

Original Article

The Effect of Alfalfa Cultivation on the Solid Fertility and Crop Production Obtained in the Transylvanian Plain

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Abstract

The paper highlights the beneficial effect of alfalfa crops on enhancing the natural fertility of cambic chernozem in the Transylvanian Low Plain on the production of alfalfa for fodder (green mass and hay), both in quantitative and qualitative terms, in an area with qualitatively superior soils in terms of fertility and favorability for most agricultural and horticultural crops. From the nutritional point of view, the fodder alfalfa is considered a plant with high claims to nutrients, being a perennial species exploiting the soil for many years, 7-10 years or even more. It forms an abundant vegetative mass and a high amount of feed to the surface unit. It is a highly consuming species of nitrogen, phosphorus, potassium, magnesium and calcium but also of microelements and requires careful and complex maintenance technology to achieve quantitative and qualitatively superior feed yields over the years of exploitation. In this context, the paper aims to treat the area of Soporul de Câmpie, located in Cluj County, in the Transylvanian Plain, an area that nature has endowed with invaluable gifts, which are suitable for a sustainable and profitable conservative agriculture.

Keywords: soil, fertility, productivity, alfalfa.

1. Introduction

Ever since the ancient times, the village inhabitants, where the research has been carried out, have been developing activities related to agriculture, fruit growing and animal husbandry, an area characterized by a low hillside landscape, with flat and moderately sloping land. Soils that are specific to this area exhibit a high humus content, are well structured and airy, are considered to be very productive from the point of view of fertility.

Due to recent climatic changes and the characteristics of the cambic chernozem soil, which in B cambic horizon (Bv) formed by alteration of the "in situ" parental material, exhibits in the upper part dark brown colors followed by yellowish brown colors due to the accumulation of clay, which, in the conditions of strong and long-lasting rainfall, promotes the accumulation and pouring of water on the surface of the soil, leading to asphyxiation and implicitly to the death of plants, with undesirable consequences for the alfalfa culture in the area [1].

In this respect, it is known that alfalfa is a plant species which, on the one hand, withstands well on unfavorable climatic conditions and on the other hand, has beneficial effects on all soils by improving the conditions of aeration and soil structuring and fertility, especially by fixing atmospheric nitrogen [1, 2, 6]. A major contribution to the sustainable

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development of each country is agriculture, which, through numerous factors, reflects the level of ensuring the security and food security of the population of each country.

In this sense, the primary factor in the development of agriculture is the soil with its attributes, being considered the natural resource of the agricultural system, with a series of constantly changing physical, chemical and biological attributes, which constitute a support for plants, a source of elements nutrients and an intermediate through which fertilizers and amendments apply, in fact, contains living matter and ensures the life of plants, while representing the essential support of life [5]. The fundamental characteristic of the soil, which distinguishes itself from the parent rock from which it originated, is its ability to be a plant life environment and to make it possible to obtain agricultural and horticultural productions, namely the fertility [2].

The purpose of this research is the evolution of the main pedoagrochemical soil characteristics of cambic faeozem soil (SRTS-2003) and cambic chernozem (SRCS-1980) for agricultural crops in the territory of Frata commune, Soporul de Câmpie village located in the Transylvanian lowlands plain and the influence of lucerne culture on the natural fertility of cambic faeozem soil and the production of fodder obtained in a very favorable agricultural area [3, 4]. The importance, originality and novelty of this research in the agronomic field is due to the changes taking place in our country, especially with the change of the forms of ownership and management of the agricultural lands, as well as of their dynamism, serious confusion in cultivated plant technology, and implicitly obtaining agricultural crops under the biological potential of varieties and productive capacity of soils.

2. Material and Method

The experimental study was carried through quantitative determinations of production and pedo-agrochemical analyzes on a field cultivated with green alfalfa in the lowlands of the Transylvanian Plain, making observations during two years (2012 and 2014) on a cambic faeozem soil, respectively a cambic chernozem located physically-geographically in the eastern part of the village of Soporul de Câmpie, on a plateau with a wide opening to the southeast, offering the most favorable conditions for the plant culture. From a geomorphological and geological point of view, the ground studied is located in the lower part of the climatic level specific to the silvosteppe area of the Transylvanian Plain (where, over time, the grassy vegetation has replaced the tree vegetation) and from a pedo-agrochemical point of

view it is recorded in the soils the significant contribution of the marshy rocks by the accumulation of calcium carbonates on the profile, an obvious accumulation of organic matter in the molar horizon (Am) and implicitly the formation of humus which leads to a high fertility of these soils.

The researches and observations were based on the soil profile digging, the study and description of its pedoagrochemical characteristics, the specific field and laboratory analyzes, the fertility status and soil favorability assessment for the field of alfalfa culture in the area of Soporul de Câmpie and the quantitative determination of the production of alfalfa. The soil profile was developed on a cambic faeozem (Fig. 1), cultivated with alfalfa on 3 ha, in the village of Soporul de Câmpie, Frata commune, Cluj County, representative of the low hills area of the Transylvanian Plain. The village is located in the southeastern part of Cluj County, 30 km from Turda and 50 km from Cluj-Napoca. It is bordered to the north by Aruncuta, to the south by Ceanu Mic, to the east by Frata and by Iuriu de Câmpie to the west.

The area where the alfalfa plot is framed is characterized as a whole by a large depression area that extends over the border of the village, flanked in the eastern part by light low hills. The climate is boreal, with relatively cold winters and hot summers reaching temperatures around 28 °C – 30 °C in July and the first half of August.

Precipitation is numerous and evenly distributed throughout the year. Winds are generally reduced in intensity. Pedoagrochemical analyzes on the soil profile were carried out according to the ICPA methodology for the agrochemical laboratories "Methodology of agrochemical analysis of soils in order to establish the necessity of amendments and fertilizers" I.C.P.A. 1981 and description of the soil profile according SRTS-2003 and SRCS-1980 [3]. Alfalfa production was determined by successive weighing.

3. Results and Discussions

Soils of the cambic faeozem type (SRTS-2003) and cambic chernozem (SRCS-1980) are also known in the literature as cambic chernozems [3, 4]. In SRCS-1980, the cambic chernozem soil type is well defined by a molar horizon A (Am), exhibiting less than 2 chromes, and a B cambic horizon (Bt) formed by alteration of the parental material, having in the upper part values and less than 3.5 chromes in the wet state and less than 5.5 in dry state, both on the faces and inside the structural elements.

In SRTS-2003, cambic faeozem is considered to be a soil subtype having a dark amber horizon and a B cambic horizon (Bv) formed by alteration of the parental material "in situ", having in the upper part

dark brown colors followed by yellowish brown colors due to the accumulation of clay.

These are soils very widespread in Romania, occupying an area of approximately 600.000 ha, which represents about 2.5% of the total area of the country and are frequently found in the wettest parts of the forests, near the forests area, to which they are transitioning in some sub-mountainous depressions, where there is encountered a rich grassy vegetation.

Grass vegetation is represented by different silvicultural species: *Festuca vallesiaca*, *Stipa joannis*, *Poa bulbosa*, *Carex praecox*, *Artemisia austriaca* and other species.

Wood vegetation is usually made up of mixtures of tree sky, garnet, oak, fluffy oak, linden mixture, ash and jug.

From the climate point of view, average annual temperatures do not fall below 8.5°C and annual average rainfall is generally 550 mm.

Parental material is generally composed of sedimentary rocks, loess deposits, clay, sands, and CaCO₃-rich marls to the depth of the soil profile.

The genesis of the cambic faeozem soil is specific: bioaccumulation and argilization is moderate, sometimes intense, forming mull type humus, where humic acids predominate; the processes of alteration, degradation, acidification, leaching and migration of colloids are not very intense, only soluble salts are totally leached, CaCO₃ is also deeply entrained and by migration and accumulation of clay, a clear differentiation of a Bv horizon, devoid of CaCO₃, where the structural aggregates are coated with a fine clay film.

Cambic chernozem soil presents the following profile horizons (SRTS - 2003): Am - Bv – Cca.

1. Pedoagrochemical characterization of cambic faeozem from Sopor de Câmpie)

a. Pedogenetic conditions (Fig. 1): Transylvanian Low Plain Area, represented by low slopes with north-eastern and southern exposure, with parental sediment, loess deposits, sands, clays and clayey deposits, groundwater depth > 10 m. The predominant natural vegetation is represented by the grass species *Festuca sp.*, *Agrostis sp.*, *Trifolium sp.*, *Lolium perene*, *Brachipodium pinatum*, *Agropyron repens* and wooded species oak tree, sessile. In these specific conditions, of wetland vegetation, lithological substrates and relief, three accumulation horizons were formed: one of the accumulation of humus (Am) at the surface, the other of the accumulation of clay (Bv) in the middle, and in depth, one of the accumulation of CaCO₃ (C_{Ca}). The main processes that led to the formation of these horizons were: bioaccumulation, alteration, leaching. Due to the higher humidity and the presence of forest vegetation, the leaching process was more intense, with CaCO₃ being washed at greater depths (over 120 cm), while washing the clay from surface horizons and accumulating it in an illuvial intermediate horizon determines the increase in water retention capacity with beneficial effects on plant growth during droughts. The purpose of the analyzed soil is for feed forage and it is located on a plateau at the base of the slope with a northern exposure in the farmland area.



Figure 1. Morphological characters in cambic faeisome (Cambic chernozem) from the tarlau named "Iacobi Forest" in Sopor de Câmpie (2012)

- Am 0-45 cm, dark brown or dark brown in wet condition, exhibiting a more or less stable glomerular structure;

- Bv 45-120 cm, dark brown to brown to brownish-yellow in humid state with prismatic structure, with structural elements covered by a fine clay film;

- C_{Ca} 120 to 140 cm deep brown, dark brown to yellowish-yellow, well-structured, strong, effervescent, dry and yellowish-brown in a wet state and devoided of structure.

The cambic faeozem soil (SRTS-2003) and cambic chernozem (SRCS-1980), physically (according to the pedological profile), has a medium to heavy-clayey texture, with evident compaction from the argiloiluvial horizon (Bv) of the accumulation of clay, which can jeopardize the aerodynamic regime and the porosity at the depth explored by the roots of the plants.

b) Pedo-agrochemical description of cambic faeozem from Sopor de Câmpie (Table 1): Within the perimeter of alfalfa culture, the dominant soil is cambic faeozem, respectively cambic chernozem, which has a succession of the Am-Bv-C_{Ca} horizons, typical of the earthquake zone encountered on more than half of the surface of the Transylvanian Plain. From the agrochemical analyzes it is revealed the significant contribution of the marly rocks to the evolution of these soils.

Being rich in CaCO₃, which gives the soil two essential qualities, a medium to heavy texture and a high degree of saturation in the bases.

From the pedoagrochemical point of view, the cambic faeozem (cambic chernozem) in the Sopor de Câmpie area (Table 1) has a neutral to a weak base reaction. It is well supplied in humus, nitrogen and phosphorus and a very high potassium content.

The degree of saturation in bases (V%) is high, which explains the slightly basic character of cambic faeozem.

In the superficial horizon the soil is well structured and airy with a loamy texture towards the clay which creates the most favorable conditions for the development of plant roots.

The fertility and productivity of this soil is very good, but in order to sustain a alfalfa culture at the level of quantitative and qualitatively superior feed production, for as many years as possible, rational maintenance and fertilization technologies are required after a rigorous agrochemical study completed once every 4 years.

Table 1. Physical and chemical analyzes of cambic faeozem soil (cambic chernozem) from "Iocobeni Forest" area of Sopor de Câmpie (2012)

Horizon and depth (cm)		pH	Hu mus %	N total %	P mobile (ppm)	K mobile (ppm)	SH (me /100 g sol)	V%	Granulometric analysis					Tex ture
									Thick san d %	Fine sand %	Dust %	Clay %	D.a. g/cm ³	
Am	0-20	7,40	4,90	0,286	19,7	129,26	1,87	92	1,11	31,2	22,2	30,6	1,03	LA
	20-45	7,50	4,61	0,188	23,2	137,19	1,96	94	1.12	32.3	23,8	31,6	1,22	LA
Bv	45-120	7,86	3,20	0,120	28,5	122,51	1,62	93	1.12	32.8	23,8	34,4	1,45	LA
CCa	120-140	7,90	-	-	-	-	0,68	95	0,21	33,7	24,4	28,3	1,50	A

Regarding the effect of alfalfa cultivation on soil fertility, in the third year of culture, there was a slight increase in the nitrogen content of the soil due to the symbiotic fixation of atmospheric nitrogen. The values of other agrochemicals of the soil remained unchanged. For the Soporul de Câmpie area, the soil taken in the study is famous for the alfalfa culture as feed for animals because animal husbandry is the basic occupation of locals in the area.

2. The influence of the fertility of the cambic faeozem soil (cambic chernozem) on the production of lucerne during the two years studied

The researches and observations were made in the III and V crop years of the alfalfa, respectively 2012 and 2014. In the years with favorable climatic conditions for the alfalfa culture, the third year and

the fourth year of exploitation are the years with the highest productive feed potential, around 30-40 t/ha green mass [7], and in year V the production of alfalfa starts to decrease. The yields contained in this research (Table 2) of 23000 kg/ha green mass in 2012 and 23380 kg/ha green mass in 2014 are below the estimated potential of alfalfa (35000 kg/ha green mass in year III crops and 34000 kg/ha green mass in the 5th year of cultivation) and below the natural fertility of the cambic faeozem soil, respectively of the cambic chernozem.

Average green fodder yields in the two-year study of alfalfa crops in Sopor de Câmpie area were inferior to its genetic potential, mainly due to the negative effects of climate disruptions and anomalies, which have led to a low level of slightly soluble nutrient ions from the soil solution made available to plant roots in the maximal consumption stages to form vegetal mass (biomass).

Table 2. Lucerne production on a cambic faeozem (SRTS 2003), cambic chernozem (SRCS 1980) in Sopor de Câmpie in the Transylvanian Plain (kg/ha of green mass)

No. Crt.	Year of alfalfa cultivation on a cambic chernozem	Estimated production according to the fertility potential of the soil (kg/ha of green mass)	Production during the two analysed years (kg/ha of green mass)		Difference kg/ha of green mass)
			2011	2012	
1	Year III - 2012	35000	23000	X	12000
2	Year V - 2014	34000	X	23380	10620

These undesirable climatic phenomena, especially the prolonged drought during the study period, did not allow production to be highlighted by the productive features and quality of the alfalfa crops analyzed. Despite all the negative influences of unfavorable climatic conditions, the high level of natural fertility of the soil has resulted in good yields of alfalfa green fodder compared to other areas equally affected by prolonged drought during plant vegetation, but on other soils with lower fertility.

The good yields of alfalfa in the two years studied are explained by the location of the culture at the base of the slope on an almost horizontal plate, where the natural moisture and fertility of the soil has influenced favorably the development of the vegetal mass and the main product alfalfa.

Also, the alfalfa is a plant species resistant to dry climatic conditions of the vegetation period due to the pivotal, deep roots that can reach up to 10-12 m depth or more but the main root mass (80-85%) is found in the first 40-50 cm of the soil [7].

4. Conclusion

The pedological profile presented highlights the influence of the climatic conditions of silvosteppe and sediment parental materials on the physicochemical characteristics of cambic faeozem soils, determining their grouping in the category of neutral to softer soil, exhibiting medium to heavy-clayey texture, it is recommended to farmers in the area to correctly apply soil cultivation, fertilization and maintenance works to alfalfa crops in accordance with the specific and global consumption requirements of fodder plant species and alfalfa.

The cambic faeozem, respectively the cambic chernozem on which the alfalfa culture was located during the two years studied have very high natural

fertility and have a good production potential to which both physical and chemical characteristics of agrochemical contribute.

The good green alfalfa yields obtained during the two years of study, highlight the high fertility level of the cambic faeozem, respectively cambic chernozem, specific to the low hills of the Transylvanian Plain, with a high capacity of water storage in the intermediate horizons, water being provided according to the requirements of plants during periods of prolonged drought from certain phenophases.

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