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Evaluation of the Main Qualitative and Quantitative Characters in the New Genotype of *Salsola Soda* Studied at the Buzău Plant Genetic Resources Bank

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RESEARCH ARTICLE

Abstract

The present study aims to evaluate a new genotype of *Salsola soda,* a halophyte plant conserved at Plant Genetic Resources Bank Buzau. Soil salinity is becoming the key factor constraining agricultural production, which is why salt-tolerant species are increasingly being considered and will be of great economic importance. *Salsola soda* is a plant with multiple uses: food, biodesalinant, companion plant in intercrops. Within the group of halophyte plants conserved in the Bank's germplasm collection, the species *Salsola soda* has been studied with particular emphasis, carrying out phenological observations, biometric determinations and laboratory analyses according to UPOV and IGPRI descriptors. Following the observations, the genotype L3 was genetically stabilized with the following characteristics: plant height of 134 cm average; plant diameter of 109 cm average, green mass of 2078 g average. The genotype studied meets the DUS test, can be cultivated throughout our country, especially on arid and high salinity soils, and can be used in various human food preparations.

Keywords: biodesalinating, core collection, genotype, halophyte.

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INTRODUCTION

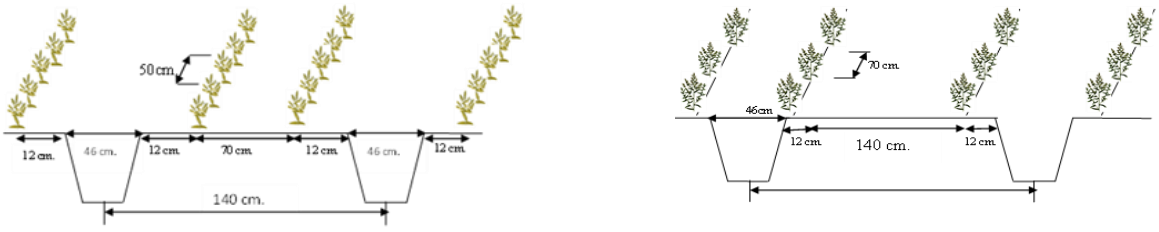
The genus *Salsola* (commonly known as saltwort) belongs to the family *Amaranthaceae*, previously *Chenopodiaceae*. The plant was recently documented as one of the endemic species in alkali grasslands typical of Central and Eastern Europe such as those in the Carpathian-basin (Centofanti and Banuelos, 2015). Genus *Salsola*, a genus of annual semi-dwarf to dwarf shrubs and woody tree species, is widely distributed across the arid and semi-arid areas of the world. The taxonomy of *Salsola* spp. is debatable and confusing due to their diversity and distribution in the Asian and the middle east deserts that lead to difficulties in their collection and investigation (Mai et al., 2022). The genus name is from the Latin words “salsus” or “sallere” meaning salty because they are halophytes capable of living in saline environments or due to their content of alkaline salts, such as potassium and sodium carbonates (Mai et al., 2022). The genus *Salsola* L. (Russian thistle, Saltwort) includes halophyte plants and is considered one of the largest genera in the family *Amaranthaceae*. The genus name derives from the Latin word salsus, which means “salty”, in reference to the salt-tolerant plants. Moreover, this genus is recognized as a cosmopolitan group of plants, which are distributed and naturalized worldwide (Murshid et al, 2020). *Salsola* species have

a variety of features that contribute to their recognition as a potential forage species in from semi-arid to dry settings along sea beaches, such as extensive seed production, and resistance to extreme climatic conditions including high temperature and extended drought conditions (Murshid et al., 2022). Salinization combined with recurrent droughts and higher uncertainty in climate stability represents a serious threat to agricultural production in many regions around the globe (Centofanti, Banuelos, 2015). Salinity is one of the major abiotic environmental stresses affecting about 6-7% of the world's total land area and agricultural productivity specifically in arid and semi-arid regions of the world (Karakaş, Cullu, Dikilitaş, 2017). The plant buds, called in Italy "agretti" or "barba di frate" are edible and commonly consumed from cultivated plants during the spring in Italy. In the past, the plant was also used as a source of sodium carbonate, from which the name "soda" (Iannuzzi et al., 2020). *Salsola* is found to be an allelopathically active species, which also decreased the growth of selected associated species during its decaying process (Murshid et al., 2020). The species of *Salsola* genus are grouped as halophytes, which are also useful for rehabilitation and reclamation of degraded saline lands and saline soils, respectively (Elshad, Kamala, 2020). Several features like high fodder value, abundant seed production, tolerance to extreme climatic conditions like high temperature and prolonged drought conditions contributed significantly towards its success as a potential forage species in semi-arid to arid environments (Elshad, Kamala, 2020).

MATERIALS AND METHODS

Within the group of halophyte plants conserved in the Bank's germplasm collection, the species *Salsola soda* has been studied with particular emphasis, carrying out phenological observations, biometric determinations and laboratory analyses according to UPOV and IGPRI descriptors. The measurements and observations were made for 10 plants. The study was started in 2019 untill 2022 at Plant Genetic Resources Bank (P.G.R.B.) which is located in south-eastern part of Romania, in Buzău County with an altitude ranging from 90-95 m. The genetic resources used in this study come from the germplasm collection from P.G.R.B. which contains cultivars originated from Dobrogea as Constanta, Galati and Braila counties and mediteraneean countries.

The sowing was carried out in the first decade of March in greenhouse, germinating at an optimal temperature of 16–18°C. Pallets of 70 cells and dimensions of 33 x 53cm were used. The planting was done between 1st 5th of May. In order to establish the crop technology, it was used two variants with different densities depending on the destination of the crop: V_1 for fresh consumption – 70 cm between rows and 50 cm between plants / row and V_2 for seed production – 140 cm between rows and 70 cm between plants / row (Figure 1).



(a) (b)

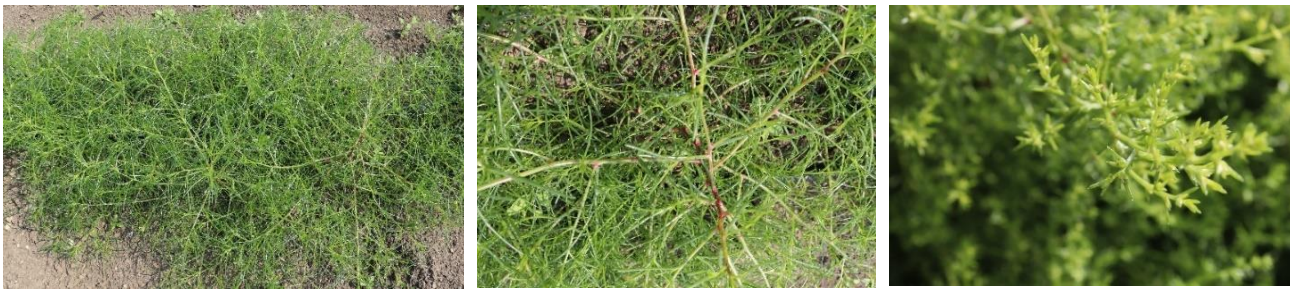
Figure 1. Crop planting schemes with different plant/row densities: a) V_1 at 70x50cm; b) V_2 at 140x70cm

The breeding methods used were repeated individual selection followed by negative mass selection. Aerial vegetative part of *Salsola soda* were used for measurements and observations and the values obtained were processed by statistical calculation using SPSS software, performing analysis of variance by ANOVA test followed by DUNCAN test with 95% confidence interval and p-value < 0.05%. Weighing operations were performed on green and dry plants at P.G.R.B. laboratory and the device used was the two-decimal precision balance Kern 572-33.

RESULTS AND DISCUSSIONS

Salsola soda L. is a halophyte annual and xerophyte plant. Stem leaves are fleshy, thick, semi-cylindrical, linear, 10-25 mm long, 2-3 mm wide, widened at the base, with bristles on the tip. Stems are erect or ascending, branched from the base or near the base; the branches are straight or slightly arched. The bracts leaves are reduced, triangular, much longer than the bracts (up to 3 times), almost horizontally deflected. Flowers are solitary, in a spicate inflorescence. Perianth almost to the base has 5 separate, cupped, lobes ovoid, jagged at the top, membranous, with fruits greatly enlarged, on the back with a small tubercular-like protrusion or traverse crest like keel. Wrist buds in the form of transverse tubercles or triangular appendages. Fruits are large, swollen. Anthers with almost no appendages. Stigma is longer than a column. Seeds are 3-4 mm long, mostly horizontal or almost oblique (Figure 2). The collection is newly introduced in our studies and genotype L3 is the one who was adapted and acclimatized to our pedo-climatic conditions with valuable phenotypic characteristics was identified from the P.G.R.B. germplasm

collection and shows specificity by non-coated seed which gives rusticity to the species. L3 genotype is remarcable compared with the other genotypes from core collection of *Salsola* due to the fact that it has a longer shelf-life and the leaves are much juicier.



(a) (b) (c)

Figure 2. (a) - L3 plant detail; (b) – sprout of L3 genotype; (c) - sprout detail

Plant height, canopy diameter, length and width leaves, plant weight were measured and are shown in the Table 1.

Table 1. The main biometric characteristics of the L3 genotype - average values and standard deviation

Trial	Plant height (cm)	Plant canopy (cm)	Main shoot no. (unit)	Leaf length (cm)	Leaf width (cm)	Plant weight (g)
V_1	96.2±1.92 [b]	78±1.58 [b]	8.6±1.14 [b]	2.38±0.19 [b]	0.114±0.05 [a]	2139±1.58 [b]
V_2	135.2±3.11 [a]	108.6±2.07 [a]	10.8±1.30 [a]	3.12±0.13 [a]	0.18±0.05 [a]	2780±1.58 [a]

Note: Different letters between cultivars denote significant differences (Duncan test, $p < 0.05$, 95% confidence level)

L3 genotype has on average, for V_1 consumption variant a plant height of 96.2 cm with a canopy diameter of 78 cm. The number of main shoot is 8.6. The leaves, thick and linear, has the average length 2.38 cm and the average width has a value of 0.114 cm. The vegetative mass for V_1 is 2139 g.

For V_2 seeds production variant the average value for plant height is 135.2 cm, for plant canopy is 108.6 cm. The average number for main shoot is 10. Regarding average values for leaves, they are 3.12 cm long and 0.18 cm width.

The vegetative mass is 2780 g.

Measurements were made in the laboratory for the main, secondary and tertiary shoots. Two weightings were made on the samples of *Salsola soda*: green plants samples and after an interval of 7 days for the dehydrated samples plants. For accurate values and to avoid errors, the dried tertiary shoots were chopped (Figure 3).

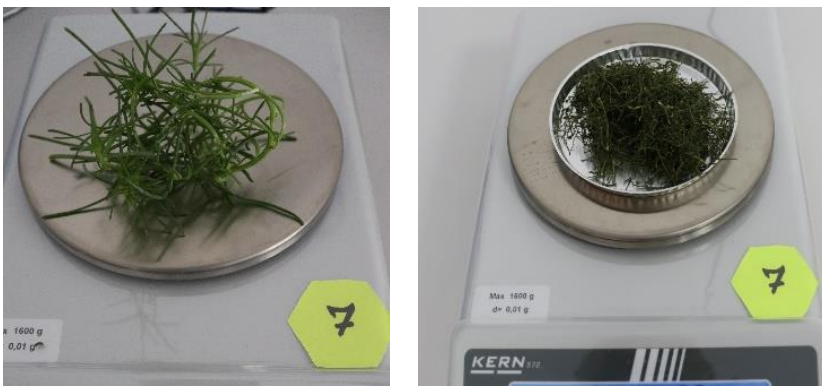


Figure 3. Green mass and dry mass weighing

In Figure 4 are presented graphically the measurements performed on the main, secondary and tertiary shoots. Blue columns represent the water losses. The percentage of water loss was determined and the average values recorded are: for the main shoots 86.95%, for the secondary ones 91.81% and for the tertiary ones 81.62%.

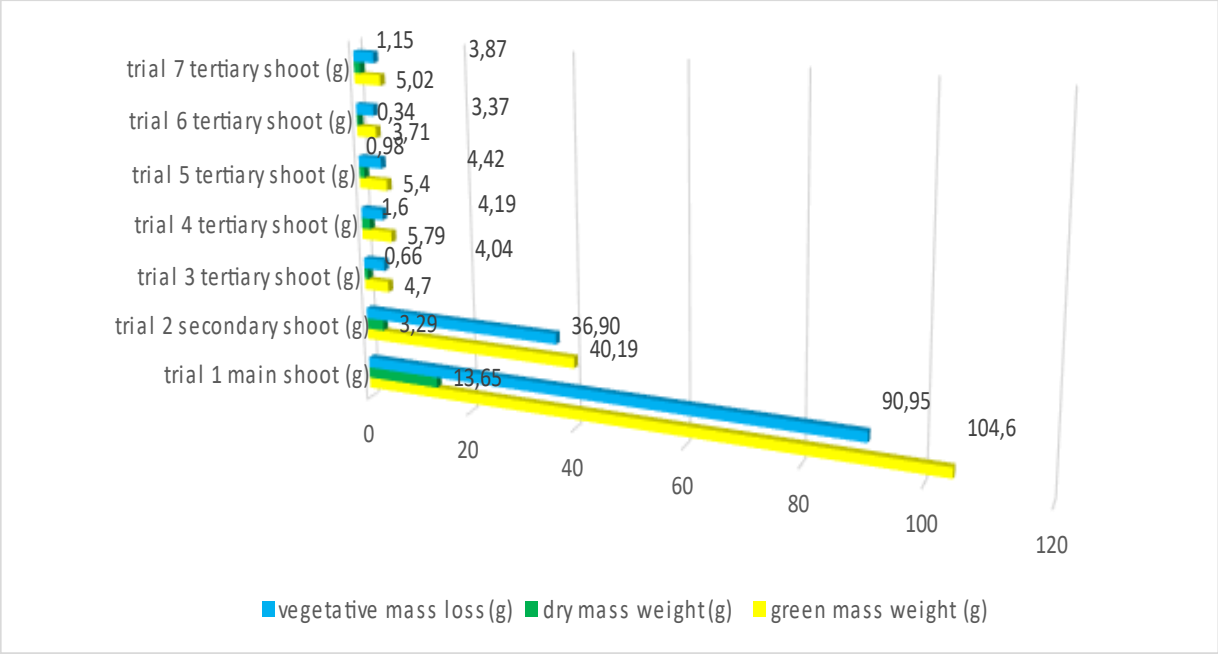


Figure 4. The dynamics of weighing in green and dry at – L3

CONCLUSIONS

The genotype studied meets the international norms of the DUS test (distinction, uniformity, stability).
A new genotype was obtained that can be cultivated throughout our country, especially on arid and high salinity soils.
The L3 genotype of *Salsola soda* can be used in various human food preparations like vegetal salt, flavor topping for foods.

Author Contributions: C.V. is the one who owns the germplasm collection of *Salsola soda*, M.P. coordinated the entire study, B.M., C.B., G.N. and C.Ş. contributed to the phenotypic observations and biometric measurements.

Conflicts of Interest

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

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