Flax Variety Response to Planting Date

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Flax is a minor agricultural crop grown in North Dakota and is used in a rotation with small grains in part to help break up small grain disease cycles. Many producers sow flax after all other crops are planted and often have problems with weed competition. As a result, state average flax yields have been very low. The five-year average flax yields from 1977-1981 and 1981-1985 were 11.4 and 12.7 bushels per acre, respectively (2,3).

Planting date is one of the major production practices a farmer can generally control. Date of planting will determine when flowering and seed set occur. Flax planted in early May will begin flowering in late June or early July, while flax planted in early June will flower from mid to late July. Temperatures are usually higher and precipitation lower during mid to late July, which can cause yields to be reduced.

Flor (1) in 1954, using six years data collected at Fargo, reported that flax planted during the periods April 25 to May 15, May 22 to June 3, June 7 to June 15 and June 21 to July 7 yielded 19, 17, 12 and 6 bushels per acre, respectively.

Flor (1) also reported that days to maturity were influenced by temperature and planting date. Flax planted in late June to early July matured 10 to 15 days later than flax planted in early June and 10 to 30 days later than flax planted in April. The delayed maturity phenomenon can result in lower flax yield dependent on weather conditions and fall frosts. Late maturing varieties tended not to mature when seeded in late June.

Jensen and Weiser (4) in 1969, using nine years data, reported higher yields from flax, wheat, durum and barley seeded in late April to early May than when seeded in late May or June. Flax planted early (April 25 to May 15), medium (May 16 to May 31), late (June 1 to June 20) or very late (June 21 to July 10) yielded 19.4, 17.4, 10.7 and 4.9 bushels per acre, respectively. Flax response to early planting is similar to that of the cool season cereal grain crops.

The North Central Experiment Station at Minot is centrally located in the 12-county area it serves. The station is very representative of this area with its Williams loam soil and annual precipitation of 16.5 inches. Development of new flax varieties and new herbicides for weed control in flax have occurred since previous flax planting date work was conducted, creating a need for additional research to study the influence of new flax varieties and herbicides on flax planting date as it affects flowering and yield in north central North Dakota.

METHODS

A trial was initiated in 1977 to study the influence of flax planting date on flax yield and other agronomic factors. Planting dates were not uniform over the nine-year period from 1977-1985 because of the variability in planting conditions from year to year. Six periods were used to group the planting dates based on growing degree days accumulated from May 1 to planting. Growing degree days were calculated using the growing degree day (GDD) formula for wheat:

$$\text{daily GDD} = \frac{\text{Max Temp F}^\circ + \text{Min Temp F}^\circ}{2} - 32$$

The maximum temperature could not exceed 95°F and the minimum temperature could not be less than 32°F.

The six planting periods were established based on the following GDD accumulations from May 1 to planting: Period 1, 0-200; Period 2, 300-350; Period 3, 700-1000; Period 4, 1200-1300; Period 5, 1500-1700; Period 6, 1700+. Planting dates of trials are found in Table 1.

The date-of-planting study was the flax variety trial planted at various time periods each year. The trials were planted in 12-inch rows with a four-row planter from 1977 to 1982 and in 6-inch rows with a seven-row planter from 1983-1985. The flax seed was cleaned and treated with mistomatic (a mercury-based compound no longer marketed) and seeding rates were adjusted for seed size, purity and germination to equal 4 million live seeds per acre (approximately 40 pounds per acre). All trials were planted on Williams loam soil which was fertilized for 40 to 50 bushel per acre flax yield based on soil tests. EPTC at 3 pounds per acre active ingredient (ai) was applied preplant incorporated for weed control in 1977 through 1980. Propachlor at 3 pounds per acre ai was applied preemergence for weed control in 1981 through 1985. All trials were sprayed with MCPA and/or bromoxynil for broadleaf weed control. Plots were straight combined at harvest time. Samples were cleaned and weighed for yield and test weight. All varieties were replicated four times.

Temperature and precipitation averages are given in Table 2, followed by specific comments on trials from 1977 to 1985.

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Flax planted in July in 1977 and 1980 did not mature. June flax plantings lingered in maturity because of cool wet falls in 1977, 1980 and 1985. In 1985, frost reduced test weights of late maturing varieties seeded June 19. In 1983, September rainfall delayed flax harvest and reduced flax test weight, especially the May 2 planted flax.

EPTC applied preplant incorporated reduced flax stands of early plantings from 1977 to 1980. In 1977, an April 29 planting was abandoned. In 1978 EPTC reduced the flax stand planted May 2 by 64 percent and the flax planted May 23 by 13 percent. Flax plants branched to compensate for the stand reductions; however, yield potential may have been reduced.

RESULTS AND DISCUSSION

Flax variety yield, test weight, growing degree days to flower, and plant height were evaluated at six different planting periods from 1977 to 1985. Not all varieties or planting periods occurred in each of the nine years, so variety means were calculated for each planting period based on the following formula:

$$\frac{\text{Sum of the variety trait from each year it occurred} \times \text{Trait average of all varieties in all years}}{\text{Sum of the traits yearly averages in the years the variety was planted.}}$$

Those varieties which were planted in all years the planting period occurred are not adjusted by this formula.

Flax planting date studies at Minot indicate a yield potential reduction with later flax plantings. Flax planted the first period yielded 23.5 bushels per acre compared to 21.8, 18.5, 16.0, 11.3 and 3.8 bushels per acre when seeded during periods 2 through 6, respectively (Figure 1). Flax seeded during periods 1 and 2 were injured with preplant EPTC in 1978 and 1979. Recovery from EPTC injury was excellent; however, yield potential of flax planted in periods 1 and 2 may have been reduced. This explains why the

Table 1. Flax Variety Seeding Date Trial Planting Dates, Minot, N.D.

	Planting Period					
Year	1	2	3	4	5	6
	date (GDD)					
1977			5/23 (722)		6/21 (1698)	7/5 (2153)
1978	5/2 (44)	5/15 (328)	6/5 (935)	6/15 (1234)		6/29 (1708)
1979		5/23 (332)	6/12 (893)	6/21 (1206)	6/29 (1513)	7/6 (1739)
1980	5/2 (67)	5/16 (337)	6/3 (978)		6/20 (1534)	7/1 (1870)
1981	5/4 (83)		6/11 (994)			
1982	5/4 (120)		6/11 (908)			
1983	5/4 (60)		6/7 (737)			
1984	5/11 (138)		6/11 (936)			
1985			6/3 (848)	6/19 (1258)		

Table 2. Temperature and Precipitation Data at the North Central Experiment Station, Minot, N.D.

	Precipitation in Inches								
	1977	1978	1979	1980	1981	1982	1983	1984	1985
Crop year, Sept-Aug	13.00	20.09	16.67	13.60	16.20	19.38	21.90	18.53	21.93
May	4.03	3.60	1.78	0.01	0.79	3.52	2.10	0.13	3.61
June	3.75	3.61	0.89	1.76	3.84	4.98	2.86	2.98	2.86
July	1.29	2.24	1.94	1.43	1.68	1.84	3.07	0.51	1.73
August	1.52	1.09	0.46	4.37	1.51	1.21	1.66	0.96	4.06
	Temperature in °F								
	1977	1978	1979	1980	1981	1982	1983	1984	1985
Crop year, Sept-Aug	40.9	38.2	35.8	41.1	42.9	36.9	41.7	40.6	38.3
May	63.6	58.6	47.8	60.7	53.4	52.3	49.7	52.0	57.5
June	64.2	62.8	63.9	64.4	61.0	59.9	62.8	63.2	57.2
July	69.3	67.7	70.5	70.7	69.5	68.4	71.0	69.8	67.7
August	60.8	67.5	65.1	62.7	69.8	65.2	72.8	71.2	61.1
No. Days over 90°	10	12	5	16	3	7	20	19	6
Last Spring Frost 32°	4/24	4/21	5/11	5/13	5/10	5/8	5/16	5/26	4/27
First Fall Frost 32°	10/1	10/7	8/4	10/11	9/16	8/28	9/21	9/23	9/23

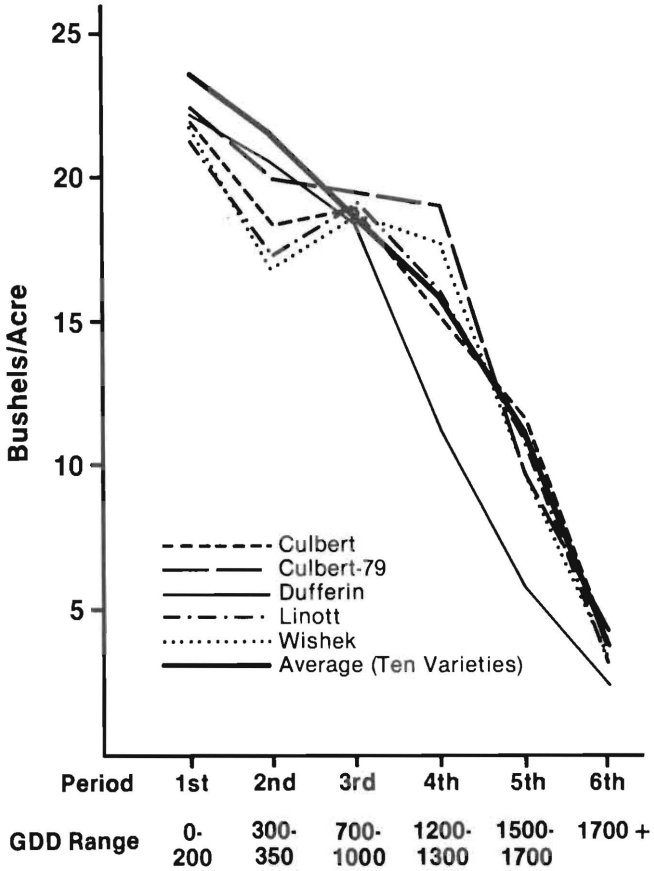

Figure 1. Flax Variety Yield Response to Six Planting Periods (1977-1985).

average yield of the new and old varieties in periods 1 and 2 exceed the yields of the older varieties which were injured by EPTC in 1977-1980 (Figure 1).

Flax seeded the middle of June, late June, and early July, periods 4, 5 and 6, yielded 32, 52 and 84 percent less than flax seeded in early May, period 1 (Figure 1). This would indicate that seeding flax prior to the middle of June is important in obtaining 20 bushel flax yields.

All flax varieties were planted in periods 1, 3 and 4 in this study. Figure 2 was developed to show the response of newer varieties. All flax varieties tended to yield less when planted in mid June or later compared to early May; however, late maturing varieties like Dufferin and McGregor yielded especially poorly when seeded in mid June or later (Figure 2). NorMan, a mid-maturing variety, responded very similarly to Dufferin and McGregor when seeded late. This data would indicate that Dufferin, McGregor and NorMan should not be seeded after the first week in June and perhaps should only be seeded in May. The maturity of these later maturing varieties tends to be delayed if seeded too late as reported by Flor (1).

Mid June planting of early varieties yielded 79 percent of their early May planting while late maturing varieties planted in mid June yielded 42 percent of their early May planting (Figure 2). NorLin was the highest yielding early variety when seeded the middle of June, period 4 (Table 2). These data support the recommendation to plant early maturing varieties when seeding in June.

These data support the fact that flax is a crop which can produce even when seeded late in the spring and can provide an alternative to the farmer if weather severely delays his planting plans on land not tillable in early spring.

Results of flax variety growing degree day accumulations from planting to flowering are found in Table 3. Flax varieties planted in early May required fewer GDD to flower than flax planted in mid June. Later maturing varieties like Dufferin, McGregor and a mid-season variety, NorMan, were influenced more by planting date than the early maturing varieties. Most early varieties had less than a 100 GDD variation from period 1 to period 4 while later maturing varieties had greater than a 200 GDD variation from periods 1, 3 and 4.

NorLin was a unique variety which required nearly the same GDD to flower regardless of planting date. Based on Table 3, NorLin would appear to be classified as a mid-season flax variety when planted in period 1; however, it would be classified among the earliest of varieties when seeded in period 4. This characteristic could explain NorLin's excellent yield potential when seeded in period 4 (Figure 2).

Average calendar days to flower were greater for period 1 than period 4, which would indicate the rate of GDD accumulation/day increases late in the growing season (Table 3).

Seed test weights of the flax varieties studied were influenced very little by seeding date, provided the flax variety matured (data not provided). Dufferin, a late-maturing variety, averaged a 47.7 pound per bushel test weight when planted in period 5 compared to 50.0 to 53.8 pound per bushel test weight when planted in periods 1 to 4.

Flax variety plant height tended to be shortest when planted in early May, period 1 (Table 4). The early-maturing varieties were only slightly taller when seeded in early or mid June. Flor and NorLin plant height changed less than 2 cm regardless of planting period. Dufferin, McGregor and NorMan had the tallest plant height of the flax varieties tested

Table 3. Flax Variety Growing Degree Day Accumulation from Planting to Flowering as Influenced by Planting Date.

	Planting Period		
Variety	1	3	4
	GDD		
Clark	1464	1505	1516
Culbert	1434	1501	1577
Culbert-79	1429	1476	1529
Dufferin	1521	1735	1714
Flor	1509	1519	1558
Linott	1442	1482	1521
McGregor	1529	1735	1700
NorLin	1490	1487	1507
NorMan	1452	1618	1670
Wishek	1452	1475	1511
Average	1472	1553	1580
Calendar days to flower	51.7	45.6	44.9

and were influenced by planting date more than the early maturing varieties. Dufferin was 9 cm, McGregor 11.6 cm, and NorMan 12.3 cm taller when planted in period 4 than when planted in period 1. Flax varieties planted in late June or early July, periods 5 and 6, were not taller than the mid June planting, period 4 (data not provided). The taller plant height from a mid June planting could create a greater potential for plant lodging; however, lodging was not a problem in this study.

SUMMARY

This nine-year study of planting date of flax indicates that delayed flax planting will reduce yield potential. Flax planted in periods 2 through 6 yielded 93, 79, 68, 48 and 16 percent, respectively, of flax planted in period 1 when average over all varieties.

Flax has the potential to produce seed when planted late into June; however, variety selection is very important when seeding late. Varieties which had an average yield greater than 17 bushel per acre when seeded in mid June

Table 4. Flax Variety Plant Height Response to Planting Date.

Variety	Period 1	Period 3	Period 4
		cm	
Clark	52.9	54.4	57.6
Culbert	51.3	55.3	57.7
Culbert-79	50.4	54.0	56.6
Dufferin	51.3	59.0	60.5
Flor	52.5	54.5	53.1
Linott	53.0	55.5	57.4
McGregor	54.2	62.5	65.8
NorLin	52.1	52.9	53.9
NorMan	50.9	59.6	63.2
Wishek	52.9	55.1	56.0
Average	52.2	56.3	58.2

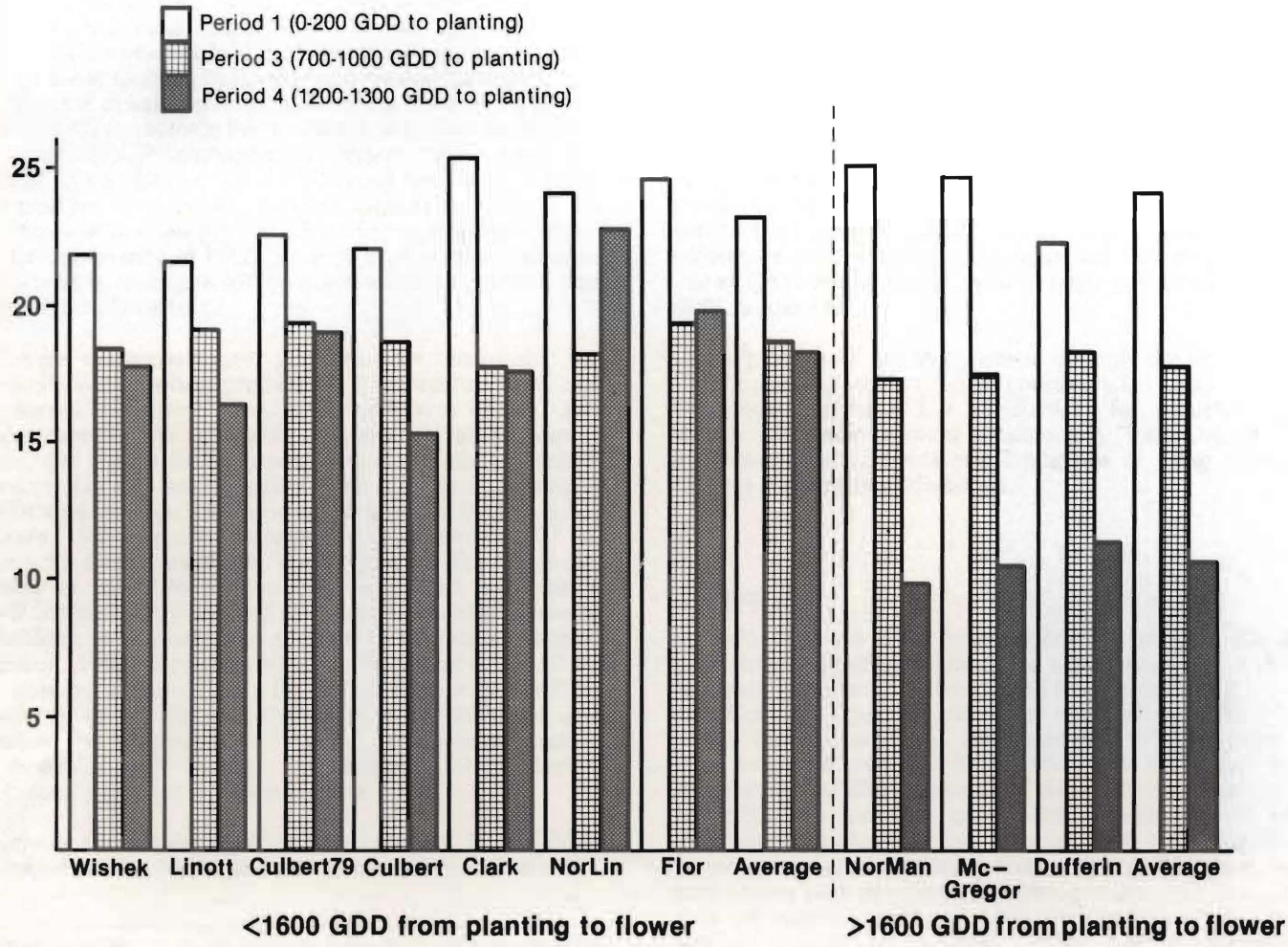

Figure 2. Flax Variety Yield Response to Three Planting Periods (1977-1985).

were Wishek, Culbert 79, Clark, NorLin and Flor. Varieties which yielded less than 12 bushel per acre when seeded in mid June were NorMan, McGregor and Dufferin. This indicates the importance of seeding early maturing varieties when planting in June.

Later maturing varieties appeared to yield slightly higher than early-maturing varieties when seeded in early May, period 1. The later varieties average yield was 24.1 bushel per acre compared to the early varieties average yield of 23.2 bushel per acre (Figure 2).

Flax varieties required greater accumulation of growing degree days from planting to flower when seeded later in the planting season, especially the later maturing varieties Dufferin, McGregor and NorMan. NorLin, an early variety, required nearly the same GDD to flower regardless of planting date and was also the highest yielded variety seeded in period 4 (mid June).

Flax plant height tended to be shortest when planted in early May. The late maturing, taller varieties tended not to be much taller than early varieties when seeded early; however, they were greatly influenced by planting dates and were 9 to 13 cm taller when seeded in mid June.

Flax test weight was generally not influenced by planting date provided the flax matured. Late-maturing varieties seeded in mid or late June were injured by frost prior to maturing and test weights were reduced.

This studies findings parallel Flor's findings (1) in many respects despite the use of new varieties, which are more disease resistant, and the use of herbicides for weed control not available to Flor in the late 40s and early 50s. Flax with its genetic improvements continues to respond similarly to planting date. Flax maturity appears to remain the most important critera in selecting a flax variety to be seeded late in the season. The present varieties available do not appear to allow us to seed any later than Flor's recommendations based on varieties used in his studies.

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