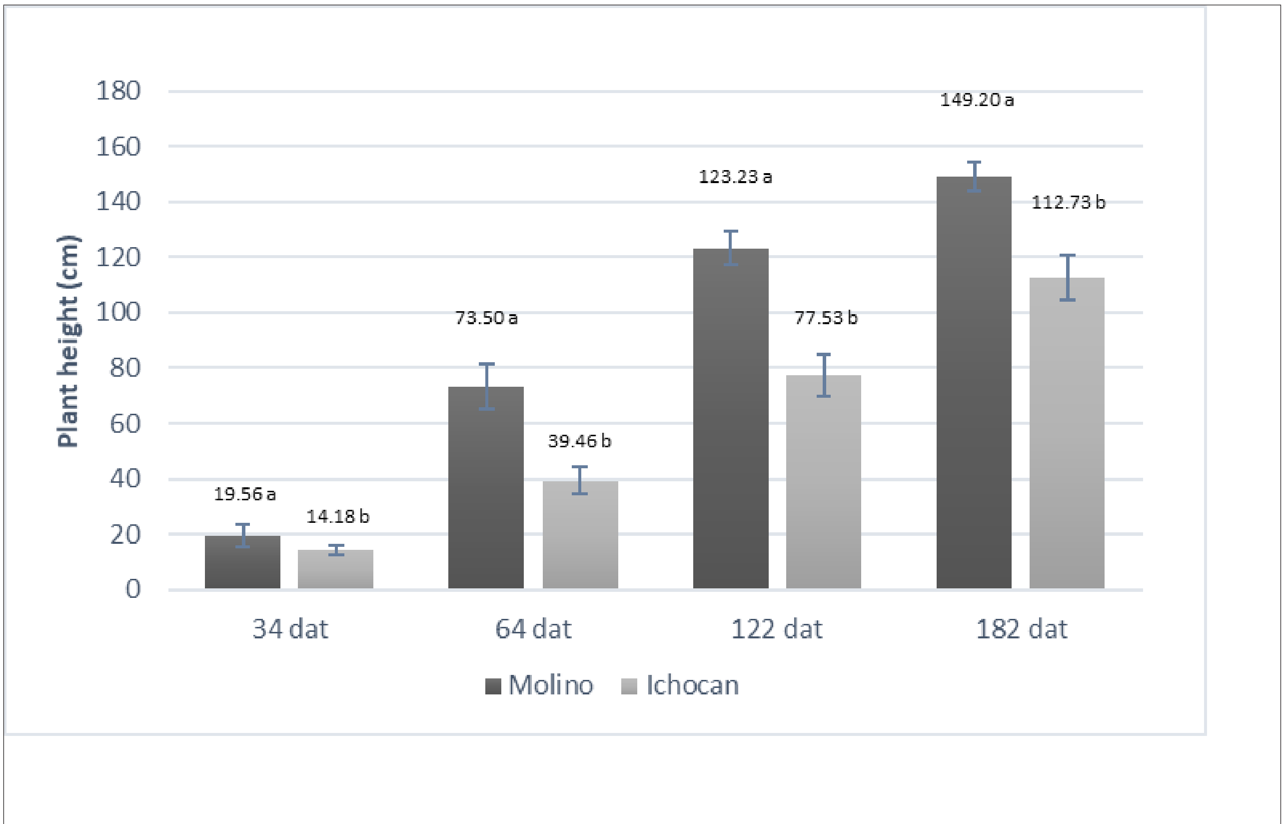

Figure 1. Plant height (cm) evaluation at different growth stages expressed in days after transplant (dat). Different letters at each dat mean a significant difference between locations.

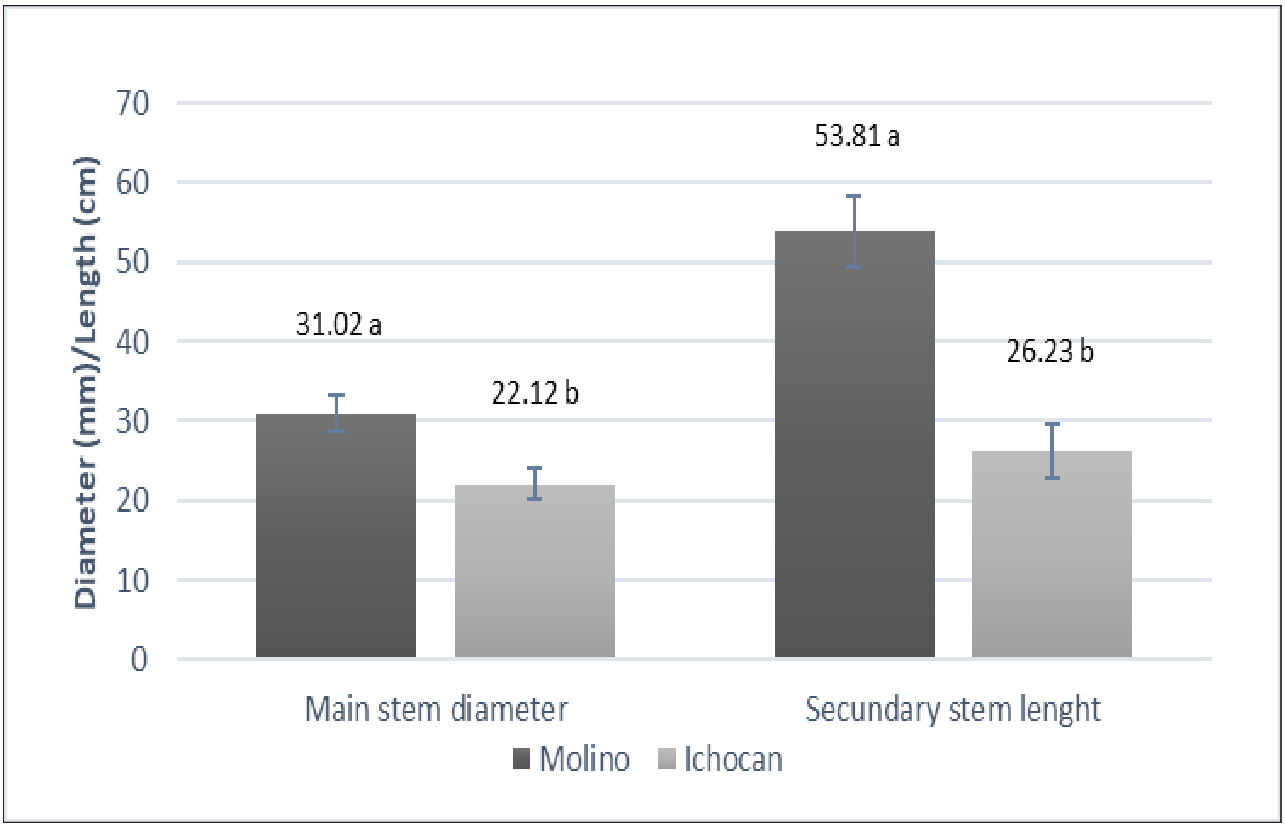

Figure 2. Main stem diameter and secondary stem length at 182 days after transplant. Different letters at each variable mean a significant difference between locations.

altitudes is detrimental for photosynthesis, directly affecting the photosynthetic apparatus (Kataria et al. 2014). CO_2 partial pressure should also be considered as a factor (Liu et al., 2020). In areas where atmospheric pressure is greater, CO_2 pressure is higher, favoring photosynthetic activity and consequently, plant growth rate (Olivo et al., 2002; Marabesi, 2007). Overall, plants adapted to these conditions have adjusted their morphology and anatomy to optimize the use of available resources (Guo et al.,2017; Liu et al., 2020).

Accumulation of degree-days and stem node formation

Considering a base temperature of 6.3 °C for golden berry (Salazar et al., 2008), the number of degree-days accumulated from the first month after transplant showed highly significant differences between experimental locations (Student T test at 1 %), favoring the lower-altitude location of Molino, due to its light higher temperatures (Figure 3). This advantage persisted throughout subsequent evaluations within a range of 42 %-45 % higher compared to the higher altitude location, Ichocan. The average daily number of degree-days accumulated up to 182 days after transplant was 13.4 in Molino and 9.42 in Ichocan.

The higher intensity and acceleration of the processes related to plant growth and development at lower altitudes seem to be related to a greater accumulation of degree-days. Table 3 shows that, because of the degree-days number accumulated, the total number of stem nodes formed until the end of the period evaluated (182 dat) was higher in the lower locality of Molino, with highly significant statistical differences compared to that reached in Ichocan.

At Ichocan, the stem nodes per cumulated degree-days ratio (0.0280) was significantly higher than for Molino (0.0235), which means that 35.66 and 42.48 degree-days are necessary for stem node formation at Ichocan and Molino, respectively. This may show a more efficient use of

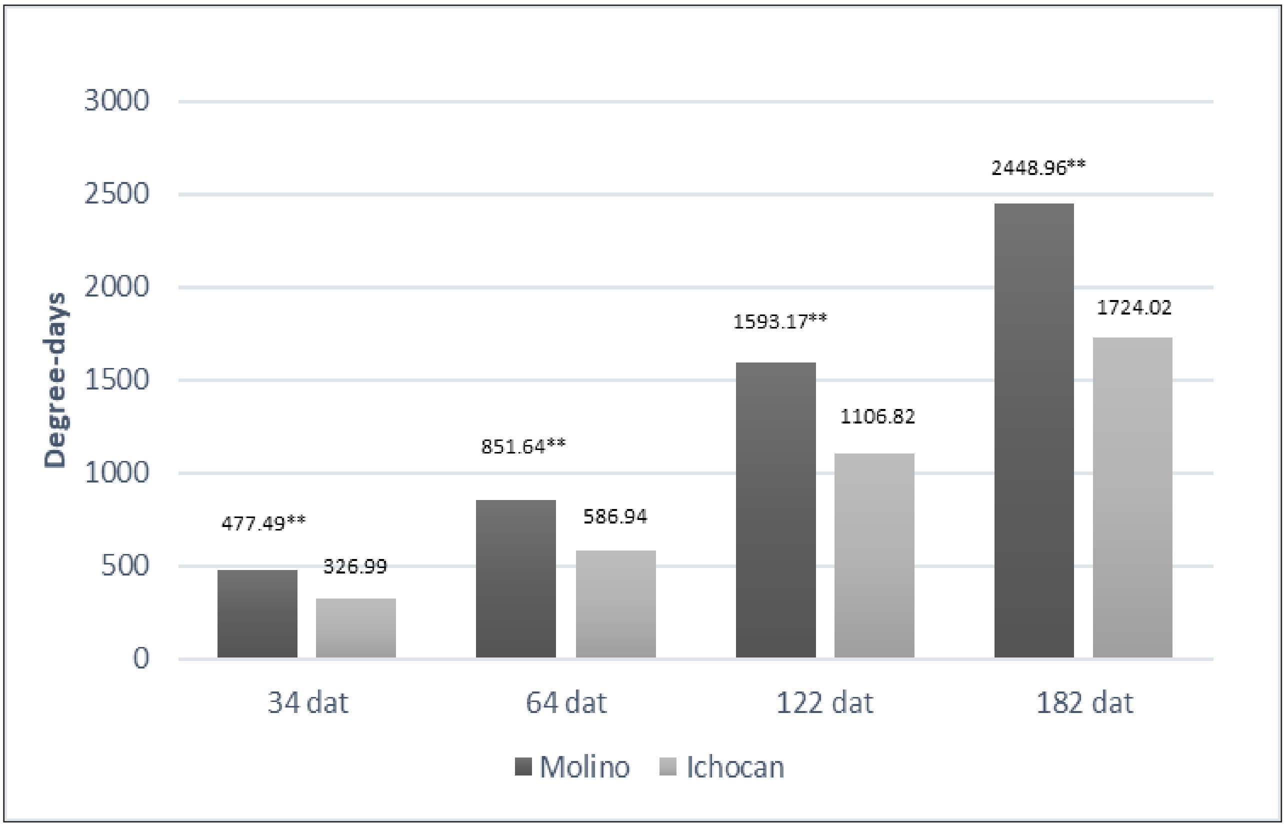

Figure 3. Number of degree-days accumulated at different growth stages expressed in days after transplant (dat). (base temperature: 6.3 ºC). **: Significant difference based on T student test at 1 %.

Table 3. Stem nodes formation up to 182 dat[1] and its relationship with accumulated degree-days.

Location (m a.s.l.)	Total number of stem nodes	Stem nodes/degree-days rate	Degree-days/stem nodes rate
Molino (2280)	57.65**	0.0235**	42.48
Ichocan (2834)	48.35	0.0280	35.66

[1]**dat:** days after transplant. ** Highly significant differences according to the T Student at 1% probability

degree-days in plants at higher altitudes. Golden berry plants growing in an environment with a 22.1 °C - 27.2 °C temperature range needed 63.1 degree-days for stem node formation, against those grown in a 19.2 °C - 22.2 °C environment, which required only 57.7 degree-days for it (Zeist et al., 2020). Furthermore, the authors stated that lower temperatures caused an earlier senescence and, in response, the plant reduced its thermal need to form each node. It is also possible that the lower cumulative degree-days required for stem node formation are related to a shorter length of internodes. This was observed by Baracaldo and Ibagué (2006) and López et al. (2010), who worked with carnations, determined that if the stem grows, the older stem nodes require fewer degree-days, and the internodes are shorter. Whereas, the younger stem nodes require more degree-days and their internodes are longer.

Finally, the different soil characteristics between both locations, such as pH, organic matter, and phosphorus content, may have also influenced the responses of growth parameters in all the parameters evaluated, except for accumulated thermal units.

Conclusions

There is a marked influence of geographical altitude on plant height, main stem diameter, and secondary stem length of golden berry plants, favoring growth at the lower-elevation location (Molino). At this location, the temperature was higher, causing a faster degree-days accumulation and greater stem node formation compared to Ichocan. However, it should be considered that golden berry plants at higher geographical elevations were more efficient in the use of degree-days for stem node formation.

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Conflict of interest

The signing authors of this research work declare that they have no potential conflict of personal or economic interest with other people or organizations that could unduly influence this manuscript

Authors Contributions

EVR: Conception and experimental work design. Execution, support and fieldwork supervision. Statistical analysis and organization of results.

JEA: Study support and supervision. Review of statistical analysis and results. Discussion and research conclusions. Article editing

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References

Angulo, R. (2005). Crecimiento, desarrollo y producción de la uchuva en condiciones de invernadero y campo abierto. In *Avances en cultivo, poscosecha y exportación de la uchuva Physalis peruviana en Colombia* (1rst ed.). Universidad Nacional de Colombia, Facultad de Agronomía.

Baracaldo, A., & Ibagué, A. (2006). *Evaluación de crecimiento en clavel estándar cv. 'Nelson' a segundo pico de cosecha en suelo y en sustratos*. [Trabajo de grado, Universidad Nacional de Colombia]. Facultad de Agronomía. Colombia, Bogotá.

Bazalar Pereda, M., Nazareno, M., & Viturro, C. (2019). Nutritional and Antioxidant Properties of *Physalis peruviana* L. Fruits from the Argentinean Northern Andean Region. *Plant Foods for Human Nutrition*, *74*(1), 68–75. https://doi.org/10.1007/s11130-018-0702-1

Calzada, J. (1970). Métodos estadísticos para la investigación (3ª ed.) Jurídica Editores, Lima – Perú. 494 p.

El-Beltagi, H., Mohamed, H., Safwat, G., Gamal, M., & Megahed, B. (2019). Chemical Composition and Biological Activity of *Physalis peruviana* L. *Gesunde Pflanzen*, *71*(2), 113–122. https://doi.org/10.1007/s10343-019-00456-8

Fischer, G. (1995). *Effect of root zone temperature and tropical altitude on the growth, development and fruit quality of cape goosverry (Physalis peruviana L.)*. Universidad de Humboldt.

Fischer, G. (2000). Crecimiento y desarrollo. In: Flórez, V.J., Fischer, G., & Sora, A.D. (Eds.). *Producción, postcosecha y exportación de la uchuva (Physalis peruviana L.)* (pp. 9–26). Unibiblos, Universidad Nacional de Colombia, Bogota.

Fischer, G., Ebert, G., & Lüdders, P. (2000). Provitamin A carotenoids, organic acids and ascorbic acid content of cape gooseberry (*Physalis peruviana* L.) Ecotypes grown at two tropical altitudes. *Acta Horticulturae*, *531*, 263–268. https://doi.org/10.17660/ActaHortic.2000.531.43

Fischer, G., & Lüdders, P. (2002). Efecto de la altitud sobre el crecimiento y desarrollo vegetativo de la uchuva *(Physalis peruviana* L.). *Revista Comalfi*, *29*(1), 1–10.

Fischer, G. & Melgarejo L. (2014). Ecofisiología de la uchuva (*Physalis peruviana* L.). In: Carvalho, C.P. & Moreno, D.A. (Eds.). *Physalis peruviana: fruta andina para el mundo.* (pp. 31–47). Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo – CYTED, Limencop SL, Alicante, Spain.

Fischer, G., Melgarejo, L. & Cutler, J. (2018). Factores pre cosecha que influyen en la calidad del maracuyá: una revisión. *Agron. Colomb*. 36(3), 217–226. https://doi.org/10.15446/agron.colomb.v36n3.71751

Fischer, G., & Melgarejo, L. M. (2020). The ecophysiology of cape gooseberry (*Physalis peruviana* L.) An Andean fruit crop. A review. *Revista Colombiana de Ciencias Hortícolas*, *14*(1). https://doi.org/10.17584/rcch.2020v14i1.10893

Fischer, G., Ramírez, F. & Casierra, F. (2016). Ecophysiological aspects of fruit crops in the era of climate change. A review. *Agron. Colomb*. 34(2), 190–199. https://doi.org/10.15446/agron.colomb.v34n2.56799

Fischer, G., & Orduz-Rodríguez, J. (2012). Ecofisiología en frutales. In *Manual para el cultivo de frutales en el trópico* (pp. 54–70). Produmedios, Bogotá.

Gariglio, N., Pilatti, R., & Agustí, M. (2007). Requerimientos ecofisiológicos de los árboles frutales. In *Árboles frutales: Ecofisiología, cultivo y aprovechamiento* (pp. 41–82). Universidad de Buenos Aires, Buenos Aires.

Guiné, R., Gonçalves, F., Oliveira, S. & Correia, P. (2020). Evaluation of Phenolic Compounds, Antioxidant Activity and Bioaccessibility in *Physalis Peruviana* L. *International Journal of Fruit Science*, *20*(1), 1–21. https://doi.org/10.1080/15538362.2020.1741056

Guo, C., Ma, L., Yuan, S., & Wang, R. (2017). Morphological, physiological and anatomical traits of plant functional types in temperate grasslands along a large-scale aridity gradient in northeastern China. *Scientific Reports*, *7*, 40900. https://doi.org/10.1038/srep40900

Kataria, S., Jajoo, A. & Guruprasad, K. (2014). Impact of increasing Ultraviolet-B (UV-B) radiation on photosynthetic processes. *Journal of photochemistry and photobiology B: Biology*, *137,* 55–66. https://doi.org/10.1016/j.jphotobiol.2014.02.004

Leggue, A. (1974). Notes on the History, Cultivation and Uses of *Physalis peruviana* L. *Journal of the Royal Horticultural Society, 99*(7), 319–314.

Lima, J., Cruz, M., Alves, D., Santos, N. & Guimarães, A. (2021). Pruning, training system, and climate conditions for the perennial cultivation of physalis. *Pesquisa Agropecuária Brasileira*, *56*, e01850. https://doi.org/10.1590/s1678-3921.pab2021.v56.01850

Liu, W., Zheng, L. & Qi, D. (2020). Variation in leaf traits at different altitudes reflects the adaptive strategy of plants to environmental changes. *Ecology and Evolution*, *10*(15), 8166–8175. https://doi.org/10.1002/ece3.6519

López, M., Chaves, B., Flórez, V. & Ruth, M. (2010). Modelo de aparición de nudos en clavel (*Dianthus caryophyllus* L.) cv. Delphi cultivado en sustratos. *Agronomía Colombiana 28*(1), 47–54.

Marabesi, M. (2007). Efeito do alto CO_2 no crescimento inicial e na fisiologia da fotossíntese em plântulas *Senna alata* (L.) Roxb. Instituto de Botânica. São Paulo. 78 p.

Miranda, D. & Fischer, G. (2021). Avances tecnológicos en el cultivo de la uchuva (*Physalis peruviana* L.) en Colombia. In: Avances en el cultivo de las bayas en el trópico (pp. 14–36). Sociedad Colombiana de Ciencias Hortícolas, Bogotá. https://doi.org/10.17584/IBERRIES

Olivo, N., Martínez, C. & Oliva, M. (2002). The photosynthetic response to elevated CO_2 in high altitude potato species (*Solanum curtilobum*). *Photosynthetica*, *40*, 309–313. https://doi.org/10.1023/A:1021370429699

Panayotov, N., & Kouzmova, K. (2022). Productivity of different cape gooseberry (*Physalis peruviana* L.) genotypes influenced by meteorological conditions in South Bulgaria. Paper presented at the IV Balkan Agricultural Congress, Edirne, Turkey, August 31–September 2, 2022.

Quiroga, R., & Kirschbaum, D. (2021). *Physalis* (uchuva): Especies frutales nativas de las Yungas subandinas con alto potencial de cultivo en Argentina. *Horticultura Argentina*, *40*(103).

Rufato, L., Muniz, J., Kretzschmar, A. A., Rufato, A. D. R., & Gatiboni, L. C. (2012). Aspectos técnicos da cultura da fisalis. *Belo Horizonte*, *33*(268), 69–83.

Salazar, M., Jones, J., Chaves, B., Cooman, A. & Fischer. G. (2008). Base temperature and simulation model for nodes appearance in cape gooseberry (*Physalis peruviana* L.). *Revista Brasileira de Fruticultura, 30*(4), 862–867. https://doi.org/10.1590/S0100-29452008000400004

Singh, N., Singh, S., Maurya, P., Arya, M., Khan, F., Dwivedi, D. H., & Saraf, S. A. (2019). An updated review on *Physalis peruviana* fruit: Cultivational, nutraceutical and pharmaceutical aspects. *Indian Journal of Natural Products and Resources*, *10*(2), 97–110.

Weber, A., Soldateli, F., Barcelar, M., Moura, A., & Bitencourt, A. (2021). Phenology and yield of cape gooseberry cultivated in open field in subtropical environment. *Comunicata Scientiae*, *12*, e3634. https://doi.org/10.14295/cs.v12.3634

Yamika, W., Aini, N., & Waluyo, B. (2019). *Physalis peruviana* L.: Growth, Yield and Phytochemical Content- A Review. *Agricultural Reviews*, *40*(4), 324–328. https://doi.org/10.18805/ag.R-130

Zeist, A., Resende, J., Vilela, J., Suek, D., Lustosa, I., Silva, D., Maus, C., Gabriel, A. & Garcia, J. (2020). Plastochron and yield of *Physalis peruviana* L. grown in different environments and transplanting dates. *Semina: Ciências Agrárias*, *41*(4), 1151–1164. https://doi.org/10.5433/1679-0359.2020v41n4p1151