A BIBLIOGRAPHIC STUDY ON GENETIC PROGRESS IN THE SPECIES *MEDICAGO SATIVA*

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Abstract: *Alfalfa (Medicago sativa L.) has been the main forage crop in Romania: the area cultivated with alfalfa cultivars oscillated, between 1938 and 2008, between 136,300 and 442,000 ha, i.e. 29.7-31.6% of the forage crop structure, or 4.8-5% of the arable land. Romania ranges among the largest alfalfa cultivating countries after the U.S.A., Argentina, and Italy (Anuarul Statistic al Romaniei, 1938-2008). In this context, it is important to increase the nutrient value of forage crop cultivars (to improve the content of digestible dried matter, particularly digestible protein and soluble sugars) (SCHITEA ET VARGA, 2007). The annual area cultivated with alfalfa cultivars in Romania ranges between 400,000 and 500,000 ha of pure alfalfa cultivars crop, and reaches about 1,000,000 ha of alfalfa cultivars mixed with other species of perennial gramineae. Alfalfa forage is noted for its high content of nutrients varying between wide limits depending on vegetation (Moisuc, 1991). In fact, alfalfa is a great water lover, and drought resistance comes from its capacity of developing a root system as rich and deep as possible and from its ability of overcoming hydric stress periods and of recovering quickly after the hydric deficit ceases (ITTU et VARGA, 1975; ITTU et al., 1978). The advantages of cultivating alfalfa cultivars are numerous: it is a perennial legume, it can be exploited for 3-5 year, it yields highly (14-20 t dry matter per ha, in an intensive system), it has a high content of crude protein (19-20% crude protein of the dry matter); in addition, it plays a very important role in crop rotations, as improving sole, leaving in the soil important amounts of nitrogen fixed symbiotically (Varga et al. 1998). Improving forage quality was a very important objective in alfalfa cultivars improvement through the selection of genotypes with rich foliage, short internodes and fistulous shoots.*

Key words: *Medicago sativa, alfalfa, genetic progress, breeding features, hay production*

A SHORT HISTORY OF THE SPECIES *MEDICAGO SATIVA*

Archaeological findings and ancient writings show that alfalfa started to be cultivated in 4,000 B.C. in South-Western Asia. Its place of origin is Persia, from where it was taken to Greece about 470 B.C. and to Italy about 150-50 B.C., where it was used to feed sheep and horses. About the beginning of the 16th century, it was taken by the Spaniards to Mexico, from where it reached the entire America and, later on, Australia and New Zealand.

At present, alfalfa is cultivated on about 40,000,000 ha, with the largest areas in the U.S.A., Argentina, Russia, Italy, France, and Canada (CHRISTIAN et al. 2000).

In Romania, alfalfa started to be cultivated in the provinces of Transylvania and Banat, towards the end of the 18th century, to be later on expanded into cultivation a century later (POPOVICI ET CIPAIANU, 1912)

ION IONESCU DE LA BRAD wrote about the attempts to cultivate alfalfa in his A Cultivation Project for the Exploitation of the Pantelimon Estate" (1865); in 1900, Roman published the brochure "Alfalfa Cultivation" in an attempt to popularise this crop. He showed that "of all forage crops, alfalfa is the most suitable for Romania's soil". Alfalfa is meant to recover fields and grasslands exhausted by the cultivation of cereals. At present, alfalfa is cultivated widely in most temperate climate countries in both northern and southern hemispheres.

ECONOMIC IMPORTANCE

Alfalfa has a high ecological plasticity: it can be cultivated in different geographical areas (in droughty steppes and in sylvo-steppes, in flooding meadows, o different types of soil with neuter to low alkaline reaction).

It yields over 50 t of green matter per ha in 3 mowings under natural conditions and over 80 t of green matter per ha in 4 mowings under irrigated conditions, or between 1- and 15 t per ha of hay.

From an agro biological point of view, alfalfa ahs a lot of characteristics: it is drought resistant and frost resistant, it valorises well irrigation water (irrigation doubles the yield), it has a high recovery capacity after mowing (with 3-4 mowings if not irrigated and 4-5 mowings if irrigated). Is supplies the soil with biological nitrogen fixed in symbiosis with bacteria from the species *Rhizobium melitoli* (over 200 kg/ha from an alfalfa cultivars crop for 4 years). The high content in estrogenic substances influences the reproduction cycle in cattle. In mixture with some species of gramineae, alfalfa can also be ensilaged. It is a good meliferous crop. It is a very good pre-emergent crop particularly on the areas where it can be irrigated due to the fact that it leaves the land depleted of water deep in the soil (below 1 m).

MORPHO-PHYSIOLOGICAL FEATURES

The alfalfa root system is very deep (it can reach up to 2 m in length), which explains its particular drought resistance (almost the entire root system is formed in the first year of vegetation). Nodosities appear on the roots as a result of the symbiosis with bacteria of the *Rhizobium meliloti* type. The leaves are made up of three obovate or lanceolate blades serrate in the upper third; the median blade has a petiole longer than the two lateral ones. Violet-coloured flowers in the species *Medicago sativa*, dark yellow in the species *Medicago falcate* and spotted (greenish-violet) in the species *Medicago varia* are grouped in prolongated axillary racemes. The fruit is a polyspermous, glabrous, twisted pod with kidney-like, yellow-greenish seeds.

Alfalfa is a typically allogamous, self-tetraploid plant in which the heterosis effect is possible in two ways: development of hybrids based on cytoplasmatic andro-sterility (GUMANIUC, 1975, 1979), and development of synthesis cultivars (GALLAIS, 1990; ROTILI et al., 2002).

HISTORY OF ALFALFA CULTIVARS IMPROVEMENT PROCESSES

They consider that ensuring the necessary forage should be done by increasing the area cultivated with forage crops as well as by increasing the share of perennial legume species (pure culture or mixture with perennial gramineae). To do so, we need high quality and yield performing cultivars (SCHITEA, 2002; MOGA et al. 1996; MOGA ET SCHITEA, 2005).

In this context, it is important to increase the nutrient value of forage crop cultivars (to improve the content of digestible dried matter, particularly digestible protein and soluble sugars) (SCHITEA ET VARGA, 2007).

The starting point in improving alfalfa cultivars in Romania was 1949, when forage crop improvement works aimed at collecting and studying local populations of forage crops: this was the starting point of a collection of 6,000 local populations of perennial and annual forage crops.

Thus, 1062 saw the appearance of the first Romanian alfalfa cultivar, Fundulea 652, which yielded 20-25% more than dried matter than local populations, which was very resistant to drought and to frost, which determined its quick expansion into cultivation (MARIA SCHITEA ET VARGA, 2007). At that time, ALLARD (1960) considered that the performances of a cultivar depnded on three factors: the number of parental lines, the mean yield of parental lines, and the mean yield of all possible combinations between parental lines.

The following alfalfa cultivars improvement works aimed at obtaining cultivars with a high yielding potential – forage and seed – with high quality of forage and good adaptability to unfavourable environmental conditions. This was achieved through the selection of genotypes characterised by a high rate of assimilation of the dried matter phenotypically expressed through recovery and quick growth after mowing, with a good distribution of the yield per mowing, genotypes with rich sprouting and relatively high plants (VARGA et al. 1983; GILLET et POISSON, 1988; GUMANIUC et VARGA, 1982).

Improving forage quality was a very important objective in alfalfa cultivars improvement through the selection of genotypes with rich foliage, short internodes and fistulous shoots. These morphological features were expressed from the point of view of forage quality through the increase of its nutrient value and of forage consumability, through high values of the crude protein content and of soluble sugars, through the increase of the digestibility coefficient, of the amount of net energy, and of the energetic value (VARGA et al. 1987; SANTIS et al. 1994; SCHITEA, 2002; SCHITEA et ORLOFF, 2004).

Disease resistance was another objective influencing both quality and quantity.

Frost and drought resistance. The high ecological plasticity seen in the very large areas of alfalfa cultures as well as some morphological features of the species (deep root system) allowed the selection of some genotypes with increased frost and drought resistance (frost and drought are limiting yield factors). In fact, alfalfa is a great water lover, and drought resistance comes from its capacity of developing a root system as rich and deep as possible and from its ability of overcoming hydric stress periods and of recovering quickly after the hydric deficit ceases (ITTU et VARGA, 1975; ITTU et al., 1978).

The genetic process depends on heritability and on the intensity of the selection during certain time intervals: it is higher when heritability and selection intensity are maximal in a minimal time interval, but in alfalfa things are more complicated because of the gamete disjunction as well as because yield concerns the entire aerial vegetative part (GUMANIUC et VARGA, 1985).

Developing alfalfa cultivars with high seed-yielding potential. In alfalfa, as well as in other forage crops, we are interested mainly in forage yield and quality; to introduce and expand new alfalfa cultivars into cultivation, we need it to also have a high seed-yielding potential (VARGA et al., 1998; MOGA et al., 1996; JULIER et al., 2000).

Studies concerning self- and inter-fertility pointed out the possibility of increasing alfalfa seed production through the selection of genotypes with high values from this point of view (MARTURA, 1999).

Resistance to soil acidity is a necessary objective as a consequence of the tendency to cultivate alfalfa cultivars on acid soils also, which they tried to solve through “in vitro” selection (BADEA et al., 1990, GALLAIS, 1990, VARGA et al., 1998; GUMANIUC et VARGA, 1985; SCHITEA, 2002).

We can see that due to the great importance of this crop species for agriculture, in general, and for animal husbandry, in particular, they carried out research in the field of developing alfalfa cultivars and alfalfa cultivation technologies over 60 years (VARGA et al., 1973, 1998; MOGA et al., 1983, 1996; VARGA et al., 1998).

At present, producing high-yielding alfalfa cultivars for high-quality forage and seed adaptable to hard environmental conditions have been the main objectives of improving alfalfa cultivars (VARGA et al., 1973, 1998; GUMANIUC, 1975, 1979; SCHITEA, 2002; SCHITEA et VARGA, 2007).

As in the other forage crops, we are interested mainly in forage production and quality; to introduce and expand new alfalfa cultivars, they also need to have a high seed-yielding potential (VARGA et al., 1998; MOGA et al., 1996; JULIER et al., 2000).

In the last decade, they have developed, in Romania, they have developed alfalfa cultivars superior to other cultivars such as Selena and Magnat, from the point of view of their main features contributing to yield and quality stability: vigour, disease resistance, recovery ability after mowing, frost resistance, and perennity.

Table 1.

Features of the Romanian cultivars of *Medicago falcata*
(GUMANIUC et al., 1984; VARGA et al., 1994; VARGA et al., 1998; SCHITEA MARIA et al., 2006)

Cultivar	Biological origin	Characterisation
Fundulea 652	Banat and Filiasi populations	Yielding progress 25%
Luxin	French cultivars Europe and Du Puits	Vulnerable to *Fusarium oxysporum*
Lutetia Gloria	The cultivar Vertus from Sweden androsterile cytoplasmatically (HS-35)	Resistant to Fusarium wilt
Triumf	The cultivars Apollo, Agate, Olimpic, Victor (U.S.A.), Furez, Vertibenda (Hungary), Vertus (Sweden), UPBS (France)	Resistant to Fusarium wilt, foliar rot, viruses
Adonis	5 components of the Romanian germoplasme	100% resistant to Fusarium wilt
Topaz	Nugget, Advantage, Anchor, Voris (U.S.A.), Trident (Australia) and Kleszczewska (Poland) plus 12 components of the Romanian germoplasme	High yield of forage and seed, high ecological plasticity
Sigma	Descendent Triumf (Romania), Vertus (Sweden), Kane (Canada), Anchor and Agathe (U.S.A.)	High yield of forage and seed, phenotypical uniformity
Magnat	Descendent of W.L. 316, Maverick, Armor and 3 components of the Romanian germoplasme	High yield and quality of forage
Granat, Satelit, Dana, Alina, Dorina, Mădălina, Sandra, Cosmina, Adin, Carina	Descendent selected depending on longevity and precocity	Yields above 17,000 meat nutrient units with intensive technological conditions (sowed in the fall and irrigated) and about 12,000-14,000 meat nutrient units without irrigation

In Romania, alfalfa crops are demi-early crops which ask for a short period of harvesting and for forage conservation to preserve its quality (SCHITEA MARIA et VARGA, 2007).

In the last two decades, they have achieved genetic progress in the development of synthesis cultivars. This issue has been studied to allow the preservation of the heterosids along the seed multiplication generations (GALLAIS, 1990; JULIER et al., 2000, PETCU ELENA et al., 2007). From the forage plants that are distiguished considering the yield and qualitative importance the main are the leguminous. Most of the legumes are excelent forager species, mainly for the ruminants becvause of their increased content in proteins. (SAMFIRA et al*.,* 2011*)*

FUTURE IMPROVEMENT FACTORS

Frost resistance, influenced mainly by fall dormancy, refers to the tendency of a cultivar to slow down development in the fall and throughout winter. This can be assessed through grades between 1 and 10 (1 = very resistant; 10 = very sensible). Thus, alfalfa cultivars with long fall dormancy got small grades (between 1 and 4) and those with very good resistance to low winter temperatures got grades between 1 and 4 (PETCU et al., 2006, 2007).

Grazing resistance is an important objective and it should be similar to that practiced in many countries from South America and Australia. It seems that in the future there will be only two ways of exploiting alfalfa cultivars – in the dehydrating industry and through grazing (ROTILI et al., 2002).

Resistance to stress factors pointed out by HANS SELYE (1968) has long been analysed ad debated for the animal kingdom. Thus, the conclusion is that each organism is the owner of a certain amount of "adaptive energy" and, implicitly, of resources necessary to produce this energy.

In plants, in general, and in alfalfa, in particular, stress can be triggered by numerous causes, among which natural conditions (that meet more or less plant requirements), as well as the way in which the cultivation technology contributes to the removal or to the strengthening of some unwanted effects of natural conditions on the plants (ROTILI et al., 2002).

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