ALLEY CROPPING, AS A MODEL OF SYSTEM ADAPTED TO CLIMATE CHANGE

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Abstract

The realization of the alley cropping for the first time in Romania was made in order to promote this type of agroforestry system applied with succces, both at European and global level, in order to improve the microclimatic conditions, to increase the agricultural production and to diversify the overall production of the system. Increasing the percentage of surfaces occupied with forest vegetation, especially in the south of the country or in plains and hilly areas, where it is poorly represented, increasing biodiversity, carbon sequestration, landscape are objectives, which are in addition to those mentioned above. Alley cropping is the cultivation of differents crops (cereals, vegetables, forage, even horticultural species) between widely spaced rows of forest trees. Trees are placed within agricultural cropland systems. The installation, with an experimental character, of the alley cropping within the Ogoru Farm and the Fundulea National Institute for Agricultural Research and Development, from Calarasi County, are the first attempts to achieve this type of agroforestry system in our country.

Keywords: alley cropping, agroforestry system, forest species, crops, microclimate, protection

INTRODUCTION

More and more specialists are looking for solutions to the major problems facing humanity: climate change, pollution, decreased biodiversity, greenhouse gases and so on (Dumitraș, 2008, Osmanski, 2020). As a solution to adapt agricultural systems to climate change some farmers in our country introduce forest vegetation, most often in the form of forest shelterbelts (strips of 5-7 rows of trees), to protect agricultural crops from the effects of strong, dry or very hot winds. Another way to associate agricultural crops with forest species is to place trees in agricultural land in the form of a single row of trees, repeated at much shorter distances than in the case of forest shelterbelts, performing both ecological and economic functions (Hodge, et. al., 1999, Mosquera-Losada, et.al., 2018, Nair, 1990). It's all about alley cropping, an innovative agroforestry system in terms of land use (Quinkenstein et al., 2009). In this sense, two experimental blocks were installed at the Ogoru Farm in Lehliu and within the National Institute for Agricultural Development Research (NIADR) Fundulea in which the agroforestry system - alley cropping was introduced.

MATERIAL AND METHOD

In order to achieve this type of agroforestry system, respectively the introduction of a single row of trees within the agricultural crops, the site conditions were analyzed. Also, the type of soil was established (Dănescu, et al., 2010 a), the climatic conditions and the existing forest vegetation in the area were analyzed. The characterization of the climatic conditions was made following the documentation from specialized works (***, 1960, ***, 1983) and the interpretation of the climatic data taken from a weather station installed within NIADR Fundulea. The forest vegetation in the area was determined and analyzed through research conducted on the route.

Within the experimental space, all planted seedlings were inventoried and measured (spring and autumn) to calculate the alive seedlings after planting and maintenance percentage, average height and growth during the vegetation period, as indicators of the development of forest species in agricultural crops. Observations were also made on the health of the seedlings.

RESULTS AND DISCUSSION

The plain area of our country, included mainly in agricultural land (https://insse.ro/cms/) must cope with climate change and the introduction of forest vegetation is a solution to mitigate their negative effects. The alley cropping system, proposed to be carried out, involves the introduction of trees in a row, which are repeated at distances that vary from one farm to another, depending on their production objectives, agricultural crops developing in the intervals delimited by trees (Mihailă E., et al., 2010).

It is considered to mitigate the negative effects of conventional agriculture by reducing soil fertility, pollution of surface and ground water and loss of biodiversity and ecosystem services, while maintaining a high level of production of agricultural crops and obtaining additional production of forest vegetation products (fig.1) (Quinkenstein et al., 2018, Vityi et al., 2018).

The characteristics of forest species and the optimal distance between rows of trees are the main elements that are taken into account when designing alley cropping (Sinclair, 1999). As regards the characteristics of forest species, the choice is made of those species which compete as little as possible with agricultural crops, in terms of light and nutrients (Jose et al., 2000. Rudebjer et al., 2001).

The rows of trees are placed at different distances, taking into account that agricultural work should not be hindered. If timber production is pursued in an alley cropping system, the recommended number of trees per hectare is

50 - 100, which corresponds to a distance between rows of trees of 33 m and a distance of 4 m between trees per row or 25 m between trees rows and 6 m between trees per row (Van Lerberghe, 2017).

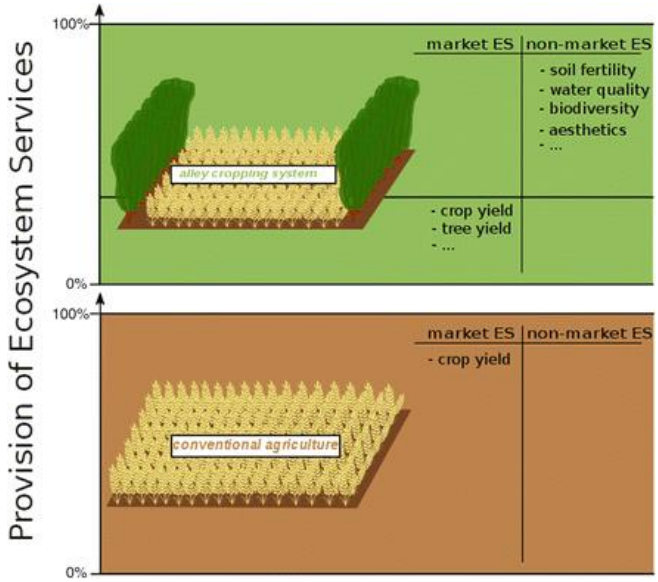

Fig.1. The scheme of an agroforestry system versus an agricultural system in terms of the functions they perform (Quinkenstein ș.a., 2018)

In order to ensure a constant long-term agricultural production, it is necessary to increase the distance between the rows of trees, research conducted in this regard showing that a distance of 25 m between rows will allow to obtain a good agricultural production 20 years, after which the shade produced by trees affects agricultural crops (Workman et al., 2003). Within the agricultural farm, respectively the NIADR Fundulea, obtaining high and constant agricultural productions are long-term objectives so that it was established that the distance between the rows of trees should be greater.

Following the site conditions analysis (Dănescu, et al., 2010 b) and taking into account on the one hand the option of farmers from Ogoru Farm, respectively the rapid growth of forest species (to fulfill ecological functions in a short time) for the realization of the alley cropping system were chosen Siberian elm and hazelnut at Ogoru farm and Siberian elm at NIADR Fundulea. At the Ogoru Farm, in the autumn of 2019, three rows of Turkestan elm and two rows of hazelnut trees were installed on an area of approximately 38 ha, spaced, starting from the perimeter hedge, in the southwestern part of the farm, at 136, 120, 90, 125 and 100 m (fig.2).

Fig.2. Alley cropping (Siberian elm /Ulm/ and hazelnut /Alun/ - crops) at Ogoru Farm

The distance between seedlings in a row was 8 m for Turkestan elm and 4 m for hazelnut. A maize crop is installed between the rows of trees / shrubs, and a greenhouse has been built between the rows of hazelnuts since the fall of 2020.

At INCDA Fundulea, the experimental culture was installed in the spring of 2021. Its surface is about 9 ha and included three planting options: V1 - the distance between the rows of trees of 75 m and the distance between the seedlings per row of 4 m, V2 - the distance between the rows of trees of 50 m and the distance between the seedlings on row of 8 m and V3 - the distance between rows of trees of 100 m and the distance between seedlings per row of 6 m (fig.3). Siberian elm was planted between crops of wheat, corn, sunflower.

Fig.3 The experimental alley cropping device installed at at NIADR Fundulea

To stimulate the growth in height of the seedlings and to protect the stem against injury, the gnawing by wild animals (rabbits, deer, etc.) (Potter, 1991) were used protective tubes, with a height of 0.90 and 1.2 m, fixed with wooden stakes.

Fig.4. Row after plantation with trees in protective tubes (April 2021), NIADR Fundulea

Following the observations and measurements made, conclusions were drawn regarding the alive seedlings percentage and maintaining the seedlings, the height of the seedlings after each growing season. The percentage of the alive seedlings for the experimental device installed at the Ogoru farm in autumn 2019 was 78% (88% in Siberian elm and 69% in hazelnut). After the completion of the additions from autumn 2020, the percentage of maintenance in spring 2021 was 93 %. The percentage of dried specimens from the experimental device at Ogoru Farm is small, 8 % in the first year and 5 % in the second year after planting, with a higher number of dry specimens in the hazelnut, 21 in 2020 and 15 in 2021 compared to the Siberian elm, where 7 specimens were dried in 2020 and only one specimen in 2021.

As for the average height value of the seedlings on the rows of trees/shrubs, it is on all rows, except R5, lower in spring 2021, compared to autumn 2020 (Fig.5). This is explained by: i) the additions made in the autumn of 2020 in the case of the other rows where the height of the seedlings used for planting was less than that of the already existing seedlings, which influenced the value of the average height; and ii) reporting, in the spring of

2021, of a number of seedlings that had a broken or dry tip and, therefore, a lower height.

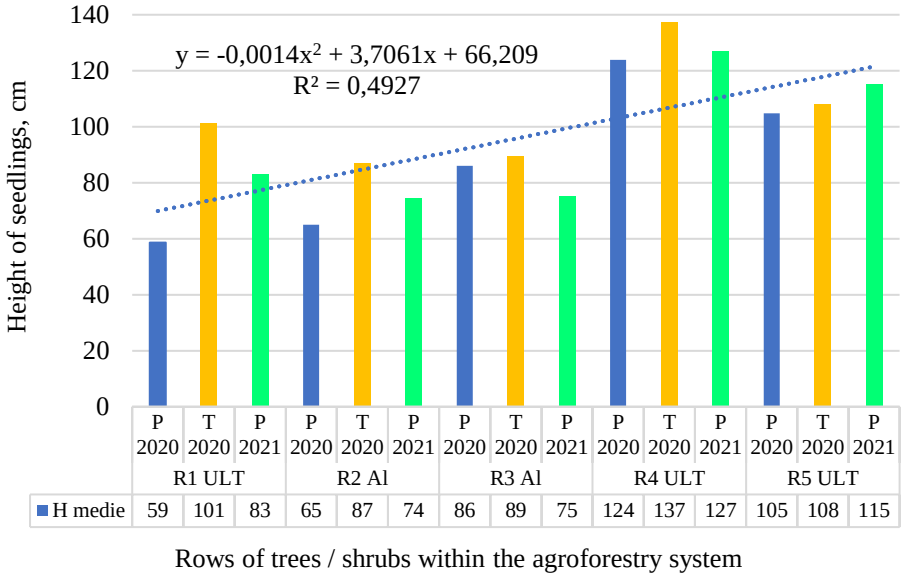

Fig.5. The average height of the Siberian elm (ULT) and hazelnut (Al) within the alley croping system installed at the Ogoru Farm, spring (P) and autumn (T)

In terms of value, the average height of seedlings ranged from 59 to 124 cm in spring 2020, from 87 to 137 cm in autumn 2020 and from 74 to 127 cm in spring 2021. The variation of the average height is due to the variation of the seedlings height, from 5 - 10 cm in the case of seedlings that were broken or partially dried and which later sprouted, to 190 - 205 cm in the case of seedlings that developed constantly from planting so far. The largest increases was recorded, predictably, at the Siberian elm.

At the experimental device installed, in the spring of 2021, at NIADR Fundulea, the percentage of alive seedlings of Siberian ulm was high, being for each experimental block of 96, 98 and even 100%. Regarding the average height on he rows of seedlings within the experimental variants, in the first part of the growing season, it varies within each row of the experimental blocks, the highest values per row being 98 cm, 97 cm in block V3, respectively block V2 and 88 cm in block V1 (Fig.6). The value of the average height for each experimental block varies from 97 cm in block V3 to 81 cm in block V1.

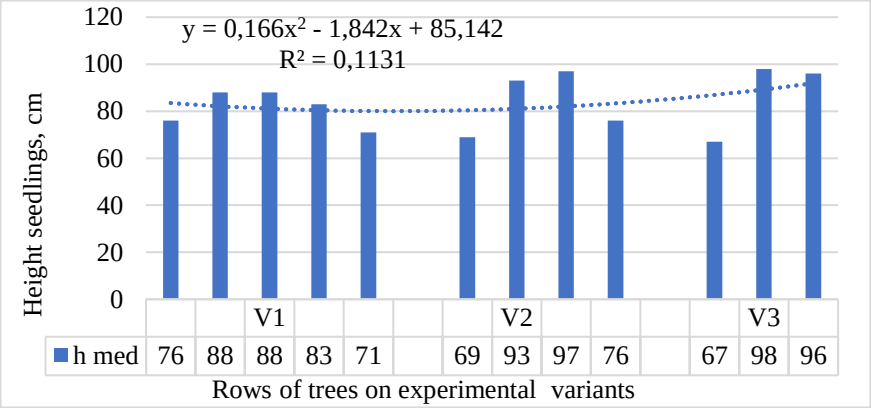

Fig. 6 The average height of the Turkestan elm from INCDA Fundulea

Benefiting in the beginning of the vegetation season in rich precipitation and warm temperatures, the Siberian elm seedlings from the experimental device installed at NIADR Fundulea registered large increases, some specimens exceeding 100 cm, reaching even 130 - 135 cm.

At the Ogoru Farm, some Siberian elm seedlings reach 200 cm after a growing season. The hazelnut seedlings, on the whole, also recorded increases, reaching heights of up to 160 cm.

To date, no diseases or pests have been reported in Siberian elm or hazelnuts in any of the experimental areas.

CONCLUSION

The installation of this type of agroforestry system, alley cropping, for the first time in our country, in agricultural farms in the south of the country, was done to analyze the effect of forest species on agricultural crops and on the microclimate.

After one, respectively two years from the establishment, it was found that the association between forest seedlings and agricultural crops within the alley cropping system was beneficial, the seedlings developing very well.

Acknowledgements

The present research was funded by the national project PN 19070403 Establishment of new agroforestry systems in Romania.

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