PLANTING DATE EFFECTS ON YIELD AND QUALITY OF OILSEED *BRASSICA SPP.*

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Unit Equivalents

Metric	U.S.
1 kilogram (kg)	2.205 pounds (lb)
1 hectare (ha)	2.471 acres (a)
1 kilogram/hectare (1 kg/ha)	0.892 pounds/acre (lb/a)
1 centimeter (cm)	0.394 inches (in)
1 metric ton (MT)	1.102 tons (ton)
1 meter (m)	1.094 yards (yd)
1 metric ton/hectare (1 MT/ha)	0.446 ton/acre (ton/a)
1 gram (g)	0.035 ounce (oz)
1 kilogram/hectoliter (kg/hl)	0.776 pounds/bushel (lb/bu)
° Celsius (C)	5/9 (°F-32)
9/5 °C + 32	° Farenheit (F)

Planting Date Effects on Yield and Quality of Oilseed *Brassica spp.*

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Summary

Spring or summer rape is a cool season crop which requires 3 to 4 months to mature. Variation in planting date within the frost-free period has a marked effect on seed yield of both rapeseed (*Brassica napus* L.) and turnip rapeseed (*B. campestris* L.). The present study was conducted to determine the effects of planting date on flowering, maturity, seed yield, oil concentration, and oil quality of rapeseed.

Two cultivars of rapeseed (Argentine type) and turnip rapeseed (Polish type) were grown in a 3-year (1979-81) planting date experiment at the Irrigated Agriculture Research and Extension Center, Prosser, Washington. Seeds were planted at four weekly intervals in 1979 starting May 3. In 1980, the first planting date was April 16, followed with three subsequent plantings at 2-week intervals. In 1981 four biweekly planting dates were again used starting April 7. Soil type was a Warden silt loam (coarse, silty, mixed, mesic Xerollic Camborthids).

Both species showed a significant yield decline with delayed planting, varying from 2,210 to 220 kg/ha. This decrease in seed yield was associated primarily with a reduction in the total days from flowering to maturity. Oil concentration in seed at maturity was also decreased with late planted rapeseeds, such as 40.1% vs 37.5%. Planting dates had no effect on test weight of either species. Erucic acid concentration of rapeseed was not affected by delayed planting.

In 1981, the yield of turnip rapeseed was substantially greater for the second sowing than for either earlier or later plantings. Late planting produced low seed yield and low erucic acid, but had no effect on glucosinolate concentration in seeds.

Yield of all rapeseed cultivars tested at Prosser increased linearly with the length of the growing season and with days from flowering to maturity. It was concluded that rapeseed can be seeded in early to mid-April and turnip rapeseed from mid-April to early May for maximum yield and oil concentration.

Introduction

Rapeseed (*Brassica napus* L.) and turnip rapeseed (*B. campestris* L.) are grown as commercial crops in southwestern Canada where the mean spring temperature ranges from 10° to 20°C. At present, there is considerable interest by both researchers and growers (2) in exploring the potential of rapeseed production in the northwestern United States, but relatively small gross returns impose a major restriction to its popularity. High yield and high oil concentration are critical to growers.

The highest rapeseed yields are usually obtained by seeding the crop just late enough to avoid early frost damage (10). In Manitoba, agronomists recommend seeding as early as possible for maximum yield and using early maturing species if seeding is delayed (7). Delay in seeding results in later maturity, reduced plant height, and more rapid vegetative and reproductive development (8, 15). Kondra (13) reported that optimum planting date varied with regions and with species; late planting resulted in a high risk of frost damage in the fall in some areas, and shortened the number of days from planting to maturity. Oil concentration generally decreased with delayed planting, but protein concentration was highly variable (9, 10, 11).

Seed yield, vegetative yield, harvest index, and number of branches per plant of rapeseed and turnip rapeseed were also affected by date of planting (4). Scott et al. (15) obtained much greater rapeseed oil yields with autumn sowings, as a result of increased seed yield with higher oil concentration, but the effect varied considerably between experiments, cultivars, and seasons. Degenhardt and Kondra (4, 5) reported that seeding date had a highly significant effect on seed yield, days to first flower, days to last flower, and maturity of first pod but no significant effect on flowering or seed formation periods. They also reported that low seed yield, days to first and last flower, and maturity of first pod were associated with late planting. Similar effects on yield and oil concentration have also been reported on safflower (1), soybean (6), and sunflower (15, 16). None of the reports described planting date effects on test weight of these crops but 1,000-seed weight was not affected by delayed seeding (3).

The purpose of this study was to determine the optimum planting date for rapeseed and turnip rapeseed in central Washington in terms of seed yield, oil concentration, and oil quality.

Materials and Methods

Two cultivars of rapeseed, 'Midas'[1] and 'Tower', and two cultivars of turnip rapeseed, 'Torch' and 'Candle', were used in a 3-year planting date study. Experiments were conducted in 1979, 1980, and 1981 on the H. P. Singleton Headquarters and Roza research unit of the Irrigated Agriculture Research and Extension Center, located 9 and 14 km NE of Prosser, Wash. The soil was a Warden silt loam (coarse, silty, mixed, mesic Xerollic Camborthids). In all experiments, 112 kg N/ha as ammonium nitrate, 25 kg P/ha as treble superphosphate, and 11 kg Zn/ha as ZnMNS (a mixture of zinc, manganese, nitrogen, and sulfur) were rototilled into the top 10 cm of the soil prior to seeding as recommended for grain crops in this area. Treflan[1] (a,a,a-Trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine) was incorporated into the top 10 cm of the soil at a rate of 1.12 kg ai/ha to control annual weeds. Plots received furrow irrigation for 24 hours so that the soil was near the upper limit of available water before seeding. Each experiment was conducted using a split-plot design with four replications having planting dates as main plots and cultivar as subplots. Temperature data were obtained from standard weather shelters located within 500 m of the experimental plots.

Seeds were planted by a belt seeder in plots 18 rows wide and 12.2 m long with 0.23 m between rows. Seeding rates were 4.5 and 6.7 kg/ha for turnip rapeseed and rapeseed, respectively (7). Furadan[1] (2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate) was mixed with the seed at planting at the rate of 0.1 kg ai/ha to control flea beetle (*Chaetocnema pulicaria*). The plots were furrow irrigated for 24 hours every 2 weeks to insure optimum moisture until pod ripening.

Days from planting to 80% emergence, from 80% emergence to 80% flowering (80% of all plants started to flower), and from 80% flowering to maturity were recorded for all cultivars of various plantings. These periods are hereafter referred to as days to emergence, days to flowering, and days to maturity, respectively. Maturity was recorded as the date when stems and pods were brown and seed moisture was less than 30%. For yield determination, 12 rows, 9.1 m long were harvested using a small plot combine. Seeds were cleaned after drying at 40°C for 48 hours and then weighed for total yield and test weight. Subsamples of the cleaned seed were pooled into two replications for oil analysis exept in 1979 when all four replications were used for chemical analyses. Oil concentration was determined using Nuclear Magnetic Resonance (NMR) procedure. Erucic acid and glucosinolate concentrations of seed were respectively determined by the gas liquid chromatography (17) and colorimeter procedures (14).

Data were submitted to analysis of variance and least significant differences. Linear regressions of seed yield on (1) days from emergence to maturity, and (2) days from flower to maturity were also calculated.

Results and Discussion

At Prosser, the average frost-free period (0°C) ranged from 151 to 189 days during the 3 years of this experiment (table 1) (12). All periods were longer than the rapeseed growing season.

Days to Emergence, Flowering, Maturity

Days to emergence. Days to 80% seedling emergence of both species were reduced with delayed planting (tables 2, 3, 4). Early planted seeds required 1, 2, or 7 days longer to germinate compared with the ones seeded late in spring. Early planting in April 1981 increased the number of days to 80% emergence (tables 3, 4). Early spring frost (−2.2°C) on April 12, 1981 may have delayed germination of both species because of low soil temperature. Results show that seeds of both species can germinate within 5 to 7 days under normal conditions. There was no significant difference in the number of days from seeding to emergence among the four cultivars tested in Prosser during the last 3 years. Both cultivars of turnip rapeseed (*Brassica campestris*) were similar in days to emergence and were 1 day earlier than the rapeseed cultivars (*B. napus*).

Days to flowering. The period from 80% emergence to 80% flowering varied over the 3 years from 30 to 35 days and 40 to 45 days for turnip rapeseed and rapeseed, respectively (tables 2, 3, 4). Early planting lengthened the period from

[1]Product and cultivar names are included for information and do not imply an endorsement by the university over other equivalent materials.

Table 1. First, last frost and frost-free days—1979, 1980, 1981, and 1961-1980 average.

Location	Year	Last spring frost		First fall frost		Frost-free days	
		Heavy frost $-2.2°C$	Light frost $0°C$	Heavy frost $-2.2°C$	Light frost $0°C$	Heavy frost $-2.2°C$	Light frost $0°C$
Roza Unit	1979	April 10	April 20	Nov 1	Nov 1	195	185
	1981	April 12	May 5	Oc 14	Oct 3	185	151
	1963-1981	April 28	May 3	Oct 23	Oct 7	177	156
		(April 8-May 17)†	(April 11-May 26)	(Oct 14-Nov 1)	(Sept 13-Nov 1)	(151-204)‡	(137-194)
H.P. Singleton Unit	1980	April 11	April 11	Oct 22	Oct 17	194	189
	1961-1980	April 12	May 2	Oct 28	Oct 1	199	152
		(Mar 15-May 1)	(April 12-May 9)	(Oct 6-Nov 25)	(Sept 15-Nov 7)	(170-245)	(124-195)

†Dates in parentheses are two extreme dates.

‡Numbers in parentheses are the range between two extremes.

Table 2. Dates of seeding, average dates of 80% emergence, 80% flowering, and maturity and intervals between stages of growth for two rapeseed and two turnip rapeseed cultivars—1979.

Treatment†	Seeding	Emergence	Flowering	Maturity	Seeding to Maturity
Rapeseed (*Brassica napus* L.)					
D_1	May 3	May 10 (7)‡	June 23 (44)	Aug 20 (58)	(109)
D_2	10	15 (5)	26 (42)	25 (60)	(109)
D_3	17	22 (5)	July 3 (42)	28 (56)	(103)
D_4	24	29 (5)	10 (42)	31 (52)	(99)
Turnip rapeseed (*Brassica campestris* L.)					
D_1	May 3	May 9 (6)	June 10 (32)	Aug 10 (61)	(99)
D_2	10	15 (5)	15 (31)	14 (60)	(96)
D_3	17	22 (5)	22 (31)	18 (57)	(93)
D_4	24	29 (5)	28 (30)	21 (54)	(89)

†D_1, D_2, D_3, and D_4: date 1, date 2, date 3, and date 4.

‡Numbers in parentheses are number of days from one stage of growth to the next and cumulative days from seeding to maturity.

Table 3. Dates of seeding, average dates of 80% emergence, 80% flowering, maturity, and intervals between stages of growth for two rapeseed and two turnip rapeseed cultivars—1980.

Treat-ment†	Seeding	Emergence	Flowering	Maturity	Seeding to Maturity
Rapeseed (*Brassica napus* L.)					
D_1	April 16	April 23 (7)‡	June 7 (45)	Aug 5 (59)	(111)
D_2	30	May 6 (6)	20 (45)	12 (53)	(104)
D_3	May 15	20 (5)	July 3 (44)	16 (44)	(93)
D_4	30	June 4 (5)	14 (40)	20 (37)	(82)
Turnip rapeseed (*Brassica campestris* L.)					
D_1	April 16	April 23 (7)	May 26 (33)	July 25 (60)	(100)
D_2	30	May 6 (6)	June 10 (35)	Aug 1 (52)	(93)
D_3	May 15	20 (5)	23 (34)	5 (43)	(82)
D_4	30	June 5 (5)	July 8 (34)	9 (32)	(71)

†D_1, D_2, D_3, and D_4: date 1, date 2, date 3, and date 4.

‡Numbers in parentheses are number of days from one stage of growth to the next and cumulative days from seeding to maturity.

Table 4. Dates of seeding, average dates of 80% emergence, 80% flowering, maturity, and intervals between stages of growth for two rapeseed and two turnip rapeseed cultivars—1981.

Treat-ment†	Seeding	Emergence	Flowering	Maturity	Seeding to Maturity
Rapeseed (*Brassica napus* L.)					
D_1	April 7	April 20 (13)‡	June 4 (45)	Aug 12 (69)	(127)
D_2	21	May 2 (11)	June 14 (43)	14 (61)	(115)
D_3	May 7	14 (7)	24 (41)	16 (53)	(101)
D_4	19	25 (6)	July 4 (40)	18 (45)	(91)
Turnip rapeseed (*Brassica campestris* L.)					
D_1	April 7	April 19 (12)	May 24 (35)	Aug 2 (70)	(117)
D_2	21	May 1 (10)	June 3 (33)	5 (63)	(106)
D_3	May 7	13 (6)	12 (30)	7 (56)	(92)
D_4	19	24 (5)	23 (30)	10 (48)	(83)

†D_1, D_2, D_3, and D_4: date 1, date 2, date 3, and date 4.

‡Numbers in parentheses are number of days from one stage of growth to the next and cumulative days from seeding to maturity.

emergence to flowering by 1 to 2 days. Variation in days from emergence to flowering of various planting dates over the years was not wide regardless of weather differences among these years (fig. 1). Turnip rapeseed species required 10 to 15 days less than those of rapeseed cultivars to bloom. The blooming character of rapeseed plants is largely independent of seeding dates.

Days to maturity. The interval from 80% flowering to maturity ranged over the 3 years from 32 to 70 days and from 37 to 69 days for turnip rapeseed and rapeseed, respectively. These dates varied from year to year depending upon the temperature (fig. 1). Delaying seeding dates reduced the number of days between flowering to maturity for both species (tables 2, 3, 4). The relatively short life cycle of turnip rapeseed was due to its short prebloom growth period. Both species required approximately the same number days from bloom to maturity.

Over the 3 years, the life cycle (seeding to maturity) varied from 82 to 127 days for rapeseed and from 71 to 117 days for turnip rapeseed (tables 2, 3, 4). The life cycle was shortened with each delay in planting. In general, a delay in seeding resulted in a greater reduction in days from flowering to maturity than in days from seeding to emergence or emergence to flowering (tables 3, 4). In 1979 the 21-day delay in seeding from May 3 to May 24 resulted in an average reduction in days from flowering to maturity of 6 and 7 days for rapeseed and turnip rapeseed respectively; in 1980 and 1981 the interval between flowering and maturity was decreased 22 to 28 and 22 to 24 days, respectively, by delaying seeding from mid-April to mid- or late May. When seeded on May 3, 1979, both rapeseed and turnip rapeseed matured 10 days earlier than when seeded on May 24 (table 2). In 1980, delaying seeding from April 16 to May 30, a period of 44 days, caused both species to mature 29 days earlier (table 3). The 42-day delay in seeding from April 7 to May 19, 1981, shortened the period to maturity by 34 and 36 days for turnip rapeseed and rapeseed, respectively. Shortening the life cycle of both rapeseed and turnip rapeseed in this study agreed with the findings of Gross (8) and Kondra (13). Gross reported that a delayed seeding date of 42 days caused both species to mature 21 days early (8). In a separate 2-year experiment, Kondra (13) found that delayed seeding of both species of 40 days resulted in a shortened growth cycle of 20 to 23 days. The range of shortening the life cycle of rapeseed and turnip rapeseed depended upon years and locations (13) where the temperature may be the main factor.

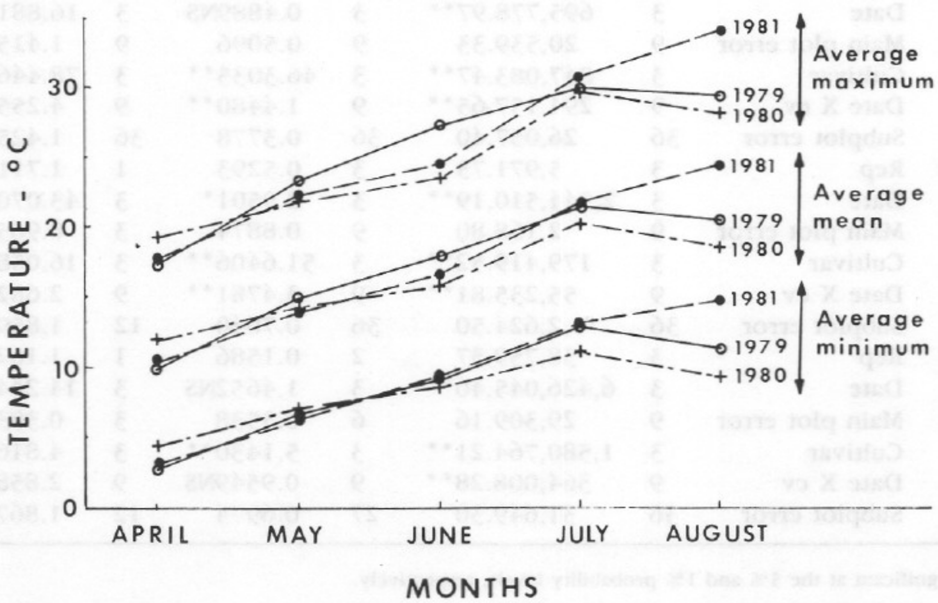

Fig. 1. Average monthly maximum, mean, and minimum temperatures of 1979, 1980 and 1981.

Seed Yield, Test Weight, Oil Concentration and Quality

The main effects of planting dates and cultivars and the date X cultivar interaction were significant ($P<0.01$) for seed yield in all 3 years (table 5). Delay in planting resulted in a low seed yield (fig. 2, 3, 4). Cultivar effects also were significant ($P<0.01$) for test weight and oil concentration of all 3 years except for oil concentration of 1981 experiment. The planting date effects were significant for oil concentration in all 3 years (table 5). Test weight was not affected by various planting dates in 1979 and 1981. However, there was a significant difference ($P<0.05$) in 1980.

Seed yield. Seed yield varied from 220 to 2,200 kg/ha and decreased significantly with the delay in planting date for all cultivars in all 3 years (fig. 2, 3, 4). Generally rapeseed yielded higher than turnip rapeseed because of the genetic background of each species. This may be explained by the longer growing season. However, under the environmental conditions of this experiment (fig. 1), turnip rapeseed (Candle and Torch) yielded as high as or more than rapeseed (Midas and Tower), particularly in 1981 (fig. 2, 3, 4). In 1981, Torch and Candle of the second seeding yielded higher than Midas and Tower planted on the same day. This result proves that turnip rapeseed can tolerate the unfavorable environment (7).

In 1979, rapeseed yields varied from 1,130 to 1,920 kg/ha (fig. 2). Midas produced high seed yield for the first three planting dates, but its yield declined significantly at the last planting date of May 24. Tower decreased in yield from the first to the second and third planting dates but increased again for the last planting dates. The last date of planting was 21 days after the first seeding date, and it may have fallen into the range of optimum planting of that cultivar. The lowest seed yields were from the latest seedings in 1980 and 1981 (fig. 3, 4). Rapeseed

Table 5. Mean squares (MS) from analysis of variance for yield, test weight, and oil content of various planting dates of spring rapeseed and turnip rapeseed—1979, 1980, and 1981.

Year	Source of variance	Seed yield		Test weight		Oil content	
		df	MS	df†	MS	df‡	MS
1979	Rep	3	17,195.93	3	0.4035	3	0.8279
	Date	3	695,778.97**	3	0.4889NS	3	16.8812**
	Main plot error	9	20,539.33	9	0.5096	9	1.4152
	Cultivar	3	847,083.47**	3	46.3035**	3	78.4467**
	Date X cv	9	294,157.65**	9	1.4480**	9	4.2557*
	Subplot error	36	26,057.40	36	0.3778	36	1.4259
1980	Rep	3	5,971.73	3	0.5293	1	1.7112
	Date	3	2,944,510.19**	3	2.9501*	3	43.0704**
	Main plot error	9	2,168.80	9	0.8874	3	0.9654
	Cultivar	3	179,419.52**	3	51.6406**	3	16.0587**
	Date X cv	9	55,235.81**	9	3.4781**	9	2.6823NS
	Subplot error	36	2,624.50	36	0.7040	12	1.8594
1981	Rep	3	38,759.37	2	0.1586	1	1.1628
	Date	3	6,426,045.46**	3	1.4652NS	3	14.2445**
	Main plot error	9	29,309.16	6	0.3538	3	0.3836
	Cultivar	3	1,580,764.21**	3	5.1430**	3	4.8161NS
	Date X cv	9	364,008.28**	9	0.9549NS	9	2.8581NS
	Subplot error	36	31,649.30	27	0.6974	12	1.8676

*,**Significant at the 5% and 1% probability levels, respectively.

NS = No significance at the 5% probability levels.

†Pooled samples were used in test weight in 1981.

‡Pooled samples were used in oil analysis in 1980-1981.

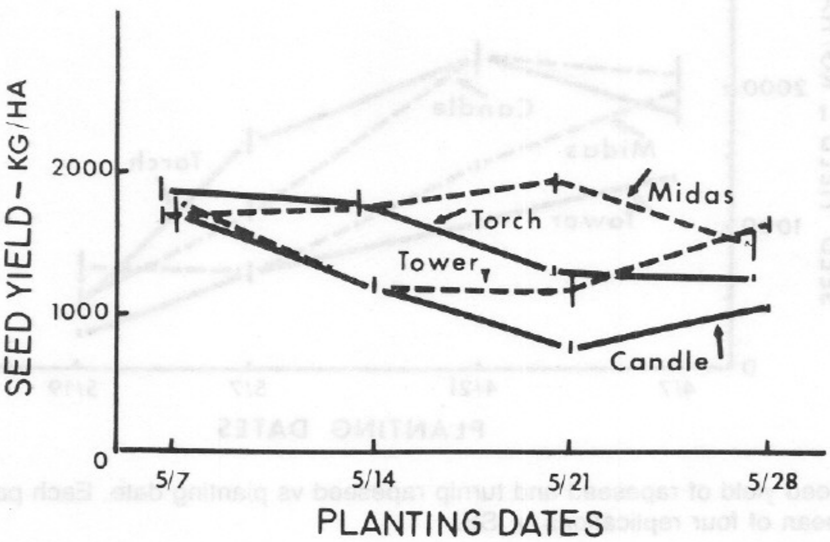

Fig. 2. Seed yield of rapeseed and turnip rapeseed vs planting date. Each point is the mean of four replications ± SE.

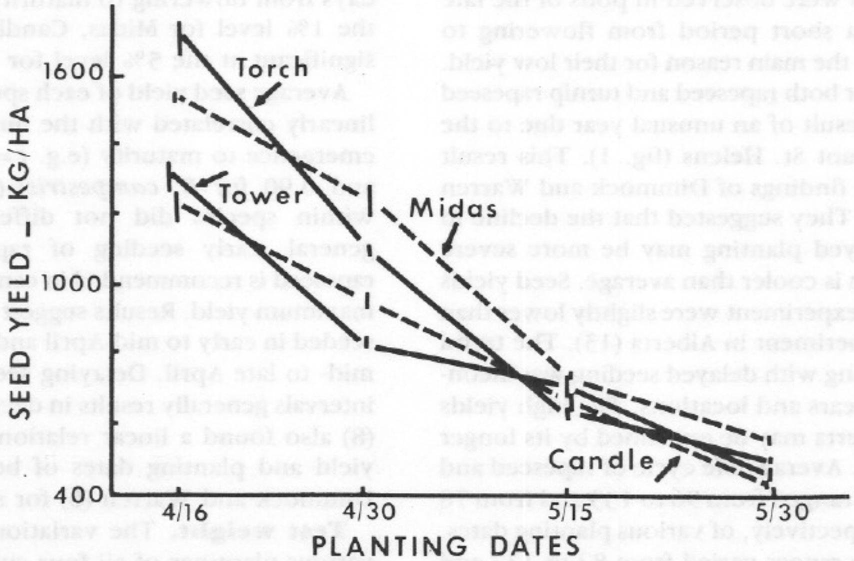

Fig. 3. Seed yield of rapeseed and turnip rapeseed vs planting date. Each point is the mean of four replications ± SE.

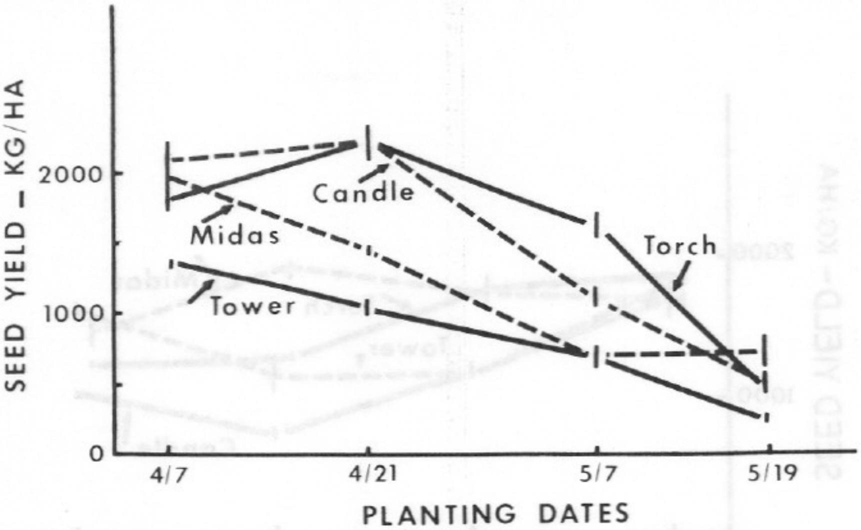

Fig. 4. Seed yield of rapeseed and turnip rapeseed vs planting date. Each point is the mean of four replications ± SE.

produced the highest average seed yield when planted on April 7, 1981. However, turnip rapeseed yielded most when planted on April 21, 1981. Undeveloped seeds were observed in pods of the late plantings, and a short period from flowering to maturity may be the main reason for their low yield. The low yield for both rapeseed and turnip rapeseed in 1980 was a result of an unusual year due to the eruption of Mount St. Helens (fig. 1). This result agreed with the findings of Dimmock and Warren on soybean (6). They suggested that the decline in yield with delayed planting may be more severe when the season is cooler than average. Seed yields reported in this experiment were slightly lower than those of the experiment in Alberta (13). The trend of yield decreasing with delayed seeding was inconsistent among years and locations. The high yields obtained in Alberta may be explained by its longer growing season. Average life cycle of rapeseed and turnip rapeseed ranged from 96 to 133 and from 78 to 105 days, respectively, of various planting dates. At Prosser these ranges varied from 82 to 127 and 71 to 117 days, respectively. However, yields at Prosser were much higher than those reported by Gross (8) at Brandon, Manitoba. Seed yields of June 12 and May 1 seedings over 3 years ranged from 30 to 1,380 and from 56 to 1,800 kg/ha for rapeseed and turnip rapeseed, respectively.

There were seeding date X cultivar interactions for seed yield in all 3 years (table 5). However, the period from flowering to maturity of both species was similar if planted at the same time. The linear correlation between seed yield of each variety, and days from flowering to maturity was significant at the 1% level for Midas, Candle, and Torch, and significant at the 5% level for Tower (table 6).

Average seed yield of each species in 3 years was linearly correlated with the number of days from emergence to maturity (e.g. $r = 0.82$ for *B. napus* and 0.90 for *B. campestris*) (table 7). Cultivars within species did not differ significantly. In general, early seeding of rapeseed and turnip rapeseed is recommended in central Washington for maximum yield. Results suggest rapeseed should be seeded in early to mid-April and turnip rapeseed in mid- to late April. Delaying seeding beyond these intervals generally results in decreased yields. Gross (8) also found a linear relationship between seed yield and planting dates of both species, as did Dimmock and Warren (6) for soybeans.

Test weight. The variation of test weight of various plantings of all four cultivars in 1980 was not consistent; however, there was a significant difference. The lowest test weight was obtained from the latest planting except for cultivar Candle (tables 5, 8, 9) which averaged 65.0 and 65.3 kg/hl for the first and the last planting, respectively.

Cultivar differences in test weight in all 3 years were reported in table 5. Average test weight of rapeseed varied from 62.4 to 64.6 kg/hl and was

Table 6. The relationship between seed yield (kg/ha) of rapeseed and turnip rapeseed and days from flowering to maturity for all 3 years.

Species	Cultivar	n	a	b	r
Brassica napus	Midas	12	– 1,378.0503	50.0411	0.85**
(Rapeseed)	Tower	12	– 946.6212	36.7225	0.68*
B. campestris	Torch	12	– 1,395.9274	50.2761	0.88**
(Turnip rapeseed)	Candle	12	– 1,471.4016	47.9982	0.83**

n = Number of mean observations, a = intercept, b = regression coefficient, and r = correlation coefficient of a linear equation.

*, ** Significant at 5% and 1% probability level.

Table 7. The relationship between seed yield (kg/ha) of rapeseed and turnip rapeseed and days from emergence to maturity for all 3 years.

Species	n	a	b	r
B. napus (Rapeseed)	12	– 2,500.6354	37.9756	0.82**
B. campestris (Turnip rapeseed)	12	3,112.4185	50.1235	0.90**

n = Number of mean observations of two cultivars from each species. a = intercept, b = regression coefficient, and r = correlation coefficient of a linear equation.

**Significant at 1% probability level.

lower than turnip rapeseed (ranged from 64.9 to 66.8 kg/hl) (tables 8, 9). The interaction between planting date and cultivar was significant in 1979 and 1980, but not in 1981. In general, test weight was one of the more stable varietal characteristics of rapeseed and turnip rapeseed (tables 5, 8, 9). No investigators reported the effects of planting dates on test weight of rapeseed and turnip rapeseed. Scott et al. (15) reported a slightly decreased 1,000-seed weight associated with late planting. In a planting date experiment in Northern New South Wales, Hodgson (11) found no changes in 1,000-seed weight of various planting in one location but not the others. These findings cannot explain the variation in test weight in this study since smaller seed will be compensated by greater number of seeds.

Oil concentration and quality. Delayed planting generally decreased the oil concentration in rapeseed which may be the result of the shortened period of time from flowering to maturity. However, differences were not always statistically significant (tables 5, 8, 9). Oil concentration varied over the 3 years. Midas had highest oil concentration at the first plantings in all 3 years. It ranged from 34.7% for the May 30 planting in 1980 to 43% for the April 7, 1981 planting. Tower followed the same trend of Midas in oil concentration, which varied from 41.3% to 37.2% for the May 3 and May 24, 1979 plantings, respectively. Similar effects were found by Kondra (13) and Scott et al. (15), but oil concentrations in seed of Kondra's experiment were lower than those obtained in central Washington. The low oil concentration associated with the delayed planting date may be explained by the short period of seed fill and high temperatures of July and August to stimulate maturity during seed formation of late planting. There were no significant differences in oil concentration of Torch in both 1979 and 1981, and for Candle in 1981. The only significance in cultivar X date for oil concentration was recorded in 1979. There was low oil concentration in seed from the last three planting dates in 1980, particularly the last date (e.g. 34.7%, 37.4%, 33.7%, and 33.4% for Midas, Tower, Torch, and Candle, respectively) (tables 8, 9).

Table 8. Test weight and chemical analysis of Midas and Tower rapeseed cultivars planted on various dates in 1979, 1980, and 1981.

Year	Date	Midas				Tower			
		Test weight	Oil concentration	Erucic acid†	Glucosinolate	Test weight	Oil concentration	Erucic acid	Glucosinolate
		kg/hl	%	%	mg/g oil-free meal‡	kg/hl	%	%	mg/g oil-free meal
1979	May 3	63.3	42.8	0.27	—	62.8	41.3	0.20	—
	10	62.7	43.0	0.10	—	62.5	41.4	0.30	—
	17	62.5	43.1	0.20	—	62.3	40.0	0.15	—
	24	61.9	40.4	0.13	—	62.1	37.2	0.33	—
	L.S.D. (0.05)	1.0	1.6	NS	—	0.3	2.2	NS	—
	L.S.D. (0.01)	1.4	2.3	NS	—	0.5	3.1	NS	—
1980	April 16	64.9	40.4	0.25	5.30	63.3	40.3	0.25	1.65
	30	66.2	38.9	0.20	5.75	63.2	38.3	0.20	2.00
	May 15	63.9	36.6	0.20	6.50	62.0	37.5	0.20	1.60
	30	63.3	34.7	0.50	5.65	61.9	37.4	0.50	1.70
	L.S.D. (0.05)	1.3	2.2	0.22	0.97	NS	NS	0.10	NS
	L.S.D. (0.01)	1.8	3.7	NS	NS	NS	NS	0.16	NS
1981	April 7	63.8	43.0	—§	—	64.1	40.7	—	—
	21	64.6	41.0	—	—	63.3	38.9	—	—
	May 7	64.1	37.0	—	—	64.2	37.5	—	—
	19	64.0	38.8	—	—	64.2	39.3	—	—
	L.S.D. (0.05)	0.6	3.9	—	—	NS	2.3	—	—
	L.S.D. (0.01)	0.8	NS	—	—	NS	NS	—	—

†Erucic acid is expressed in % of the total fatty acid.

‡Glucosinolate analysis was not evaluated in 1979 and 1981.

§Erucic acid analysis was not evaluated in 1981.

Table 9. Test weight and chemical analysis of Torch and Candle turnip rapeseed cultivars planted on various dates in 1979, 1980, and 1981.

Year	Date	Torch				Candle			
		Test weight	Oil concentration	Erucic acid†	Glucosinolate	Test weight	Oil concentration	Erucic acid	Glucosinolate
		kg/hl	%	%	mg/g oil-free meal‡	kg/hl	%	%	mg/g oil-free meal
1979	May 3	65.2	36.7	0.90	—	63.8	38.4	1.75	—
	10	65.8	37.3	0.38	—	65.8	39.2	1.63	—
	17	66.1	37.0	0.98	—	65.0	40.4	2.40	—
	24	66.2	37.3	0.75	—	65.0	37.2	1.60	—
	L.S.D. (0.05)	NS	NS	NS	—	1.1	1.0	NS	—
	L.S.D. (0.01)	NS	NS	NS	—	1.5	1.4	NS	—
1980	April 16	66.7	38.1	0.90	4.60	66.1	40.8	1.90	1.20
	30	66.5	36.6	0.45	4.35	65.0	39.0	1.45	1.60
	May 15	68.2	32.1	0.45	4.40	65.7	36.6	1.05	1.70
	30	65.9	33.7	0.60	4.20	66.0	33.4	1.15	1.70
	L.S.D. (0.05)	1.1	2.9	0.24	NS	1.0	1.5	0.38	NS
	L.S.D. (0.01)	1.5	4.8	0.40	NS	NS	2.5	0.63	NS
1981	April 7	65.0	38.3	—§	—	65.1	40.4	—	—
	21	65.0	37.8	—	—	64.1	40.1	—	—
	May 7	66.0	37.1	—	—	65.0	38.2	—	—
	19	65.0	40.0	—	—	65.0	40.9	—	—
	L.S.D. (0.05)	NS	NS	—	—	NS	NS	—	—
	L.S.D. (0.01)	NS	NS	—	—	NS	NS	—	—

†Erucic acid is expressed in % of the total fatty acid.

‡Glucosinolate analysis was not evaluated in 1979 and 1981.

§Erucic acid analysis was not evaluated in 1981.

Erucic acid was analyzed in 1979 and 1980 while glucosinolate was determined in 1980 only (tables 8, 9). Erucic acid level was low in rapeseed, and it varied from 0.10% to 0.50% of the total fatty acid concentration, while in turnip rapeseed erucic acid ranged from 0.38% to 2.40%. In 1979, planting date effects on erucic acid were not significant. However, in 1980 delayed planting of rapeseed doubled the erucic acid levels, e.g., 0.25% vs 0.50% for April 16 and May 30 plantings, respectively (table 8). In contrast to rapeseed, turnip rapeseed decreased their erucic acid concentration significantly with delayed plantings (table 9).

Glucosinolate concentration was low (1.20 to 2.00 mg/g oil-free meal) for Tower (rapeseed) and Candle (turnip rapeseed) and high (4.20 to 6.50 mg/g oil-free meal) for Midas (rapeseed) and Torch (turnip rapeseed) (tables 8, 9). The planting date effects of glucosinolate were not significant except for Midas. Glucosinolate concentration increased with delayed planting dates from April 16 to May 15 (table 8).

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