The influence of weather conditions on economic characteristics of sunflower hybrids in macro experiments from 1997 to 2007

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ABSTRACT

Over the period of 11 years (1997-2007), macro experiments with sunflower hybrids were set up at the location of Vinkovci. The experiments included hybrids of recognized world companies, from 13 to 30 per each test. During 11 years, the average head diameter, stem height, disease incidence of *Sclerotinia sclerotiorum*, grain yield, oil yield and oil content were recorded for each hybrid. The highest plant height was recorded in 1997 and 1998 (204 cm), while the lowest plant height was observed in 2006 (169 cm). Average plant height throughout the experiments was 188 cm. Head diameter ranged from 18.1 to 22.9 cm, averaging 19.6 cm. The greatest incidence of white rot disease (*Sclerotinia sclerotiorum*) occurred in 2005 (39.6% of infected plants). The average grain yield was 3 t ha^{-1} and it varied from 1.13 t ha^{-1} in 2005 to 4.56 t ha^{-1} in 2000. The oil content was between 42.05 and 48.17 %, with an average over experiments of 44.42%. The lowest oil yield was obtained in 2005 (0.49 t ha^{-1}) and the highest in 2000 (2.04 t ha^{-1}), with an average of 1.31 t ha^{-1}).

Key words: economic characteristics – sunflower – weather conditions.

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is one of the four most significant oleaginous plants, planted on more than 20 million hectares worldwide with grain yields varying from 0.5 to 3.6 t ha^{-1} and an average grain yield of 1.16 t ha^{-1} (FAOSTAT, 2002). Production of sunflower in Croatia has significantly varied over the past 25 years. Average grain yield was between 1.9 to 2.5 t ha^{-1}, depending on the climate conditions of the production year (Liovic et al., 2006). Numerous pathogens can attack sunflower and one of the most important ones is white rot, *Sclerotinia sclerotiorum* (Lib.) de Bary (Duvnjak et al., 2005; Hudec, 2006). The highest disease incidence can be expected in years with cold and wet months during the vegetation period. Sunflower breeding programs must be based on creation of new genetic variability and hybrids with high oil and grain yield potential (Krizmanic et al., 2004; Hunyadi et al., 2007). Through several years of field experiments in Croatia, many hybrids have been tested and only those with the best economic characteristics were recommended to producers. Experiments also gave a direction to breeding program and seed production work. An overview of such experiments is given in this manuscript.

MATERIALS AND METHODS

During 11 years, experiments were set up in the experiment field of PIK Vinkovci. Experiments included hybrids of well-known world companies (Pioneer, RWA, KWS, Monsanto, Agricultural Institute Osijek, Institute for Crops and Vegetables of Novi Sad). The size of the main parcel was 250 m^2. Sowing was done with pneumatic sowing machines with the same crop density for all hybrids (65,000 grains per ha). Common sunflower agrotechnique was used. Protection was given with fungicide Konker (vinclosolin 20% + carbendasim 16.5%) with dosage of 1.5 l ha^{-1}. Spraying was done with field sprayer in R1-R2 sunflower stage (head size 2 cm) (Schneiter and Miller, 1981). The intensity of white rot (*Sclerotinia sclerotiorum*) incidence was determined in stage R8, by counting infected plants (40 of each hybrid). Grain yield was determined after the harvest with electronic measurer (Schrran Engeneering, model 715) and presented as tons of dry grain per hectare (grain moisture 9%, 2% ingredients). Grain moisture was determined with Dickey John measurer, model GAC 2000 (grain analysis computer).

Weather conditions: In Table 1, amount of rainfall and average temperature over the vegetation (April - August) and over the year (1997-2007) are presented. The driest year was 2007, with 94.1 mm of rainfall over the vegetation period and 238.7 mm over the year, average temperature during the vegetation period was 19.8 ºC. The largest amount of rainfall was in 2001, with 939.7 mm over the year and 514.2 mm over

the vegetation period. The lowest average temperature in 2001 (17.8 ºC). The amount of rainfall over the vegetation period 1997-2007 was 149.6 mm lower and temperature 0.8 ºC higher compared to historical records (1970-2005).

Table 1. Amount of rainfall and average temperature over the vegetation period (April - August) and over the year for the Vinkovci location

Year	Amount of rain fall (mm)		Average temperature ºC	
	Vegetation	Year	Vegetation	Year
1997	384.2	672.8	17.9	11.7
1998	375.4	683.9	18.6	11.3
1999	504.7	867.6	18.7	11.5
2000	153.4	315.2	19.7	12.9
2001	514.2	939.7	17.8	11.4
2002	483.6	682.4	18.7	12.3
2003	105.8	513.6	18.5	11.7
2004	312.8	911.9	20.1	10.9
2005	496.7	859.2	18.0	10.6
2006	461.3	639.7	18.2	11.6
2007	94.1	238.7	19.8	12.9
Average 1997-2007	353.3	665.9	18.7	11.7
Average 1970-2005	502.9	628.5	17.9	11.4

RESULTS AND DISCUSSION

Grain and oil yield, oil content, plant height, head diameter, and incidence of white rot disease varied depending on the year of production (temperature, amount and distribution of rainfall) and hybrid (Table 2). Plant height and head diameter were mostly influenced by the hybrid. In the course of the breeding program, head diameter was reduced from 22.9 cm (1997) to close to 18 cm. The objective was to reach a lower stem with smaller head diameter to facilitate a high crop density and reduced risk of lodging due to head weight, especially in wet years. White rot incidence mostly depended on rainfall and temperatures over the vegetation period. In accordance with this, the lowest disease incidence was determined in very dry years (2003 - 2.1% of infected plants; 2007 - 3.4% of infected plants) and the highest disease incidence in wet and cold years (2005 - 39.6% of infected plants; 2001 - 37.2% of infected plants). The average grain yield was 3 t ha^{-1}. The lowest average grain yield was in 2005 (1.13 t ha^{-1}) and the highest in 2000 (4.56tha^{-1}). The average oil content (1997-2007) was 44.42%. Average oil yield was 1.31 t ha^{-1}, the lowest record in 2005 (0.49 t ha^{-1}) and the highest in 2000 (2.04 t ha^{-1}).

Table 2. Results of research on economic characteristics of sunflower hybrids in macro experiments from 1997 to 2007

Year	No. of hybrids	Plant height (cm)	Head range (cm)	*Sclerotinia sclerotiorum* (%)	Grain moisture (%)	Grain yield (tha^{-1})	Oil content (%DMC^{-1})	Oil yield (tha^{-1})
1997	20	204	22.9	12.5	11.3	2.81	42.05	1.18
1998	17	204	21.1	11.1	10. 6	2.76	44.31	1.26
1999	13	184	19.8	12.2	9.7	2.39	44.17	1.06
2000	20	196	19.4	4.1	7.8	4.56	44.77	2.04
2001	24	184	18.1	37.2	11.8	2.31	44.55	0.96
2002	30	196	19.1	5.6	7.4	2.84	43.64	1.24
2003	20	170	18.7	2.1	8.0	4.35	45.32	2.03
2004	26	185	20.1	9.8	13.2	2.94	43.76	1.20
2005	30	181	19.9	39.6	15.7	1.13	42.46	0.49
2006	24	169	18.2	12.4	12.8	2.97	45.47	1.21
2007	25	198	18.3	3.4	8.7	3.89	48.17	1.75
Average	**23**	**188**	**19.6**	**13.6**	**10.6**	**3.00**	**44.42**	**1.31**
Min	13	169	18.1	2.1	7.4	1.13	42.05	0.49
Max	30	204	22.9	39.6	15.7	4.56	48.17	2.04

CONCLUSIONS

Based on the result of a macro field experiment from 1997 to 2007 in Vinkovci, the following conclusions can be reached:

1. Grain and oil yield of sunflower hybrids was significantly influenced by temperatures and the amount and distribution of rainfall.
2. Weather conditions have less influence on plant height, head diameter and oil content.
3. White rot (*Sclerotinia sclerotiorum*) incidence is significantly influenced by weather conditions (rainfall and temperatures)
4. The breeding program reached important results on creation of new hybrids with increased yield and oil potential.

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