Bulletin No. 634

Winter Rape Production Practices in Northern Idaho

G. A. Murray, D. L. Auld, L. E. O'Keeffe and D. C. Thill

Agricultural Experiment Station
University of Idaho
College of Agriculture

'5

Contents

About the Authors

Glen A. Murray is a professor of plant science, Dick L. Auld is an associate professor of plant science, Lawrence E. O'Keeffe is a professor of entomology, and Donald C. Thill is an assistant professor of plant science. All four are in the University of Idaho Department of Plant, Soil and Entomological Sciences, Moscow.

Published and distributed by the
Idaho Agricultural Experiment Station
R. J. Miller, Director

University of Idaho College of Agriculture
Moscow 83843

3M 7-84

$1.00 per copy

Winter Rape Production Practices In Northern Idaho

G. A. Murray, D. L. Auld, L. E. O'Keeffe and D. C. Thill

Introduction

Winter rape *(Brassica napus* L.) production in northern Idaho has ranged from 2,000 to 10,000 acres during the past 30 years but is currently less than 5,000 acres. 'Dwarf Essex,' the variety currently produced in this area, is sold to limited markets as either birdseed or for processing as an industrial oil. High concentrations of erucic acid in the oil and glucosinolates in the meal make Dwarf Essex seed unsuitable for human and livestock consumption.

New winter rape varieties recently developed in northern Europe contain low levels of both erucic acid and glucosinolate. If these varieties are adapted to northern Idaho, or if adapted varieties can be developed, the market potential for winter rape could be greatly expanded.

Because winter rape generally must be planted on fallow ground under dryland conditions, the potential acreage that could be seeded is limited. Selection of varieties with ability to germinate and establish at minimum soil moisture could increase recrop production of winter rape.

This bulletin summarizes 8 years of research on winter rape cultural practices, varietal adaptation and pest control. This information, combined with use of improved varieties, has the potential to expand the acreage and yield of winter rape in northern Idaho.

Plant Characteristics

Winter rape is a winter annual from the mustard family. Seedlings emerge in the late summer and early fall and overwinter as a dense rosette of leaves that effectively prevents soil erosion (Fig. 1). Much of the leaf tissue freezes during the winter, and new growth is regenerated from the thickened crown in February or March to form a single flowering stalk.

Fig. 1. Dense ground cover in late September from winter rape seeded in August on fallow ground.

Basal and secondary branching from this main flowering stalk can occur under low plant populations and favorable environments. The bright yellow flowers appear in early May.

Winter rape is self-fertile but under field conditions may be completely cross-pollinated if sufficient insect pollinators are available. Winter rape continues to flower until limited by either low soil moisture or high temperatures. Harvest usually occurs in late July or August. The black seeds are the largest of all oilseed mustards, having 82,000 to 100,000 seeds per pound. At maturity, seeds contain from 40 to 55 percent oil by weight.

Variety Trials

In mid-August of 1978, 1979 and 1980, about 20 varieties (Fig. 2) of winter rape were planted in replicated trials located at Moscow, Nezperce and/or Bonners Ferry. Trials were harvested the following summer to determine seed yield, oil content, fatty acid composition of the oil and glucosinolate concentration of the meal left after oil extraction. Data from six varieties grown as a source of industrial oil and six varieties that produce an edible oil were summarized.

Fig. 2. Field tour of winter rape variety trials at the UI Plant Science Farm east of Moscow.

Industrial Oil Varieties

Average seed yields of the six industrial oil varieties ranged from 2,560 to 4,440 pounds per acre (Table 1). 'Gorczanski,' 'Norde' and 'Hector' produced 18, 17 and 11 percent more seed, respectively, than Dwarf Essex when averaged over three locations and 5 years of testing. Both 'Bishop' and 'Indore' yielded less than Dwarf Essex. Bishop matured quite late in these production areas, and Indore suffered winter kill at most test locations.

Neither of these cultivars should be used for commercial production in northern Idaho. The utilization of Gorczanski, Norde and Hector may improve commercial seed yield of winter rape in northern Idaho.

At Moscow in 1980-81, the varieties of Norde, Hector and Dwarf Essex had good winter survival (Table 2), while Bishop, Gorczanski and Indore had a poorer winter survival. Oil content of the six varieties ranged from 40.1 to 43.1 percent. The rape grown at Moscow generally had higher oil contents than the rape grown at Nezperce and Bonners Ferry because of the warmer temperatures and better maturity at Moscow.

Analysis of the seed grown at Moscow in the 1979-80 trial indicated that erucic acid comprised from 37.4 to 43.2 percent of the oil contained in the six industrial varieties (Table 2). The oil in Bishop had 37.4 percent erucic acid, while the oil of the other five varieties contained 41.9 to 43.2 percent erucic acid. Because premium industrial oils are

Table 1. Seed yield of industrial oil varieties of winter rape grown at three locations in northern Idaho.

Variety	Moscow			Nezperce		Bonners Ferry		5-year	% of
	1978-79	1979-80	1980-81	1978-79	1979-80	1979-80	1980-81	average	Dwarf Essex
	(lb/acre)								(%)
Industrial Oil									
Gorczanski	—	3,260	4,180	—	2,730	5,820	6,190	4,440	118
Norde	5,570	3,340	4,130	3,680	2,460	6,650	5,460	4,410	117
Hector	—	3,210	4,190	—	2,490	6,140	4,980	4,200	111
Dwarf Essex	3,480	2,890	2,900	3,590	2,440	5,700	4,900	3,770	100
Bishop	—	2,600	3,590	—	1,650	4,820	3,610	3,250	86
Indore	—	1,910	2,720	—	1,920	3,540	2,710	2,560	68
Edible Oil									
Jet Neuf	4,430	3,880	4,510	4,240	3,000	6,240	4,510	4,360	120
WW827	5,100	3,320	—	4,400	2,540	5,480	—	4,170	115
Primor	3,600	3,620	3,740	4,020	2,740	7,010	—	4,200	116
Brink	4,590	3,630	3,210	3,810	2,530	4,950	2,040	3,900	108
Quinta	3,220	3,100	4,260	2,720	2,440	6,160	5,260	3,530	98
Sipal	4,110	2,850	2,770	3,970	2,580	3,740	4,100	3,450	95

expected to have high concentrations of erucic acid, seed from the variety Bishop would probably be of less value than other varieties when marketed.

The meal from all of the varieties except Indore contained high amounts of glucosinolates (Table 2). These toxic products limit the use of the meal by-product as a high protein animal feed supplement. Nonruminant livestock fed diets containing glucosinolates show a reduction in the rates of both growth and reproduction. The development of high yielding varieties that did not contain glucosinolates would improve the price growers receive for rapeseed.

Edible Oil Varieties

Average seed yield of the six edible oil varieties ranged from 3,450 to 4,360 pounds per acre (Table 1). The varieties 'Jet Neuf,' 'WW 827,' 'Primor' and 'Brink' yielded from 20 to 8 percent more seed than Dwarf Essex. The varieties 'Sipal' and 'Quinta' had seed yields that were similar to Dwarf Essex. The seed yield potential of edible oil varieties is similar to industrial oil varieties. This means growers can produce good crops of either type of winter rape.

Winter survival of the six edible oil cultivars ranged from 64 to 86 percent at Moscow in 1980-81 (Table 2). All six of the edible oil varieties had acceptable winter survival. The oil contents of the edible oil varieties were about 2 percent lower than those of the industrial oil varieties and ranged from 40.1 to 42.2 percent.

All of the edible oil varieties evaluated in this test contain less than 2 percent erucic acid in the oil, but they have relatively high levels of glucosinolates (Table 2). As with industrial oil varieties, a need exists to develop or introduce varieties with low levels of glucosinolates if the seed is to be used as livestock feed or for human consumption.

Production Practices

Seedbed Preparation

Lack of soil moisture in the top foot of soil, soil crusting and waterlogging (Fig. 3) are three factors that can limit establishment of winter rape. Because of these factors, most winter rape is planted on fallow ground, and preparation of the seedbed should be done in a manner that reduces these problems.

Soil moisture retention in the surface 6 inches of soil is of utmost importance in establishing winter rape. In areas where fallowing is a normal practice and in marginal recrop areas, fallowing must be accomplished in a manner to prevent moisture loss in the surface 6-inch zone.

Seedbed preparation begins in the fall with the harvest of the previous crop. In areas with 14 to 18 inches of precipitation, and in areas where the soils remain unfrozen most of the winter the stubble from the previous crop should be left standing as upright as possible. Upright stubble aids snow capture and has been shown to store 20 percent more water in the winter months than clean fall tillage. In areas where the soil is frozen, fall chisel plowing or rough tillage aids in capture of water.

Fig. 3. Waterlogging damage on winter rape near Reubens, Idaho.

Table 2. Winter survival, oil content, erucic acid content and glucosinolate content of 12 varieties of winter rape evaluated in northern Idaho during 1978-81.

Variety	Origin	Winter survival	Average oil content	Glucosinolate content	Erucic content
		(%)	(%)	(%)	(%)
Industrial Oil					
Gorczanski	Poland	53	42.5	6.0	42.7
Norde	Sweden	75	43.1	6.3	42.9
Hector	Sweden	71	42.7	6.8	43.2
Dwarf Essex	Netherlands	77	42.6	7.8	41.9
Bishop	Canada	40	40.1	7.8	37.4
Indore	Oregon	51	41.8	T	42.2
Edible Oil					
Jet Neuf	France	86	40.1	6.2	T
WW827	Sweden	85	40.8	6.4	T
Primor	Sweden	78	41.5	5.8	T
Brink	Sweden	85	42.2	5.8	T
Quinta	West Germany	79	40.7	6.8	T
Sipal	Sweden	64	41.6	7.8	T

T = trace, usually less than 2% in self-pollinated seed samples.

Fallowing should begin as soon as soil conditions permit in the spring and continue at intervals to prevent weed growth and moisture loss. Weeds should be controlled before two or three expanded leaves develop. Plant residues should be maintained on the surface for as long as possible by using sweep cultivation. These residues are particularly important for moisture conservation early in the year. Later, the dust layer is more important than surface residue in prevention of soil moisture loss. Rod-weeding or sweep cultivation can be used later in the season as surface residues decline.

Cultivation depth should be uniform and shallow except for the first and last cultivations. Excessive losses of soil moisture will occur if cultivation depth is gradually increased over the fallowing period. The last cultivation should be deep enough to allow seeding into moisture.

The final seedbed should be fine but firm enough to allow good soil contact with the seed. A roller may be needed to firm up loose seedbeds.

Soil crusting can be prevented by avoiding excessive working of the soil and proper timing of cultivator and roller use. Cultivating and rolling should not be done when the soil is wet or when rain is expected within a few days.

Winter rape does not tolerate poorly drained sites. Wet bottomland and drainage areas should not be seeded to winter rape.

Rowspacing and Seeding Rates

Commercial recommendations for seeding rates of winter rape range from 4 to 12 pounds per acre. Rowspacings are usually 7 to 14 inches. Studies were conducted at Moscow to determine the response of winter rape to seeding rate and rowspacing.

Seed yield of Dwarf Essex winter rape planted on 7-inch rowspacings was significantly better than all other rowspacings tested in 1976-77 (Table 3). Seed yield on 21-inch rowspacings was less than half the seed yield obtained from 7-inch rowspacings. Since a low seeding rate (3 pounds per acre) was used at all rowspacings, lower yields of winter rape in wider rowspacings could have been caused by inadequate plant populations at the wider rowspacings. Consequently, a second trial was conducted in 1979-80 to simultaneously evaluate the influence of seeding rate and rowspacing. In this trial, seed yields of winter rape planted on 7- and 14-inch rowspacings were the same (Table 3). No increases in yield were noted as seeding rates increased from 6 to 18 pounds per acre (Table 4).

Table 3. Yield of Dwarf Essex winter rape planted on four rowspacings under dryland conditions in 2 years near Moscow, Idaho.

Rowspacings	Yield 1976-77	Yield 1979-80	Oil 1979-80
(inches)	———(lb/acre)———		(%)
7	5,055 a**	6,487 a	46.9 a
7,14,7*	3,488 b	—	—
14	4,101 b	6,890 a	47.2 a
21	2,229 c	—	—

*A pair of rows with 7-inch rowspacing; with 14 inches between pairs of rows.

**Means followed by the same letter are not significantly different according to Duncan's multiple range test.

Based on these trials, satisfactory winter rape stands can be obtained with seeding rates of 3 to 6 pounds per acre and 7-inch rowspacings. Higher rates should be used (7 to 10 pounds per acre) if rape is seeded on 14-inch rowspacings, if seeded later than Aug. 25 or if residues and clods prevent soil contact with the seed.

Rowspacing and seeding rate had no effect on oil percentage of the seed (Tables 3 and 4). Average oil percentage was 47.0 percent.

Seeding Depth

Preliminary investigations have shown that seeding deeper than 2 inches reduces vigor and fall development of winter rape seedlings (Table 5). Depth to moisture is a critical factor in the establishment of winter rape. Deep seeding increases the chances of good soil moisture for seed germination but also delays emergence and reduces stands. Delayed plant emergence may increase the probability of soil crusting because of increasing opportunities for rainfall after planting that could compact the soil surface.

Table 4. Yield of Dwarf Essex winter rape planted at three seeding rates in 1979-80 at Moscow, Idaho.

Seeding rate	Yield	Oil
———— (lb/acre) ————		(%)
6	7,147	47.1
12	7,007	47.4
18	6,453	46.7
LSD (0.05)	NS	NS

Table 5. Influence of seeding depth on stand and vigor of Dwarf Essex winter rape in 1977-78 at Moscow, Idaho.*

Depth of planting	Stand score	Vigor score
(inches)	———— (score) ————	
2	1.2 a**	1.0 a**
4	2.5 b	2.5 b
6	1.8 a	1.8 a

*Plots scored for stand and vigor: 1 = good performance; 2 = average performance; 3 = poor performance.

**Means within a column not followed by the same letter are different at the .05 level of probability according to Duncan's multiple range test.

Planting Dates

Planting winter rape in the first 2 weeks of August gave the highest percent winter survival and the highest seed yields (Table 6). When planted in late August, winter survival and seed yield declined slightly. Delaying planting until Sept. 13 reduced winter rape survival by 50 percent and seed yield by 34 percent compared to winter rape seeded in early August. Oil content of the varieties was not affected by date of planting. Optimum planting date for winter rape is during the first 2 weeks of August.

Sipal and Brink survived better than Dwarf Essex and Primor when seeded in mid-September. Sipal had the lowest survival of all edible oil varieties when planted in August (Table 2), indicating that varietal responses to planting dates will need to be tested for each new variety introduced into this area. Even the most hardy varieties showed significant reductions in both winter survival and seed yield when planted in September. Cultivars with higher levels of winter hardiness are needed to allow the production of winter rape after the harvest of early maturing cereal and pea crops.

Ability of seed to germinate under conditions of reduced moisture would also be a desirable trait. The potential for recrop production of rape would increase the acreage and decrease the cost of producing a crop of rapeseed.

Table 6. Average winter survival, seed yield and oil content of several varieties of winter rape planted at four dates during 1978, 1979 and 1980 at Moscow, Idaho.

Planting date	Winter survival	Oil content	Seed yield
	(%)	(%)	(lb/acre)
Aug. 1	75	44.0	3,970
Aug. 15	73	44.1	3,900
Aug. 29	68	44.4	3,620
Sept. 13	37	43.7	2,670
LSD (0.05)	15	NS	640

Recrop Studies

Winter rape establishment was good after peas harvested for freezing or canning but was poor after peas or barley harvested as dry seed in 1980-81 (Table 7). In 1981-82, winter rape stands were poor after the harvest of processing peas and completely failed to establish after peas or barley harvested as dry seed. Limited soil moisture in recrop ground and in the latest planting date in 1981 on fallow prevented successful establishment of winter rape. Soil moisture percentage of about 12 percent (wt/wt) in the surface 6 inches of soil was required for good establishment of winter rape.

Winter rape planted on fallow in 1980 produced about 1,000 pounds per acre more seed than winter rape after green peas (Table 7). No seed yields were obtained from winter rape after peas or barley harvested for dry seed in either year. Winter rape seed yields were not different when planted in early or mid-August on fallow in 1981. No yields were obtained from late planted fallow plots because the smaller plants in these areas were unable to withstand the wet soil conditions in these plots.

Oil percentage in the seed of winter rape was not affected by planting after peas harvested for processing in 1980 (Table 7). Nor was it affected by different dates of seeding on fallow in either 1980 or 1981.

Based on these studies, winter rape should be seeded on fallow or recrop acreage that contains at least 12 percent moisture in the surface 6 inches of soil. Seed yields of winter rape on fallow will probably be 20 percent higher than on recrop acreage. Winter rape planted after spring peas harvested as processing peas offers the greatest opportunity for successful establishment under dryland conditions. Winter rape establishment after harvest of spring peas or barley for dry seed does not appear feasible

Table 7. The effect of previous crop on stand establishment, yield and oil levels of winter rape grown in 1980-81 and 1981-82 at Moscow, Idaho.

Year	Previous crop	Planting date	Stand	Seed yield	Oil	Soil moisture*
				(lb/acre)	(%)	(%)
1980-81	Green peas	July 31	good	3,750	41.9	
	Dry peas	Aug. 21	poor	0	—	
	Spring barley	Sept. 5	poor	0	—	
	Fallow	July 31	good	4,550	42.2	
	Fallow	Aug. 21	good	3,400	42.6	
	Fallow	Sept. 5	good	4,670	42.1	
	LSD (0.05)			430	NS	
1981-82	Green peas	Aug. 4	poor	0	—	10.5
	Dry peas	Aug. 18	none	0	—	5.4
	Spring barley	Aug. 31	none	0	—	2.2
	Fallow	Aug. 4	good	4,250	45.1	16.1
	Fallow	Aug. 18	good	4,225	45.6	12.2
	Fallow	Aug. 31	poor	0	—	11.0
	LSD (0.05)		—	NS	NS	—

*In surface 6 inches

most years under dryland conditions. In years where summer rainfall is sufficient to raise moisture levels to 12 percent or more in the surface 6 inches of soil, winter rape will probably establish.

Under irrigated conditions, stubble could be irrigated, volunteer grain and weeds germinated and a seedbed prepared. With appropriate weed control, winter rape should be successful on irrigated recrop ground.

Fertilization

Seed yield and oil content of Dwarf Essex winter rape were measured in response to nitrogen, phosphorus, sulfur and lime applications from 1978-81 at several locations in northern Idaho (Fig. 4). Detailed results from these trials can be found in University of Idaho Research Progress Report No. 226.

Nitrogen

Nitrogen rates for optimum seed yields were 75 to 100 pounds per acre (Table 8). Residual soil nitrate nitrogen in these trials averaged 80 to 96 pounds per acre (20 to 24 ppm) in a 3-foot profile. Based on these data, winter rape in the Moscow and Nezperce areas would require about 155 to 200 pounds of total nitrogen for optimum yields. Apparently, about one-half of the total nitrogen required for winter rape accumulates in the soil during normal fallow and cropping operations. If winter rape was raised on recrop ground, 20 to 30 pounds per acre of additional nitrogen per ton of straw would be needed for straw decomposition.

Seed yields of winter rape at Moscow and Nezperce were higher when nitrogen was applied in the spring than when nitrogen was applied in the fall (Table 8). Winter rape fertilized in the spring averaged 463 pounds of seed per acre more than winter rape fertilized in the fall over 2 years of study at both locations.

Split applications of nitrogen, with two-thirds in the fall and one-third in the spring, produced yields less than when nitrogen was applied in the spring

Fig. 4. Healthy stand of flowering winter rape.

Table 8. Effect of nitrogen rate and time of application on seed yield and oil percentage at Moscow and Nezperce, Idaho.

Application		Seed yield			Oil percentage		
		Moscow		Nezperce	Moscow		Nezperce
Time*	Rate	1978-79	1979-80	1978-79	1978-79	1979-80	1978-79
		(lb/acre)			(%)		
—	0	4,638	4,574	2,275	46.8	48.7	45.3
F	25	5,297	—	2,618	47.5	—	44.8
F	50	4,928	4,708	—	47.6	48.9	—
F	75	5,417	—	—	46.5	—	—
F	100	—	5,428	2,132	—	48.7	44.7
F,S	15,10	5,600			46.8		
F,S	30,20	5,410			48.0		
F,S	45,30	5,749			46.0		
S	25	5,573	—	2,091	46.8	—	45.7
S	50	5,631	5,720	—	45.5	48.5	—
S	75	5,997	—	—	46.7	—	—
S	100	—	6,079	2,674	—	48.1	43.6
LSD (0.05)		244	608	446	NS	0.4	1.4
NO_3-N (ppm)**		24	20	23	24	20	23

*F = fall, S = spring

**Total amount of NO_3-N in 3 feet of soil.

but more than when nitrogen was applied in the fall (Table 8). Although not tested, split applications of nitrogen with one-third in the fall and two-thirds in the spring may be as effective as nitrogen applied in the spring only.

Losses of fall-applied nitrogen caused by leaching and volatilization are well documented in many areas of northern Idaho and could have contributed to lower yields of rape fertilized in the fall. Additionally, European research has shown that winter hardiness of winter rape declines as nitrogen levels increase. Reduced stands of winter rape were observed from fall-applied nitrogen and lime in 1978-79 at Moscow in trials adjacent to the nitrogen experiments.

Oil percentage was generally not affected by time of nitrogen application (Table 8). Excessive rates of nitrogen reduced oil percentage in the seed, especially at Nezperce in 1978-79. Delayed maturity of seed caused by the high nitrogen rates probably caused the reduced oil levels.

Phosphorus Responses

No change in seed yield or oil percentage was noted in response to phosphorus application. Lack of phosphorus incorporation may have limited winter rape response even though soil levels of phosphorus were low. Phosphorus will probably be needed for winter rape when University of Idaho soil test values are below 4 ppm. If soil test values are below 4 ppm, apply 40 to 60 pounds of phosphorus (P_2O_5) in the fall. Phosphorus should be incorporated 2 to 4 inches in the soil or banded adjacent to or below the seed for best results.

Sulfur Responses

Winter rape response to sulfur applications were variable. Soils with at least 10 ppm in the surface foot will probably not require sulfur applications for winter rape production.

Nitrogen Timing and Liming Application

Addition of 50 pounds nitrogen in the fall or spring provided 755 and 687 pound increase, respectively, in seed yield over the control (Table 9). Fall application of lime with fall-applied nitrogen reduced seed yield compared to nitrogen alone. Application of lime in the fall with nitrogen applied in the spring gave yields comparable to 50 pounds nitrogen alone in the fall. Winter rape fertilized with lime in the fall and nitrogen in the spring average 1,125 pounds of seed per acre more than winter rape fertilized with lime and nitrogen in the fall.

Winter rape fertilized in the fall with 50 pounds nitrogen per acre or in the spring with 50 pounds nitrogen per acre yielded the same. Thus, nitrogen loss overwinter does not account for differences observed between fall-applied nitrogen and lime treatments and spring-applied nitrogen and lime treatments. The number of reproductive nodes on winter rape plants that received a combination of fall-applied lime and spring-applied nitrogen were higher than the number of reproductive nodes on winter rape plants that received a combination of fall-applied lime and fall-applied nitrogen (Table 9). The control plants, however, had the highest number of reproductive nodes of all treatments.

Fall application of lime generally had no influence on yield, except when applied at rates of 5,000 pounds per acre with spring-applied nitrogen (Table 9). When lime and nitrogen were applied in the fall, reduced stands were noted. Lime applications have increased diseases of certain vegetable crops in Oregon. Additionally, fall-applied nitrogen can reduce the winter hardiness of rape. Perhaps either or both of these possibilities could have reduced populations and subsequent yields of rape in these studies.

Bonners Ferry N, P and S (1979-80)

Soil test values for nitrogen, phosphorus and sulfur were exceedingly high (Table 10). The Devoigne silt loam soil has characteristically given similar oil test values in previous years.

No seed yield, oil percentage, stand or vigor response were noted from nitrogen, phosphorus or sulfur applications (Table 11). Winter rape fertilized

Table 9. Effects of nitrogen and liming on seed yield, oil content and reproductive nodes of winter rape in 1978-79 at Moscow, Idaho.

Rate			
N	Lime	Seed yield	Oil content
(lb/acre)			(%)
0	0	4,056	48.0
50 F*	0	4,811	48.0
50 F	1,000	4,192	48.1
50 F	3,000	3,962	47.8
50 F	5,000	4,279	47.6
50 S	0	4,743	47.8
50 S	1,000	5,187	47.8
50 S	3,000	5,027	47.9
50 S	5,000	5,594	47.9
LSD	(0.05)	471	NS

*F = fall applied, all lime applied in fall; S = spring applied.

Table 10. Soil test taken on Aug. 16, 1979, for winter rape fertilizer trials, Bonners Ferry (Devoigines silt loam).

Soil depth	NO_3-N	SO_4	P	K	Soil reaction
(inches)	(ppm)				(pH)
0 to 6	—	104	6.9	180	7.5
0 to 12	153				
12 to 24	138				
24 to 36	101				

with 48, 60 and 42 pounds of nitrogen, P_2O_5 and sulfur, respectively, produced 1,910 pounds per acre more than winter rape receiving no fertilizer, but this yield response was not significant because of high biological variability. The cause of this variability is unknown. Additional trials are needed to ascertain the influence of fertilization of winter rape at Bonners Ferry.

Seed yields at Bonners Ferry were the highest of all locations tested. The cool temperatures and frequent morning dews apparently are very favorable for winter rape production.

Fertilizer Recommendations

Apply nitrogen in the spring or in split applications with one-third in the fall and two-thirds in the spring. Optimum rates are 75 to 100 pounds per acre on summer fallow ground that has 100 pounds of residual nitrogen in the soil as indicated by soil test. Total nitrogen requirements, residual and mineralizable soil nitrogen plus applied nitrogen, appears to be 175 to 200 pounds per acre.

Phosphorus will probably be required for winter rape and should be incorporated before planting or banded at time of seeding. Use winter wheat soil test guidelines (Table 12) for phosphorus application rates.

Soils with at least four ppm of residual sulfur in the surface foot may not require sulfur applications

Table 11. Influence of nitrogen, phosphorus and sulfur on agronomic performance of Dwarf Essex winter rape at Bonners Ferry, Idaho, in 1979-80.

Fertilizers			Seed			
N	P	S	Yield	Oil	Stand*	Vigor*
----(lb/acre)----				(%)	(number)	
0	0	0	6,304	42.4	2.2	1.8
16	0	0	7,208	42.4	1.5	1.2
32	0	0	6,999	42.4	1.2	1.5
48	0	0	6,720	42.3	2.2	2.0
32	0	14	7,064	42.6	1.8	2.0
32	0	28	7,607	42.7	2.5	2.2
32	0	42	7,550	42.5	2.0	2.2
16	20	14	7,256	42.3	2.0	1.8
32	40	28	6,668	42.0	1.5	1.5
48	60	42	8,214	41.8	2.2	2.0
LSD (0.05)			NS	NS	NS	NS

*Visual estimate with 1 = best; 5 = worst stand or vigor on April 3, 1980.

Table 12. Phosphorus (P) fertilizer rates based on soil test.

Soil test* (0 to 12 inches)	Apply (pounds/acre)	
(ppm P)	(P_2O_5)	(P**)
0 to 2	60	26
2 to 4	40	18
over 4	0	0

*Sodium acetate extractable P.
**$P_2O_5 \times 0.44 = P \times 2.29 = P_2O_5$

for winter rape production. Additional work is required for further sulfur recommendations.

Winter rape responded to 5,000 pounds of lime incorporated in the fall when soil pH was 5.3. Applications of high rates of lime and nitrogen in the fall should be avoided.

Swathing

Seed maturity of winter rape is variable because of its indeterminate flowering habit. Consequently, mature pods shatter causing seed loss (Fig. 5) while others are still green. Harvesting early to reduce shatter losses reduces oil content and makes seed storage difficult because of higher seed moisture. Swathing may be one method of reducing seed loss and storage problems.

The objectives of these studies were to determine the influence of time and height of swathing on yield, oil percentage and seed moisture of winter rape. Trials were conducted at Moscow in 1978-79 and 1979-80 and at Nezperce in 1979-80.

Swathing height and date generally did not alter seed yields or oil percentage of winter rape except when seed moisture was 33 percent or higher. When seed moisture was 33 percent, swathing at 18 or 24 inches above ground level significantly reduced seed yield compared to yield of rape not swathed. When seed moisture was 31 percent or lower, swathing height did not influence seed yield. Seed filling apparently requires more stem and leaf tissue when winter rape seed has more than 33 percent moisture.

Because no yield advantages were found from swathing, swathing of winter rape is not a recommended practice. Swathing could allow faster and earlier harvesting and reduce storage problems but can reduce seed yields and oil percentage if not done at proper seed moisture.

If swathing or winter rape is attempted, seed moisture percentage must be carefully determined. Seed moisture percentage is difficult to determine

Fig. 5. Winter rape shattered by wind and rain.

accurately because black, red and green seed will simultaneously exist on the same plant. Estimates of seed moisture begin with careful selection of the pods. Several pods should be taken from main and lateral branches in proportion to relative maturity of the pods on main and lateral branches. Remove seed from the pods, and determine the percentage of black seed in the sample. Swath when black seed percentage is between 60 and 75 percent. Seed moisture levels would range between 30 and 40 percent, respectively, at 60 and 75 percent black seed.

Insect Control

Few insect pests require control in winter rape fields. Cabbage seed pod weevil (CSPW) *Ceutorhynchus assimilis* Paykull and the cabbage aphid *Brevicoryne brassicae* (L.) are primary pests. Nine species, including three flea beetles, armyworms, cabbage worms, aphids, lygus bugs and the diamond back moth are considered secondary pests of rape.

Pollinating insects and predators of key pests are found in flowering winter rape. These beneficial species should be considered before control measures are initiated.

Cabbage Seed Pod Weevil

The CSPW has a single generation each year and overwinters out of rape in plant residue at or just below the soil surface. The weevils are ash-gray in color and less than ⅛ inch long with dark curved snouts (Fig. 6). Weevils fly from hibernation sites to nearby cruciferous plants on sunny, warm, spring days and move to rape that is flowering. Peak numbers of adults are observed in fields in full bloom.

Mating occurs in early spring. Females begin laying eggs as soon as pods are formed and continue until seeds are approaching maturity. The female lays eggs singly in feeding punctures in the pods. Each female is capable of laying 25 to 60 eggs during a growing season. Egg hatch is retarded during periods of cool temperatures. At Moscow, egg numbers stay at low levels through May and generally during the first week in June but are four to five times higher in pods during the last part of June.

The larvae are white, legless grubs with light brown heads (Fig. 7). They feed on the developing seeds and pith material in the pods. Each larva will consume or destroy five to seven rape seeds to complete its development. Three larval molts take from 14 to 40 days depending on temperature. Egg hatch is not observed until the end of May, and the larval stage does not become the predominant life form until mid-June. Beginning mid-June, the rate of insect development increases significantly, and this accelerated population growth continues into the later part of the growing season. Mature larvae cut a small circular hole in the pod and crawl or drop to the soil surface where they burrow in the soil and construct an earthen cell to pupate.

New adults emerge from the soil and move to host plants where they commonly feed on pods or stems that are still green, but they cause little injury. When plants have fully matured, this new generation flies to hibernation sites to spend the winter.

Several wasp parasites of the CSPW are known in the Pacific Northwest. On occasion, these natural enemies may play a significant role in regulating CSPW larval numbers and subsequent damage, especially in unsprayed fields.

Larvae feeding on developing seeds of winter rape cause reduced yields. The potential for yield loss in northern Idaho generally averages from 15 to 35 percent in unsprayed winter rape, but greater individual losses have been observed.

Little damage to seed occurs in May, and damage in early June is negligible for the area. The majority of larval feeding and resulting damage as loss of seeds occurs from mid to late June most years. At this time, all pods, regardless of age, are suitable

Fig. 6. Adult cabbage seedpod weevil.

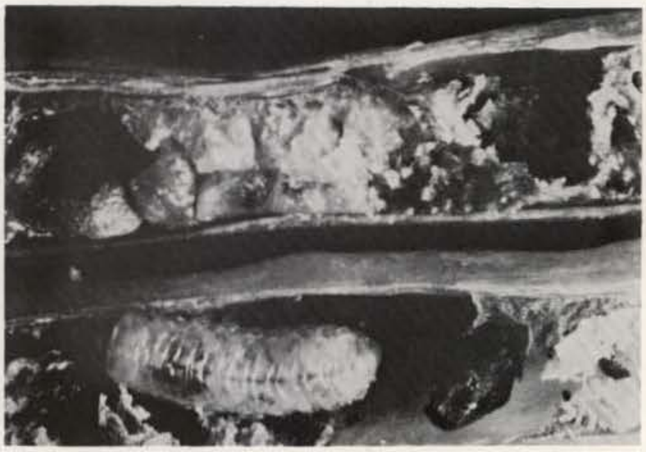

Fig. 7. Larva and damage caused by larva to developing seeds. Each larva can consume or destroy five to seven seeds.

sites for insect development and temperature is optimal for the insect. These conditions, however, would be expected to occur somewhat earlier at nearby lower elevations and somewhat later at higher elevations.

Sweeping with an insect net has been used to assess adult populations, and presence or absence can be determined. Up to 30 CSPW adults per 180° sweep can be observed in rape fields in full bloom. It is the populations present in the field when temperatures are warm and pods are susceptible that they inflict economic loss. Numbers as low as three to six per sweep in late June have caused economic problems. The relationships of sampling time, location and number of CSPW adults in a field and potential yield reductions are not precisely known.

Adult and immature CSPW populations were monitored from the initiation of bloom to harvest in commercial rape fields during 4 years. Efficacy of commercially applied insecticides by air at recommended rates was studied for several chemicals. Timing of ethyl parathion applications was also determined. When appropriate, 2- to 5-acre untreated areas within treated fields were maintained as checks.

Populations of CSPW eggs and larvae in these trials followed the developmental patterns discussed earlier. Two or three applications of thiodan or Penncap M (not currently registered for use in rape) applied at recommended rates during late May and early June generally reduced adult CSPW populations to low levels (2 to 3 CSPW per 180° sweep) but failed to control larvae. Estimated yield losses averaged 15 percent for 11 fields protected with these insecticides during 2 years.

Ethyl parathion was observed to control CSPW eggs and larvae in rape pods when applications were made to small plots on days when temperatures were at least 70°F. Efficacy of ethyl parathion for egg and larval control when applied commercially by air at recommended rates and times was evident by estimating yield losses (Table 13). Single applications were not as effective as when two applications approximately 7 days apart were used. In the latter case, crop loss was reduced to less than 1 percent. The lack of adequate control for single applications at some locations was thought to be caused by problems of adult reinfestation occurring mid to late June.

Control recommendations in areas where rape is grown regularly should be based on the presence of adult CSPW and timed to prevent damage from larvae in rape pods. Two postbloom aerial applications of ethyl parathion at 0.5 pound actual insecticide per acre 5 to 7 days apart will prevent CSPW damage. Ethyl parathion also controls the cabbage aphid. Occasionally aphid infestation, however, in winter rape might require an early season insecticide application.

Weeds and Their Control

Weeds are generally not a problem when winter rape is properly established on well managed fallow ground. Properly timed cultivations during the fallow period and dense ground cover provided by well established winter rape, control most annual weeds and reduce growth of perennial weeds. Perennial weeds such as quackgrass (*Agropyron repens*), Canada thistle (*Cirsium arvense*) and field bindweed (*Convolvulus arvensis*) may require special treatment during the fallow year.

Perennial Weeds

During the fallow year, preceding the planting of winter rape, the timing is right to control troublesome perennial weeds such as Canada thistle, field bindweed and quackgrass. A combination of a tillage and herbicide spray program is usually best for control of these perennial weeds. Exercise caution, however, when selecting a herbicide spray program to avoid damage to the subsequently planted winter rape crop. Avoid using soil residual herbicides such as dicamba (Banvel), picloram (Tordon) and chlorsulfuron (Glean). If 2,4-D is used, do not plant treated land until 3 months after treatment or until the chemical has disappeared from the soil.

Table 13. Estimated yield loss by percent cabbage seedpod weevil with and without one or two ethyl parathion treatments (0.5 lb ai/acre), northern Idaho.

Time	Year 1 (single treatment) by May 28		Year 2 (single treatment) by June 4		Year 3 (double treatment) by June 3 and 10	
	(%)		(%)		(%)	
Location	TRT	UTC[1]	TRT	UTC	TRT	UTC
1	5.7[2]	20.7	5.7	18.6	0.3	51.9
2	7.8	—	6.0	21.6	0.3	26.1
3			12.9	33.0	0.2	10.5
4			18.6	42.0		
5			20.4	39.0		

[1]UTC: unsprayed control area of at least 5 acres in treated fields.

[2]Each percentage figure based on average number CSPW emergence holes at harvest for 10 randomly selected plants from each of four areas in treated and untreated field portions.

Canada thistle, field bindweed and quackgrass can be controlled in fallow by a thorough tillage program. It can, however, take 2 to 5 years to effectively control dense, established stands of these weeds with cultivation alone. Cultivation should begin 12 to 14 days after emergence, with about 14 to 18 days between subsequent tillages. The interval between tillages should be frequent enough to cause continued depletion of root food reserves. This can be accomplished by cultivating when newly emerged plants are relatively small (Canada thistle, rosettes 2 to 4 inches in diameter; field bindweed, vines less than 4 inches in length; and quackgrass, at the 3- to 4-leaf stage and less than 6 inches tall). The optimum depth of cultivation is 4 inches.

For Canada thistle and field bindweed, use a tillage implement that will sever the shoots from the root stock (e.g. field cultivator equipped with duckfoot sweeps). For quackgrass, use a tillage implement, such as a disk, that will pull the rhizomes to the surface where they will desiccate and die.

Quackgrass can be controlled during the fallow year with application(s) of fluazifop-butyl (Fusilade 4E) at the rate of 0.5 pound (ai) per acre (1 pint) plus 1 quart of oil concentrate (use nonphytotoxic crop oil that contains 15 to 20 percent surfactant). Apply the herbicide by ground using 25 gallons of dilute spray per treated acre with 30 to 60 psi pressure. Spray to obtain thorough coverage of quackgrass foliage but not to runoff. Use standard pesticide hollow core or flat fan nozzles. Treat quackgrass when it has three to five leaves but not when it is more than 10 inches tall. Repeat treatment if regrowth occurs or to control newly germinating seedlings. Care should be taken to avoid planting any crop into this seedbed within 60 days of the last application.

Annual Weeds

Trifluralin (treflan) is the only herbicide registered for use with winter rape. Rates vary with soil texture and formulation (Table 14). Apply trifluralin in accordance with label instructions. Good establishment of winter rape is also essential for effective weed control.

Winter rape should be planted in early to mid-August at proper rates and depths (see seeding rate and depth section) to ensure good stands. Once established, the dense ground cover prevents establishment of annual weeds and slows growth of established perennial weeds.

Table 14. Rates and formulation of Trifluralin (Treflan*) for weed control in winter rape.

Soil texture	Formulation		
	E.C.	PRO-5	5G/5GL
	———(pints)———		(pounds)
coarse	1	0.8	10
medium	1.5	1.2	15
fine	2	1.6	20

*Incorporate 3 to 4 inches deep with equipment specified on label.

Weed control may be a major problem for establishment of winter rape after another crop. Under dryland conditions, moisture may not be sufficient to germinate weeds before planting. On irrigated ground, the soil profile should be moistened to 2 feet to allow germination of crop and weed seeds after harvest and for sufficient moisture to support fall growth of winter rape. Normal seedbed preparation operations should be used to control crop and weed seedlings. As with fallowing, the last cultivation should be timed to kill the last flush of weeds just before planting. Trifluralin may be incorporated 3 to 4 inches deep as part of the last seedbed preparation operation if desired.

Diseases and Their Control

Diseases are generally not a problem for winter rape production in this area, but *Pythium* and *Sclerotinia* spp. have occasionally been problems under certain conditions. Pythium is most likely to occur when winter rape is seeded Sept. 1 or later. Combinations of Pythium and reduced winter hardiness caused by late seeding have reduced winter rape stands at both Grangeville and Bonners Ferry. Poor stands in wet areas may also be partially attributable to Pythium infection. Seeding winter rape between Aug. 1 and 15 in well-drained fields should avoid problems with Pythium.

Sclerotinia has been found in small areas of winter rape fields but generally is not of major consequence. Excess nitrogen has increased incidence of Sclerotinia in other oilseed crops and may do the same in winter rape. *Sclerotinia* spp. also attacks potatoes, peas, beans and other Idaho crops. At the present time, no evidence exists to suggest that inclusion of winter rape in the rotation has increased the incidence of Sclerotinia when in rotations with other susceptible crops. Avoiding excess nitrogen application and using good rotation practices should prevent most Sclerotinia problems.

Potential Markets

Twelve million tons of rapeseed are produced on 20 million acres of land throughout the world. Canada, China, India, Poland, France, Denmark and West Germany produce more than 90 percent of this crop. Most rapeseed is processed with both the meal and oil consumed within the country in which it is produced. Less than 15 percent of the rapeseed crop is sold on the export market. Canada produces more than 60 percent of the rapeseed traded in the international marketplace. Japan and western

Europe buy 80 and 10 percent, respectively, of the world's exported rapeseed crop. Most of the exported rapeseed is sold as whole seed. In 1981, Japan bought $390 million of rapeseed while purchasing only $11 million of processed rapeseed oil.

Nearly all the rapeseed exported contains an edible oil that is low in erucic acid and has meal with low levels of glucosinolate. In the U.S., current regulations limit the use of any rapeseed oil for products destined for human consumption. To be competitive in the export market, U.S. farmers would need to grow rapeseed varieties that produce an edible oil with low levels of erucic acid and meals with low levels of glucosinolates.

Rapeseed grown in the Pacific Northwest could be sold to export markets in direct competition with the Canadian crop that is currently shipped through Vancouver, B. C. The Canadian rapeseed crop is spring-planted and harvested in late September. Canadian rapeseed contains from 40 to 42 percent oil. Winter rapeseed grown in northern Idaho matures by early August and contains from 42 to 46 percent oil. If varieties were grown that produce seeds with low levels of erucic acid and glucosinolate, it is possible the U.S. crop could receive a premium for both early delivery and higher oil content.

The price of rapeseed in the international marketplace has been competitive with sunflower seeds and has averaged $270 per ton over the past 5 years. To obtain competitive ocean freight rates, however, would require a minimum shipment of 15,000 tons of rapeseed. To be viable, three to four shipments would need to occur annually. A venture of this magnitude would require the cooperative efforts of growers, processors and exporters. The economic benefits, however, of increasing the number of crop commodities exported from this region could be substantial.

Other publications on winter rape and vegetable oil research at the University of Idaho College of Agriculture are available:

MS 73	The Potential of Vegetable Oil as an Alternate Source of Liquid Fuel for Agriculture in the Pacific Northwest ..	$5.00
MS 84	The Potential of Vegetable Oil as an Alternate Source of Liquid Fuel for Agriculture in the Pacific Northwest II	$5.00
PR 226	Fertilization Studies with Winter Rape in Northern Idaho	NC

You can get copies of these publications from your University of Idaho Cooperative Extension Service county office. Or, you can order directly:

Agricultural Communications Center
Agricultural Publications Building
University of Idaho
Moscow, Idaho 83843

Please list publications by title and number on your order. Make your check payable to **University of Idaho.**

Two other publications are available from Washington State University Cooperative Extension and Agricultural Research Center, Pullman:

EXT 1064	Rapeseed Culture and Use
RES XB 0921	Performance of Spring and Winter *Brassica* (Rape) in Central Washington

SERVING THE STATE

Teaching . . . Research . . . Service . . . this is the three-fold charge of the College of Agriculture at your state Land-Grant institution, the University of Idaho. To fulfill this charge, the College extends its faculty and resources to all parts of the state.

Service . . . The Cooperative Extension Service has offices in 42 of Idaho's 44 counties under the leadership of men and women specially trained to work with agriculture, home economics and youth. The educational programs of these College of Agriculture faculty members are supported cooperatively by county, state and federal funding.

Research . . . Agricultural Research scientists are located at the campus in Moscow, at Research and Extension Centers near Aberdeen, Caldwell, Parma, Tetonia and Twin Falls and at the U. S. Sheep Experiment Station, Dubois and the USDA/ARS Soil and Water Laboratory at Kimberly. Their work includes research on every major agricultural program in Idaho and on economic activities that apply to the state as a whole.

Teaching . . . Centers of College of Agriculture teaching are the University classrooms and laboratories where agriculture students can earn bachelor of science degrees in any of 20 major fields, or work for master's and Ph.D. degrees in their specialties. And beyond these are the variety of workshops and training sessions developed throughout the state for adults and youth by College of Agriculture faculty.