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PERFORMANCE OF SEVERAL SUNFLOWER HYBRIDS UNDER SEMICONTINENTAL CLIMATE OF SOUTHERN ROMANIA

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Abstract

In our paper, we present resistance at drought of eight sunflower hybrids in system Express Sun and in system Clearfield, belonging to NARDI Fundulea, in climatic condition of three years 2020, 2021 and 2022, by analyzing data regarding seed yield, hectoliter weight, seed oil content. Average seed yield in year 2020, was between values of 581 kg/ha at sunflower hybrid FD15CL44 and 2668 kg/ha at sunflower hybrid FD15E27, in year 2021, was between values of 2358 kg/ha at sunflower hybrid FD20CL70 and 4031 kg/ha at sunflower hybrid FD15E27 and in year 2022, was between values of 2814 kg/ha at sunflower hybrid FD22CL83 and 4232 kg/ha at sunflower hybrid FD18E41. Average hectoliter weight in year 2020, was between values of 44.6 kg/hl at sunflower hybrid FD22CL66 and 64.5 kg/hl at sunflower hybrid FD18E41, in year 2021, was between values of 33.6 kg/hl at sunflower hybrid FD20CL70 and 45.6 kg/hl at sunflower hybrid FD19E42 and in year 2022, was between values of 54 kg/hl at sunflower hybrid FD22CL83 and 66.4 kg/hl at sunflower hybrid FD21CL77.

Key words*: sunflower, seed yield, drought.*

INTRODUCTION

Sunflower is cultivated in follow continents: South America, North America, Asia, Africa, Oceania (Australia) and Europe (source: CABI). Regarding world sunflower production by country, Romania was in 2019, on forth places with 3569150 tonnes production per year, with 1282700 hectares and with an average of seed yield of 2782 kg/ha, after Russian Federation, Ukraine and Argentina (source: Atlas Big). In 2020, Romania was on fifth place with 2198670 tonnes after Russian Federation, Ukraine, Argentina, China mainland (source: Science Agri). In Romania, sunflowers represent an important crop and are the most important oleaginous plant. In year 2020, in Romania, sunflower was cultivated on a surface of 1.170.372 ha with an average yield of 1883 kg/ha and with a total yield of 2.204.312 tons (source: MADR). In year 2021, in Romania, from all cultivated area crops (8263 thousand hectares) sunflower was cultivated on a surface of 1124 thousand hectares with an average yield of 2530 kg/ha and with a total production of 2843 thousand tons (source: INSSE).

Seed yield of sunflower is limited by disease caused by pathogens like: *Plasmopara halstedii* - downy mildew, *Sclerotinia sclerotiorum* - Sclerotinia stalk rot and head rot, *Alternaria* spp. - Alternaria leaf spot and blight, *Botrytis cinerea* - Botrytis blight or gray mold, *Macrophomina phaseolina* - charcoal rot, *Phoma macdonaldii* - Phoma black stem, *Diaporthe helianthi* - Phomopsis stem canker, *Puccinia helianthi* - rust, *Septoria* spp. - Septoria leaf spot and blight, *Verticillium dahlia* - Verticillium leaf mottle/wilt, *Albugo tragopogonis* - white rust (Risnoveanu et al., 2019; Oprea et al., 2022; Sara et al., 2022; Gulya et al., 2016; CABI)

Sunflower is attacked by birds (Sausse, 2021) and pests like *Tanymecus dilaticollis* - maize leaf weevil, *Brachycaudus helichrysi* - leaf-curling plum aphid, *Helicoverpa armigera* – corn earworm, *Homoeosoma nebulellum* - European sunflower moth, *Ostrinia nubilalis* - European corn borer, *Agriotes* sp. - wireworms, *Agrotis segetum*- turnip moth, *Opatrum*

sabulosum- darkling beetle, *Aphis fabae* - black bean aphid (Demenko et al., 2019; Georgescu et al., 2018; 2022; Trașcă et al., 2019; Trașcă et al., 2021; Trotuș and Buburuz, 2015).

Seed yield of the sunflower is significantly influenced by the climatic conditions of the agricultural year (Partal, 2022) and water stress decreases the seed yield of sunflower hybrids (Duca et al., 2022).

Drought affect seed yield and seed oil content in sunflower thought high temperatures during the phenophase of vegetation of seed filing (Pekcan, 2021; Dunareanu and Radu, 2020). Seed yield is affected under water stress in flowering time (Darbani et al., 2020).

Drought stress affects yield components and seed weight per plant is reduced with 36.26% (Hanafy and Sadak, 2023).

Content of oleic acid from oil of sunflower hybrids, decrease and content of linoleic acid increase up to 14% under drought stress. Saturated fatty acid, of sunflower hybrids under drought stress, content of palmitic acid increases with 0.39 up to 0.74% and content of stearic acid decreases up to 1.33 (Petcu et al., 2001).

MATERIALS AND METHODS

Sowing date was on dates April 13, 2020, April 16, 2021 and April 7, 2022, in Fundulea location, situated in south-eastern of Romania, in non-irrigated field, in randomized block, in three repetitions, in three years, eight sunflower hybrids belonging to NARDI Fundulea. Sowing date and climatic condition influenced oil content of sunflower genotype according to Popa et al., 2017. Three sunflower hybrids was cultivated in system Express Sun (FD15E27, FD18E41, FD19E42) and five sunflower hybrids (FD15CL44, FD20CL70, FD21CL77, FD22CL66, FD22CL83) in system Clearfield.

FD15E27 is a sunflower hybrid semi-late in system Express Sun, resistant to parasite broomrape (*Orobanche cumana*) at race F-G (incda-fundulea.ro).

FD18E41 is a sunflower hybrid semi-late in system Express Sun, resistant at sulfonylurea herbicides, resistant to parasite broomrape (*Orobanche cumana*) at race F-G (incda-fundulea.ro).

FD19E42 is a sunflower hybrid semi-late in system Express Sun, resistant at sulfonylurea herbicides, resistant to parasite broomrape (*Orobanche cumana*) at race F-G (incda-fundulea.ro).

FD15CL44 is a sunflower hybrid semi-late in system Clearfield, resistant at imidazolinone herbicides, genetic resistance to downy mildew (*Plasmopara halstedii*) at races 304, 330, 710, 714, resistant to parasite broomrape (*Orobanche cumana*) at race E (incda-fundulea.ro).

FD20CL70 and is a sunflower hybrid semi-late in system Clearfield, resistant at imidazolinone herbicides, resistant to parasite broomrape (*Orobanche cumana*) at race E (incda-fundulea.ro).

FD21CL77 is a sunflower hybrid semi-late in system Clearfield, resistant at imidazolinone herbicides.

FD22CL66 is a sunflower hybrid semi-late in system Clearfield, resistant at imidazolinone herbicides.

FD22CL83 is a sunflower hybrid semi-late in system Clearfield, resistant at imidazolinone herbicides.

Sunflower hybrids in system Express Sun was sprayed with herbicide with substance active tribenuron methyl when sunflower genotype has four true leaves (BBCH 18). Sunflower hybrids in system Clearfield was sprayed with herbicide with substance active imazamox when sunflower genotype has four true leaves (BBCH 18).

RESULTS AND DISCUSSIONS

Temperatures (°C) registered in three years, 2020, 2021 and 2022 at National Agricultural Research and Development Institute Fundulea (NARDI Fundulea) is presented in Table 1.

In month April 2021, average temperature was 9.7ºC (lower than average of 60 years of 11.3ºC) and because of that the emergence of sunflower hybrid was delayed up to 23 days. In month April, in years 2020 (average temperature 12.3ºC) and 2022 (average temperature 12.3º1), the emergence was after 10 days of sunflower hybrids sowing. In period of vegetation of sunflower (from month April up to September) in years 2020, 2021 and 2022, temperatures registered was higher than

average of 60 years excepting months April 2021 (9.7°C) and September 2021 (17.3°C).

Table 1. Average monthly temperatures registered in period 2020-2022

Temperatures (°C) registered in Fundulea				
Month	Year			
	2020	2021	2022	Average of 60 years
January	0.9	1.6	2.1	-2.4
February	5.2	3.2	4.7	-0.4
March	8.3	5.1	4.4	4.9
April	12.3	9.7	12.1	11.3
May	17	17.2	17.9	17
June	21.7	21.1	22.6	20.8
July	25.1	25.3	25	22.7
August	25.5	24.2	25.6	22.3
September	20.8	17.3	18.6	17.5
October	14.7	10.2	13.5	11.3
November	6.1	7.7	9	5.4
December	3.9	2.6	3.5	0

Rainfall (mm) registered in three years, 2020, 2021 and 2022 at National Agricultural Research and Development Institute Fundulea (NARDI Fundulea) is presented in Table 2.

Rainfalls (mm) registered in period of vegetation of sunflower (from month April up to September) in years 2020 (248.6 mm), 2021 (273.2 mm) and 2022 (216.3 mm), was lower than average of 60 years (351.8 mm).

Year 2022 with a total of 285.4 mm of rainfalls, was the driest from past 60 years (average of 60 years was 584.3 mm in Fundulea location).

Table 2. Average monthly rainfalls registered in period 2020-2022

Rainfalls (mm) registered in Fundulea				
Month	Year			
	2020	2021	2022	Average of 60 years
January	2	77	4.8	35.1
February	16.6	16.2	5.4	32
March	29.8	59	12.3	37.4
April	14	31	47.6	45.1
May	58	57.6	30.1	62.5
June	68.4	135	59.6	74.9
July	34.2	21.2	29.2	71.1
August	5.4	24.4	14.4	49.7
September	68.6	4	35.4	48.5
The amount of precipitations in the growing season of sunflower	248.6	273.2	216.3	351.8
October	28.6	56.4	5.2	42.3
November	20	33.8	19.6	42
December	77.6	37.6	21.8	43.7
Annual sum	423.2	553.2	285.4	584.3

Rainfalls registered in month June 2021 (135 mm) allow development of pathogens such as *Plasmopara halstedii* (sunflower downy mildew) for late epoch of sowing (month May). In year 2021, sunflower downy mildew has a big attack from last three years.

Average seed oil content (%) of sunflower hybrids in Fundulea location, was lower in year 2021 at all sunflower hybrids tested than years 2020 and 2022 (Table 3).

Average seed oil content (%) of all sunflower hybrids tested was in year 2020 at value of 41.11% and seed oil content (%) was among the values of 32.54% at FD22CL66 and 49.49% at FD15E27.

Average seed oil content (%) of all sunflower hybrids tested was in year 2021 at value of 38.39% and seed oil content (%) was among the values of 33.72% at FD22CL66 and 44.57% at FD15E27.

Average seed oil content (%) of all sunflower hybrids tested was in year 2022 at value of 40.47% and seed oil content (%) was among the values of 36.61% at FD20CL70 and 50.53% at FD19E42.

Sunflower hybrids FD15E27 in year 2020 and FD19E42 in year 2022, obtained a distinct significant positive difference compared to the average seed oil content (%) of sunflower hybrids.

Sunflower hybrids FD15CL44 in year 2020 and FD15E27 in year 2021, obtained a significant positive difference compared to the average seed oil content (%) of sunflower hybrids.

Table 3. Average seed oil content of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

Sunflower hybrid	Seed oil content (%)			Difference			Symbol		
	2020	2021	2022	2020	2021	2022	2020	2021	2022
FD15CL44	47.31	37.00	39.11	6	-1	-1	*	-	-
FD15E27	49.49	44.57	45.08	8	6	5	**	*	-
FD18E41	40.65	39.24	38.05	0	1	-2	-	-	-
FD19E42	44.59	42.33	50.53	3	4	10	-	-	**
FD20CL70	36.85	37.60	36.61	-4	-1	-4	-	-	-
FD21CL77	38.61	38.51	37.52	-3	0	-3	-	-	-
FD22CL66	32.54	33.72	38.83	-9	-5	-2	oo	-	-
FD22CL83	38.87	34.18	38.04	-2	-4	-2	-	-	-
Average	41.11	38.39	40.47	0	0	0	-	-	-

LSD 5% = 5.34 LSD 1% = 7.41 LSD 0,1% = 10.30
(Least Significant Difference)

Sunflower hybrid FD22CL66 in year 2020, obtained a distinct significant negative difference compared to the average seed oil content (%) of sunflower hybrids.
Factor Year was insignificant to seed oil content (%) of sunflower hybrids. Factor Sunflower hybrid and interaction between factor year and factor sunflower hybrid, influenced very significant positive the seed oil content (%) of sunflower hybrids (Table 4).
Average seed yield (kg/ha) of sunflower hybrids in Fundulea location, was lower in year 2020 at all sunflower hybrids tested than years 2021 and 2022 (Table 5).

Table 4. ANOVA analysis of variance for seed oil content (%) of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

	Degrees of Freedom	Sum of Squares	Mean Square	F value	Signification
Factor A	2	96.989	48.495	6.7515	
Error	4	28.731	7.183		
Factor B	7	1096.693	156.670	17.0982	***
A x B	14	351.107	25.079	2.7370	***
Error	42	384.846	9.163		

Factor A = Year
Factor B = Sunflower hybrid
A x B = Interaction between Factor Year and Factor Sunflower hybrid

Table 5. Average seed yield (kg/ha) of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

Sunflower hybrid	2020	2021	2022	Difference			Symbol		
				2020	2021	2022	2020	2021	2022
FD15CL44	581	2954	3399	-1194	-329	26	ooo	-	-
FD15E27	2668	4031	3409	893	747	36	**	**	-
FD18E41	1897	3518	4232	122	235	859	-	-	**
FD19E42	1941	3639	3065	166	356	-308	-	-	-
FD20CL70	922	2358	3352	-853	-925	-20	oo	oo	-
FD21CL77	1257	2585	3048	-518	-698	-325	-	o	-
FD22CL66	2345	3748	3662	570	464	290	*	-	-
FD22CL83	2589	3433	2814	814	150	-559	**	-	o
Average	1775	3283	3373	0	0	0	-	-	-

LSD 5% = 527 LSD 1% = 731 LSD 0,1% = 1016
(Least Significant Difference)

Average production (kg/ha) of all sunflower hybrids tested was in year 2020 at value of 1775 kg/ha and seed yield (kg/ha) was among the values of 581 kg/ha at FD15CL44 and 2668 kg/ha at FD15E27.
Average production (kg/ha) of all sunflower hybrids tested was in year 2021 at value of 3283 kg/ha and seed yield (kg/ha) was among the values of 2358 kg/ha at FD20CL70 and 4031 kg/ha at FD15E27.
Average production (kg/ha) of all sunflower hybrids tested was in year 2022 at value of 3373 kg/ha and seed yield (kg/ha) was among the values of 2814 kg/ha at FD22CL83 and 4232 kg/ha at FD18E41.
Sunflower hybrids FD22CL83 in year 2020, FD15E27 in years 2020 and 2022, FD18E41 in year 2022, obtained a distinct significant positive difference compared to the average seed yield (kg/ha) of sunflower hybrids.
Sunflower hybrid FD22CL66 in year 2020, obtained a significant positive difference compared to the average seed yield (kg/ha) of sunflower hybrids.
Sunflower hybrid FD15CL44 in year 2020, obtained a very significant negative difference compared to the average seed yield (kg/ha) of sunflower hybrids.
Sunflower hybrid FD20CL70 in years 2020 and 2021, obtained a distinct significant negative difference compared to the average seed yield (kg/ha) of sunflower hybrids.
Sunflower hybrids FD21CL77 in year 2021 and FD22CL83 in year 2021, obtained a significant negative difference compared to the average seed yield (kg/ha) of sunflower hybrids.
Factors Year, sunflower hybrid and interaction between factors year and sunflower hybrid, influenced very significant positive the seed yield (kg/ha) of sunflower hybrids (Table 6).
Average hectoliter weight of sunflower hybrids in Fundulea location, was lower in year 2021 at all sunflower hybrids tested than years 2020 and 2022 (Table 7).
Average hectoliter weight of all sunflower hybrids tested was in year 2020 at value of 55.2 kg/hl and was between the values of 44.6 kg/hl at FD22CL66 and 64.5 kg/hl at FD18E41.
Average hectoliter weight of all sunflower hybrids tested was in year 2021 at value of 40.2 kg/hl and was between the values of 33.6 kg/hl at FD22CL66 and 45.6 kg/hl at FD19E42.

Table 6. ANOVA analysis of variance for seed yield of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

	Degrees of Freedom	Sum of Squares	Mean Square	F value	Signification
Factor A	2	37614382.694	18807191.347	50.9448	***
Error	4	1476671.222	369167.806		
Factor B	7	13094573. 333	1870653.333	22.2690	***
A x B	14	11186686.417	799049.030	9.5122	***
Error	42	3528111.750	84002.661		

Factor A = Year
Factor B = Sunflower hybrid
A x B = Interaction between factors Year and Sunflower hybrid

Table 7. Average hectoliter weight (kg/hl) of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

Sunflower hybrid	Year			Difference			Symbol		
	2020	2021	2022	2020	2021	2022	2020	2021	2022
FD15CL44	52.0	41.8	54.8	-3	2	-4	-	-	-
FD15E27	61.3	45.0	61.3	6	5	2	-	-	-
FD18E41	64.5	45.3	61.8	9	5	3	**	-	-
FD19E42	56.4	45.6	60.1	1	5	1	-	-	-
FD20CL70	53.1	37.7	59.2	-2	-3	0	-	-	-
FD21CL77	60.2	38.7	66.4	5	-2	7	-	-	*
FD22CL66	44.6	33.6	56.5	-11	-7	-3	oo	o	-
FD22CL83	49.1	34.0	54.0	-6	-6	-5	-	-	-
Media	55.2	40.2	59.3	0	0	0	-	-	-

LSD 5% = 6.2 LSD 1% = 8.7 LSD 0.1% = 12.1
(Least Significant Difference).

Average hectoliter weight of all sunflower hybrids tested was in year 2022 at value of 59.3 kg/hl and was between the values of 54 kg/hl at FD22CL83 and 66.4 kg/hl at FD21CL77.

Sunflower hybrid FD18E41 in year 2020, obtained a distinct significant positive difference compared to the average hectoliter weight (kg/hl) of sunflower hybrids.

Sunflower hybrid FD21CL77 in year 2022, obtained a significant positive difference compared to the average hectoliter weight (kg/hl) of sunflower hybrids.

Sunflower hybrid FD22CL66 in year 2020, obtained a distinct significant negative difference compared to the average hectoliter weight (kg/hl) of sunflower hybrids.

Sunflower hybrids FD22CL66 in year 2021, obtained a significant negative difference compared to the average hectoliter weight (kg/hl) of sunflower hybrids.

Factors year and sunflower hybrid and interaction between these factors, influenced very significant positive the hectoliter weight (kg/hl) of sunflower hybrids (Table 8).

Table 8. ANOVA analysis of variance for hectoliter weight (kg/hl) of sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

	Degrees of Freedom	Sum of Squares	Mean Square	F value	Signification
Factor A	2	4824.809	2412.404	87.7546	***
Error	4	109.961	27.490		
Factor B	7	1382.337	197.477	17.4837	***
AxB	14	426.605	30.472	2.6978	***
Error	42	474.385	11.295		

Factor A = Year
Factor B = Sunflower hybrid
A x B = Interaction between factors Year and Sunflower hybrid

Regarding pathogen *Diaporthe helianthi* who produce *Phomopsis* stem canker, in year 2021 was observed an attack degree between 5% at FD15E27, FD19E42, FD21CL77, FD22CL83 and 10% at FD22CL66 (Table 9).

Table 9. Attack degree of pathogen *Diaporthe helianthi* on sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

Sunflower hybrid	2020	2021	2022
FD15CL44	0	7	0
FD15E27	0	5	0
FD18E41	0	7	0
FD19E42	0	5	0
FD20CL70	0	7	0
FD21CL77	0	5	0
FD22CL66	0	10	0
FD22CL83	0	5	0

In year 2021, in Fundulea was observed an attack degree of pathogen *Plasmopara halstedii* who produce sunflower downy mildew of 2% at FD15E27 and 3% at sunflower hybrids FD15CL44 and FD20CL70 (Table 10).

In years 2020 and 2022, we observe at all sunflower hybrids studied, a bird attack between 5-30%, in phenological growth stages of ripening (BBCH- 80-89).

Table 10. Attack degree of pathogen *Plasmopara halstedii* on sunflower hybrids in Fundulea location, in years 2020, 2021 and 2022

Downy mildew %	2020	2021	2022
FD15CL44	0	3	0
FD15E27	0	2	0
FD18E41	0	0	0
FD19E42	0	0	0
FD20CL70	0	3	0
FD21CL77	0	0	0
FD22CL66	0	0	0
FD22CL83	0	0	0

CONCLUSIONS

Agricultural year thought climatic condition influenced very significant positive the seed yield (kg/ha) and hectoliter weight (kg/hl) of sunflower hybrids and was insignificant regarding content of seed oil (%).

Sunflower hybrid influenced very significant positive the seed yield (kg/ha), seed oil content (%) and hectoliter weight (kg/hl).

Although year 2022, was the driest year in the last 60 years, seed yield of all sunflower hybrids tested was very good, do to rainfalls from phenological growth stages of development of seed (BBCH 71-79).

REFERENCES

Darbani, S. P., Mehrabi, A. A., Pordad, S. S., Maleki, A., Farshadfar, M., (2020). Effect of drought stress on agro-morphological traits in sunflower (*Helianthus annuus* L.) genotypes and identification of informative ISSR markers. *Plant Genetic Resources*, *18*(2). 49–62.

Demenko, V. M., Golinach, O. L., Vlasenko, V A. (2019). The phytosanitary status of sunflower crops of north-eastern Forest-Steppe of Ukraine. *Bulletin of Sumy National Agrarian University. The series: Agronomy and Biology*, 4(38). 3–7.

Duca, M., Burcovschi, I., Gîscă, I. (2022). Drought effect on quantitative traits of sunflower genotypes. *Analele Universităţii din Oradea, Fascicula Biologie Tom. XXIX*(1). 30–37.

Dunareanu, I. C, Radu, V. L. (2020). Sunflower yield and yield component sunder field conditions of ARDS Şimnic. *Annals of the University of Craiova-Agriculture, Montanology, Cadastre Series,* 50(1). 120–126.

Georgescu, E., Vasian, I., Toader, M., Cană, L., Tötös, S. M., Gorgan, M. (2022). New data concerning the evolution of the European sunflower moth (*Homoeosoma Nebulellum* Den. & Schiff.) in sunflower crops in the South-East of Romania. *Scientific Papers. Series A. Agronomy, LXV*(1). 334–341.

Georgescu, E., Toader, M., Ionescu, A.M., Cana, L., Rasnoveanu, L. (2018). Researches concerning sunflower seeds treatment against *Tanymecus dilaticollis*, in green house conditions. *"Agriculture for Life, Life for Agriculture" Conference Proceedings, 1*(1). 64–71.

Gulya, T. J., Mathew, F., Harveson, R., Markell, S., Block, C. (2016). Diseases of sunflower. *Handbook of Florists' Crops Diseases; McGovern, RJ, Elmer, WH, Eds,* 787–837.

Hanafy, R., Sadak, M. (2023). Foliar spray of stigmasterol regulates physiological processes and antioxidant mechanisms to improve yield and quality of sunflower under drought stress. *Journal of Soil Science and Plant Nutrition, 23*. 2433–2450.

Oprea, D., Pacureanu-Joita, M., Anton, F. G., Risnoveanu, L. (2022). The resistance of sunflower to the attack of some pathogenic agents in the climate conditions of the Northeast Baragan. *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca Agriculture. 79*(2). 54–58.

Partal, E. (2022). Sunflower yield and quality under the influence of sowing date, plant population and the hybrid. *ROMANIAN AGRICULTURAL RESEARCH,* 39. 463–470.

Pekcan, V., Yilmaz, M. I., Evci, G., Kaya, Y. (2021). The evaluation of drought stress tolerance in sunflower inbred lines. *In Conference paper of International Agricultural, Biological & Life Science Conference, Edirne, Turkey, 1-3 September,10053-1059* Available from: (https://www.researchgate.net/publication/358564490 [accessed Mar 22 2023].

Petcu, E., Arsintescu, A., Stanciu, D. (2001). The effect of drought stress on fatty acid composition in some Romanian sunflower hybrids. *Romanian Agricultural Research, 15*. 39–43.

Popa, M., Anton, F. G., Rîşnoveanu, L., Petcu, E., Băbeanu, N. (2017). The effect of planting date and climatic condition on oil content and fatty acid composition in some romanian sunflower hybrids, *AgroLife Scientific Journal, 6*(1), 212–217.

Rîşnoveanu, L., Joiţa-Păcureanu, M., Anton, F. G., Popa, M., Bran, A., Sava, E. (2019). Genetic resources for improving resistance to the main diseases in sunflower. *Romanian Agricultural Research, 36*. 99–105.

Sara, U., Rajbongshi, A., Shakil, R., Akter, B., Sazzad, S., Uddin, M. S. (2022). An extensive sunflower dataset representation for successful identification and classification of sunflower diseases. *Data Brief, 42*. 108043.

Sausse, C., Chevalot, A., Lévy, M. (2021) Hungry birds are a major threat for sunflower seedlings in France. *Crop Protection, 148*, 105712.

Trașcă, F., Trașcă, G., Georgescu, E. (2019). New data about the control of wireworms (*Agriotes* spp.) from the main field crops under the Piteşti-Albota area. *Annals of N.A.R.D.I. Fundulea, 87*. 261–269.

Trașcă, G., Podea, M. M., Ghiorghe, C., Dinuță, C. I., Gheorghe, R. M., Georgescu, E. (2021). Research on the control of *Agriotes spp*. in the sunflower crop in the context of restriction of seed treatment with neonicotinoid insecticides. *Annals of N.A.R.D.I.Fundulea*, 89. 191–200.

Trotuș, E., Buburuz, A. A. (2015). Researches regarding the knowledge and control of specific pests from sunflower crops, under the center of Moldova conditions. *Romanian Journal for Plant Protection*, *8*. 36–46.

https://insse.ro/cms/sites/default/files/field/publicatii/anuarul_statistic_al_romaniei_carte-ed.2022.pdf

https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.26714#sec-11

https://www.atlasbig.com/en-us/countries-sunflower-production

https://scienceagri.com/10-worlds-biggest-sunflower-seed-producers/

https://madr.ro/culturi-de-camp/plante-tehnice/floarea-soarelui.html

https://www.incda-fundulea.ro/fise/floareas.html