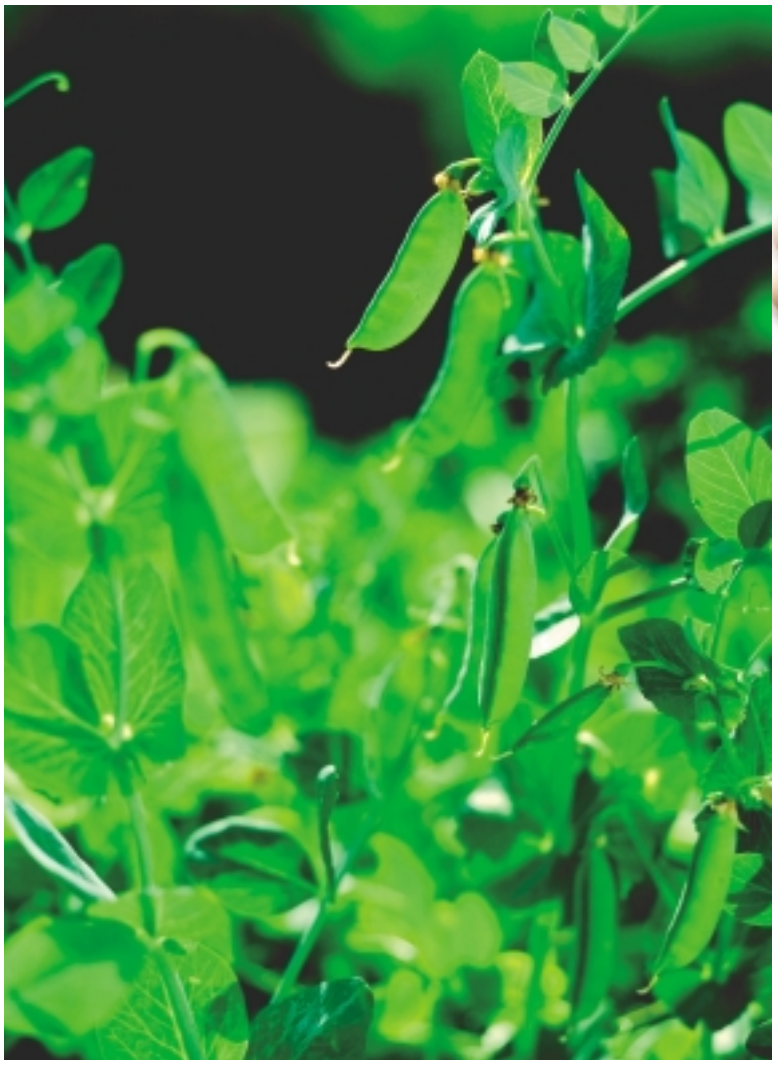
6/Field Pea



Field Pea QuickTips

Seeding Rate	Target 8 plants/ft^2 (88 plants/m^2).
Seeding Depth	2 to 3 inches (5 to 7 cm).
Seeding Date	15 to 30 April in Brown and Dark Brown soil zones. Early to mid-May in Black and Grey soil zones.
Recommended Varieties	Many available.
Best Performance	On cereal stubble in the Black and Grey soil zones.
Rolling	After seeding; or if the soil is too wet, before the 5 leaf stage.
Registered Herbicides & Registered Fungicides	Refer to Table 5.6 (Weed Control) 6.9 and 6.10 or the Saskatchewan Agriculture and Food Guide to Crop Protection.
Rotational Frequency of Field Pea Production For Disease Control	4 years for mycosphaerella.
Swathing or Desiccation	No more than 1/3 green pods.
Direct Harvesting	20% seed moisture.
Storage Moisture	16%

6/Field Pea Production

Field Pea Production Contents

continued...

Field Pea

Introduction

Pea is among the oldest crops in the world as it was first cultivated as early as 9000 years ago. It is native to Syria, Iraq, Iran, Turkey, Israel, Jordan, and Lebanon, and has been cultivated in Europe for several thousand years. It is now grown in all climatic zones, including the tropics where it is grown at high elevations.

Early in the century, first Ontario and then Manitoba led Canadian pea production. Since the mid-1980's, Saskatchewan has produced the majority of Canadian pea with significant acreage also being grown in Alberta and Manitoba. Ontario is no longer a large scale producer. In Saskatchewan, pea yields average 1800 lb/ac (2018 kg/ha), but yields as high as 3500 lb/ac (3900 kg/ha) have been reported.

• About 60% of the Canadian pea crop is exported to Europe, South America, and Asia.

The large European livestock feed market is the major pea market, South Asia is also a significant market for yellow pea. An increasing amount is being used in Saskatchewan for livestock feed, with a small amount of the pea crop processed into pea fibre, pea protein and pea starch. Increasing amounts of pea are exported to South America and the Indian subcontinent for food use. A small portion of the Canadian pea crop is used domestically as food. A further 10% of the crop is required for planting seed. This high percentage is due to the large size of the pea seed.

Pea seeds contain 20 to 25% crude protein, containing a high percentage of the amino acid, lysine. This makes pea an excellent livestock feed. Some components of the pea seed (trypsin inhibitors) prevent its complete digestion and utilization. These components are at very low levels in pea compared to the levels in soybean, so they are of little concern when pea is used for food or in most livestock rations (Table 6.1).

Table 6.1 *Chemical composition of feed pea (90% dry matter basis).*

Chemical		Average
Moisture (%)		10.00
Crude protein (N x 6.25%)		22.60[1,5]
Ether extract		1.38[1]
Linoleic acid		0.56[2]
Fibre measurements		
	Crude fibre (%)	5.50[1]
	Acid detergent fibre (%)	8.19[3]
	Neutral detergent fibre (%)	16.65[3]
	Lignin (%)	0.85[3]
Starch (%)		46.80[4]
Total ash (%)		3.30[1]
Phytic acid (%)		1.20[1]

Source [1]*Marquardt and Bell, 1988.* [2]*Rhone-Poulenc Animal Nutrition, 1993.* [3]*Fonnesbeck et al., 1984.* [4]*McLean et al., 1974.* [5]*Sask. Feeding Testing Lab 1990.*

Plant Characteristics

The two major types of pea are the round seeded, used primarily for food and feed, and the wrinkled seeded, which are usually harvested when immature and used for freezing and canning. The round-seeded pea is the main type grown in Saskatchewan. Pea seeds may have either green or yellow cotyledons under a white or occasionally pale green seed coat (Figures 6.1.1 - 6.1.7). A third type of pea has coloured seed coats and coloured flowers. This type includes the Austrian winter pea and maple pea, which are forage or feed pea types and not normally used for food. Marrowfat pea seeds are large, angular, green and used in snack foods and other specialized foods primarily in various Asian markets.

Pea seed weighs from 100 to

Figure 6.1.1 *Alfetta Pea*

Source *Saskatchewan Pulse Growers, 2000*

Figure 6.1.2 *CDC Verdi Pea*

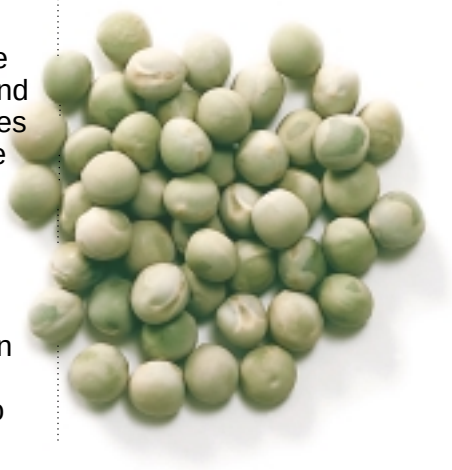


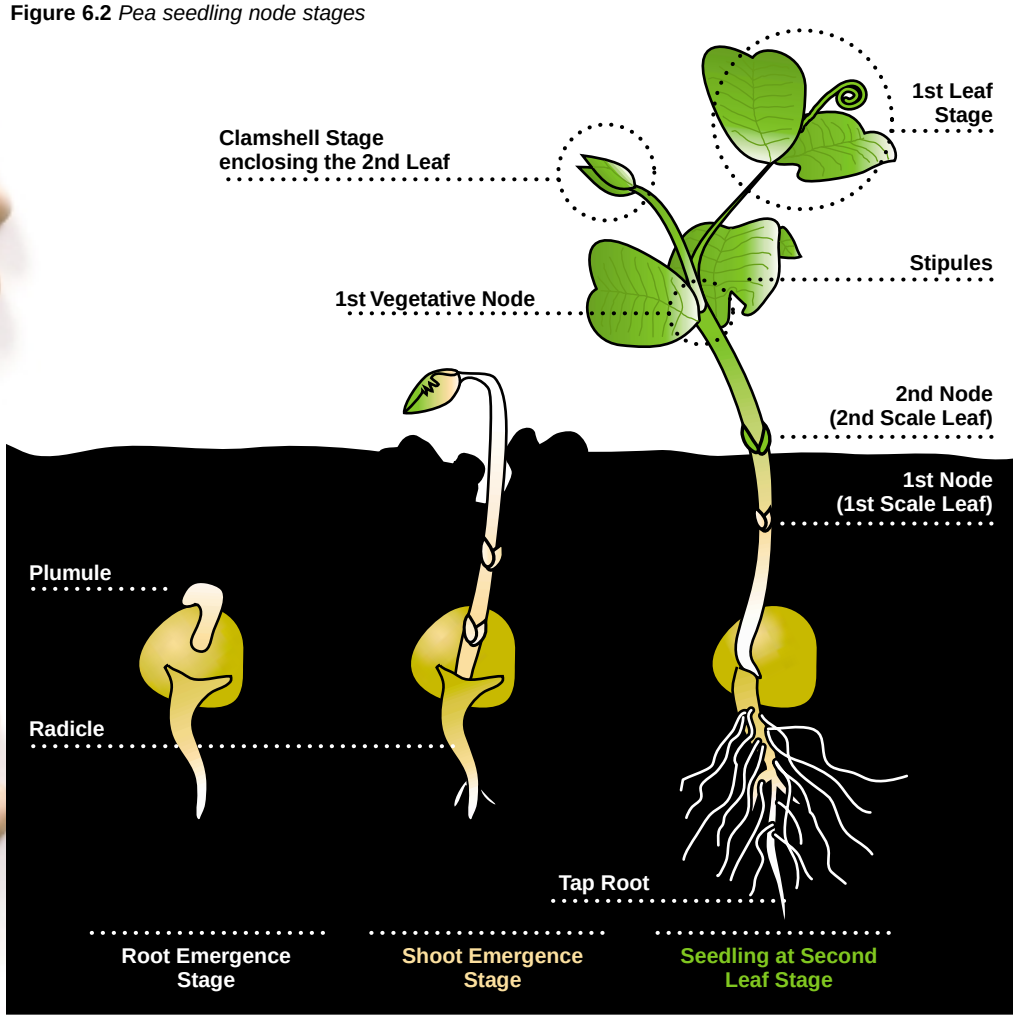
Figure 6.1.3 *CDC Handel Pea*

Source *Saskatchewan Pulse Growers, 2000*

Figure 6.1.4 *Delta Pea*

Figure 6.1.5 *Keoma Pea*

Figure 6.2 *Pea seedling node stages*



350 g/1000 seeds (commonly 190 to 260 g/1000 seeds) when dry and mature. Germination will occur when soil temperatures reach 5˚C. Upon germination and seedling emergence, the pea cotyledons and seedcoat remain below the soil surface (Figure 6.2). The first two scale leaves are relatively small, and seldom emerge completely from the ground. If the young seedling is damaged, regrowth is possible from buds at the base of these scale leaves. The first scale leaf is located at the 1st node position. The second scale leaf develops at the 2nd node position. Under favourable growing conditions, basal branches will develop from one or both of these nodes by the 6-leaf stage.

• **Scale leaves are not considered true leaves.**

The first true leaf, located at the 3rd node position, usually consists of 1 pair of leaflets and a tendril. As the plant grows, leaves have increasingly more leaflets and tendrils. A pair of large stipules, which are leaf-like, develop at the base of each leaf. In semi-leafless peas tendrils replace all the leaflets, but the stipules are still present.

• **Semi-leafless pea plants have many tendrils, which intertwine, resulting in enhanced standability and reduced lodging.**

Semi-leafless varieties repre-

sent the majority of varieties recommended for Saskatchewan.

Pea plant growth can be either:

• Determinate, in which plants reach a certain growth stage and then mature or,

• Indeterminate, where plants continue to grow and flower over a prolonged period of time until some stress factor induces maturity.

• Varieties grown in Saskatchewan are moderately to strongly indeterminate.

Older varieties, such as Century and Trapper, have normal leaves, grow tall, and mature late in the season, especially under conditions of adequate moisture and nutrients. These varieties can flower for a long time, so later flowers may compensate for a short period of drought during early flowering. However, these varieties are at risk of not maturing during a short growing season. Most new varieties have shorter vines and earlier maturity.

Those pea varieties adapted to Saskatchewan produce their first flower at about the 12th to 16th node, and flowering continues at successive nodes as growth continues. Each flowering node produces 1 - 3 flowers, which self-pollinate before they open. The plants produce mature seedpods between 1.5 to 4 inches long (4 to 10 cm) and about 0.5 inches wide (1.3 cm). When mature each pod contains from 6 to 10 seeds.

The best growing temperature range is when daytime highs are between 13 and 23˚C. The plants cannot tolerate drought or high temperatures. Flowers often blast (open briefly and abort without setting seed) in hot weather. The plants flower for a shorter period, and fewer flowers result in pods, if daytime high temperatures are over 27˚C for several successive days. Seedlings can tolerate frost down to –7˚C for a short time, but frost at the flowering stage can cause heavy pod losses. Frost during the immature seed stage causes discoloured and deformed seeds.

Equipment and Modifications

Most existing farm equipment can be used or modified to successfully produce a pea crop. One exception is the need for a roller, which is used to smooth the soil surface to make it easier to harvest pods close to the soil surface. The roller substantially reduces cutterbar damage and may improve seed quality by reducing earth tag (earth sticking to seeds) and speeds up swathing or direct harvesting.

Seed drills or air seeders must have adequate metering devices to handle the large pea seeds. It is advisable to run a trial sample of your seed through the seeder and monitor for broken or cracked seed emptying through the opener. If in doubt, a germination test should be conducted as only slight visible damage may result in severe reduction in germination. Seeds with cracked seed coats produce small, weak seedlings that rarely emerge from the soil. If an air seeder or air drill is used, extra caution is necessary to avoid seed damage.

• Pea seeds are very sensitive to seed coat damage.

• The air velocity should be set as low as possible without the hoses plugging.

• To obtain low enough airflow rates to reduce seed damage in some machines, it may be necessary to reduce the travel speed. Since a slower speed requires lower seed flow rates, a reduced air velocity will carry seed without plugging. Refer to the manu-

Figure 6.1.6 *Montana Pea*

Source *Saskatchewan Pulse Growers, 2000*

Figure 6.1.7 *Trapper Pea*

Table 6.2 *Yield, water use from three soil depths and water use efficiency for four crops, 1996-97.*

Source *Adapted from Miller, P. and A. J. Bussan, 1998*

Crop	Yield	Soil Depth				WUE
		0 – 24 (0–0.6 m)	24 – 36 (0.6-1.0 m)	36 – 48 (1.0-1.3 m)	0 – 48 (0-1.3 m)	
	bu/ac (kg/ha)	Inches of water used by crop (cm)				lb/ac/in.
CWRS wheat	41.2 (2771)	2.7 (6.9)	1.4 (3.6)	0.8 (2.0)	4.9 (12.4)	220
Yellow pea	34.9 (2347)	2.6 (6.6)	0.6 (1.5)	0.3 (0.8)	3.5 (8.9)	210
Desi chickpea	25.4 (1708)	3.2 (8.1)	1.2 (3.0)	0.7 (1.8)	5.1 (12.9)	140
Laird lentil	19.3 (1298)	2.8 (7.1)	0.8 (2.0)	0.3 (0.8)	3.9 (9.9)	110

facturer's recommendations for optimum fan speeds and machine configuration.

• Rapid seed movement through hoses and manifolds can result in seed coat damage when seed reaches the seed opener. If seed cracking or splitting is noticed, then the installation of an "air brake" immediately above the opener should be considered. "Air brakes" reduce air velocity and allow seed to flow by gravity through the opener.

Swather and combine modifications can also significantly reduce seed loss, increase harvest efficiency, and improve seed quality in pea. Vine lifter guards, pick-up reels, flex headers and air reels improve the cutting of plants with pods near or in contact with the soil surface. Generally, the pea crop will result in higher wear on swathers and combines, from increased soil contact, which increases the cost of repairs and leads to more frequent machine replacement.

Most pulse seeds require gentle handling to prevent splitting and reduced germination. Some varieties are more easily damaged. Even non-visible minute damage to the seed can result in a substantial loss in germination. Seed with low moisture content (less than 14%) is particularly susceptible to damage, which increases greatly when handled in cold temperatures (lower than -20˚C). To reduce damage during extensive handling of pulses, special conveying equipment should be considered. Refer to PAMI Research Update #660, Conveying Equipment For Pulse Crops for detailed information on handling pulse crops.

Field Selection and History

Pea plants cannot tolerate certain herbicide residues (See Chapter 5./Weed Control for details.). The Saskatchewan Agriculture and Food publication "Guide to Crop Protection" contains up-to-date information on the problems caused by active residues from herbicides. Growers should consult this publication and herbicide product labels to help them avoid residue problems. These problems can vary, depending on soil properties and weather conditions, so, if in doubt, bioassays or tests for active chemical should be conducted.

Field pea can be sensitive to long-term residual herbicides such as Ally, Amber, Assert, Banvel, Curtail, Lontrel, Muster, Poast FlaxMax, Prestige and Unity. Short term residual herbicides such as Banvel and 2,4-D/MCPA can, under certain conditions, have an adverse effect on pea growth. Restrictions apply to the usage of preharvest Poast Ultra. The recommended period, following chemical application,

before pea can be grown safely, varies with the type of chemical, the rate applied, and soil characteristics, such as pH and organic matter. If residual herbicide persistence is a possibility, then a test strip of pea should be planted on the intended field the year prior to production for monitoring. Ensure that the test crop is allowed to mature to make certain flowering, pod formation and seed set occurs normally. A chemical assay can also be conducted to determine residue levels. Accurate chemical application records are essential for a grower to evaluate the risk of herbicide residues.

Canada thistle, quackgrass, or perennial sow-thistle are likely to be problematic weeds. Wild buckwheat and Russian thistle infestations can cause harvest difficulties. Clean fields offer the best chances of success for pea production. Routinely monitor and survey fields in all years to ensure that the limited herbicide choices registered for use in pea will be able to control the weeds present in the field. A fall or pre-plant application of glyphosate can be an economical method of perennial weed control.

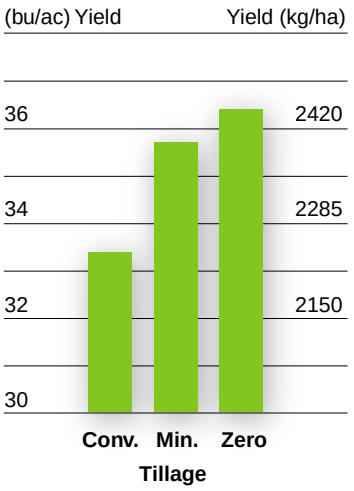
Pea is especially suited to cropping on cereal stubble because of the depleted soil nitrogen reserves and reduced disease risks. Recent results by Agriculture and Agri-Food Canada at Swift Current have also shown that the majority of pea roots and soil water use occur in the top 24 inches (0.6 m) of the soil (Table 6.2). Therefore, field pea is less dependent on over-winter soil water recharge than deeper rooting crops, such as cereals. Though the majority of roots and water uptake is from the top 24 inches (0.6 m) of the soil, pea root systems are very efficient and the crop utilizes this water for increasing yield. The water use efficiency (WUE, weight of grain produced per unit of soil water plus rainfall used) of pea is equal to that of spring wheat. Results also demonstrate the benefit of pea in rotation as unused soil moisture and nutrients remain below 24 inches (0.6 m) for a subsequent deeper-rooted crop.

Seeding on stubble is a normal practice in the moist, sub-humid regions of the prairies. Seeding on summerfallow in these areas can result in excessive vine growth and lodging due to excessive nitrogen levels. Excess growth results in increased difficulties at harvest and greater disease incidence. In selecting fields for production the following need be considered:

- **Pea should not be planted on pea stubble, since it will have a higher risk of ascochyta (mycosphaerella) blight.**
- **Pea following alfalfa, bean, flax, or lentil has a medium risk of seedling blights or root rot.**
- **Sclerotinia risk is increased when pea is planted following sunflower, canola, mustard, bean, faba bean, or lentil.**
- **Pea should only be planted on the same field every 4 - 5 years.**

Traditional pea production recommendations include spring tillage, but pea performs very well in direct seeding systems, if the seed is planted at uniform depth. The large seed provides for good emergence through surface residue. Planting pea into standing cereal stubble provides shelter for newly emerging plants and helps prevent soil erosion. Results from long term tillage system trials conducted at Indian Head reveal that pea yields were greater with a zero or minimum tillage system as compared to a conventional system (Figure 6.3). Pea produced under the minimum or zero tillage systems also exhibited higher water use efficiency, indicating that they produced more

Figure 6.3 *The effects of tillage systems on field pea grain yield.*



Source *Adapted from Lafonde et al, 1999*

Table 6.3 *Average yield of field pea relative to CWRS wheat in tillage trials at Swift Current (1993-96) and Assiniboia (1995-96) when sown on fallow and wheat stubble treatments.*

	Fallow	Stubble
	Yield (% of wheat)	
Total 6 site-year average	124	134
Driest 3 site-year average	110	126

Source *Agriculture and Agri-Food Canada – SPARC, Swift Current*

grain per unit of moisture used than did the conventional tillage system.

In selecting fields it should be cautioned that;

• Pea does not tolerate salinity or waterlogging.

• Stone-free and level fields are preferred. Stony fields should be rolled and vine lifters used to minimize harvest difficulties.

• Pea plants develop best in deep soils and grow poorly in eroded or compacted soils.

As field pea is a cool season crop sensitive to drought, especially during flowering and pod set, it yields highest in the cooler **Black** and **Grey** soil zones. In the **Dark Brown** and **Brown** soil zones dryland pea yields are, on average, less than yields in the **Black** or **Grey** soil zone, or than when grown under irrigation. However, yields exceeding 2400 lb/ac (2690 kg/ha) have been produced and maturity issues are of less concern.

For production in the **Black** and **Grey** soil zones:

• Short stature, early maturing varieties are best suited in moist, short-season areas.

For production in the **Dark Brown** and **Brown** soil zones:

• Early seeding in mid to late April can reduce the risk of encountering adverse heat and drought effects. This allows for seed production before mid-July when hot, dry weather usually occurs, causing flower abortion.

• Indeterminate types flower over a longer period so they are more likely to be able to compensate for periods of hot, dry weather during flowering.

• Taller varieties can be easier to harvest.

Research from Agriculture and Agri-Food Canada at Scott and Swift Current shows that pea is better suited to the Brown and Dark Brown soil zones than previously thought. This is consistent with producer experience in these regions. Pea yields in the Brown soil zone were competitive with CWRS wheat yields in a tillage trial, especially when both crops were grown on wheat stubble (see Table 6.3). In this trial, three of the site-years were wetter than normal, two had near normal climatic values, and one was drier than normal. The key is early seeding too avoid heat stress during flowering. Pea matures earlier than wheat and thus avoids the most severe drought stress in late August.

When seeded into cereal stubble, pea has shown a strong response to early spring seeding at Swift Current (Table 6.4). Pea yields declined sharply as seeding date was delayed. It is critical that field pea be seeded as early as soil temperatures permit to get the maximum yield potential from a pea crop in the Brown soil zone.

A unique feature to growing field pea in the Brown soil zone is that normal-leafed cultivars can yield about 5% higher than semi-leafless cultivars due to higher photosynthetic capacity and earlier crop canopy closure (Figure 6.4).

Table 6.4 *Relative yields of field pea grown in cereal stubble at different spring seeding dates at Scott (1993-96) and Swift Current (1994-96).*

Site	Date 1*	Date 2	Date 3
	Yield (% of Date 2)		
Scott	76	100	84
Swift Current	117	100	77

Source *Agriculture and Agri-Food Canada – SPARC, Swift Current*

*Seeding dates were May (4-7), mid-May (16-22) and late May / early June (25-3) at Scott and were on or near April 21, May 5, and May 24 at Swift Current.

Normal-leafed varieties and narrow-row spacing [8 inches (20 cm) vs 12 inches (30 cm)] assist in reduced soil water evaporation rates by providing quicker and more complete canopy closure. Plant root exploitation of between-row soil moisture is further facilitated by narrow-row spacing. Differences are more pronounced in stubble cropping situations where soil moisture is lower.

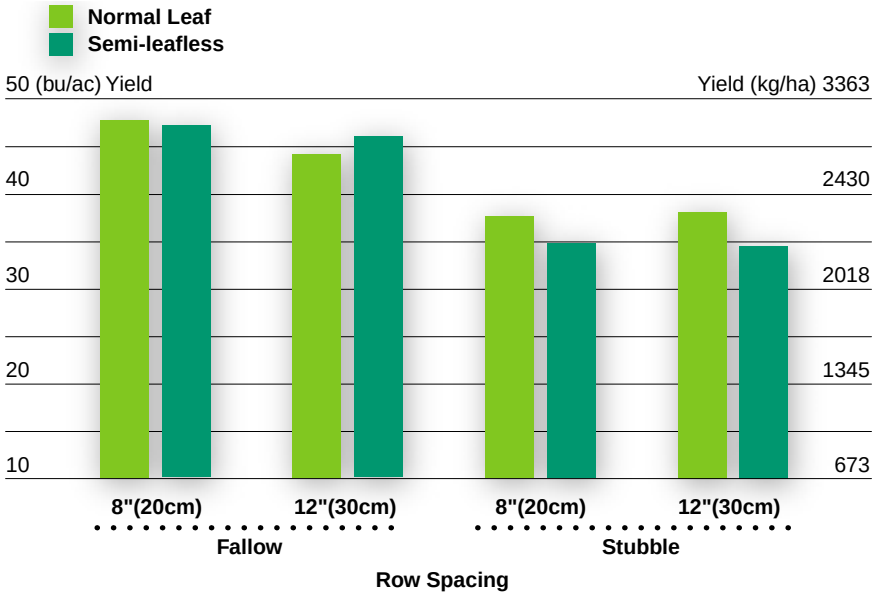
It is not known if diseases such as mycosphaerella will plague the dry Prairie region as is the case for the moister Parkland region.

Further studies conducted at Swift Current demonstrated the benefit of producing pea on untilled stubble and the influence of the previous crop stubble height (Figure 6.5).

Yields usually increased as the stubble height increased. The influence of seeding into tall standing stubble helped reduce soil moisture evaporation, particularly during the period prior to flowering. This resulted in greater moisture use efficiency by the crop. As stubble height increased, the height of the lowest pod also increased, which can facilitate swathing or combining and possibly reduce shattering losses.

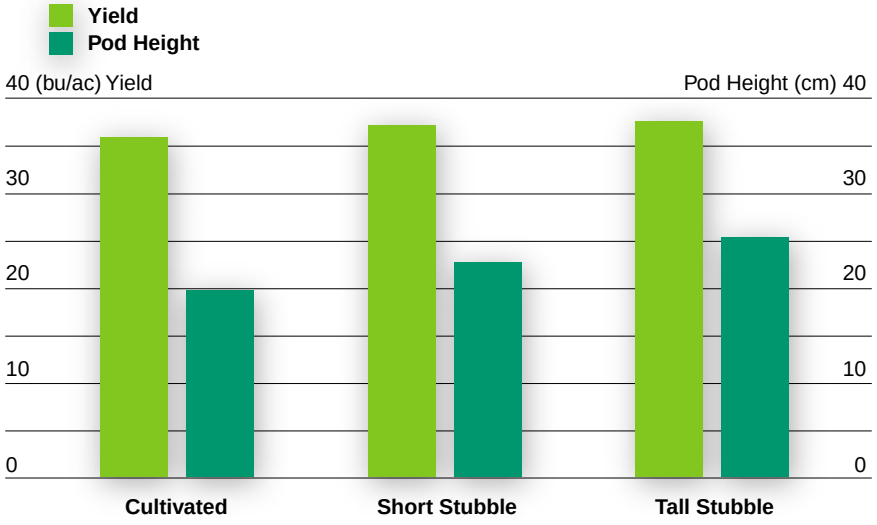
The dry Prairie region could potentially supply high quality, economical seed for production in moister regions. Due to low disease pressure in the dry Prairie, pea seed is naturally of very high quality. Also, pea seed size has typically been 10 to 15% smaller in the dry Prairie than the Parkland due to greater soil moisture stress during seed filling. If the smaller seed maintains similar vigour and yield potential as the larger seed, as anecdotal evidence suggests, then it becomes a more economical seed source of any cultivar, due to the greater number of seeds per unit of volume.

Figure 6.4 *Influence of leaf-type and row spacing on yield of pea in the Brown soil zone. Average 1995-98*



Source *Adapted from McConkey and Miller, 1999.*

Figure 6.5 *Effect of cultivation and stubble height on yield and height of the lowest pod in pea. Average 1996-98*



Source *Cutforth et al., 1999.*

Varieties

A large number of pea varieties are recommended for Saskatchewan (refer to Chapter 3./ Variety Selection, Table 3.2). Most are higher yielding, earlier maturing, shorter in vine length, and less prone to lodging compared to the older varieties. Selection of a variety depends on seed cost, the target market and the area in which the crop is grown. A selected market will have specific colour, size, shape, or cooking characteristic requirements.

High yield and small seed size are important in the livestock feed market. Varieties with coloured flowers and brown seeds, such as maple pea, are slightly less desirable as feed because they have higher tannin levels than the green or yellow pea. Tannins are bitter and reduce protein digestibility. The level is low enough in these varieties that detrimental effects are minimal. Pea intended for sale for food, but of poor quality, can be sold as feed. Disease, poor weather, and damage during threshing and cleaning can downgrade food pea to feed pea.

Quality is extremely important in the food pea market. A large proportion of production is of yellow pea. They are often about 10 – 15% higher yielding than green pea and in addition, green pea seeds are subject to bleaching, especially if alternating rainy and hot sunny days occur prior to harvest. Bleaching can downgrade seed quality of dry green pea, and may make it unsuitable for food. Good quality green pea usually sells at a slightly higher price than yellow pea; however, the net returns may still be higher for yellow pea due to its higher yield. Green and yellow food pea markets pay attention to seed smoothness, roundness, colour uniformity and size. Some varieties are more consistently round than others.

Vine length and leaf type can be important considerations. The strongly indeterminate varieties have a lower risk of major yield loss due to flower blasting on hot days because of the longer flowering period. Their longer vines, also result in less difficulty in harvesting. Under adequate moisture conditions, the early types are more likely to mature in a limited growing season, such as may occur in cooler areas. Under all moisture conditions, the semi-leafless varieties are less prone to lodging. Short and medium vine types and semi-leafless types do provide less weed competition so effective weed control is more important.

Most varieties have similar susceptibility to disease. No varieties are resistant to ascochyta (mycosphaerella) blight. (See Chapter 3./Variety Section, Table 3.2 for details).

All varieties of peas, except Princess, should be seeded early to produce the highest yields. Princess pea is very early in maturity and if seeded early, it matures rapidly during and after the mid-July hot spell, which results in low yields. Seeding Princess in the first week of June results in higher yields as it allows it to be at early pod set stage in mid-July. The pods can then fill during cooler weather in August and this results in higher yields.

Crop Management

Seeding Considerations

Seed quality has a large impact on crop yield. Seed should have both high germination and vigour. The risk of crop failure is substantially reduced if seed germination is 90% or better. Pea seed is very susceptible to physical damage during handling, especially if the seed moisture content is below 14%. To maintain pea seed quality, gentle

handling is essential as damaged seed will not germinate and emerge.

Damaged seeds result in decreased germination and increased susceptibility to infection by seed rot. Cracked or damaged seed can also reduce seedling vigour, the ability to germinate and emerge under adverse conditions. Seedling vigour is critical when pea is planted into cold, wet soil; a frequent occurrence in the Black and Grey soil zones. Poor seedling vigour results in a plant that develops slowly and is vulnerable to attack by seedling diseases. Agrox B-3/D-L Plus/DLC, Apron FL, Captan Flowable and Thiram 75WP are registered seed treatments for pea. Apron FL is specific for the control of seed rot caused by Pythium species. Studies in Alberta have shown that the benefit of using seed treatment with poor quality seed is inconsistent, but it may reduce disease, if planting into wet soil. This research has demonstrated that emergence of poor quality field pea can be improved with seed fungicide treatment.

• Using planting seed from fields treated with pre-harvest glyphosate should be avoided as the seed may contain residue, which reduces germination, vigour, normal root development and inoculant efficacy.

Inoculation

For detailed information on inoculation refer to Chapter 4./Plant Nutrition. The legume-Rhizobium combination has the potential to fix up to 70% of the nitrogen needed by the pea crop so it is important to ensure proper inoculation. To carry out successful pea inoculation, a grower should use Rhizobium inoculant of the pea strain. The inoculant must be stored in a cool place prior to use and must be used before the expiry date. Seed inoculant (peat-based or liquid) should be thoroughly mixed with the seed just prior to seeding and after any fungicidal seed treatment. Granular (soil implant) inoculant is seed placed or banded below the seed (Chapter 4./ Plant Nutrition, Inoculant).

Fertilization

Fertilizer requirements are discussed in Chapter 4./Plant Nutrition, Fertilization.

Time of Seeding

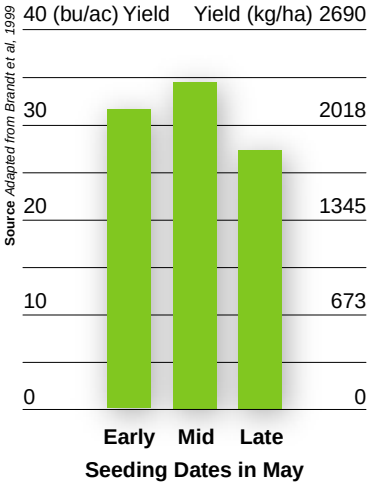
Pea seeds will germinate at soil temperatures as low as 4˚C , and pea seedlings will tolerate light frosts and can even regrow from the scale nodes after severe frost. The best yields and quality are usually obtained from early seeding. Seeding can begin when the average soil temperature at depth of seeding reaches 5˚C, if the soil is not too wet. Using a soil thermometer, measure the soil temperature at the depth of seeding in the morning and in the afternoon. Average the two measurements to obtain the soil temperature. Germination and plant development are more rapid when pea seeds are planted into warmer soils, but later seeding is less likely to provide the best yields. Later seeding does decrease the chance of seedling diseases. Producers in the Black and Grey soil zones may wish to consider seed treatments for early seeding into cool, moist soils.

• In the Black and Grey soils pea should be planted in early May.

• In the Brown and Dark Brown soil zone pea should be seeded between April 15 and May 5 to reduce the risk of flower blast during the hot temperatures of July.

At Scott, indications were that field pea should be seeded earlier than wheat, but, unlike Swift

Figure 6.6 *Influence of date of seeding on yield of pea during 4 years at Scott (1993-1997).*



Current, no advantage was seen to seeding as early as possible (Figure 6.6). Results of this four-year study indicated that in the Dark Brown soil zone, on average, yields were optimized by planting up to mid-May. Yield losses occurred when seeding was delayed until late May.

Seeding Rate

Determining the best seeding rate involves careful consideration and calculation. Pea seed varies with size, variety, and even with the seed lot. Within a variety or seed lot, the size can vary 10 to 20%. A 20% difference in seed cost can be important. Seeds can be sized during cleaning to produce a more uniform lot.

Some flexibility is available in determining the best plant population. A final plant establishment of 8 plants/ft^2 (88 plants/m^2) is recommended. The grower may use higher or lower rates, based on the moisture conditions in the field, date of seeding, weed pressure, and experience in management of the crop. However, stand density does not increase in direct proportion to the increase in seeding rate because of reduced percent emergence resulting from increased in-row competition.

The best seeding rate is a compromise. Seeding rates above those recommended are used to compensate for expected losses. For instance, if post-emergent harrowing losses of 15% are probable, a 15% boost in seeding rate could offset losses, and result in achieving the recommended plant number after harrowing. Higher seeding rates often result in higher yields because higher than recommended rates reduce competition from weeds by allowing the crop to close off the canopy earlier. However, higher plant numbers may increase the rate of spread of disease, particularly under cool moist conditions. The benefits from weed suppression and possible earlier maturity from higher plant densities must be compared to the increased risk of disease and higher seed costs.

• Recommended seeding rates are based on a goal of 8 plants/ft^2 (88 m^2), or 13 plants per meter of row with rows 6 inches (15 cm) apart.

• Seed drills should be calibrated after inoculation as inoculant may reduce the flow rate through the equipment.

• Seeding rates should also be calculated based on the tested germination rate of the seed (see Chapter 2./General Production, Seed Quality).

• Lower than recommended seeding rates will reduce the competitive ability of pea and will usually result in reduced yields.

To calculate seeding rate the following information is needed:

• The desired plant population (plants/ft^2)

• Likely plant survival (% seedling vigour or % germination).

• 1000 seed weight in grams.

Seeding rate (lb/ac) = (population/ft^2 x 1000 seed wt in grams ÷ % survival) x 10

For example, with a population of 8 plants/ft^2, a 1000 seed wt of 240 g, and 90% of seed producing vigourous seedlings, seeding rate = (8 x 240 ÷ 90) x 10 = 213 lb/ac or 239 kg/ha.

• Rule of thumb: 0.8 x 1000 seed weight in grams = seeding rate in lb/ac, assuming 95% germination or better (otherwise divide by percentage germination).

The seeder calibration (done after inoculation) involves some of the same information, plus the row spacing:

Number of seeds/foot of row

= (population/ft² x row spacing (inches) ÷ 12 ÷ % survival x 100

For the above example, with 9 inch row spacing, number of seeds/foot of row = (8 x 9 ÷ 12 ÷ 90) x 100 = 6.7 seeds/foot of row.

Assuming 100% survival, seeding rates for a range of seed sizes are presented in Table 6.5. The adjustment for seed survival should include an adjustment for the rate of germination and the rate of production of healthy vigourous plants.

If pea is intercropped with a cereal for silage, pea is generally seeded at 75 to 100% of the recommended rate, whereas the cereal seeding rates are reduced to 25% of normal. Pea may be intercropped with canola or mustard to reduce lodging and facilitate swathing. To be effective, pea is generally seeded at the recommended rate, while the oilseed is seeded at 50% of the recommended rate. Seeding the cereal or canola 5 to 7 days after seeding pea will help the pea seedlings compete in the mixture.

Table 6.5 *Seeding rate vs seed size in pea.*

Seed weight	Seeding rate	
g / 1000 seeds	lb/ac	kg/ha
150	120	135
180	144	161
210	168	188
240	192	215
270	216	242
300	240	269

Seeding

Traditionally, early spring cultivation to the seeding depth has been the recommended method to warm and mellow the soil for more rapid germination. Spring cultivation should be minimized, particularly in drier areas to avoid drying out the soil and to reduce the risk of soil erosion. Recent advances in direct seeding have provided a solution to this problem. A properly designed direct-seeding opener and packer system can create a micro-climate in the seed row, which allows for soil warming and produces excellent germination conditions. The elimination of prior cultivation retains soil moisture reserves and eliminates the risk of erosion. The retention of soil moisture allows for shallower seeding and rapid emergence of the crop.

Field pea is susceptible to mechanical seed damage, especially if the seed moisture level is below 14%. Some growers use a water hose to wet a truck box full of seed the day before seeding and let the excess moisture drain off over night. This procedure adds about 1% seed moisture and helps to reduce damage. Consideration should be given to moisturizing the seed prior to handling and seeding if the moisture content of the seed is below 14%. Refer to PAMI report #704 Research Update: Moisturizing Pulses to Reduce Damage for information on raising the moisture content of pea.

Seed into moisture:

• The recommended seeding depth is 2 to 3 inches (5 - 7 cm) when seeding into pre-worked soil. When direct seeding, it is recommended to seed shallower, but the seed must be placed firmly into moist soil. In either case it is recommended to place seed 1.5 inches (4 cm) into moisture.

• Pea seedlings can emerge from deep placement (3 inches or 7 cm); thus, it is better to plant on the deep side than to plant too shallow.

• If soil moisture is not limiting, shallow seed placement will result in earlier emergence and provide greater weed competition.

• Frequently check seeding depth. Large-seeded pea seeds are prone to seed bounce because of soil and/or moisture differences within the field or,

more commonly, to excessive travel speed. Seed bounce will often leave seeds on or close to the soil surface and can result in uneven germination. If seed is observed on the soil surface – slow down.

During germination, the seed swells to twice its size and when it germinates, the seeds remain underground. Pea seedlings are able to emerge from relatively deep seed placement because the seeds are large, but the seeds are quite sensitive to moisture conditions. They require adequate moisture for germination, but soils that are too wet foster seed and seedling disease. Also, waterlogged soils do not provide enough oxygen for adequate germination.

If the drill, discer, or air seeder does not have packer wheels, the soil should be harrowed or harrow packed to level and firm it around the seed. If soil moisture is excessively high, delay harrowing or harrow packing for 1 or 2 days to allow moisture uptake in the presence of air. Overpacking should be avoided, particularly if the soil is a very wet clay or low organic matter Grey soil where crusting can occur. Rolling should also be done at this stage, provided that the soil is not too wet.

Intercropping

Two different types of pea intercrops (both crops grown together in the same field) are occasionally used. The need for intercropping to improve "standability" of the pea crop has been reduced by the availability of shorter vined, semi-leafless varieties. Even in low and tangled crops, advances in harvesting equipment, such as vine lifters, pick-up reels, and flex headers, have made it possible to harvest without large losses. As a result, the use of intercropping for improved standability has declined.

A pea-canola (peaola) or pea-yellow mustard mixture is sometimes used to provide growth support for pea vines. This improved standability reduces the opportunity for disease and lodging. Standard harvest equipment can then be used, and swathing is delayed less after a rain. A crop desiccant usually is not needed. Shattering losses are minimized since the pea plants can mature in the swath, which is anchored and dries well after a rain. The oilseed provides a buffer for the pea in the combine and in the augers, reducing pea seed damage. The crop can be cut higher off the ground, resulting in less "earthtag" (dirt stuck to the seed coat), and more standing stubble is left to trap snow over winter.

• When intercropping with canola, fertilizer recommendations for canola should be followed, even though the excess nitrogen availability will reduce nodulation of the pea plants.

Several herbicide options exist (Refer to the Saskatchewan Agriculture and Food Crop Protection Guide for detailed options). Sencor-trifluralin mixture should only be used if a triazine-tolerant canola variety is used. The crop can be combined at 16% moisture for the pea and 9 to 9.5% moisture in the canola.

• The two crops should be separated before they are binned.

If they are dried together, mixing with a bin spreader will help reduce clumping of the oil seed and dockage, which may restrict airflow in the drier.

A pea-cereal intercrop can be used to improve silage quality. The cereal increases the carbohydrate content, which facilitates ensiling. The legume increases and balances the protein content. Barley is often the preferred cereal as it is high yielding and early maturing, and

barley has a higher feeding value than oat. If the barley and pea are seeded in strips, they do not compete directly. They are then harvested across the strips to provide some mixing of the harvested materials. If the pea and barley are seeded as a mixture, **yields are lower than when they are seeded alone**, but the peas will twine around the barley and stay off of the ground. The mixture is generally harvested when the lower pods reach maturity and show signs of starting to dry down, and the cereal is in the late-milk to soft-dough stage. Earlier harvesting increases the proportion of cereal in the mix; late harvesting increases the proportion of pea seeds. After swathing, the pea mixture should be allowed to wilt to 65% moisture before ensiling.

In-Crop Considerations

Rolling

Stones or soil lumps on the soil surface interfere with pea harvesting. Rolling will flatten these into the soil surface and level out soil ridges caused by seeding. Rolling allows for higher speeds when swathing or direct combining, and reduces guard and sickle section breakage. Pea can be rolled after harrowing or harrow packing if conventional tillage is used or after seeding if direct seeded.

• Rolling can be done anytime from immediately after seeding up to the 5-leaf stage.

• All rolling should be carried out on dry days to lessen the spread of disease.

• Post-emergent rolling or harrowing is best done on warm days or late afternoons when plants are partially wilted and more flexible.

• In heavy clay soils, where rolling before emergence can cause crusting problems or reduce oxygen movement to the seed, allow one to two days for the seed to take up moisture in the presence of oxygen before rolling.

• On light sandy soils or under low residue conditions, such as summerfallow, rolling can increase the possibility of wind and sand blasting of the seedlings. Under these conditions delay rolling until the 5-leaf stage.

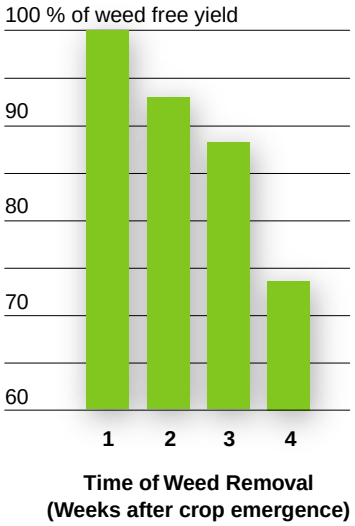
• Increased crop injury can occur if rolling occurs immediately before or after herbicide application.

• Most pea producers prefer to roll before the pea crop emerges.

Weeds

For further information on weed control see Chapter 5./ Weed Control. Field pea is a poor competitor with weeds. However, pea plants are more competitive with annual weeds, if they emerge rapidly and cover the soil surface before the weeds germinate. If emergence of the pea seedlings is slow or germination is poor, weeds have an advantage. Factors such as diseases, insects, and low fertility will also reduce the competitive ability of pea. Inexpensive herbicides, as used in cereal production, are not as available in pulse production. An effective weed control program involves an integrated approach, combining preventative and cultural methods (such as disease-free seed, appropriate tillage and careful planning of rotations) with effective use of selective chemicals. Research conducted at the Lacombe Research Center demonstrated that early weed removal in field pea can have a significant positive impact on grain yields (Figure 6.7). Similar results on time of weed

Figure 6.7 *Effect of time of weed removal on yield of field pea.*



Source *Harker, H.N., G. Clayton and R. Blackshaw, 1998*

removal have been obtained in the Saskatchewan AFIF Spoke Site program.

Research at Morden has determined that different varieties have a different competitive ability against wild mustard. Tall, normal leaf rapidly developing varieties, were more competitive than the shorter types. The wild mustard grew above the canopy of the shorter pea varieties. The leaf form (semi-leafless vs normal) did not appear to make a difference in competitive ability.

Research indicates that the competitive ability of pea depends strongly on the weed types and the environmental conditions. A Melfort study showed that pea was more competitive at higher seeding rates of up to 9 plants/ft^2 (100 plants/m^2). At lower seeding rates with reduced competition, the use of herbicides to control weeds becomes more important.

Good weed management depends on a strategy that considers the management system of the farm and the entire field rotation, rather than simply the pea crop. Techniques described in Chapter 5./ Weed Control are applicable to pea.

Harrowing with a tine harrow between planting and crop emergence will often control weeds that have escaped previous efforts. Harrowing should be avoided immediately after crop emergence to prevent damaging the seedlings. Postemergent harrowing for weed control is generally less effective. Weed control may be erratic and crop damage may cause variable maturity. The amount of damage is reduced if finger weeders or flexible harrows are used.

Several herbicides are registered for use in pea in Saskatchewan. Chapter 5./Weed Control lists these herbicides and briefly discusses their use. Additional information is found in the publication " Guide to Crop Protection" from Saskatchewan Agriculture and Food, and of course, on the herbicide labels. Always follow label precautions and directions, as they may vary for different crops.

Quackgrass, perennial sowthistle, and Canada thistle are difficult weeds to manage in a pea crop and are easier to control in other years of the rotation. Pre-harvest application of glyphosate in the previous crop is one method that can be used to control these weeds. Spot spraying in the pea crop may be advisable as pea losses are generally severe. Wild buckwheat, cleavers, Russian thistle, and kochia are weeds that can remain green and make harvesting pea difficult, and interfere with drying and storage of the crop. Weed management in pea is easier, if fields with infestations of these weeds are avoided, or if these weeds are controlled in other years in the rotation.

Pea plants are sensitive to residual herbicides. Keep a complete record of herbicide use for each year and refer to recropping restrictions on the label. If herbicide carryover is suspected, a test area can be seeded in the year prior to seeding the pea crop. The test area should be allowed to mature to properly indicate potential problems as the pea plant may initially show normal growth, but may not set seed or may die later in the season. A chemical assay can also detect herbicide residues. Pea plants are also especially sensitive to 2,4-D drift, which can cause serious crop injury.

If trifluralin is used, fall incorporation provides the advantages of uniform distribution of active ingredient and conservation of spring soil moisture by reducing the need for spring tillage. Fall incorporation can result in improved crop

tolerance, and the reduction in spring tillage should allow earlier seeding. However, fall-incorporated products are not recommended if the soil is prone to erosion from wind or water in the fall or spring or if fall soil conditions prevent thorough incorporation. A spring tillage operation is recommended to warm and aerate the soil to activate those herbicides which are fall applied. Although not registered for this use, studies at Scott and Indian Head, using surface-applied trifluralin or ethalfluralin under no-till conditions, have shown weed control and crop safety comparable with incorporated trifluralin or ethafluralin in some years. Pre-seeding burnoff by herbicide applications of glyphosate are usually only effective for later seeding dates as few weeds germinate prior to early seeding dates for pea, except for winter annual weeds, such as stinkweed and flixweed.

• If post-emergent herbicides are used, they should be applied before the 4- or 5-leaf stage to ensure weeds are at the best stage for optimum coverage and control, and the pea crop will be the most resistant to damage. Pursuit or Odyssey can be applied up to the 6th node stage in the Black soil zone.

• Crop damage due to late herbicide applications is a common problem. With adverse weather conditions a pea plant can reach the 5th node stage and still be only 3 inches (7.5 cm) tall.

• Ensure the sprayer is thoroughly cleaned prior to use. Residue of many broadleaf herbicides and some grassy herbicides can cause significant damage.

Application of post-emergent herbicides after pea vines reach the 5-leaf stage causes vine damage from the sprayer, and pea plants often will show increased sensitivity to herbicide injury by this point. Annual weeds (particularly broadleaf species) may already be too large for effective control and the yield may have already been reduced, even if the control measures are effective.

A number of glyphosate products are registered for pre-harvest weed control in pea. Applications of these products do not desiccate the crop and their benefit in drying down the crop has been inconsistent.

• Do not use these products if you plan on retaining the seed for planting. Glyphosate carryover in seed can result in irregular germination, plant development and poor nodulation or seedling death.

Insects

Crop loss from insects in pea crops is sporadic, but the potential for yield and quality loss is high for specific insects, if their populations are high. Insects are most effectively controlled if the grower maintains an integrated management system that includes a knowledge of the biology of the insects that might cause problems, field scouting, knowledge of insect survey projections, sound agronomy, and the use of insecticides when necessary.

The numbers of insects in any given field is dependent on a multitude of factors, including weather, the farm management system, the number of insects in previous years, and the buildup of various predators, diseases, and parasites.

In Saskatchewan, it is not likely that any insects other than grasshoppers will be a problem. Even the grasshopper risk is not severe. Saskatchewan Agriculture and Food publishes an annual grasshopper forecast that indicates the likelihood of a grasshopper out-

Source Bert Vandenberg

Figure 6.8 *Pea aphid*

break. It is based on surveys of egg numbers in each crop district. Regular field inspections should be used to verify that insects are at damaging levels.

Grasshoppers usually lay their eggs in areas with green growth in the fall. Good fall weed management discourages egg laying. When grasshoppers hatch in the spring, they are only 1/10 inch (0.25 cm) long. They can be spotted in uncultivated areas such as ditches, stubble, pasture, and field edges, by looking carefully, or by using a cloth net swept near the soil surface. Grasshopper survival and crop damage will be the greatest in hot, dry springs, and in field areas that accentuate those conditions such as south slopes and sandy soils. These conditions speed up the grasshopper hatch, bringing more hungry insects to the crop at one time. A heat-stressed crop is less tolerant of insect damage than one with adequate moisture because when stressed, growth is slowed and the damaged leaf area is not quickly replaced.

Grasshoppers chew through young shoots, even if they do not eat the plant. Grasshopper damage to seedlings bordering ditches and roads can occur. Grasshopper problems are more likely in the warmer, drier southwest region of Saskatchewan. In these areas, summerfallow is more common, and these tilled areas can be incorporated into the grasshopper management system. Clean summerfallow will starve newly emerged grasshoppers. If grasshoppers have already begun to feed when summerfallowing is started, they will be more likely to move to neighbouring fields. In this case, trap strips of green growth can be left to concentrate the grasshoppers before applying a registered insecticide. The effectiveness of the trap strip will be increased, if it is planted early in the year.

Stubble cropping increases the risk of grasshopper problems because the previous crop provides a habitat that encourages egg laying. This risk is greatest in years when a warm spring occurs and severe or very severe grasshopper outbreaks are forecast.

Although grasshoppers can cause severe damage to a pea plant, peas are not a preferred food for them. In addition, the main areas of pea production are not in the main areas which usually have heavy grasshopper infestation. In general, infestations of grasshoppers 10/m^2 do not cause enough damage to be of economic significance, but the stage of crop growth, when infested, plays an important role in the effect that grasshoppers have on the crop in any given year.

Table 6.6 (in Appendix) outlines those insecticides available for use of pea in Saskatchewan. Knowledge about application of each insecticide will enhance activity and optimize use. Insecticides should be used with caution.

Pea aphid is a problem of economic importance in Manitoba. In Saskatchewan's cooler climate in the areas where pea is grown, aphids develop more slowly and are less likely to cause severe problems. Pea aphids are small (about one-eighth of an inch), light green, long-legged, slow-moving insects (Figure 6.8). They may overwinter as eggs in alfalfa and clover and then fly into neighbouring pea fields, but more commonly they blow in from the United States in early summer. Populations of 10 aphids per plant can begin to cause an economic effect, especially if the plants are heat stressed. The aphids suck the sap from the plant and weaken it, but even more importantly, they can act as the disease-spreading mechanism for viral diseases. Under warm, moist conditions,

aphids reproduce at astonishing rates. Early seeding, or late arrival of the aphids reduces damage as aphids are less attracted to older plants. Aphids can be controlled chemically or biologically, but heavy rains or strong winds can also virtually eliminate them.

Cutworms occasionally cause problems. The risk is low, unless more than 2 to 3 cutworms/m^2 occur in the top 3 inches (7 cm) of soil. Cutworms overwinter as eggs or young larvae that feed on newly emerged shoots in spring. The shoots may be cut off below the soil surface. Crops, such as pea, where the cotyledons (seeds) remain below the soil surface, can often recover from cutworm damage if cool, moist growing conditions occur. However, recovered plants are generally set back 4 to 7 days by the damage.

Red-backed cutworm moths (more common in the Black and Dark Grey soil zones) lay their eggs in weedy areas. Good weed management in late summer can discourage them. Pale western cutworm moths (more common in Brown and Dark Brown soil zones) lay their eggs in loose soil. Fall tillage encourages them to lay eggs in an area.

If insecticide sprays are used in areas where bees are kept, they should be applied in the evening or early morning, when bees are not foraging. Beekeepers in the area should be notified at least 48 hours in advance of any insecticide treatment.

Diseases

Disease management through crop rotation is important in reducing the likelihood and severity of disease. Several diseases occur in pea in Saskatchewan and are outlined in Table 6.7.

Mycosphaerella/Ascochyta diseases are the most common disease complex of pea in western Canada and are of great economic importance. At present, no known source of resistance to mycosphaerella blight is available. However, some variation in susceptibility occurs among varieties (see Chapter 3./Variety Selection). Three different species of fungi are responsible for this disease complex: *Mycosphaerella pinodes* which causes blight, *Ascochyta pisi* which causes leaf and stem spot and *Phoma medicaginis var. pinodella* which causes foot rot. All three fungi can occur simultaneously and it is often difficult to distinguish between them in the field. Losses of up to

Table 6.7 *Diseases of field pea in Saskatchewan.*

Disease	Disease severity
Fungal	
Ascochyta/mycosphaerella blight	Widespread and causes significant economic losses when infection occurs before flowering.
Ascochyta foot rot	Widespread and causes significant economic losses when infection occurs before flowering.
Powdery mildew	Widespread and usually of economic importance only in late plantings or late maturing low spots.
Pythium seed rot	Most severe in cold, wet and compacted seedbeds.
Seedling blight	Widespread, but usually not of economic importance.
Botrytis stem and pod rot	Infrequent and usually not of economic importance.
Sclerotinia stem rot	Widespread, but usually not of economic importance.
Bacterial blights	Infrequent and usually not of economic importance, except when infected seed is imported and grown under overhead irrigation.
Viruses	Infrequent and usually not of economic importance

Source *From Martens et al, 1984 and R.A.A. Morrall and A.E. Slinkard. Personal Communications*

Source Department of Biology, U of S

Figure 6.9 *Mycosphaerella blight showing lesions on stems, leaves and pods of pea plants.*

80% have been reported when a heavy infection occurs in mid-June. In western Canada greater than 90% of the disease damage is caused by mycosphaerella blight as opposed to foot rot or leaf/stem spot.

Mycosphaerella causes dark irregular spots on leaves and stems. The spots may grow together to form larger lesions (Figure 6.9), and the leaves may dry up, but remain attached to the plant. Most lesions are found on the lower leaves and stems, which are closer to the stubble-borne inoculum on the soil surface. Stem lesions usually are first found at the point of leaf attachment and are brown to purple in colour; stem lesions can merge. For every 10% infected stem area about 5-6% yield loss can be expected. The lesions may also be found on the flower stalks before flowering ceases, and are followed by blossom drop. Lesions form on pods and the fungus can infect the seed as well. If 10-15% of the pod area is covered with lesions, then 5-10% of the seeds are likely to become infected. Seeds in older pods are most susceptible to damage. Infected seed may appear normal, or may be shrunken and discoloured. Lesions caused by ascochyta foot rot are commonly more concentrated at the base of the stem, and near the point where the cotyledons are attached. With ascochyta foot rot, a blackening of the taproot and base of the stem may occur. Early season infection leads to weathering of the stem base and the collapse of the plants as the first pods fill, resulting in premature lodging and further yield and quality reductions.

Mycosphaerella is a seed-borne disease, but infected plant debris is the primary source of infection in established pea-growing areas. Mycosphaerella produces persistent, long-lived chlamydospores that maintain the fungus in the soil for long periods of time. Pea stubble may carry spores for several years and these spores can be blown several miles (kilometers). Seedlings contract infection as they emerge through infected residue, and additional transmission may occur with rain splash of soil onto leaves and stems. High humidity and warm temperatures (15 – 25˚C) favour development of this disease.

• Crop rotation with a 4-year break between pea crops, and removal or burial of infected plant material, reduces the amount of inoculum.

• Seed testing (see Chapter 3./Variety Selection, Table 3.1 for seed testing labs) and sowing disease-free seed decreases the risk of spreading mycosphaerella into new pea-growing areas. Seed produced in semi-arid areas is less likely to carry the disease.

• If disease-free seed cannot be found, use seed with infection levels as low as possible. Seed treatment may be beneficial if the seed is planted on new pea land.

• No varieties are resistant to ascochyta blight. However some varieties exhibit higher tolerance to the disease.

• As spores may travel in the wind, planting pea crops away from fields seeded to pea in the preceding 4 years may be helpful.

• Foliar fungicide applications of Bravo should be considered if severe symptoms occur at the early flowering stage and environmental conditions favour disease development.

The development of leaf lesions on the bottom third of the plant will not greatly affect yield, and application of fungicide will rarely be beneficial. However, when weather conditions favour ascochyta development and the disease is present in the middle third of the plant

canopy at flowering, fungicide application can be economically viable.

A set of guidelines for identifying situations where foliar fungicide application is most cost effective is being developed at Agriculture and Agri-Food Canada, Saskatoon Research Centre through partial funding by the Agri Food Innovation Fund. Growers using the guidelines choose risk factors that best describe:

A/ Plant stand,

B/ Number of days with rain in the last 14 days,

C/ 5-day weather forecast, and

D/ Amount of disease.

The relative risks associated with each factor that control disease development are shown in Table 6.8.

• Growers are advised that these guides are presently in the development stage and further refinements are ongoing.

• USE OF THE DECISION SUPPORT SYSTEM IS THE RESPONSIBILITY OF THE PRODUCER. AGRICULTURE AND AGRI-FOOD CANADA DOES NOT ASSUME ANY LIABILITY REGARDING ITS USE.

The risk value is then calculated as **A+B+C+D**.

• When the risk value is 50 or above, a fungicide application is recommended.

• If the risk value is less than 50, a fungicide application is not recommended, but a new assessment should be made at 3 - 5 day intervals until the crop is no

Table 6.8 *Disease risk assessment to evaluate the need for fungicide application in pea.*

This assessment summarizes the relative risk associated with factors that control disease development. However, the decision to apply a fungicide is the producer's responsibility and AAFC does not assume any liability regarding its use. Developed by Drs. Lone Buchwaldt and Bruce Gossen, AAFC, 1999

Source *AAFC*

Inspect at least 10 locations in the pea crop at 10% flowering.	**Risk Factor**
A. Plant stand	
1. Thin (resulting in high weed pressure and low yield expectation)	0
2. Moderate (resulting in some weeds and a potential low yield)	5
3. Normal (approximately: 8 pea plants/ft^2 [88 plants/m^2])	10
4. Dense (more plants than normal or variety with lush growth habit)	15
B. Number of days with rain in the past 14 days	
0 days	0
1-2 days	5
3-4 days	10
5-6 days	15
7 or more days	20
C. The 5-day weather forecast	
1. Dry	0
2. Unpredictable	10
3. Light showers	15
4. Amount of rain	20
D. Amount of mycosphaerella/ascochyta blight on pea foliage at first bloom stage.	
1. No visible symptoms	0
2. Up to 10% of the leaf area infected on the bottom 1/3 of the plants	5
3. 10 to 20% of the leaf area infected on the bottom 1/3 of the plants	10
4. 20 to 50% of the leaf area infected on the bottom 1/3 of the plants	20
5. 20 to 50% of the leaf area infected on the bottom 1/3 of the plants, and up to 20% of the leaf area infected on middle 1/3	30

Source Department of Biology, U of S

Figure 6.10 *Seedling blight of pea plants.*

Source Pulse Manual 1997, 4-15

Figure 6.11 *Sclerotinia plant lesions on pea stems.*

longer flowering. If the crop remains almost disease-free until after flowering, fungicide application is generally not cost-effective.

Seedling blight can be caused by a number of different fungi. Often the young seedling is killed as it emerges, and before the leaves expand (Figure 6.10). Seed rot is caused by Pythium species which are favoured by cool, wet soils with poor aeration during the first 24 hours after planting. In severe cases, seedlings are encased in a white cottony mold. The fungi that cause seedling blight are common in the soil. Infection is more likely if the soil around the seed is excessively wet. Planting pea after alfalfa, bean, flax, or lentil increases the risk. This disease may be more difficult to control in no-till systems due to the presence of surface residue that maintains a more favourable environment for the fungi.

• The most effective control strategy for soil-borne seedling diseases is a 4-year rotation that includes a pulse crop only once.

Agrox B-3, DL & Agrox D-L Plus (contains insecticides), Apron FL, Captan Flowable and Thiram are registered seed treatments for the control of seed rot and seed-borne seedling blights. Studies in Alberta have failed to show a consistent benefit from these treatments however, a benefit may occur in cold, wet soils.

• Seed treatment with Apron FL can protect seed from seed rot and other seed treatments can reduce early season root rot. Seed treatments will not prevent rot root later in the plants development.

• Chemical seed treatments can reduce the viability of Rhizobium inoculant. Always apply the fungicide seed treatment to the seed first and allow the seed to dry before adding the Rhizobium inoculant. Apply the Rhizobium inoculant immediately before planting to minimize exposure to the fungicide application.

Sclerotinia stem rot symptoms include a white mat-like growth on stems and pods lying on the soil surface. Leaves turn yellow and wilt, and hard black bodies (sclerotia) develop inside the hollow pea stem and pods (Figure 6.11). Infection occurs when spores of the fungus develop on flower petals, stems or pods. Generally, yield losses are minor, although infected plants may wilt or ripen prematurely. Of greater concern are the black sclerotia contaminating both the soil and the pea seed at harvest. Sclerotia survive in the soil and are carried with the seed. They produce spores the following growing season that can be carried miles by wind. The risk of sclerotinia is greater if pea follows lentil, bean, faba bean, rapeseed, canola, mustard, sunflower, or safflower. Risk is also increased if the crop is sprinkler irrigated, the crop canopy is dense, or if the crop is subject to cool, moist weather.

• Sclerotinia stem rot is less likely to be of economic concern with the newer short, erect, semi-leafless pea varieties. Severe infection occurs only after lodging, and these types of pea plants do not lodge early, unless flattened by a severe hail or rainstorm or Phoma foot rot.

• Field monitoring should occur if the disease is present in the field or if weather conditions favour its development. Crop rotations that favour the buildup of the disease should be avoided.

Powdery mildew can cause yield loss if infection occurs prior to pod set. Infection usually occurs in the second week of July, and thus it is more serious on medium and late maturing varieties or on late-planted pea crops.

• Early seeding or growing an early maturing variety may minimize losses to powdery mildew.

The first symptoms of the disease are white powdery spots that occur first on the upper surface of leaves and stipules and then on stems and pods. The white spots can eventually spread to cover the entire plant (Figures 6.12.1, 6.12.2, 6.12.3). Under the white mat, the pea plant appears brown or purple. Heavily infected plants do not mature normally. Crop desiccants are often much less effective in crops heavily infected by powdery mildew. Frequent rain can reduce the infection by causing spores to swell and burst rather than germinate. The disease is favored by periods of warm and dry daytime conditions, and cool nights with heavy dews. The fruiting bodies over-wintering on plant debris result in the initial infection, which produces conidia that are carried by the wind.

• Several powdery mildew-resistant pea varieties are currently available, the yellow food varieties AC Melfort, CDC HANDEL, CDC MOZART and Highlight, and the food type green-seeded variety SW Parade.

The fungicide Kumulus DF is a registered fungicide and may be of benefit if powdery mildew is present in the area. Sulfur is the active ingredient in Kumulus DF, but it is in a form that stays in suspension in water.

Fungicide applications should be considered about the third week of July when the following conditions occur:

• visible initial symptoms of the disease are present (inspect leaves inside the crop canopy),

• combination of warm, dry days and cool nights with heavy dew and

• a susceptible variety is being grown.

Crop rotation and burial of crop residues help to reduce the incidence of powdery mildew. Presence of powdery mildew on the pea plants can interfere with the effectiveness of desiccants.

Bacterial blight is not common, but can be destructive in wet years. Initial infection in western Canada is usually from infected seed imported from areas where the disease is more common. Dark green, water-soaked spots form on leaves, stems and pods. Under cool and humid conditions, these spots enlarge and turn brown, and often have a greasy appearance. The infection spreads by rain or irrigation from infected pea stubble or from direct contact between infected plants. Hailed fields have increased levels of bacterial blight. Harvest equipment can also spread it. Contaminated straw will be free of the bacteria after a year, but the bacteria can overwinter in pea seed.

A second bacterial disease where infection is facilitated by openings caused by hail is **pink seed.** The pathogen enters the pods through wounds and discolours the seeds. Yield is generally not affected, but pink-coloured seeds are undesirable and are treated as dockage, so the quality is reduced. Pink seeds are often confused with treated seed and may be considered a contaminant. However, the pink seed-treatment will wash off, but the infected seeds remain pink. The level of infection is extremely low (less than 0.01%).

Pea seed-borne mosaic virus causes mottled yellowing of the upper leaves and decreased vigour. It has rarely been a problem in Saskatchewan, but can be introduced by planting of infected seed from elsewhere. Aphids can spread the virus further.

Herbicide injury can cause symptoms similar to diseases such

Source *Department of Biology, U of S*

Figure 6.12.1 *Powdery mildew on pea plants. 1%*

Source *Department of Biology, U of S*

Figure 6.12.2 *Powdery mildew on pea plants. 10%*

Source *Department of Biology, U of S*

Figure 6.12.3 *Powdery mildew on pea plants. pods*

as distortion of leaves and stems, yellowing, stunting, and dead areas on the edges of leaves and between the veins. Flowers may abort and in serious cases, seed set may be reduced.

A list of registered seed treatments and foliar fungicide products for use in Saskatchewan are shown in Appendix Tables 6.9 and 6.10.

Irrigation

Pea can consistently be grown successfully under irrigation in the Brown or Dark Brown soil zones. In general, the agronomy of irrigated pea is similar to that of dryland pea. Early maturing short vine varieties are best suited for irrigated production. Yields average 2700 lb/ac (3027 kg/ha), but can be as high as 3500 lb/ac (3924 kg/ha).

Excess irrigation can result in early lodging and disease development. Rotations that include at least a 3-year break away from legumes, canola, mustard, and sunflower reduce the risk of soil-borne diseases. Typically, pea is grown on cereal stubble.

Irrigation prolongs the growing season requirement, making it critical to seed as soon as soil temperatures reach 5˚C. Seed should be placed 2 to 3 inches (5 - 7 cm) deep or into moisture. Light irrigation (less than 1 inch, or 2.5 cm) before seeding may promote germination. Lack of potassium can limit yield on sandy soils after several years of irrigation. Potassium fertilizer should be used, if soils test below 240 lb/ac (269 kg/ha).

Once established, pea plants can tolerate low moisture, but not drought, until the beginning of flowering. Excess moisture during vegetative growth increases vine growth, but does not increase yield. The best yields (more pods per plant and more seeds per pod) are obtained if soils are brought to field water capacity just before flowering and all water used is continually replaced during the flowering period. The field water capacity should be based on 2 ft (60 cm) soil depth, if pivot irrigation is used, and on 3 ft (1 m) depth, if sideroll or gravity sprinklers are used.

• The plants can use 2 inches (5 cm) of water per week, whether from rain or irrigation.

After flowering is complete, continued irrigation is not recommended as it is likely to delay maturity and promote stem diseases. See Chapter 3./Variety Selection for suitable pea varieties for irrigated production.

Harvest

The decision of when to harvest involves a compromise. Harvesting too early does not allow the seeds of yellow varieties to fully mature as some seeds remain green, resulting in a reduced grade. Harvesting too late increases harvesting losses from shattering and increases the risk of weather damage to seeds. Green varieties may bleach. The crop dries very quickly once mature, if the weather is warm and dry. Field scouting helps determine the best time to harvest. Scouting should be done during warm, dry periods to reduce the transmission of disease.

• The crop matures from the bottom up and is mature if the bottom pods are dry and tan coloured, and if seeds have detached from the pods and will rattle. At maturity, middle pods are yellow-tan and the pea seeds are dry and firm. Top pods are similar to middle pods, or may have some green seeds that are not yet dry and firm.

If the crop is uniformly mature, it can be straight-cut, or swathed and immediately combined. If some areas of the crop are green or have

Table 6.11 *Timing for swathing and combining pea.*

Pea type	Colour of crop and/or seed at cutting stage	Quick test for proper moisture content at combining	Storage moisture content	Comments
Yellow	Swath: Bottom third of pods are ripe, middle third of pods and vines are yellow coloured, and upper third of pods are turning yellow. Straight cut: When fully mature	Thresh when seeds are firm and can no longer be penetrated with thumbnail (20% moisture content or lower).	16% is dry and safe for storage	Some shattering losses usually occur. Inclusion of green weeds when threshing may cause earth-tagging and result in down-grading. Seed with less than 14% moisture can suffer seed coat breakage and peeling during combining. Low cylinder speeds help reduce damage. Green weed seeds or foreign material should be promptly cleaned out to reduce spoilage during storage.
Green	Swath: vines are yellow coloured and seed has good green colour Desiccate: vein pattern of upper-most pods easily recognized and 75-90% of pods have turned yellow Straight cut: waiting for full maturity without desiccation can increase risk of bleaching	Thresh when seeds are firm and can no longer be penetrated with thumbnail (20% moisture content or lower).	16% is dry and safe for storage	2% bleached seeds is maximum. High humidity, bright sunshine, and warm temperatures during final maturation cause bleached seeds. Bleaching can also be caused by rain near maturity or while in the swath. Seed with less than 14% moisture can suffer seed coat breakage and peeling
Feed	Swath: vines are yellow coloured. Vines are often prostrate	Thresh when seeds are firm and can no longer be penetrated with thumbnail (20% moisture content or lower).	16% is dry and safe for storage	Bleached, split, cracked, or earth-tagged seed is acceptable for feed. Combine settings and operation are not as critical as for the food pea market.

green weeds, while other areas are dry, spot combining, desiccation, or swathing may be beneficial.

A guideline for harvesting and storage is shown in Table 6.11.

Desiccation

Desiccation reduces the risk associated with swathing, such as wind movement of the swath, disease and sprouting of the crop in the swath. Standing, desiccated crops dry more rapidly after a rain than do swaths and generally retain better seed quality. The effectiveness of desiccants will be reduced if the crop is covered with powdery mildew. The desiccant cannot penetrate the white fungus layer. Consider using powdery mildew resistant varieties, if desiccation is to be used for late-maturing crops.

Reglone and ReglonePro (surfactant added) are registered desiccants for use in pea in Saskatchewan. They can be used when all pods are fully mature. Desiccants will not hasten maturity, but will dry vines and kill most weeds that interfere with harvesting. Heavy infestation of dense weeds, such as kochia, can restrict adequate coverage and swathing should be considered. Desiccation

is often used on dry green pea varieties in order to reduce the time before combining and to help retain the bright green colour demanded by the food market. Desiccate green pea when 75-90% of the pods have turned to yellow colour and the vein pattern on the uppermost pods are clearly distinguishable. After desiccation, combine at 20% seed moisture and aerate down to 16% moisture to help retain the green colour.

Glyphosate herbicides are recommended for pre-harvest management of perennial weeds. This will reduce the amount of green material going into the combine, but glyphosate is not an effective desiccant. Glyphosate should be applied a week or two prior to harvest. Earlier applications can result in reduced crop yield, reduced quality, and residue in the seed.

• As germination of the seed and vigour of the seedling can be reduced, pre-harvest glyphosate is not recommended if seed will be used for planting.

Swathing

To avoid excessive shattering losses, pea crops must be swathed at the correct stage.

• The crop can be successfully swathed when a majority of vines and pods are yellow to tan. Pods will cure in the swath if no more than 1/3 of them are green.

Fully-formed seeds will generally dry without much shrinkage. Delays to allow low-lying areas to mature may jeopardize the quality of the rest of the crop, and are likely to increase shattering losses. If the crop is short with many pods near the ground, swathing, while the crop is still partly green (18 to 20% moisture), will help reduce shattering losses. Swathing at night or early in the morning may also reduce shattering losses as the pea pods will be damp from dew.

The pea crop is often lodged at harvest. Swathing is easier if done at right angles to the direction of lodging. If the crop is long and heavy, a narrow swather cut may be necessary.

If the crop is swathed when fully mature, the combine should directly follow the swather to prevent windblown swaths. The use of a canola swath roller may help reduce wind damage by flattening the swath, if the swath requires a few days of warm weather to cure. A dry swath is more prone to wind damage, and shattering may occur during rolling.

Straight Cutting

Pea pods are not prone to excess shattering if they are left standing, so the preferred harvest method is to straight combine at full maturity. Some varieties, such as Carneval, may be more prone to shattering. Straight combining results in fewer losses at the cutterbar because most of the pea seeds released from cut pods are carried onto the header and into the combine.

Threshing

Ideally, the crop can be threshed at 20% moisture content. The splitting and cracking of seeds increases as the seeds dry. If seed is dry (16%) shattering losses can be significant. If combining is done during hot weather, restricting combining to early cool mornings with dew present may be prudent. When threshed too green or wet, the vines are more likely to plug and wrap in the combine, slowing harvest operations, and increasing the amount of earthtag.

• Pea seeds require gentle handling for optimal quality.

Slow combining speeds will minimize possible shattering losses; the pick-up or reel speed should

coincide with ground speed. Cylinder speeds of 250 to 600 rpm, depending on cylinder diameter, are often used. Concaves may be initially set to between 1/4 and 5/8 inch (0.6 and 1.5 cm) clearance in front and to 1/2 inch (1.2 cm) clearance in the rear. Chaffer sieves are often set at a 5/8 to 3/4 inch (1.5 to 1.8 cm) opening and cleaning sieves at 3/8 to 1/2 inch (0.9 to 1.2 cm). The tailings should be kept to a minimum to reduce seed damage. To minimize the incidence of earthtag during combining, combines can be modified with a perforated clean elevator door trap and scrapers attached to every 4th or 5th paddle in the clean grain elevator. Close the unloading auger slides on the combine hopper to prevent plugging the auger in the clean grain tank. Slowing down the combine engine when unloading will reduce seed cracking.

A very mature crop can be pulled and combined, using special equipment such as a Rake-up or Sund pick-up. This harvest method requires a weed free crop with dry, brittle stems, which occurs usually as a result of a very mature crop and rain and redrying. This harvest method is not suited to green pea varieties as the seed may bleach before it is sufficiently mature to harvest.

Post Harvest

Drying

Because harvest is more successful at higher moisture levels, drying is often necessary. The crop should be cleaned as soon as possible after harvest.

• Pea seed can be stored at 16% moisture or lower.

• If the crop is to be used as seed, grain driers should not be operated at temperatures over 45˚C , as high temperatures and rapid cooling will cause stress cracking of the seed and reduced germination.

Drying should take place in two stages, if the moisture content must be reduced by 5% or more. An aeration bin can be used effectively in conjunction with a hot air dryer. For best efficiency, pea seeds can be dried to within 2% of final moisture content and then tempered in the aeration bin for at least 6 hours after which they can be cooled to outdoor temperature. This slow cooling reduces cracking and removes an additional 2% moisture content during the cooling process. Drying at temperatures above 45˚C may cause quality losses due to hardening, if the pea seeds are intended for food use. Temperatures up to 70˚C should only be used for drying feed pea. Aeration bins can be used for drying, and to eliminate condensation problems during fall and spring periods. During these times, the fan can be run sufficiently to cool or warm the grain in parallel with seasonal temperature changes. This practice prevents development of air circulation patterns and condensation in the bin.

Storing and Handling

To avoid heating in the bin, the crop should be cleaned of all green seeds and dockage before storage. With pea seeds, a great deal of respiration occurs, especially shortly after harvest. The term "going through a sweat" is used to describe this period. Extra care should be taken to routinely monitor bins and to inspect for moisture buildup or

Table 6.12 *Number of weeks for safe storage of pea at the specified grain moisture content and storage temperature.*

Storage temp. (0C)	Moisture content (%)				
	12	14	16	18	21
25	31	16	7	4	2
20	55	28	13	7	4
15	100	50	20	12	6
10	200	95	38	20	21
5	370	175	70	39	20

Source *Sokhansanj, 1995.*

spoilage. Aeration bins can be used effectively to deal with sweating problems and to cool the grain in fall and warm it in spring to relieve moisture problems due to condensation. Storage of pea seed at too high a moisture content or temperature can lead to germination and spoilage. Maximum storage periods at various moisture contents and temperatures are provided in Table 6.12.

Grading

The Canadian Grain Commission under recommendation of the Producer Trade Advisory Committee sets the standards for the pea grades (see Tables 6.13 and 6.14).

Fall Land Preparation

Pea straw is a good forage. Cattle can be turned into pea fields to graze stubble and straw or it can be baled. Threshed pea straw should be baled before rain occurs since the hollow stems fill with water, mold develops, and the value is greatly reduced for livestock feed. Chopping the pea straw with barley in a tub grinder will produce a high quality feed for overwintering cattle and sheep. However, removal of the straw from a field will greatly reduce the amount of nitrogen returned to the soil through decomposition of the pea straw.

When green or tough straw is combined, a straw chopper should be used. Uniform spreading and chopping of straw and chaff are critical, particularly in direct seeding systems, as poorly chopped pea straw will bunch up in most cultivators and seeders.

If disease problems in the pea crop were pronounced, it might be desirable to bury all the residue that might carry the disease. This practice can leave the soil prone to erosion, though cover crops can help reduce the risk.