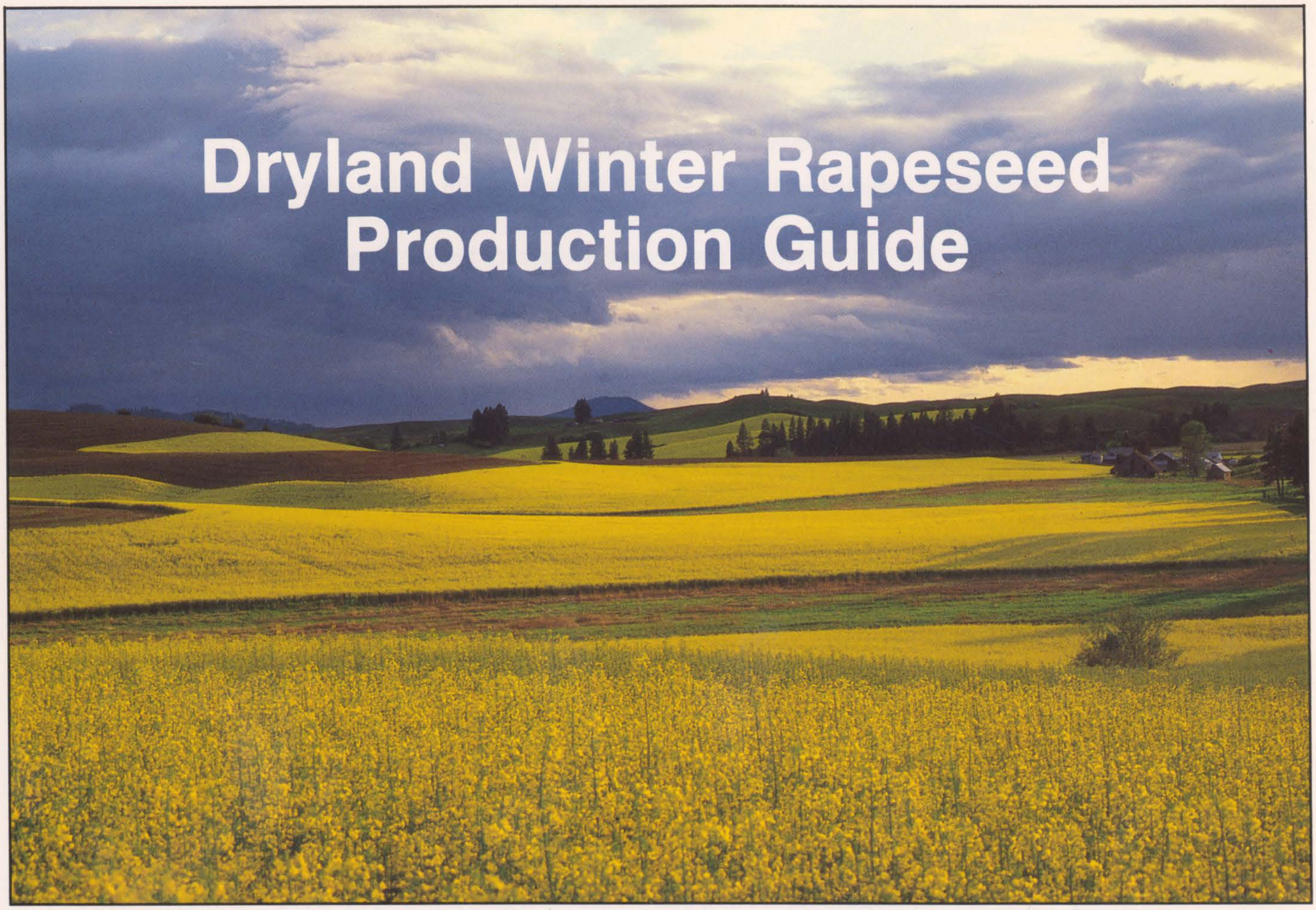
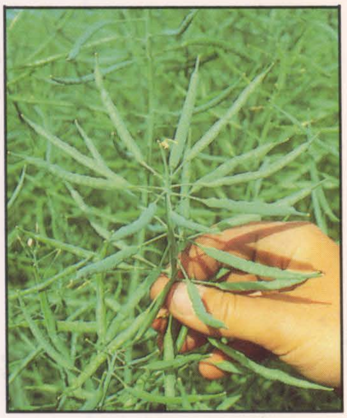
Dryland Winter Rapeseed Production Guide





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Cooperative Extension System

University of Idaho

College of Agriculture

Basic Recommendations

- Plan winter rapeseed production strategy beginning with the harvest of the previous crop.
- Use cost-effective practices and secure a contract before planting.
- Select industrial or edible varieties to match your district, crop rotation and climate.
- Select well-drained fields that minimize waterlogging damage and fields with few potential weed and disease problems.
- Prepare the seedbed, plant and fertilize for optimum yields.
- Remember, few herbicides, insecticides and seed treatment fungicides are available. Timing of pesticide application and cultural practices is important for effective control of weeds, insects and diseases.
- Monitor crop maturation and time harvest operations to coincide with optimum yield and seed quality.
- Harvest winter rapeseed in mid-June for optimum forage yield and quality.

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Increased demand for alternative crops in the Pacific Northwest has attracted increased interest in rapeseed. Winter rapeseed has demonstrated better adaptation than spring types in many production areas of the Pacific Northwest. Numerous winter rapeseed varieties are readily available to producers. This publication provides current production information for winter rapeseed grown in dryland environments in northern Idaho. Many of the production practices apply also to eastern Washington, eastern Oregon and western Montana.

Rapeseed production districts

Winter rapeseed production in Idaho is restricted by production districts to avoid cross-pollination between edible and industrial varieties (Fig. 1). District I permits the production of edible winter rapeseed varieties only. District II permits the production of industrial varieties only. Districts III, V and VI permit production of industrial varieties without restriction and production of edible varieties under specific conditions. District IV prohibits all rapeseed production.

Rapeseed production district regulations apply to certified seed production as well as to commercial seed production. The Idaho Department of Agriculture governs the establishment and enforcement of the rapeseed production districts. For more information, see University of Idaho CIS 819, *Rapeseed Production Districts in Idaho,* or contact the Idaho Department of Agriculture in Boise.

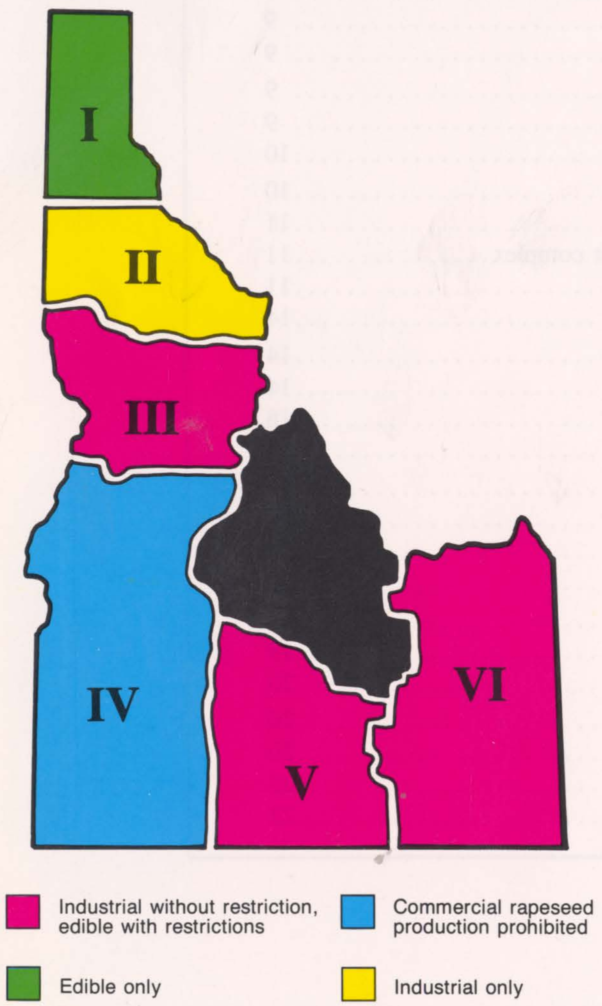

Fig. 1. Current (1990) rapeseed production districts in Idaho.

Rotation and field selection

Commercial seed production

Recommended rotation restrictions for growing winter rapeseed in sequence with other dryland crops are listed in Table 1. All currently available winter rapeseed varieties are susceptible to the triazine herbicides. Rhizoctonia root rot, Fusarium root rot and Sclerotinia stem rot are diseases common to rapeseed, field peas, lentils, sunflowers, mustards and other cruciferous crops. Mustards (*Brassica* spp.) are difficult to control, and mustard seed in a rapeseed seedlot can result in dockage penalties. Avoid planting in fields where volunteers from previous mustard crops or mustard weed species are expected.

Winter rapeseed can be grown in rotation with either fall- or spring-seeded small grains with few restrictions. Rapeseed and small grains appear to have no diseases in common. Mustards, volunteer rapeseed and other annual broadleaf weed problems can be controlled with herbicides

Table 1. Crop rotations and potential problems for winter rapeseed production.

Crop	Wait period (years)	Potential problems
Wheat Barley Oats	0	No diseases in common. Control mustards and other annual broadleaf weeds in the cereal crop. Do not use herbicides that may carry over.
Buckwheat	1	Volunteer buckwheat can be a serious weed problem.
Corn	1	Atrazine carryover is detrimental to winter rapeseed. No wait period is necessary if triazine-resistant rapeseed varieties are used (currently available in spring rapeseed only).
Field peas Faba beans Clovers	1	Rhizoctonia root rot, Fusarium root rot and Sclerotinia stem rot are common disease problems. Less risk associated with these crops than with other crops.
Alfalfa	2	Rhizoctonia root rot, Fusarium root rot and Sclerotinia stem rot are common disease problems.
Mustards Sunflowers Lentils	3	Rhizoctonia root rot, Fusarium root rot and Sclerotinia stem rot are common disease problems. Contamination with mustards should be avoided. Control mustards during rotation period.

in a small grain crop preceding rapeseed production. Avoid using soil residual herbicides such as dicamba (Banvel), picloram (Tordon) and chlorsulfuron (Glean) that may carry over into the winter rapeseed crop.

Volunteer cereals may occur in a winter rapeseed crop in years when late-summer precipitation permits recropping immediately after winter cereal production. Harvesting techniques that minimize grain loss and cultivation after cereal seedling emergence will minimize winter volunteer cereal problems. Avoid planting in fields where grain shattering losses have been high.

Winter rapeseed requires higher soil moisture levels during germination and emergence than either wheat or barley, yet rapeseed does not tolerate waterlogged soils. Avoid fields or portions of fields with poor drainage and high water tables.

Certified seed production

Additional location and rotation restrictions apply to certified winter rapeseed production (Table 2). Growers interested in producing certified rapeseed should first consult the latest *Idaho Rules of Certification* for rapeseed published annually by the Idaho Crop Improvement Association.

Winter rapeseed varieties

Rapeseed uses and production areas (Fig. 1) are determined by the erucic acid level in the seed oil. Industrial rapeseed varieties produce oils with high levels of erucic acid (40 to 55 percent). These oils are used as lubricants and in the manufacture of nylon-like products. High levels of erucic acid in animal diets have been linked to a number of metabolic and heart disorders.

Edible varieties contain less than 2 percent erucic acid in the seed oil. These oils are used for cooking and in margarines and salad dressings.

Canola varieties produce oils with less than 2 percent erucic acid and meals with less than 30 micromoles per gram of glucosinolates. High levels of glucosinolates in poultry rations have caused thyroid disorders. Industrial and edible rapeseed varieties may contain any level of glucosinolates.

Table 2. Minimum isolation distances and rotation restrictions for individual fields producing foundation, registered and certified classes of rapeseed.

Certification class produced	Isolation distance: Fields of cross-pollinated varieties	Isolation distance: Fields of self-pollinated varieties	Years since previous rapeseed crop
	feet	feet	
Foundation	1,320	660	5
Registered	1,320	660	4
Certified	660	330	3
Different generation of same variety	15	15	*

Source: 1990 Idaho Rules of Certification. Idaho Crop Improvement Association, Inc., 1641 South Curtis Road, Boise, Idaho 83705.

*No time limit specified in certification rules.

Industrial varieties

Two varieties of industrial winter rapeseed have been extensively evaluated for yield and quality across the Pacific Northwest (Table 3). Dwarf Essex, with a history of production in the region, has produced excellent seed yields and good levels of erucic acid (Tables 4 and 5).

Bridger has produced seed yields equal to or slightly lower than Dwarf Essex's but has produced higher oil and erucic acid levels. Bridger's glucosinolate levels have been significantly lower than those of Dwarf Essex in all production environments (Table 6). Therefore, domestic and export crushers of industrial rapeseed have preferred Bridger to Dwarf Essex for blending with canola meals to develop feed products with less than 30 micromoles glucosinolates per gram.

Edible and canola varieties

Canola rapeseed varieties produced in the Pacific Northwest should meet or exceed specifications for Canadian-grown "canola" edible rapeseed to be economically competitive. Therefore, varieties should be selected that consistently produce seeds with less than 2 percent erucic acid in the oil and less than 30 micromoles of glucosinolates per gram of defatted meal. Glucosinolates should be determined using the procedure recommended by the Canadian Grain Commission. Nearly all varieties evaluated have produced oils containing less than 2 percent erucic acid

Table 3. Industrial-, edible- and canola-quality winter rapeseed varieties currently available in the Pacific Northwest.

Variety	Attributes
Industrial types	
Dwarf Essex	Imported over 30 years ago from Holland where it is grown as a forage variety. Dwarf Essex has high levels of erucic acid and glucosinolates.
Bridger	Released by the University of Idaho in 1986 and protected by the U.S. Plant Variety Protection Act (PVP 8500171). Bridger produces high levels of erucic acid and intermediate levels of glucosinolates.
Edible types	
Bienvenu Jet Neuf	Developed by UNCAL/Serasem in France. Bienvenu and Jet Neuf have been grown extensively in Europe. In Pacific Northwest trials, both varieties produce an edible quality oil and meals with high levels of glucosinolates.
Canola types	
Cascade	Released by the University of Idaho in 1986 and protected by U.S. PVP 8500172. In Pacific Northwest trials, Cascade has consistently produced canola-quality seed with low levels of glucosinolates.
Glacier	Developed by the Swedish Seed Association and protected by U.S. PVP 8600004. Glacier produces edible oil and intermediate levels of glucosinolates in Pacific Northwest environments.

Table 4. Seed yields of six winter rapeseed varieties at four Pacific Northwest locations, 1987-1989.

	Northern Idaho			Western Washington			Western Oregon			Western Montana		
	1987	1988	1989	1987	1988	1989	1987	1988	1989[1]	1987	1988	Average
	pounds per acre											
Industrial types												
Dwarf Essex	829	6,095	5,982	3,569	4,089	3,115	3,449	3,325	1,630	3,072	2,000	3,380
Bridger	843	5,674	4,154	4,098	3,152	4,048	2,228	2,669	2,034	2,537	2,155	3,054
Edible types												
Bienvenu	1,105	7,638	4,010	3,929	5,727	1,726	4,055	3,750	1,598	2,328	1,890	3,432
Jet Neuf	947	5,859	4,397	3,488	3,198	3,121	2,866	3,248	1,834	3,258	2,544	3,160
Canola types												
Cascade	688	5,987	5,484	3,977	4,208	3,937	2,969	2,346	1,533	2,595	1,642	3,215
Glacier	989	6,229	5,556	4,036	3,895	3,787	3,726	2,828	2,547	2,943	2,095	3,512
LSD (p = 0.05)[2]	277	681	1,474	1,060	1,388	1,360	851	685		902	906	

[1]Data represents one replication; no statistical analysis run.

[2]LSD = least significant difference. Within each year at each location, seed yields that differ by more than the LSD value shown are statistically different at the 0.05 probability level.

Table 5. Oil contents and erucic acid levels of two varieties of industrial winter rapeseed grown at four locations in the Pacific Northwest, 1987-1989.

	Northern Idaho			Central Washington			Western Oregon			Western Montana		
	1987	1988	1989	1987	1988	1989	1987	1988	1989	1987	1988	Average
	% of whole seed											
Oil content												
Dwarf Essex	36.5	40.5	40.7	47.1	44.5	46.8	43.2	43.9	39.0	38.9	39.6	41.9
Bridger	37.1	41.2	40.4	46.4	45.6	46.8	44.2	44.0	40.7	39.0	40.0	42.3
LSD (0.05)[1]	1.1	0.9	0.8	1.6	2.3	2.1	1.4	1.4	—	1.1	1.0	
	% of oil content											
Erucic acid												
Dwarf Essex	—	45.9	47.8	44.6	49.7	—	43.0	43.8	—	52.0	48.8	47.0
Bridger	53.1	51.5	51.4	46.8	43.6	—	42.1	47.2	—	51.4	50.6	48.6

Note: Oil content and erucic acid levels are based on duplicate determinations but not statistically analyzed.

[1]LSD = least significant difference. Within each year at each location, oil contents that differ by more than the LSD value shown are statistically different at the 0.05 probability level.

Table 6. Glucosinolate contents of six varieties of winter rapeseed grown at four locations in the Pacific Northwest, 1987-1989.

	Northern Idaho			Eastern Washington			Western Oregon		Western Montana		
	1987	1988	1989	1987	1988	1989	1987	1988	1987	1988	Average
	μmoles/g of defatted meal										
Industrial types											
Dwarf Essex	190	124	105	94	66	28	144	150	170	142	121
Bridger	58	42	37	27	23	15	46	47	60	54	41
Edible types											
Bienvenu	184	104	89	82	—	20	116	120	142	117	108
Jet Neuf	184	138	118	100	69	34	156	161	162	141	126
Canola types											
Cascade	19	15	15	12	5	5	22	22	31	26	17
Glacier	46	24	21	—	9	14	33	39	40	36	26
Average of location	114	75	64	63	34	17	86	90	101	86	

Note: Glucosinolate contents were based on duplicate determinations but not statistically analyzed. Canola-quality meals must not exceed 30 μmoles of glucosinolates per gram of defatted meal.

when grown in isolation and from certified quality seed. Current varieties differ greatly in the level and stability of their glucosinolates.

Most edible rapeseed varieties available before 1986, such as Bienvenu and Jet Neuf, had high levels of glucosinolates (Tables 3 and 6). Only recently have varieties been developed with low to intermediate levels of glucosinolates remaining in the seed meal after oil extraction. Two canola varieties (Cascade and Glacier) have been evaluated extensively in the Pacific Northwest. Both varieties have seed yields about the same as those of earlier edible varieties containing high levels of glucosinolates (Bienvenu and Jet Neuf) (Table 4). In nine of 10 tests, Cascade and Glacier produced similar seed yields, but Glacier produced higher levels of glucosinolates (Table 6). Glacier did not produce canola-quality seed at many test sites.

Variety selection

Growers should consider district restrictions, seed yield, erucic acid level and glucosinolate data before selecting either an industrial or edible rapeseed. **Varieties that have not been evaluated in regional tests should not be grown.** Because of extensive variety development programs in northern Europe and at the University of Idaho, regional growers should be able to select from among an increasing number of quality varieties in future years. Additional information on winter rapeseed varieties evaluated in the National Winter Rapeseed Variety Trials from 1985 through 1989 are available in University of Idaho Agricultural Experiment Station publications MS 98, MS 113, MS 120 and MS 130.

Seeding

Seedbed preparation

Seedbed conditions that promote rapid germination, uniform emergence and early stand establishment are essential for winter rapeseed production. Seed of rapeseed is small and requires a fine, firm seedbed to maximize contact between the seed and moist soil. The seedbed should be free of weeds and volunteer crop growth (see "Weed Control," page 9). Overworking a seedbed results in a loss of surface soil moisture and promotes soil crusting. Loose or overworked seedbeds can be firmed with a roller before seeding.

A moderate amount of crop residue on the soil surface to reduce erosion is tolerable. Excessive amounts of residue will interfere with proper seed placement. Uniform distribution of previous crop residue during harvest is essential for good seedbed preparation.

Seedbed preparation and planning should begin immediately after harvest of the previous crop. In areas where soils freeze during winter, fall chiseling should be used to aid water infiltration and reduce soil erosion. Spring tillage should begin before annual weeds reach the two-leaf stage and after soil has dried sufficiently to prevent compaction during tillage. The first tillage operation in spring should be 4 to 6 inches deep and retain as much residue on the surface as possible.

Later tillage should be timed to control annual weeds at the two-leaf stage and perennial weeds within 2 weeks of their emergence. To conserve moisture, each tillage operation should be shallower than the one before. The last tillage operation should occur about 1 week before planting. It should be timed to kill the last flush of weed seedlings and bring soil moisture close to the surface.

Rollers should be used with or after the last tillage operation to firm the soil and allow moisture into the planting zone. Packer wheels on drills also can help improve seed contact with the soil. Preplant fertilizer and herbicide applications should occur just before final seedbed tillage operations.

Seeding dates

Winter rapeseed should be planted on fallow from early to mid-August in most dryland production areas. Planting dates in the Willamette Valley of western Oregon can be delayed until early September. Cold tolerance, yields and oil contents of winter rapeseed usually decline when planting is delayed beyond recommended dates. Planting at recommended dates helps plants avoid hot summer temperatures detrimental to flower and pod development. It also provides early competition with potential weeds, reduces incidence of Pythium and ensures adequate winter hardiness. By November, plants should completely cover the soil for optimum winter survival and erosion control on fallow ground (Fig. 2). Planting earlier than August can expose emerging plants to flea beetle infestations.

Fig. 2. Winter rapeseed planted in mid-August provides complete ground cover by November 1.

Seeding rates

Seed winter rapeseed at 4 to 12 pounds pure live seed per acre. Use the higher seeding rates (8 to 12 pounds per acre) if planting is delayed, where weed problems exist and when seed placement is affected by surface residues or clods left to reduce soil erosion. The higher seeding rates produce plants with finer stems that can more easily lodge, but the higher rates also can hasten crop maturation.

Use the lower seeding rates (4 to 7 pounds per acre) in areas where late-summer drought is a possibility. Most commercial small grain drills can be set to deliver rapeseed within the recommended range. Always use certified seed free of seed-borne blackleg (*Phoma lingum*) and Alternaria black spot (*Alternaria* spp.).

Seeding depth and row spacing

Best germination and emergence of winter rapeseed occur at seeding depths of ½ to 1 inch under adequate soil moisture conditions. Where dust mulch was developed to conserve soil moisture during the fallow period, winter rapeseed has emerged from as deep as 5 inches. However, seeding winter rapeseed deeper than 2 inches often delays emergence, reduces seedling vigor and delays fall crop development.

The 6- to 14-inch row spacing provided by most commercial small grain drills is acceptable for winter rapeseed production. The narrower row spacings (6 to 7 inches) permit quicker row closure by the crop and reduce weed competition.

Double disk openers are best for planting rapeseed into moist soil at a uniform depth. Hoe-type openers place seed less exactly but can be used with less seedbed preparation. Use of press wheels, roller packers or harrows improves seed contact with the soil. Broadcast seeding and harrowing to incorporate seed usually produces uneven stands and is not recommended. A few growers and fieldmen have reported successful use of broadcast seeding and harrowing under some irrigated and dryland conditions.

Fertilization

Correct fertilization practices are necessary to produce optimum yields of winter rapeseed. The information presented in this section is based on results from field trials conducted in northern Idaho and other winter rapeseed production areas of the world. Detailed results of Idaho field trials can be found in University of Idaho Research Progress Report 226. Additional fertilization information is available in University of Idaho CIS 785, *Northern Idaho Fertilizer Guide: Winter Rapeseed.*

The first step in learning the fertilization requirements of winter rapeseed is to collect a soil sample representative of the field. A 12-inch soil sample is needed for phosphorus, potassium, sulfur and micronutrients. Soil samples representing the 0- to 12-inch, 12- to 24-inch and 24- to 36-inch depths should be collected for nitrate and ammonium analysis. For information on the proper procedures for collecting, packaging and storing soil samples refer to University of Idaho Extension Bulletin 704, *Soil Sampling.*

Nitrogen

The amount of nitrogen (N) fertilizer required for winter rapeseed production on any given field depends on: (1) the rapeseed variety and its potential yield and (2) the amount of useable N already present in the soil profile — mineralizable N and inorganic N in the forms of nitrate (NO_3) and ammonium (NH_4).

The amount of *total* N needed to produce a winter rapeseed crop can be estimated from the potential yield for the field site (Table 7). The amount of *fertilizer* N needed depends on total N need, the amount of mineralizable N (based on percentage organic matter to a depth of 12 inches, see Table 8) and the amount of inorganic N. The calculation for fertilizer N needed is as follows:

Total N needed for a specific yield (lb/a) (Table 7)	______
Minus mineralizable N (lb/a) (Table 8) -	______
Minus soil test N (lb/a) -	______
Equals nitrogen fertilizer required (lb/a)	______

For more detailed information on how to determine N fertilizer needs of winter rapeseed see University of Idaho CIS 785, *Northern Idaho Fertilizer Guide: Winter Rapeseed.*

Phosphorus

Adequate levels of soil phosphorus (P) are required for high yields of winter rapeseed. Soils testing at less than 2 ppm P in the surface foot of the soil profile should receive 60 pounds P_2O_5 per acre. Soils testing between 2

Table 7. Estimated total N needed by a winter rapeseed crop based on potential yield.

Potential yield (lb/acre)	Total N need (lb/acre)
1,500	150
2,000	185
2,500	220
3,000	255
3,500	285
4,000	310

Table 8. Mineralizable N release rates for northern Idaho soils.

	Organic matter			
	<2%	2 to 3%	3 to 4%	>4%
Release level	low	medium	medium high	high
Pounds N released per acre	25	35	45	55

and 4 ppm P require 40 pounds P_2O_5 per acre for high yields. Phosphorus should not be added to soils containing more than 4 ppm P.

Potassium

Soil potassium (K) levels are normally sufficient for rapeseed production in northern Idaho; however, K should be applied to soils when soil test K values are less than 75 ppm. Soils testing between 50 and 75 ppm K should receive 60 pounds K_2O per acre. Soils with less than 50 ppm K should receive 80 pounds K_2O per acre.

Sulfur

Plants require sulfur (S) to use N efficiently. Adequate levels of S are necessary for maximum production of winter rapeseed. Since S is mobile in soils, it is prone to leaching during winter and early spring. Consequently, testing soils for S is important.

Soils testing at less than 10 ppm S in the surface foot of the soil profile should receive S applications of 25 pounds per acre. Readily available forms of S rather than elemental forms should be applied because elemental S becomes available to plants slowly.

Boron

Winter rapeseed requires more boron (B) than other crops often grown in rotation with it. On soils testing at less than 0.5 ppm B, uniformly broadcast 1 to 2 pounds of B. Application of more B can easily produce toxic levels. Never apply B in a band. Boron should be applied before or at seeding.

Other micronutrients

Winter rapeseed has not been shown to respond to applications of chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo) or zinc (Zn). Extensive field studies with these nutrients have not been conducted. Applying these nutrients without established guidelines poses greater chances of creating toxicity problems than of correcting deficiencies. Avoid applications of these materials in northern Idaho.

Growers in the Kootenai River Valley of Boundary County should watch for Mn deficiencies. If Mn deficiencies appear on plant tissue in spring, Mn should be applied as a foliar spray at rates not exceeding 3 pounds per acre.

Fertilizer application

Nitrogen fertilizer applications should be split between fall and spring in areas receiving more than 18 inches of precipitation. Fall-applied N is susceptible to leaching. Also, high N rates in fall reduce rapeseed's winter hardiness. No more than 50 percent of the required N should be applied in fall.

Phosphorus and/or K should be applied before or at planting. Broadcast applications should be incorporated into the seedbed. Sulfur can be incorporated or surface applied in fall. Sulfur may also be applied with N in spring.

Rapeseed is very sensitive to fertilizers applied in the furrow with the seed. Nitrogen and S fertilizers applied with the seed should not exceed 10 pounds of N plus S per acre with adequate soil moisture present. In-furrow N, S and K applications should be eliminated if soil moisture conditions for seed germination are marginal.

Weed control

Winter rapeseed can suppress annual weeds without herbicides when planted early on well-managed fallow ground. It is an effective rotation crop for weed control. When planted into a freshly tilled, fallowed seedbed in early to mid-August, winter rapeseed usually emerges sooner than weeds and produces ground cover dense enough to outcompete nearly all annual weeds found in the Pacific Northwest.

Planting in September can result in a weedy crop that is low in productivity and oil quality. Rapeseed yield declines and weediness increases rapidly with progressively later planting dates (Fig. 3).

Management practices that enhance late-summer and early-fall crop growth contribute to weed control. In particular, adequate fertilization and disease control enhance rapeseed vigor.

Perennial weeds

During the fallow season, control perennial weeds such as Canada thistle, field bindweed and quackgrass. A combination tillage and herbicide spray program is usually best. Be careful when selecting an herbicide spray program to avoid damaging the winter rapeseed crop. Glyphosate (Roundup), 2,4-D and fluazifop-butyl (Fusilade 2000) are the only herbicides registered for control of perennial weeds in fallow before planting winter rapeseed. Follow label rates and recommendations. Do not use soil residual herbicides such as dicamba (Banvel), picloram (Tordon) and chlorsulfuron (Glean) prior to planting.

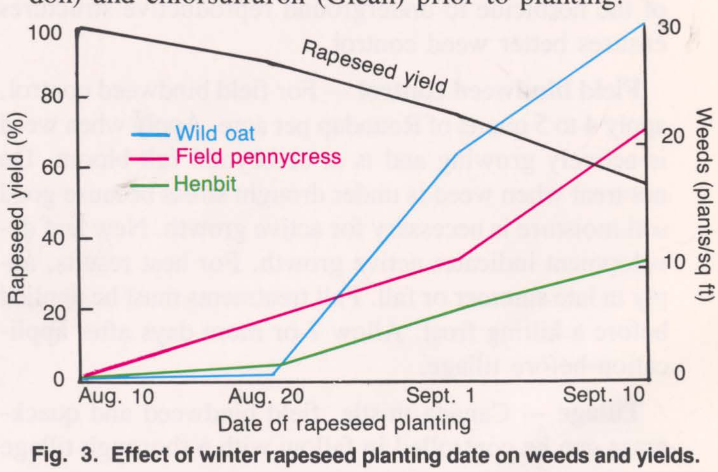

Fig. 3. Effect of winter rapeseed planting date on weeds and yields.

It is best to apply 2,4-D to broadleaf perennial weeds in fall after harvest and preceding fall-summer tillage operations. Early- to mid-spring 2,4-D applications during the fallow year can be made. This allows 2,4-D to decompose naturally before planting. Do not plant 2,4-D-treated land until 3 months after treatment or until the chemical has disappeared from the soil.

Quackgrass control — For quackgrass control, apply Roundup when the quackgrass is 8 to 12 inches high and growing actively. Do not till between harvest and a fall Roundup application or in fall or spring before a spring application. Allow at least 3 days between application and tillage. Do not plant winter rapeseed within 30 days of the last Roundup application.

Quackgrass can also be controlled during the fallow year with fluazifop-butyl (Fusilade 2000). Use Fusilade at the rate of 0.25 to 0.375 pounds of active ingredient (a.i.) per acre (32 to 48 ounces of product) in a solution containing either 0.25 percent nonionic surfactant or 1 percent of a crop oil concentrate. Use a crop oil that is nontoxic to plants or a once-refined vegetable oil concentrate that contains 15 to 20 percent emulsifier surfactant.

Apply the herbicide by ground using 5 to 40 gallons of dilute spray per treated acre with 40 to 60 pounds per square inch of pressure at the nozzle tip. Use standard pesticide hollow cone or flat fan nozzles. Spray to obtain thorough coverage of quackgrass foliage but not to runoff.

Treat quackgrass with Fusilade when it is 6 to 10 inches tall. Cultivation of treated grasses is not recommended within 7 days before or after Fusilade application. Cultivation 2 to 3 weeks after applying the herbicide may help control weeds. Do not plant winter rapeseed within 60 days of the last Fusilade application.

Canada thistle control — For Canada thistle control, apply Roundup when thistles are actively growing before the last killing frost in fall or in early summer when thistles are past the bud stage. At these growth stages, food reserves are moving to underground reproductive structures and the herbicide will move with them. Movement of the herbicide to underground reproductive structures ensures better weed control.

Field bindweed control — For field bindweed control, apply 4 to 5 quarts of Roundup per acre. Apply when weed is actively growing and is at or beyond full bloom. Do not treat when weed is under drought stress because good soil moisture is necessary for active growth. New leaf development indicates active growth. For best results, apply in late summer or fall. Fall treatments must be applied before a killing frost. Allow 7 or more days after application before tillage.

Tillage — Canada thistle, field bindweed and quackgrass can be controlled in fallow with a thorough tillage program, although herbicide-tillage combinations are often more effective. It can 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 weeds emerge, with about 14 to 18 days between subsequent tillages. Cultivate often enough to deplete root food reserves. Cultivate when newly emerged plants are relatively small — when Canada thistle rosettes are 2 to 4 inches in diameter, field bindweed vines are less than 4 inches long and quackgrass is at the 3- to 4-leaf stage and less than 6 inches tall. The optimum cultivation depth for perennial weed control is 3 to 4 inches.

For Canada thistle and field bindweed, use a tillage implement that will sever the shoots from the root (e.g., a field cultivator equipped with duckfoot sweeps). For quackgrass, use a spring-tooth harrow or other tillage implement that will pull the rhizomes to the surface where they will dry out and die.

Annual weeds

Summer fallowing will control most volunteer crops and annual weeds. The only herbicide currently registered in the United States for use at or just before planting rapeseed is trifluralin (Treflan). Treflan must be applied by ground application at the rate of 0.5 to 1.0 pounds active ingredient per acre, prior to planting rapeseed. Application rates vary with soil texture and formulation (Table 9).

Treflan must be mechanically incorporated (mixed) into the soil with tillage implements. A clean, clod-free soil is necessary for adequate mixing. Treflan may be incorporated 3 to 4 inches deep as part of the last seedbed preparation operation, if desired.

Apply Treflan in accordance with label instructions. Good establishment of winter rapeseed is essential for effective weed control with Treflan.

Treflan can provide excellent control of many weed species, but is not effective on several including other mustards and wild oat (*Avena fatua* L.) (Table 10). If these Treflan-tolerant species are numerous, they must be controlled before planting winter rapeseed.

Diseases

Plant diseases that attack winter rapeseed in the dryland production zones of the Pacific Northwest are generally not a problem in winter rapeseed production. Sclerotinia

Table 9. Application rates of trifluralin (Treflan) for weed control in winter rapeseed based on soil texture.

Soil texture	Trifluralin application rate
	pounds active ingredient/acre
Coarse	0.5
Medium	0.75
Fine	1.0

stem rot and seedling blights caused by several soil-borne fungi are the most frequent problems. Blackleg and alternaria black spot occur infrequently in rapeseed producing areas of the Pacific Northwest. Both can be introduced from other rapeseed producing areas on infected seed.

Sclerotinia stem rot or white mold

Stem rot in winter rapeseed is caused by the fungus *Sclerotinia sclerotiorum* (Fig. 4). This fungus survives in the soil for years as small, hard, black bodies called sclerotia. The fungus has many alternate host crops in Idaho including peas and alfalfa (see "Rotation and Field Selection," page 4).

Stem, branch, pod and leaf tissues can become infected, producing soft, watery lesions. Lesions continue to expand and become grayish white (Fig 5). Severely infected plants appear bleached and stand out from surrounding healthy plants. Black sclerotia are often found in the center cavities of bleached stems.

High inoculum levels, high plant populations, high humidity and excessive nitrogen favor the development of stem rot. Proper rotation with nonsusceptible crops and deep plowing can reduce sclerotia levels. Use certified seed lots free of sclerotia. No fungicides are currently registered for control of sclerotinia stem rot in winter rapeseed.

Seed rot, seedling blight and root rot complex

Seed rot and seedling blight caused by several fungal pathogens can reduce winter rapeseed stands in Idaho. Several *Pythium* species are the primary cause of seed rot and seedling blight in this area, but several *Fusarium* species and the fungus *Rhizoctonia solani* also can cause this problem.

Seedlings are infected shortly after planting and if severely infected, fail to emerge. Infected seedlings that emerge lack vigor and often succumb to other stresses such as winter damage.

Planting too late (September 1 or later) into cold, wet soils or planting too deep increases stand losses from these fungi. Proper seedbed preparation and seed placement reduce the impact of seed rotting fungi by encouraging rapid germination and emergence.

Several commercial formulations of the fungicide captan are registered for use as a seed treatment on rapeseed in Idaho. Captan will help prevent seed rot but will not protect developing seedlings. No systemic fungicides to control seedling blight are currently registered for winter rapeseed. Before using any registered fungicide, read its label.

Root rot complex in winter rapeseed is caused by the same fungi that cause seed rot and seedling blight. Lesions form on roots and stem bases, producing stunted, nonvigorous plants that yellow from the base upward. Proper rotation and management to establish a vigorous crop can reduce the impact of root rot on yield. No fungicides are available for root rot control.

Blackleg

Blackleg in winter rapeseed is caused by the fungus *Phoma lingum* (Fig. 6). It is one of the most devastating diseases in rapeseed production in Canada. Blackleg is spread either by infected seed stocks or by airborne spores from neighboring fields. The fungus attacks the entire aboveground portion of the plant. Lesions formed from early infections often grow into cankers that girdle the stem (Figs. 7 and 8).

Seed-borne or early-season foliar infections can reduce winter rapeseed yields by more than 50 percent. Late-season foliar infections can have minimal impact on yield but can contribute to seed-borne spread of the disease. No fungicides are available to control foliar infections.

Table 10. Effectiveness of trifluralin (Treflan) on weeds common in rapeseed.

Weeds trifluralin will control	
Broadleaf weeds	
Lambsquarters, common	*Chenopodium album*
Pigweed	*Amaranthus* spp.
Henbit	*Lamium amplexicaule*
Knotweed, prostrate	*Polygonum aviculare*
Purslane, common	*Portulaca oleracea*
Chickweed, common	*Stellaria media*
Grasses	
Downy brome (cheatgrass)	*Bromus tectorum*
Chess	*Bromus secalinus*
Annual bluegrass	*Poa annua*
Weeds trifluralin will not consistently control (not labelled for control)	
Established perennial plants	
Broadleaf weeds	
Mustard family species, including	
Field pennycress	*Thlaspi arvense*
Shepherdspurse	*Capsella bursa-pastoris*
Tumble mustard	*Sisymbrium altissimum*
Tansy mustard	*Descurainia pinnata*
Wild mustard	*Brassica* spp.
Pineappleweed	*Matricaria matricarioides*
Sunflower family, including	
Mayweed chamomile (dog fennel)	*Anthemis cotula*
Horseweed	*Conyza canadensis*
Groundsel, common	*Senecio vulgaris*
Prickly lettuce	*Lactuca serriola*
Sowthistle, annual	*Sonchus oleraceus*
Cluster tarweed	*Madia glomerata*
Cornflower (bachelor's button)	*Centaurea cyanus*
Nightshade family, including	
Hairy nightshade	*Solanum sarrachoides*
Cutleaf nightshade	*Solanum triflorum*
Legume family, including	
Volunteer pea or lentil	*Pisum* or *Lens*
Sweet clover	*Melilotus* spp.
Black medic	*Medicago lupulina*
Mallow family, including	
Common mallow	*Malva neglecta*
Volunteer crops	
Volunteer wheat	*Triticum* spp.
Volunteer barley	*Hordeum* spp.
Volunteer corn	*Zea mays*
Volunteer rye	*Secale cereale*
Wild oat	*Avena fatua*

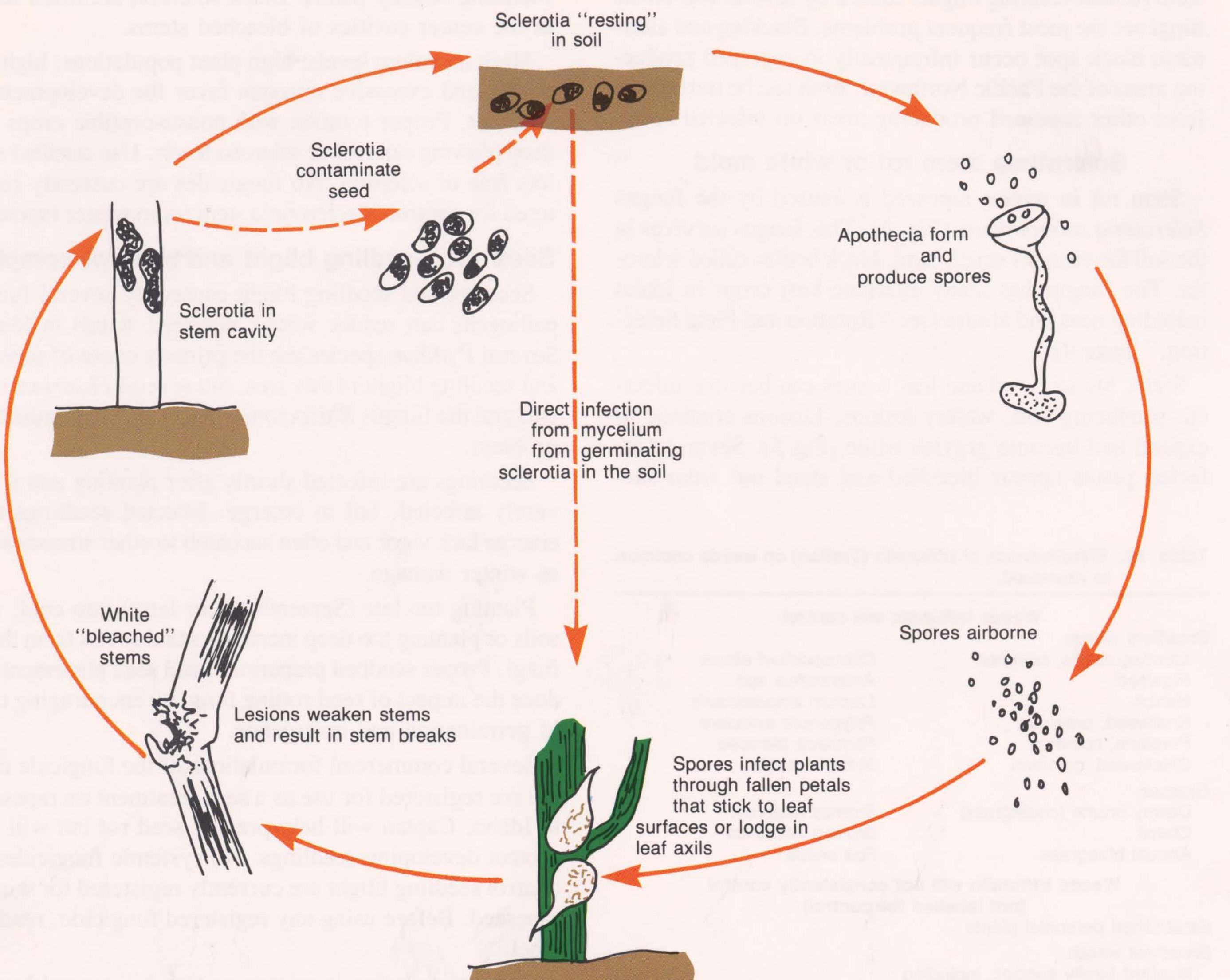

Fig. 4. Life cycle of *Sclerotinia* fungus on winter rapeseed.

Fig. 5. Sclerotia and white moldy growth from sclerotinia stem rot appear at the base of a winter rapeseed stem.

Blackleg of winter rapeseed occurs infrequently in Idaho. It is likely that blackleg will occur more frequently as increased rapeseed production encourages movement of seed stocks from areas where this disease now occurs. Spread of seed-borne diseases such as blackleg are usually favored by the reuse of common seed lots with unknown infection levels.

Benomyl (Benlate) fungicide is registered in Idaho for use as a seed treatment on rapeseed (4 ounces active ingredient per hundredweight) to control seed-borne *Phoma lingum*. Using certified seed stocks properly treated with benomyl will reduce the likelihood of introducing blackleg. Always consult the label before using any registered fungicide.

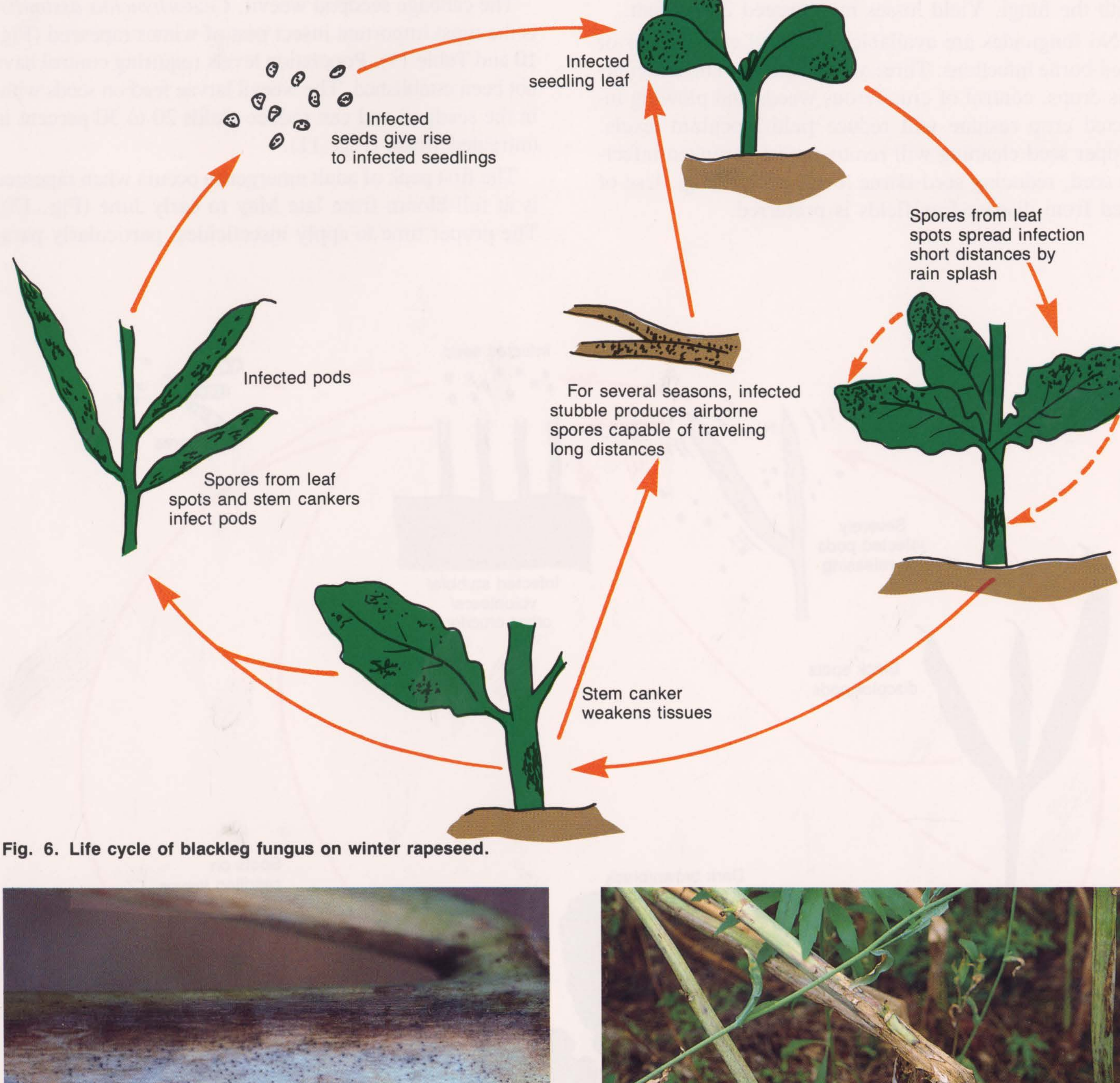

Fig. 6. Life cycle of blackleg fungus on winter rapeseed.

Fig. 7. A winter rapeseed stem infected with the blackleg fungus has characteristic black spots and girdling.

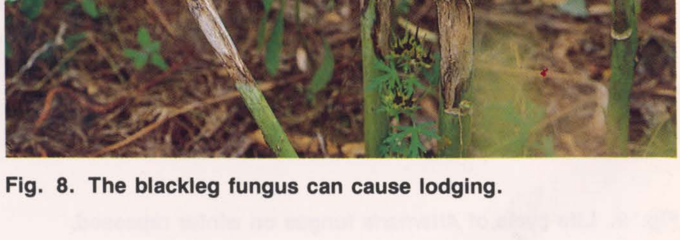

Fig. 8. The blackleg fungus can cause lodging.

Alternaria black spot

Caused by the fungi *Alternaria brassicae* and *A. raphani* (Fig. 9), alternaria black spot is one of the most common rapeseed diseases in Canada. All above-ground portions of the plant are susceptible to infection. Spots develop on leaves, stems and pods. Spots vary in size and in color from all gray to gray with black or purplish borders to all black. Infected pods may contain shrunken seed infected with the fungi. Yield losses may exceed 20 percent.

No fungicides are available to control either foliar or seed-borne infections. Three-year rotations to noncruciferous crops, control of cruciferous weeds and plowing infected crop residue will reduce field inoculum levels. Proper seed cleaning will remove most shrunken infected seed, reducing seed-borne levels of the fungi. Use of seed from disease-free fields is preferred.

Insect pests

Several insect pests of winter rapeseed have been identified. Cabbage seedpod weevil and aphids are major pests (Figs. 10, 11 and 12). Expanded rapeseed acreages will probably increase the incidence of insect pests and of the economic losses they cause.

Cabbage seedpod weevil

The cabbage seedpod weevil, *Ceutorhynchus assimilis*, is the most important insect pest of winter rapeseed (Fig. 10 and Table 11). Population levels requiring control have not been established. The weevil larvae feed on seeds within the seedpod and can reduce yields 20 to 30 percent in untreated fields (Fig. 11).

The first peak of adult emergence occurs when rapeseed is at full-bloom from late May to early June (Fig. 13). The proper time to apply insecticides, particularly para-

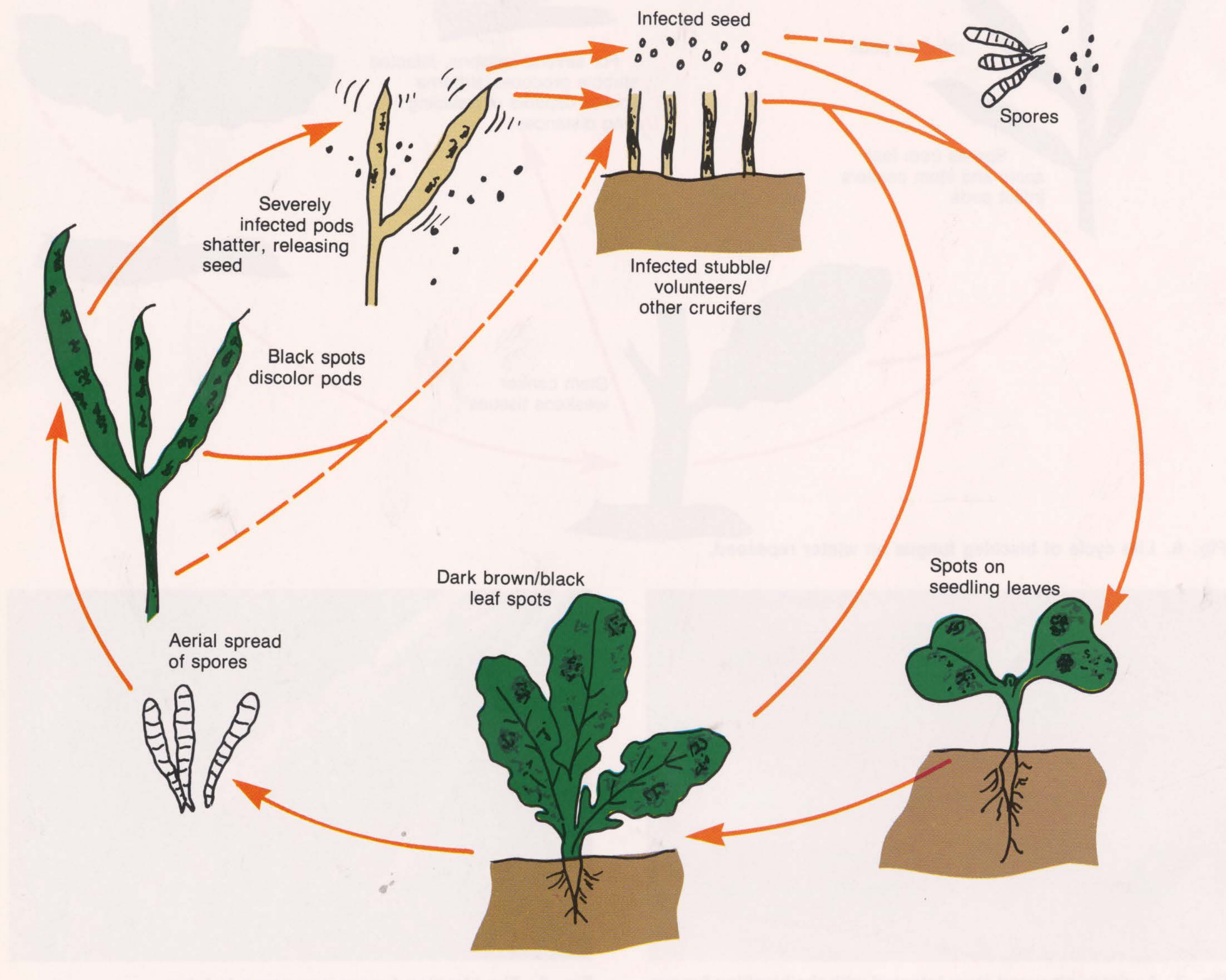

Fig. 9. Life cycle of *Alternaria* fungus on winter rapeseed.

Fig. 10. Adult cabbage seedpod weevils are about ⅛-inch long and ash gray.

Fig. 11. Larvae of the cabbage seedpod weevil damage immature seeds.

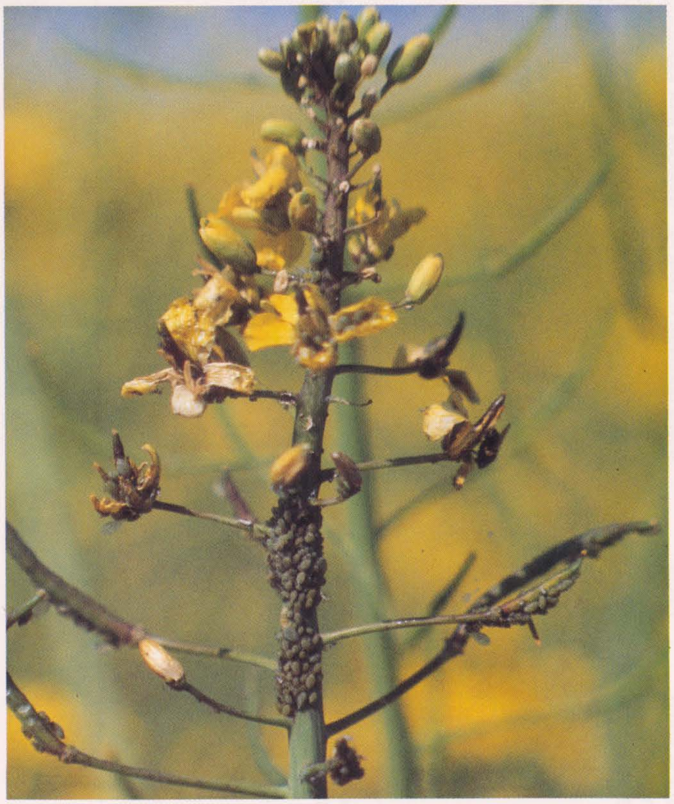

Fig. 12. Aphids and terminal flower of winter rapeseed.

thion, is near the end of bloom when temperatures are at least 70°F. These higher temperatures help parathion penetrate into the plant canopy and seedpods. Higher temperatures also stimulate weevil flight activity and help to ensure that most beetles are in the field when the spray is applied. If parathion is applied under these conditions, a single application is often effective, but the field should be checked 5 to 7 days later. If two to three weevils per sweep are found, a second application should be considered.

If parathion is applied when temperatures are less than 70°F or before the weevils enter the field, a second application probably will be necessary. Parathion applied at the appropriate temperature and time also kills eggs and young larvae in the pods before they cause much damage. Note that the second peak in adult flight activity represents movement of new weevils out of the field to overwintering sites (Fig. 13). Apply no controls at this time.

Parathion can cause substantial bee kills. Because of the susceptibility of honeybees to parathion, beekeepers should be forewarned of parathion applications so they can move their bees. An advantage of applying parathion after full bloom is reduced potential for bee loss.

Other management options for cabbage seedpod weevil control are limited. Parathion, while relatively inexpensive and effective, is broad spectrum in its activity and highly toxic to nontarget organisms, including humans. Parathion use may increase problems with aphids, cabbageworms and diamondback moths by killing their natural enemies. Sole reliance on one insecticide may also eventually lead to insecticide resistance, which renders the insecticide ineffective. Alternatives to parathion must be

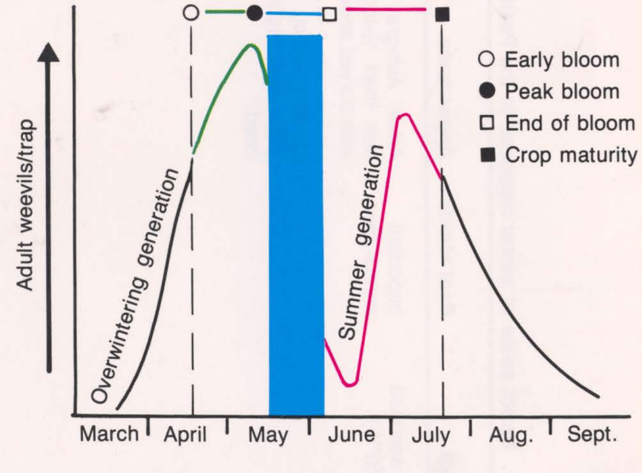

Fig. 13. Generalized seasonal flight activity of cabbage seedpod weevils in winter rapeseed in northern Idaho.

Table 11. Insect pests of winter rapeseed in the Pacific Northwest.

Insect pest	Pest status	Appearance	Plant parts susceptible to attack	Damage	Control[1]	Comments
Cabbage seedpod weevil (CSPW)	Important annual pest	*Adult:* Ash-gray weevil less than ⅛-inch long with curved snout. *Larvae:* White, legless grub with light-brown head.	Adult beetles are attracted to yellow color of flowers. Peak adult populations occur at full bloom. Eggs are laid in young pods during and following bloom.	Larvae feed on seeds within pod. Each larva can destroy 5-6 seeds. Yield reductions in untreated plots will generally be 20-30 percent, but higher yield losses can occur.	Parathion and endosulfan are currently registered for use on winter rapeseed in Idaho and Washington. Insecticides should be applied *after* full bloom, but before end of bloom. Parathion and endosulfan should be applied when daytime temperatures are above 70°F and 60°F, respectively. Parasites contribute to control of this pest but to an unknown extent.	Economic thresholds need to be established. Other insecticides need to be evaluated for CSPW control. Bee protection has to be considered. Varietal susceptibility of rapeseed needs to be evaluated. Parasite impact needs study. Wild mustard and cole crops are also hosts of CSPW.
Aphids Cabbage aphid Turnip aphid Green peach aphid	Potential key pests	Winged and nonwinged forms measure ⅛ inch or less; green-gray body coloring.	*Fall:* Develop on rosettes. Winged and nonwinged forms can be present. *Spring-Summer:* Rapeseed terminals can be infested by winged and nonwinged forms.	Sap sucking by the aphids can affect rosette size and vigor. This can affect overwintering survival and yields the next season. Feeding by aphids can stop terminal growth leading to reduction in plant size and seed yields.	No insecticides are currently registered for aphids in rapeseed in the PNW. Predators and parasites are very important and can successfully control aphids under the right conditions.	Impact of fall and summer aphid populations on rapeseed yield needs to be evaluated. Insecticides for use against fall and summer aphid populations need to be evaluated. Parasites and predators need further study. Aphid flight pattern and rapeseed planting date relationships need study. Varietal susceptibility of rapeseed needs evaluation.
Flea beetles (several varieties)	Minor	*Adults:* About ⅛-inch long and shiny green-black. Some species have light-colored markings on wing covers. *Larvae:* Whitish, cylindrical and worm-like with small legs and brownish heads.	Seedlings of rapeseed planted in July and sometimes August.	Adult beetles feed on cotyledons shortly after seedling emergence. This can result in reduction of plant vigor and yield loss or even death.	No seed treatment, systemics or foliar-applied insecticides are registered to use on rapeseed in PNW.	These insects are a problem only in early-planted winter rapeseed. Flea beetles are a serious problem on spring rapeseed.

Table 11. (cont'd)

Insect pest	Pest status	Appearance	Plant parts susceptible to attack	Damage	Control[1]	Comments
Diamondback moth	Minor	*Adult:* Small gray moths, about ⅓-inch long. Moths have a row of three diamond-shaped yellow spots down the middle of the back. *Larvae:* Small ⅓-inch-long greenish worms with fine, scattered erect hairs on body.	Leaves during summer growth.	Early instars produce small leaf mines. Later feeding by larger instar produces small shot-like holes. Can lead to total defoliation. Some varieties are affected more than others.	No insecticides are currently registered in PNW.	Canadians report an economic threshold of 300 worms per square meter on spring rapeseed. Parasites and predators are often important in control of this insect.
Cabbageworms	Minor	*Adults:* White butterflies with 3 to 4 black spots on wings. *Larvae:* Green worms (up to 1¼-inch long). Velvety appearance.	Leaves during summer growth.	Larval feeding produces holes in the leaves. Some varieties affected more than others (Dwarf Essex — low, Sipal — high).	No insecticides are currently registered in PNW.	Parasites and predators may be important for control. Biological insecticides (bacteria and viruses) are used to control this pest in cole crops.
Cabbage maggot	Minor	*Adults:* Dark gray with black stripes on thorax and many black bristles over body. About ¼-inch long. *Larvae:* White maggots, ¼-inch long.	Overwintering rosettes	Larvae feed in roots. High numbers can sever roots and cause plants to be stunted. May also lead to plant lodging.	No insecticides are currently registered in PNW.	This pest is now a threat to spring rapeseed. Its importance to winter rapeseed has not been established.
Loopers and armyworms (several species)	Minor	*Adults:* Brown moths of various sizes. *Larvae:* Green-brown caterpillars.	Spring and summer foliage. Possibly young plants in late summer-fall.	Defoliation	No insecticides are currently registered in PNW.	The cabbage looper is a potential defoliator. These insects need to be monitored and evaluated with regard to their pest status.
Lygus bugs (several species)	Minor	*Adults:* Pale green-brown bugs about ¼-inch long. *Nymphs:* Similar in general appearance to adults but smaller and without wings.	Flowers, buds and pods.	Bud and seed blast. Reduced yield.	No insecticides are currently registered in PNW.	Considered a problem on spring rapeseed. Their importance to winter rapeseed is not known.

[1]Be sure to read and follow label requirements for all pesticides.

found, and these alternatives need to be effective, more selective in their toxicity and safer.

Endosulfan does not affect the weevil larvae; therefore, more than one application will be needed for control. Since it kills adult weevils only, endosulfan should be sprayed just after full bloom. Sprays must be applied in the evening to prevent bee kill. Endosulfan works best when temperatures are higher than 60°F. Endosulfan has given inconsistent results and costs more than parathion.

Parasites and predators of the cabbage seedpod weevil exist and may eventually be important in its overall management. More information is needed to assess the importance of natural enemies.

Aphids

Many aphid species occur on winter rapeseed in the Pacific Northwest (Table 11). The cabbage aphid (*Brevicoryne brassicae*) and the turnip aphid (*Lipaphis pseudobrassicae*) are the most prevalent. Although the importance of aphids is unknown, these insects potentially can affect rapeseed in two ways. In fall, aphids on rosettes can reduce vigor. In spring and early summer, aphids feeding on terminals (Fig. 12) can stunt plants and reduce yields.

No insecticides are currently registered for use against aphids on winter rapeseed. Biological control, while potentially important, may not be effective enough to provide economically acceptable control. Further study is needed to assess the importance of the aphids. Control of cabbage seedpod weevil with parathion may affect aphid status because parathion kills the aphids' natural enemies.

Other insects

Other potential insect pests of winter rapeseed include flea beetles, cabbageworms, loopers, diamondback moth, cabbage maggot and lygus bugs (Table 11). All have been found in winter rapeseed fields in northern Idaho. At this time, these insects are considered minor pests. As chemical components of winter rapeseed are modified for marketing purposes (edible vs. industrial), the crop's pest complex may also change.

Specialist feeders such as cabbage aphids respond to certain chemicals (i.e., glucosinolates) in rapeseed and use them to identify rapeseed as an acceptable food. Generalist feeders such as lygus bugs, loopers and armyworms may be repelled by the same chemicals. Rapeseed with low levels of glucosinolates may reduce the levels of cabbage aphid but increase the importance of loopers.

Flea beetles can be a significant pest problem on winter rapeseed planted very early in Idaho. The economic importance in Idaho of the other insect pests associated with winter rapeseed production in Canada such as diamondback moth, western cabbageworm and beet webworm are unknown. No seed treatment and few foliar insecticides are registered to control insect pests of winter rapeseed in Idaho.

Harvesting and storage

Harvest rapeseed at the proper stage of maturity and properly adjust and inspect the combine. The small, round seeds easily leak from tiny holes in elevators and from improperly sealed truck beds. Inspect all equipment regularly. Maximizing yield and quality of rapeseed requires much more care than cereals do.

Harvest timing

Winter rapeseed is an "indeterminate" plant, which means that some overripe and some immature pods will exist on the same plant at harvest time. Combining should begin when there are no green seeds and the average seed moisture content has dropped to 10 percent. Once rapeseed is ready to harvest, any delay can result in very high shatter losses. Birds, wind and splitting of pods in hot weather can swiftly and severely decrease crop yield. A chemical product with the trade name Spodnam has been used to reduce shatter losses in eastern and central Washington. It has not been tested in other areas.

Combine adjustments

Rapeseed is easy to thresh and hard to feed into the combine. Experienced growers recommend raising the reel to its maximum height and moving it as far rearward as possible. Reel speed should match ground speed because the reel will shatter pods upon contact. If the cutter bar can be moved forward, it should be at its forwardmost position.

One grower, Charles Swenson of Genesee, Idaho, now deceased, made a special "Rape" header in which he moved the cutter bar 14 inches forward and reduced the reel diameter by 10 inches. He reported that these modifications improved crop feeding and reduced shatter losses.

Palouse growers recommend the following combine adjustments: Cylinder speed as slow as possible, concave open 3/4-inch or more, fan/air speed and settings similar to those used for wheat, shoe chaffer open fairly wide, and lower sieve closed to ⅛ inch or less.

Rapeseed seed will leak from any small hole or crack in the combine. The machine should be routinely inspected and all leaks plugged or taped.

All combines should be adjusted to minimize breakage and chopping of the rapeseed residue. The crop should pass through the threshing cylinder or rotor drum quickly and smoothly. Blank-off plates may be used in place of slotted grates to reduce chaffer loading.

A universal recommendation from all growers is: Be patient. Harvesting rapeseed is slow, difficult and cannot be hurried. Take as little of the stalk into the machine as possible because the high moisture content of the green material makes separation of seed from other plant parts more difficult.

Swathing

Swathing of winter rapeseed is not generally recommended for the Palouse. Research trials conducted in the Moscow and Nezperce areas found no yield advantage from swathing. If attempted, swathing must be done at the proper stage of plant maturity. Swathing too early will lead to excessive green seed, reduced oil content and high seed moisture. Swathing too late will lead to excessive seed loss due to shattering of mature pods.

Seed moisture content must be determined carefully. In research trials, swathing at 33 percent moisture reduced seed yield compared with swathing at moisture levels of 31 percent or lower. To estimate seed moisture, select several pods from main and lateral branches. Remove seed from the pods, and determine the percentage of black seed in the sample. Swath when the percentage of black seed is between 60 and 75 percent. Corresponding seed moisture levels would be 40 percent and 30 percent, respectively. No green seed should be present when rapeseed is swathed.

Forage production and utilization

Winter rapeseed produces abundant forage in late fall and early spring, times when green forage is usually in short supply. Rapeseed forage available during these periods could reduce winter feeding costs.

Rapeseed forage typically contains abundant nutrients to support animal production. However, nutritional disorders have been associated with livestock grazing rapeseed and other *Brassica* species. These disorders include bloat, pulmonary emphysema, hyperthyroidism, polioencephalomalacia and hemolytic anemia. Generally, these disorders are avoided when animals are adapted to the available forage. A 7- to 10-day adaptation period of controlled grazing or a diet partially of dry, harvested forages will prevent disease symptoms. Information is lacking on the effect of grazing timing and intensity on subsequent seed production.

Winter rapeseed may also be grown for harvested forage. Rapeseed that has been allowed to mature to the flowering stage provides an abundant source of highly nutritious forage. In trials at Moscow, Idaho, and Kalispell, Montana, forage dry matter yields averaged 2 to 13 tons per acre with 10.4 to 13.6 percent protein (Table 12). Preliminary studies indicate that harvested rapeseed forage causes lesser nutritional disorders in livestock than does grazed forage. Due to the rapeseed plant's high moisture content, it may be stored best as a high-moisture silage.

Variety trials for forage production

In the 1984-85 and 1985-86 growing seasons, six varieties of rapeseed were evaluated for forage yield at either Moscow, Idaho, or Kalispell, Montana. Four varieties of forage rapeseed were compared with two commercial varieties. Plots were harvested in mid-June when the developing seeds were in the hard dough stage. As expected, the forage varieties produced more forage than the shorter and more determinate oilseed varieties in nearly every trial (Table 12).

Both Dwarf Essex and Bishop are historic forage varieties introduced from Europe where they have been used extensively for sheep pasture. The SEMU varieties are new commercial varieties developed specifically to combine high forage yields with low levels of glucosinolates. Growers in the Pacific Northwest should be able to obtain these types of varieties to maximize forage yield and forage quality.

The protein contents of the varieties did not differ in the two trials with the highest yields, Kalispell 1984-85

Table 12. Forage yields and protein contents of six varieties of winter rapeseed at Moscow, ID, and Kalispell, MT.

	Yield				Protein			
	1984-85		1985-86		1984-85		1985-86	
Variety	Moscow	Kalispell	Moscow	Average	Moscow	Kalispell	Moscow	Average
	tons/acre				%			
Forage varieties								
Bishop	2.5	5.8	10.8	6.4	10.6	12.6	10.7	11.3
SEMU 100/22	2.4	6.0	—	4.2	11.6	12.6	—	12.1
SEMU 103/83	2.2	5.8	13.0	7.0	11.1	12.1	10.4	11.2
Dwarf Essex	2.2	5.0	12.6	6.6	12.6	13.6	12.0	12.7
Oilseed varieties								
Bridger	2.1	4.9	11.7	6.2	12.6	13.4	10.9	12.3
Cascade	2.0	3.9	10.7	5.5	13.1	13.1	11.9	12.7
LSD 0.05[1]	0.56	0.80	NS		1.4	NS	NS	
Harvest date (June)	20	5	23		20	5	23	

[1]For each year, means within a location that differ by more than the LSD value are statistically different at the 0.05 probability level.
NS = not significant.

and Moscow 1985-86 (Table 12). At Moscow in 1984-85, the forage varieties generally had slightly lower protein contents than the oilseed varieties because of inadequate nitrogen fertilization. The varieties produced a forage that averaged 11.3 to 12.7 percent protein on a dry weight basis. This indicates that additional sources of protein will need to be included in some livestock rations.

Harvest date

During the 3 years from 1985 to 1987, fall-planted Dwarf Essex was harvested at 2-week intervals from mid-April to late June to determine the effect of harvest date on forage yield and protein content. In mid-April, forage yields were generally less than 1 ton of dry material per acre (Fig. 14). The total forage yield increased steadily, reaching a maximum in late June or early July. By mid-June in the 1984-85 and 1985-86 studies, forage yield exceeded 6 tons per acre.

The Bridger variety was included in the 1986-87 trial. That year, both Bridger and Dwarf Essex had reduced forage yields due to inadequate nitrogen fertilization and herbicide damage that stunted early-spring growth. Under these conditions, the shorter plants of Bridger had forage yields equivalent to those of Dwarf Essex. Forage yields were maximum when harvest was delayed until late June.

Delayed harvest resulted in reduced protein levels in 1984-85 and in 1985-86. The protein content of the forage declined from over 30 percent at the mid-April harvest to approximately 15 percent at the mid-June harvest (Fig. 15). Inadequate nitrogen fertilization in the 1986-87 trials reduced protein content in the forage so that by mid-June the protein content of the forage was less than 5 percent.

Based on these studies it appears that a mid-June harvest date will optimize both forage yield and total protein per acre. If growers need higher-protein feeds, fall-planted rapeseed could be harvested earlier in spring, but forage yield will be significantly lower.

Production costs and budgeting

Budgets are simply organized guidelines in the overall management of the farm business. Budgeting is forward planning involving the prediction of both physical and financial data for the farm plan.

The University of Idaho Cooperative Extension System publishes enterprise budgets for many crops and types of livestock produced in Idaho. An enterprise budget is an estimate of the total cost of producing a specific crop, class of livestock or livestock product. The UI budgets are based on production data collected from Idaho farms and ranches and on information from extension agents, extension specialists and others familiar with the commodities.

The key to successful budgeting is to make realistic estimates of prices, production and input quantities. Predictions that are overly pessimistic or optimistic hamper the budgeting process. Table 13 summarizes the assumptions used to develop the northern Idaho rapeseed budget in Table 14.

Variable and fixed costs

Production costs are categorized as either variable or fixed. Variable costs vary with the level of production. Costs that vary in the short run (1 year or less) include fertilizer, chemicals, seed, fuel, hired labor and certain repairs.

Fixed costs remain constant over the short run. These costs are incurred whether or not the fixed input is used in the production process. Examples of fixed costs are insurance, property taxes, depreciation, interest on long-term loans, building repairs and long-term cash or fixed leases.

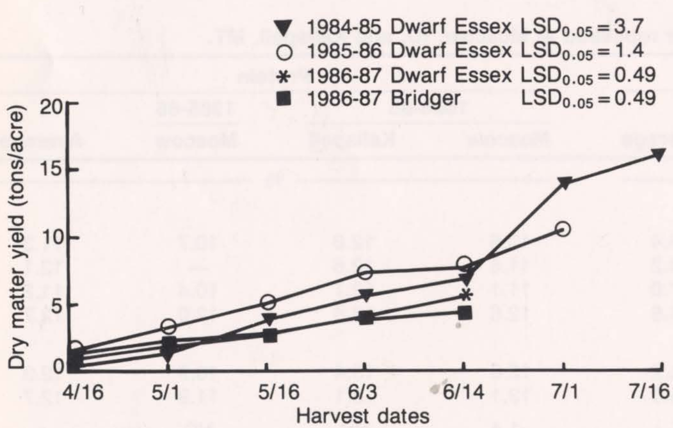

Fig. 14. Forage yields of winter rapeseed harvested from mid-April to mid-July at Moscow, Idaho. (Yields within a given year and variety that differ by more than the LSD value are statistically different at the 0.05 probability level.)

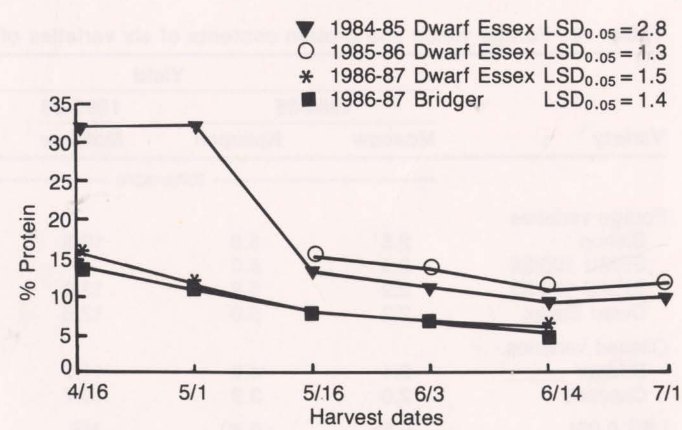

Fig. 15. Protein contents of winter rapeseed forage harvested from mid-April to early July at Moscow, Idaho. (Protein contents within a given year and variety that differ by more than the LSD value are statistically different at the 0.05 probability level.)

Table 13. Assumptions for developing an enterprise budget for rapeseed production in northern Idaho.

Factor	Assumption
Farm size and rotation	Farm size is 1,000 acres with a 4-year rotation consisting of summer fallow, rapeseed, wheat, and peas or lentils. Summer fallow costs are included in the rapeseed budget (Table 14).
Yield	Estimated yield of dryland winter rapeseed is 2,000 pounds (20 cwt) per acre.
Commodity prices	The price of rapeseed is based on its historic level and projected short-term trends. An estimation of price for 1990-91 is $9.40 per cwt.
Labor costs	Labor costs of field operations are calculated by multiplying the number of annual tractor hours by 1.1. For self-propelled machinery, the multiplier is 1.2. The multiplier accounts for time spent servicing the machinery, loading and unloading. Labor cost is determined by multiplying the hours as calculated above by the labor wage rate ($5.75 per hour).
Crop insurance	Crop insurance was not included in the budget but should be included if applicable.
Interest	Both intermediate and short-term capital are used to finance machinery, equipment and operating inputs. The capital to finance operating inputs is charged at 13 percent interest from the time inputs are applied until the harvest month. The cost of capital for machinery and equipment is based on average investment and an interest rate of 13 percent.
Custom	All fertilizer and chemicals were custom applied.
Land (net rent)	A land charge is included in the budget on a crop-share basis and reflects the income an owner would receive if he rented the property or the cost an operator would pay if he rents. The typical lease agreement in the dryland region of northern Idaho is based on a crop share of 33 percent for the landlord and 67 percent for the tenant. The landlord pays property taxes and 33 percent of certain cash expenses (fertilizer, seed and chemicals).
Machinery	All machinery is valued at current replacement cost. This assumption will overstate ownership costs compared with what producers are currently experiencing. However, it does indicate the ability of an enterprise to replace current depreciable assets. To effectively examine their long-term profitability, producers should consider current replacement costs of farm machinery.

Table 14. Enterprise budget for northern Idaho winter rapeseed production.

	Unit	Price or cost per unit	Quantity per acre	Value or cost per acre	Your value
1. Gross receipts from production					
Winter rapeseed	cwt	9.40	20.00	$ 188.00	
Total				$ 188.00	
2. Variable costs					
Preharvest					
30-0-0-6	lb	0.11	100.00	$ 11.00	
Air apply dry	acre	5.00	1.00	5.00	
16-20-0	lb	0.13	200.00	26.00	
Fertilizer spreader	acre	1.25	1.00	1.25	
Rapeseed - Essex	lb	0.20	12.00	2.40	
Parathion 8 lb a.i.[1]	qt	9.56	0.25	2.39	
Air spray	acre	5.00	1.00	5.00	
Machinery	acre	14.30	1.00	14.30	
Tractors	acre	10.58	1.00	10.58	
Labor (tractor and machinery)	hour	5.75	1.67	9.61	
Interest on operating capital	dollar	0.13	26.14	3.40	
Subtotal, preharvest				$ 90.92	
Harvest					
Machinery	acre	11.30	1.00	$ 11.30	
Labor (tractor and machinery)	hour	5.75	0.71	4.10	
Subtotal, harvest				$ 15.40	
Total variable costs				$ 106.32	
3. Income above variable costs				$ 81.68	
4. Fixed costs					
Machinery	acre	37.74	1.00	$ 37.74	
Tractors	acre	23.20	1.00	23.20	
Land (net rent)	acre	48.25	1.00	48.25	
Total fixed costs				$ 109.18	
5. Total costs				$ 215.51	
6. Returns to risk and management				$ -27.51	

Note: Land charge is ⅓ cost share.

[1]0.5 lb a.i. per acre.

Short-run decisions may take into account variable costs only. Fixed costs have already been incurred regardless of the level of production. Long-run decisions should take into account both variable and fixed costs because over the long run (more than 1 year), all costs of production must be recovered if the farm business is to survive.

The importance of using variable and fixed costs in decision making is illustrated in the following example:

In the rapeseed budget (Table 14), variable harvest costs are $15.40 per acre. Assume that the fixed costs of harvesting the crop are $24.00 per acre. This gives a total harvest cost of $39.40 per acre ($15.40 plus $24.00). Now assume that just before harvest a neighbor offered to harvest the crop for $30.00 per acre. Should the operator harvest the rapeseed crop or accept the neighbor's offer? Since this is a short-run decision, the operator would consider variable costs only. The out-of-pocket cash costs are $15.40 per acre compared with $30.00 offered by the neighbor. Therefore, the operator would harvest the crop himself.

Remember, in the short run only certain resources are variable, and only these resources should be considered in decision making. If the neighbor had made the same offer the previous winter and the operator had had sufficient time to sell his harvesting equipment, then a long-run decision would result. In this case, all costs of production would be considered variable, so total harvest costs, including cash and noncash costs, would be $39.40. Thus, hiring the neighbor to harvest the crop appears to be the more profitable option, but factors such as timeliness and long-term commitment to the agreement should also be considered.

Enterprise budgets

The first section of the budget in Table 14 shows gross receipts from production estimated at $188.00 per acre ($9.40/cwt x 20 cwt). The second section contains variable costs, estimated at $106.32 per acre. The third section contains income above variable costs. The fourth section contains fixed costs per acre, including insurance, taxes, depreciation, interest on owner equity or long-term loans, certain repairs and long-term cash or fixed leases.

Depreciation reflects the decline in value of a capital resource due to obsolescence, age and wear over its productive life. A variety of methods can be used to calculate depreciation. Each method yields a different result. Some methods calculate depreciation for tax purposes, while others calculate depreciation for management. The best method to use in budgeting calculates depreciation over the useful life of an asset, not its tax life. The tax life of an asset and its useful life are unlikely to be equal.

Depreciation per year in Table 14 is calculated using the following formula:

$$\text{Depreciation per year} = \frac{\text{purchase price} - \text{salvage value}}{\text{years owned}}.$$

Interest cost is calculated by multiplying average investment by the prevailing interest rate (i) or

$$\text{Interest cost} = \frac{(\text{new cost} + \text{salvage value})}{2} \times \text{i}.$$

The interest rate in the rapeseed budget is assumed to be 13 percent, the cost of borrowing intermediate-term capital.

Other items such as property taxes and insurance are calculated using current tax and insurance rates. The annual property tax is calculated by multiplying current market value by the property tax rate. Insurance is calculated by multiplying average investment by the insurance rate.

Annual fixed costs can be converted to per-acre costs for each piece of equipment simply by dividing by the number of acres that are farmed each year. Fixed costs per acre for each piece of equipment can then be added to determine total fixed costs per acre for the crop in question. For the rapeseed enterprise budget in Table 14, total fixed costs per acre equal $109.18.

Total costs ($215.51) are the sum of variable and fixed costs. These are subtracted from gross receipts to obtain net returns to risk and management. Net returns are compensation to the producer for his management and the risk he assumes in producing the rapeseed crop. Return on his investment was included in interest costs.

Budget analysis: The next step

Many agricultural producers think of constructing budgets as the end of the process. Budgets are ''built'' or updated, taken to the banker and then either discarded or put on the shelf until the next year. In most cases enterprise budgets should be considered as only the beginning of the process.

A couple of often-ignored steps can provide valuable information about marketing the commodity and susceptibility of the enterprise to risk. Both steps use the enterprise budget as the basis for performing further calculations. These two steps are (1) calculating breakeven prices and quantities based on variable and fixed costs contained in the budgets and (2) calculating the impact of variations in price and/or quantity on returns.

Breakeven analysis — Breakeven levels can show product prices or quantities needed to cover variable, fixed and total costs. To calculate breakeven prices, you must know yields and costs. The rapeseed enterprise (Table 14) uses 20 cwt per acre as the level of production for planning purposes. Variable costs are estimated at $106.32 per acre

($90.92 preharvest and $15.40 for harvest). The breakeven price (BEp) needed to cover variable costs is calculated as follows:

$$\begin{aligned} \text{BEp} &= \text{variable costs} \div \text{yield} \\ &= \$106.32 \div 20 \text{ cwt} \\ &= \$5.32 \text{ per cwt.} \end{aligned}$$

The breakeven price needed to cover fixed costs would be $5.46 per cwt, and the breakeven price to cover all costs of production would be $10.78 per cwt. This information can help formulate rapeseed marketing and management plans. For example, an offer of $7.00 per cwt for the rapeseed crop would leave the grower about $1.68 per cwt to cover fixed costs. But with fixed costs of $5.46, the grower would lose $3.78 per cwt.

If a grower has contracted rapeseed at some price level, the yield necessary to cover costs can also be calculated. Assuming a contract price of $10.00 per cwt, the breakeven quantity (BEq) is calculated as follows:

$$\begin{aligned} \text{BEq} &= \text{variable costs} \div \text{contract price} \\ &= \$106.32 \div \$10.00 \text{ per cwt} \\ &= \$\ 10.63 \text{ cwt per acre.} \end{aligned}$$

The grower needs to produce 10.64 cwt per acre to cover variable costs, 10.92 cwt per acre to cover fixed costs and 21.55 cwt per acre to cover all costs of production.

Risk analysis — Rapeseed prices and yields fluctuate. Input prices also fluctuate. What impact does this variation in yield, price or both have on the profitability of the enterprise? Yield and price variations will affect gross revenue and returns above variable, fixed and total costs. The greater the variability in price or yield, the greater the risk and income fluctuation.

By examining the rapeseed budget in Table 14, the riskiness of this enterprise in relation to price fluctuations can be assessed. In the last 5 years, harvest prices for industrial rapeseed in northern Idaho have ranged from $6.00 to $12.00 per cwt with the average being $9.50 per cwt.[1] In all 5 years, harvest price exceeded the breakeven needed to cover variable costs of production ($5.32 per cwt). However, the breakeven to cover all costs ($10.78) was exceeded in only 3 of the 5 years, which suggests some price risk in the long run.

What happens to net returns if we assume that the 1990 harvest price for rapeseed will fluctuate between $7.40 and $11.40 per cwt (Table 15)? At $7.40 per cwt, gross revenue on a yield of 20 cwt would be $148.00 per acre. At $11.40 per cwt it would be $228.00. Assuming the costs presented in Table 14, income above variable costs would be $41.68 at $7.40 per cwt and $121.68 at $11.40 per cwt. Returns over all costs of production would be minus $67.51 at the low price and $12.49 at the high price.

[1]Reported by Stegner Seed and Grain, Lewiston, Idaho.

Table 15. Sensitivity of returns to price and yield fluctuations in northern Idaho rapeseed production.

	Price of winter rapeseed ($/cwt)				
Yield	**7.40**	**8.40**	**9.40**	**10.40**	**11.40**
cwt/acre	$				
	Net returns after variable costs				
16.00	12.08	28.08	44.08	60.08	76.08
18.00	26.88	44.88	62.88	80.88	98.88
20.00	41.68	61.68	81.68	101.68	121.68
22.00	56.48	78.48	100.48	122.48	144.48
24.00	71.28	95.28	119.28	143.28	167.28
	Net returns after fixed costs				
16.00	9.22	25.22	41.22	57.22	73.22
18.00	24.02	42.02	60.02	78.02	96.02
20.00	38.82	58.82	78.82	98.82	118.82
22.00	53.62	75.62	97.62	119.62	141.62
24.00	68.42	92.42	116.42	140.42	164.42
	Net returns to risk and management				
16.00	-97.11	-81.11	-65.11	-49.11	-33.11
18.00	-82.31	-64.31	-46.31	-28.31	-10.31
20.00	-67.51	-47.51	-27.51	-7.51	12.49
22.00	-52.71	-30.71	-8.71	13.29	35.29
24.00	-37.91	-13.91	10.09	34.09	58.09

Pesticide residues

These recommendations for use are based on currently available labels for each pesticide listed. If followed carefully, residues should not exceed the established tolerances. To avoid excessive residues, follow label directions carefully with respect to rate, number of applications and minimum interval between application and reentry or harvest.

Groundwater

To protect groundwater, when there is a choice of pesticides, the applicator should use the product least likely to leach.

Trade Names

To simplify information, trade names have been used. No endorsement of named products is intended nor is criticism implied of similar products not mentioned.

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