

INFLUENCE OF DROUGHT AND HAILSTORM ON THE YIELD AND YIELD COMPONENTS OF SUNFLOWER

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Abstract

In this paper results are presented for the Osijek (OS) sunflower hybrids in two very different years regarding rainfall and air temperature. In 2002, the amounts of rainfall and air temperature were optimal, but in 2003 unprecedented drought was recorded during the vegetation period and a heavy hailstorm occurred at the beginning of July that caused huge damage to hybrids in the experimental field at the Agricultural Institute Osijek. In this research the following were analyzed: plant height, mass of 1000 grains, grain yield, oil content and oil yield. Based on the analyzed traits, results in 2002 were significantly better compared to 2003. The OS sunflower hybrids were shown to have a high potential for grain yield, oil content and oil yield as well as drought tolerance. In conditions of significant leaf, stem and head damage by the hailstorm, our hybrids realized satisfying results.

Introduction

Sunflower (*Helianthus annuus* L.) hybrid breeding is based on usage of cytoplasmic male sterility and restorer genes to recover fertility in the F1 generation. By long-standing work at the Agricultural Institute Osijek, inbred lines with good combining abilities were created that were used in creation of hybrid combinations with good economic properties. New hybrid combinations were tested in a microtrial network for two or three years, and the best were submitted to the Institute for Seed and Seedlings for the approval procedure for new hybrids. In this paper results are shown of the investigation of new hybrid combinations in two very different climatic years (2002 and 2003).

Materials and Methods

In this trial 17 new hybrid combinations were tested with three approved hybrids: Apolon, Fakir and Orion. Trials were set up on the experimental field of the Agricultural Institute Osijek, with three replications in an RCBD. The type of soil was Eutric Cambisol with 1.8-2% of humus. In both years, optimal crop management was applied, and hybrids had good conditions for development. Trials were sown with a distance of 70 cm between rows, and 25 cm within row. The size of the plots was 11.2 m sq. During the vegetation period, all estimations were done, and at the beginning of physiological maturity, plant height was

measured. In the first part of September, experiments were harvested using a Wintersteiger combine for experimental plots. After harvesting, the following were estimated in cleaned samples: grain moisture, 1000-grain mass, grain yield, and oil content in the grain determined by a NMR Analyzer. Data were statistically processed by analysis of variance.

Results and Discussion

In two-year of testing of the new OS sunflower hybrids, statistically significant differences were found among the tested traits. In 2002, air temperatures and rainfall were optimal. In 2003 unprecedented drought was recorded, especially in June and August (Figure 1). Average air temperatures exceeded a longtime average by 4-5C, and high daily air temperatures caused soil drying and heating to a depth of 2 cm until soil temperature reached 45C. At the beginning of July 2003, a hailstorm at the experimental field caused severe damage to the hybrids. In the trials, hybrids lost about 90% of their leaf area, with large injuries to stems and heads. After that, hot days without rainfall came again which prevented disease development on damaged plants. Until the hailstorm, almost all hybrids were in good condition regardless of drought and high temperature; they had well developed root systems, and good results were expected as evidence to the breeders that highly drought tolerant hybrids were created. New OS sunflower hybrids had emphasized LAI (Leaf Area Index) and LAD (Leaf Area Duration), in a positive correlation with drought and disease resistance (Panković et al., 1977; Cukadar-Olmedo et al., 1997; Marinković and Dozet, 1997; Krizmanić et al., 2001).

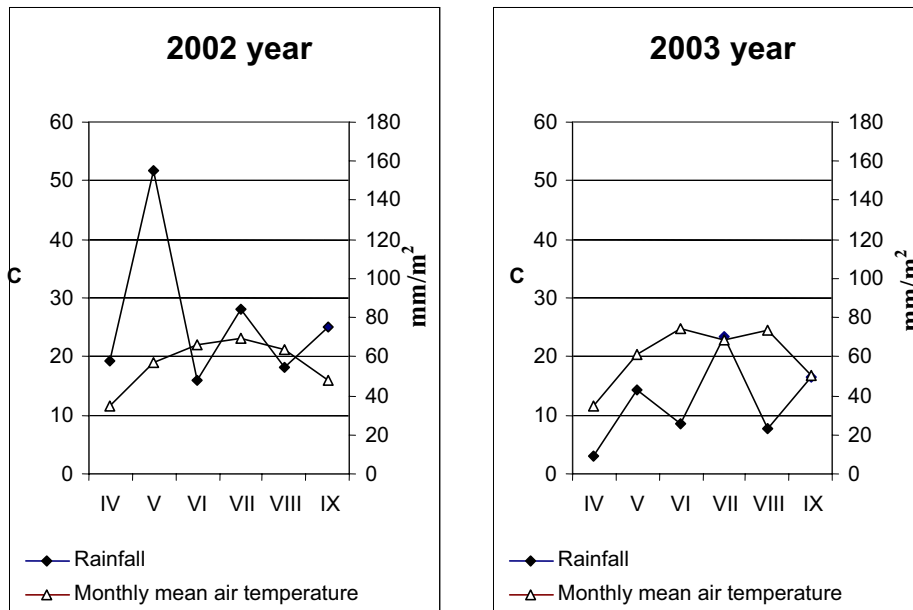


Figure 1. Rainfall and monthly mean air temperature in Osijek (Meteorological station Osijek, Klisa Airport).

Based on analyzed traits of OS sunflower hybrids, it is clear that results achieved in 2002 were significantly better than 2003 (Table 1). In 2002, the average plant height was 197 cm, and in 2003 it was 50 cm less. In both years tested, the shortest plants were hybrid Apolon (162 and 125 cm), which was a goal in creation of new hybrids with increased harvest index and emphasized resistance to lodging.

Between hybrids and years significant differences were found in the 1000-grain mass (63.0 and 51.6 g), with a difference of 11.4 g between years. 1000-grain mass is one of the most important objectives in sunflower breeding. According to Morozov (1970), increasing 1000-grain mass by only one gram gives an increase in grain yield of 40 g/kg.

Table 1. Average values of sunflower analyzed traits in 2002 and 2003.

Hybrid	Plant height (cm)		1000- grain mass (g)		Grain yield (kg/ha, 9+2)		Oil content in DM (%)		Oil yield (kg/ha)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
H-1	186	148	60.9	53.3	5336	2093	51.72	45.62	2510	874
H-2	191	146	61.8	49.3	4658	2391	49.73	45.02	2108	979
H-3	175	140	54.4	47.1	4672	2032	55.36	48.44	2356	896
H-4	186	143	59.9	56.2	4663	2509	50.19	43.58	2130	997
Apolon	162	125	60.8	54.3	4509	2100	54.39	47.50	2232	909
H-6	211	154	64.1	47.4	5089	2722	47.23	41.94	2187	1040
H-7	213	147	66.7	55.2	5095	2629	44.53	36.77	2065	879
H-8	211	159	59.0	46.2	4095	2679	47.28	43.42	1762	1057
H-9	207	149	57.1	54.2	3866	2710	50.52	43.45	1780	1071
H-10	187	133	64.5	53.7	4399	2405	44.90	41.23	1797	906
H-11	192	141	62.2	51.8	4744	2628	48.40	38.71	2089	926
H-12	199	140	67.9	55.3	5280	2195	48.64	43.40	2338	866
H-13	215	143	64.1	51.0	5089	2282	47.97	39.02	2219	808
Fakir	233	156	76.1	53.1	4839	1922	43.78	37.34	1926	652
H-15	179	145	57.0	47.6	3780	2324	51.51	44.85	1773	949
H-16	176	149	58.2	48.6	4137	2311	48.60	46.26	1828	975
H-17	214	158	70.1	54.4	5149	2075	49.21	39.86	2305	753
H-18	193	154	59.3	49.5	3899	2423	52.49	48.37	1862	1067
H-19	190	145	63.3	51.6	4048	2305	47.89	44.53	1764	934
Orion	217	159	72.7	51.8	5350	2181	43.48	41.20	2118	818
Average:	197	147	63.0	51.6	4635	2346	48.89	43.03	2057	918
LSD 5%	19	15	5.1	3.0	868	ns	0.87	1.81	398	225
LSD 1%	25	20	6.8	4.0	1164	ns	1.17	2.42	534	302
CV (%)	5.77	6.15	4.90	3.51	11.35	14.22	1.08	2.55	11.72	14.89

The highest grain yield in 2002 was in hybrid Orion (5,350 kg/ha), and in 2003 hybrid H-6 (2,722 kg/ha). Average grain yields in 2002 were 4,635 kg/ha, and in 2003 2,346 kg/ha which showed the consequences of a hailstorm in 2003 (Ahmad et al., 1998; Muro et al.,

2001). Grain yield is a very complex trait, with polygenic inheritance, and is largely influenced by environment (Krizmanić et al., 1992; Marinković and Dozet, 1997). With regard to damage grade of the hybrids, these results are encouraging because they point to the high yield potential of our hybrids.

Oil content in grain is a genetically conditioned trait, but can be under a large influence of environment: air temperature and amount of easy accessible water and mineral nutrients in the oil biosynthesis phase (Marinković, 1993; Marinković and Dozet, 1997; Krizmanić et al., 1992, 2001). In 2002 the average oil content was 48.89%, and in 2003 43.03%, which is 5.86% less in relationship to the previous year. The highest oil content in both years of the investigations was in hybrid H-3 (55.36 and 48.44%), and then in hybrid Apolon. In addition, some new OS sunflower hybrids had a high oil content too.

Oil yield is very strong and positively correlated with grain yield and oil content (Marinković and Dozet, 1997; Teklewold et al., 2000; Krizmanić et al., 2001). Average oil yield in 2002 (2057 kg/ha) showed a high grain yield potential and oil content in tested hybrids. Between hybrids a significant differences existed, especially emphasized in hybrids with oil yield over 2000 kg/ha. Significantly lower oil yield (918 kg/ha) was realized in 2003, as a consequence of strong plant damage.

Conclusions

Based on the results obtained during 2002 and 2003, it can be concluded that experimental OS sunflower hybrids have high potential for grain yield, oil content, oil yield, and emphasized tolerance to drought. In conditions of significant leaf, stem and head damage by a hailstorm, our hybrids realized satisfying results.

References

- Ahmad, G., Z. Quresh, R. Ahmad, and F. Begum. 1998. Effect of defoliation on the yield and yield components of sunflower. *Sarhad Journal of Agriculture*. 14(5):433-436.
- Cukadar-Olmedo, B., J.F. Miller, and J.J. Hammond. 1997. Combining ability of the stay green trait and seed moisture content in sunflower. *Crop Science*. 37(2):378-382.
- Krizmanić, M., V. Jukić, and M. Bilandžić. 1992. Značaj oplemenjivanja nekih kvantitativnih svojstava suncokreta i njihov utjecaj na urod ulja po hektaru. *Sjemenarstvo*. 9(4-5):241-252.
- Krizmanić, M., A. Mijić, M. Bilandžić, T. Duvnjak, Z. Jurković, and R. Sudar. 2001. Utjecaj agrotehnike i sortimenta na uzgoj suncokreta u aridnim uvjetima. *Sjemenarstvo*. 18(1-2):43-55.
- Marinković, R. 1993. Components of genetic variability for characters affecting oil yield of sunflower (*Helianthus annuus* L.). *J. Genet. Breed.* 47:289-294.
- Marinković, R. and B. Dozet. 1997. Genetska istraživanja na suncokretu u svetu u funkciji oplemenjivanja. *Naučni institut za ratarstvo i povrtarstvo Novi Sad. Zbornik radova*. 29:569-592.
- Morozov, V.K. 1970. Selekcija podsolnečnika v SSSR. Piščepromizdat. Moskva.
- Muro, J., I. Irigoyen, A.F. Militino, and C. Lamsfus. 2001. Defoliation effects on sunflower yield reduction. *Agron. J.* 93(3):634-637.
- Panković, D., M. Plesničar, Z. Sakač, and T. Čupina. 1997. Fiziološke i molekularne osnove tolerantnosti suncokreta prema suši. *Naučni institut za ratarstvo i povrtarstvo Novi Sad. Zbornik radova*. 29:611-624.
- Teklewold, A., H. Jayaramaiah, and B.N. Jagadesh. 2000. Correlations and path analysis of physio-morphological characters of sunflower (*Helianthus annuus* L.) as related to breeding method. *Helia*. 23(32):05-114.