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The Influence of Agroforestry Curtains on the Production of Autumn Cereals, in the Climatic Changes Conditions from Braila Plain, Romania

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Abstract

Under the current climate changes in the Braila Plain, Romania, with soil drought and increased scorching during spring, the most suitable crops are autumn straw cereals, which efficiently capitalize on winter moisture. The paper presents the experimental results obtained in demonstration plots of wheat, barley and triticale under the pedoclimatic conditions of the Braila Plain, Romania, in the years 2023 and 2024, and the influence of agroforestry curtains on them. The pedoclimatic conditions of the two agricultural years, 2022 – 2023 and 2023 – 2024, the agrochemical soil analyses, the biometrics of the wheat, barley and triticale genotypes, as well as the productions obtained are presented. The statistical processing of the experimental data was carried out using the ANOVA and correlation tests, in order to make recommendations for farmers in the area of interest.These results were possible through the implementation of the research project ADER 1.2.2., entitled "Establishment of agroforestry curtains and the study of their influence on the anti-erosion protection and evapotranspiration of agricultural crops", which is being implemented between 2023 and 2026, being funded by the Ministry of Agriculture and Rural Development, Bucharest, Romania.

Keywords: Wheat, Barley, Triticale, Yield Performance, Agroforestry Curtains, Climatic Changes.

Introduction

The agroforestry system used in the ADER 1.2.2 research project is an ecologically sustainable planting model that took into account both the microclimate and economic benefits, being realized with energy species (poplar, acacia, Miscanthus) to obtain energy pellets and with fruit tree and shrub species (apple, plum, raspberry, blackberry, elderberry), for the valorization of fresh fruits or by processing into various jams, juices or compotes. Being a planting and cultivation model that combines annual crops and perennial woody plants, agroforestry systems can effectively increase the land use rate and have been widely used in arid and semi-arid areas [1-3].

For the agroforestry curtains within the SCDA Brăila, several species were chosen, some forest, for obtaining pellets and others fruit-bearing, for obtaining fruits, so that the transition of land areas from arable to forestry will result in economic and financial growth for SCDA Brăila, as well as for the farms that will be able to subsequently implement this project.

The agroforestry curtains planned and designed at SCDA Brăila are a benefit for the future, so that there is stable protection for agricultural crops and at the same time, they can also offer sustainable food to the community and even visitors, tourists from other areas.

As conceived since the initial proposal, these agroforestry curtains can bring anti-erosion stability and fertility and moisture retention in the soil, as well as protection against pests for agricultural crops, but also economic benefits and profitability for

the farms that will implement the proposed system.

Energy poplars can be used because the calorific value of one kilogram of poplar is 4.95 kWh, while the calorific value of one kilogram of hardwood is 3.1-4.2 kWh. Thus, energy poplar guarantees a safe and non-polluting source of energy (higher calorific value 17,000 – 18,000 kJ/kg), without excessive carbon dioxide emissions. On the other hand, growing energy poplar in agroforestry curtains protects forests from continuous deforestation caused by the rush for cheap firewood. It could also make very good use of land unsuitable for other crops, such as, for example, floodplains, around sewage treatment plants, etc.

It has been proven that heating with energy poplar is 10 times cheaper than heating with diesel and 30% cheaper than heating with gas. In addition to energy purposes (pellets, briquettes, wood chips), poplar can also be successfully used in the following areas: raw material for cellulose, paper industry, furniture and construction wood industry, pallet and match manufacturing.

Experiences so far confirm an average production of approximately 35-40t/ha at a humidity of about 30%-35%, this value oscillating depending on the type of soil and the water regime, and as dry mass/ha (8-10% humidity) 15-20 tons can be obtained.

Harvesting can be done partially mechanically with a chainsaw and trailers for exploitation in the case of smaller areas, or with special machines (combine, tractor, trailer) in the case of large areas (over 3-5ha). The harvesting time is in the winter months (December - March, after the leaves fall), thus ensuring better exploitation of the machinery and workforce. From the bibliographic data, it was found that the establishment of an energy poplar plantation is not a cheap investment, but starting from the second year, the money invested is quickly recovered. It is important to mention that in EU countries the different varieties of energy poplar are subsidized crops. Subsidies can be of different types (e.g. 50% of the plantation establishment costs, annual subsidies, mixed subsidies, etc.).

The life span of an energy poplar plantation is about 25-30 years, which, starting from the second year, does not require any other intervention, apart from harvesting.

A Previous Study Shows that Energy Poplar Plantations Can Be Profitable Because

- Cost of establishing one hectare of plantation: 780 Euro
- Cost of planting and clearing the land in the first year: 200 Euro/ha/year
- Starting from the second year, the expenses are minimal: 100 Euro/ha/year (harvesting)
- The price of poplar chips is about 30 Euro/ton (at a humidity of about 30%) and, as a result, at a production of 35 tons/ha the income obtained is about 1050 Euro/ha.
- The gross income thus achieved is approximately 950 Euro/year (1050 - 100 Euro/ha/year)
- The net income/year even at a production of only 30 tons/ha is 760 Euro/ha/year, comparable to the income achieved from other agricultural crops, and this can be maintained for 25 -30 years without special work.

30 tons/ha/year x 30 Euro/ton = 900 Euro/ha/year;
780 Euro (cost of plants) + 200 Euro (cost of planting + land clearing) = 980 Euro;
980 Euro/ 25 years = 39.2 Euro/ha/year amortization of the investment;
900 Euro/ha/year (gross profit) - 39.2 Euro/ha/year (depreciation) - 100 Euro/ha/year (harvest) = 760.8 Euro net profit/ha

Materıal and Method

The fruit species were chosen according to the initial terms of reference and on the recommendation of specialists from some fruit research stations.

In the phase 2/2024 of the project, fruit trees of the apple (Malus domestica) and plum (Prunus domestica) species were planted, purchased from SCDP Bistrița, the varieties chosen being on the recommendation of the researchers for their resistance to diseases and pests and increased tolerance to drought.

The establishment of the agroforestry curtains was carried out according to the schemes drawn up in the first phase of the project, to cover the perimeters of the soils of the two experimental centers CE Chișcani and CE IMB, with two rows of energy and forestry species and 1 row of fruit trees, according to the schemes in figure 1.

Figure 1: The layout Schemes of Agroforestry curtains in the two Experimental Centers of SCDA Brăila

The Tree Planting was Carried out İn Stages, As Follows

In December 2023, with the help of GPS-RTK, the lines for planting fruit trees were drawn at CE Chișcani and the planting of 260 apple trees, purchased from SCDP Bistrița, was successful.

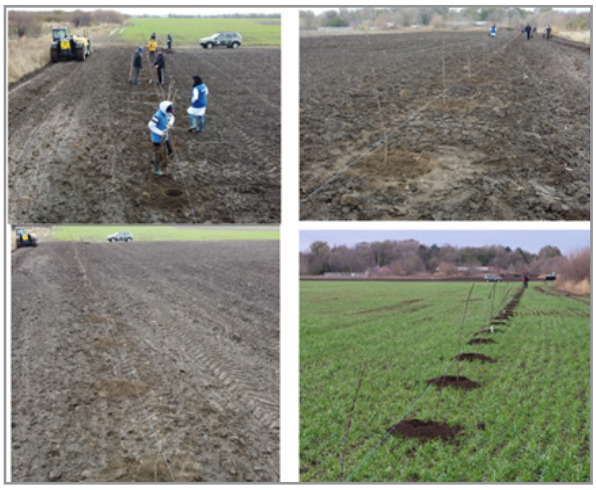


Figure 2: Aspects During Manual Planting of Fruit Trees

In December 2023, 260 apple trees of the varieties were planted: Florina– 20 pcs., Auriu de Bistrița – 80 pcs., Salva – 80 pcs. and Bistrițean – 80 pcs.

In March 2024, the planting of fruit trees continued in the agro-forestry curtains at CE Chișcani, namely 650 apple trees of the Idared varieties – 300 pcs. and Golden delicious – 350 pcs., as well as 130 plum trees, of the Carpatin varieties – 10 pcs., Matilda – 10 pcs., Diana – 20 pcs., Stanley – 40 pcs., Anna Spath – 30 pcs. and Iulia – 20 pcs. (Figure 3 and Figure 4).

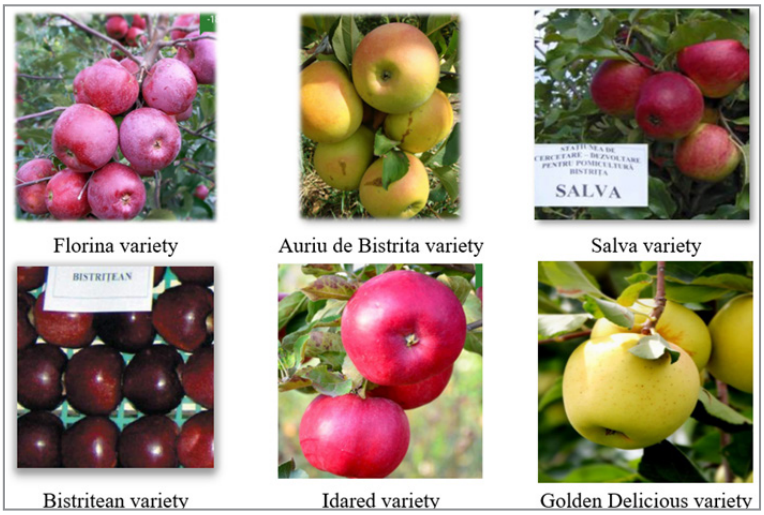


Figure 3: Varieties of Apple Trees Planted in the Forest Courtain at ARDS Braila

Figure 4: Varieties of Plum Trees Planted in the Forest Courtain at ARDS Braila

For 2025, the introduction of new species, both energy (Miscanthus sp.) and fruit trees / shrubs, will be considered, to replace energy trees that will not withstand drought or for various other reasons.

Miscanthus giganteus, or Chinese reed, elephant grass, originating in Asia, is a perennial energy plant from the Miscanthus family. It is characterized as a sterile herbaceous plant that reproduces only vegetatively through rhizomes.

The plants produce a large amount of dry matter per hectare and are used as energy plants, important biomass resources.

Like willow or energy poplar, it is a perennial plant (over 20 years), with intensive development: 3 - 4.0 m in height, with high productivity per cultivated area (Illinois (USA) - 60 t/ha, Ontario (Canada) - 45 t/ha). Over the winter it remains in the forest canopy, and in the spring, it can be chopped and made into energy pellets.

It is a plant that does not produce seeds and is therefore non-invasive, and its roots can reach up to six meters deep to search for water.

Miscanthus giganteus is unpretentious; after the first year, as a rule, no treatment or care of the land is required. Miscanthus grows without fertilizers; because during the winter all the leaves fall and act as a natural fertilizer for the soil.

In the first year after planting, it is not harvested because it is not economically profitable and is left on the field.

Miscanthus is harvested in early spring with a combine or baler, and the collected materials can be easily stored without the need to be dried. This cycle is repeated every year.

At the moment, at the Polizești Experimental Center, of the SCDA Brăila, 2 ha of Miscanthus are cultivated, from where rhizomes can be harvested to be planted in forest curtains (Figure 5).

Figure 5: Miscanthus Giganteus Nursery from CE Polizesti for ARDS Braila

Results and Discussion

The climatic situation in the last 2 agricultural years, at SCDA Brăila, is presented in table 1., table 2. Compared to the agricultural year 2022 - 2023, when the deviation of total recorded precipitation was + 24.1 mm compared to the multiannual, in the agricultural year 2023 - 2024 the precipitation deviation was -71.9mm. In other words, in this area, where there was no irrigated, no production could be obtained at all.Regarding the average monthly temperatures recorded in the same analyzed periods, deviations from the multiannual average of +1.9oC were noted in the agricultural year 2022-2023 and +3.6oC in the agricultural year 2023 - 2024.

Table 1: Climatic Situation of the Agricultural Year 2022 - 2023

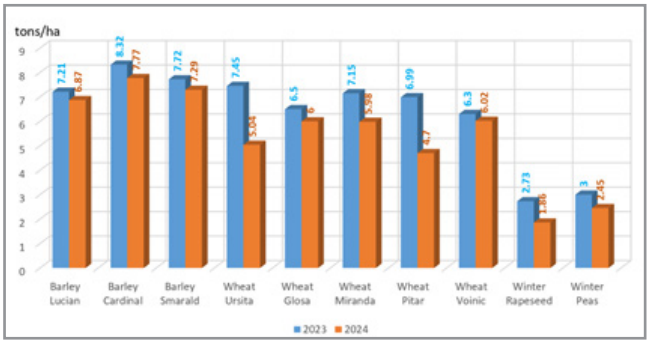
Climatic Elements		2022				2023								TOTAL
		IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	Average
Precipitation (mm)	Monthly average	32	6	31	20	64	7	13	66	40	26	106	55.1	466.1
	Multiannual monthly average	32	30	33	36	28	27	26	35	48	62	46	39	442
	Deviation	0	-24	-2	-16	36	-20	-13	31	-8	-36	60	16.1	24.1
Temperature (0C)	Monthly average	17.9	13	8.1	2.9	4.4	1.4	7.9	10.4	16.6	21.6	24.7	24.7	12.8
	Multiannual monthly average	17.3	11.5	5.6	0.6	-2.1	-0.2	4.7	11.2	16.7	20.9	22.9	22.1	10.9
	Deviation	0.6	1.5	2.5	2.3	6.5	1.6	3.2	-0.8	-0.1	0.7	1.8	2.6	1.9

Table 2: Climatic Situation of the Agricultural Year 2023 - 2024

Climatic Elements		2023				2024								Total
		IX	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	Average
Precipitation	Monthly average	4.5	3.4	124	22.87	15.9	0.3	40.4	26.1	35.0	47.3	33.2	17.2	370.1
	(mm)	32	30	33	36	28	27	26	35	48	62	46	39	442
	Deviation	-27.5	-26.6	91	-13.1	-12.1	-26.7	14.4	-8.9	-13.0	-14.7	-12.8	-21.8	-71.9
Temperature (0C)	Monthly average	20.9	15.9	8.1	3.6	0.4	7.4	8.2	16.8	16.6	24.3	26.5	25.2	14.5
	Multiannual monthly average	17.3	11.5	5.6	0.6	-2.1	-0.2	4.7	11.2	16.7	20.9	22.9	22.1	10.9
	Deviation	3.6	4.4	2.5	3.0	2.5	7.6	3.5	5.6	-0.1	3.4	3.6	3.1	3.6

The graph in figure 6 presents the production results of autumn crops at SCDA Brăila, obtained in 2024, compared to 2023. The percentage differences were positive only for the Smarald barley variety (+3.63%) and the Glosa wheat variety (+8.97%).

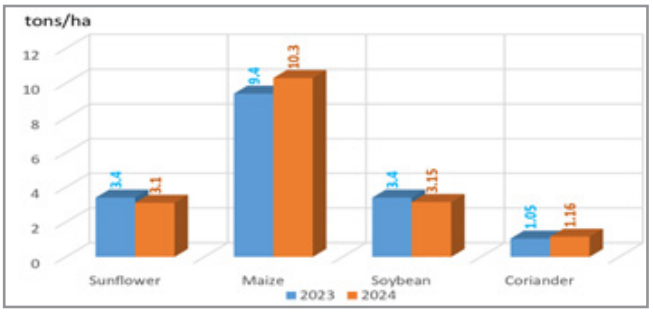
The largest negative production differences in 2024, compared to 2023, were obtained for the Pitar wheat variety (-44.3%), autumn rapeseed (average on the demonstration lot with over 30 varieties) for which the difference was -30.4%, autumn peas (-19.3%), the Miranda wheat variety (-10.49%) and the Voinic wheat variety (-8.34%).



Autumn cultures	2023	2024	Percentage differences (%)
Barley Lucian	7.21	6.87	-4.72
Barley Cardinal	8.32	7.77	-6.61
Barley Smarald	7.72	7.29	-5.57
Wheat Ursita	7.45	5.04	-32.35
Wheat Glosa	6.5	6	-7.69
Wheat Miranda	7.15	5.98	-16.36
Wheat Pitar	6.99	4.7	-32.76
Wheat Voinic	6.3	6.02	-4.44
Winter Rapeseed	2.73	1.86	-31.87
Winter Peas	3	2.45	-18.33

Figure 6: Comparative Production Results Obtained for Autumn Crops, at SCDA Brăila in 2023 and 2024

In the spring crops, the production results in 2024, compared to those in 2023, had a positive difference only in corn (average production of hybrids in the demonstration lot), by +9.57%, while in sunflower and soybean (also average in the demonstration lots), negative differences of 8.82% were also recorded (Figure 7).



Spring crops	2023	2024	Percentage differences (%)
Sunflower	3.4	3.1	-8.82
Maize	9.4	10.3	9.57
Soybean	3.4	3.15	-7.35
Coriander	1.05	1.16	10.48

Figure 7: Comparative production results obtained for spring crops, at SCDA Brăila in 2023 and 2024

By daily monitoring of the maximum and minimum air temperature, throughout the vegetation period of agricultural crops, it was possible to calculate the sum of useful temperature degrees (GDU), which was 3469 GDU in 2023 and 2932 GDU in 2024, for the corn crop, and the sum of cumulative precipitation was 234 mm in 2023 and only 158 mm in 2024 (Figure 8).

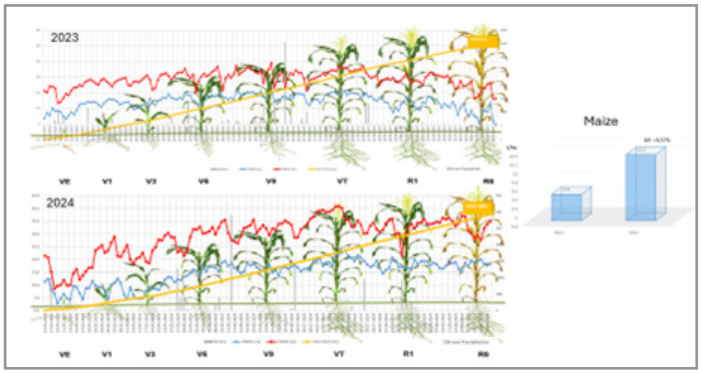


Figure 8: Comparative Results of GDU and Production in Maize crop, in 2024 and 2023, at ARDS Brăila

In 2024, a greater amplitude between the maximum and minimum daily air temperatures can also be observed, with a shortening of the vegetation period to harvest, of 26 days in 2024, compared to 2023.

For sunflower, in 2024, 2808 GDU and 157 mm of precipitation were recorded, during the vegetation period, from sowing to harvest, compared to 3150 GDU and 233 mm of cumulative precipitation in 2023, and a shortening of the vegetation period of 12 days (Figure 9).

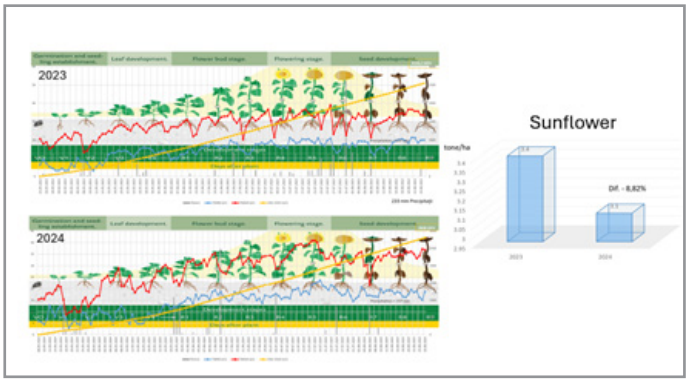


Figure 9: Comparative results of GDU and Production in Sunflower crop, in 2024 and 2023, at ARDS Brăila

For soybean, in 2024, 2641 GDU and 132 mm of cumulative precipitation were recorded during the growing season, compared to 2023, in which 3295 GDU and 219 mm of precipitation were recorded (Figure 10). The growing season to harvest was shorter in 2024 by 37 days, compared to the growing season in 2023.

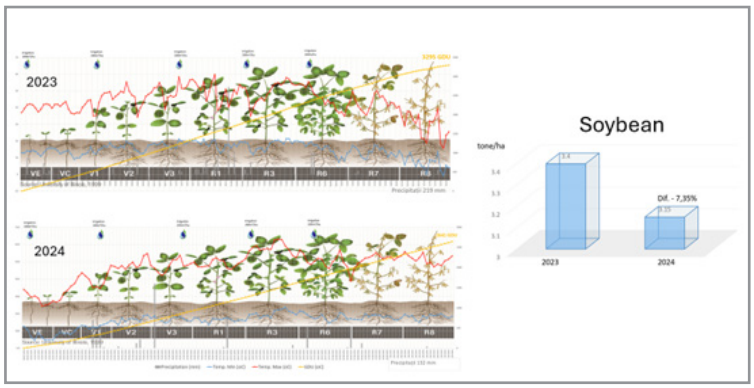


Figure 10: Comparative Results of GDU and Production in Soybean Crop, in 2024 and 2023, at ARDS Brăila

Conclusions

- Atmospheric heat negatively influences the physiology of agricultural plants, through deficiencies in root absorption and photosynthesis, increasing evapotranspiration and resulting in leaf drying, poor pollination of flowers and lack of fruiting, i.e. seed formation.
- On the other hand, where intensive irrigation is used, disease and pest attacks frequently occur, weed invasion and implicitly technology costs increase through the application of irrigation and phytosanitary treatments.
- Even if satisfactory production is maintained on irrigated lands, economic and operational challenges significantly limit crop profitability.
- It is essential to explore solutions to reduce operational costs, diversify crops to have a market for the products obtained and invest in advanced technologies that can increase the efficiency and sustainability of agriculture.
- It is also crucial to support and revitalize the Romanian seed market to ensure better access to the most efficient seed material in the pedo-climatic conditions of the area.

- The ADER 1.2.2. project is intended to lead to the implementation of good practices for establishing protective forest curtains with the lowest possible costs and which will bring in the future both increased economic efficiency per hectare, but especially resilience to climate change and the conservation of natural soil and water resources, through adequate management of sustainable agriculture.
- The influence of forest curtains is very good on the decrease in atmospheric heat, the attack of diseases and pests, as well as on increasing the economic efficiency of agricultural crops [4-18].

Acknowledgements

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