EVALUATION OF SAFFLOWER CULTURE (CARTHAMUS TINCTORIUS) AS A FORAGE ALTERNATIVE FOR SUNFLOWER CULTURE (HELIANTHUS ANNUUS) IN THE ARID AREAS OF SOUTHERN ROMANIA

Gheorghe Ivan[1], Tudora Catalina[2],
[1]INMA Bucharest, Romania,
[2]National Institute of Research and Development for Biological Sciences, Bucharest, Romania

Keywords*: *drought, heat tolerance, safflower, sunflower.

ABSTRACT

Climate changes is a reality in Europe today, the continent is affected by heat waves unthinkable in the past, accompanied by prolonged drought, with substantial economic costs and reduced food and water resources. Romania is situated in the high risk of drought and desertification, their effects are visible especially in the south and southeast, areas of major importance in obtaining food resources.

This article presents a study of an experiment that was conducted on two adjacent sites in Roata de Jos (Southern Romania), a site cultivated with safflower and other with sunflower, the interest beeing the evaluation safflower culture as an alternative to sunflower culture from the perspective terms of income traditional farmers in drought conditions.

INTRODUCTION

Along with the aggravation of global warming, drought is only one of the biggest disasters that can strike mankind today. The extent and its effects are so important to our future that currently do not have spared no effort in fighting drought.

On a global scale, drought has a devastating impact on agriculture, besides the known areas such as the Sahara, the Arabian Peninsula, Central Asia, South-western United States, southwestern Africa and Australia, we see the emergence of new regions where drought makes presence felt as well as east Africa, the center of North America and south-East Europe.

On top of the hot zone it is and the south is Romania. Figure 1 shows the increase in the number of tropical nights (minimum temperature 20°C) combined with hot days (maximum temperature above 35°C) in the current and future climate conditions.

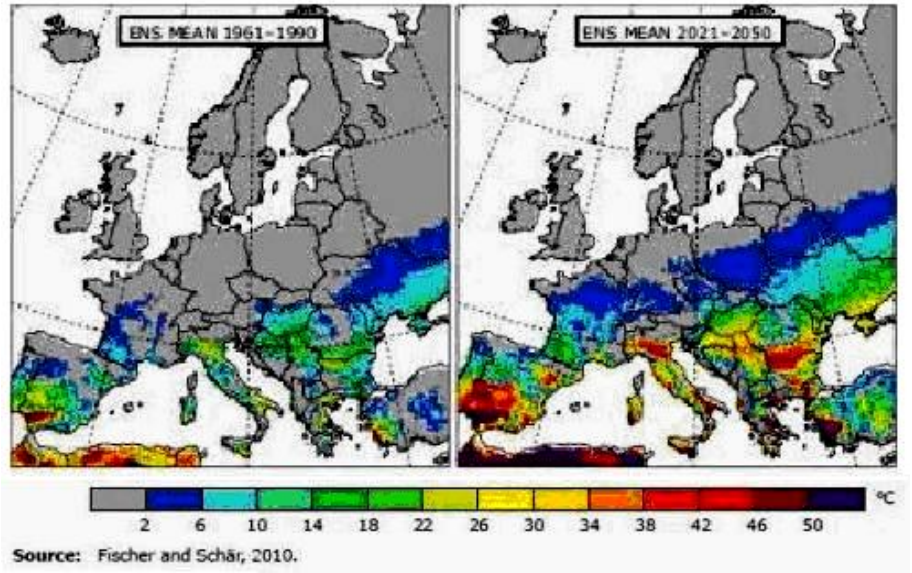

Fig.1 Increase in the number of combined tropical nights and hot days under present and future climate conditions [1]

According to meteorological data, analyzed over a period of 40 years, respectively from 1961 to 2000, it reveals that the most vulnerable areas in Romania to agricultural drought are extreme southern and south-eastern regions, especially southern Oltenia, Muntenia, Moldavia and Dobrogea (yellow areas in Figure 2) of these areas from the more signals related to the manifestation of degradation processes of environmental conditions, especially in terms of desertification. This situation requires a quick fix, knowing that the quantity and quality of grain crops represented in all these areas for Romania granary of the country.

According to meteorologists, Romania is the first European country located north of the parallel 44 faced seriously with agricultural drought.

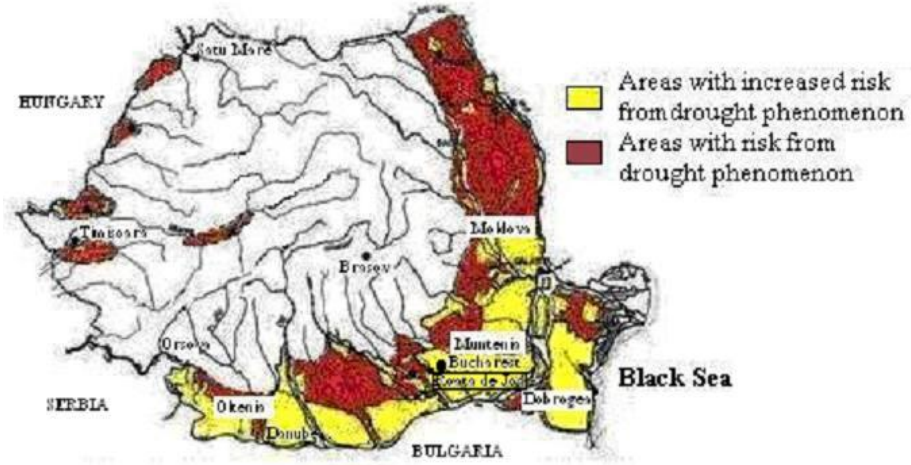

Fig.2 Risk areas in Romania to droughts [2]

MATERIAL AND METHODS

The study that we present it was conducted within the project "Biofuels-common source of sustainable development of the area of cross-border cooperation". This study presents an experiment that was conducted on two adjacent sites in Roata de Jos (Southern Romania), a site cultivated with sunflower and other with safflower, the interest beeing the evaluation safflower culture as an alternative to sunflower culture from the perspective terms of income traditional farmers in drought conditions.

Next, we present in short the features and technologies of cultivation in Romania of the two cultures analyzed, sunflower and safflower, relevant from the point of view of the study.

Sunflower culture

Sunflower (Helianthus annuus L.) is an annual herbaceous plant of the Compositae family, native to Central America. The plant grows well in a temperature range of 20...25°C, temperatures above 25°C reduce productivity and oil content of seeds [3].

A single sunflower plant consumes 70...80 liters of water throughout the growing season, the sunflower having growing conditions in areas falling 450...600 mm annual precipitation [3].

Sunflower is pretentious to high consumption of nutrients as, well as crop rotation due to susceptibility to diseases and pests. It must not return to the same field earlier than six years, and monoculture is excluded, leading to the growth of her attacks of diseases, parasitic plants and pests. As you reduce the number of years that returns to the same field, sunflower seed production field decreases.

Also, it must be avoided the predecessor or postdecessor attacked plants common diseases (soy, beans, flax and canola) and water consuming plants deep rooting (lucerne, sainfoin, sorghum, Sudan grass, sugar beet).

The best predecessor for sunflower are plants that release early the field, offering the possibility by soil tillage to accumulate and to keep a larger quantity of water. Usually, cereal grains and the winter wheat is primarily sunflower predecessor, but it is cultivated with good results and after corn. In our experiment the predecessor plant was the wheat.

Fertilisation

Although sunflower consume large quantities of nutrients (40...60 kg N, 15...23 kg P_2O_5 and 75...120 kg K_2O, to a production of 1000 kg seeds) [3]. The majority of nutrients are consumed in a period of two months until the beginning of flowering.

To reduce growth of the vegetative parties to the detriment of the fructification parties, it must to avoid unilateral application and large doses of nitrogen fertilizer.

After flowering, nitrogen should be used only with phosphorus which has a favorable effect on the production of seeds and the percentage of oil in the seeds. Depending on fertility and moisture of soil, the predecessor plant and anticipated production, the recommended doses are 60...120 kg/ha nitrogen and 60...140 kg/ha of phosphorus in a ratio of 1:1. Potassium fertilizers occur only required on the poor soils in this element.

The manure is well exploited by the sunflower in moderate doses of 15...20 t/ha, applied under the deep plowing along with phosphorus and potassium fertilizers. When applying manure, fertilizer doses are reduced accordingly.

Land preparation

The soil tillage are intended to realise a better loose, structured, no hardpan, well supplied with water and free of weeds. Primary tillage begins by stubble discing in the fall to incorporate residue from the previous crop.

Weed management

Spraying an herbicide for bed weed control is usually done in March.

Monocotyledonous against weeds, the herbicide is applied volatile 80CE Diizocab (800 g/l butoxide) or Triflurom (240 g/l trifluralin) in the preparation of the seed bed and incorporating the immediate dose of 7…10 l/ha and 4…5 l/ha. Antidicotiledoneic herbicide is applied simultaneously with sowing Gesagard 50 WP in strips of 23 cm wide at a time, at a dose of 1…2.5 kg/ha [3] .

Seeds and planting

The sunflower stem ends with a single capitulum with a diameter of 25...50 cm. The average number of seeds in a capitulum is 1200...1500, the weight of 1000 seeds is 40...80 g.

For our study we used early hybrid seed Romina.

The seeds used must have a minimum purity of 98%, a germination of over 85%, to be great (weight of 1000 seeds 70...80 g), uniform and healthy.

The seeds treatment is done with Apron 35SD dose of 4 kg/t of seeds, against blight, Fundazol 50 (2kg/t), Benlate 50 WP (2kg/t, Quinolate (2kg/t), Ronilan 50 WP (2kg/t), against white and gray and Heptachlor 400C (6…7 l/t), Furadan 35 ST (28 l/t) [4].

The planting begins when the soil temperature at seeding depth reached 7ºC for a week and tends to increase. In terms of calendar optimal, the planting period is between 1...15 April.

The planting too early and delayed, outside the optimum age, determine significant production decreases. Optimal density is between 40,000 ... 60,000 plants harvested/ha. When plantng, density will be about 10...15% higher.

The planting is made at the distance of 70 cm between rows, at a depth of 4...7 cm depending on soil texture and moisture, using a quantity of seeds 5...6 kg/ha [4].

Maintenance culture

The sunflower is very sensitive to early weed growth vegetation. Weed control is the most important measure for obtaining high production. It is done by mechanical and chemical.

If you have not used herbicides are needed 2...3 mechanical hoeing between rows and 2...3 manual hoeing on the row.

The first hoeing mechanic is done at a depth of 6 cm, immediately after it is distinguish the rows, when plants formed the first pair of leaves. Once the first manual hoeing on the rows is done and if it is too thick culture, is done the rarity. A second mechanical hoeing should be done to 8 cm deep, as soon as weeds appear (10...12 days). Last hoeing mechanic is done at a depth of 6 cm, in order not to damage the roots, about 15 days after hoeing two and be completed when the plants reached 50...60 cm, height after that the plants break easily [4].

The hoeings number is reduced by applying herbicides at 2 mechanical hoeing between rows and possibly a hoeing manual on row.

The sunflower responds well to irrigation with significant production increases. In critical phase water from flowering appearance (when he size of a dime) until the end of seed filling 1...3 watering apply rules 500...600 m^3/ha [3]. During flowering, sprinkler irrigation should be avoided, because the water washes the pollen and prevents flying insects do pollination.

Harvest

Sunflower is harvested with combine grain harvester provided for, preferably, with sunflower equipment harvesting, when the humidity seeds reached 14...15%. To avoid losses by shaking and breaking strains seeds, harvesting should be done in 6...8 days, until the water content of seeds reach 10...12% [5]. In our experiment we used the romanian combine grain harvester C110, equipped with sunflower harvesting equipment 6F.

Safflower culture

Carthamus tinctorius (L.), known in Romania as the safflower, is an annual herbaceous plant of the Compositae family, similar to the sunflower, native to Asia and Africa.

The safflower has a root systems that penetrate the soil to a depth of 2.5 m, which allows it to develop and arid climates.

In Romania, safflower has been grown since 2003, when they were grown approx. 5,000 ha and 10,000 ha in 2004. Safflower production obtained was was comparable to sunflower production, in areas with less fertile soils and moisture deficit.

Fertilization

The fertilization is done by 40...60 kg N and 19...34 kg P_2O_5, only once, before the plowing, during August-September.

Land preparation

In August, it is executed a work of stubble filds, using tractor with a disc harrow, following the basic plowing to be done in September, at a depth of 25...30 cm.

Weed management

Weed control is done mechanically prior to planting, in October, a tractor equipped with a cultivator and a disc harrow, with a spraying an herbicide. Herbicide that is used is Dual Gold 650 EC 1.5 l/ha, against monocotyledonous and dicotyledonous weeds.

Seeds and planting

The safflower capitulas have a diameter 1.5...3.5 cm and contains 15...20 achenes with four edges and pearly white color, similar to the sunflower, but much smaller, having a weight of 1000 seeds 30...40 g, and the unsaturated fatty acid content of 43...52%.

The safflower planting is done in the month of October at a depth of 5 cm in rows at a distance of 40...50 cm and 18 cm on the row. The harvesting culture optimal density must be 220,000...250,000 plants/ha.

Plants mature at 110...150 days from seeding, if the seeding was done in spring, and 200 days after seeding, if the seeding was done in autumn.

Maintenance culture

The maintenance of safflower culture is made with two mechanical hoeing in April-May.
Harvest
The safflower is harvested with combine grain harvester equipped with a cereal header, when the safflower leaves are dry and the humidity seeds reached 10...11%. The harvesting can begin in mid-September in dry weather. In our experiment, due to long lasting drought conditions, the harvesting was done on August 16, 2012.
The stems can be chopped (if combine grain harvester is equipped with chipper) and incorporated into the soil or baled and used as fuel briquettes. After harvesting, the seeds are cleaned of impurities, being taken to reduce their moisture content below 9%.

Fees and Insurances
In this study did not take into account the fees and insurances of land and equipment property.
Office Expense
In this study did not take into account the office expense.

RESULTS AND DISCUSSION

Next, we present the technological sheets of the two cultures that make the object of our study, conducted on adjacent lots in Roata de Jos area (geographic area: plain, no irrigated system, previous culture: wheat).

Table 1

Technological sheets of sunflower culture

SUNFLOWER CULTURE - TECHNOLOGICAL SHEET				
No.	Works	Period	Equipments	Materials
1	Discing stubble	October	U650M[*1]+GD6.4[*2]	
2	Fertilized	October	U650M+MA3.5[*3]	70 kg/ha P
3	Plowing at 25 cm+harrowing and milling	October	U650M+PP4[*4]+GS1.2[*5]	
4	Fertilized	March	U650M+MA3.5	50 kg/ha N
5	Hebicide	March	U650M+ MET1200[*6]	
6	Prepared seedbed	March	U650+CPGC 4[*7]	
7	Seeds treatment	March	MTS 4[*8]	3 kg/t Tiradin plus
8	Planting at 70 cm	March	U650M+SPC8[*9]	5 kg/ha
9	Mechanical hoeing I + fertilized	April	U650M+CPU8[*10]+F4[*11]	50 kg/ha N
10	Manual hoeing	April	-	
11	Mechanical hoeing II	June	U650M+CPU8	
12	Manual hoeing	June	-	
13	Phytosanitary treatment	June	U650M+MSJP2[*12]	
14	Harvest	August	C110+6F[*13]	1600 kg/ha
15	Disking stems chopped	August	U650M+GD3.2+2GCR[*14]	

[*1] Tractor 65 hp
[*2] Disc harrow width 6.4 m
[*3] Fertilizer machine 3.5 t
[*4] Plug worn 4 furrows
[*5] Harrow starry width 1.2 m
[*6] Herbicide machine 1200 l
[*7] Seedbed preparation combine 4m width
[*8] Treated seeds machine 4 tons
[*9] Grain precision seeders 8 sections
[*10] Cultivator universal wear 8 row
[*11] Fertilized equipment
[*12] Phytosanitary treatment machine 2,000 liters
[*13] C110 combine grain harvester + sunflower equipment 6F
[*14] Harrows rotary

Table 2

Technological sheets of safflower culture

SAFFLOWER CULTURE - TECHNOLOGICAL SHEET				
No.	Works	Period	Equipments	Materials
1	Discing stubble	August	U650+GD6,4[*2]	
2	Fertilized	September	U650M+MA3.5[*3]	40 kg/ha N 20 kg/ha P
3	Plowing at 25 cm + harrowing and milling	September	U650+ PP4[*4]+GS1.2[*5]	
4	Prepared seedbed	Octomber	U650+ CPGC 4[*7]	
5	Hebicide	Octomber	U650M+MET1200[*6]	Dual Gold 650 EC 1.5 l/ha
6	Planting at 50 cm	Octomber	U650M+SPC8[*9]	15 kg/ha
7	Mechanical hoeing I	April	U650M+CPU8[*10]	
8	Mechanical hoeing II	Mai	U650M+CPU8	
9	Harvest	August	John Deere 1155[*15]	1.200 kg/ha

[*5] John Deere 1155 combine grain harvester

Table 3

Total costs, returnes and profit for the two cultures

Culture	Sunflower	Safflower
Total costs *	388.4 Euro/ha	247.5 Euro/ha
Returnes (prices 2012)	636.4 Euro (397.7 Euro/t)	448.6 Euro (373.4 Euro/t)
Profit	248 Euro	201.1 Euro

* Appreciation is expressed to Roata de Jos cooperators who provided support and information for this study

CONCLUSIONS

The main conclusions of the study are:

- The profit obtained from safflower culture was comparable to that of sunflower culture. It can be said that by working less to get the same profit**.** The year 2012 was a good year for the price of sunflower, this causing a higher profit sunflower, compared with the profit safflower. But in 2013 and 2014, the price of sunflower significantly decreased, gross profit per hectare fell below 200 euro.
- The number of works and machinery neccesary for the culture safflower are greatly reduced compared to those of sunflower culture, lower costs representing actual benefit to the farmer in Romania.
- For the safflower culture are not necessary specific equipments, which represents additional lower costs.
- The small number of works for safflower culture protects the structure of land and reduce the pollution of environment.
- The effects of climate change the last decades in areas of southern and southeastern Romania, areas of major importance in obtaining food resources, and aspects related to lack of cash, labor force and machines, will determine the change the range of traditional cultures in this area.

BIBLIOGRAPHY

1. **Dumitru M.**, 2005 - *Conventia natiunilor unite privind combaterea desertificarii si implementarea acesteia in Romania*, Workshop 10-11 February 2005, Brasov.
2. **Fischer, E. M.,** 2007 - *The role of land-atmosphere interactions for European summer heat waves: Past, present and future*, PhD Thesis. [PDF].
Mediterranean most at risk from European heatwaves, Nature News, 17/05/2010.
Mediterranean most at risk from European heatwaves, Nature News, 17/05/2010.
3. **Ion V.**, 2010 - *Fitotehnie*, www.horticultura-bucuresti.ro;
4. **Ivan Gh.**, 2012 - *Oil plants harvesting in Romania*, Publishing „Terra Nostra" Iasi, pg. 26-40 and 78-83.
5. **Popescu V.**, 1996 -*Cultura florii-soarelui si a rapitei*, Publishing Fermierul roman, Bucureşti;