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Agronomy Section

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Sunflower Date of Planting Study in Western North Dakota 3-year Summary

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Summary

An early-season NuSun sunflower (*Helianthus annuus* L. c.v. Mycogen 8242NS) cultivar was planted on four different dates in 1999 and 2000 and on five different dates in 2001 on the Miles Hanson Farm near Bowman, ND. Plant populations in all three years were lower for the first two planting dates compared to later planting dates. Achene yield and oil yield was significantly lower for the early-planted sunflower compared with 23 May planted sunflower. Oleic acid content was significantly greater for the 23 May planting date compared with late April and mid June planting dates. These data suggest that planting early-season NuSun sunflower varieties in mid- to late-May will likely produce the highest achene yields as will as the highest oleic content. Delaying planting increases the risk of injury to yield and quality.

Introduction

Sunflower is considered a late season crop in much of North Dakota with planting occurring as late as the last half of June. However, late June plantings often result in lower yields and oil content. In addition, when harvest is delayed by weather, as seen in the fall of 1998, mechanical drying of seed is required thus adding to production expenses.

Although seeding date and the effect of plant density has been studied in Canada (Gubbels, 1989, and Deido, 1985) and at Minot, ND

(Zarnstorff, 1998), there has been minimal date of planting research in southwest North Dakota. Southwest North Dakota is unique in that it tends to have less snow cover; thus soils tend to warm and dry out earlier than in other parts of the state. These conditions suggest that it may be possible to plant sunflower earlier in southwest North Dakota. Sunflower has been planted successfully in late April in parts of Minnesota and South Dakota (Robinson, 1970) and Mandan Indians were known to plant sunflower in April in the Bismarck-Mandan area (Anonymous, 1989). Yields and quality of early-planted sunflower has generally been above average.

Aside from the potential for improved yield and quality of early-planted sunflower, there may be other advantages to earlier planting. No-till producers in southwest North Dakota promote the need for early closure of the crop canopy (Manitoba-North Dakota Zero Tillage Farmers Assoc., 1997) because, early canopy closure produces a more favorable microclimate of humidity and cooler soils resulting in more efficient use of available moisture for plant development. Early canopy closure also provides more competition to late germinating weeds when compared to late seeded crops that shade the ground later in the season. In date of seeding trials conducted at Mandan, ND and at Akron CO when sunflower was seeded prior to peak weed emergence, the crop provided increased competition to weeds (Tanaka and Anderson, 1998, 1997).

If sunflowers are seeded early in narrow rows and weeds are controlled early with pre-plant and post-plant herbicide products, early canopy closure should control late germinating weeds, eliminating the need for herbicides or cultivation later in the season. Also early planting will provide producers the opportunity to harvest high quality seed earlier with less cost required for post harvest handling.

Increased yield and quality of sunflower planted at the proper date will improve producers' net returns. Sunflower planted in narrow row spacing may help producers in southwest North Dakota succeed in growing sunflower since sunflower may be more competitive than weeds when grown in narrow rows. Limited water would be used by the crop to increase marketable seed yield rather than by unwanted weed biomass. Soil moisture is usually the limiting factor for crop yields when grown in diverse rotations in southwest North Dakota. Early planted sunflower may be more effective in utilizing available moisture and precipitation than sunflower that is planted at the current recommended dates for the state. Early seeding should mean early harvest thus providing a greater chance for soils to be recharged with moisture prior to seeding the next crop in the rotation sequence.

The objective of this project is to determine and demonstrate the optimum planting date of sunflower for southwest North Dakota.

Materials and Methods

The study was conducted during a three-year period of 1999 through 2001 at a site near Bowman, ND. (N 46.32^{o} W 103.40^{o}) A randomized complete block design with four replications for each seeding date was used. Size of each plot seeded was 40 feet by 2,680 feet. Soil was sampled and analyzed each year and fertilized according to the soil analysis for a 1,500 to 2,000 pound per acre yield. In 1999 and 2000 anhydrous ammonia, the primary nitrogen source, was knifed into the soil prior to planting with the balance of nitrogen, phosphorous, potassium and a micronutrient mix applied through the drill. In 2001 anhydrous ammonia was knifed into the soil and the balance of nitrogen, phosphorous, potassium, and a micronutrient mix were applied with the use of Anderson openers at the same time the seed was planted.

Stored soil moisture was estimated at the first planting date using the Brown soil moisture probe. Stored soil moisture was estimated to be 7.7, 4.4, and 6.4 inches in the upper 3.5 feet of the soil in 1999, 2000, and 2001 respectively. Rainfall was measured manually at the site approximately 1.5 miles from the field in 1999 and with an automated self-tipping bucket in the field in 2000 and 2001.

In 1999 and 2000, Sonalan 10G (ethalfuralin) at the rate of ten pounds of product per acre was pre-plant incorporated and Poast (sethoxydim) was applied post-emergence at the rate of one pint per acre for weed control at all locations in all years. In addition to the herbicides used, plots were hand weeded to control kochia and Russian thistle in 2000. Weed control at Bowman was considered good to excellent and no additional treatment was used in 1999. In 2001, Roundup (glyphosate) at the rate of 16 fluid ounces per acre was tank mixed with 3 ounces per acre of Spartan (sulfentrazone) and was applied between three and 20 days prior to planting. Poast was applied post-emergence at the rate of one pint per acre to all planting dates. A second application of Poast was required for the 1st and 2nd planting dates.

The NuSun sunflower cultivar Mycogen 8242NS was planted in all three years of the study. A 40-foot Concord air-drill with low disturbance points was used in 1999 and 2000 and the same drill with Anderson openers was used in 2001. The seeding rate was adjusted for a goal of 23,000 plants per acre for the final harvest population.

Fields were scouted on a regular basis for pests and beneficial insects. Sunflower beetle adults and larva population levels were initially medium to high but beneficial insect populations were sufficient to control this pest through the 1999 season. In 2000 and 2001 sunflower beetle levels were low throughout the season. In 1999 sunflower moth (*Homoeosoma electellum*) adult flights infested the first date of planting. Adult moth populations required treatment. Treatment was applied after egg laying had occurred in the first date of planting but before the second date began to bloom. In 2000 and 2001 adult sunflower moth populations were low and did not require treatment. However in 2001 painted lady butterfly (*Vanessa cardui*) infested the field early and the entire field was sprayed with an insecticide. High levels of red seed weevils (*Smicronyx fulvus*) were found in the first three planting dates in 2001 and treated with an insecticide. Black sunflower stem weevil (*Apion occidentale*) was noted at all locations for all three years of the study but populations were below the recommended treatment threshold.

In 2000 and 2001 cold, wet soil conditions along with downy mildew appeared to have reduced final harvest stands. Plots were scouted for wireworm but neither insects nor feeding symptoms were found. A hailstorm on June 3, 2000 further reduced the plant stand for the 1st and 2nd planting dates that year.

The center 30 feet of each plot was harvested with a combine. In 1999, harvest of the 28 April and 23 May planting dates occurred on 10 October; and the 4 June and 14 June planting dates were harvested 28 October. In 2000, the 26 April planting date was harvested on 25 September; and the remaining planting dates were harvest on 28 September. In 2001, the 25 April and the 9 May planting dates were harvested on 3 October; the 23 May and 7 June planting dates were harvested on 4 October; and the 20 June planting date was harvested on 17 October. Final plant stands were taken at harvest. Seed was weighed from each plot and sampled for moisture and dockage. Moisture and dockage adjustments were made and the results reported. Dr. Jerry Miller, ARS, NDSU, Fargo, ND analyzed seed for oil

content using Nuclear Magnetic Resonance (NMR) and fatty acid profile using liquid-gas chromatography.

All data were statistically analyzed using SAS Statistical software version 6.12 (SAS Institute Inc., 1996). ANOVA was used to analyze data generated within years; and GLM was used to analyze data across years.

Results

In this paper planting dates are defined as 1st planting date = 28 April 1999, 26 April 2000, 25 April 2001; 2nd planting date = 10 May 2000, 9 May 2001; 3rd planting date = 23 May 1999, 24 May 2000, 23 May 2001; 4th planting date = 4 June 1999, 7 June 2000, 7 June 2001; and the 5th planting date = 14 June 1999 and 20 June 2001. Soil conditions in 1999 were extremely wet and prevented planting on the 2nd planting date. A mid-June planting date was added in 1999.

Above average May precipitation in 1999 and 2001 (Figure 1) and cold soils in early spring during all three years made stand establishment difficult for plantings prior to the 3rd planting date (Table 1). In addition to cold, wet soils in 2000, hail on 3 June further reduced plant populations. Downy mildew reduced final plant populations for the first two planting dates in 1999 and 2000 and in the 4th planting date in 2001. Above normal rainfall in June when this particular planting date was emerging is thought to have provided an environment ideal for the development of downy mildew. In 2001, the first three planting dates emerged during May and early June during one of the driest growing periods of the growing season, thus escaping detectable infection with downy mildew. Though plant population varied between the planting dates it is unlikely that plant population would have affected seed yield. Bhatti, et. al. (1999) found yields to be unaffected by a plant population in the range of 11,000 to 20,000 plants per acre. Growing degree days (Figure 2) provided by NDAWN for Bowman were near normal in 1999 but warmer than normal temperatures in July, August, and September provided higher than normal growing degree days in 2000 and 2001. The first fall killing freeze of the growing seasons occurred 14 September 1999, 22 September 2000, and 4 October 2001.

Achene yield (Table 2) was significantly higher for the 3rd planting date compared to the 1st planting date in all three years of this study. In two of the three years the 3rd planting date produced the highest yield of any of the other planting dates sown in their respective year. However, in 2001, the 5th planting date produced the greatest achene yield of any of the planting dates sown that year.

Achene test weight (Table 2) was highest for the 1st planting date in the year where the first fall killing freeze occurred earlier than the average date of the first killing freeze. In 2000 test weight was highest for the 2nd and 3rd planting dates and lowest for the 1st and last planting dates. Test weight was highest for the 5th planting date when the first fall killing freeze occurred later than the average date of first killing freeze.

Achene oil content (Table 3) had a similar pattern as test weight. The lowest oil content for 1999 occurred for the 5th planting date. In 2000

oil content was lowest for the 1st and last planting date for that year, and in the year when the first killing freeze occurred nearly 15 days later than the average date of the first killing freeze, oil content was highest for the 5th planting date.

Oil yield (Table 3) was highest for the 3rd planting date in two of the three years. In 1999 when an early fall freeze occurred oil yield was lowest. However in 2000 lowest oil yield occurred for the 1st planting date. When the first killing freeze was delayed by nearly 15 days, the 5th planting date produced the highest oil yield.

Oleic content (Table 4) of the oil produced was greatest for the 3rd planting date. Oleic content for the 5th planting date was significantly lower than the 2nd, 3rd, and 4th planting dates. Oil produced by the 5th planting date contained less oleic fatty acid than the minimum, required by NuSun processors. Linoleic content was greatest for the 5th planting date and lowest for the 3rd planting date. Linoleic acid content is the inverse of oleic content (Figure 3) (Fick and Miller, 1997). In high linoleic varieties, environment is thought to play a key role in fatty acid composition while in high oleic sunflower varieties, environment influences fatty acid content to a lesser extent (Dorrell and Vick, 1997).

Producers in southwest North Dakota can expect early sown NuSun sunflower to yield less than sunflower planted from mid-May through the first week of June. Also oil quality may tend to be lower for early planted sunflower compared to sunflower sown from mid-May through early June. An early fall freeze adversely impacts both yield and quality while an extended growing season improved yield but reduced oleic content for late planted sunflower.

Cooperating Producer and Organizations

The authors wish to thank Miles Hansen, Bowman, ND for his cooperation in this study. He shared his time, equipment, and knowledge to help move this study forward. Mycogen provided seed. In addition, we wish to thank the Slope County Agriculture Improvement Association, the National Sunflower Association, and the North Dakota State Board of Agricultural Research and Education for their financial support.

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Table 1. Harvest plant population of Mycogen 8242NS in sunflower date of planting study, Bowman, ND.

Planting date[1]	1999	2000	2001	3-year mean
	plants/acre	plants/acre	plants/acre	plants/acre
1st	18937	11598	16008	15514
2nd	--	14066	16117	--
3rd	29161	20074	20364	23200
4th	26318	18440	19058	21272

5th	26741	--	20909	--
Mean	25289	16044	18491	19995
CV%	8.5	16.1	8.7	--
LSD .05	3455.1	4122	2473	--

[1] Planting Date: 1st date = 28 Apr 1999, 26 Apr 2000, 25 Apr 2001; 2nd date = 10 May 2000, 9 May 2001; 3rd date = 23 May 1999, 24 May 2000, 23 May 2001; 4th date = 4 Jun 1999, 7 Jun 2000, 7 Jun 2001; 5th date = 14 Jun 1999, 20 Jun 2001.

Table 2. Achene yield and test weight of Mycogen 8242NS in sunflower date of planting study Bowman, ND.

	-----1999-----		**-----2000-----**		**-----2001-----**		**--3-year mean--**	
Planting date[1]	**Test weight[2]**	**Yield2**	**Test weight[2]**	**Yield[2]**	**Test weight[2]**	**Yield[2]**	**Test weight[2]**	Yield[2]
	lb/bu	lb/ac	lb/bu	lb/ac	lb/bu	lb/ac	lb/bu	lb/ac
1st	31.6	1207	26.1	1159	28.7	1116	28.8	1161
2nd	--	--	27.1	1310	28.7	1137	--	--
3rd	28.1	1765	27.0	1435	28.1	1398	27.7	1533
4th	25.7	1508	25.9	1362	29.7	1324	26.9	1398
5th	22.6	990	--	--	30.1	1581	--	--
Mean	27.0	1367	26.5	1317	29.1	1312	27.8	1364
CV%	5.6	13.6	1.9	11.3	3.1	6.3	--	--
LSD .05	2.4	298	0.8	238	1.4	128	--	--

[1] Planting date: 1st date = 28 Apr1999, 26 Apr 2000, 25 Apr 2001; 2nd date = 10 May 2000, 9 May 2001; 3rd date = 23 May 1999, 24 May 2000, 23 May 2001; 4th date = 4 Jun 1999, 7 Jun 2000, 7 Jun 2001; 5th date = 14 Jun 1999, 20 Jun 2001.

[2] Adjusted to 10% moisture basis.

Table 3. Achene oil content and oil yield of Mycogen 8242NS in sunflower date of planting study Bowman, ND.

	-----1999-----		-----2000-----		-----2001-----		--3-year mean--	
Planting date[1]	**Seed oil content[2]**	**Oil yield[2]**	**Seed oil content[2]**	**Oil yield[2]**	**Seed oil content[2]**	**Oil yield[2]**	**Seed oil content[2]**	**Oil yield[2]**
	%	lb/ac	%	lb/ac	%	lb/ac	%	lb/ac
1st	43.0	520	40.0	463	40.8	455	41.3	479
2nd	--	--	42.5	557	39.1	445	--	--
3rd	44.0	776	42.7	612	41.7	583	42.8	657
4th	43.1	648	41.1	560	42.5	563	42.2	590
5th	39.6	392	--	--	44.5	703	--	--
Mean	42.4	584	41.6	548	41.7	550	42.1	575
CV%	2.5	14.6	1.7	11.5	1.6	7.0	--	--
LSD $_{.05}$	1.7	137	1.1	101	1.1	60	--	--

[1] Planting date: 1st date = 28 Apr1999, 26 Apr 2000, 25 Apr 2001; 2nd date = 10 May 2000, 9 May 2001; 3rd date = 23 May 1999, 24 May 2000, 23 May 2001; 4th date = 4 Jun 1999, 7 Jun 2000, 7 Jun 2001; 5th date = 14 Jun 1999, 20 Jun 2001.

[2] Adjusted to 10% moisture basis.

Table 4. Fatty acid profile of Mycogen 8242NS in sunflower date of planting study Bowman, ND, 1999- 2001.

Planting date[1]	**Palmitic**	**Stearic**	**Oleic**	**Linoleic**
	---------- % ----------			
1st	5.0[a]	4.5[a]	54.9[az]	33.7[az]

2nd	4.5a	4.4a	65.0ab	24.1a
3rd	4.5a	4.4a	65.8b	23.0a
4th	4.7a	4.1a	58.7ab	30.5a
5th	5.0a	4.9a	43.3z	44.9z
Mean	4.7	4.4	58.4	30.4
SD	0.21	0.31	5.15	5.08
CV%	4.4	7.0	8.8	16.7
p =	0.12	0.23	0.02	0.03

[1] Planting date: 1st date = 28 Apr1999, 26 Apr 2000, 25 Apr 2001; 2nd date = 10 May 2000, 9 May 2001; 3rd date = 23 May 1999, 24 May 2000, 23 May 2001; 4th date = 4 Jun 1999, 7 Jun 2000, 7 Jun 2001; 5th date = 14 Jun 1999, 20 Jun 2001.

Numbers in the same column with the same letter are not significantly different.

Figure 1. Monthly precipitation during the growing season in comparison to the 1985-2001 average at the Miles Hansen farm, Bowman, ND.

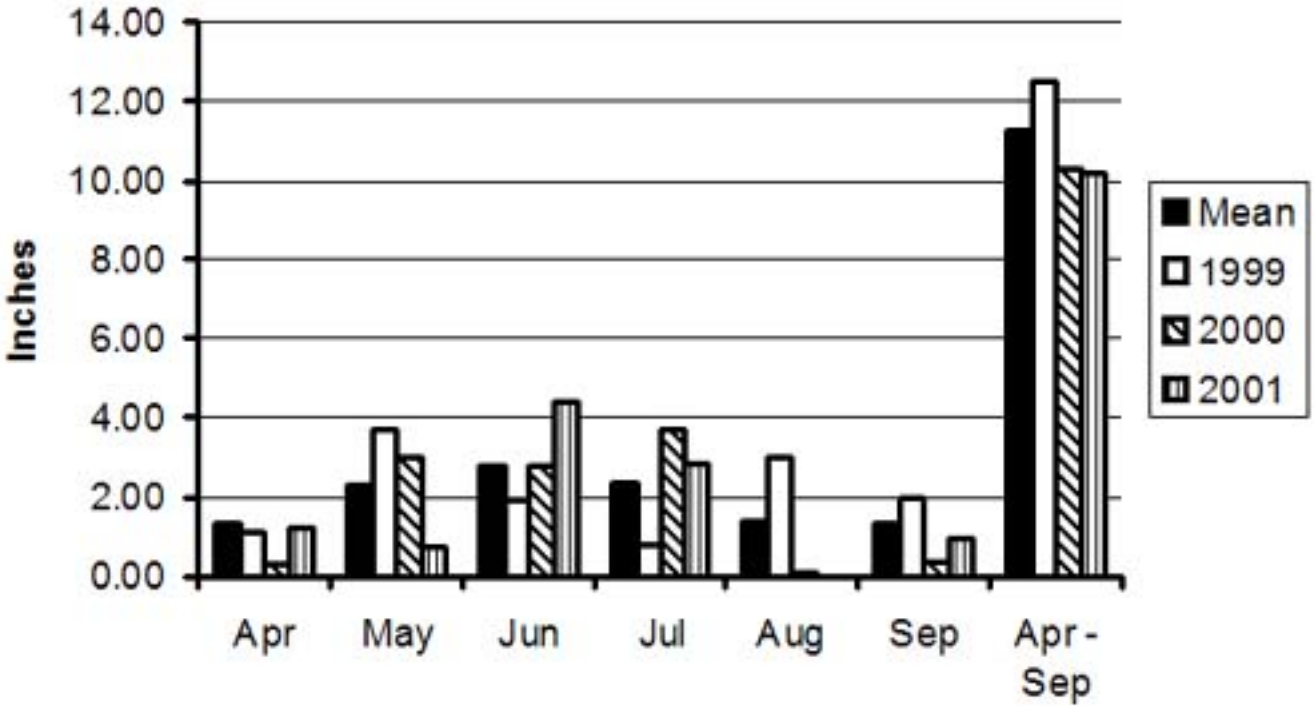


Figure 2. Comparison of the monthly accumulated growing degree days (GDD) with the mean for Bowman, ND.

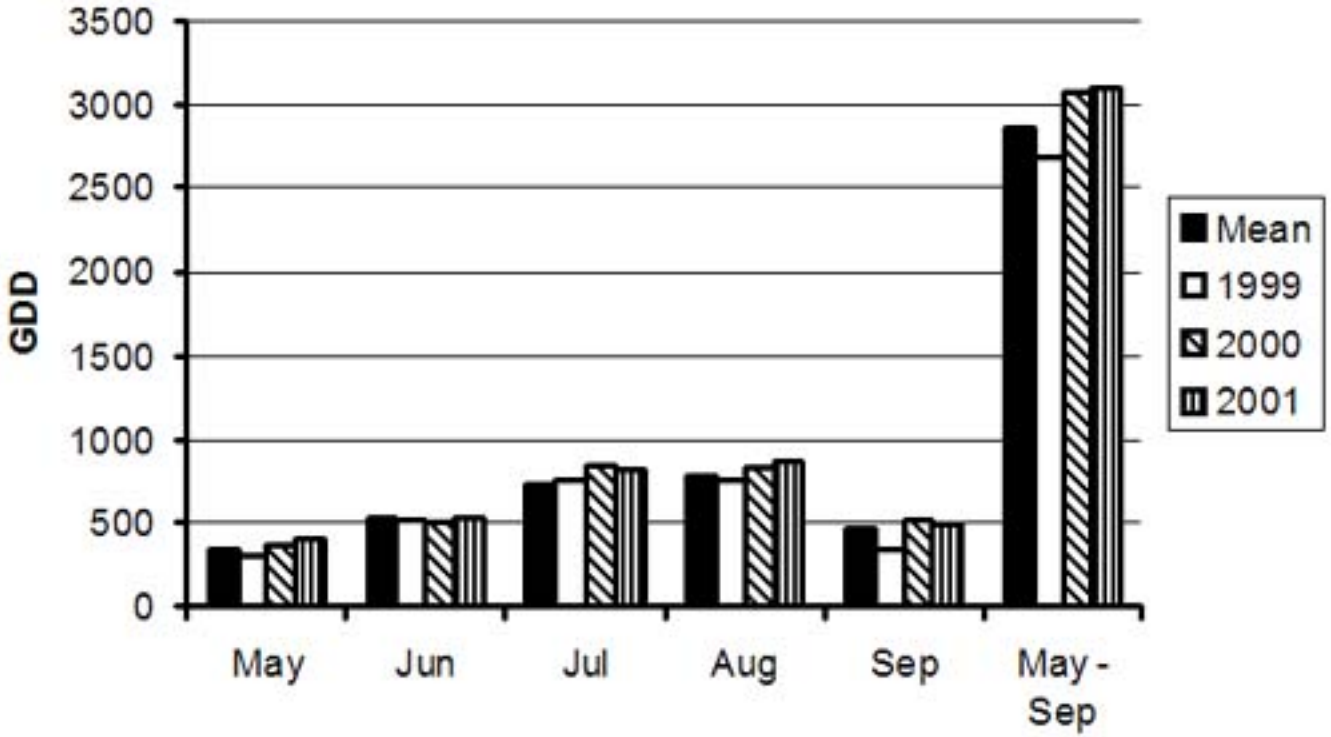
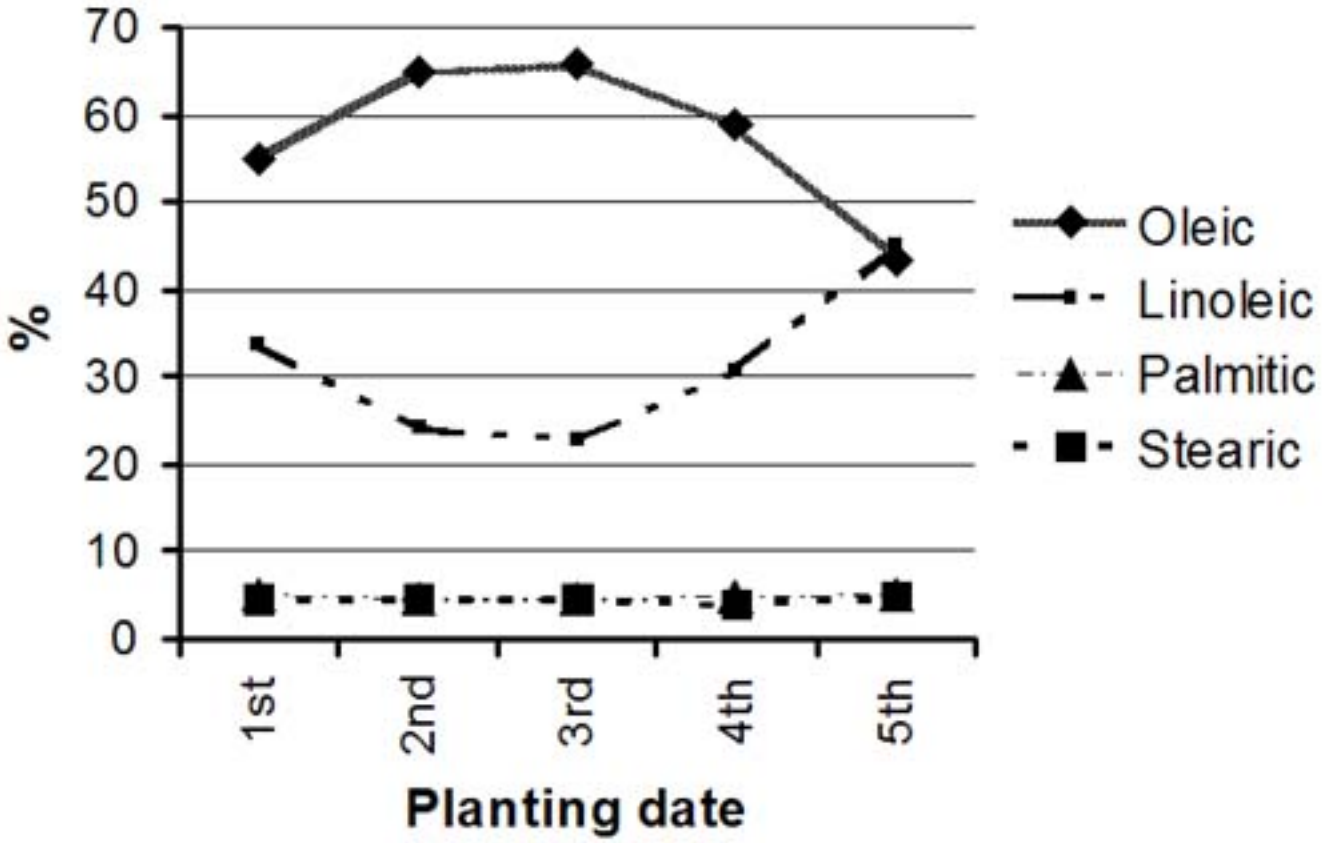


Figure 3. Combined data of the fatty acid profile comparison of Mycogen 8242NS, 1999-2001.



Planting date: 1st date = 28 Apr1999, 26 Apr 2000, 25 Apr 2001; 2nd date = 10 May 2000, 9 May 2001; 3rd date = 23 May 1999, 24 May 2000, 23 May 2001; 4th date = 4 Jun 1999, 7 Jun 2000, 7 Jun 2001; 5th date = 14 Jun 1999, 20 Jun 2001.

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