

SUNFLOWER HYBRIDS ADAPTED TO THE FINNISH GROWING CONDITIONS

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Abstract

A sunflower breeding program was established in late 1970s to develop an early maturing, short stature (EMSS) sunflower hybrids for the northern latitudes. Now these EMSS sunflower hybrids have been tested in yield trials during several years. In 1999 six early maturing, short stature sunflower hybrids MDA 3410, MDA 3435, MDA 3615, MDA 3617, MDA 35057 and MDA 38015 were tested in a yield trial and compared with five early hybrids from Europe and United States: 'Primo'(Mycogen), 'Antonil' and 'Kinil' (Pioneer), 'IS 6111' (Interstate Payco) and 'NK 231' (Northrup King). All the MDA hybrids, except MDA 3435, were 1 to 3 weeks earlier than the control hybrids. The earliness decreased the seed yield. The average seed yield for MDA hybrids was 2679 kg/ha and for the control hybrids 3187 kg/ha. MDA hybrids are all short stature hybrids. Plant height was 54-72 cm compared to control hybrids 71-116 cm. It is obvious that the sunflower varieties for Finnish growing conditions should reach the physiological maturity around 1100 growing degree-days (base +5°C). Now the required earliness has been reached in this sunflower breeding program.

Keywords: Sunflower hybrid, early maturing, short stature, northern latitudes

Introduction

The wide range of genetic diversity among sunflower cultivars made it possible to start the breeding program to create early maturing sunflower varieties for the cool weather conditions. During the early eighties The Ministry of Agriculture started to look for new crops as an alternative to conventional crops because of the huge over production of cereals. As a marginal crop in Finland the growing area for sunflower would be limited, but even to fill the import quantity of 5000 tons would mean a good niche crop and a good income for troubled farmers. But there is undoubtedly markets for early sunflower also in other cool areas or as a winter crop in more favored countries or in the areas where plantings have been delayed or destroyed by rain, hail, insects or other causes. Now these early maturing, short stature (EMSS) sunflower hybrids have been tested in yield trials during several years and their growing behavior and potentials are documented in this paper.

Objectives

The objective of this study was to determine the earliness and the seed yield of the early maturing, short stature sunflower hybrids when compared to the early check hybrids from Europe and United States. It is widely known fact that earliness in sunflower means generally the reduced plant height

and the lower seed yield (DEDIO, 1988). In this ongoing breeding program the emphasis was to combine the extreme earliness with moderate yielding potential and a proper phenotype which could be grown either as a row crop or as a solid seeded wheat type crop in a cool climate condition.

The trial site's geographical position is 60°25' northern parallel in the Eurasian continent's coastal zone. The mean temperature is several degrees higher than that of other areas of the same latitude. The temperature is raised by the Baltic Sea, inland waters and, above all, by airflow from the Atlantic, which are warmed by the Gulf Stream. The average length of the growing season is 140 days in southern Finland where the EMSS sunflower cultivars are grown. The mean effective temperature sum (base + 5°C) in this area is 1291 degrees. Irregular rains caused by rapid changes in the weather characterize the climate. The mean sum of rain during growing season is 350 to 400 mm.

Six EMSS sunflower hybrids MDA 3410, MDA 3435, MDA 3615, MDA 3617, MDA 35057 and MDA 38015 were tested in a yield trial and compared with five early hybrids from Europe and United States: 'Primo' (Mycogen), 'Antonil' and 'Kinil' (Pioneer), 'IS 6111' (Interstate Payco) and 'NK 231' (Nortrup King). The yield trial was grown in 1999, at the Research Station of Mildola Oy. A randomized complete block design (RCBD) with four replicates was used with the control hybrids Primo, Antonil and Kinil in the experiment A. The cultivars IS 6111 and NK 231 were compared with Primo and MDA 3615 in the experiment B with two replicates at the same trial site.

The entries were planted on 19th of May in five row plots in the experiment A and in two row plots in the experiment B. The row space of 43 cm and the row length of 8 m were used. Plots were hand-thinned at V-2 stage into 110 000 plants/ha crop density. The pre-emergence herbicide, trifluralin (Treflan), was used to control the weeds. The NPK fertilizers were applied so that total N was 70 kg/ha. Growing data were collected three times a week as follows: the beginning of flowering (50 % of the plants at R-5.1 stage), plant height (cm), days to physiological maturity (R-9), seed yield (kg/ha) and oil percentage. Oil content was measured by NMR. Seed samples were dried down to 5% moisture level before analyzing. The fatty acid composition was determined by gas chromatograph (HP 5890). The oil sample was extracted from 5 grams of seed. Weather data was also collected by Hardi Metpole weather system. All the entries were harvested after physiological maturity stage with the plot combine.

Conclusion

The summer 1999 was exceptionally dry and warm (see Table 1). After planting in May the next good rain, 27 mm, was in August. All the trials suffered from drought. The experiment B suffered even more than the experiment A because of the higher clay content of the soil in that part of the field. The monthly mean temperatures were higher compared to the long term mean values through the whole growing season. At the end of September the mean effective temperature sum was 1485 degrees compared to the long term mean value of 1291 degrees. This season's late fall allowed also the latest hybrids to be harvested.

All MDA hybrids were 1 to 3 weeks earlier than the control hybrids except MDA 3435, which matured at the same time with Primo (see Table 2 and 3). Primo was shortest and earliest from all the control hybrids. It has been marketed and grown now in Finland for six years. Due to Finland's often cool and rainy weather in September even Primo seems to be too late for Finnish growing conditions. The earliest hybrid was MDA 3615, which matured 8 days earlier than Primo in the

experiment A. The growing degree-days (base +5°C) needed for the physiological maturity were 1106 and 1183 respectively. MDA 3617, MDA 3410, MDA 35057 and MDA 38015 all matured 5 to 7 days earlier than Primo with 1114 to 1133 growing degree-days. All the other control hybrids, Antonil, Kinil, IS 6111 and NK 231 needed over 1200 growing degree-days which is too much when southern parts of Finland usually reach only 1100-1200 degrees. This summer's very good weather made it possible also for these hybrids to get matured and harvested by plot combine.

It is obvious that the sunflower varieties for the Finnish type of the weather conditions should reach the physiological maturity around 1100 growing degree-days, which is the mean value in southern parts of Finland at the end of August. In September the rainy weather usually causes disease problems, *Sclerotinia sclerotiorum* and *Botrytis cinerea*. Also the first night frost can damage the crop severely already in September.

All the MDA hybrids are short stature sunflowers. Height varied in this study from 60 cm to 72 cm compared to Kinil and Antonil 105 cm and 116 cm respectively.

Seed yields and oil contents are presented in Table 2 and 3. Earliness decreased the seed yield significantly in the experiment A. The best seed yields were obtained from the later hybrids. Antonil was the latest in the experiment A, matured in 114 days and produced 3463 kg/ha seed yield. The earliest hybrid at the same trial, MDA 3615, matured in 95 days and produced 2656 kg/ha seed yield. Compared to turnip rape, the main oilcrop grown in Finland, with the average seed yield of 1800 kg/ha, early sunflower hybrids seem to be a good opportunity for a farmer according to this study.

Fatty acid compositions are presented in Table 4. In generally the relative proportions of oleic and linoleic acids vary with temperatures during the seed maturation period. Linoleic acid percentage is usually higher in a lower temperatures (MILLER, 1987). In these experiments linoleic acid varied from 67,9% to 73,0%. REHDER and MILLER (1999) reported linoleic acid content for the varieties IS 6111 and NK 231 of 65,2% and 64,9% respectively, in Casselton, North Dakota, years 1997 and 1998. In our experiments the linoleic acid contents for the IS 6111 and NK 231 were 71,0% and 69,6% respectively.

The required earliness for Finnish growing conditions has been reached in this sunflower breeding program. To get more data about these early maturing, short stature hybrid's yield potential more testing is needed. Their suitability for different short season areas outside Finland would be a next interesting topic to study.

References

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Table 1. The weather data from the trial site (Tuusula, Finland) in 1999 compared to the long term (1961-1990) mean values.

Month	The effective temperature sum $\sum(T-T_b) \quad T_b=5^\circ\text{C}$		Monthly mean temperature $^\circ\text{C}$		Monthly rain mm	
	<u>1961-1990</u>	<u>1999</u>	<u>1961-1990</u>	<u>1999</u>	<u>1961-1990</u>	
	<u>1999</u>					
April	3	64	2,8	6,1	38	59
May	163	150	10,3	6,7	35	10
June	467	531	15,1	17,7	43	25
July	828	940	16,7	18,2	70	25
August	1139	1263	15,0	15,4	76	87
September	1291	1485	10,1	12,4	70	29
					$\sum 332$	
	$\sum 235$					

Table 2. Results from the experiment A, where six early maturing, short stature sunflower hybrids 'MDA' were compared to the control hybrids 'Primo', 'Kinil' and 'Antonil'. Trial was planted at Tuusula, Finland in 1999.

Variety	Days to Flower (R-5.1)	Plant Height Cm	Days to Maturity (R-9)	Degree-days (base +5°C)	Seed yield 9% moisture kg/ha	Yield % Compared with Primo	Oil % 5% moisture (NMR)
PRIMO	63	68	103	1183	2790	100	47,3
MDA 38015	58	72	97	1121	2751	99	45,2
MDA 3410	56	63	96	1114	2616	94	48,3
MDA 35057	56	65	98	1133	2549	91	48,4
MDA 3615	54	66	95	1106	2656	95	46,3
MDA 3617	55	69	96	1114	2702	97	46,3
MDA 3435	60	71	104	1192	3076	110	52,3
KINIL	68	105	110	1264	2691	96	45,8
ANTONIL	70	116	114	1312	3463	124	46,4
AVERAGE	60	77	101		2810		47,4
MIN. PLOT	53	60	95		2231		
MAX. PLOT	71	122	114		3688		
C.V.	1,58	4,25	0,60		10,26		
LSDt.05	1,1	4,0	0,7		348,9		
F-VALUE	149,68	136,63	477,75		3,95		
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Table 3. Results from the experiment B, where early maturing, short stature sunflower hybrid 'MDA 3615' was compared to the control hybrids 'Primo', 'IS 6111' and 'NK 231'. Trial was planted at Tuusula, Finland in 1999.

Variety	Days to Flower (R-5.1)	Plant Height Cm	Days to Maturity (R-9)	Degree-days (base +5°C)	Seed yield 9% moisture kg/ha	Yield % Compared with Primo	Oil % 5% moisture (NMR)
PRIMO	62	71	94	1100	2847	100	47,3
MDA 3615	54	60	89	1048	2405	84	45,9
IS 6111	71	92	114	1312	3329	117	46,5
NK 231	78	99	116	1335	4005	141	41,4

Table 4. Fatty acid compositions of the tested cultivars.

FATTY ACID PROFILES %					
Variety	Palmitic C 16:0	Stearic C 18:0	Oleic C 18:1	Linoleic C 18:2	Others
MDA 3615	6,3	4,9	15,2	71,5	2,1
MDA 3410	6,4	4,6	17,0	69,7	2,3
MDA 3617	6,3	4,7	15,5	71,4	2,3
MDA 38015	6,5	4,7	15,5	71,2	2,3
MDA 35057	6,1	5,5	17,7	68,4	2,3
Primo	6,2	4,9	13,9	73,0	2,0
MDA 3435	5,9	6,2	17,6	67,9	2,4
Kinil	5,8	4,6	17,4	70,0	2,2
Antonil	5,9	3,8	17,3	70,8	2,2
IS 6111	5,8	4,2	17,0	71,0	2,0
NK 231	5,2	5,2	18,7	69,6	2,1