Sunflower Planting Date: An Important Decision

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Sunflower production involves a series of decisions, and one of the most controversial is optimum date of planting. Planting date affects not only sunflower growth, but it also affects the severity of damage from insects and fungi that feed on sunflower. Planting date recommendations vary among specialists. Consequently, recommendations are often generalized to include a 1- to 2-month period in the northern states.

The sunflower varieties and hybrids grown on Minnesota farms do not usually require the entire growing season, so planting dates range from late April to early July. Research plot data in this report show the effect of date of planting on sunflower growth, seed yield, seed quality, and oil quality. The effect of date of planting on severity of damage from sunflower pests is also discussed.

Date-of-planting trials were conducted from 1967 through 1969 with Peredovik, Armavirec, and Krasnodarets oilseed varieties and Arrowhead, Mingren, and 66 VI nonoilseed varieties at Rosemount and Grand Rapids. USDA 894 hybrid was used from 1982 through 1984 at Grand Rapids, Crookston, and Morris. Trials were located on sandy soil at Grand Rapids and on silt loam soil at the other locations.

EFFECT OF PLANTING DATE ON GROWTH

Planting date had a major effect on rate of sunflower growth. Within a 10-week range of planting dates, the number of days from planting to emergence decreased by 53 to 68 percent between early and late planting, and the number of days from planting to flowering decreased by 21 to 30 percent between early and late planting (Tables 1, 2, 3). The more rapid growth from late planting can be attributed to higher temperatures, which lead to increased growing degrees per day, rather than to photoperiod.[1] Faster emergence from late planting was associated with up to 22 percent lower seed mortality at Grand Rapids (Table 1). Although differences were small, seed mortality was greatest in the April and June plantings at Rosemount (Table 2). Rapidly changing soil moisture levels and desiccation of sprouted seeds may account for the lower emergence from June plantings at Rosemount.

Although sunflower plant height and number of leaves per plant differed among planting dates, no trends with planting date occurred in the trials with open-pollinated varieties (Tables 1, 2). But with USDA 894 hybrid, there was a consistent trend for taller plants and more leaves per plant in sunflower planted between May 17 and June 22 (Table 3). The emergence to head visible stage of sunflower planted between these dates occurred within June and July when daylength is greatest. Since leaf number is determined before head visible stage, the differences in leaf numbers among dates of planting may be associated with photoperiod. Some sunflower varieties respond to photoperiod as short

[1]Robinson, R. G. 1971. Sunflower phenology--year, variety, and date of planting effects on day and growing degree-day summations. Crop Sci. 11:635-638.

Table 1. Average performance of three oilseed and three nonoilseed sunflower varieties at six dates of planting, Grand Rapids, 1967

Planting (date)	Planting to emergence (days)	Emergence (percent)	Planting to flowering (days)	Height (inches)	Leaves/ plant (number)	Test weight/ bushel (pounds)	Seeds/ pound (number)	Seed oil (percent)[1]	Large seed (percent)[2]	Seed yield/ acre (pounds)
May 9	17	74	78	50	24	30	5340	37	64	1850
May 18	13	72	72	50	25	30	5150	38	70	1840
May 26	9	89	68	51	25	29	5340	35	71	1760
June 6	11	86	69	54	24	27	5740	33	70	1530
June 15	9	90	64	53	25	26	6570	33	58	1210
June 26	8	96	62	60	25	24	7440	32	47	580
LSD 5%	1	8	2	3	2	1	500	2	14	320

[1]Average of three oilseed varieties, 10-percent moisture basis. [2]Average of three nonoilseed varieties held on a 20/64 round-hole sieve.

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Table 2. Average performance of three oilseed and three nonoilseed sunflower varieties at seven dates of planting, Rosemount, 1967-69

Planting (date)	Planting to emergence (days)	Emergence (percent)	Planting to flowering (days)	Height (inches)	Leaves/ plant (number)[1]	Test weight/ bushel (pounds)	Seeds/ pound (number)	Seed oil (percent)[2]	Large seed (percent)[3]	Seed yield/ acre (pounds)
April 24	17	83	85	61	29	29	6210	39	40	1520
May 3	15	88	80	65	29	28	6480	39	43	1760
May 12	13	89	75	64	28	27	6570	38	43	1650
May 21	10	89	70	62	28	27	6570	37	48	1520
May 31	10	85	68	61	27	27	6670	35	46	1340
June 17	10	81	65	60	29	27	7200	36	31	1040
June 28	8	83	62	61	30	25	7960	33	30	830
LSD 5%	1	3	1	2	1	1	140	2	6	120

[1]Cotyledons counted as two leaves. [2]Three oilseed varieties, 10-percent moisture basis. [3]Three nonoilseed varieties held on a 20/64 round-hole sieve.

Table 3. Average plant and seed characteristics of sunflower following 11 dates of planting at Grand Rapids, Crookston, and Morris, 1982-84

Planting (date)	Planting to emergence (days)	Planting to flowering (days)	Height (inches)	Leaves/ plant (number)[1]	Head moisture (percent)	Test weight/ bushel (pounds)	Seeds/ pound (number)
April 27	19	88	65	29	36	34	9,720
May 2-5	17	84	68	30	35	33	9,720
May 11-12	15	80	67	30	41	33	9,860
May 17-18	13	76	69	31	46	33	10,160
May 24-25	11	74	70	32	53	32	10,550
May 31-June 2	10	71	73	31	58	31	11,730
June 8-11	9	69	73	32	62	26	12,720
June 14-15	8	67	72	31	63	26	13,470
June 21-22	7	65	71	32	66	24	13,470
June 28-29	7	63	67	30	70	22	16,200
July 6	6	62	61	27	71	20	15,460
LSD 5%	3	2	4	1	3	2	260

[1]Cotyledons counted as two leaves.

day plants;[2] sunflower in both early and late plantings developed to head visible stage under shorter days than did sunflower planted May 17 to June 22, and this may account for their having fewer leaves.

Head moisture percentages were measured at harvest soon after the first killing frost in the fall. Sunflower heads from plantings prior to May 11 were driest, and each delay in planting date resulted in incrementally higher head moistures (Table 3).

EFFECT OF PLANTING DATE ON SEED YIELD AND PESTS

Sunflower planted during the first half of May generally produced highest yields. Yields declined significantly from the maximum in plantings later than May 26 at Grand Rapids (Tables 1, 4), later than May 12 at Rosemount (Table 2), later than May 25 at Crookston (Table 4), and after May at Morris (Table 4). The lower yields from April compared with early and mid-May plantings may be associated with shorter plants (Tables 2, 3) and fewer leaves per plant (Table 3).

Sunflower midge is an insect that can devastate a sunflower crop, but serious damage was avoided by delaying planting until June (Table 3, Crookston 1982). Sunflower in small research plots may be injured more by midge and other mobile insects than sunflower in large fields, because the insects may move to plots that have sunflower in the proper stage for feeding if other sunflower fields in the area are in a less attractive stage of growth. Nonetheless, observations in other plots and fields confirm that in years and areas of severe midge infestations, planting should be delayed until June to avoid serious yield reductions. Unfortunately, such delays in planting date reduce the potential yield (without midge) that the field is capable of producing.

[2]Robinson, R. G., L. A. Bernat, H. A. Geise, F. K. Johnson, M. L. Kinman, E. L. Mader, R. M. Oswalt, E. D. Putt, C. M. Swallers, and J. H. Williams. 1967. Sunflower development at latitudes ranging from 31 to 49 degrees. Crop Sci. 7:134-136.

Table 4. Average seed yields and oil percentages of sunflower following 11 dates of planting at Grand Rapids, Crookston, and Morris

Planting (date)	Seed yields/acre (pounds)					Oil concentrations (percent)[1]				
	Grand Rapids	Crookston		Morris		Grand Rapids	Crookston		Morris	
	1982-84	1982	1984	1983	1984	1982-84	1982	1984	1983	1984
April 24-27	1800	0[2]	--	1540[6]	--	43	--	--	42	--
May 2-4	1970	0[2]	1990	1870[5]	2070	43	--	40	41	45
May 11-12	1900	0[2]	2240	1710	2290	42	--	41	41	45
May 17-18	2040	0[2]	2040	1170	2710	41	--	41	41	43
May 24-25	2000	10[2]	2160	1670	2270	42	--	41	41	43
May 31-June 2	1730	420[3]	1910	1740	1320	41	39	41	39	41
June 8-11	1310	1490[4]	1610	--	930	37	42	39	--	38
June 14-15	890	1500[4]	1540	--	1290	34	41	39	--	39
June 21-22	500	1530	970	0[7]	1460	32	40	29	--	36
June 28-29	120	950	450	0[7]	920	29	37	23	--	32
July 6	20	120	0	0	430	25	--	--	--	32
LSD 5%	300	310	330	380	510	6	--	--	--	--

[1]10-percent moisture basis. [2,3,4]Midge damage very severe, severe, or light, respectively. [5,6,7]Downy mildew very severe, severe, or medium, respectively.

Sunflower losses from some other insects are also affected by planting date. Research in South Dakota[3] indicated that serious losses from seed weevils were avoided by planting sunflower before May 10. Losses from sunflower moth are influenced by movement of the moths from states southwest of Minnesota, so future relationships with date of planting may be associated with winds and the development of the sunflower crop in other states. In years of sunflower moth larvae damage, losses were usually greatest in the earliest planted sunflower, whereas very late-planted sunflower escaped. Corn rootworm adults often consume the ray flowers and pollen of late-planted sunflower in southern Minnesota, but economic loss, if any, has not been determined.

Losses from other sunflower insects and diseases have generally not followed a repetitive trend with planting date. However, volunteer sunflower emerges early and is a potential source of rust spore inoculum which is more serious on late- than on early-planted sunflower in neighboring fields.

Prevalence of downy mildew disease is often associated with planting date (Table 4, Morris 1983), but the true relationship is with rainfall at the time of emergence when seedlings are most susceptible. Moist soil and splashing rain help to spread the spores. Such conditions can occur after any planting date, but early-planted sunflower, because of its slower growth, remains in the most susceptible stage for a longer time than late-planted sunflower.

[3]Gednalske, J. V., and D. D. Walgenbach. 1982. Planting date and tillage as weevil control aids. The Sunflower 8(2):42-43.

EFFECT OF PLANTING DATE ON SEED QUALITY

Test weight per bushel, a grading factor for both oilseed and nonoilseed sunflower, declined from earliest to latest planting (Tables 1, 2, 3). Sunflower planted after mid-June failed to meet the minimum U.S. Grade 1 or 2 requirement of 25 pounds per bushel and would be designated Sample grade.

Buyers of nonoilseed sunflower often pay more for large seed or require that a minimum percentage of seed be held on a 20/64 inch round-hole sieve. Nonoilseed varieties planted after mid-June produced significantly smaller seed (Tables 1, 2). Seed size of oilseed sunflower declined (more seeds per pound) continuously as planting was delayed through May and June (Table 3).

Seed oil percentage, the major measure of quality in oilseed sunflower, was highest in seed from April and May plantings and lowest in seed from late June and July plantings (Tables 1, 2, 4).

EFFECT OF PLANTING DATE ON GROSS DOLLAR RETURN PER ACRE

Sunflower marketing differs from that of other oilseed crops. Sunflower growers individually benefit from or are penalized for the oil percentage of their seed. Consequently, gross return per acre is directly affected by both seed oil percentage and yield. Price per pound for oilseed sunflower used in the United States is usually increased by 2 percent for each percentage of oil over 40 percent and decreased by an equal amount for seed below 40 percent. Seed for export is often priced 1 percent higher for each percentage of oil over 40 percent but decreased 1.5 percent for seed

of 39 percent oil, 3 percent for seed of 38 percent oil, and an additional 2 percent for each oil percentage below 38 percent.

The gross returns per acre from the date of planting trials using a price of 12 cents per pound and the 2 percent oil premium-discount commonly used for domestically crushed seed are reported in Table 5. In every trial, planting date greatly affected return per acre.

Table 5. Gross monetary return per acre from sunflower date of planting trials (Tables 1,2,4) using a base price of 12 cents per pound (oil premium-discount ± 2 percent) for seed of 10 percent moisture and 40 percent oil

	Return/acre (dollars)						
Planting	Grand Rapids	Crookston		Morris		Rosemount	Grand Rapids
date	1982-84	1982	1984	1983	1984	1967-69	1967
April 24-27	229	0	--	192	--	179	--
May 2-4	251	0	239	229	273	207	--
May 9-12	237	0	274	209	302	190	209
May 17-18	250	0	250	143	345	--	212
May 21	--	--	--	--	--	171	--
May 24-26	250	--	264	204	289	--	190
May 31-June 2	212	49	234	205	162	145	--
June 6-11	148	186	189	--	107	--	158
June 14-17	94	184	181	--	152	115	125
June 21-22	50	184	91	0	161	--	--
June 26-29	11	107	36	0	93	86	58
July 6	2	--	0	0	43	--	--

EFFECT OF PLANTING DATE ON OIL QUALITY

Four fatty acids combined with glycerol are the major components of sunflower oil. The proportions of these fatty acids give sunflower oil its unique characteristics. The major acid, linoleic, is the only fatty acid that is essential for good human nutrition; it also has the desired polyunsaturation recommended by most nutritionists. The second major acid, oleic, is monounsaturated and has more resistance to rancidity than the linoleic acid fraction of sunflower oil. The saturated acids, stearic and palmitic, also impart stability to the oil.

Sunflower oil from seed grown in the northern states and Canada is of unusually high nutritional quality because of its high linoleic acid concentration. Sunflower oil from seed grown in the southern states is generally much lower in linoleic and much higher in oleic acid than oil from northern seed. High temperatures during seed development result in lower linoleic and higher oleic acid concentrations[4]. Robinson et al. suggested that delaying sunflower planting in the southern states until July would allow the seed to ripen during the cool fall months thus increasing linoleic acid concentrations[5]. This hypothesis has been confirmed by both research and production, so some late-planted sunflower from the South is intermediate in oil composition between spring-planted southern and northern sunflower.

The fatty acid composition of the oil from seed produced at Grand Rapids and Crookston was similar; the combined data are shown in Table 6. Linoleic acid concentrations in the oil from Morris averaged about 10 percentage points less, so the Morris data are shown separately in Table 7. The total unsaturated acid concentrations for all trials and for dates within trials were nearly constant at about 90 percent, although there was a nonsignificant trend for slightly higher oil saturation at the later planting dates. Varying proportions of linoleic and oleic acids were almost the sole difference among dates in oil composition. The trends from early to late planting were for linoleic acid to increase and for oleic acid to decrease. These trends are shown graphically as an average of all trials in Figure 1.

[4]Robinson, R. G. 1978. Production and culture. In J. F. Carter (ed). Sunflower science and technology. Agronomy 19:89-143. Am. Soc. of Agron., Madison, WI 53711.

[5]Robinson, R. G., F. K. Johnson, and O. C. Soine. 1967. The sunflower crop in Minnesota. Minnesota Agric. Ext. Bull. 299:1-32.

Table 6. Average fatty acid composition of oil from sunflower seed produced at Grand Rapids and Crookston[1] following 11 dates of planting, 1982-84

Planting (date)	Unsaturated acids (percent)			Saturated acids (percent)	
	Linoleic	Oleic	Linoleic + Oleic	Stearic	Palmitic
April 27	70	20	90	4	6
May 4	68	22	90	4	6
May 11	69	21	90	4	6
May 17-18	72	19	90	4	6
May 24-25	73	16	89	4	6
May 31-June 1	73	16	89	4	7
June 8-11	75	14	89	4	7
June 14-16	74	15	89	4	8
June 21-22	73	16	89	4	7
June 28-29	77	12	89	5	7
July 5-6	74	15	89	4	7
LSD 5%	3	3	--	1	1

[1] 1982, 84.

Table 7. Average fatty acid composition of oil from sunflower seed produced at Morris following 11 dates of planting, 1983-84

Planting (date)	Unsaturated acids (percent)			Saturated acids (percent)	
	Linoleic	Oleic	Linoleic + Oleic	Stearic	Palmitic
April 27-30	59[1]	32[1]	91	4[1]	5[1]
May 2-5	59	31	90	4	6
May 11	60	30	90	4	6
May 18	60	30	90	4	6
May 24-25	65	26	91	4	6
June 1-2	68	22	90	4	6
June 8	62	26[2]	88	6[2]	6[2]
June 15	65	24[2]	89	5[2]	6[2]
June 22	63	24[2]	87	7[2]	6[2]
June 29	68	20[2]	88	5[2]	7[2]
July 6	69	20[2]	89	4[2]	8[2]
LSD 5%	5	4	3	2	1

[1] 1983 data adjusted to be comparable with 2-year averages. [2]1984 data adjusted to be comparable with 2-year averages.

The composition differences among locations and dates of planting may be related to differences in air temperature during the time of seed development. Temperatures at Morris averaged 4° F higher in August and 2° F higher in September than temperatures at Grand Rapids and Crookston. The higher temperatures at Morris contributed to lower linoleic acid levels. At all locations, the early plantings were in the seed development stage in August when temperatures averaged 68° F to 72° F. The later plantings developed seed in September with temperatures averaging 54° F to 56° F. Consequently, cooling temperatures as the season progressed through August and September may account for the increasing linoleic acid concentrations in seed from early- to late-planted sunflower.

Experimental high-oleic-acid hybrids are in the market development process. Oil from these hybrids is over 80 percent oleic acid, and the oil composition does not appear to be highly sensitive to temperature. These hybrids are grown under contract to avoid mixture with normal sunflower. They may greatly expand the market for northern oilseed sunflower. Planting date is not expected to affect the oil composition of these hybrids.

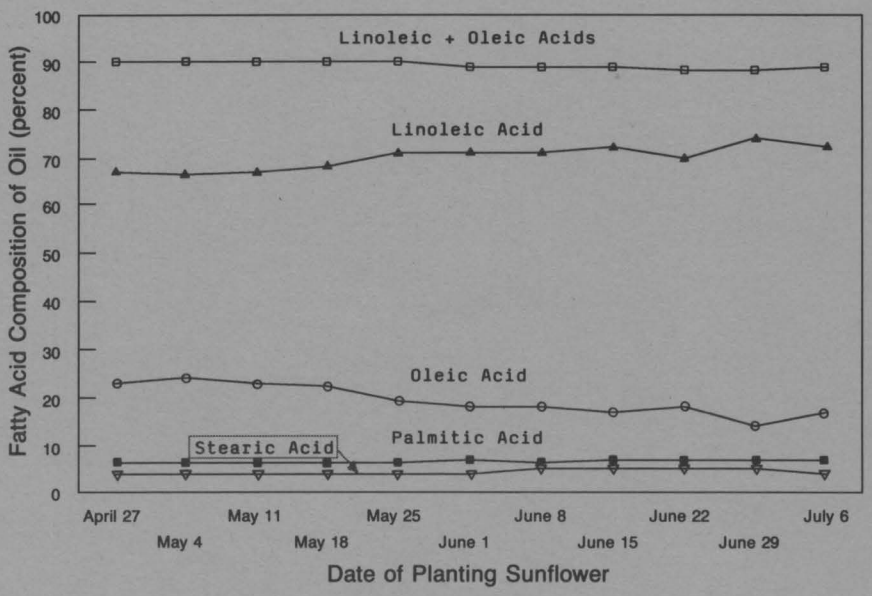

Figure 1. Average fatty acid composition of oil from sunflower seed produced at Grand Rapids, Crookston, and Morris following 11 dates of planting, 1982-84.

SUMMARY

Date of planting had a major influence on sunflower growth, yield, and monetary return. Early-planted sunflower grew more slowly but matured and dried earlier than late-planted sunflower. Planting date did not appreciably affect total unsaturation of sunflower oil, but early planting reduced the polyunsaturation of the oil.

Monetary return per acre of oilseed sunflower is determined by both seed yield and oil percentage. Highest returns in these trials were from planting between May 2 and May 26 at Grand Rapids, Crookston, and Morris and during the first week of May at Rosemount. These returns and the earlier harvest or lower drying costs associated with early planting suggest that planting during the first half of May may be optimum in Minnesota. Avoidance of midge damage may dictate delaying planting until June, but the delay reduces potential yield and monetary return. Consequently, unless monetary return for sunflower is high relative to other crops or until a practical control of midge is developed, growers may decide to use crops other than sunflower when midge is a threat.