PERFORMANCE OF SPRING AND WINTER *BRASSICA* (RAPE) IN CENTRAL WASHINGTON

An N. Hang
G. C. Gilliland

Washington State University
Agricultural Research Center

Research Bulletin
XB 0921 1982

Unit Equivalents

Metric		U.S.
1 kilogram (kg)	=	2.205 pounds (lb)
1 hectare (ha)	=	2.741 acres (a)
1 kilogram/ha	=	0.892 pounds/acre (lb/a)
1 centimeter (cm)	=	0.394 inches (in)
1 metric ton (MT) or ton	=	1.102 tons (ton)
1 meter (m)	=	1.094 yard (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	=	°Fahrenheit (F)

The authors are Assistant Agronomist and Agricultural Research Technologist II, Irrigated Agriculture Research and Extension Center, Washington State University, Prosser, WA 99350.

Work was conducted under project number 0481.

Trade names have been used to simplify information. No endorsement of products is intended by the University.

Performance of Spring and Winter Rape (*Brassica* spp.) in Central Washington

An N. Hang and *G. C. Gilliland*

SUMMARY

Rapeseed is grown in many countries for its valuable oil and protein, and ranks fifth among the leading oil-producing seed crops in the world with total production at more than 8 million metric tons annually. The present studies were conducted to evaluate the adaptation and performance of spring and winter rape cultivars in the irrigated area of central Washington.

Rapeseed cultivars from Canada and several European countries were planted on Warden loam at the H. P. Singleton Headquarters and Roza Units of the Irrigated Agriculture Research and Extension Center 9 and 14 km NE of Prosser, WA. The experimental plots were fertilized with a preplant application of 112 kg N and 56 kg P/ha which was incorporated into the top 10 cm of the soil. Plots were furrow irrigated prior to seeding and at 2-week intervals when needed until harvest. Trifluralin herbicide was surface incorporated at 1.12 kg ai/ha prior to seeding.

Spring Rape

Eight and 11 cultivars of spring rape (*Brassica napus* L. and *Brassica campestris* L.) were planted on May 7, 1979 and April 17, 1980, respectively. The seeding rates were 4.5 and 6.7 kg/ha for *B. campestris* and *B. napus*, respectively. All cultivars emerged 5 to 6 days after planting. *B. campestris* cultivars required 28 to 32 days to bloom, about 13 to 14 days less than *B. napus* cultivars, and they also matured about 18 to 19 days earlier than the *B. napus* cultivars. Both species reached maturity within 90 to 110 days. Yields ranged from 700 to 2,100 kg/ha depending upon the species. *B. napus* cultivars produced relatively higher yield and oil content under favorable growing conditions. Yields of *B. campestris* cultivars ranged from 1,200 to 1,600 kg/ha with 38% to 43% oil content, which was about 1% to 2% lower oil content than the *B. napus* cultivars.

Winter Rape

Ten and 12 winter cultivars (*Brassica napus* L. and *B. campestris* L.) were seeded on September 28, 1979 and September 16, 1980, respectively, at a seeding rate of 6.7 kg/ha. All cultivars emerged 5 to 6 days after planting and reached the 7- to 10-leaf stage before winter dormancy. There was no winter kill, but cold weather caused necrosis at the margins of some of the youngest leaves. The degree of winter damage varied with the cultivars. The plants overcame the damage and grew normally the following spring.

Plants made rapid spring growth, bloomed in April, and reached maturity early in July, requiring 9 to 10 months to mature. Seed yields of winter rape cultivars were more than twice the yield of spring rape tested in the same location, ranging from 3,600 to 5,500 kg/ha in 1981. Oil content varied from 38.3% to 48.7%, and other seed qualities were similar to spring rape cultivars.

These results show that both spring and winter rape cultivars can be grown in central Washington. The acceptability of the crop will depend upon establishing a market that will make the net return competitive with other irrigated crops.

INTRODUCTION

Rapeseed is an old cultivated crop which originated in India and Japan some 4,000 years ago (2). It is now grown in many countries and has been introduced in North America and Australia. More than 8 million metric tons of rapeseed are produced annually, making it the fifth leading oilseed crop in the world. It usually contains 40% to 49% oil and 22% to 24% protein, and has high nutritional value (2). The full potential of rapeseed products has not been realized in some cultivars because of the presence of two toxic compounds: erucic acid in oil and glucosinolate in meal. High erucic acid oil (above 40%) can be used in preparing lubricants, rubber compounding agents, fibers, plastics, waxes, surface active agents, and chemical intermediates (10). Low erucic acid oil (less than 2%) is used, in preparing food for human consumption (salad, cooking oil, margarine, and shortening). Rapeseed meal after oil extraction is an excellent source of protein supplement (above 40%) for livestock (8). Rapeseed proteins have a very well-balanced essential amino acid composition which compares favorably with soybean proteins. However, the presence of high glucosinolate (above 2 mg/g oil-free meal) in some cultivars is not suitable for livestock (1,6,8). The intact glucosinolates (a group of sulfur compounds) are apparently free from toxicity, but, on hydrolysis by myrosinase enzyme (E.C. 3.2.3.1) present in the seed and unheated meal, these compounds can cause adverse metabolic effects when the meal is fed in appreciable quantities to livestock (8).

Both spring and winter rapeseed are grown commercially. Sweden produces both types, but Canada produces only the spring type, and Poland produces mainly the winter type. Rapeseed production has expanded rapidly in Canada with nearly 2.8 million hectares planted in 1978.

Winter rape has been grown commercially on a limited acreage in northern Idaho as a rotation crop with winter wheat (3).

Rapeseed belongs to the Crucifer (mustard) family. Most of the species in the genera *Brassica* are grown for oilseed, fodder, or as vegetable crops. Botanically, rapeseed is divided into *B. napus* (Argentine type) and *B. campestris* (turnip or Polish rape). The two types of rape differ slightly in growth habit, seed yield, and in oil and protein concentrations in the seed. Turnip rape (*B. campestris*) has a little lower oil content than the Argentine type rape (*B. napus*). Rapeseed grows well on a wide range of soils, and it requires as much as or more water than wheat (6,7). It is a cool season crop which tolerates hot days and dry weather, especially when accompanied with cool night temperatures (1). Both *B. napus* and *B. campestris* have spring or summer annual and winter annual crops.

Spring Rapes

Cultivars belonging to *B. campestris* are more tolerant to frost than those of *B. napus*, but usually yield less. *B. napus* cultivars shatter severly at maturity (1,6). *B. napus* cultivars grow 90 to 140 cm tall with 40% to 44% oil content, and require a growing season of 100 to 110 days for high yield. *B. campestris* cultivars grow 80 to 90 cm tall with 40% to 43% oil content and require only 85 to 95 days to mature.

Yield and oil content of the various cultivars fluctuate with environmental changes from one growing area to another. In Canada *B. napus* cultivar yields averaged from 1,300 to 1,400 kg/ha without irrigation compared with yields nearly twice that high under irrigation (5).

Winter Rape

Winter rape grows 100 to 135 cm tall with 40% to 49% oil content and requires a growing season of 280 to 300 days to mature. Seeding usually occurs from mid-August to mid-September. A rosette of leaves is produced in the fall with maturity occurring in late June to early July the following year. Winter rape is the main oilseed crop in Europe (e.g., France, Sweden, and Poland) for both industrial and human consumption. In the United States, winter rape acreage varies from 2,000 to 3,000 ha annually (3). Essentially, the only cultivar grown is 'Dwarf Essex' which produces a high seed yield with a high oil content and high concentrations of erucic acid and glucosinolates.

Winter rape normally outyields the spring crop by 25% to 30%. Winter rape matures earlier, making it more suitable for the intensive cereal growers who require a "break crop" which can be grown using machinery and equipment already available on the farm.

The objective of this study was to determine the seed and oil yield of spring and winter rape as potential new crops for irrigated central Washington.

MATERIAL AND METHODS

Experiments were conducted from 1979 to 1981 on the H. P. Singleton Headquarters and Roza Units of the irrigated Agriculture Research and Extension Center, located 9 and 14 km NE of Prosser, WA. The soil was a Warden loam (coarse-silty, mixed, mesix Xerollic Camborthids).

In all experiments, 112 kg N/ha, as ammonium nitrate, 56 kg P/ha as treble superphosphate, and 11 kg/ha Zn 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. Trifluralin was incorporated into the top 10 cm of the soil at a rate of 1.12 kg ai/ha to control weeds. Experimental plots were pre-irrigated before seeding. Each experiment was conducted using a randomized-complete block design with four replications.

Spring Rape

Rapeseed cultivars (table 1) were planted on May 7, 1979 and April 17, 1980 in plots consisting of 12 rows 6.10 m long with 23 cm between rows. Seeding rates were 4.5 and 6.7 kg/ha for *B. campestris* and *B. napus*, repectively, as suggested by Capcara and Downey (5,6). Furadan was mixed with the seed at planting at the rate of 0.1 kg ai/ha (or 2 kg/ha of Furadan 5G) to control fleabeetle. The plots were furrow irrigated every 2 weeks for 24 hours to insure optimum moisture until pod ripening.

Observations were made weekly to record the growth stages of each cultivar. For yield determination, six rows, 4 m long were harvested when the seed moisture was less than 8%.

Winter Rape

Ten cultivars of winter rape (*B. napus* and *B. campestris*) ranging from very low to high erucic acid and glucosinolate were tested at Prosser in 1979-1980 (table 1). The seed bed was prepared as for the spring rape plots. Seeds were planted on September 28, 1979. Individual plots for each cultivar were three rows, 30 m long with rows spaced 23 cm apart. In 1980-81, 12 cultivars were seeded on September 16 with individual plots of 18 rows, 12 m long spaced 23 cm apart.

Plots were irrigated in April before flowering and thereafter at 2-week intervals until pod ripening. Seed yields were obtained by harvesting 1 row 20 m long in July 1980 and by harvesting four plots of 12 rows 6 m long in 1981.

Data collected for all trials (winter and spring planted) included clean seed yield, test weight, plant height (except winter rapes in 1979-1980 experiment), days to 50% and 100% flowering and maturity, and oil, erucic acid, and glucosinolate contents. Oil content was determined by the standard Nuclear Magnetic Resonance (NMR) procedure by Drs. Capcara and Downey at Agriculture Canada Research Station, Saskatoon (5). Erucic acid and glucosinolate contents of dry seed were respectively determined by the gas liquid chromatography and colorimetry procedures by Dr. Kleiman of the USDA Northern Region-

Table 1. Cultivars, sources and uses of spring and winter rape.

Crop	Cultivar	Source	Use
Spring rape			
Brassica napus	Midas	Canada	cooking oil
	Tower, Regent, Altex[1]	Canada	industrial oil
	75G2180	Canada	animal feed, bird seed
B. campestris	Torch	Canada	animal feed, bird seed
	Candle	Canada	animal feed, bird seed
	CZY5-1366; CZY5-1767	Canada	animal feed, bird seed
	CZY6-914; DH-716	Canada	animal feed, bird seed
	R-500	Canada	industrial oil
Winter rape			
Brassica napus	Primor	France	animal feed, cooking oil
	Gorczanski	Poland	animal feed (meal), bird seed
Brassica spp.	Dwarf Essex	Holland	industrial oil
	Norde	Sweden	animal feed (meal), bird seed
	Brink	Sweden	animal feed (meal), bird seed
	Rapora	West Germany	animal feed (meal), bird seed
	Quinta	West Germany	animal feed (meal), bird seed
	ORB-78-253	USA—Oregon	animal feed (meal), bird seed
	Jet neuf	France	animal feed, cooking oil
	Sipal	Sweden	animal feed (meal), bird seed
	Herkules	Sweden	animal feed (meal), bird seed
	Bishop	Canada	animal feed (meal), bird seed

[1]Cultivars from the Univ. of Manitoba and Univ. of Alberta with all other Canadian cultivars from the Agric. Res. Sta. at Saskatoon.

al Research Center at Peoria, Illinois. All seed data were based on 4.6% moisture.

RESULTS AND DISCUSSION

Spring Rape

All spring rape cultivars emerged 5 to 6 days after planting. *B. campestris* cultivars reached 50% bloom 28 to 32 days after planting in 1979 and 1980, respectively (tables 2 and 3). *B. napus* cultivars required about 41 to 45 days to reach 50% bloom in the same respective years. The early planting date in 1980 probably accounts for the longer periods from planting to bloom compared with 1979. Full bloom was observed 7 days later for both species in both years. In both years *B. campestris* averaged 90 and 89 days, respectively, from seeding to maturity while *B. napus* required 108 days (tables 2 and 3). These maturities are in agreement with results from several locations in the northern states and Western Canada (5). Both *B. napus* and *B. campestris* grew taller in 1979 than in 1980 (tables 2 and 3).

There were no significant differences among the yields of *B. napus* cultivars in 1979 except for Midas which showed a significant yield reduction due to shattering after maturity. There were no significant differences among the yields of *B. campestris* cultivars which averaged 420 kg/ha lower in yield than *B. napus* in 1979. In 1980 the average yields of *B. napus* cultivars were 500 kg/ha lower than in 1979 (tables 2 and 3). Yields ranged from 750 kg/ha (cv. 'Tower') to 1,650 kg/ha (cv. 'Midas'). *B. campestris* cultivars in 1980 yielded as high as in 1979. In 1980 there were significant differences among the yields of *B. napus* as well as *B. campestris*. Cultivars 'R-500' and 'CZY5-1366' were the highest yielding cultivars of *B. campestris*. Average yield of *B. napus* was lower than *B. capestris*, e.g., 1,308 vs 1,400 kg/ha. The year of 1980 was relatively poor for *B. napus*. Frequent rainfall, associated with high humidity in 1980 caused a detrimental effect on rape yield, particularly on cv. 'Tower' (table 3). These results indicated that under unfavorable conditions *B. campestris* cultivars do better than *B. napus* (1). In general, the incidence of insects and diseases was minimal for both years with the exceptions of *B. napus* in 1980. Bertha army worms (*Manestra configurata* L.) were observed to attack fully developed pods as well as mature pods, particularly cv. 'Tower'. This insect may have contributed to the low average yield of *B. napus* in 1980. The ranking of cultivars was different for each species over the years.

Yields of all cultivars tested at Prosser were higher than the reported average seed yield of the dryland northern states (5), but, of course, the production costs would also be much higher on irrigated land. Spring rape crops averaged only 440 kg/ha in eastern Montana, and 600, 790, and 450 kg/ha in Langden, Minot, and Williston, North Dakota, respectively. Average yields of all locations in Saskatoon, Saskatchewan, Canada ranged from 510 to 2,350 kg/ha and 270 to 2,130 kg/ha for *B. napus* and *B. Campestris*, respectively. The yields reported in Prosser were generally comparable or slightly lower than yields reported in the Saskatoon, Saskatchewan area under irrigation. The shattering of seed when the crop was subjected to strong wind about harvest time and seed loss with improper harvesting equipment may have contributed to the lower yield of rape obtained in some locations in the United States.

Test weights did not differ a great deal from year to year (tables 2 and 3). Test weights of the *B. napus* were only slightly lower than *B. campestris* cultivars. The mean test weights of all *B. napus* cultivars were 63.8 kg/hl in both years, while the mean test weights of *B. campestris* increased from 64 kg/hl

in 1979 to 66.1 kg/hl in 1980.

Seed oil content of both *Brassica* spp. was low in 1980 as compared with that of 1979. Oil content reported herein is higher than that of seed in Idaho, Montana, and North Dakota and nearly the same as the average oil contents of all cultivars tested in western Canada (5).

Erucic acid content in seeds was low and ranged from a trace (0.2%) to 1.9% in the cultivars tested at Prosser except for 'R-500', a new commercial cultivar (tables 2 and 3). These values are considered to be acceptable for human consumption. The oil from cultivar 'R-500' contained 46.9% erucic acid which is acceptable for industrial use only. Glucosinolate in the oil-free meal varied from a trace (less than 1 mg/g oil-free meal) to 7.2 mg/g oil-free meal. Most of the cultivars have low dry meal glucosinolate content with the exception of cvs. 'Midas', 'Torch', and 'R-500' which have normal glucosinolate contents (from 4.3 to 7.2 mg/g oil-free meal) (tables 2 and 3). The erucic acid and glucosinolate contents in seed of the respective cultivars tested at Prosser were fairly constant, and values were comparable to results reported in Canada (1,5).

Table 2. Agronomic performance of spring rape, Prosser, WA, 1979.

Cultivar	Plant height	Flowering 50%	Flowering Full	Maturity	Seed yield	Test weight	Oil content	Erucic acid	Glucosinolate
	cm	days[1]			kg/ha	kg/hl	%	%	mg/g oil-free meal
Brassica napus									
Regent	146	42	49	108	2090a*	63.4bc*	44.0[2]	0.30[2]	2.15[2]
Altex	141	41	48	107	2130a	64.9a	43.7	0.35	1.80
Midas	142	42	49	109	1360b	64.2ab	44.4	0.20	5.75
Tower	136	42	49	107	1730ab	62.7c	43.5	0.20	2.00
Mean	141	42	49	108	1820	63.8	44.0	0.24	2.92
df					15	15			
Sx					120	0.28			
CV(%)					17.3	1.7			
Brassica campestirs									
Torch	136	28	36	90	1280a*	65.2a*	40.0	0.45	4.35
Candle	138	29	36	89	1290a	63.4b	41.6	1.45	1.60
CZY5-1366	139	28	36	91	1620a	62.7b	41.8	T[3]	T[3]
CZY5-1767	135	28	36	90	1400a	64.8a	42.8	T[3]	T[3]
Mean	137	28	36	90	1400	64.0	41.6		
df					15	15			
Sx					59	0.34			
CV(%)					17.0	2.1			

Note: Values with an asterisk (*) in a column for each *Brassica* group followed by the same letter are not significantly different at 5% level according to Duncan's new multiple range test.
[1]Days from seeding to flowering or maturity.
[2]Samples were pooled from the replications for oil, erucic acid, and glucosinolate determinations; therefore, no statistical analyses were computed.
[3]T = trace (less than 0.2% for erucic acid and 1.0 mg/g for glucosinolate).

Winter Rape

All winter rape cultivars emerged 5 to 6 days after planting in both falls of 1979 and 1980. Seedlings grew normally, produced leaves before freezing temperatures occurred, and then remained dormant in the rosette stage over winter. The number of leaves and height of seedlings depended upon the date of planting. In 1979, seedlings were at the 7- to 8-leaf stage going into a severe winter as compared with 9 to 10 leaves in 1980 with a mild winter. The early planting date in 1980 probably accounts for the greater leaf development. Freeze damage was observed both years on the young leaves of cvs. 'Brink', 'Norde', 'Gorczanski', 'Rapora', and 'Quinta' during the 1980-1981 winter because of the lack of snow cover. Plants recovered rapidly and initiated new growth in early April. All cultivars bloomed in mid-April except 'Quinta', 'Bishop', and 'Rapora' which bloomed in late April. Winter rape matured 9 to 10 months after seeding. Plants of early and late plantings bloomed and reached maturity at approximately the same time.

Most of the cultivars tested were lodged at maturity because of the heavy seed set and wind interference with the exception of cvs. 'ORB 78-259' and 'Brink'. In the 1979-1980 experiment, yields ranged from 550 kg/ha (cv. 'Quinta') to 4,050 kg/ha (cv. 'Rapora') (table 4). The low yield of Quinta in the 1979-1980 experiment was attributed to low germination rate and winter damage. The ranking of cultivars was different each year. In the second year trial mean yields ranged from 3,580 kg/ha (cv. 'Gorczanski') to 5,500 kg/ha (cv. 'Dwarf Essex'), but this large yield difference was not significant because of the wide yield variation across replications probably caused by shattering (table 5).

In general, yields reported in Prosser are apparently higher than the average yield of winter rape grown in France (e.g., 4,640 kg/ha vs 2,400 kg/ha). The cultivar 'Jet neuf' accounts for 90% of the winter rapeseed in France and about 65% in several other European countries (8). The yield of 'Jet neuf' averaged 2,645 kg/ha in France as compared with 5,290, 4,350, and 6,990 kg/ha at Prosser, WA, Moscow (dryland) and Bonners Ferry, ID, respectively (4). As a dryland crop, winter rape averaged only 1,800 kg/ha at Pendleton, OR (4). Test weight was fairly constant both seasons, ranging from 64.8 to 66.8 kg/hl in 1979-1980, and from 64.3 to 66.8 kg/hl in 1980-1981. There were significant differences among cultivars. 'Primor' ranked the highest with 66.8 kg/hl while 'Gorczanski' and 'Rapora' were the lowest with

64.4 and 64.3 kg/hl, respectively (table 5).

Oil content in dry seed ranged from 37.7% (cv. 'Quinta') to 44.8% (cv. 'Dwarf Essex') in the 1979-1980 season, and from 44.0% (cv. 'Jet neuf') to 48.7% (cv. 'Gorczanski') in 1980-1981. Average oil content of the rapeseed harvested in 1980 was 5.2% lower than in 1981 (40.8% vs. 46.0%) (tables 4 and 5). There were significant differences in oil contents of the 12 cultivars tested in 1980-1981 at the 10% level. Erucic acid content in oil ranged from 1.9% (cv. 'Primor') to 49.9% (cv. 'Dwarf Essex') in 1980 and from 2.5 (cv. 'Brink') to 48.4% (cv. 'Dwarf Essex') in 1981. Glucosinolate content in oil-free meal ranged from 2.4 (cv. 'ORB 78-253') to 7.1 mg/g (cv. 'Sipal'). However, in 1981, glucosinolate content in meal was low. It varied from 0.9 (cv. 'ORB 78-259') to 3.0 mg/g oil free meal (cv. 'Gorczanski') (tables 4 and 5).

Table 3. Agronomic performance of spring rape, Prosser, WA, 1980.

Cultivar	Plant height	Flowering 50%	Flowering Full	Maturity	Seed yield	Test weight	Oil content	Erucic acid	Glucosinolate
	cm	days[1]			kg/ha	kg/hl	%	%	mg/g oil-free meal
Brassica napus									
Regent	124	45	52	109	1320c*	63.4a*	40.6[2]	0.60[2]	1.90[2]
Altex	123	44	52	108	1380b	64.8a	39.7	0.45	1.85
Midas	126	45	52	109	1650a	64.8a	40.6	0.25	4.60
Tower	126	45	52	108	750d	61.9b	39.6	0.25	1.20
75G-2180	122	44	51	108	1340c	64.2a	39.8	T[3]	T[3]
Mean	124	45	52	108	1308	63.8	40.0		
df					19	19			
Sx					71.6	0.30			
CV(%)					6.0	2.1			
Brassica campestris									
Torch	97	30	37	89	1400ab*	67.1a*	38.2	0.90	4.60
Candle	95	30	36	87	1250b	66.3b	40.8	1.90	1.20
CZY5-1366	96	31	38	88	1500a	65.7bc	40.8	T[3]	T[3]
DH-716	96	30	37	89	1240b	65.9bc	41.1	T[3]	T[3]
CZR6-914	97	31	38	88	1450ab	66.2b	40.2	T[3]	T[3]
R-500	97	32	39	90	1540a	65.5c	39.7	46.9	7.2
Mean	96	31	38	89	1400	66.1	40.2		
df					23	23			
Sx					40	0.13			
CV(%)					13.9	1.0			

Note: Values with an asterisk (*) in a colmun for each *Brassica* group followed by the same letter are not significantly different at 5% level according to Duncan's new multiple range test.
[1]Days from seeding to flowering or maturity.
[2]Samples were pooled from the replications for oil, erucic acid, and glucosinolate determinations; therefore, no statistical analyses were computed.
[3]T = trace (less than 0.2% for erucic acid and 1.0 mg/g for glucosinolate).

CONCLUSIONS

Winter rape yields were more than twice those of the spring rape cultivars tested at the same location. Both spring and winter rape cultivars were relatively well adapted to central Washington conditions. The acceptability of rape as an irrigated crop in central Washington depends upon market availability and price. An advantage of rapeseed as an alternate crop is that the conventional small grain equipment can be utilized in its production and rapeseed can fit into crop rotations, such as wheat, barley, and dry beans.

REFERENCES

1. Adolphe, D. 1979. Canola-Canada's rapeseed crop. Rapeseed Assoc. of Canada. Pub. No. 56, Canada.
2. Anderson, P. G. (ed.). 1978. Rapeseed—An important crop for reproduction of oil and protein. Proc. 5th Int. Rapeseed Conf. Malmo, Sweden. Published by the organizing committee of the 5th Int. Rapeseed Conf., Malmo, Sweden.
3. Auld, D. L., G. A. Murray, E. R. Mink, and B. W. Studer. 1977. Alternative crops for northern Idaho. CIS No. 380. Univ. of Idaho, Coll. of Agric., Coop. Ext. Serv. Agric. Exp. Sta.
4. Auld, D. L. (ed.). 1979-1981. Development of oilseeds as alternative crops for the Pacific Northwest. Univ. of Idaho, Wash. State Univ. and Oregon State Univ. Annual Progress Reports 1979-1981. (Unpublished).
5. Capcara, J. J. 1979-1980. Regional rapeseed test 1979-1980. Agriculture Canada. (Research reports—unpublished data).
6. Downey, R. K., A. J. Klassen, and J. McAnsh. 1974. Rapeseed: Canada's "Cinderella" crop. 3rd ed. Rapeseed Asso. Canada. Winnepeg, Manitoba. Pub. No. 33.
7. Krogman, K. K., and E. H. Hobbs. 1975. Yield and morphological responses of rape (*Brassica campestris* L. cv. 'Span') to irrigation and fertilizer treatments. Can. J. Plant Sci. 55: 903-909.
8. Maheshivari, P. N., D. W. Stanley, and J. I. Gray. 1981. Detoxification of rapeseed products. J. Food Protection 44:459-470.
9. Moniet, Marie-Laure. 1980. Colza oleagineaux: les varieties. Cultivar. April 1980:36-37. France (in French).
10. U.S. Department of Agriculture (eds.). 1969. A national program of research for new crops and minor oilseeds. A Joint Task Force of the USDA and the State Univ. and Land-Grant Colleges.

Table 4. Agronomic performance of winter rape, Prosser, WA, 1979-1980.

Cultivar	Flowering 50%	Flowering Full	Maturity	Seed yield	Test weight	Oil content	Erucic acid	Glucosinolate
	days[1]			kg/ha	kg/hl	%	%	mg/g oil-free meal
ORB 78-253	202	210	280	1580[2]	65.2[2]	40.4[2]	38.9[2]	2.4[2]
Dwarf Essex	203	210	282	2880	65.0	44.8	49.9	6.0
Norde	202	209	280	3050	66.4	42.8	48.3	5.2
Gorczanski	202	210	280	3060	66.3	41.9	44.3	6.5
Jet neuf	203	212	283	1370	66.1	39.3	5.7	6.3
Rapora	203	210	281	4050	65.4	40.4	9.2	5.0
Primor	202	210	281	2290	66.8	38.3	1.9	6.3
Sipal	203	212	282	1180	64.7	40.5	4.7	7.1
Quinta	215	223	291	550	66.4	37.7	2.5	6.2
Brink	204	212	283	2280	66.3	41.7	6.7	4.9
Mean	204	212	282	2230	65.9	40.8	21.2	5.6

[1]Days from seeding to flowering or maturity.
[2]Data from only one plot for each cultivar; therefore, no statistical analysis was computed.

Table 5. Agronomic performance of winter rape, Prosser, WA, 1980-1981.

Cultivar	Flowering 50%	Flowering Full	Maturity	Plant height	Seed yield	Test weight	Oil content	Erucic acid	Glucosinolate
	days[1]			cm	kg/ha	kg/hl	%	%	mg/g oil-free meal
ORB78-259	201	207	287	102	5370a*	66.0ab*	44.2c**	46.0a*	0.9c*
Dwarf Essex	201	207	288	121	5500a	64.7cd	47.6ab	48.4a	2.6ab
Norde	201	207	290	105	4590a	64.9cd	48.0a	47.6a	2.5ab
Gorczanski	201	207	285	127	3580a	64.4d	48.7a	46.9a	3.0a
Bishop	220	223	297	134	4090a	66.3ab	46.3a-c	40.6b	2.7a
Herkules	202	209	286	102	4790a	64.9cd	46.8a-c	38.2b	1.8b
Jet neuf	207	213	293	113	5290a	65.6b	44.0c	8.8cd	2.4ab
Rapora	202	208	286	105	3880a	64.3d	44.9bc	10.4c	2.4ab
Primor	202	208	287	110	4340a	66.8a	44.9bc	4.6de	2.4ab
Sipal	202	208	289	104	4300a	66.3ab	46.0a-c	6.3c-e	2.8a
Quinta	217	223	295	116	4890a	64.6cd	45.1bc	3.6de	2.5ab
Brink	201	208	287	101	5130a	65.6bc	46.1a-c	2.5e	2.8a
Mean	205	211	289	112	4640	65.4	46.0	25.3	2.4
df					47	47	23	11	11
Sx					890	0.29	1.01	1.73	0.25
CV(%)					38.7	0.9	3.11	9.65	14.7

Note: Values with a single asterisk (*) in a column followed by the same letter are not significantly different at 5% level according to Duncan's new multiple range test. Values with a double asterisk (**) in a column followed by the same letter are not significantly different at 10% level according to Duncan's new multiple range test.

[1]Days from seeding to flowering or maturity.