

Ecological and economic impact of dodder species (*Cuscuta* spp. Convolvulaceae) on pratological ecosystems

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Abstract This paper is based on a study carried out on several prato-ecosystems (grasslands, crops of perennial leguminous fodders) in the south-eastern region of Romania. All these ecosystems are characterized by the presence of a holoparasitic anthophyte, namely *Cuscuta* spp., which has a deep impact on vegetation due to the fact that it determines modifications in the structure of the vegetal carpet, it decreases the arable surface, results in quantitative and qualitative crop losses, represents a vector concerning the transmission of such diseases as viroses and microplasmoses to the host plant, and its impact on the biodiversity determines the degradation of the landscapes' decorative aspect.

Although dodders parasitize a significant number of plants, the most important are the damages produced on perennial leguminous fodders, such as: alfalfa, clover, cockshead, *lotus corniculatus* and several combinations for sown meadows and natural grasslands. Nevertheless, further species are endangered as well, such as vegetables (onions, chives, tomatoes, carrots, spinach), textile plants (flax, hemp, cotton), industrial plants (potatoes, beets) and ruderal plants on railway sides or irrigation channels. Moreover, it also affects timber, such as willow, acacia, plops, blackberry trees and even gramineae, even if they do not represent its favorite host plants [31]. In Romania, almost 20% of the alfalfa and red clover crops are affected by this parasitic plant; and the spreading of dodders result in annual losses of over 20 million RON [38].

Damages caused by weeds are numerous, and their percentage varies depending on several pedoclimatic and social factors. For this reason, authors tend to slightly disagree when it comes to an estimation of crop losses [39], these aspects being very problematic and having a social impact at an environmental, agricultural as well as economic level.

According to several authors, out of the three main causes of agricultural damage (diseases, pests and weeds), weeds cause the greatest damages. Worldwide, agricultural losses brought about by pests represent approximately 9-12%, whereas those produced by weeds reach a percentage of 14-15% [33]. By taking into account the current situation of the agricultural sector, the main goal of agricultural development on the short and medium terms should be a quantitative and qualitative increase of agricultural production, so as to ensure a certain food safety of the population [15], as well as an intensification of its contribution to external trade, given that the necessary requirements for environmental protection are fulfilled.

“A sustainable agriculture can be promoted only if certain conditions are fulfilled by farmers, especially with regard to culture rotation, fertilization, pest

Key words

Cuscuta spp., ecological impact, economic impact

control and an efficient energy usage” [14, *own translation*].

Weeds affect not only the quantity, but also the quality of crops. Those crops harvested from fields affected by weeds carry large quantities of weed seeds.

Weed control in the current context of Romanian agriculture represents a main national problem, since weeds have been causing significant damages on crops, covering surfaces to a degree of between 50 and 100%; losses which are completely ignored at the moment, despite the fact that they may affect 60% of the country's arable surface [5].

Material and Method

This study has been carried out on prato-ecosystems, such as grasslands and crops of perennial leguminous fodders, in the south-eastern region of Romania. Therefore, several field trips were undertaken, where the crops were analyzed from a phytosanitary perspective, with a view to analyze the presence of dodder species. However, it has to be mentioned that, in comparison to previous years, this year no culture was found to be uniformly infested with *Cuscuta* sp;

fact which indicates that un-doddered seeds had been used; *cuscuta* has only been present on certain areas of the analyzed crops. Not only the field excursions, but also the phytosanitary controls were performed systematically, depending on the biology of *cuscuta*. However, in the case of perennial leguminous fodders,

the samples for the quantization of crop damages had been collected before the crop was mown. The region that has been analyzed represents in fact an agricultural surface belonging to the Sibiu and Brasov counties. The situation of the infested prato-ecosystems is presented below, both graphically (Fig. 1) and as a table (Table 1).

Table 1

Centralized data regarding the Sibiu and Brasov counties in 2012

Nr. crt.	CULTURE TYPES	SIBIU COUNTY (ha)	BRASOV COUNTY (ha)
1.	GRASSLANDS	107.718	118.327
2.	FODDERS	72.885	59.025
3.	ALFALFA	7.740	8.150
4.	CLOVER	866	300

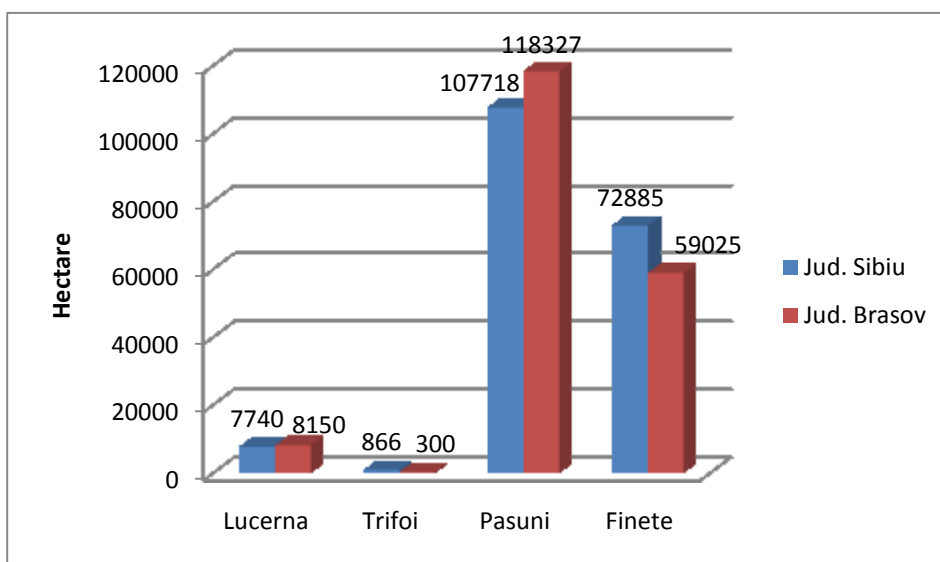


Fig. 1 Surface covered by the prato-ecosystems of the analyzed region in 2012

Results and Discussions

Within the analyzed region a significant invasion of *Cuscuta spp.* has been recorded, this fact having been favored by both a vegetative and generative propagation. Wolswinkel's research [37] carried out by means of carbon tracer ^{14}C , showed that dodders are able to extract 100% of the sap of the *Vicia faba* species. According to the results of our research, there are no fodder crops that are not, at least partially, infested with dodders.

Damages generated by *Cuscuta sp.* Dodders represent the most dangerous quarantine parasitic weeds not only in our country, but in most countries which have a temperate or warm climate. According to old farmer beliefs, dodders were produced by drought, humidity or by mineral fertilizers. Since the parasite's morphology and biology were unknown, it was

believed that the plant was staying alive due to some miraculous roots, embedded in the soil and difficult to notice. Due to the damages it has produced, dodders have represented a concern and at the same time an important topic for botanists and agro-phyto-technicians since the 18th century. Then, in the 19th century new technical methods of seed cleansing in so-called un-doddering stations were invented.

Cuscuta has some peculiarities and several features which can explain the plant's adaptation to parasitism: an enormous fertility capacity (over 10,000 seeds per plant); a long period of subsistence to look for a host plant; a long germinative ability by installment, due to the phenomenon of tegumentary inhibition, etc. Among its peculiarities, the following ones are of a significant importance: the lack of a cotyledon; presence of chlorophyll in all plant organs, except for the root, and still no photosynthesis except under conditions of

carbon-dioxide-enriched air; lack of a meristem and of a root tip, thus determining a solely upward movement of assimilates; endurance of living haustoria within the plant while the parasite's stems are dead; haustoria that can regenerate the parasitic weed, thus rendering it perennial, etc.

An entire plant protection system, including agricultural specialists and producers, is necessary in order to successfully carry out a systematic control of the crops the aforementioned specialists owe or are responsible for, including the abidance by the technical norms necessary for a phytosanitary control. In order to accomplish an efficient inventory and evaluation system of damages caused by *Cuscuta spp.*, a large number of observations on both synchronic and diachronic levels is needed. Therefore, especially in the case of private agriculture, it is extremely important that every single allotment, irrespective of its size, is controlled phytosanitarilly on a regular basis.

Parasite on perennial leguminous fodders. Because certain phytosanitary quarantine rules have not been abided by, dodders spread on large surfaces; and their seed reserves in the soil increase by year. Although dodders parasitize a significant number of plants, the most important are the damages produced on perennial leguminous fodders, such as: alfalfa, clover, cockshead, *lotus corniculatus* and several combinations for sown meadows and natural grasslands. Nevertheless, further species are endangered as well: vegetables (onions, chives, tomatoes, carrots, and spinach), textile plants (flax, hemp, and cotton), industrial plants (potatoes, beets) and ruderal plants on railway sides or irrigation channels. Moreover, it also affects timber, such as willow, acacia, plops, blackberry trees, etc.

Vector of viroses and microplasmoses. Besides decreasing production, cuscuta is also dangerous because of its toxicity, since it contains substances which are harmful to animal health, thus decreasing the quality of fodders. Cuscuta facilitates the transmission of viroses onto trifoliates and potatoes, the viral chlorosis of sugar beet, etc. [3]; [26]. The transfers occurs naturally when *Cuscuta spp.* infests two or several plants (identical or different species), and the mechanism had been intensively used for experimental reasons [13]; [7]; [9]; [32]; [20]; [10]; [19]; [21]; [22]; [23]; [18]; [16]; [17]; [28].

Biodiversity and degradation of the landscape aspect. Beside the damages produced on crops of leguminous perennial fodder, dodders can often be found on grasslands, thus influencing in a negative way the aspect of landscape, and implicitly tourism [6]; [30]; [31].

The most significant types of ecosystems affected by cuscuta species are the pratologic ecosystems. However, there is a huge number of species which represent host plants for dodders; this fact affecting the biodiversity of ecosystems at a process level, as well as with regard to human society and animal health. In

agriculture crop losses are significantly high because of dodders. There has been relatively little research done on the impact of cuscuta on natural plant communities, but in general it is clear and obvious that biodiversity is lessened in regions affected by *cuscuta*.

Such factors as an unsustainable management of pratecosystems, the occurrence of such invasive species as cuscuta, and climate change have a very negative impact on biodiversity [4]. Therefore, lessening the occurrence of cuscuta in agricultural ecosystems contributes in fact to public health and environment preservation.

Cuscuta spp. Are usually avoided by herbivores, most probably because of their colour, thus influencing the structure of plant communities. Moreover, according to several studies, *Cuscuta spp.* Extract is toxic for nematodes [24]; [27]; [12].

Cuscuta, an invasive species? Despite their ecologic significance, parasitic plants face more endurance challenges than many autotrophic plants. This fact is especially valid for the group of invasive species, including *Cuscuta* – in some countries [8]. Even if approximately half of *Cuscuta* species would need preservation measures, the genre as a whole is listed with Government records as a toxic or quarantine weed.

Many natural and semi-natural ecosystems worldwide are affected by invasive plants one way or the other. Such parasitic plants have numerous effects [36], and several authors suggested categorization schemes of these effects [25]; [34]. Roughly, the types of impact can be subdivided into the following groups: impact on agricultural systems and natural ecosystems; impact on genetic diversity, and social impact. In comparison to the impact of weeds on agricultural systems, there have been relatively few studies regarding their impact on natural ecosystems [35].

By the term of 'invasive species', one should not assume a sort of foreign species, since most of them are autochthonous, endowed with an astonishing adaptation ability. Often, a particular species of invasive plants was not regarded as being able to affect the local crops, and when its intriguing ability was nonetheless noticed, it was often too late for any measures to be taken [11]. The invasion phenomenon often takes place in habitats characterized by a rather weak competition; usually because of human intervention. In order for a plant to be considered invasive, it has to be characterized by several features: rapid means of propagation; production of numerous seeds every year; to have means of vegetative reproduction; to grow quickly; to be avoided by phytophagic animals, etc. [11]

Adair and Groves [1] provide a useful summary of possible methods for the ecologic evaluation of the impact of invasive plants. Although they focus on space-invasive plants, many of their principles apply to agricultural invasive plants, such as *Cuscuta spp.*

The types of impact that have to be quantified depend on the ecosystem type. Undoubtedly, agricultural invasive plants have a sociological impact, since they usually have economic losses as a consequence, such as increase in management costs and decrease in output. Methods of identifying and determining the social and economic impact of weeds (autohtonous and foreign species) in agricultural systems have been discussed by Auld [2] and Sinden [29].

Conclusions

Crop damages are particularly significant. Monitoring *Cuscuta* species and their spreading tendencies, as well as their prevention and therapy generates positive and immediate economic and social effects, by means of creating an integrated protection system of cultures. Moreover, it might also determine a qualitative and quantitative increase of agricultural production, which benefit farmers on the short, medium and long run. Furthermore, they will be mirrored in the quantity and quality of fodders, animal health and welfare of farmers; since it is universally acknowledged that the decrease in risk of diseases, parasites and weeds within agricultural ecosystems would influence public health and environmental protection in a very positive way. *Cuscuta* species determine by their spreading a decrease in the arable surface of grasslands and crops. If they are not kept under control, they will eventually cover the greatest part of the arable surface. The necessary costs for controlling these evasive species increase by year, since the surfaces attacked by dodders increase on a yearly basis as well. The results that have been obtained by the analysis of this data and by means of corroboration with previous conclusions concerning the morphology and dynamics of dodder attacks could be regarded as a means of underlying those prato-cultural measures necessary to be applied onto affected cultures.

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