RED CLOVER VARIETIES CREATED AT LIVADA A.R.D.S.

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Introduction

The red clover breeding program at the Livada Agricultural Research and Development Station (Livada A.R.D.S.) has achieved continuous progress in improving yield potential, forage quality, and adaptation to stress conditions caused by climate change. During the period 1990–2026, the program developed 13 cultivars, including two tetraploid and eleven diploid varieties.

The advantages of red clover cultivation are well recognized:

- Red clover has a high nutritional value, excellent digestibility, and is rich in vitamins and carotene. It is also an important nectar-producing species for honeybees.
- It enriches the soil with nitrogen and improves the physical and chemical properties of the soil, thereby contributing to the development of sustainable agricultural systems with positive ecological, economic, and social impacts.
- It plays an important role in crop rotation, serving as an excellent preceding crop for many agricultural species.
- It has a beneficial environmental effect by reducing the need for nitrogen fertilizers.
- It can be successfully cultivated both as a pure stand and in mixtures with forage grasses.

The development and introduction into production of high-performing red clover cultivars represent an important measure for increasing the quantity, quality, and stability of forage and seed production.

The objective of this paper is to present the new red clover cultivars developed at Livada A.R.D.S. and registered in recent years, characterized by improved productivity, forage quality, and adaptability to the climatic conditions of Romania.

The new red clover cultivar 'Ardelean Liv', officially registered in 2026, is the result of many years of breeding work carried out at Livada A.R.D.S.. The breeding program aimed to accumulate favorable genes involved in determining high productivity and yield stability under diverse soil and climatic conditions.

Under the provisional designation Syn4-017, this breeding line was evaluated in control nurseries and comparative yield trials conducted at Livada A.R.D.S., where it demonstrated superior agronomic performance. Based on the favorable results obtained during the testing period, the line was submitted in 2023 for official testing within the ISTIS (State Institute for Variety Testing and Registration) network and was officially registered as a cultivar in 2026.

Literature review

Red clover breeding activities began in 1960 at the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca (USAMV Cluj-Napoca). Since 1989, breeding research has

continued at Livada A.R.D.S., focusing on the development of synthetic diploid and tetraploid cultivars.

The initial stage of the breeding program focused on collecting a diverse red clover germplasm, including local populations and cultivars obtained from breeding programs and gene banks worldwide. This germplasm served as the basis for selecting parental material with superior adaptation to the major biotic and abiotic stress factors occurring under Romanian conditions.

The area cultivated with red clover in Romania fluctuated between 171000 and 105000 hectares during the period 1938–2025, with the maximum area of 264000 hectares recorded in 1975 (Romanian Statistical Yearbook, 2025). The main reason for the decline in red clover cultivation in recent years has been the substantial reduction in livestock numbers.

Materials and methods

The synthetic cultivar 'ARDELEAN LIV' presented in this study was developed using the polycross Half-sib method, in which selection is based on the evaluation of general combining ability, followed by progeny testing and the selection of the most valuable genotypes for inclusion in the synthetic population (Varga et al., 1998; Savatti et al., 2004; Schitea, 2010; Moisa, 2012).

Results

The genetic composition of this synthetic cultivar consists of approximately 67% domestic germplasm and 33% foreign germplasm. It is characterized by excellent plant uniformity under field conditions. The stems are slender and hollow, exhibiting good lodging resistance. Under normal environmental conditions, plants reach a height of 80–90 cm, producing 22–27 shoots per plant and 5–7 internodes per shoot. The inflorescences are elongated-oval and pink to red in color, containing 85–110 florets per flower head, with 18–24% double flower heads. The cultivar also exhibits good resistance to winter conditions, drought, and diseases (Table 1).

Table 1. Morphophysiological characteristics of the red clover cultivar Ardelean Liv compared with the standard cultivar David Liv

Cultivar	Regrowth capacity after cutting (score 1–9)	Winter hardiness (score 1–9)	Drought tolerance (score 1–9)	Disease resistance (score 1–9)	Persistence (% plants surviving in the third growing year)
Ardelean Liv	1.5	1.4	2.2	1.4	90
David Liv (control)	1.8	1.7	2.3	1.6	75

The red clover breeding nursery was established under rainfed conditions on a typical argic preluvisol (brown luvic soil), characterized by a tendency toward acidification and a low humus content.

The last three years (2023–2025) were characterized by considerable fluctuations in both precipitation and temperature. A common feature throughout the experimental period was that, from autumn sowing until the onset of winter, soil moisture conditions were optimal for seedling emergence. However, climatic conditions differed markedly during the development of the three forage harvests and, in particular, during seed production.

The 177.4 mm of precipitation recorded in May and June 2024 ensured satisfactory forage and seed yields, despite the fact that July and August 2024 experienced the highest temperatures recorded in recent years.

Overall, 2024 was a favorable year for red clover cultivation. The abundant rainfall received during May and June (177.4 mm) promoted the development of the three forage cuts as well as seed production.

In contrast, 2025 was characterized by severe drought, beginning in June, when the average temperature exceeded the long-term mean by 2.6°C. The drought was intensified by extremely high temperatures, which remained above 30°C in the shade, together with a precipitation deficit of 70.4 mm compared with the long-term average for the region. These conditions adversely affected forage production from the second and third cuts, and had an even more pronounced negative impact on seed crop development (Figures 1 and 2).

Climate change, characterized by large year-to-year fluctuations ranging from extremely wet to extremely dry conditions, requires the evaluation of cultivar responses to these environmental factors.

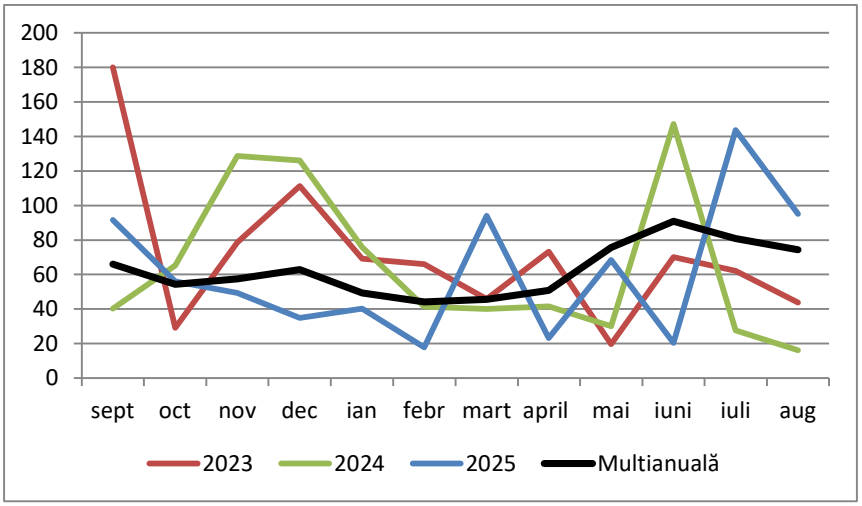

Figure1. Distribution of precipitation (mm)

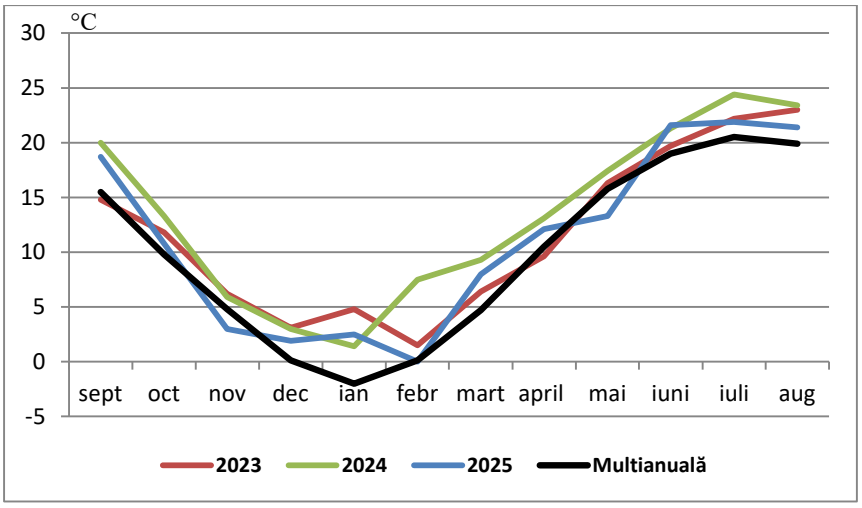

Figure. 2. Distribution of temperatures (°C)

Experimental data were analyzed using appropriate statistical methods (Ceapoiu, 1968).

Based on the evaluations conducted at Livada A.R.D.S. during the period 2023–2025, the newly registered cultivar demonstrated consistently good performance with respect to forage yield throughout the experimental period (Table 2).

The yield results obtained during 2023–2025 were strongly influenced by the meteorological conditions prevailing during the red clover growing season, which varied considerably from one year to another.

The experimental results showed that the highest fresh forage yields were obtained in 2023 and 2024, both favorable years for red clover cultivation. In contrast, yields declined in 2025 due to the severe drought that occurred in June, coinciding with the critical stages of plant growth, flowering, and seed development (Table 2).

In the comparative variety trials, considering the cumulative production from the three harvests, the new cultivar Ardelean Liv exhibited the best overall performance during the three-year evaluation period, producing an average fresh forage yield of 53.2 t/ha, representing an 8% increase over the standard cultivar David Liv (Table 2).

2. Table 2. Fresh forage yield (t/ha) of red clover cultivars developed at Livada A.R.D.S. during 2023–2025

Cultivar	2023	2024	2025	Mean	±	% of control
Someșan	57.8	62.1	39.3	53.1	3.7	107
Syn 2-017	55.1	59.9	37.4	50.8	1.4	103
Ardelean Liv	57.7	62.5	39.3	53.2	3.8	108
Livezeanu	58.4	61.6	39.1	53.0	3.6	107
Tinu Liv	51.0	59.8	36.3	49.0	–0.4	99
Livada 10	57.5	60.4	38.0	52.0	2.6	105
David Liv (control)	51.6	60.0	36.6	49.4	0.0	100
Mean	55.6	60.9	38.0	51.5	2.1	104
LSD (5%)	2.4	2.3	1.1	–	1.8	–

The value of these diploid synthetic cultivars also lies in their high flowering and seed-setting capacity, producing, on average over the three years, more than 500 kg/ha of seed under intensive production technology with autumn sowing.

High seed production capacity, an essential characteristic for the multiplication of newly developed cultivars, was observed in the diploid synthetics Livezeanu, Ardelean Liv, Syn 2-017, and Someșan, which produced seed yields 6–9% higher than the control cultivar David Liv, with statistically significant differences (Table 4). Their superior performance is primarily attributed to enhanced drought tolerance, hollow stems, and good resistance to diseases.

The highest seed yield, 623 kg/ha, was obtained by the synthetic cultivar Livezeanu in 2023, a year considered highly favorable during seed development and harvest.

In contras during 2025 both soil and atmospheric drought severely limited seed formation. The lack of rainfall and temperatures exceeding 30°C during June adversely affected pollination, resulting in poorly developed seeds and a substantial reduction in seed yield.

3. Table 4. Seed yield (kg, ha^{-1}) of diploid red clover cultivars developed at Livada A.R.D.S. during 2023–2025

Cultivar	2023	2024	2025	Mean	±	% of control
Someșan	593	613	337	514	31	106
Syn 2-017	620	594	327	514	31	106
Ardelean Liv	614	612	335	520	37	108
Livezeanu	623	615	336	525	42	109
Tinu Liv	581	617	288	495	12	103
Livada 10	557	618	280	485	2	100
David Liv (control)	536	603	310	483	0	100
Mean	589	610	316	505	22	105

LSD (5%)	22	26	4	–	23	–

An important objective of the red clover breeding program at Livada A.R.D.S. is the improvement of forage quality.

The newly developed cultivars Someșan, Ardelean Liv, and Livezeanu provided forage with superior nutritional quality, ranking first in crude protein concentration, with average values over the three-year period of 20.3%, 20.1%, and 20.0%, respectively (Figure 3).

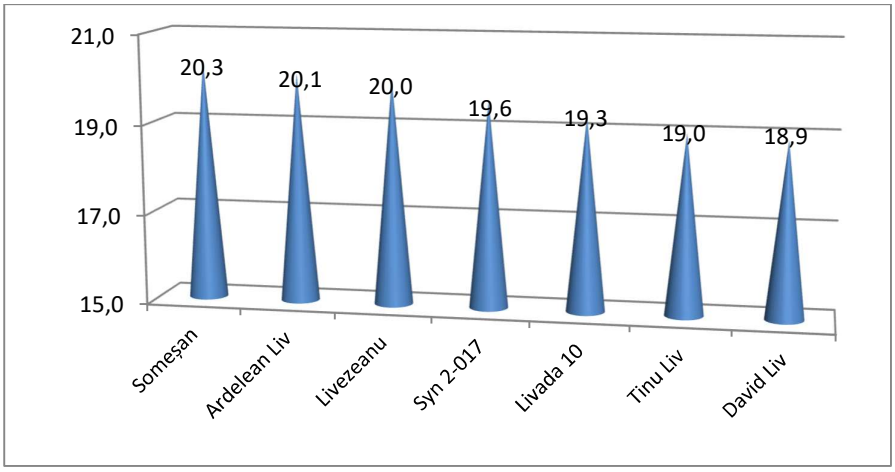

Figure 3. Crude protein content of dry matter in red clover cultivars developed at Livada A.R.D.S.

The synthetic cultivars Someșan, Ardelean Liv, and Livezeanu therefore represent significant genetic progress in improving forage and seed productivity as well as forage quality.

The genetic progress achieved in the Livada A.R.D.S. red clover breeding program, illustrated in Figure 4, demonstrates that the new synthetic cultivars Ardelean Liv, Someșan, and Livezeanu produced yield increases of 7–9% for fresh forage and 6–9% for seed yield compared with the standard cultivar David Liv during the three-year evaluation period.

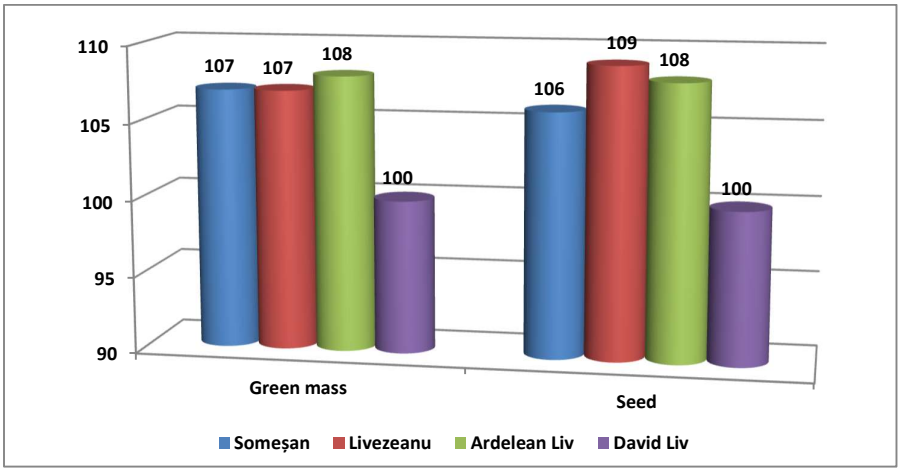

Figure 4. Genetic progress achieved in the red clover breeding program at Livada A.R.D.S.

Conclusions

The new red clover cultivar 'Ardelean Liv', officially registered in 2026, is the result of several years of breeding work carried out at Livada A.R.D.S., aimed at accumulating favorable genes responsible for high productivity and yield stability under diverse soil and climatic conditions.

The cultivar Ardelean Liv exhibits excellent resistance to drought, lodging, and diseases.

Compared with the standard cultivar David Liv, Ardelean Liv produced 8% higher fresh forage yield and 8% higher seed yield, with statistically significant differences.

The cultivar also provides high-quality forage, with an average crude protein content of 20.1%.

The cultivation of Ardelean Liv, together with the other newly developed cultivars, is recommended for all red clover growing regions under both intensive and conventional production systems.

Abstract

The northwestern part of the country through Livada A.R.D.S. is a reference point in the improvement of the red clover.

As a result ofresearch conducted on this species, by using a diverse germplasm from differentcrop areas of red clover, in A.R.D.S. Livada during 1989-2026 were created and recorded 13 synthetic varieties of red clover, two tetraploids and 11 diploids, from which three varietieswere patented.

The genetic progress made in the improvement of red clover, presented in this paper demonstrates that the new synthetic cultivars Ardelean Liv, Someșan, and Livezeanu produced yield increases of 7–9% for fresh forage and 6–9% for seed yield compared with the standard cultivar David Liv during the three-year evaluation period.

Keywords: red clover, genetic progress, forage and seed productivity, forage quality

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