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CEREAL CROPS
PRODUCTION GUIDE

Cereal Crops

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Introduction

Cereal crop production in the Atlantic Provinces is quite different today compared to previous decades. Ever-evolving farming practices mean significant changes in farm management strategies for cereal crops.

Using the concept of the Maximum Economic Yield (MEY) management approach, each fixed and variable production cost component is weighed carefully before proceeding. Maximum economic yields result from paying more attention to components such as soil fertility (i.e. particularly the nutrient contributions from organic sources), seed depth placement and combine losses, to mention a few. Further fine-tuning of pesticide selection and timing, reduced tillage systems for optimal seedbeds, crop rotations, nitrogen catch crops, and utilization of revenue "safety nets" are important factors in this region's cereal production. To lessen machinery carrying costs, neighbouring producers are in a good position to form machinery co-ops to purchase certain types of equipment such as land levellers, roller harrows and specialized combine headers or rely on custom operators for procedures such as manure spreading and injection and/or pesticide storage and application.

Cereal crop production in the region is very important to provide feed sources and provide the needed crop rotations with other crops (i.e. forages, potatoes, vegetables). At times, net returns alone (affected by market price and/or climatic Influences) may not justify cereal crop production. However, the benefits from cereals in a sound crop rotation and the need to help reduce the importation of livestock feed should justify progressive cereal crop production in this region.

Soil and Crop Management

Sound soil and crop management practices are important in cereal production to maintain good soil fertility, structure, organic matter content and minimize erosion and compaction damage. Most farmers are quite aware of the cost of soil degradation. They are taking steps to conserve and enhance soil through winter cover crops, proper crop rotations, manure incorporation, and improved tillage methods. Cropping systems that leave the soil disturbed and bare of vegetation after autumn harvest contribute greatly to soil erosion.

Tillage

There are many options available in the Maritimes when it comes to tillage equipment. Primary tillage implements such as chisel plows, off-set disc harrow, or conservation tillage are used on corn or grain stubble to produce quicker initial tillage results than the conventional mould board plowing practice. The chisel plow, or off-set discs, are sometimes referred to as "conservation tillage implements." These implements can leave higher amounts of crop residue on the soil surface of sloping fields (greater than 5% slope) to minimize potential soil erosion losses.

When using a disc or even spring tooth harrows, consideration should be given to limiting the number of passes and rolling prior to planting, if necessary. Too often, seed placement is too deep in overworked and fluffy soils.

Whatever tillage system is utilized, the seedbed produced should:

- Permit early planting
- Maintain or improve the soil structure
- Destroy weeds germinated prior to planting
- Permit uniform depth and placement of seed and fertilizer
- Provide conditions for rapid seed germination

Adaptation

Cereals perform well under the cool, moist growing conditions present in the Atlantic region. Hot, dry weather in the latter part of the summer may hamper grain filling and be detrimental to yield and grain quality. Warm, humid weather is detrimental to high yield and quality since most leaf and head diseases become more severe when moisture remains on the plant surfaces for long periods of time. Excess soil moisture is also responsible for the poor performance of cereals. Barley and wheat are the most sensitive, and oats least affected by wet soil.

Autumn sown cereals (winter wheat, rye and triticale) are more particular in their requirements than the corresponding spring-planted crops. Autumn planted cereals may be successfully grown in most years when sown under conditions of proper seeding date and suitable field selection. Winter barley is very susceptible to winter injury. No winter barley varieties are recommended at this time based on the Maritime Cereal Cultivars Performance Trials. The use of well-drained soils is critical as winter cereals may die if subjected to ice sheeting or frost heaving during winter melt periods when snow cover is lost. Winter cereals have a higher yield potential than spring cereals but require more management. Winter cereals cannot be planted in the spring because they require a period of cold temperature to stimulate them to flower and produce seed.

Species Selection

The nutritional requirement of each animal enterprise will dictate the preferred feed source. The feeding value of wheat on an energy basis is higher than barley, rye or oats. An average livestock producer must produce or purchase 3.7 tonnes of oats to equal the feeding value of 3.2 tonnes of barley or 3 tonnes of wheat. The feeding value of oats is lowest, primarily due to the presence of the non-digestible hull. The oat groat (kernel less hull) or hulless oat is very high in energy and protein quality.

Understanding that each species has a different feeding value, a producer must then choose the species that best suits the land capability and require end-use.

All grain species do best on well-drained, fertile, high pH soils. However, some species are more tolerant to conditions that are less than ideal. The following figures indicate some of the requirements of cereals.

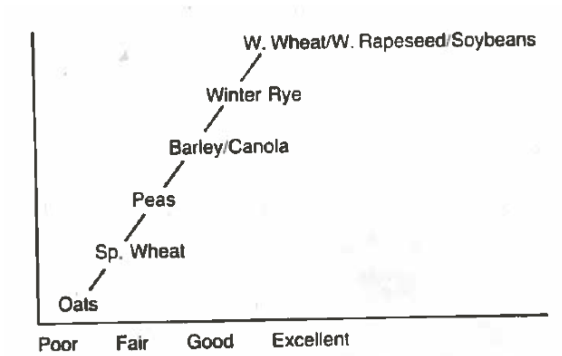

Figure 1. Relative drainage requirement for cereal crops.

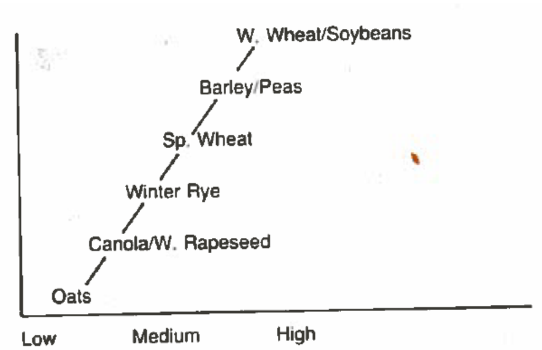

Figure 2. Relative pH requirement for cereal crops.

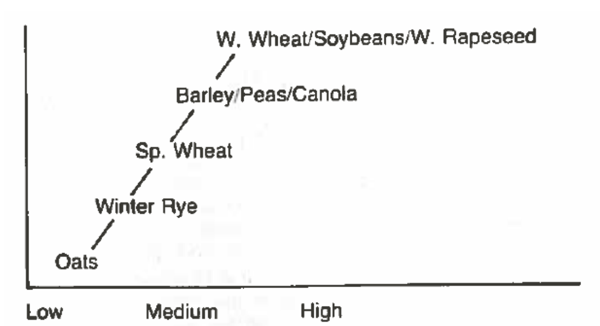

Figure 3. Relative P & K requirement for cereal crops.

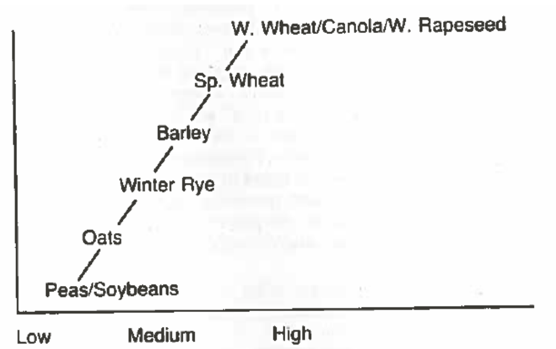

Figure 4. Relative Nitrogen requirement for cereal crops

In general, oats can tolerate poorer growing conditions and require fewer inputs, but yield and quality are considerably less than other grains (Table 1).

Table 1. Estimated removal of plant nutrients by various crops

Crop	Dry Matter Yield (t/ha)	Nitrogen (N)	Phosphorus (P_2O_5)	Potassium (K_2O)	Calcium (Ca)	Magnesium (Mg)
		Kg/ha				
Oat Grain	3.1	56	22	17	3	4
Oat Straw	4.5	28	11	67	9	10
Barley Grain	3.2	56	28	17	2	3
Barley Straw	3.4	22	11	50	13	3
Wheat Grain	2.7	56	28	17	1	7
Wheat Straw	3.4	22	5	39	7	3
Corn Silage	12.3	112	56	151	12	21
Alfalfa Hay	8.9	213	50	275	132	27
Timothy Hay	8.9	151	39	163	20	11
Red Clover Hay	8.9	168	39	179	121	29

Variety Selection

Varieties differ in their inherited agronomic characteristics of days to maturity, straw strength (lodging), disease resistance, yield potential and winter hardiness. Varieties should be selected to suit individual requirements keeping in mind that appropriate crop management practices may overcome some variety limitations. Varieties with high yield potential but susceptible to lodging may have this limitation overcome by using a plant growth regulator. Early spring planting of a variety susceptible to certain leaf diseases may decrease yield loss.

Specific characteristics for each variety can be found in the Maritime Cereal Cultivars Performance Trials report, which is updated annually.

Seed Quality

Seed quality is extremely important to obtain a good yield of high-quality grain. Using pedigreed seed produced under inspected quality control program guarantees variety purity, low weed seed content and high germination. In cereal grain, the following pedigreed seed grades exist: Breeder, Select, Foundation, Registered and Certified. The first four grades are used by seed growers to increase seed supplies. Certified seed is the grade intended for general crop production. Certified seed can be identified by a blue tag on the bag carrying two identification numbers.

Non-pedigreed seed cannot be sold or guaranteed by variety name. If non-pedigreed seed is to be used, it should be tested for germination and cleaned to remove seeds of weeds and other crops. To check for germination, take a representative sample of the grain being sown and count out 100 seeds. Spread these on a moist paper towel, fold the towel and place between two plates. Keep the seeds moist and at room temperature for seven to eight days. Determine germination by counting the number of seeds that produce normal sprouts and roots. If the germination is below 75%, the seed should not be used. Some seeds may be dormant due to drying. To overcome this, chill seed in the refrigerator for three to four days before testing. Dormant seeds will germinate normally in the field. Seed which germinates readily and produces rapidly growing seedlings is high in vigour. High vigour seed is an additional indication of quality.

In addition to germination, there are other criteria that characterize good seed, including high protein content, kernels that are uniform, plump, and of clear colour, and freedom from disease organisms.

Seed of adequate germination and vigour should be treated with a fungicide before planting.

Seeding Rate

The seeding rate in kilograms per hectare of grains should be determined after considering a number of factors, including desired plant population (may vary with tillering ability of species and variety), kernel weight and percent germination of the seed lot being used. The desired plant population (plants/ m^3) can only be accomplished if seeding rates are adjusted to accommodate seed weight. Seed lots of different seed weights will contain a different number of seeds in one kg of grain. For example, a seed lot with a seed weight of 30 g/1000 seeds will have 33,333 seeds/kg, while a seed lot of 40 g/1000 seeds will contain only 24,000 seeds/kg. If both these seed lots were planted at the same weight/ha, there would be a 33% difference in the actual seeds planted. In order to ensure that the desired amount of viable seed is being planted, the rate must also be adjusted to accommodate the specific germination percentage of the individual seed lot being used. For the non-intensive grain grower, the following rates can be used as a rough guide: oats 120 kg/ha; barley 125 kg/ha and winter and spring wheat 134 kg/ha. For the more intensive grain grower, see Table 2 for seeding rates based on 1000 kernel weight and viable seeds/m^3.

Table 2. Seeding rate of grains (kg/ha)

Seed Sample wt of 1000 seeds(g)	**Viable Seeds/m^3**				
	250	***300***	***350***	***400***	***450***
30	75	90	105	120	135
35	87	105	123	140	158
40	100	120	140	160	180
45	112	135	158	180	203

Seeding Date

Spring grains should be sown as early as the land can be prepared satisfactorily. Early seeding gives the crop more time between emergence and maturity, providing a longer growing period for plant development. Under average conditions, each week's delay in spring seeding of grain beyond the first date when soil conditions are favourable results in an approximately ten percent reduction of total yield.

An early sown grain crop is more resistant to most disease and insect pests because it is at a more advanced growth stage when attacked. Higher yields of well-filled grain with a higher weight per unit of volume result from early seeding. Early sown spring grain matures early, allowing for early harvest when weather is usually more favourable.

The seeding date also has an important influence on the performance of winter cereals. Seeding before the optimum seeding date produces plants with excessive top growth, which are susceptible to disease and lodging. Seeding after the optimum seeding date results in plants that are not well established before freeze-up, making them more susceptible to winter injury, heaving and delaying growth the following spring. Zones of optimum planting dates have been established based on autumn temperatures in each region (Figure 5, Table 3). For best results, seed within the optimum period indicated for your area. Some variation in the optimum planting period may occur within zones due to local factors, for example, sheltered south-facing slopes. Recommended dates may need some adjustments based on local experience. Differences in autumn weather between years will also cause the optimum dates to vary.

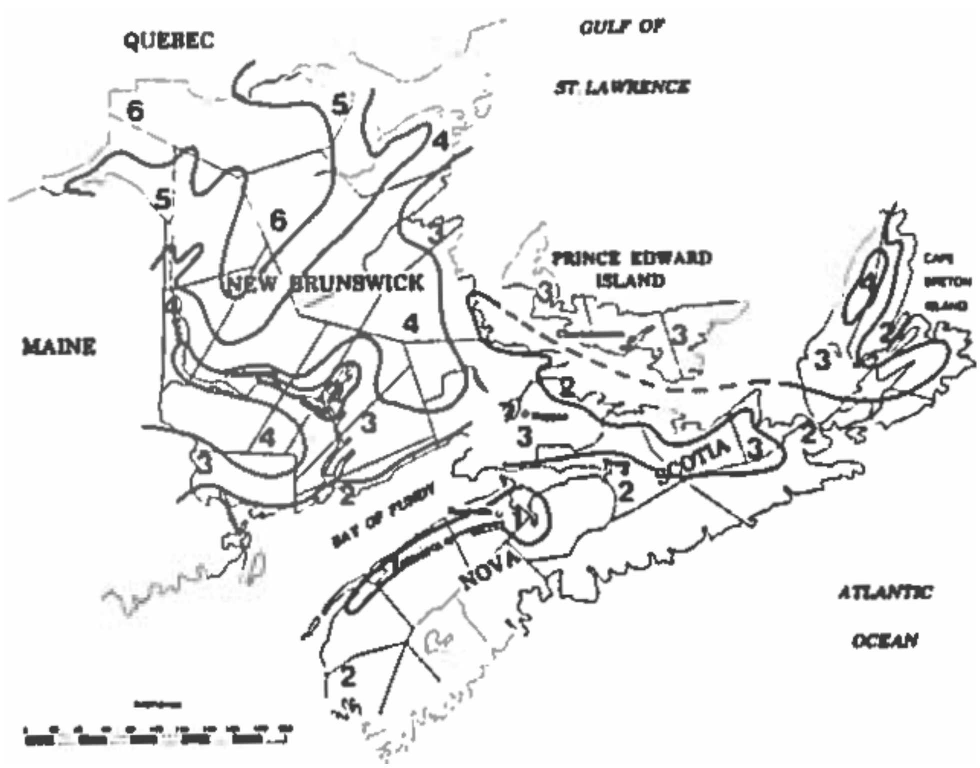

Figure 5. Zones of optimum seeding period for winter grains based on climatic data

Table 3. Date of optimum seeding for winter grains, by zone

Zone	Seeding Date
1	Sept. 10-25
2	Sept. 5-20
3	Sept. 1-15
4	Aug. 27-Sept. 7th.
5*	Aug. 22-Sept. 2nd.
6*	Aug. 20-Aug. 27th.

* Production of winter grains in zones 5 and 6 is very risky, other agronomic factors must be suitable in each zone.

Seeding Methods

Cereals are usually seeded with a grain drill, pneumatic seeder or by broadcasting. The method chosen should permit the earliest and most rapid seeding of spring cereal on existing soil conditions. Objectives are to maintain consistency of seeding rate, depth and seed coverage for uniform germination and emergence. These objectives are usually easier to achieve with drill seeding than broadcasting. However, some operators obtain good results with the latter method by harrowing lightly after broadcasting to cover the seed.

Under normal conditions, cereal grain is sown approximately 1-2 cm deep. Seeding depth is a management factor that many farmers take for granted but is far more important than most think. If cereals are sown too deeply, emergence is slowed, plants are weak and yield potential is lost. Seed placement in the soil should be relatively shallow, so the crop emerges quickly, avoides seedling disease and saves energy to put into growing early leaves rather than using energy to push up through 4-8 cm of soil. The only danger in seeding too shallow is lack of moisture. However, it is not usually a problem with early seeded crops in the Maritimes. Methods to ensure proper seeding depth are level seedbed prior to planting, depth bands on the seeder and possibly rolling prior to planting. Depending on soil texture and moisture, rolling immediately after seeding may help pack loose, dry soil more firmly around the seed to improve uptake of moisture. Avoid packing or rolling land which is damp, as it may crust. Rolling these areas after the grain has emerged is a safer practice

Flotation Spring Seeding

Flotation seeding can be used to plant spring cereals on lands that normally remain wet in the spring until well beyond the optimum planting date. Tractors equipped with flotation tires are needed to plant soon after ground frost has come out. The best time is when the top few centimetres of soil begin to dry, but the plowed area's main portion may be very close to field water capacity. Fields to be seeded in this method should be fall plowed with special care to ensure a smooth soil surface since spring tillage will be minimal.

Several approaches have been used to facilitate the planting process. The most commonly used method is to broadcast the fertilizer, harrow the field with a light cultivator to a shallow depth (5-10 cm), broadcast the seed and then cover with a chain harrow. In some cases, the fertilizer and seed are applied and then incorporated by harrowing.

This practice should only be followed when adequate flotation equipment is available to avoid soil compaction and when the fields are sufficiently damp that conventional seeding will be delayed beyond an acceptable date.

Tramlines

Tramlines are unseeded parallel rows established at planting time in cereals to accommodate the wheels of equipment used for precise applications of fertilizers, plant growth regulators and pesticides. These missing rows do not contribute to lower yields, and they avoid the late-maturing low-quality harvest caused by grain damaged by tires of application equipment. This distance between the unseeded rows of a tramline set must correspond to the tire spacing of equipment to be used to apply additional management inputs.

The distance between sets of tramlines is usually a multiple of the seeder width and must match the effective application distance of both sprayer and fertilizer applicator. A popular tramline spacing is 12 m, which can be accomplished using either a 6m, 4m or 3m wide seeder. Producers with narrower spray booms and fertilizer applicators may wish to use a tramline system with a 9m wide spacing. The pneumatic type air seeders are well suited for making tramlines as the delivery tubes can be closed off at the distributor head. Conventional type seeders have been successfully modified to establish tramlines by mechanically opening and closing drill spouts, using a lever from the tractor seat or a remote hydraulic cylinder.

In establishing a tramline system, two complete sets of tramlines should be made around the outside of the field. This allows adequate room to use the inside tramline to turn at the end of the field without concern that a slightly wide turn may result in a sprayer boom contacting an obstruction on the edge of the field. After the two outside tramlines have been established, seeding should start on the straightest, longest side of the field and progress across the full width of the field. Where a field has no obvious straight side, a pass can be made the length of the field to establish a reference point. Seeding is then done on either side of this initial pass until the field is completed.

The tractor used for spraying and fertilizing should have the narrowest tires possible to lessen the required width of the unseeded tramline and reduce excessive damage along the edge of the tramline.

Growth Stages of Cereals

Recommendations on the timing of herbicides, supplementary nitrogen, foliar applied plant growth regulators and fungicides are made so that crops receive the required treatments at proper growth stages for maximum benefit rather than by calendar date. In the Zadoks growth scale, plant growth is measured on a scale of 0-100. Growth is divided into ten principle stages, each of which is further subdivided into ten stages (Table 4, Figure 6).

Table 4. Main Zadoks growth stages of cereals

0-9	Germination
10-19	Seedling growth
20-29	Tillering
30-39	Stem elongation
40-49	Booting (first awns visible at 49)
50-59	Head emergence (complete at 59)
60-69	Flowering (half complete at 65)
70-79	Milk development (watery ripe at 71)
80-89	Dough development (dough hard at 87)
90-99	Ripening (harvest can start at 92 when seed not dented by thumbnail)

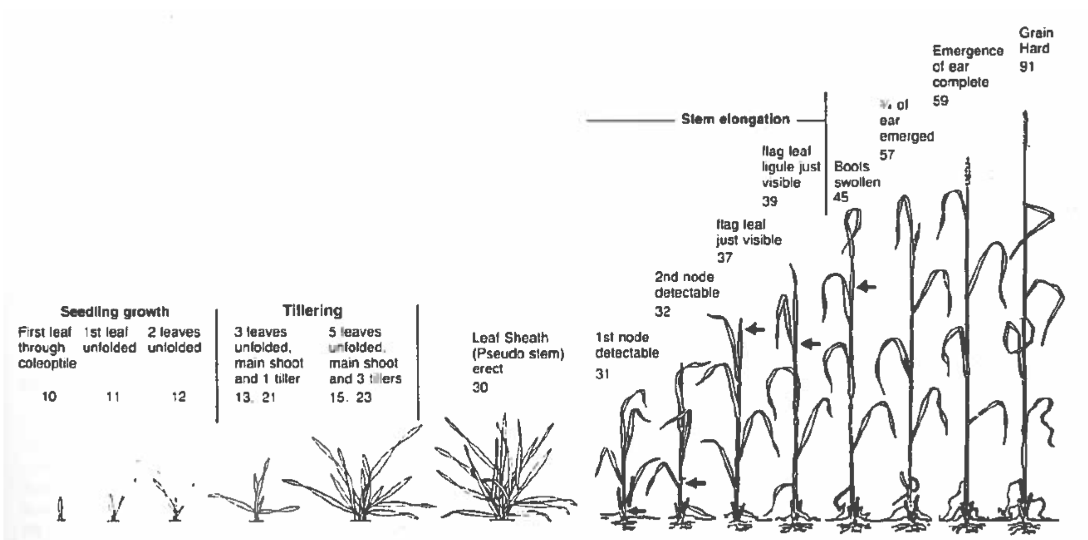

Figure 6. Zadoks growth stages in cereals.

Under seeding

The highest grain yields are obtained by seeding and harvesting the crop with cereal production as the primary goal. Under seeding of cereal grains with grasses and legumes can reduce yields, but the benefits of this practice may sometimes have move overall impact on the farming operation than the yield reduction. Large acreages of cereals are grown in rotation with potatoes, where soil conservation is a primary concern. Cereals alone do not provide soil restoration. Under seeding is a sustainable practice that assists in conserving soil moisture, soil physical characteristics and soil fertility. It can be successfully accomplished and provide a benefit on many farms. There are a number of factors that must be taken into consideration when under seeding. These are the seeding rates of the cereal and the forage and the choice of the forage. Field-scale experiments at the Charlottetown Research Station have shown the value of under seeding barley with red clover and certain varieties of annual ryegrass. There can be problems associated with under seeding. Mixed crops maintain moist conditions around the cereal plants, increasing the chance of diseases and lodging. Weed control and fertility needs are usually different for cereals and forages. This makes proper management of both types of plants more difficult. Forages mixed in the cereals will increase combine problems if the cereal lodges and the forage grows above the cereal. These problems are avoided if the correct cereal forage combination is seeded at appropriate rates. Cereal producers may wish to consider over seeding of forages into cereal stands after the herbicides have been applied as an alternate method of seeding forages. This practice will reduce the problems of weed control and harvest operations, and if moisture is adequate for forage seed germination, a forage stand should establish. This method, from a forage point of view, will be less successful than a direct seeding. If cereals are seeded down to forages, seeding rates for the cereal cover crop should be reduced by 50%.

Crop Nutrition

Plants require sixteen essential elements for growth and development. Nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) are required in the largest amounts. Calcium and magnesium are also required in significant amounts but are generally adequately supplied by a good liming program. There is little evidence of deficiency of other trace elements.

Lime

Most of the Atlantic Region's soils are acidic because of their original parent material and the high annual precipitation, which leaches elements such as calcium, magnesium and potassium, from the soil surface layer. On low pH soils, the efficiency of applied fertilizer and the activity of soil micro-organisms are reduced (Table 5). Soils of the Atlantic Region require frequent applications of ground limestone to maintain appropriate pH levels. The amount of lime required to reach optimum pH is best determined by soil testing. Dolomitic and calcitic limestone are equally effective in raising pH, but dolomitic limestone also supplies magnesium to the soil. Cereals grow best when the soil pH is 6.0 - 7.0.

Table 5. Fertilizer efficiency at various pH values

Soil pH	Nitrogen Efficiency	Phosphorus Efficiency	Potash Efficiency	Overall Fertilizer Efficiency
6	89%	52%	100%	80%
5.5	77%	48%	77%	67%
5	53%	34%	52%	46%

When possible, soil pH should be corrected before fertilizer is applied. Liming in the fall and fertilizing the following spring is more effective than applying both lime and fertilizer in the spring. Lime applications made during the seeding year are of some benefit but do not have sufficient time to be completely effective during the application season. Surface applications of lime on emerged seedlings are of little immediate value. For best results, lime should be incorporated into the soil to the depth of cultivation.

Nitrogen

In cereal production, nitrogen is essential for proper plant growth and many of the processes within the plant, such as photosynthesis and protein production. When cereals follow legumes in the rotation, considerable nitrogen may be available from the soil, but fertilizer nitrogen is still required for top yields. Availability of nitrogen is generally the factor that limits cereal growth in the Atlantic Region. As the availability of N increases, the rate of vegetative growth increases.

Farmers should be aware that there is a definite conflict in that higher nitrogen rates will cause an increased incidence of disease and lodging. When high levels of N are used in conjunction with fungicides for disease control and growth regulators for lodging control, splitting the N application may be beneficial. When multiple or split applications of N are used, it is important that the low rates of materials be applied uniformly. The use of pneumatic fertilizer spreaders in combination with tramlines, has generally given superior results to those obtained with spinner type spreaders. If soils are high in phosphorus and potassium, as is often the case in potato rotations, good grain yields can be obtained by the application of 60-90 kilograms per hectare of nitrogen alone.

For winter cereals, generally 2-3 applications of 30-60 kg N/ha are used. Early N applications are beneficial to yield while late N applied after heading will not influence final yield but should increase protein content. For spring cereals, up to two applications of 30-60 kg N/ha are used, with later applications most useful in increasing protein content. The total amount of N a cereal crop can utilize depends on its yield potential. If other factors allow for high yield, a crop can benefit from higher N levels. Nitrogen cannot overcome limiting factors such as drought, late seeding, or diseases, and optimum N level will be lower under such conditions.

Phosphorus

Phosphorus is required for early growth. Therefore, high levels are needed near the developing seedling root. Applied fertilizer phosphorus in most soils of the Atlantic Region remains primarily wherever it is applied. Higher phosphorus rates are required where soil tests indicate low levels of available phosphorus, where little fertilizer has been applied recently when the fertilizer is broadcast or cereals are seeded early into cold soils. Lower rates may be used on soils testing high in phosphorus and when fertilizer is drilled with the seed. The availability of phosphorus is most dependent upon soil pH, for at low pH levels, the phosphorus is held in a form unavailable to the plant. Winter wheat benefits greatly from phosphorus applied through the drill with the seed. This is because available phosphorus decreased as soil temperature dips in the fall. 50-100 lbs/acre MAP down the planter with the seed is common practice. If seed placed phosphorus is not practiced, 200 lbs/acre of phosphorus should be broadcast and incorporated before planting. Phosphorus should not be left on the soil surface due to the risk of erosion and phosphorus moving to waterways.

Potassium

Cereal crops require potassium for good root development, kernel filling and lodging resistance. Higher rates are required on soils testing low in potassium or where little fertilizer or manure has been applied in recent years. Higher rates are required when straw from the previous crops has been removed than when straw has been incorporated into the soil for a number of crops.

Sulphur

Plants require sulphur for the synthesis of amino acids, which are essential components of proteins. It also contributes to the digestibility of plants to ruminant animals by narrowing the Nitrogen: Sulphur ratio. In the past, there was enough atmospheric sulphur contributed to the soil via acid rain to account for the plants' needs. However, as those levels decrease (70% in NS from 1990-2015, Environment Canada: 2017), there becomes a need for sulphur fertilizer applications to provide for plant needs.

Chlorine

Chlorine is a micronutrient, meaning it is essential for plant growth but is needed in relatively small amounts. Chlorine is an important component of energy reactions in plants. It should also be noted that chlorine is highly soluble and mobile in the soil, so it will leach easily in wet conditions, possibly reducing the available supply for the following crop. Chlorine is often applied as a component of potash.

Fertilizers

Soil fertility can be improved by adding granular fertilizers, manure, cover crops and underseeding or various combinations of these. The following recommendations refer to granular fertilizer. When using manure or other sources of fertility, the amounts required should be calculated based on the analysis of the material being used. Your provincial soils lab can assist you with specific fertility recommendations on an individual field basis.

Where Phosphorus (P) and Potassium (K) levels are high, moderate levels of fertilizer application (40-60 kg/ha) should be sufficient to maintain high P and K levels, and under such conditions, there is little difference between various methods of application. Where soil fertility levels are low-medium, moderate rates of fertilizer drilled beside and below the seed are more efficiently utilized than when broadcast. This is especially true of developing seedlings. Levels of banded fertilizer should not exceed 55kg of (N), 110kg of P_2O_5 or 55kg of K_2O per hectare. Where fertilizers containing urea and diammonium phosphate are major nitrogen sources, these rates should be decreased by approximately ½ (Table 6).

Table 6. General fertilizer recommendations for Atlantic grain crops

Crops	Conditions	Kg of Nutrients per hectare			Example Analysis	Rate (kg/ha)
		N	P_2O_5	K_2O		
Spring wheat, oats & barley (not under - seeded)*	Early Seeding (late April)	20-40	40-80	40-80	12-24-24	175 to 300
	Early Topdress	20-60	0	0	34-0-0	60-180
	Normal Seeding/Topdress	60-90	30-80	30-80	20-10-10	300 to 450
	Later seedings (late May, June)	50-80	25-80	25-80	20-10-10	250 to 400
*Reduce the N on underseeded crops to 1/2 the above rates; P_2O_5 and K_2O should remain the same.						
Soybeans, Peas, Buckwheat	Incorporate or band(not with the seed) at planting	10-15	40-70	40-70	5-20-20	200 to 350
	At seeding	25-50	25-50	25-50	17-17=17	150-300
For above crops: Use the lower rates of P2O5 and K2O where manure, lime and fertilizer have been regularly applied. Use the higher rates if applications have been infrequent.						
Winter wheat and rye[3]	At seeding	10-25	40-100	40-100	5-20-20	200 on fertile, 300-500 on less fertile soils
	Just before spring growth begins	30-75	0	0	46-0-0	100-125
	Growth stage 25-30 (end of tillering)[1]	25-30	0	0	46-0-0	75 to 125
	Growth stage 25-30 (boot to heading)[2]	30-60	0	0	34-0-0	100
1. This application should be increased to 40-60 kg N/ha where a final application at Growth stage 39 - 45 is NOT planned.						
2. This application will raise grain protein of wheat. Response will be limited on rye. Yield increases are limited. Tramline systems or aerial applications are necessary to prevent crop trampling.						
3. The higher rates may cause excessive lodging of rye.						

Fertilizer Ratios and Analyses

The best fertilizer to use in a given situation depends on the amounts of nitrogen, phosphorus and potassium required. Results of soil sample analysis are the best indicators of the required fertilizer, ratios and analysis for a given crop on a given field. When soil test results are not available, general guidelines should be followed.

For general conditions of low to medium levels of phosphorus and potassium, a 1-1-1 ratio is recommended. Commonly available fertilizer with 1-1-1 ratios include 17-17-17, 15-15-15 and 10-10-10. All are generally satisfactory, although handling properties may vary depending on nutrient sources used in their manufacture. The higher analysis materials are generally more economical per unit of plant nutrient. Three hundred thirty-five kilograms per hectare of 17-17-17, or 370 kilograms per hectare of 15-15-15 provide 56 kilograms per hectare each of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). These are the maximum rates of nitrogen and potassium, which can be safely drilled in with the seed, providing the source of nitrogen is not urea or diammonium phosphate.

For winter cereals, fertilizer with a 1-4-4 ratio such as 5-20-20 is generally recommended for fall application, followed by a broadcast application of nitrogen in early spring and subsequent applications at later growth stages.

When high phosphorus rates are required with medium rates of nitrogen and potassium, fertilizer with a 1-2-1 ratio such as 10-20-10 or 8-16-8 may be used. Where high rates of nitrogen and low to medium rates of phosphorus and potassium are required, fertilizer with a 2-1-1 ratio such as 20-10-10 may be used. If these mixtures are not readily available and since they may be difficult to handle under moist conditions, it may be better to apply sufficient 1-1-1 ratio fertilizer in the drill to meet phosphorus and potassium requirements and broadcast the additional nitrogen as ammonium nitrate (34-0-0) or urea (46-0-0).

Pest Management

Pests, including weeds, insects and diseases, are major limiting factors in producing high-yielding, high-quality grain crops. While potentially destructive, the full impact of most pests can be significantly reduced by a number of preventative and curative methods. These involve the major areas of government regulation, appropriate crop management, resistant varieties and chemical control. The integration of several of these methods provides the best results.

Regulation

Numerous regulations are present, which help prevent the introduction of new or more difficult to control pests into the Atlantic region. Federal, or Provincial regulatory agencies administer these for the protection of individual growers and the entire grain industry. An example of such regulations for pest control is the licensing system for new varieties, which requires oats to be resistant to Victoria blight, a very destructive disease that has been eliminated by requiring all new oat cultivars to be resistant. Another illustration may be cited in the Pedigreed Seed regulations, which limit weed seed content in seed grain and requires the complete elimination of specified noxious weeds from certified seed.

Crop Management

Crop rotation and other good crop management techniques such as early seeding are effective methods for pest control. Each additional year a field is in continuous cereals increases the number of weeds, disease-causing fungi and insect pests present, which are detrimental to yield. Examples of such situations include: the gradual buildup of grass weeds (particularly quackgrass), increased diseases such as Take-all, Fusarium head blight and insects in continuous cereal fields. A break crop denies these pests the hosts they require, resulting in a decline in their population. A significant yield loss due to pests may occur in the second year that cereals are planted in a field. Barley after barley has been shown to lower yields by up to 500 kg per hectare.

Pests can be quite mobile, and crops to be seeded in adjacent fields must also be considered. This is a particular consideration in the spread of the fungus inciting powdery mildew on wheat. If winter wheat is infected in the fall, it may infect a susceptible spring-planted wheat shortly after emergence in an adjacent field. If spring wheat can be planted at a distance from the winter wheat, infection will be delayed until a more advanced stage of growth on the spring wheat and thus lessen disease severity.

Integration of pest control can best be illustrated by the value of controlling grass weeds in cereal fields. Weeds can act as alternate hosts of fungi causing diseases, a severe root and basal stem disease of cereals, particularly wheat. When the weed host is eliminated, the population level of the disease-causing pathogen is reduced, and less disease occurs in the cereal crop. The weed must be destroyed by the spring prior to planting winter cereals or the fall prior to seeding spring cereals.

In those areas where soil erosion is not a problem, fall plowing to bury crop debris will assist in decomposing the residues on which disease-causing fungi and insects survive between grain crops. Early decay of such plant materials in the fall will reduce the overwintering of many pests.

Resistant Varieties

A disease-resistant variety should always be used whenever possible. Resistance may not be total, and some disease symptoms may develop, but even partial resistance may reduce the yield loss. Many cultivars are susceptible to a number of diseases. However, if resistance is present to even one, this is still of value in those years or circumstances when that one disease may be prominent.

Herbicides

Weeds compete with grain to reduce yield, and large weed plants cause difficulty during combining. Weed competition starts very soon after emergence of the crop and weeds. The critical weed-free period for cereals is 1-3 leaf stage for spring cereals, and between 500-1000 growing degree days (base 10) for winter cereals. One or two weeds per square meter will not cause serious yield loss, but they do act as a source of weed seeds that will contaminate the field for the next growing season. Also, individual plants of large vigorous weed species such as lamb's-quarters and wild radish will cause yield loss of grain plants located in the vicinity of the weed plant. Weeds have their greatest competitive effect early in the growth period of the crop. Removal of the weeds for the first few weeks after crop emergence is usually all that is necessary to ensure maximum yields. Weeds that emerge later in the summer are usually not very vigorous as they are suppressed by the taller growing cereal crop.

Management practices can reduce weeds in grain production. The use of crops in the rotation that smother weeds and reduce or prevent weed seed formation will reduce weed problems in the following grain crop. The use of a stale seedbed technique before planting grain will also help to reduce weed problems. In this technique, the soil is prepared for planting but left for a few days to let weed seed germinate, and weeds emerge. The soil is then shallowly cultivated, or a burn-down type herbicide is used to kill this first flush of weeds, and the grain crop is planted. Removal of the first flush of weeds removes early weed competition, but success is dependent on many factors. Once the crop and weeds have emerged, then cultivation between the rows when the weeds are very small in the cotyledon to first leaf stage will help to reduce the weed infestation and competitive effect on the crop. Several mechanical vibrating rod type weeders are available today for mechanical weed control in grain crops.

Herbicides can give good weed control but must be accurately selected to control the weeds present in the field.

Herbicides should be considered a production tool and not a cure-all for poor management. Young, rapidly growing weeds are more easily destroyed than large older weeds. Consideration should be given to using tramlines when herbicides are applied post-emergent as this will result in less damage to the crop and give greater application accuracy. Late spraying gives poor weed control and may reduce yield due to crop injury; most yield depression due to weed competition occurs during the early stages of crop and weed growth.

Quackgrass infested fields should be cleaned up before seeding cereals. This is usually done with a glyphosate application in the fall. There are also a few pre-emergent broadleaf herbicides available on the market today. Do not neglect grain fields after harvest, but use shallow cultivation and herbicides to control quackgrass and other weeds. The success of weed control with herbicides depends on proper application. Read and carefully follow the instructions on the product label.

For current information on herbicides registered for field crops, check out OMAFRA Pub. 75A – Guide to Weed Control: Field Crops.

Insect Control

The population of insects such as armyworms, aphids and cereal leaf beetles may build up very rapidly, and producers should regularly inspect their fields to detect such increases before they reach a level at which control is difficult or the crop is already damaged. Control of aphids will also reduce the harmful effects of barley yellow dwarf virus, which is aphid transmitted. Early seeding will effectively reduce insects' importance as the host crop in early seeded fields will be more advanced in growth when attacked and thus less liable to severe yield loss. It is often difficult to determine when an insect population has reached a level at which use of an insecticide will be warranted, and in such instances, grower and crop specialist’s experience is helpful. Under certain conditions, the use of an insecticide seed treatment provides sufficient protection from some insects and eliminates the requirement for a foliar-applied insecticide. In order to select the proper insecticide, careful observation and identification of the insect pest in question is required.

Aphids

Aphids are small, soft-bodied green insects that feed on cereals. They can cause significant damage by feeding on the plants, weakening them and potentially reducing yields accordingly. The most significant impact of cereal aphids is their ability to act as vectors for barley yellow dwarf virus (BYDV). The impact of cereal aphids depends on factors such as weather conditions, population size, natural predators and the presence or absence of BYDV.

To mitigate the effects of cereal aphids and BYDV, plant cereal crops so that the crop is advanced enough to withstand damage when aphids are widespread. Insecticides may be used and should target the life stage when aphids are developing their wing pads, prior to migration. Lady beetle larvae are considered a natural predator of cereal aphids, so chemical control may not be necessary if a large population of lady beetle eggs is found during scouting.

Figure 7. Cereal aphids feeding on leaf, lady beetle larvae feeding on aphids (photo: https://eap.mcgill.ca/CPCP_2.htm)

Wireworm

Wireworms are reddish-brown worms that can cause significant damage in crops by way of feeding damage. Wireworms feed on the roots of seedling cereal crops, resulting in poor crop emergence and localized areas of sparse stands. The risk of wireworm is greatest in cereal fields which have recently been transitioned from sod.

Seed treatments containing both an insecticide and fungicide can offer some control while the plant establishes itself.

Figure 8. Wireworm (photo: https://eap.mcgill.ca/CPCP_2.htm)

Armyworm

Armyworms are dark green to brown worms with white stripes along their back and sides. They feed on the leaves and heads of cereals, only leaving the stems behind. For this reason, they are considered extremely destructive. As feed diminishes in one area, armyworms will move to areas with more plentiful food sources. Insecticidal control should be employed as soon as worms are found.

Figure 9. Armyworm (photo: https://eap.mcgill.ca/CPCP_2.htm)

Disease Control

Diseases are major yield and quality limiting factors in the production of successful grain crops. Fungi, or moulds incite most cereal diseases that occur in the Atlantic Region, but others are caused by viruses, bacteria or nematodes. While potentially destructive, most diseases' full impact can be significantly reduced by preventative and curative practices.

Intensity of Symptoms on Leaves for each Score*										
	0	1	2	3	4	5	6	7	8	9
Upper Leaves	Free	Free	Free	Free	Isolated	Isolated	Scattered	Light-moderate	Moderate -severe	Severe
Middle Leaves	Free	Free	Free	Isolated	Scattered - light	Moderate	Moderate	Severe	Severe	Severe
Lower Leaves	Free	Scattered	Scattered	Light	Light-moderate	Moderate -severe	Severe	Severe	Severe	Severe
*Area of leaves covered by symptoms: Free = 0%, Isolated = 1%, Scattered = 5%, Light =10%, Moderate = 25%, Severe = 50%, of more.										

Table 7. Rating scale for cereal leaf diseases

Such practices involve preventative crop management techniques, the use of resistant cultivars and fungicide treatments. The integration of all suitable methods usually provides the most cost-effective system, depending on the current market price situation for the particular cereal crop.

Grain producers are encouraged to examine their crops on a frequent schedule and have practical knowledge of diseases. The knowledge required by grain producers must include recognizing diseases and their symptoms at an early stage. The severity of the symptoms must also be assessed in order to quantify potential damage (**Error! Reference source not found.**). A 0-9 scale for measuring disease severity is also used in establishing the level of disease resistance recorded in lists of recommended cultivars for the region. Understanding the method of spread of pathogens will also assist in estimating the final severity of crop damage. Most virus diseases of cereals are transmitted by aphids, and in such instances, aphid control constitutes an essential part of disease control. Finally, understanding the environmental conditions influencing the development of a potential epidemic will help determine the value of applying chemical treatments.

Seedling Blight/Common Root Rot/Spot Blotch

Seedling blight, common root rot, and spot blotch are all diseases of barley that are caused by the fungus *Bipolaris sorokiniana*. Damage caused by this fungus can lead to sparse stands and low yields or poor quality grain.

Seedling blight and common root rot can occur at any time throughout the growing season, especially at the seedling stage. Infected seedling will turn brown at the base, eventually spreading to the plant's leaves and roots. Infected roots may appear underdeveloped and brown in colour. Since they cannot access sufficient nutrients to the rest of the plant, the plant will damp-off and die.

Figure 10. Seedling blight/common root rot of barley roots (photo: https://eap.mcgill.ca/CPCP_2.htm)

Spot blotch is present on the leaves of the cereal plant and can be characterized by dark brown lesions that are oval and elongated. Advanced symptoms may appear irregular as the blotch expands. Tissue surrounding the blotches may appear light green or yellowish. Infection generally occurs in July, when conditions are hot and humid for long periods. Infected heads may have kernels with black tips.

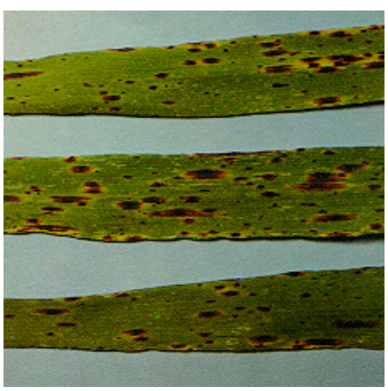

Figure 11. Spot blotch infection of barley leaves (photo: https://eap.mcgill.ca/CPCP_2.htm)

The fungus causing these three diseases overwinters in the soil, on infected crop or weed residue, or on infected seeds. Fungal seed treatments are available to combat fungal spores present in the soil or on infected seed. Management of alternate weed hosts, especially quack grass, can be achieved using herbicides, crop rotation, and soil fertility management.

Take-All

Take-all is a fungal disease of most cereal crops, caused by *Gaeumannomyces graminis*. Although oats can be infected*, they do not show symptoms. The fungus overwinters on soil, debris and roots of the infected crop and host plants. Lack of weed control and lack of crop rotation are major factors in severe take-all infections.*

Infected plants tend to be located in concentrated areas of the field, year after year, with the size of the area expanding each growing season. Plants will have stunted growth and reduced tillering. Infected heads may appear bleached and have poor kernel fill, turning black and sooty as the disease develops. The roots of the plant may be under-developed and covered in dry black rot. Black fungal spores may be found on the inside of the lower sheath leaves, which is the easiest field diagnosis for this disease.

Figure 12. Wheat heads infected with take-all (photo: https://eap.mcgill.ca/CPCP_2.htm)

To reduce the amount of fungus in the soil, long crop rotations and the control of host plants around the perimeter of the field are recommended. Fertilization to increase the viability of the crop may also contribute to reducing the severity of the disease. Ploughing in crop residues allows them to decompose more quickly, destroying the food source for the fungus.

Figure 13. Cereal plant roots infected with take-all (photo: https://eap.mcgill.ca/CPCP_2.htm)

Net Blotch

Net blotch is a disease of barley caused by the fungus *Pyenophora teres*. Net blotch is characterized by light green to brown patches at the tips of the leaves, which become dark brown as the disease develops and display a netted pattern within the lesion. Lesions extend between the veins of the leaf. Severe infections may cause yellowing around the blotch or cause withering and death of the leaf. The stem of the plant may be weakened. Small blotches may appear on the head of the plant, further contributing to reduced yields. Early symptoms can be confused with spot blotch.

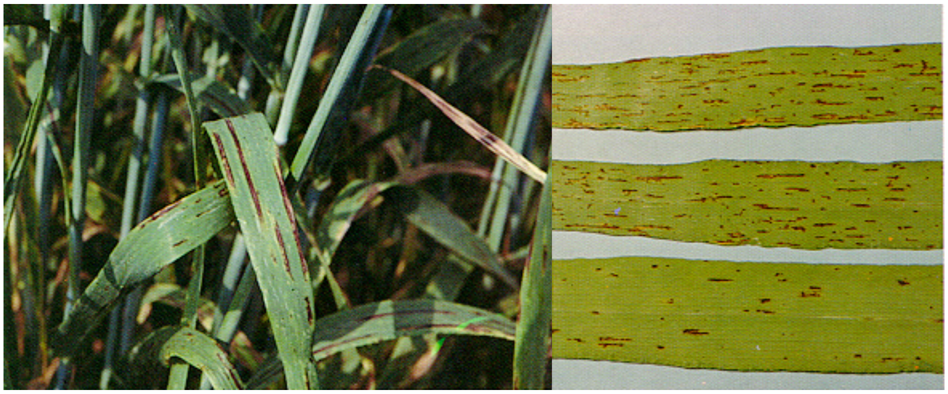

Figure 14. Net blotch in barley (photo: https://eap.mcgill.ca/CPCP_2.htm)

Cool, humid weather conditions are ideal for developing net blotch, making control of particular importance in the spring and fall. The disease overwinters in the seed and on crop residues, infecting seedlings via fungal mycelia or older plants via spores carried by the wind from crop residues. Crop rotation and destruction of infected crop residues by ploughing are important methods of control. There are also seed treatments that may be effective in reducing seedling infection.

Leaf Stripe

Leaf stripe is a disease of barley caused by *Pyrenophora graminea.* Although it is not prevalent in Atlantic Canada as of 2020, a resurgence in Western Provinces means that there is a risk of it being imported into the area, and is therefore important to note.

Symptoms of leaf stripe are similar to those of net blotch. Yellow or brownish lesions extend from the tip to the base of the leaf, confined between the veins. These lesions may result in tearing of the leaf as the disease progresses. Severe infection may result in stunted plant growth.

Figure 15. Leaf stripe in barley (photo: https://eap.mcgill.ca/CPCP_2.htm)

Ploughing down infected crop residues, crop rotation and the use of treated seed can be effective in the control of leaf stripe.

Scald

Scald is a disease of both barley and rye, caused by the fungus *Rhynchosporium secalis*.

Symptoms of scald include oval or irregularly shaped blotches on the leaves and sheath of the plant. Severe infections will result in the expansion of the lesion to the point of girdling, at which point the plant will wither and die. Lesions will appear water-soaked and be bluish- to grayish-green in colour, progressing to brown (barley) or bleached and straw-like (rye).

Figure 16. Scald on barley (photo: https://eap.mcgill.ca/CPCP_2.htm)

Conditions for disease development include periods of damp, cool weather, so it is of particular importance in the spring. The plants can typically handle moderate levels of infection in the spring without impacting the yield, but if conditions persist through late June, severe infections can impact yields significantly.

The fungus overwinters on infected crop residues, producing spores in the spring, which are spread by rain or wind. The cycle of infection and spore production continues until the weather conditions get too hot but will continue when the temperatures decrease again in the fall. Infection can also occur on alternate host plants and in the seed.

Effective control of scab can be achieved through crop rotation, ploughing down crop residues, controlling weeds and alternate hosts and using treated seed. Resistant cultivars may be planted.

Powdery Mildew

Powdery mildew is a disease of spring and winter wheat, caused by the fungus *Ecysiphe graminis* f.sp. *tritici*. It is rarely found in barley.

Symptoms of powdery mildew include small fluffy white spots on the leaves of the plant. The area underneath the fluffy mycelia is yellowish. Small black flecks, which are the fruiting bodies of the fungus, can be found on older leaf lesions and also on the stems and heads of the plant.

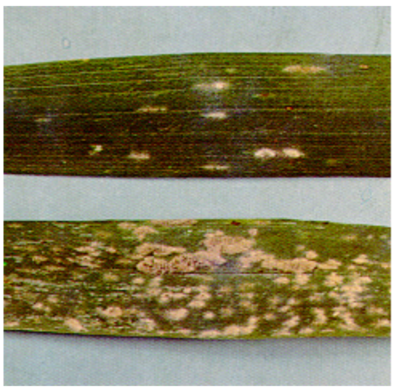

Figure 17. Powdery mildew on wheat (photo: https://eap.mcgill.ca/CPCP_2.htm)

The fungus overwinters on crop residues or on the winter wheat plant itself. The severity of infection may be worsened by high nitrogen levels but may be tempered with adequate levels of phosphorus and potassium. Effective control of powdery mildew can be achieved through crop rotation away from wheat, plough-down of crop residues and the planting of resistant varieties. Infection is heightened when winter wheat and spring wheat are grown close to one another, so the two crops should be grown well apart. Foliar fungicide options are also available, especially when high nitrogen levels are applied to benefit the crop. Fungicidal seed treatments may also be beneficial.

Septoria Leaf and Glume Blotch

Septoria leaf and glume blotch are diseases of wheat caused by the fungus *Septoria nodorum*.

Symptoms of leaf blotch include light green to yellow lesions, which usually appear on the lower leaves of the plant before spreading to the upper leaves. The lesions become light to reddish-brown with yellowish margins as the infection continues and become large and irregular in shape. Leaves with severe infections will turn yellow and die. Leaf-sheaths and stems can also be infected, making the plant weak and more susceptible to lodging.

Figure 18. Septoria leaf blotch in wheat (photo: https://eap.mcgill.ca/CPCP_2.htm)

Glume blotch appears as small light brown lesions on the glumes in the head of the plant that darken and expand with age. The fruiting bodies appear as dark specks on lighter coloured, old lesions. Infected heads will result in yield reductions via shrivelled kernels or no kernel production at all.

Figure 19. Septoria glume blotch in wheat (photo: https://eap.mcgill.ca/CPCP_2.htm)

The fungus overwinters on infected crop residues and volunteer wheat. Infected seed has the potential to cause huge problems in the subsequent crop. Ideal conditions for infection include warm, wet weather with temperatures in the 20-25^{0}C range. Effective control of septoria leaf and glume blotch can be achieved through the use of clean fungicide-treated seed and the elimination of infected crop residues by plough-down. Foliar fungicides and crop rotation will also increase control.

Fusarium Head Blight and Stem Breakage

Fusarium head blight is a disease of all cereal crops caused by the fungus *Fusarium graminearum*. It is most commonly seen in spring wheat. Fusarium head blight can dramatically impact yield and quality of cereal production in years when conditions favour disease development.

Symptoms of fusarium head blight can usually be seen in late July. One or more spikelets on the wheat head appear bleached and can be mistaken for early ripening. As the infection progresses, the entire head becomes bleached with tinges of pink fungus. Infected seeds may appear pinkish or white and are referred to as tombstones. Severe infections may lead to poor yields with grains that may be contaminated with vomitoxin.

The root system of the cereal plant may also be infected by the Fusarium fungus and will result in poor emergence, damping-off and stunted plants. Infection moving into the stem and nodes will result in stem breakage.

Fusarium head blight has a wide host range, making control challenging. Conditions favouring disease development include humid weather during the ripening growth stage. Control methods include fungicide-treated seed, crop rotation, and field sanitation. Even using multiple control methods together will only result in partial control.

Snow Mould

Snow mould is a disease of fall rye and winter wheat caused by several different fungi, including *Fusarium nivale*, *Sclerotinia borealis* and *Typhula spp.* These fungi are active at low temperatures and cause infection when there is snow coverage but little frost in the soil.

Symptoms of snow mould include a pinkish tinge to the plant early in the spring. Black sclerotia may also appear on what remains of the previous year's growth and are made up of reproductive mycelia.

Snow mould is difficult to control, but cultural practices such as crop rotation, field sanitation and seeding date can help to minimize the impact of these fungi.

Smut

Covered smut and loose smut are diseases of barley, wheat and oats caused by the fungus *Ustilago spp*.

Symptoms of smut include black spore masses, which replace the individual grains on the plant's head. Heads infected with loose smut have a thin membrane containing the spores, which ruptures easily, allowing them to escape and get dispersed by the wind. A bare spike is left behind where the grain would normally form. When spores are released and land on other plants, the infection forms systemically, becoming evident when the head emerges from the boot. Covered smut has spores contained in a more durable membrane so that the spores are not released until the kernels are mature. At this time, spores are released, infect the seed, and continue the disease cycle when the seeds are planted for the subsequent crop.

Figure 20. Loose smut of wheat (photo: https://eap.mcgill.ca/CPCP_2.htm)

There is a direct correlation between the amount of disease present in the field and the level of infection present in the field where the seed was grown. Effective control methods include resistant cultivars and systemic fungicide seed treatments. Lack of control or continued use of an infected seed source will compound disease issues year after year and lead to significant yield loss.

Ergot

Ergot is a disease of many cereals, particularly rye, caused by the fungus *Claviceps purpurea*.

Symptoms of ergot include hard, curved bodies purple-black in colour. These bodies occur in the space where a kernel would normally be, although it is several times the size of a normal kernel. These bodies will fall to the ground and proceed to develop spores, which are spread by rain or wind, or they are harvested with the seed and continue their reproductive process when the seed is planted. Spores are also spread by insects who are attracted to the honeydew substance produced by the infected area.

Figure 21. Ergot in various cereal crops (photo: https://eap.mcgill.ca/CPCP_2.htm)

Cool, wet weather conditions are ideal for disease development because it extends the infection period during flowering. Susceptibility of the plant to infection decreases after flowering is complete.

Ergot bodies pose a great risk when it comes to their presence in feed grain as they contain toxins that interfere with the circulatory system of livestock. The level of ergot bodies should be limited to 0.1% by weight and can be reduced through proper cleaning of the grain.

Ergot can be controlled through the use of crop rotation and field sanitation. Weed control of alternate hosts in and around the perimeter of the field is also important.

Crop Management

1. Provision of optimum growing conditions in terms of field selection, soil drainage, soil pH, tillage, fertilization rate, proper seeding rate and depth and early planting dates.
2. Respect for legislation designed to exclude new pathogens or new races of existing pathogens. Such regulations prevent the importation of unregistered seed lots of cultivars. This eliminates the problem of introduced pathogens, which may not be controlled by existing levels or types of disease resistance.
3. Crop rotation is essential to reduce the severity of diseases and helps to suppress weed and insect damage to crops. Crops should be diversified as much as possible within individual farms and within a region to help overcome the buildup of aerially transmitted diseases. The collective crop health within any region of the Atlantic Provinces is governed by the success of each producer in reducing the buildup of disease organisms. Crop rotation for disease control requires knowledge of host ranges of the pathogen in question, as frequently, a cereal pathogen will attack and survive on different species of crops that may be used in rotations. Corn should not be rotated with cereal crops because both are hosts to a number of fungal pathogens (e.g. fusarium), which increase in severity when these crops are included back-to-back in rotations.
4. Field hygiene is essential in order to reduce the survival of disease inciting pathogens. This, in conjunction with crop rotation, is particularly important in controlling foliar pathogens of cereals and recommended action includes the proper and timely soil incorporation of crop debris or stubble and control of alternate hosts of pathogens such as perennial grass weeds.

Fungicides

Fungicide seed or foliar treatments should be considered only after an assessment of the severity of the diseases in question, and the yield potential of the crop has been made. In deciding if a seed treatment is required, consider the disease susceptibility of the cultivar in question and the potential for planting in relatively warm soil, which will enhance emergence. Foliar diseases should be assessed for severity in the field prior to the application of all foliar fungicides (Table 8).

Fungicides should be applied at the recommended rate and time. Reduced rates (below label rates) are not recommended since this tends to favour the development of insensitive types of pathogens whereby the fungicide loses its ability to control diseases. This is believed to occur by removing sensitive strains of the pathogen, leaving an already present resistant minority strain to develop unhindered by competition. The repeated use of the same fungicide also leads to insensitivity. It is important to rotate groups of fungicides to reduce resistance issues. Fungicides for powdery mildew control have been recorded to lose their effectiveness after repeated use for some ten years. For this reason, an integrated pest management approach is recommended to reduce disease severity to an acceptable level. An integrated pest management plan will incorporate cultural, physical and chemical controls, reducing the pressure of relying only on fungicides. When possible and necessary, a second application of fungicides should use a chemical from a different group than that which was applied for the first application. The success of control should always be monitored so that the need for corrective application procedures may be determined for future use.

Table 8. Conditions most likely to lead to development of cereal diseases in the Atlantic region.

Condition	Disease Influence	Host
Spring cereals:		
Cool, wet planting season	Increased scald	Barley
Excess rain early to mid-season, humid conditions	Increased net blotch, septoria diseases	Barley, wheat
	Reduced powdery mildew	Wheat, barley
Excess moisture from heading to maturity	Increased septoria glume blotch	Wheat
	Increased fusarium head blight	Wheat
Excess moisture at harvest	Increased sooty moulds, lower seed quality, increased lodging	All cereals
Dry, hot conditions	Reduced foliar and head diseases, increased symptoms of take-all and other root rots	All cereals
Winter cereals:		
Excessive, long-lasting snow cover	Increased snow moulds	Winter wheat and rye
Lack of mid-winter snow cover	Reduced winter survival	Winter wheat and rye
Wet (delayed) planting	Reduced fall growth and winter survival	Winter wheat
Early planting	Excessive foliar diseases	Winter wheat

The following is a procedure to help determine if a fungicide should be applied to cereals for disease control:

- Identify disease and severity
- Determine disease reaction of cultivar
- Assess the potential of success of non-fungicide methods
- Estimate potential yield and profitability of crop
- Estimate treatment cost and potential for yield increases
- Determine maturity and estimate days to harvest

It is important to remember that most fungicides for use in cereals are preventative. They will need to be applied before the disease becomes a problem or in the very early stages of colonization. Spraying afterwards will not control the disease or prevent yield loss but will further decrease profitability by adding cost.

For up to date information on products registered for insect and disease control in field crops, visit OMAFRA Pub. 812 – Field Crop Protection Guide.

Combining

Due to improper combine adjustment and operation, grain losses have occasionally been found to be as high as one-third of the total yield. Such losses were determined based on actual combine yield before and after proper adjustment of the machines. Grain losses can be detected by examining the ground behind the combine and by sampling the straw walkers and the sieves using a small window screen. This determines the location and extent of losses, and the operator should then correct these.

Header

For best feeding of the grain, adjust the reel speed to be slightly faster than the ground speed of the combine. This will keep the front of the grain head clear of grain and will prevent plugging. If the reel speed is too fast, cut material may be carried around the reel. Adjust the reel height so the reel bat contacts the grain just below the heads so the reel will not warp, or shatter.

Tailings

Next, you should check a sample of material coming up through the tailings return elevator. If the grain is not being threshed from the head, it may be necessary to increase cylinder speed or decrease concave clearance, or both. If an excessive amount of threshed grain is present, the adjustable sieve may need to be opened to allow the grain to drop through, as these will be carried by the clean grain elevator up into the grain bin.

Grain in bin

After a good sample of the grain is in the bin, stop the combine and check it. If the grain is being hulled or cracked, reduce cylinder speed or increase concave clearance, or both. If an excessive amount of chaff and other lighter foreign material is in the grain bin, the fan choke opening should be increased slightly. Chaff and other light material can also be reduced by closing the sieve and reducing the chaffer openings slightly.

Un-threshed heads in the grain may occur because the adjustable sieve is opened too wide. Also, the cylinder speed may be too slow or the cylinder-to-concave clearance too wide.

Straw Behind Combine

Lastly, check for grain in and under the straw. Grain loss at this point can result from the straw walkers being over-loaded due to too high a feed rate, improper straw walker speed, or damaged check flaps. If straw matting on walkers is a problem, then add additional riser fingers or fishbacks.

Loss can also occur from grain being blown over the upper sieve by too much wind or chaffer not open far enough.

Grain loss monitors are available, which indicate grain being lost over the straw walkers and cleaning sieves. The monitor must be calibrated properly.

Combines are designed to work on level ground. Sloping ground reduces the combine's cleaning and separating ability and increases losses significantly, especially during side-hill and up-hill operation. On sloping ground, reduce forward speed to reduce losses.