



The Growth and Development of the Potato According to their Variety in the Central Area of Romania

Nicolae-Tiberiu DRĂGHICI¹, Alexandra-Mihaela NAGY^{1*} and Camelia SAVA-SAND^{1,2}

¹ University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Doctoral School of Agricultural Engineering, 3-5 Calea Mănăştur, Cluj-Napoca, Romania

² "Lucian Blaga" University of Sibiu, Faculty of Agricultural Science, Food Industry and Environmental Protection, 7 Dr. Ion Raţiu, Sibiu, Romania

*Corresponding author: A.M.Nagy e-mail: alexandra.nagy@ulbsibiu.ro

RESEARCH ARTICLE

Abstract

In Europe, the potato (*Solanum tuberosum* L.) was first cultivated in botanical gardens. Currently, in our country, special emphasis is placed on potato cultivation, especially in the central area of the country. In Romania, potato consumption is high, being considered "the second bread" by the entire population. In this study, the capacity of growth and development for some potato varieties was observed, to highlight their suitability in the central area of Romania. Four varieties of potatoes as certified seed tubers were used in this study ('Productiv', 'Alouette', 'Salad Blue' and 'Paradiso'). Varieties were provided by the Potato Research - Development Station from Romania. During the vegetation period, the following criteria were monitored: the height of the main stem, the number of principal stems, the number of leaves on the main stem, the length of the median leaf on the main stem and the chlorophyll content of the leaves. The three potato varieties ('Alouette', 'Salad Blue' and 'Paradiso'), were grown under the same conditions as the control ('Productiv'), in Sibiu county, Romania. Following the measurements and their interpretation from a statistical point of view, it was demonstrated that the 'Alouette' variety had the best growth and development.

Keywords: development, growth, *Solanum tuberosum* L., variety

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INTRODUCTION

The potato is the third most important agricultural crop in the world, after rice and wheat (Allen and Scott, 1980). It was initially identified in Peru, and was brought to Europe by the Spanish in the 16th century. In Romania, it was introduced at the end of the 18th century, being cultivated for the first time by pharmacists in the botanical gardens of Transylvania (Anca et al., 2012; Barascu et al., 2016). In Romania, potato consumption is high, being considered "the second bread" (Anca et al., 2012). The reason behind this saying is that it has multiple uses in the food industry. Potato tubers can be processed, finally creating different products in the form of chips, flakes, flour or other products. The potato is also used in the alcoholic beverage industry, being the raw material in the processing of some spirits. Starch, glucose, dextrin or other biochemical compounds can also be extracted from the potato (Anca et al., 2012). The potato is a crop that prefers moist and cool growing conditions (Allen and Scott, 1980). Geographically, it can be cultivated up to latitude 72° and maximum altitudes of 1000-1500 m (FAO, 2023). According to Food And Agriculture Organization of the United Nations Statistics for Europe, between 2011-2015, potato production per hectare was constant, then experienced a slight increase, from an average production of 20-21 t/ha, to 22-23 t/ha, until in 2020. Regarding potato

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production in Romania, in the same period, it was fluctuating, between 10 and 18 t/ha, in 2019-2020, standing at 15 t/ha (FAO, 2023). Considering the importance of the potato in the territory of Romania, the current study shows the differences between four potato varieties cultivated in the territory of our country.

The main objective on this study was to discover the best varieties which can be adapted to the environmental and climate requirements of the central area of Romania. According to the official Catalog of Romanian cultivated plants for the year 2023 (Testing and Registering Variety Institute of Romania, 2023) there are 28 cultivated varieties, including the `Productive` variety. But, unofficially, several varieties of seed potatoes are sold on the territory of Romania, according to the profiling sites that sell the planting material. The four potato varieties were cultivated on the area of Didactic Farm from the „Lucian Blaga” University of Sibiu, in the village of Rusciori, Romania (45°48'40.43"N; 24° 3'1.37"E).

MATERIALS AND METHODS

Description of the experimental site

The present study was developed on Rusciori, a village near the city of Sibiu, from the same County, within the Didactic Farm of the „Lucian Blaga” University of Sibiu (Figure 1).

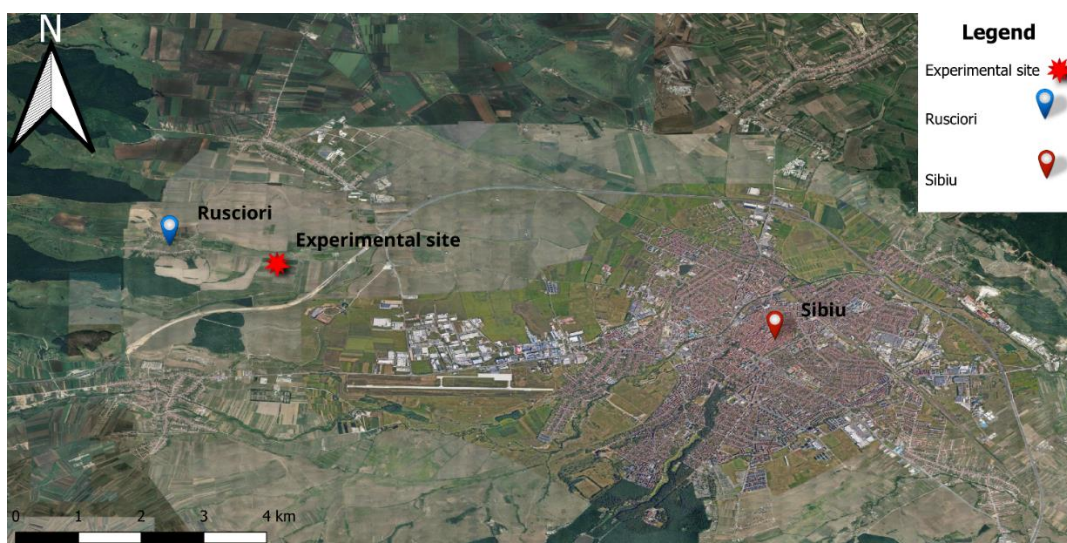


Figure 1. The location of the experimental site between the village of Rusciori and the city of Sibiu. Source: QGIS - qgis.org

Climatic conditions

The climatic conditions during the vegetation period, specifically the maximum and minimum temperatures of the days, along with precipitations are presented in the graph in Figure 2. It displays the temperatures and recorded precipitations starting from the day when the tubers were planted (3rd May) until the day of harvest (6th September). The sum of the degrees was 2421°C, and the total precipitation was 254.5 mm, in whole period of vegetation.

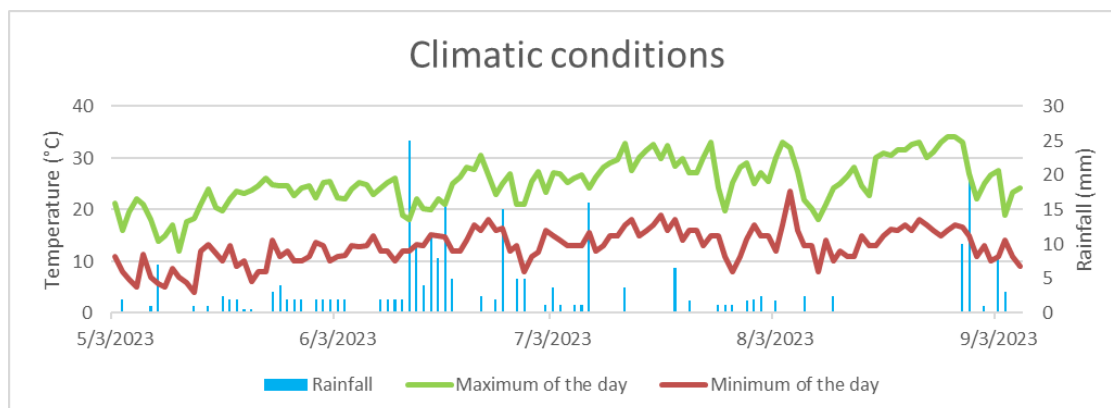


Figure 2. The climatic conditions during the experimental period in Rusciori, Sibiu County. Source: meteoblue.com

Description of varieties

The varieties used in this research are 'Productiv', 'Alouette', 'Paradiso' and 'Slad Blue'. All of them are certified plant material obtained from Potato Research - Development Stations from Targu Secuiesc (SCDCTS), Romania and Potato Research - Development Stations from Miercurea Ciuc (SCDCMC), Romania and they are:

- 'Alouette', originally from the Netherlands;
- 'Paradiso', originally from the Netherlands;
- 'Productiv', an autochthonous variety, developed at SCDCTS, currently maintained in the conservation stage according to the Official Catalog Of varieties, from Romania;
- 'Slad Blue', originally from Scotland.

All four varieties are described on the Table 1, in order to their provider, type of variety, shape of tuber, epidermis and flesh color.

Table 1. Summary characterization of *Solanum tuberosum* L. varieties studied

Variety	Provider	Type of Variety	Shape of Tuber	Epidermis Color	Flesh Color
'Alouette'	SCDCMC	Early	Oval-long	Red	Yellow
'Paradiso'	SCDCMC	Early	Oval-long	Yellow	Yellow
'Productiv'	SCDCTS	Early	Round-oval	Yellow	Yellow
'Salad Blue'	SCDCTS	Early	Oval	Blue	Purple to blue with white insertions

Note: SCDCTS – Potato Research - Development Stations from Targu Secuiesc; SCDCMC – Potato Research – Developmen Stations from Miercurea Ciuc

Experiment design

The experiment was designed on a plot with dimensions of 17 x 10 m (Lxl), which means 170 m², where the four varieties were planted. Each variety was planted on a subplot with a size of 3,25 x 8,4 m (Lxl), with a total area for each variety 27,3 m². The distance between the subplots was 0,8 m with a 0,8 m protection strip for each outer side of the plot. The tubers were planted at a distance of 0,5 m between rows and 0,25 m between tubers per row, resulting 30 plants per each row.

The experimental procedure

The preparation of the field was done by autumn plowing, and the preparation of the seed bed was done by two perpendicular passes with the disc, the last work being a pass with the milling cutter. No fertilizers or soil amendments were applied to the plots, nor were they irrigated. The planting was done manually at the beginning of May 2023. At the end of May 2023, the rows were rehoed and the plots were sprayed with herbicides. Throughout the vegetation period, five treatments (Tabel 2) against the main diseases (*Phytophthora infestans*, *Alternaria solani*) and pest (*Leptinotarsa decemlineata* L.) were applied. The harvest of tubers were done in 6th September 2023.

Table 2. Phytosanitary treatments performed on the experimental site

Crt. No.	Date of treatment	Vegetation phenophase	Product used	Active substance	Pest/disease
1	30.05.2023	Leaf development	Sencor liquid 600 SC	Metribuzin	Weeds
2	20.06.2023	Formation of side shoots	Folpan 80 WDG Karate zeon	Folpet Cyhalothrin	<i>Phytophthora infestans</i> <i>Leptinotarsa decemlineata</i> L.
3	30.06.2023	Flowering	Alcupral 50 PU Acrobat mz 69 WG	Copper oxychloride Mancozeb and dimethomorph	<i>Phytophthora infestans</i> <i>Alternaria solani</i>
4	10.07.2023	Development of fruits	Folpan 80 WDG Karate zeon	Folpet Cyhalothrin	<i>Phytophthora infestans</i> <i>Leptinotarsa decemlineata</i> L.
5	23.07.2023	Development of fruits	Acrobat MZ 69 WG Champ 77 WG	Mancozeb and dimethomorph Copper hydroxide	<i>Alternaria solani</i> <i>Phytophthora infestans</i>
6	05.08.2023	Senescence	Champ 77 WG	Copper hydroxide	<i>Phytophthora infestans</i>

Data collection and analyzing

Between June and July, five biometric observations were made to the four varieties in order to establish the influence of each variety to the height on the main stem, the number of main stems, the number of leaves on the main stem and the length of the median leaf. The height of the main stems was done by measuring each stem from the soil (Figure 3). After that, the number of main stems, the number of leaves on the main stem and the length of the median leaf were determined using a similar determination method that was used by Tessema and collaborators (Tessema et al., 2022; Tessema et al., 2020). All determinations were made on differently 10 plants of the same variety. In addition, the average of twenty determination for the chlorophyll content of the leaves for each plant was determined. The determination of the chlorophyll content was made using the SPAD-502PLUS device created by Konica Minolta, Japan, the device measures light wavelengths in the red (650 nm) and near-infrared (960 nm) light spectrum (Figure 4).



Figure 3. Determination of the height of the main stem in the experimental field. Each segment of the ruler is 10 cm.



Figure 4. Measuring the chlorophyll content with the SPAD-502PLUS device, on a potato leaf from the experimental field in Rusciori.

All collected data, were preelucrated by the Polifact Statistic Program, with Duncan test, using a monofactorial experience with four graduation. Each graduation is representig one of the studied variety.

RESULTS AND DISCUSSIONS

During the vegetation period, to protect the plants from pathogens and pests, 6 treatments were applied according to Table 2. The pathogens against which the treatments were applied are the main agents of potato infestation at the global level, *Phytophthora infestans* and *Alternaria solani* (Sharma et al., 2022; Haverkort at al., 2009). In general, potato diseases can be prevented by three general methods of control, namely: inducing a greater resistance of plants to a certain pathogen through selection and improvement, creating resistant varieties in this way (Haverkort at al., 2009; Walters and Fountaine, 2009), the selection of planting material that does not show signs of infection with pathogens and finally the application of phytosanitary treatments on the plants in the vegetative stage (Murmur et al., 2017). One of the most widely used fungicides on a global scale against *Phytophthora infestans* are the solutions that contain copper (Black, 1951), in the treatments applied in this experiment, Champ 77 WG was used, which has copper hydroxide as its active substance, against *Phytophthora infestans*, and Acrobat MZ 69 WG, a product based on mancozeb and dimethomorph, was used for *Alternaria solani* (Powelson and Inglis, 1999). For pests, two treatments were applied against *Leptinotarsa decemlineata* L., this being the most important potato pest (Coombs et al., 2003). The applied product was Karate Zeon, with the active substance cyhalothrin.

After centralizing all collected data, a significant difference according to Duncan's MRT ($p < 0,05$) were obtained (Table 3). It was observed that the best results were identified for the 'Alouette' variety regarding the height of the main stem (43.54 cm), followed by the control variety 'Productiv' (38.32 cm), 'Paradiso' variety (30.24 cm) and 'Salad Blue' variety (28.64 cm). The highest average value for the number of main stems was the variety 'Alouette' (6.24), followed by 'Salad Blue' (5.64), control, 'Productiv' (5.36), and the lowest value being the variety 'Paradiso' (4.02). The average number of leaves found on the main stem was 11.40 for the variety 'Alouette', followed by the

control with an average of 10.00, 'Salad Blue' with an average of 9.48, and the last average was for the variety 'Paradiso' with 9.38. The average length of the main leaf was 17.88 cm in the variety 'Alouette', equal to the average of the control, followed by the variety 'Salad Blue' with 14.4 cm and 'Paradiso' with 13.90 cm.

Finally, the most important indicator in this study was the chlorophyll content of the leaf, expressed in SPAD units. The highest chlorophyll content was the control variety with a value of 46.25 SPAD units, followed by 'Alouette' with a value of 38.25 SPAD units, 'Paradiso' with 36.25 SPAD units and finally 'Salad Blue' with 31.09 SPAD units. The 'Productiv' variety had better results only for the chlorophyll content with very small differences respect of 'Alouette' variety. This results reflects that 'Alouette' variety is superior by the control variety.

Table 3. Biometric observations on the experimental site regarding the growth of plants

Variety	Height of the main stem (cm)	No. of principal stems	Leaves no. on the main stem	Length of leaf (cm)	The chlorophyll content of leaves (SPAD units)
'Alouette'	43.54 ^a	6.24 ^a	11.40 ^a	17.88 ^a	38.25 ^{ab}
'Paradiso'	30.24 ^c	4.02 ^b	9.38 ^b	13.90 ^b	36.25 ^b
'Productiv'	38.32 ^b	5.36 ^a	10.00 ^b	17.88 ^a	46.25 ^a
'Salad Blue'	28.64 ^c	5.64 ^a	9.48 ^b	14.24 ^b	31.09 ^b
DS 5%	3.56 – 3.83	1.33 – 1.43	1.25 – 1.34	1.92 – 2.07	9.11 – 9.79

Note: The means in the column inside the table followed by different letters are significant according to Duncan's MR test ($p < 0.05$).

The results obtained by the control for the chlorophyll content are comparable to the results obtained by Barascu and collaborators (Barascu et al., 2016) for two local varieties of potato, from Brasov County. They measured the amount of photosynthesis in the years 2013-2014, during June, with maximum values of 46.6 SPAD units for both years (Barascu et al., 2016). Minotti et al. (1994) consider that an interval of 49 to 56 SPAD units is the threshold at which the nitrogen content of the plant is optima (Minotti et al., 1994).

In the literature references, it was observed that the amount of chlorophyll is directly proportional to the nitrogen content of the plant (Gianquinto et al., 2004). The assimilation of nitrogen from the soil helps to concentrate a greater amount of dry substance in the tuber (Mustonen et al., 2004), it will affect the yield of small tubers (Errebhi wt al., 1998) and can lead to the total increase of biomass of the plant (Goins et al., 2004).

The measurements made during the vegetation period show that the 'Paradiso' and 'Salad Blue' varieties were negatively influenced by the lack of precipitation compared to the variety 'Alouette' and 'Productiv', which can be considered varieties more resistant to water stress.

These results are supported by specialized literature, particularly in the case of non-adaptation to climatic conditions. Insufficient water, as in the case of this study (total precipitation below 500 mm) (Byrd et al., 2014), leads to a 60% reduction in the size of potato plant leaves, comparable to a potato plant receiving an optimal water quantity (Walters and Fountaine, 2009). Other authors suggest that in the case of drought-sensitive varieties and under water stress conditions, the above-ground part of the plant will suffer, exhibiting poor development (Walters and Fountaine, 2009). Under these water stress conditions, the above-ground part of the plant will suffer, exhibiting poor development (Walters and Fountaine, 2009). Under these water stress conditions, the number and height of the main stems are also affected (21.9), resulting in a reduced tuber yield (Allen and Scott, 1980).

CONCLUSIONS

Considering the results obtained after the experiment, the 'Alouette' variety can be one of the options of potato growers in the central area of Romania, more precisely Sibiu County. From a physiological point of view, this variety has a good development and great adaptability to the pedoclimatic conditions of the area, comparable to the native Romanian variety ('Productiv'). We do not consider the variety 'Salad Blue' suitable for cultivation in the studied area because the assimilation of nitrogen from the soil, in the plant, is deficient compared to the other varieties in the experiment. The claim is based on the results obtained from the readings taken with the SPAD-502PLUS device. Reduced assimilation was correlated with biometric measurements, thus there was poor development of the whole plant, resulting in low tuber yield.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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