ALTERNATIVE SOLUTIONS TO THE CROP PLAN FOR THE EAST AREA OF ROMANIA, IN THE CONTEXT OF DRY-FARMING

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Abstract
Implementation of the dry-farming work system is one of the solutions that allow maintaining the balance between the growing demand for the production of food and plant materials with different uses, together with the negative impact that intensive agriculture has on the planet's natural resources.
The paper aims to observe how some species of oilseed plants, namely Sinapis alba L., Linum usitatissimum L., and Coriandrum sativum L., can adapt to the prolonged drought conditions of the south-eastern part of Romania and its impact on the quality and quantity of the harvests obtained. Sinapis alba L. proved to be the plant with the highest sensitivity to the lack of precipitation, suffering losses of 70-80%. The emergence of coriander was higher compared to flax and mustard.
***Keywords**: dry-farming, alternative crops, drought, productions.*

INTRODUCTION

Pollution contributes to the decline of the quality of life through the negative effects it has on the fundamental elements of the planet, namely water, soil, and air. The survival of all living things, mainly humans, depends on their well-being. The need to cover the food requirement directly, through fruits and vegetables and their derivatives, and indirectly through animals, accelerated over decades, the impurity of the three essential components. Thus, food quality decreased because the number of products obtained was the goal pursued to keep up with population growth. Climate conditions that are changing less favorably for crops are one of the consequences of environmental pollution. Agricultural plants, which were and are the basis of human and animal nutrition, show an increasingly weak behavior towards the instability of abiotic factors. Although breeders have made efforts to create resistant varieties and hybrids, some agricultural species have exhausted their genetic combinations variability, becoming challenging to preserve them over time. This will eventually lead to the loss of valuable plant species and not only. To slow down the process of depletion of biological material or to prevent its disappearance, researchers are turning to the cultivation of alternative plant species that can provide the necessary nutrients for human and animal feed and have a remarkable resistance to the stress caused by climate change. In addition to the biological material used, cultivation technology also plays a fundamental role in the quality of the agricultural products obtained. Intensive agriculture has worsened the soil structure and environmental pollution over time. The destruction and consumption of the planet's natural resources is an irreversible process that can only be kept in a state of stagnation. Even if the restoration of some resources may be possible, it is a long-term process. In agriculture, protecting the environment and the soil can be done by adopting the dry-farming work system, based on more environmentally friendly technological practices.

In this paper, three species of oleaginous plants were analyzed *Sinapis alba* L., *Linum usitatissimum* L., and *Coriandrum sativum* L., with different valuable characteristics, which can replace, where appropriate, common crops such as rapeseed and sunflower.

Sinapis alba L. is an oilseed plant used as a substitute for other common crops due to its resistance to drought and heat conditions (Hassan F. U. et Arif M., 2012, Arif M. et al., 2018). It can also be used as a carpet of plant residues, a rich nitrogen source. Due to the content of sulfurized essential oils, it prevents the appearance and inhibits the growth of some species of harmful organisms (Sáez-Bastante et al., 2016, Rodríguez-Lizana A. et al., 2018).

Linum usitatissimum L. is used in various industries and is among the first and oldest cultivated oleiferous plants (Meena R. L. et al., 2011, Mirshekari M. et al., 2012). Its rich oleic content has also been proven to be beneficial to feed certain animal species when mixed in powdered form with other seeds and dry plant debris (Sing K. K. et al., 2011).

Coriandrum sativum L. has benefits in the food and pharmaceutical industry, being a strongly aromatic plant (Shams M et al., 2016, Nahed M. et al., 2015, Krivda S.I. et al., 2020).

MATERIALS AND METHODS

The location of the experience was in the Chiscani Experimental Field within the Agricultural Research and Development Station, Braila, Eastern Romania. The experience was established on a wet vermic phreatic soil, with pH 7.9 - 8.4; humus content 2.4 – 3.1%; apparent density 1.10 – 1.31 g/cm3; field capacity 22.9 – 25.2 %; wilting coefficient 6.7 – 10.2%; the minimum ceiling of active humidity 13.8 – 17.4 %. The soil was processed by classical technology based on plowing. During the vegetation period, we intervened with fertilizing substances and pesticides without applying irrigation precisely to observe the behavior of these alternative crops to the harshness of environmental factors, namely soil drought and atmospheric heat.

The field experiment was placed in a Latin rectangle in three repetitions, each repetition having an area of 15 harvestable m^2.

The following parameters were analyzed: yield, density, and quality indices (MTG - the mass of a thousand grains, and HM – hectoliter mass).

RESULTS AND DISCUSSIONS

The temperatures during the sowing-harvest period of the three crops observed, although with an average of 2.5°C below the multiannual monthly average, did not create problems for the studied crops of *Linum usitatissimum* L., *Coriandrum sativum* L., and *Sinapis alba* L.

According to specialized literature, flax culture needs temperatures of a minimum of 1-3 °C for germination, 14-16 °C for growth, and a maximum of 24-26 °C for fertilization and maturation (Vasiliu Maria et al., 2016).

Coriander culture requires a temperature of 5 °C for germination, and for growth and ripening, it needs temperatures between 14 - 25 °C, temperatures above 30 °C affect the health of the plants.

Mustard germinates at a minimum of 1 °C and develops in good conditions at temperatures of +7 °C. From table 1, it can be observed that these temperatures were suitable for the studied crops.

Table 1. Climate conditions from March to July 2022, in Braila

Climate conditions March - July 2022						
Month	Average air temperatures (°C)	Multiannual monthly average (°C)	Deviation from multiannual T (°C)	Precipitations (mm)	Multiannual monthly average (mm)	Deviation from the multiannual precipitation average (mm)
III	3,8	11,2	-7,4	13,8	26	-12,2
IV	11,9	16,7	-4,8	25,1	35	-9,9
V	18	20,9	-2,9	24,3	48	-23,7
VI	22,7	22,9	-0,2	33,3	62	-28,7
VII	24,8	22,1	2,7	8,9	46	-37,1
Average	16,2	18,8	-2,5	105	217	-111,6

Precipitation was in short supply with 111.6 mm in March-July period, which is considered dry. The lack of water was the cause of yields below the optimal ranges specific to these three analyzed crops.

The quality indices with optimal values of the flax crop are MTG between 7 and 9.7 g and HM 64 – 75 kg/hl. Table 2 shows the average weight of one thousand grains is 4.4 g. The optimal yield of flax, under favorable pedo-climatic conditions and properly applied technology, can reach 1700 kg/ha. In the study area, the yield was 1307.5 kg/ha. Based on these observations, it turns out that both the quality and the quantity of harvested seeds suffered due to the lack of soil moisture (precipitations and irrigation). According to the two indices, MTG and HM, the seeds were of suitable size.

Table 2. Quality indices and yield of *Linum usitatissimum* L.

***Linum usitatissimum* L.**				
Repetition	**U%**	**HM (kg/hl)**	**MTG (g)**	**Yield (kg/ha)**
1	6,7	67,2	4,42	1271
2	6,3	63,5	4,32	1403
3	6,6	64,7	4,44	1249
Average	**6,53**	**65,13**	**4,39**	**1307,50**

Figure 1. *Linum usitatissimum* L. plants, vegetation period

Coriander crop has, under optimal growing conditions, MTG 7 – 10 g, HM 45 – 50 kg/hl, and yields of 1500 kg/ha. Table 3 shows the HM value of 26.7 kg/hl and the optimal MTG. Thus, the seeds had good MTG values, but the HM index was approximately 50% lower. Like the flax crop, the yields obtained from the coriander crop were 600 kg/ha below the specific optimum.

Figure 2. *Linum usitatissimum* L. plants, before harvesting

Table 3. Quality indices and yield of *Coriandrum sativum* L.

***Coriandrum sativum* L.**				
Repetition	**U%**	**HM (kg/hl)**	**MTG (g)**	**Yield (kg/ha)**
1	7,6	26,4	7,58	942
2	7,2	26,9	9,50	806
3	6,8	26,8	8,44	957
Average	**7,20**	**26,70**	**8,51**	**901,89**

Figure 3. *Coriandrum sativum* L. plants, vegetation period

Figure 4. *Coriandrum sativum* L. plants, harvesting

The mustard crop behaved similarly to the coriander crop. The seeds had very good MTG (7.73 g compared to the variety specific of 6.3 g) and sub-optimal HM of 68 kg/hl. Of all the three crops studied, mustard yield was the lowest, with 700 – 1200 kg/ha below the specific optimum. These results show that this crop is sensitive to the influences of environmental factors, especially the lack of rainfall

Table 4. Quality indices and yield of *Sinapis alba* L.

***Sinapis alba* L.**				
Repetition	**U%**	**HM (kg/hl)**	**MTG (g)**	**Yield (kg/ha)**
1	5,5	38,8	7,20	360
2	5,7	11,9	8,06	244
3	5,9	24,9	7,92	339
Average	**5,70**	**25,20**	**7,73**	**314,63**

The average density of emerged plants was 524 flax plants / m² with a sowing density of 800 germinating grains / m², 176 coriander plants / m² with a sowing density of 250 germinating grains / m², and 68 mustard plants / m² with a sowing density of 160 germinating grains / m².

Regarding the physical characteristics of flax plants, their average height was 32.6 cm below the lower limit of the specific range of 55 – 75 cm (Vasiliu Maria et al., 2016).

However, the number of inflorescence branches was 35 capsules/plant, a value within the range of 15 – 40 described in the literature. Similarly, the ramifications of the stem were in large numbers, the flax plants

Figure 5. *Sinapis alba* L. plants, vegetation period

Figure 6. *Sinapis alba* L. plants, before harvesting

being characterized by their presence compared to the linen seeds, which lack ramifications. Figure 7 shows that the number of capsules is influenced by the number of branches, thus a low number of branches causes a high number of capsules, and vice versa.

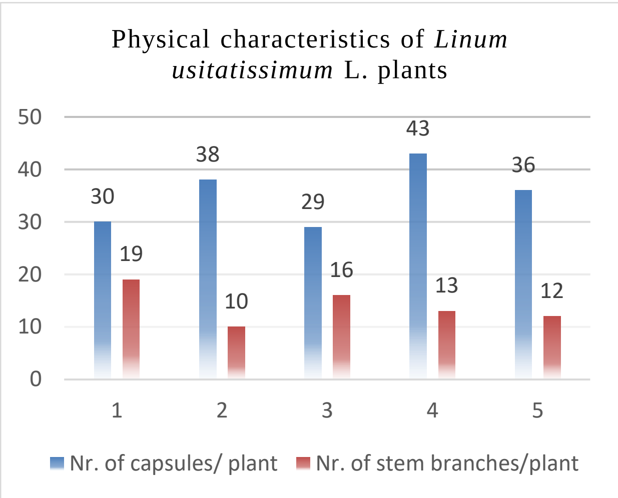

Figure 7. Physical characteristics of *Linum usitatissimum* L. plants

CONCLUSIONS

Environmental factors are vital in achieving bountiful harvests. Any imbalance between the components of the environment manifests itself on crops, as is also observed in the case of flax, coriander, and mustard plants.

The temperatures were favorable in the study area throughout the growth period and maturity of the plants. However, the lack of rainfall affected the number of seeds and their qualitative indices.

Regarding the three crops, the yields were low compared to those obtained in normal climatic conditions on a national level.

The yields obtained in the study area for flax and coriander crops in 2022 were 400 and 600 kg/ha lower, respectively, compared to the average yields obtained under normal conditions.

The mustard crop was the most affected from this point of view, suffering losses of 70 – 80 %.

The pedological drought manifested itself in the mustard crop and in terms of the plant density per m², the percentage of emergence being only 43%. Similarly, emergence was 70% for coriander and 66% for flax.

The height of the flax plants was small, yet the number of capsules and stem branches had the specific values described in the specialized literature corresponding to Romania.

For the eastern part of Romania, in drought conditions, flax and coriander crops can be part of the crop plan of agricultural farms for years without precipitation.

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REFERENCES

Arif Muhammad, Muhammad Asif Shehzad, Salman Mushtaq. 2012. *Inter and intra row spacing effects on growth, seed yield and oil contents of white mustard (Sinapis* *alba l.) under rainfed conditions*. Pak. J. Agri. Sci., Vol. 49(1), 21-25.

Hassan F. U. and M. Arif. 2012. *Response of white mustard (Sinapis alba L.) to spacing under rainfed conditions*. The Journal of Animal & Plant Sciences, 22(1): 2012, Page: 137-141. ISSN: 1018-7081.

Krivda S.I., N.V. Nevkrytaya, V.S. Pashtetsky, S.S. Babanina, O.B. Skipor, N.S. Krivchik, A.V. Skiba. 2020. *Analysis of the collection of Coriandrum sativum L. as a source of high-potential samples for selection research*. International Journal Of Biology And Biomedical Engineering, Volume 14, ISSN: 1998-4510, DOI: 10.46300/91011.2020.14.10.

Meena Rang Lal, T. K. Singh, Rakesh Kumar, Aniruddha Roy, Hari Om. 2011. *Production potential and economics of linseed (Linum usitatissimum L.) as influenced by fertility levels and seed rates in dryland conditions*. Environment & Ecology 29 (1A): 456—458. ISSN 0970-0420.

Mirshekari Mohammad, Reza Amiri, Hammid Iran Nezhad, Seyeed A Sadat Noori, Omid R. Zandvakili.2012. *Effects of planting date and water deficit on quantitative and qualitative traits of flax seed.* American-Eurasian J. Agric. & Environ. Sci., 12 (7): 901-913. ISSN 1818-6769. DOI 10.5829/idosi.aejaes.2012.12.07.1781

Nahed M. Rashed a, R.Kh. Darwesh. 2015. *A comparative study on the effect of microclimate on planting date and water requirements under different nitrogen sources on coriander (Coriandrum sativum, L.).* Annals of Agricultural Science (2015) 60(2), 227–243.

Rodríguez-Lizana A., M.A. Repullo-Ruibérriz de Torres, R. Carbonell-Bojollo, C. Alcántara, R. Ordóñez-Fernández. 2018. *Brachypodium distachyon, Sinapis alba, and controlled spontaneous vegetation as groundcovers: Soil protection and modeling decomposition.* Agriculture, Ecosystems and Environment 265 (2018) 62–72.DOI https://doi.org/10.1016/j.agee.2018.05.012

Sáez-Bastante, P. Fernández-García, M. Saavedra, L. López-Bellido, M.P. Dorado, S. Pinzi. 2016. *Evaluation of Sinapis alba as feedstock for biodiesel production in Mediterranean climate*. Fuel 184 (2016) 656–664. DOI http://dx.doi.org/10.1016/j.fuel.2016.07.022

Shams Mostafakamal, Mahdi Ramezani, Sasan Zandi Esfahan, Ehsan Zandi Esfahan, Atilla Dursun, Ertan Yildirim. 2016. *Effects of climatic factors on the quantity of essential oil and dry matter yield of coriander (Coriandrum sativum L.).* Indian Journal of Science and Technology, Vol 9(6), DOI: 10.17485/ijst/2016/v9i6/61301, ISSN (Print): 0974-6846. ISSN (Online): 0974-5645.

Sing K. K., D. Mridula, Jagbir Rehal & P. Barnwal. 2011. *Flaxseed: A potential source of food, feed and fiber*. Critical Reviews in Food Science and Nutrition, 51:3, 210-222, DOI http://dx.doi.org/10.1080/10408390903537241.

Vasiliu Maria, Vasiliu Vlad-Mihai, Popescu Livia, Vasiliu Doina, Rîşnoveanu Luxiţa, 2016*,"Plantele de Câmp: Importanţă, Întrebuinţări, Biologie, Ecologie, Tehnologia de cultivare, Valorificarea recoltei"*, Editura Ceres, Bucureşti, ISBN 978-973-1113