horticultura brasileira

Research

SILVA, GO; AZEVEDO, FQ; MELO, JWP; PEREIRA, GE; PATIÑO-TORRES, AJ; CARVALHO, ADF; RAGASSI, CF; PEREIRA, AS. 2022. Growth, fresh mass accumulation and distribution in new Brazilian potato cultivars. *Horticultura Brasileira* 40: 208-213. DOI: http://dx.doi.org/10.1590/s0102-0536-20220210

Growth, fresh mass accumulation and distribution in new Brazilian potato cultivars

Giovani O da Silva [1]*; Fernanda Q Azevedo [2]; Jackson WP de Melo [3]; Gabriel E Pereira [3]; Albania J Patiño-Torres [4]; Agnaldo DF de Carvalho [5]; Carlos Francisco Ragassi [5]; Arione da S Pereira [2]

[1]Embrapa Hortaliças, Canoinhas-SC, Brasil; giovani.olegario@embrapa.br (*author for correspondence); [2]Embrapa Clima Temperado, Pelotas-RS, Brasil; fernanda.azevedo@embrapa.br; arione.pereira@embrapa.br; [3]Universidade de Brasília (UnB-FAMV), Brasília-DF, Brasil; jwpachecco@gmail.com; gb.emiliano28@gmail.com; [4]Universidade de São Paulo, Escola Superior de Agricultura "Luiz de Queiroz", Departamento de Genética (USP-ESALQ), Piracicaba-SP, Brasil; albaniajose@gmail.com; [5]Embrapa Hortaliças, Brasília-DF, Brasil; agnaldo.carvalho@embrapa.br; carlos.ragassi@embrapa.br

ABSTRACT

The present study aimed to evaluate the plant growth curve of two new potato cultivars, to better understand the dynamics of the plant development throughout the growth cycle, and to subsidize management strategies. Field experiments were carried out in Canoinhas-SC, and Pelotas-RS, in the spring 2019. The new potato cultivars BRS F50 - Cecília and BRS F183 - Potira were compared with the standard cultivar widely grown in the country, Asterix. The experimental design was randomized complete blocks with four replications of plots composed of 43 useful plants, plus borders. Destructive samples of four plants per plot were carried out at 28, 42, 56, 70, 84, 98, and 112 days after planting. Morpho-agronomic characters were evaluated throughout the crop cycle, and the determination of tuber yield was done at its end, harvesting 15 plants per plot. Cecília presented a great development of the aboveground plant parts, and a high tuber yield. Potira also showed a good tuber yield, but was late in the plant development cycle, requiring specific studies on differentiated management of this character. In general, genotypes with a greater development of the aboveground plant parts are more productive, however, in this analysis it is not possible to consider only characters related to the leaf production or even the leaf area, but the plant structure as a whole, including stem development.

Keywords: *Solanum tuberosum*, growth curve, morphophysiology.

RESUMO

Crescimento, acúmulo e distribuição de matéria fresca em novas cultivares de batata

O presente estudo objetivou avaliar a curva de crescimento das plantas de duas novas cultivares de batata, para melhor conhecer a dinâmica do desenvolvimento das plantas ao longo do ciclo de crescimento vegetativo, e para subsidiar eventuais estratégias diferenciadas de manejo. Os experimentos de campo foram conduzidos em Canoinhas-SC, e Pelotas-RS, na primavera de 2019. Foram avaliadas as novas cultivares de batata BRS F50 - Cecília e BRS F183 - Potira, e a cultivar testemunha amplamente cultivada no país, Asterix. O delineamento experimental foi em blocos completos casualizados com quatro repetições de parcelas compostas por 43 plantas úteis, mais bordaduras. Coletas destrutivas de quatro plantas por parcela foram realizadas aos 28, 42, 56, 70, 84, 98 e 112 dias após o plantio. Foram avaliados caracteres morfoagronômicos ao longo do ciclo da cultura, e ao final, com a colheita de 15 plantas por parcela, foi realizada a determinação da produtividade de tubérculos. Cecília apresentou maior desenvolvimento da parte aérea das plantas e também elevada produtividade de tubérculos. Potira também apresentou boa produtividade de tubérculos, mas ciclo de desenvolvimento das plantas mais tardio, necessitando de estudos mais específicos sobre o manejo diferenciado considerando esta característica. Foi verificado ainda que, em geral, os genótipos com maior desenvolvimento da parte aérea foram mais produtivos. No entanto, nesta análise não se pode considerar apenas os caracteres relacionados à produção de folhas ou mesmo a área foliar, mas a estrutura das plantas como um todo, incluindo o desenvolvimento das hastes.

Palavras-chave: *Solanum tuberosum*, curva de crescimento, morfofisiologia.

Received on June 7, 2021; accepted on April 22, 2022

In Brazil, the potato (*Solanum tuberosum*) is highly important economically. In 2020, the production exceeded 4.12 million tons on approximately 125,700 hectares with an average yield of 41.9 t ha^{-1} (IBGE, 2022).

Among many strategies for reaching high yields in the potato crop, the use of adapted cultivars stands out, providing an adequate number and size of tubers, good leaf area and an adequate number of stems per plant, as well (Pereira *et al*., 2020). Furthermore, the growth analysis provides information on the dynamics of the vegetative development for each genotype, individually. The growth analysis is obtained by measuring the accumulated biomass at regular intervals, and observing the plant morphological characteristics, as well. A growth curve can be obtained for each plant organ studied, including the portion that grows underground (tubers), and the contribution of the different organs to the total growth (Pereira *et al*., 2020).

The dry matter accumulation in plants throughout their development results primarily from photosynthetic activity, in addition to the result of nutrient absorption (Fernandes *et al*., 2010). The greater the leaf surface, the greater the photosynthetic activity tends to be (Jadoski *et al*., 2012), so the leaf area index can be used to estimate the yield potential of a genotype, as well as the phenological stage of the crop.

The knowledge on the plant development along time can also help in determining the best spacing between plants, the best stages of development to carry out cultural practices such as hilling, topdressing, the most critical moments for phytosanitary controls and irrigation, in addition to the best moment for the aboveground plant desiccation (Silva *et al*., 2020).

This study aimed to evaluate the plant growth curve of two new potato cultivars, in order to better understand the dynamics of plant development throughout the vegetative cycle, and to subsidize eventual differentiated management strategies.

MATERIAL AND METHODS

Two experiments were carried out in southern Brazil: Canoinhas-SC (26°10'S, 50°21'W, 765 m altitude) and Pelotas-RS (31°41'S, 52°26'W, 57 m altitude). According to Köppen-Geiger, the climate of these locations is classified as Cfb and Cfa, respectively. The soils are classified as Dystrophic Red Latosol and Red-Yellow Podzolic with clayey and sandy loam textures, respectively (Embrapa, 2013). Climatological data were obtained from automatic stations located near the experiments. The temperature during the experiments varied between 18 and 35°C in Canoinhas and between 24 and 36°C in Pelotas. The accumulated precipitation was 387.4 and 795.6 mm for Canoinhas and Pelotas, respectively. The planting dates were respectively, August 12, 2019 and August 21, 2019, for Canoinhas-SC and Pelotas-RS.

In both locations, fertilization was carried out with 3,000 kg ha^{-1} 04-14-08 N-P-K. Seed tubers with 40-50 mm in diameter, previously stored for eight months in a cold chamber at 3.5±0.5°C, were used. The planting spacing was 35 cm between plants and 75 cm between rows. Hilling was carried out 30 days after planting.

Cultivars BRS F50 – Cecília and BRS F183 - Potira, registered by Embrapa in 2020, and Asterix, a cultivar widely grown in the country for French fry processing and multipurpose fresh market were evaluated. The experimental design was randomized complete blocks with four replications of plots composed of 43 useful plants, plus borders.

Samples of four plants per plot were collected at 28, 42, 56, 70, 84, 98 and 112 days after planting (DAP), to estimate the growth curves. The plants were separated into stems, leaves and tubers. Soon after collecting the plants, the following characters were measured: fresh mass of leaves (LFM, t ha^{-1}); stem fresh mass (SFM, t ha^{-1}); fresh mass of aboveground parts: leaves plus stems (LSFM = LFM + SFM); leaf number (LN, plant^{-1}); stem number (SN, plant^{-1}); length of the longest stem (LLS, cm); and tuber fresh mass (TFM, t ha^{-1}). The leaf area index (LAI) was obtained as the ratio between the leaf area and the area occupied by the plants (m^2/m^2). Leaf area was obtained by the leaf disc method, by collecting 20 leaf discs with the aid of a drill with a known area, weighing the leaf discs on a precision scale and multiplying these values by the leaf mass (Leaf mass), according to Silva *et al*. (2020).

After the last sample was collected, in each plot, 15 plants were harvested to estimate the final yield: total tuber number (TTN, number ha^{-1}), total tuber yield (TTY, t ha^{-1}), marketable tuber number (MTN, number ha^{-1}), and marketable tuber yield (MTY, t ha^{-1}), considering as marketable, tubers larger than 45 mm in diameter.

The homogeneity of the data was evaluated by the Levene test, the normality of the residues by the Jarque-Bera test, and the data were submitted to the sphericity test of the model. Individual and joint analyzes of variance were performed using the F test at a 5% level of significance, and of regression. Means were compared by the Tukey test at 5% of significance. All analyzes were performed using the R statistical software (R Core Team, 2020).

RESULTS AND DISCUSSION

The clones differed (P≤0.1%) according to the fresh mass of leaves, fresh mass of stems, fresh mass of shoots, number of stems per plant, fresh mass of tubers, and leaf area index in the joint analysis of the stages of cultivation in Canoinhas-SC and Pelotas-RS (data not shown). The development stage had an effect on all evaluated characters, except the number of stems per plant. The interaction between the clones and the development stage (G×S) was significant for fresh mass of leaves, fresh mass of stems, number of leaves and fresh mass of tubers.

Although the experiment site had a significant effect on the fresh mass of leaves, fresh mass of stems, fresh mass of tubers, number of leaves, length of the longest stem, and leaf area index, there was no interaction between the genotypes and the environment (G×E) for these characters. Despite the differential effect of environment on some characters, this effect did not significantly alter the ranking of the genotypes, which allows us to make the discussion based on their average performance in the locations.

The leaf number and the plant height are characters commonly used for the evaluation of the plant vigor, as they can be indirectly linked to tuber yield. The same as for the specific leaf area, which can vary according to the leaf blade size, since the photosynthetic potential of plants determines about 90% of tuber yield (Fernandes *et al*., 2010; Zanon *et al*., 2013).

The leaf fresh mass reached the maximum point close to 74 and 77 DAP for the cultivars Asterix and Cecília, respectively, with higher values for Cecília, 13.90 t ha^{-1}, followed by Potira, 10.48 t ha^{-1} at 86.42 DAP, and lower for Asterix, 8.55 t ha^{-1} (Figure 1).

The stem fresh mass was also higher for Cecília, 9.39 t ha^{-1} at 88.62 days, lower for Asterix, 5.64 t ha^{-1} at 83.35 DAP, and an intermediate value for Potira, 8.19 t ha^{-1}, although later, at 119.65 DAP (Figure 1). These data indicate that Cecília presents greater development of the aboveground parts, and that Potira would be later than the others.

In turn, tuber fresh mass increased linearly up to 112 DAP for all genotypes, the date of the last evaluation, and was higher for Cecília, 45.00 t ha^{-1}, while for Potira and Asterix, it was 33.06 and 31.88 t ha^{-1}, respectively (Figure 1).

The length of the longest plant stem, in the average of the four genotypes, was greater in Pelotas, with 101.78 cm, and reached earlier, at 59.48; while in Canoinhas it was 95.70 cm at 76.23 DAP. On the other hand, the total leaf number per plant was higher in Canoinhas, 84.51 leaves at 76.32 DAP, than in Pelotas, 68.98 leaves at 53.03 DAP (Figure 1).

The period of greatest decrease in measures and indices of shoot growth (leaves and stems), and the corresponding increase in tuber mass, is due to a natural process of the potato plants, in which the photoassimilates produced in the shoot are translocated to the tubers to be stored mainly in the form of starch. This process starts at the beginning of the tuber formation phase and tends to accelerate with the development of the crop, and to gradually decrease at the end of the vegetative cycle and end with the senescence of the plants (Fernandes *et al*., 2010). This fact occurred to a lesser extent in Asterix, since this cultivar showed less development of the aboveground parts. Since the tuber fresh mass exceeded the total fresh mass of the aboveground plant parts, which is the sum of the fresh mass of leaves and fresh mass of stems, in the sampling carried out at 84 DAP for Cecília and Asterix, occurring later in Potira, at 98 DAP (data not shown). These results indicate the need for studies of differential field management for these genotypes, mainly for Potira.

Regarding the stem number, Potira had a lower average number (3.46) than Cecília (5.82) and Asterix (6.01). As for Asterix, Fernandes *et al*. (2010) also found that this cultivar had a large number of stems per plant, 6.30. These authors comment that the distribution of leaves on a greater number of stems can be an advantage, as it represents a reduction in self-shading (Fernandes *et al*., 2010). However, as can be seen in this work, this theory is only applied if leaf development is considered together, because in the case of Asterix, there is a greater number of stems, but less leaf development.

The leaf area index showed a maximum value of 4.95 at 78.95 DAP for Cecília, that is, leaf surface equivalent to almost five times the area of soil occupied by the plants, being slightly lower for the other cultivars, close to 4.20. For Potira, it occurred later, at a time very close to the fresh mass of leaves (Figure 1).

Characters related to the development of plant aboveground parts (leaves and stems), distribution in the plant and the stem number can be used to define the spacing between plants, where larger spacings can be studied for genotypes with higher values for these characters (Pereira *et al*., 2020).

As for the total and marketable tuber yield at the end of the crop cycle, the genotypes differ significantly, but they did not differ in terms of total and marketable tuber numbers. It was verified that although there was a significant effect of environment, there was no genotype x environment interaction for these characters. For both total and marketable tuber yield, Cecília was superior to Asterix, and Potira presented intermediate yield, but not differing from the other cultivars (Table 1).

Observing jointly the plant aboveground parts and tuber yield data, a clear trend of higher tuber yield for the genotypes with greater aboveground plant part development, for the three cultivars, can be noticed. This reinforces the importance of including in the evaluations of clones in the phase development, some characters related to the aboveground plant parts.

Silva *et al*. (2018) evaluated the same genotypes of this study, in an earlier generation of selection, when these two Brazilian genotypes had not yet been registered as cultivars, aiming to assess their tuber yield potential in comparison to other clones and two standard cultivars, including Asterix. They reported average values of 58.57, 56.69 and 52.81 cm for the longest stem at 60 DAP for Potira, Cecília and Asterix, respectively. The stem number was 4.34, 6.27 and 6.24, respectively. At that time in the vegetative cycle, the plants were still growing, but the stem number, which is determined earlier in the potato development cycle, was quite similar to that found in the present study. The authors also reported that both clones presented higher marketable yield potential than Asterix, with averages of 29.75, 28.71 and 15.66 t ha^{-1}, respectively, which are also very similar to the present study, confirming the high yield potential of these cultivars, and the lower number of stems for Potira.

Fernandes *et al*. (2010) evaluated the growth of the cultivar Asterix from 20 to 97 DAP, and found an average of 6.3 stems per plant, a value also similar to the present study, 6.01. The authors also reported that the stem number did not increase as the crop cycle progressed. The length of the largest Asterix stem was close to 60 cm and did not increase after 55 DAP.

Regarding the leaf area index, other studies evaluated this character in Asterix, and found contrasting values, ranging from 1.00 (Zanon *et al*., 2013) to 3.21 and 4.44 (Cogo *et al*., 2006), while in the present study it ranged from 4.16 to 4.95. Higher values of leaf area, within certain limits, may be related to greater solar radiation interception, and associated with greater plant growth and tuber yield (Jadoski *et al*., 2012). And, the best spatial distribution of this leaf area, which would provide better photosynthetic efficiency, may depend, for instance, on the stem number per plant (Fernandes *et al*., 2010) and plant structure, as well (Silva *et al*., 2020).

Pereira *et al*. (2020) evaluated the growth of four potato genotypes in the Midwestern Brazil, including Potira and Asterix, several similarities being found with the present study, such as, a greater stem number per plant for Asterix, 6.00, compared to Potira, 3.00. They found that these genotypes did not differ significantly regarding the leaf number, 56.33 and 54.42, and the height of the longest stem, 56.12 and 58.33, respectively for Asterix and Potira. Potira had a higher leaf area index than Asterix. In the evaluation of the dry mass of the aboveground plant parts, the authors also reported a greater and a later development of Potira in relation to Asterix, in addition to greater total

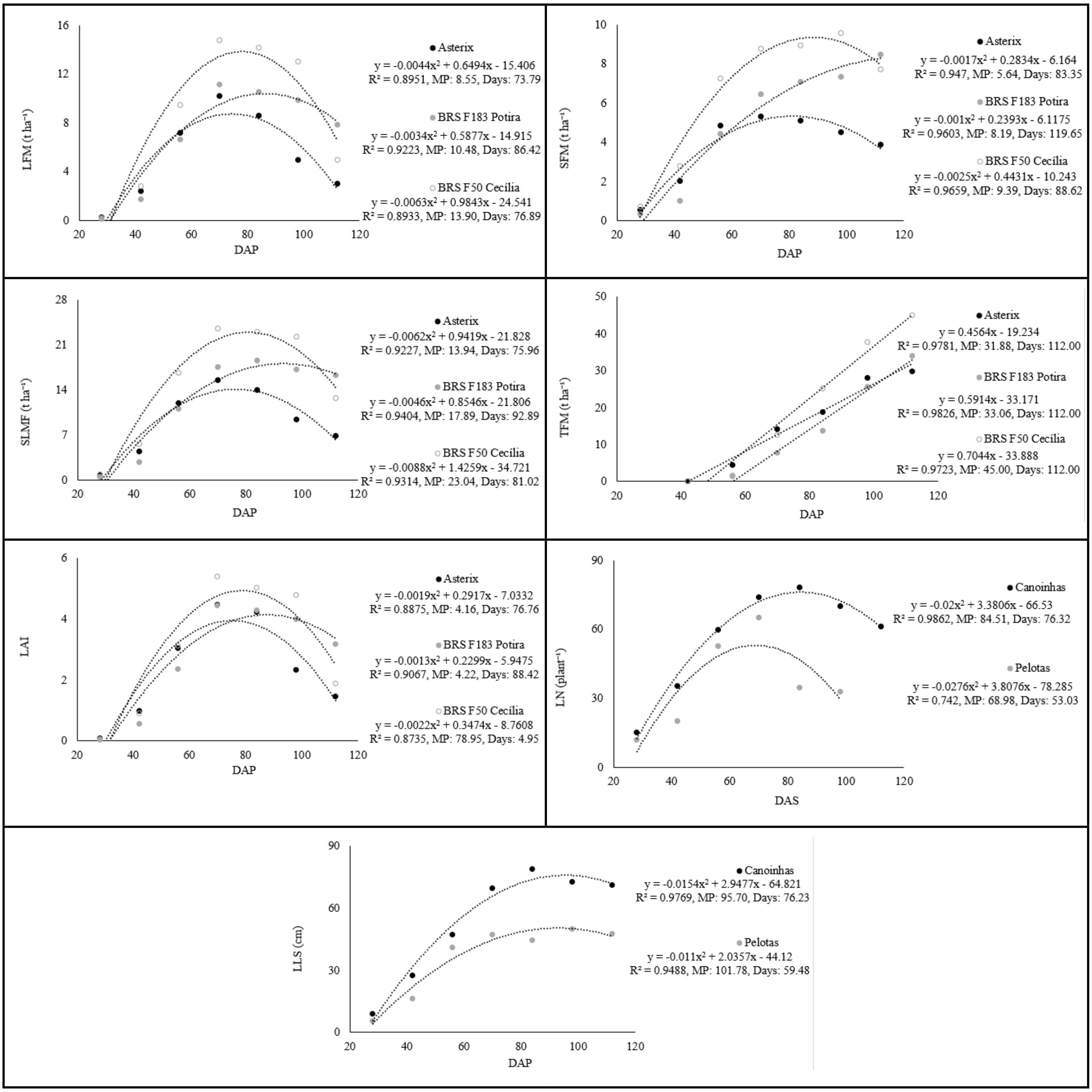

Figure 1. Functions of accumulation of leaf fresh mass (LFM, t ha^{-1}), stem fresh mass (SFM, t ha^{-1}), fresh mass of the aboveground plant parts, leaves and stems (LSMF, t ha^{-1}), tuber fresh mass (TFM, t ha^{-1}), leaf area index (LAI), leaf number (LN, $plant^{-1}$), and length of the longest stem (LLS, cm) of three potato genotypes, depending on the number of days after planting (DAP), in Pelotas-RS and Canoinhas-SC, Brazil. R^2= coefficient of determination, MP; Days= maximum point and respectively number of days calculated by the regression equation. Pelotas and Canoinhas, 2022.

and marketable tuber yields, with values of 58.60 and 35.44 t ha^{-1} of total yield, and 48.24 and 23.46 t ha^{-1} of marketable yield, respectively.

Silva *et al*. (2020) evaluated the growth of these genotypes in three environments, and also reported a higher tuber yield and a later aboveground part development for Potira and Cecília compared to Asterix. The average yield of marketable tubers in these environments was 29.08, 24.28 and 16.20 t ha^{-1}, while in the present study it was 23.80, 27.24 and 13.38 t ha^{-1}, respectively for the same genotypes. The maximum leaf area index reported in that study was lower and occurred earlier, with mean values of 2.55 at 78.33 DAP for Asterix, 2.34 at 70 DAP for Potira, and 2.20 at 69.83 DAP for Cecília, probably due to environmental effects that may have caused lower plant development, since the genotypes are genetically identical. But, interestingly, this did not affect tuber yield, as they were quite similar to the present study, indicating that the leaf area index alone may not have a strong relationship with tuber yield.

To better understand the relationship between the measured characters in the successive sample collections, a simple correlation analysis was carried out between characters (Table 2). Significant correlations were observed between the characters that measure the aboveground plant parts, i.e., leaf fresh mass, stem fresh mass, fresh mass of the aboveground plant parts, leaf number, length of the longest stem and leaf area index, all of them being correlated to each other. According to Silva *et al*. (2018), the vegetative characters, such as stem number and size and plant vigor, are related to the index of vegetative area available for photosynthesis. However, tuber fresh mass was correlated with the aboveground plant part fresh mass, but only weakly (r = 0.30). The tuber fresh mass correlation being more pronounced in relation to the length of the longest stem (r = 0.50), and to the stem fresh mass (r = 0.49), than with the leaf fresh mass (r = 0.19), or with the leaf area index (r = 0.21). The information that plant height, represented herein by the length of the longest stem, is more strongly associated with the tuber mass than characters that measure the leaf mass and number, and the leaf area index itself agree with Silva *et al*. (2020). The positive relationship between plant height and tuber yield was also found by Khayatnezhad *et al*. (2011), and Fekadu *et al*. (2013). In addition, plant vigor has also been reported to have a positive effect on tuber yield (Pereira *et al*., 2017). Cecília presented a greater development of leaves and stems, and probably a greater effect on tuber yield has occurred due to the plant structure, with more developed stems in terms of its weight/structure, than just the greater leaf number or mass and the leaf area index, as well.

This study allowed us conclude that Cecília presents a great development of the aboveground plant parts, and a high tuber yield. Potira also shows a good tuber yield, but it is later in the plant development cycle, requiring specific studies on differentiated management considering this character. In general, genotypes with a greater development of the aboveground plant parts are more productive, however, in this analysis it is not possible to consider only characters related to the leaf production or even the leaf area, but the plant structure as a whole, including stem development.

Table 1. Breakdown of the genotype and planting location interaction for the total tuber number (TTN), total tuber yield (TTY), marketable tuber number (MTN), and marketable tuber yield (MTY) of three potato cultivars evaluated in Canoinhas-SC and Pelotas-RS, Brazil. Canoinhas and Pelotas, 2022.

Source of variation	TTN (plant^{-1})	TTY (t ha^{-1})	MTN (plant^{-1})	MTY (t ha^{-1})
Genotype (G)	n.s.	*	n.s.	*
BRS F50 - Cecília	7.87 a	34.68 a	4.21 a	27.24 a
BRS F183 - Potira	6.17 a	30.34 ab	3.41 a	23.80 ab
Asterix	9.51 a	23.08 b	2.97 a	13.38 b
Environment (E)	*	*	*	*
Canoinhas	9.32 a	40.21 a	5.08 a	33.23 a
Pelotas	6.38 b	18.52 b	1.98 b	9.72 b
G×E	n.s.	n.s.	n.s.	n.s.
General mean	7.85	29.37	3.53	21.47

n.s. =not significant by the F test, *significant by the F test, 5%. Means followed by same letters in column, did not differ by the Tukey test, 5%.

Table 2. Pearson correlations for leaf fresh mass (LFM), fresh mass of stems (SFM), fresh mass of the plant aboveground parts, leaves and stems (LSMF), leaf number (LN), tuber fresh mass (TFM), stem number (SN), length of the longest stem (LLS), and leaf area index (LAI) of three potato cultivars at different stages of development, in Canoinhas-SC and Pelotas-RS, Brazil. Pelotas and Canoinhas, 2022.

	SFM	LSFM	TFM	LN	SN	LLS	LAI
LFM	0.87*	0.98*	0.19	0.87*	0.02	0.77*	0.97*
SFM		0.95*	0.49*	0.81*	0.08	0.82*	0.83*
LSFM			0.30*	0.86*	0.04	0.81*	0.95*
TFM				0.20	-0.01	0.50*	0.21
LN					0.08	0.82*	0.89*
SN						-0.06	0.01
LLS							0.82*

*significant by the t test, 5%.

REFERENCES

COGO, CM; ANDRIOLO, JL; BISOGNIN,

DA; GODOI, RDS; BORTOLOTTO, OC; BARROS GT. 2006. Crescimento, produtividade e coloração dos chips de tubérculos de batata produzidos sob alta disponibilidade de potássio. *Ciência Rural* 36: 985-988.

EMBRAPA. 2013. Sistema brasileiro de classificação de solos. Centro Nacional de Pesquisa de Solos: Rio de Janeiro.

FEKADU, A; PETROS, Y; ZELLEKE, H. 2013. Genetic variability and association between agronomic characters in some potato (*Solanum tuberosum* L.) genotypes in SNNPRS, Ethiopia. *International Journal of Biodiversity and Conservation* 5: 523-528.

FERNANDES, AM; SORATTO, RP; SILVA, BL; SOUZA-SCHLICK, GD. 2010. Growth and dry matter accumulation and distribution in potato cultivars during the winter crop season. *Pesquisa Agropecuária Brasileira* 45: 826-835.

IBGE. 2019. Levantamento sistemático da produção agrícola. SIDRA, Rio de Janeiro. Available at https://sidra.ibge.gov.br/home/lspa. Accessed April 6, 2022.

JADOSKI, SO; LOPES, EC; MAGGI, MF; SUCHORONCZEK, A; SAITO, LR; DENEGA, S. 2012. Method of determination of the leaf area of the potato cultivar Agata from linear dimensions. *Semina* 33: 2545-2554.

KHAYATNEZHAD, MR; SHAHRIARI, BR; GHOLAMIN, RG. 2011. Correlation and path analysis between yield and yield components in potato (*Solanum tuberosum* L.). *Middle-East Journal of Scientific Research* 7: 17-21.

PEREIRA, AS; SILVA, GO; CARVALHO, ADF; PONIJALEKI RS. 2017. Performance of advanced potato clones: plant vigor, tuber yield and specific gravity. *Horticultura Brasileira* 35: 440-444.

PEREIRA, GE; RAGASSI, CF; CARVALHO, ADF; SILVA, GO; VILELA, MS. 2020. Growth and yield of potato genotypes in the Brazilian Midwest. *Pesquisa Agropecuária Tropical* 50: e64339-e64339.

R CORE TEAM. 2929. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Available at http://www.r-project.org/. Accessed March 8, 2021.

SILVA, GO; PEREIRA, AS; CARVALHO, ADF; AZEVEDO, FQ. 2018. Seleção genotípica de clones de batata para rendimento de tubérculos, aspecto vegetativo e qualidade de fritura. *Revista Brasileira de Ciências Agrárias* 13: 01-10.

SILVA, GO; AZEVEDO, FQ; RAGASSI, CF; CARVALHO, ADFD; PEREIRA, GE; PEREIRA, ADS. 2020. Growth analysis of potato genotypes. *Revista Ceres* 67: 207-215.

ZANON, AJ; STRECK, NA; KRÄULICH, B; SILVA, MR; BISOGNIN, DA. 2013. Desenvolvimento das plantas e produtividade de tubérculos de batata em clima subtropical. *Revista Ciência Agronômica* 44: 858-868.