Scientific Papers. Series B, Horticulture. Vol. LXIX, No. 2, 2025
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

PORTULACA GENOTYPES BREEDED AND BIOBANKED AT PLANT GENETIC RESOURCES BANK BUZĂU

Geanina NEGOŞANU[1], Costel VÎNĂTORU[1], Bianca MUŞAT[1], Camelia BRATU[1], Matilda POPESCU[1], Adrian PETICILĂ[2]

[1]Plant Genetic Resources Bank, 56 Nicolae Bălcescu Blvd, Buzău, Romania
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăşti Blvd, District 1, Bucharest, Romania

Corresponding author email: geanina.neacsu11@gmail.com

Abstract

Portulaca grandiflora and P. oleracea were introduced into breeding studies at Plant Genetic Resources Bank (PGRB) Buzău. The germplasm collection of P. grandiflora contains several genotypes highlighted by a varied color palette, while for P. oleracea several genotypes have been developed that can be cultivated and have great production potential. Among them, the cultivar G2 stands out, demonstrating distinct phenotypic expression which will be presented in this article. Following biometric measurements and phenological observations, average values were recorded with a height of 68 cm, a diameter of 82 cm, and a plant weight of 1570 g, with the note that the production potential could be doubled if staggered harvesting is practiced. The results recommend Portulaca as a viable food alternative with valuable nutritional and medicinal properties, especially in the context of climate change.

Key words*: germplasm collection, production potential, phenotype, food alternative, climate change.*

INTRODUCTION

The *Portulacaceae* family counts more than 100 species worldwide (Ocampo, 2013). The best known in Romania are *Portulaca oleracea* L. or Purslane and *Portulaca grandiflora* P. or Stone flower, the first one being considered an edible wild plant and one of the three most commonly reported weeds worldwide (Carrascosa et al., 2023). Known as a noxious weed that affects conventional crops, it is also traditionally eaten in Spain, Greece, Italy, Turkey, USA, and China (Feng et al., 2015). The most appreciated parts of purslane are fresh leaves and stems, with a distinctive sour taste (Petropoulos et al., 2019), purslane being mainly used in fresh green salads, but they also can be pickled or cooked (Takergari et al., 2013). The unanimous appreciation is due to an exceptional nutritional content, *P. oleracea* being rich in omega-3 fatty acids, antioxidants such as vitamins A, C, E and B, minerals such as potassium, calcium, magnesium, especially when plants are grown under stress conditions where higher concentrations of beneficial compounds are found (Montoya et al., 2023). These compounds are associated with the pharmacological properties of the species, such as its antioxidant, anti-inflammatory, antidiabetic, anti-obesity and hepatoprotective potential among others, which have led some to consider purslane a "food of future". A halophytic species, perfectly adapted to water deficit, high salinity and temperatures, it can be integrated with minimal crop costs in order to recover and improve soil quality (Carrascosa et al., 2023).

Perceived in Romania as a harmful weed to crops, *P. oleracea* occurs among vegetable or flowers seedlings, in orchards but also in wasteland, growing solitary or forming a green carpet covering the soil (Figure 1).

a) b)

Figure 1. *P. oleracea* grown in: a) basil seedling; b) on asphalt

1It vegetates in the most harsh places and when it is uprooted and left in the ground purslane doesn't die, but, on the contrary, it has the ability to emit adventitious roots on all its vegetative organs at soil contact, resuming its vegetation cycle and thus speeding up the rate of maturation and self-sowing in the ground. At PGRB Buzau, starting with 2021, *P. oleracea* and *P. grandiflora* species have been taken under study, by introducing them in breeding programs. Thus, several genotypes with distinct phenotypic expressivity were obtained, both in *P. grandiflora* for ornamental purposes and cultivable varieties, in *P. oleracea*, with high yield potential and a lifespan between 3 and 4 months. This article describes the *P. oleracea* G2 genotype, which was characterized by valuable biometric and phenological traits.

MATERIALS AND METHODS

The research works were carried out at PGRB Buzau (45°09´N, 25°5´E, 95 m) located in SE Romania, characterized by continental climate, steppe characteristic vegetation and leached chernozem soil.

The period analysed in this study was 2024. The genetic resources of *P. oleracea* come from the PGRB Buzau seed collection. Three cultivated genotypes were analysed: G1, G2 and G3 (Figure 2).

a) b)

Figure 2. *Portulaca oleracea* plants: a) cultivated genotype; b) wild purslane

The sowing was done in the first decade of March in protected spaces. Seeds were placed in 70-cell black plastic trays filled with commercial peat under nursery conditions. Seedlings were transplanted after 45 days, on 05.05.2023, at the stage of 6-8 leaves and 7-8 cm in height. No fertilizers, insecticides or other agrochemicals were used during the seedling growth.

The breeding methods used were repeated individual selection followed by negative mass selection. Phenological observations and biometric measurements were carried out according to the UPOV and IPGRI data sheets. Weighing operations were performed at PGRB Buzau laboratory on green plants and the device used was the two-decimal precision balance Kern 572-33. Leaf chlorophylls was assessed and the results were expressed in CCI units, using a CCM-200 plus, chlorophyll content meter (Figure 3).

a) b)

Figure 3. Laboratory instruments: a) CCM-200 plus, chlorophyll content meter; b) two-decimal precision balance Kern

Data were statistically analysed by the IBM SPSS v29.0. (SPSS Inc., Chicago, IL, USA) program. Prior to the analysis of variance (ANOVA), data were checked for normality. Then raw data for each genotype were subjected to one-way ANOVA, and when significant effects were recorded, the comparison of means was performed with Duncan's multiple range test at $p \leq 0.05$.

RESULTS AND DISCUSSIONS

In Romania, the Portulaca first descriptions belong to Zach C. Panțu, *Plantele cunoscute de poporul român* (1906), like a "plant with a glabrous, branched stem, lying on the ground; fleshy leaves, yellowish flowers; fruits are globose capsules with reniform seeds".

According to Thalassinos and al. (2023) *P. oleracea* is a species well known for its ability to tolerate abiotic stresses and grows in soil burdened with anthropogenic activities. The wild variety has a taproot capable of penetrating soil layers to a depth of 25-30 cm and a

secondary root spreading at a diameter exceeding 30 cm. The colour of the stem varies from shades of green to reddish, it is glossy and juicy with a sour and salty taste. Characteristic of wild *P. oleracea* is the ascending circular branching of the main and second shoots around the stem, on a radius that can vary from 5 to 50 cm. Leaves are sessile, conical towards the base and rounded towards the tip; intense yellow small flowers with 3-7 mm long sepals and 3-8 mm long petals, united at the base. The inflorescence consists of 2-7 flowers that gradually mature (green capsules at immaturity and brownish at full maturity) (Figure 4).

a) b)

Figure 4. *Portulaca oleracea*: a) sprout detail; b) inflorescence detail

Purslane has been identified to contain the highest amount of omega-3 fatty acid of any green leafy vegetable and no cholesterol (Nemzer et al., 2020). Cultivated *P. oleracea* can provide more information for farmers as an alternative food source with nutritional benefits. Unlike the wild version, the cultivated form is vigorous with an erect port (Figure 5).

a) b)

Figure 5. *P. oleracea*: a) cultivated species with a strong, erect port; b) basal plant detail

It also has a strongly developed root in both horizontal and vertical planes, a tall habit, with 7-15 strongly branched main shoots.

During the study, we did not detect any diseases and/or pests that would cause significant damage to the crop. Through the breeding methods used, three genotypes were obtained: G1, G2 and G3.

All three genotypes presented a rich, branched and developed root in the horizontal plane, with a diameter between 25-30 cm and in the vertical plane with depths that varied between 15 and 23 cm (Figure 6).

Figure 6. *P. oleracea* root, cultivated species

The differences were observed in terms of biometric characteristics of aerial parts. The cultivars show a valuable characteristic, namely branching, which materializes in the formation of multiple stems with many inflorescences, which thus leads to increased plant mass. The bush has a lignified stem which gives it resistance and which varied between 1.7 to 3.1 cm in G1, from 1.8 to 3.3 cm in G2 (Figure 7) and between 1.7 to 2.5 cm in G3.

Figure 7. *P. oleracea* lignified stem at G2 genotype

Characteristic for cultivated genotypes are the erect, very vigorous and tall shoots. They have anthocyanin coloration in the lower half, are tender, crunchy, with a salty and sour taste. Easy harvesting is allowed because of the stem texture with a superior quality production (Figure 8). When the shoots are broken, a penetrating aroma specific to beetroot (*Beta vulgaris* var. *rubra*) or Malabar spinach (*Basella rubra*), known for their very high anthocyanin content, is released.

a) b)

Figure 8. *P. oleracea:* a) anthocyanin coloration shoots; b) strong yellow green colour leaves with spatula-shaped

The foliage is dense and the leaves are grouped in clusters of five at the top of every shoot. The leaves are succulent, fleshy, hairless and spatula-shaped. On the underside of the leaf, veins are weakly pronounced and the RHS colour chart (sixth edition) is 143A (strong yellow green) (Figure 8).

The length of leaves varies between 3.8-4.8 cm, in G1, 3.7-4.5 cm in G2 and 3.0-4.1 cm range in G3; the width varied between 1.1-1.7 cm, in G1, 1.2-1.6 cm range in G2 and 1.1.-1.6 cm in G3; the leaf weight varied between 0.25-0.44 g in G1, 0.22-0.34 g in G2 and between 0.30-0.38 g in G3; the leaf thickness was 0.1 mm for all genotypes;

The mean height plant varied between 60 to 80.4 cm in G1, from 64 to 86.4 cm in G2 and between 63 and 73 cm in G3. The canopy diameter varied between 44.0-61.5 cm in G1, from 52 to 67 cm in G2 and the range was 41.3 to 64 cm for G3. The inflorescences are grouped at the bottom of every shoot and are composed of 4-11 flowers that bloom in staggered order. The flowering runs from May to September. After flowering, they form capsules with gradual seed maturation (Figure 9).

Figure 9. *P. oleracea* inflorescences with flowers and seed capsules in different stages of maturation

The capsules are initially light green and as they mature they dehydrate and turn brown. The fruit is a dehiscent capsule. At full maturity, the dehiscent capsules suddenly open and the seeds inside are dispersed into the environment, usually at noon, when the thermal oscillations are maximum (Figure 10).

Figure 10. *P. oleracea* mature dehiscent capsule

On average, a main shoot weighs 126.43 g, has 9 inflorescences with 6.4 capsules each, a plant contains an average of 1239 capsules, each capsule containing 88.3 seeds, which means an average of 109492 seeds/ plant, due to the presence of very vigorous shoots with a rich foliage and a large number of inflorescences (7-60). The plant has a very high yield potential if harvested in a staggered way, breaking off the main shoots to stimulate the emergence of young ones. The average weight of a G2 mature plant is 1570 g. The seeds are staggered released on the soil in one season that can provide the seed requirement for the establishment of 2 ha of crop.

Crop technology

The genotypes obtained have a large, vigorous habit and require a larger space for nutrition and development, which is why the planting scheme was used at 70 cm between rows and 35-40 cm between plants per row (Figure 11).

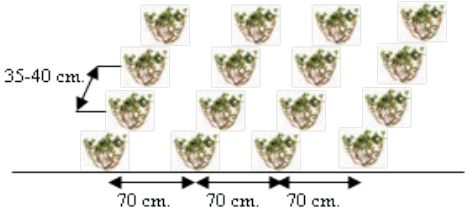

Figure 11. Cultivated *P. oleracea* - scheme culture: 70 cm between rows and 35-40 cm between plants/row

The sowing depth should be less than 0.5 cm, the seeds can germinate even uncovered at the soil surface (Vînătoru et al., 2019). Due to the very small size of the *Portulaca* seeds, several seeds are usually used for sowing, leading to a group of seedlings to be sown, which necessitates thinning as a mandatory operation after sowing. The plant's water needs are provided by the ramifications of the root system in horizontal plane, conferring resistance to drought. *P. oleracea* is characterized by tolerance and a very high potential of adaptability to thermohydric stress. The harvesting can start from May to late September, as the plant has a high regeneration power and thus ensures staggered production.

Main shoots chlorophyll determinations showed values ranging from 5.7 to 11.3 CCI.

Biometric observations at full maturity phenophase revealed maximum average values such as: canopy diameter 82.48 cm in G2, plant height 68.36 cm in G2, height sprout 2.46 cm in G2, diameter sprout 1.76 cm in G2.

Regarding the leaves dimensions, the measurements indicated average values such as: maximum leaf weight 0.34 g in G1, leaf length 4.24 cm and leaf width 1.38 cm in G3 (Table 1). Different small-case letters indicate significant differences among average values of biometric observations.

Table 1. Biometric measurements at cultivated *P. oleracea* growth aerial parts

Genotype	Canopy diameter (cm) CD	Plant height (cm) PH	Height sprout (cm) HS	Diameter sprout (cm) DS	Leaf weight (g) LW	Leaf length (cm) Ll	Leaf width (cm) LWdth
G1	68.28±6.30^{a}	57.3±9.36^{ab}	2.12±0.34^{a}	1.24±0.16^{a}	0.34±0.71^{a}	4.24±0.6^{b}	1.36±0.26^{a}
G2	82.48±4.11^{b}	68.36±4.61^{b}	2.46±0.66^{a}	1.76±0.33^{b}	0.28±0.50^{a}	4.08±0.35^{b}	1.36±0.18^{a}
G3	67±3.80^{a}	51±9.73^{a}	1.81±0.26^{a}	1.32±0.32^{a}	0.31±0.48^{a}	3.52±0.41^{a}	1.38±0.19^{a}

*Letters represent Duncan test results with 95% confidence interval and $p < 0.05\%$.

Regarding the development of aerial parts, the biometric determinations highlighted significant differences in the G2 genotype compared to the other two genotypes. Higher average values were recorded in G2 with a number of main sprouts of 8.4, a maximum level of sprout weight of 114.95 g and the highest number of inflorescences: 28.6 per sprout, and 192 per plant. G1 contains the maximum level of capsules/inflorescence: 8. G2 has the maximum number of seeds/capsule: 95 and of seeds/plant: 116998.2 (Table 2).

Table 2. Biometric measurements at cultivated *P. oleracea* development aerial parts

Genotype	Number of main sprouts NMS	Sprout weight (g) SW	Number of inflorescences/ sprout NIS	Number of inflorescences/ plant NIP	Number of capsules/ inflorescence NCI	Number of seeds/ capsule NSC	Number of seeds/plant NSP
G1	6.8±0.83^{a}	94.97 ± 4.76^{a}	17.6 ± 2.3^{a}	98.4 ± 20.35^{a}	8 ± 2.23^{a}	84.4 ± 14.74^{a}	71127 ± 35251.26^{a}
G2	8.4±1.14^{b}	114.95 ± 22.29^{b}	28.6 ± 5.85^{b}	192 ± 64.73^{b}	7.2±2.58^{a}	95± 18.39^{a}	116998.2± 16525.54^{b}
G3	5.7±1^{a}	94 ± 9.39^{a}	18.2 ± 2.38^{a}	118.8 ± 41.31^{a}	7.6±1.14^{a}	93.8 ± 12.02^{a}	82653± 25993.38^{a}

*Letters represent Duncan test results with 95% confidence interval and $p < 0.05\%$.

CONCLUSIONS

P. oleracea was submitted to breeding work at PGRB Buzau obtaining a valuable G2 variety with distinct phenotypic expressivity and high yield potential.

The cultivar can be successfully cultivated in an ecological system, being appreciated as food alternative, and also as a medicinal plant due to the active principles in its biochemical composition.

The culture technology for this species was developed.

In the future, PGRB Buzau will provide growers with both seeds and seedlings for testing.

REFERENCES

Carrascosa, A., Pascual, J. A., Ros, M., Petropoulos, S. A., & Alguacil, M. D. M. (2023). Agronomical practices and management for commercial cultivation of *Portulaca oleracea* as a crop: a review. *Plants*, 12(6), 1246.

Feng, L., Chen, G. Q., Tian, X. S., Yang, H. M., Yue, M. F., & Yang, C. H. (2015). The hotter the weather, the greater the infestation of *Portulaca oleracea*: opportunistic life-history traits in a serious weed. *Weed Research*, 55(4), 396-405.

Montoya-García, C. O., García-Mateos, R., Becerra-Martínez, E., Toledo-Aguilar, R., Volke-Haller, V. H., & Magdaleno-Villar, J. J. (2023). Bioactive compounds of purslane (*Portulaca oleracea* L.) according to the production system: A review. *Scientia horticulturae*, 308, 111584.

Nemzer, B., Al-Taher, F., & Abshiru, N. (2020). Phytochemical composition and nutritional value of different plant parts in two cultivated and wild purslane (*Portulaca oleracea* L.) genotypes. *Food chemistry*, 320, 126621.

Ocampo, G. (2013). Morphological characterization of seeds in Portulacaceae. *Phytotaxa*, 141.1, 1-24.

Pantu Z. (1906). *Plantele cunoscute de poporul roman*.

Petropoulos, S. A., Fernandes, Â., Dias, M. I., Vasilakoglou, I. B., Petrotos, K., Barros, L., & Ferreira, I. C. (2019). Nutritional value, chemical composition and cytotoxic properties of common purslane (*Portulaca oleracea* L.) in relation to harvesting stage and plant part. *Antioxidants*, 8(8), 293.

Tarkergari, S., Waghray, K., & Gulla, S. (2013). Acceptability studies of value added products with Purslane (*Portulaca oleracea*), 93-96.

Thalassinos, G., Levizou, E., & Antoniadis, V. (2023). Can soil improvers (biochar, bompost, insect frass, lime, and zeolite) achieve phytostabilization of potentially toxic elements in heavily contaminated soil with the use of purslane (*Portulaca oleracea*)? *Agronomy*, 13(11), 2827.

Vînătoru C., Musat B., Bratu C. (2019).*Treaty on Special Vegetables*. Buzau, RO. Alpha MDN Publisher, 555-562.