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Comparative study of the growth of commercial potato varieties (*Solanum tuberosum* L.) obtained from vegetative seedlings

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Abstract: This study evaluated the development of four commercial potato varieties (Yungay, Tomasa, Amarilis, and Clon Bella) under controlled greenhouse conditions in the city of Huánuco. The main objective was to assess the variability in key characteristics such as root development, stem elongation, tuber formation, and minituber production, considering four treatments, with the Yungay variety as the control. Evaluations were carried out at 60 and 120 days after planting. Variables analyzed included the number of leaves, stem length (cm), fresh shoot weight (g), root length (cm), number and weight of tubers and minituber, and tuber diameter (mm), using a completely randomized design with 10 replications per treatment. Statistical analyses were conducted using ANOVA, followed by Tukey's test for mean comparison. The results showed significant differences between the varieties. Tomasa exhibited better performance in terms of weight (10.04 g/tuber) and tuber diameter (1759 mm), suggesting a greater capacity for biomass allocation to storage organs. In contrast, the Yungay variety, used as the control, excelled in minituber production (62.20 minitubers/plant), highlighting its potential for seed propagation. Additionally, root length varied among the varieties, with Yungay (29.00 cm) and Clon Bella (26.00 cm) standing out in terms of root development. The latter also stood out in leaf development, with 91.13 leaves/plant and a stem length of 58.00 cm. These results emphasize the importance of considering the specific characteristics of each variety when selecting the most suitable for different agronomic objectives, such as maximizing tuber yield or nutrient use efficiency.

Keywords: Foliage development; Greenhouse potato cultivation; Minitubers; Root elongation; Tuber formation.

Introduction

The potato (*Solanum tuberosum*) is one of the most important crops worldwide due to its high nutritional value and essential role in global food security. Beyond its dietary significance, it is a key component of the agricultural economy (Devaux et al., 2020). With a global production exceeding 370 million metric tons in 2023 (FAO, 2023). This tuber is cultivated in over 150 countries (Çaliskan et al., 2022). Asia stands out as the leading producer, accounting for 53.4% of total output, with China and India reaching the highest production volumes at 93 million and 60 million metric tons, respectively (FAO, 2023). Therefore, potato is a cornerstone of food security and economic development, playing a pivotal role in the livelihood and growth of smallholder farmers (Devaux et al., 2020; Doboch et al., 2022; Wengle et al., 2024). From an economic and social perspective, its production serves as a fundamental pillar for rural development and the stability of the agricultural sector.

As in the case of Peru, the significance of potato cultivation extends beyond its productive aspect, encompassing cultural, social, and economic dimensions within local communities (Tirado-Malaver et al., 2021; Calizaya et al., 2023). In 2022 and 2023, national production reached 6 and 5 million metric tons, respectively (FAO, 2023). However, despite its prominence, potato crop productivity still faces significant challenges, many of which are related to varietal selection and the quality of planting material.

Variety selection is a key determinant of production efficiency and yield stability. Each variety exhibits distinct differences in plant architecture, nutrient uptake efficiency, resistance to environmental stressors, and adaptation on specific agroclimatic conditions (García-Segura et al., 2021; Nasir and Toth, 2022; Arteaga-Chamorro et al., 2022). These variations not only impact final yield but also influence the crop's competitiveness within the agricultural sector, particularly in the face of climate variability (Xing et al., 2022; Sifuentes-Ibarra et al., 2024).

Despite advancements in technologies aimed at enhancing potato production, knowledge gaps persist regarding the evaluation of commercial variety performance under diverse cultivation conditions. In this context, the present study aims to compare the development of commercial potato varieties (Yungay, Tomasa, Amarilis and Clon Bella) to generate data which support the selection of high-yielding plant materials. This, in turn, will optimize production strategies and enhance the crop's overall competitiveness.

Results and Discussion

Characteristics of aerial growth

Foliage development constitutes a pivotal factor in plant physiology, as it mediates the translocation of photoassimilates, fundamental for both vegetative growth and the accumulation of reserves in storage organs, particularly tubers (León-Burgos et al., 2021). Consequently, biomass partitioning, dictated by intrinsic varietal attributes, environmental dynamics, and agronomic practice, exerts a direct influence on crop productivity (Flores-López et al., 2021).

Table 1. reveals statistically significant differences in leaf number among the four evaluated potato varieties. At 60 days after planting, Yungay exhibited the most vigorous foliar development, averaging 77.00 leaves per plant, while Tomasa showed moderate growth with 26.88 leaves per plant. In contrast, no foliar development was observed in the Amarilis and Clon Bella varieties at this stage, indicating that both experience a markedly slower initial growth phase. At 120 days of cultivation, it was observed that the Clon Bella variety exhibited a higher number of leaves, surpassing the control (Yungay) by an average of 31.53 leaves per planta, with significant differences between both varieties (Table 1). On the other hand, , although the Tomasa variety displayed an average of 19.75 fewer leaves than Clon Bella, but did not show significant differences, when compared to the latter. Finally, the Amarilis variety displayed the lowest number of leaves, with an average of 41.25 leaves per plant, a value that was significantly lower compared to the other varieties.

Enhanced leaf development may increase the plant´s photosynthetic capacity, which in turn, could favor biomass accumulation and improve the final crop yield (Potter and Jones, 1977; Jerez-Mompies and Martín-Martín, 2012; Jerez-Mompie et al., 2014).

The stem is one of the primary aerial structures of the plant, as it serves as a structural framework for the leaves while also acting as a channel for nutrient transport across the planta system (Thornton, 2020). In the current research, stem development followed a pattern similar to that of that of leaf growth. At 60 days after planting, the control variety, Yungay, exhibited the greatest stem elongation, with an average of 35.60 cm, followed by Tomasa with 16.25 cm. The differences between these two varieties were statistically significant.

At 120 days of cultivation, the Clon Bella variety exhibited a greater stem length compared to the Yungay variety, with a difference of 7.20 cm. However, this difference was not statistically significant (Table 1). The yungay variety reached a stem length of 50.80 cm, a value lower than that reported in other studies. For instance, Taipe and Taype (2023) recorded an approximate height of 66 cm at 110 days of cultivation under open-field conditions in Huancavelica. Similarly, in a study conducted in Huancayo under greenhouse conditions, Perez et al. (2024) reported that plant height ranged between 72 and 81 cm at 60 days of cultivation. Stem length is determined, in part, by the cultivar (Egúsquiza, 2000); albeit factor such as agronomic management and environmental conditions may also influence its development (Sánchez-Bernal et al., 2008; Barona et al., 2015).

The variability in fresh weight among varieties may be determined by the growth rate, which influences nutrient assimilation for shoot formation. In turn, these differences are subject to the environmental conditions under which the plant develops (Jerez-Mompie et al., 2016). In this study, the Yungay variety once again exhibited a markedly superior performance compared to Tomasa at 60 days after planting, surpassing it in shoot fresh weight by 12.12 g, a statistically significant difference. At 120 day, the Clon Bella variety exhibited the highest shoot fresh weight, reaching 39.73 g, surpassing the control (Yungay) by 10.18 g, although without statistical differences (Table 1). Similarly, the Tomasa variety did not show significant differences compared to the previously mentioned varieties, recording a fresh weight of 28.34 g, which was 1.21 g lower than the control (Yungay) (Table 1).

Characteristics of the root system

The root system serves as the primary pathway for nutrient uptake from the soil, enabling crop growth and development. In potato cultivation this system is characterized by its shallow nature, exhibiting lower density and limited branching (Hopkins et al., 2020). Consequently, the majority of its roots is largely concentrated in the upper 30 cm of the soil horizon (Thornton, 2020)

Therefore, root system development is a key determinant of potato growth and productivity. Under the conditions of the present study, the control variety (Yungay) exhibited the greatest root length at both 60 and 120 days of cultivation, recording values of 26.30 cm and 29.00 cm, respectively. At 60 days, this difference was statistically compared to the other varieties. Despite this, at 120 days, Amarilis and Clon Bella showed no significant difference relative to Yungay, with slightly lower values of -0.4 cm and -3.0 cm, respectively (Table 2).

When comparing the Yungay variety with a previous study conducted in Pasco, an opposite trend was observed at 40 days of cultivation, where the Tomasa variety reached a root length of 14.25 cm, surpassing Yungay, which recorded 13.00 cm (Basilio and Puente, 2024). These discrepancies suggest that root system behavior may be influenced by environmental and edaphic factor, as well as the genetic characteristics of each variety (Iwama, 2008). In this context, variations may be attributed to the differences in soil moisture conditions (King et al., 2020), as well as nutrient availability, both of which directly affect root growth rates (Joshi et al., 2016; Hopkins et al., 2020).

Indicators of tuber yield and quality

The primary function of the tuber is to store energy produced through photosynthesis in the leaves (Thornton, 2020). Potato quality is influenced by agronomic management, as it regulates the supply of essential nutrients for the crop's physiological processes (Naumann et al., 2020; Stark et al., 2020a). Likewise, soil and environmental conditions play a crucial role (Thornton, 2020). Nevertheless, the genetic traits of each variety area also key determinants of tuber quality (Stark et al., 2020b).

As observed in Table 3, tuber formation commenced in the Yungay (control) and Tomasa varieties at 60 days after planting, with Yungay producing an average of 1.6 more tubers per plant than Tomasa, a statistically significant difference compared to the other varieties. At 120 days, Tomasa exceeded the control by 0.4 of tuber per plant, though the difference was not statistically significant.

Similarly, Tomasa exhibited the highest average tuber weight (Table 3), reaching 10.04 g, which represented an increase of 1.47 g compared to the control, with statistical significance. However, its difference from the Clon Bella variety was marginal (0.2 g) and not statistically significant. A comparable trend was observed in tuber diameter, where Tomasa reached 1759.00 mm, surpassing Yungay by 460.3 mm. Similarly, the Clon Bella and Amarilis varieties exhibited significantly smaller tuber diameters, registering values of 725.60 mm and 522.60 mm, respectively. Nonetheless, despite the numerical differences recorded, no statistically significant differences were found among the varieties (Table 3). These findings suggest that the Tomasa variety exhibits a higher sprouting capacity and grater efficiency in nutrient assimilation. In contrast, the Yungay variety ranks second, as its average tuber weight was 1.27 g lower than that of Clon Bella. However, it produced a greater number of tubers (+0.5 tuber/plant). This analysis suggest that the selection of potato variety may be guided by specific production goals whether focused on tuber quantity or size.

Tuber weight is a key quality indicator and critical selection criterion across various agricultural production systems. Nevertheless, a higher number of tubers can offset a lower average weight, as observed in Yungay variety. This genotype may be physiologically inclined to allocate more resources toward cell division in storage organs rather than their thickening. Such a developmental behavior could be

Table 1. Comparison of the variables of number of leaves, stem height (cm) and fresh shoot weight (g) between commercial varieties of potato (*Solanum tuberosum* L.).

Variety	Number of leaves				Stem height (cm)				Fresh shoot weight (g)			
	60 CD		120 CD		60 CD		120 CD		60 CD		120 CD	
Yungay	77.00	a	59.60	bc	35.60	a	50.80	a	17.21	a	29.55	ab
Tomasa	26.88	b	71.38	ab	16.25	b	31.88	b	5.09	b	28.34	ab
Amarilis	0.00	c	41.25	c	0.00	c	29.20	b	0.00	b	22.13	b
Clon Bella	0.00	c	91.13	a	0.00	c	58.00	a	0.00	b	39.73	a

Different letters indicate significant differences according to Tukey's test (α = 0.05). CD: Cultivation days.

Fig 1. (Left) Location of the city of Huánuco. (Right) Location of the Universidad de Huánuco.

Table 2. Comparison of the variable root length (cm) between commercial varieties of potato (*Solanum tuberosum* L.).

Variety	60 CD		120 CD	
Yungay	26.30	a	29.00	a
Tomasa	16.00	b	22.00	b
Amarilis	0.00	c	28.60	a
Clon Bella	0.00	c	26.00	a

Different letters indicate significant differences according to Tukey's test (α = 0.05). CD: Cultivation days.

Table 3. Comparison of the variables number of tubers, tuber weight (g) and tuber diameter (mm) between commercial varieties of potato (*Solanum tuberosum* L.).

Variety	Number of tubers				Tuber weight (g)				Tuber diameter (mm)	
	60 CD		120 CD		60 CD		120 CD			
Yungay	2.40	a	2.30	a	5.82	a	8.57	b	1298.70	a
Tomasa	0.80	b	2.70	a	0.97	b	10.04	a	1759.00	a
Amarilis	0.00	c	1.60	a	0.00	c	8.23	b	522.60	a
Clon Bella	0.00	c	1.80	a	0.00	c	9.84	a	725.60	a

Different letters indicate significant differences according to Tukey's test (α = 0.05). CD: Cultivation days

Table 4. Comparison of the variables number of minitubers between commercial varieties of potato (*Solanum tuberosum* L.).

Variety	Number of tubers	
Yungay	65.20	a
Tomasa	36.00	b
Amarilis	7.50	d
Clon Bella	17.80	c

Different letters indicate significant differences according to Tukey's test (α = 0.05). CD: Cultivation days.

influenced by reduced levels of phytohormones, particularly gibberellins, which are known to promote cell elongation and expansion in tubers (Bhatla and Lal, 2023; Kondhare, 2022).

On the other hand, unlike tubers, minitubers are primarily used as propagation material (García-Segura et al., 2021). Regarding their formation, the Yungay variety (control) recorded the highest value, exceeding Tomasa by 81%, with a statistically significant difference (Table 4). In contrast, varieties such as Clon Bella and Amarilis exhibited significantly lower values, with averages of 17.80 and 7.50 minitubers per plant, respectively. This reduced production of vegetative propagules may limit their suitability for accelerated seed multiplication programs, particularly in contexts where the scalability and availability of planting material are of strategic importance.

Materials and Methods

Plant material

The study employed four commercial potato varieties: Tomasa, Clon Bella, and Amarilis, along with the control variety Yungay, which is the most widely cultivated in Peru due to its high yield potential and broad adaptability to diverse environmental conditions.

Prior to planting, seed tubers were visually inspected to discard those exhibiting mechanical damage or symptoms of disease. Only uniform seed tubers were selected for the experiment.

Study area

The experiment was conducted in the designates potato cultivation section (95 m^2) within the greenhouse facilities of the Universidad de Huánuco, located in the district and province of Huánuco, department of Huánuco, at an elevation of 1866 meters above sea level (Fig 1).

Experimental design

A completely randomized design (CRD) was used, comprising four treatments corresponding to the varieties (T0: Yungay, T1: Tomasa, T2: Amarilis, T3: Clon Bella), with 10 replicates per treatment. Each experimental unit consisted of two individual plants, each grown in a separate pot.

Agronomic management

The study commenced with greenhouse planting in June 2023 and concluded with harvesting in January 2024. The planting was carried out in pots containing a prepared soil substrate, which is composed of moss, topsoil, humus and supplementary fertilizer. Throughout the crop's development, irrigation was performed manually twice per week, delivering a volume of 0.022 m^3/m^2 per application. This practice effectively maintained optimal soil moisture levels without inducing waterlogging conditions.

Fertilization was restricted to foliar applications of a compound fertilizer (N20-P20-K20) at a concentration of 2 g/L, administered biweekly throughout the growth cycle.

As a preventive measure against *Rhizoctonia solani*, the primary fungal pathogen affecting potato crops, a fungicide containing benomyl as the active ingredient was applied on a monthly basis at a rate of 10 g/L. No insecticide treatments were administered within the greenhouse during the entire experimental period, as pest incidence remained negligible.

Evaluation procedure

Data collection was carried out 60 and 120 days after planting. The variables assessed included:

- Number of leaves per plant: The total number of fully expanded leaves per planta was recorded.
- Stem length (cm): Measured from the base to the apex of the main stem using a measuring tape.

A total of 10 plants per treatment were harvested for the following measurements:

- Fresh shoot weight (g): Shoots were weighed immediately using an electronic balance, and results were expressed in grams.
- Root length (cm): The root system was gently washed, and the main root was measured using a graduated ruler.
- Number of tubers and minitubers per plant: All developed tubers per plant were counted, distinguishing between tubers and minitubers.
- Tuber weight (g): Tubers were weighed per plant, and the average per experimental unit was calculated.
- Tuber diameter (mm): The transverse diameter of tubers was measured using a Vernier.

Statistical analysis

Data were compiled into a database and subjected to analysis of variance (ANOVA) to detect statistically significant differences among the evaluated varieties. When significance was observed ($p \leq 0.05$), Tukey's Honest Significant Difference (HSD) test at a 5% probability level was applied to identify statistically superior treatments. All statistical analyses were performed using RStudio software.

Conclusion

The comparative analysis of four commercial potato varieties (Yungay, Tomasa, Amarilis and Clon Bella) revealed significant variability in morphological and physiological traits under greenhouse conditions. Notably, the Tomasa variety exhibited superior performance in terms of tuber weight and diameter, whereas Yungay stood out for its higher capacity to produce minitubers for seed use. These findings underscore the influence of genetic variability on root development, nutrient assimilation, and the formation of storage organs. Furthermore, the results highlight the potential of specific varieties to be strategically selected based on agronomic priorities, whether for maximizing seed production or tuber yield. It is recommended that future field trials be conducted under diverse agroecological conditions to validate these findings and support large-scale varietal recommendations.

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Statement of contributions

BLCR was the Project manager, responsible for supervision and monitoring. AJSA was responsible for execution and data collection.
GSC was responsible for writing of the article, providing statistical guidance, and analyzing and interpreting the data.
MLTF was the research advisor.

References

Arteaga-Chamorro GA, Ortiz-Calle RS, Cartagena-Ayala YE (2022) Dynamics of the nutrient absorption in the potato crop (Solanum tuberosum) Superchola variety, for pre-basic seed production. Siembra. 9(2): 1-12.

Bhatla SC, Lal MA (2023) Gibberellins. In: Plant Physiology, Development and Metabolism. Springer, Singapur. p. 431-441.

Barona D, Mateus-Rodríguez J, Montesdeoca F (2015) La planta de papa: Ecofisiología y nutrición mineral. In: Brown D, Orteaga-Andrade S, Yaguana G (eds) Manual para la producción de semilla de papa usando aeroponía – diez años de experiencia en Colombia, Ecuador y Perú. INIAP, CIP, p.110-131.

Basilio-Aire DJ, Puente-Roman CJ (2024) Efecto de Amistar Top y Mertec en dos formas de aplicación frente a *Rhizoctonia solani* en las variedades Tomasa y Yungay (*Solanum tuberosum* L.) en Yanahuanca. Bachelor thesis, Cerro de Pasco, Peru.
Çaliskan ME, Yousaf MF, Yavuz C, Zia MAB, Çaliskan S (2022) History, production, current trends, and future prospects. In: Çaliskan ME, Bakhsh A, Jabran K (ed) Potato Production Worlwide, 1st edn. Academic Press. p. 1-18.
Calizaya F, Gómez L, Zegarra J, Pozo M, Mindani C, Caira C, Calizaya E (2023) Unveiling ancestral sustainability: A comprehensive study of economic, environmental, and social factors in potato and quinoa cultivation in the highland Aynokas of Puno, Peru. Sustainability. 15(17): 13163
Devaux A, Goffart JP, Petsakos A, Kromann P, Gatto M, Okello J, Suarez V, Hareau G (2020) Global food security, contributions from sustainable potato agri-food systems. In: Campos H, Ortiz O (eds) The potato Crop, Springer Cham, p.3-35.
Doboch M, Gedebo A, Haile A, Beshir HM (2022) Improving potato productivity through optimum agronomic management to ensure food security of smallholder farmers. Cogent Food & Agriculture. 8(1).
Egúsquiza BR (2000) La papa: producción, transformación y comercialización. International Potato Center.
FAO (2023) FAOSTAT database. https://www.fao.org/faostat/en/#data
Flores-López R, Casmiro-Marín M, Sotelo-Ruiz E, Rubio-Covarrubias O, López-Delgado H (2021) Fertilización NPK, distribución de biomasa y número de minitubérculos de papa en invernadero. Revista mexicana de ciencias agrícolas. 11(8): 1827-1838.
García-Segura DR, Valdez-Aguilar LA, Ramírez-Rodríguez H, Zermeño-González A, Cadena-Zapata M (2021) Potato minituber production in aeroponics compared to soil and coir dust. Terra Latinoamericana. 39: 1-10.
Hopkins BG, Stark JC, Kelling KA (2020) Nutrient Management. In: Stark J, Thornton M, Nolte P (eds) Potato Production Systems. Springer, Cham, p. 155-202.
Iwama, K (2008) Physiology of the potato: New insights into root system and repercussions for crop management. Potato Research. 51: 333-353.
Jerez-Mompie E, Martín-Martín R (2012) Behavior of growth and yield of the potato (*Solanum tuberosum* L.) variety Spunta. Cultivos tropicales. 33(4):53-58.
Jerez-Mompie E, Martín-Martín R, Díaz-Hernández Y (2014). Estimate of the leave area in two potato varieties (*Solanum tuberosum* L.) for non destructive methods. Cultivos tropicales. 35(1): 57-61.
Jerez-Mompie EI, Martín-Martín R, Morales-Guevara D (2016) Classic growth analysis in three potato (*Solanum tuberosum* L.) varieties. Cultivos tropicales. 37(2): 79-87.
Joshi M, Fogelman E, Belausov E, Ginzberg I (2016) Potato root system development and factor that determine its architecture. Journal of Plant Physiology. 205: 13-123.
King BA, Stark JC, Neibling H (2020) Potato irrigation management. In: Stark J, Thornton M, Nolte P (eds) Potato Production Systems. Springer, Cham, p. 418-446.
Kondhare KR (2022) Phytohormone-Mediated regulation of sprouting in tuber and storage root crops. In: Aftab T (ed) Auxins, cytokinins and gibberellins signaling in plants. Springer, Cham. p. 285-311.
León-Burgos AF, Beltrán-Cortes GY, Barragán-Pérez AL, Balaguera-López HB (2021) Distribución de fotoasimilados en los órganos vertederos de plantas solanáceas, caso tomate y papa Una revisión. Revista Ciencia y Agricultura. 18(3): 79-97.
Nasir MW, Toth Z (2022) Effect of drought on potato production: A review. Agronomy. 12(3): 635.
Naumann M, Koch M, Thiel H, Gransee A, Pawelzik E (2020) The importance of nutrient management for potato production Part II: Plant nutrition and tuber quality. Potato Research. 63:121-137.
Perez E, Rafael-Rutte R, Osorio G (2024) Water stress in commercial potato (*Solanum tuberosum* L.) cultivars in the central region of Peru. Journal of High Andean Research. 26(1): 46-55.
Potter JR, Jones JW (1977) Leaf area partitioning as an important factor in growth. Plant Physiology. 59(1): 10-14.
Sánchez-Bernal EI, Ortega-Escobar M, González-Hernández V, Camacho-Escobar M, Kokashi-Shibata J (2008) Crecimiento de plantas de papa (*Solanum tuberosum* L.) cv. Alpha, inducido por diversas soluciones salinas. Interciencia. 33(9): 643-650.
Sifuentes-Ibarra E, Ojeda-Bustamante W, Macías-Cervantes J, Merino-Leyva RI, Preciado-Rangel P, Ruelas-Islas JR (2024) Controlled wáter déficit and its effect on the yield and quality of three potato varieties. Revista Mexicana de Ciencias Agrícolas. 4(8): 1-12.
Stark JC, Love SL, Knowles NR (2020a) Tuber Quality. In: Stark J, Thornton M, Nolte P (eds) Potato Production Systems. Springer, Cham, p.480-497.
Stark JC, Novy R, Love SL (2020b) Variety selection and management. In: Stark J, Thornton M, Nolte P (eds) Potato Production Systems. Springer, Cham, p.35-61.
Taipe N, Taype D (2023) Efecto de la fertilización biológica, orgánica y química en el rendimiento de papa (*Solanum tuberosum* L.). Bachelor thesis, Huancavelica, Peru.
Thornton, M (2020) Potato growth and development. In: Stark J, Thornton M, Nolte P (eds) Potato Production Systems. Springer, Cham, p.19-33.
Tirado-Malaver RH, Mendoza-Sáenz J, Titado-Lara R, Tirado-Malaver R (2021) Multivariate analyzes to characterize and typify potato production farms (*Solanum tuberosum* L.) in Cutervo, Cajamarca, Peru. Tropical and Subtropical Agroecosystems. 24(3): 1-15.
Wengle SA, Musabaeva S, Greenwood-Sánchez D (2024) Second bread: Potato cultivation and food security in Kyrgyztan. The Journal of Development Studies. 60(11): 1691-1712.
Xing Y, Zhang T, Jiang W, Li P, Shi P, Xu G, Cheng S, Cheng Y, Zhang F, Wang X (2022) Effects of irrigation and fertilization on different potato varieties growth, yield and resources use efficiency in the Northwest China. Agricultural Water Management. 261(1): 107351.