Research about Adaptation of Agricultural Technologies for Successive Crops, in the Conditions of Current Climate Changes and Desertification Phenomena in South-Eastern Territory of Romania

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Abstract.

Recently, in the South-Eastern part of Romania, there has been a significant increase in the average annual temperature and a decrease in average rainfall, so that the phenomenon of desertification is more and more obvious, and agricultural crops are increasingly inefficient.
On the other hand, the pedological drought and the irrigations applied permanently, bring an increase of the content of soluble salts at the level of the plant roots, so that the technologies must be permanently adapted to the environmental conditions. An alternative is the use of green crops, which would bring a supply of organic matter to the soil, as well as the practice of successive crops, after the autumn crops. The paper presents the experimental results recorded in the agricultural year 2019 - 2020, regarding the use of successive crops at the Agricultural Research and Development Station of Braila, Romania, both for the main production and as green field, to increase soil fertility. Agricultural technologies should be continuously adapted to environmental conditions and farmers should primarily seek to preserve natural resources, namely soil fertility and groundwater purity, through technologies adapted to each ecosystem.

Keywords: double crops; soil fertility; water preservation; sustainability technologies

1. Introduction

The aridization process that have been registered in the last years in the South-East of Romania, have brought great financial damages to the farmers. The increase of the average annual temperature by over 2 degrees Celsius every year, together with the lack of precipitation in the periods of maximum need of the crop plants, produces the phenomenon of pedological and burnt drought, which diminishes the agricultural productions. Therefore, it is necessary to expand production through successive crops. A recent ERS study found that about one-third of the expansion in harvested corn crop acreage represented shifts from hay production, Conservation Reserve Program (CRP) enrollment, or grazing land use (Wallander et al., 2011). Cropland expansion is not without negative environmental consequences. Land that remains in hay, grazing, and CRP provides impor-tant environmental services, such as wildlife habitat (Claassen et al., 2011) and carbon reduction benefits (Horowitz and Gottlieb, 2010). We have all noticed in recent years climate change, which has significantly reduced agricultural production and increased costs on each farm, especially in areas where the phenomena of aridity and desertification are becoming more pronounced. However, these phenomena are a consequence of the abusive

management of existing natural resources, in an attempt to obtain the highest possible productions for the highest possible profit. In this paper, we will try to evaluate the experimental results of successive crops to observe how we can adapt our agricultural technologies and increase production through successive crops, given the extreme drought that occurred in the agricultural year 2019 - 2020, in North Bărăgan Plain, Romania.

2. Material and methods

The hydroclimatic environment in Brăila County was characterized this year by extreme pedological and atmospheric drought in all seasons, with significant variations in temperature from night to day and very large water deficits for crops, which led to decreased production and agricultural production quality, both in irrigated system, but especially in non-irrigated. The synthesis of the climatic data registered at the Chiscani Experimental Center of SCDA Brăila (Table 1) shows for the whole agricultural year an increase of the average temperature compared to multiannual by + 2.3ºC, with the biggest deviations during the winter, of + 3.7ºC and in autumn 2019, of + 2.4ºC, then continued in the spring with a deviation of + 1.5ºC and in summer with a deviation of + 1.7ºC. Both the increase in average temperature and the lack of rainfall, which recorded negative deviations from the multi-year of -61.4 mm / m^2 in autumn 2019, followed by a deficit of -44.7 mm / m^2 in winter, then -56 mm / m^2 in spring and -59 mm / m^2 this summer, totaling for the whole agricultural year a total deficit of -222 mm / m^2 in Câmpia Brăilei, led to the affectation of all autumn and spring crops, as well as crops perennials.

Table 1

The main climatic elements between October 1, 2019 - September 30, 2020

Climatic elements		2019		2020										TOTAL AVERAGE
		X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	
Rainfall (mm)	Monthly average	23,9	8,7	14,3	4	28	2,6	4,6	45,8	30,1	54,8	3,1	39,5	**259**
	Multiannual monthly average	30	33	36	28	27	26	35	48	62	46	39	32	**442**
	Deviation	**-6,1**	**-24,3**	**-21,7**	**-24**	**1**	**-23,4**	**-30,4**	**-2,2**	**-31,9**	**8,8**	**-35,9**	**7,5**	**-183**
Temperatures (ºC)	Monthly average	13,2	10,2	3,9	0,9	4,6	8,7	11,9	16,4	22	24,4	24,6	20,4	**13,4**
	Multiannual monthly average	11,5	5,6	0,6	-2,1	-0,2	4,7	11,2	16,7	20,9	22,9	22,1	17,3	**10,9**
	Deviation	**1,7**	**4,5**	**3,3**	**3**	**4,8**	**4,1**	**0,7**	**-0,3**	**1,1**	**1,5**	**2,5**	**3,1**	**2,5**

The determinations regarding the soil water reserve on the depth of 0 - 125 cm, made in the Laboratory of agrochemical studies of SCDA Brăila, highlight at this end of September, deficits of - 667 mm / m^2 for maize cultivation, of - 863 mm / m^2 for sunflower cultivation and - 931 mm / m^2 per field, after harvesting autumn crops. The experiment was located within CE Chişcani of SCDA Brăila, on a carbonatic vermic chernozem type soil, with the physico-chemical characteristics detailed in tables 4 and 5.
Thus, the physical analyzes of the soil horizons revealed an apparent density between 1.19 g / cm^3 in the processed horizon (Aβ), up to 1.44 g / cm^3 in the other soil horizons.

3. Results and Discussion

Based on the climatic data recorded daily at CE Chişcani, SCDA Brăila, it was possible to make a graph of minimum and maximum temperatures, the amount of useful degrees

accumulated from sowing to harvesting, as well as the accumulated precipitation during this period. It is observed that the need for useful degrees above 6°C accumulated between July 10, 2020 - October 18, 2020 was sufficient for corn, sunflower, soybeans and hemp, but insufficient for sorghum cultivation, which is a thermophilic species, with a GDU requirement between 2500 - 3500, a fact that was also observed in the lower productions obtained by sorghum in successive cultivation.

Biometric measurements performed before harvesting showed the following experimental results:

- For successively cultivated maize, the maximum plant size was recorded at the variant with the minimum fertilization dose and the minimum sowing density, while the maximum number of cobs was recorded at the maximum fertilization dose and the maximum sowing density. However, the best result in terms of cob length was recorded by the double fertilized variant, but sown at the minimum density (fig. 1).

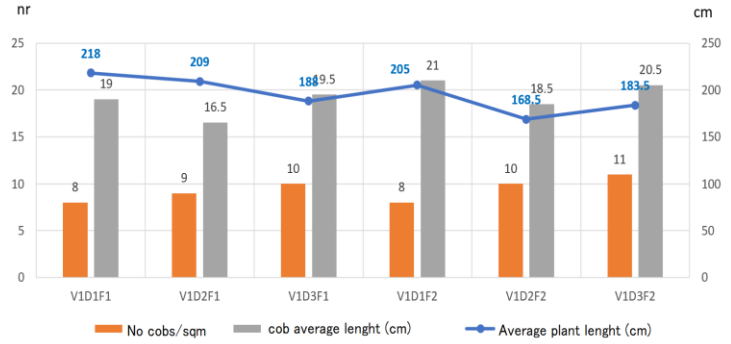

Figure 1. Graph of the average results of biometrics for the successive maize crop

- In the successively cultivated sunflower crop, the biometric measurements showed that the best results were obtained by the fertilized variant with the usual dose, at the minimum density, while the increase of the fertilizer dose and the plant density had the weakest results (fig. 2).

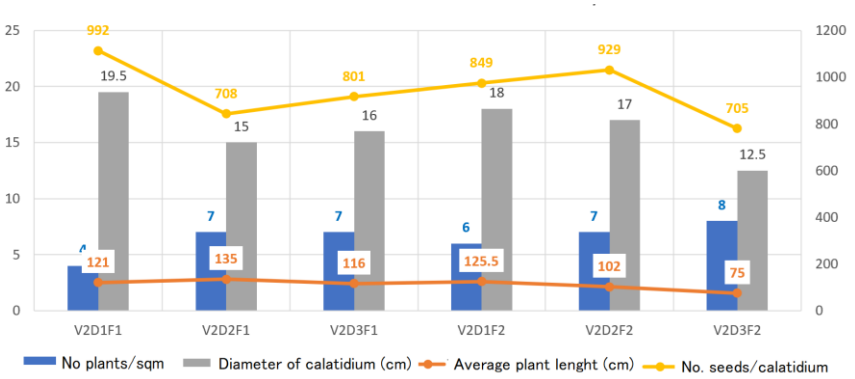

Figure 2. Graph of the average results of biometrics for the successive sunflower crop

- In soybean successive cultivation, the results of biometric measurements are represented in the graph in Figure 3, observing the best results in double fertilization and minimum sowing density.

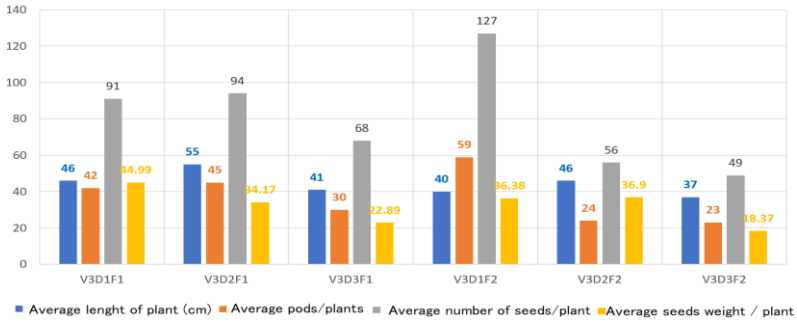

Figure 3. Graph of the average results of biometrics for the successive soybean crop

- In canabis successively crop, at SCDA Brăila, the best results were obtained for the fertilized variant with minimum dose, for all measured biometric elements (fig. 4).

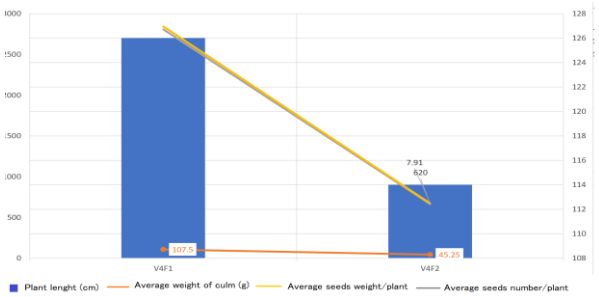

Figure 9. Graph of the average results of biometrics for the canabis successive crop

At SCDA Brăila, in the climatic conditions of extreme drought registered in 2020, after the application of 5 irrigation norms with 500mc / ha each, the productions for successively cultivated maize were differentiated only by the applied technology.

The maximum production was obtained by the double fertilized variant (400kg NPK 18: 46: 0) and with the minimum sowing density of 70000 bg / ha, followed by the single fertilized variant (200kg NPK 18: 46: 0) with the sowing norm of 80,000 bg / ha (Fig. 5).

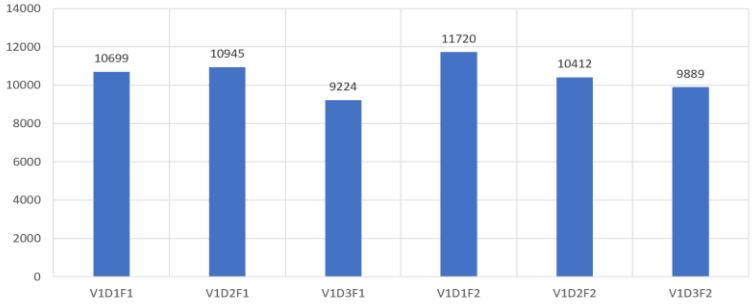

Figure 5. Graph of average yields obtained for successive maize cultivation, under irrigation conditions and different fertilization norms and different sowing densities

The sunflower production cultivated successively at SCDA Brăila, with different fertilization doses and sowing densities was higher at the dose of 400kg NPK 18: 46: 0 and the sowing density of 65000 bg / ha, followed in descending order by the variant fertilized with a dose of 400kg NPK 18: 46: 0 and the sowing density of 55000 bg / ha, and the variant fertilized with 200kg NPK 18: 46: 0 and the sowing density of 75000 bg / ha (fig. 6).

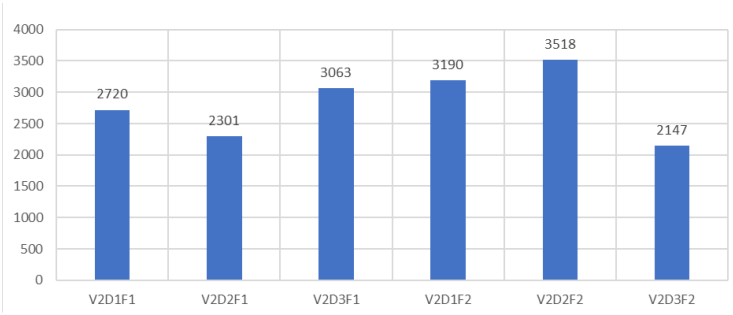

Figure 6. The graph of the average productions obtained for the successive sunflower culture, in irrigation conditions and different fertilization norms and different sowing densities

In soybean cultivation, the highest yields were obtained by the fertilized version with a dose of 400 kg / ha NPK 18: 46: 0 and the sowing density of 550000 bg / ha, followed by the variant fertilized with 200 kg / ha NPK 18:46 : 0 and the sowing density of 450000 bg / ha and the fertilized variant with 200kg / ha NPK 18: 46: 0 and the sowing density of 550000 bg / ha (fig. 7).

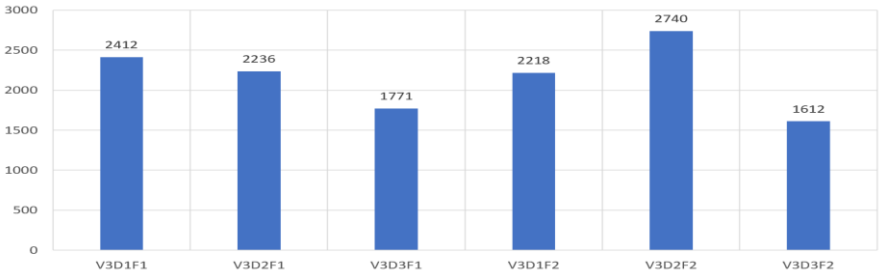

Figure 7. Graph of average yields obtained for successive soybean cultivation, under irrigation conditions and different fertilization norms and different sowing densities

In the successive crops of hemp and sorghum, fertilized with different doses, the highest yields were obtained by the variants fertilized with 400kg / ha of N: P: K 18: 46: 0 (fig. 8), with a production difference of 20kg / ha for canabis and 253 kg / ha for sorghum.

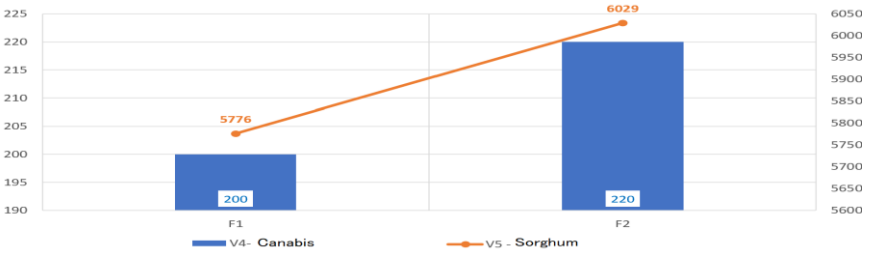

Figure 12. Graph of average yields obtained for successive crops of hemp and sorghum, under irrigation conditions and different fertilization norms and different sowing densities

Soil agrochemical analyzes, in the experimental variants with different fertilization doses for the four successive crops, showed the following results:

Regarding the dynamics of soil pH, after the use of successive crops as green manure, in 2020, at CE Chişcani, a decrease in soil pH was observed after the incorporation of hemp, soybean and a significant increase in pH soil after incorporation of sunflower and corn plant mass (fig. 9).

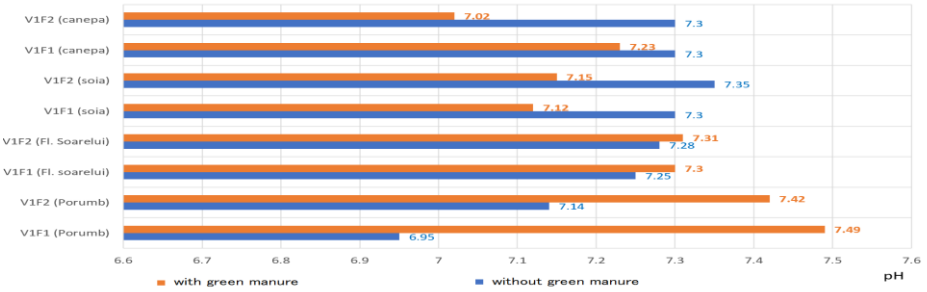

Figure 9. Soil pH dynamics in aqueous soil extract: water 1: 2.5 after incorporation of successive crops as green manure

Analyzes on the dynamics of soluble salts in the soil, in the arable layer 0-25 cm, after the incorporation of successive plants as green manure, showed that only after the incorporation as green manure of soybean crop is observed a decrease in total soluble salts in soil, the rest of the crops increasing the total content of soluble salts (fig. 10)

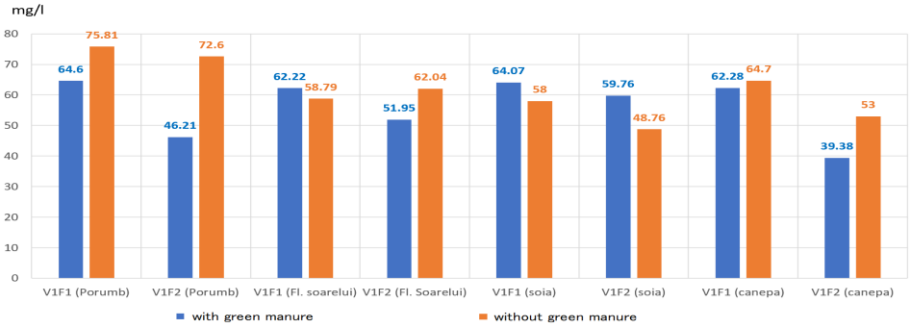

Figure 10. Dynamics of total salts in the arable layer 0-25 cm, analyzed in aqueous soil extract: water 1: 5 after incorporation of successive crops as green manure

Regarding the dynamics of the total nitrogen content, after the use of successive crops as green manure, a significant increase can be noticed only in the soybean crop, with 8 to 21 ppm depending on the fertilization norm previously applied (fig. 11).

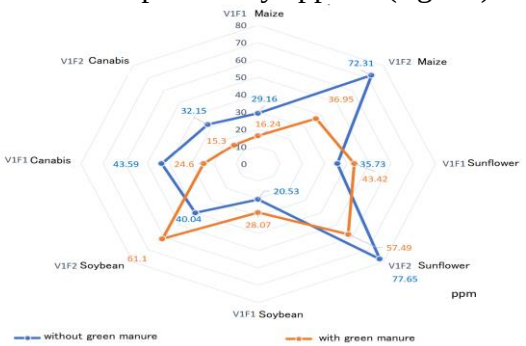

Figure 11. Dynamics of total nitrogen accumulation in the arable layer 0-25 cm, analyzed in aqueous soil extract: water 1: 5, after incorporation of successive crops as green manure

Regarding the accumulation of assimilable phosphorus in the soil after the use of successive crops as green manure, it was observed that there is no positive correlation (fig. 12), but this

can be explained precisely by the fact that it takes a longer time to biodegrade organic matter incorporated into the soil until it is decomposed and phosphorus becomes assimilable.

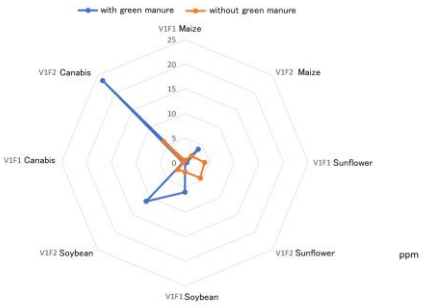

Figure 12. Dynamics of accumulation of assimilable phosphorus (P2O5) in the arable layer 0-25 cm, analyzed in aqueous soil extract: water 1: 5, after incorporation of successive crops as green manure

The most interesting aspect of the experiment on the assimilation of nutrients in the soil, after the incorporation of successive crops, was found in the dynamics of potassium accumulation, in the sense that in sunflower was very significantly increased in both fertilizers, and in corn and soybeans only in the maximum fertilization variant (fig. 13).

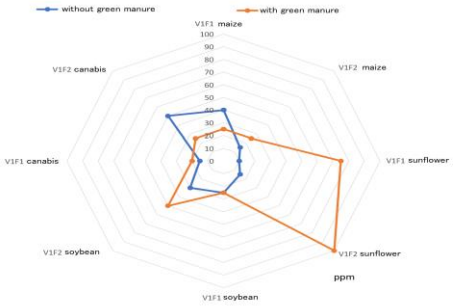

Fig. 13. Dynamics of assimilable potassium (K_2O) accumulation in the arable layer 0-25 cm, analyzed in aqueous soil extract: 1: 5 water, after incorporation of successive crops as green manure

Regarding the accumulation of organic matter in the soil, after the practice of successive crops as green manure, it could be assessed that in all experimental variants, the percentage of organic matter increased by 11% compared to the variants in which the residues were not incorporated vegetable (fig. 14).

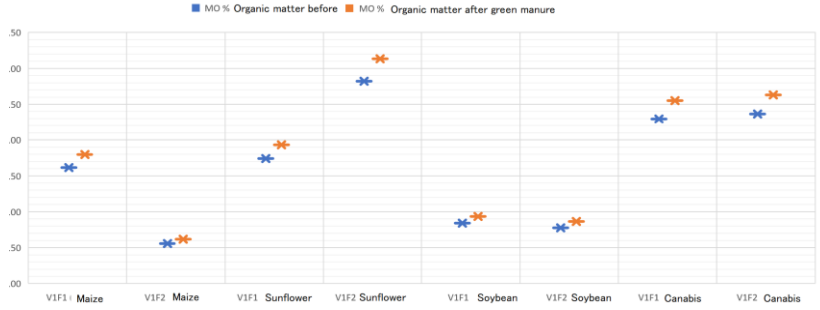

Fig. 14. Dynamics of accumulation of organic matter in the arable layer 0-25 cm, analyzed by calcination, before and after the incorporation of successive crops as green manure

The dynamics of the apparent density of the soil, after the incorporation of the vegetative mass of the successive crops showed a decrease of it, with up to 21% of the initial value for maize, with up to 17% for sunflower, 15.4% for canabis and 10, 6% for soybean (Fig. 15).

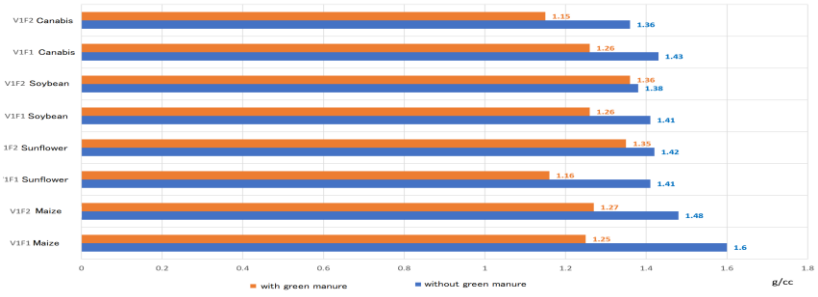

Figure 15. Dynamics of bulk density in the arable layer 0-25 cm, before and after the incorporation of successive crops as green manure

4. Conclusion

- In the conditions of the current climatic changes in the South-East of Romania, which have produced every year phenomena of pedological drought, heat and aridization, the culture technologies must be adapted from year to year.

- First of all, it is necessary to ensure the need for water and fertilizers for agricultural crops.

- Second, it has been observed that crop-damaging insects have had several development cycles per year in recent years, which implies more phytosanitary treatments.

- Thirdly, due to the shift of the seasons, it is necessary to adapt the sowing date for spring crops and the use of successive crops after autumn crops, which in recent years have brought higher yields even than the main yields.

- Last but not least, due to the lack of precipitation, in areas where there are no irrigation systems, the technologies will have to include only liquid fertilization, so that the plants are able to absorb nutrients.

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