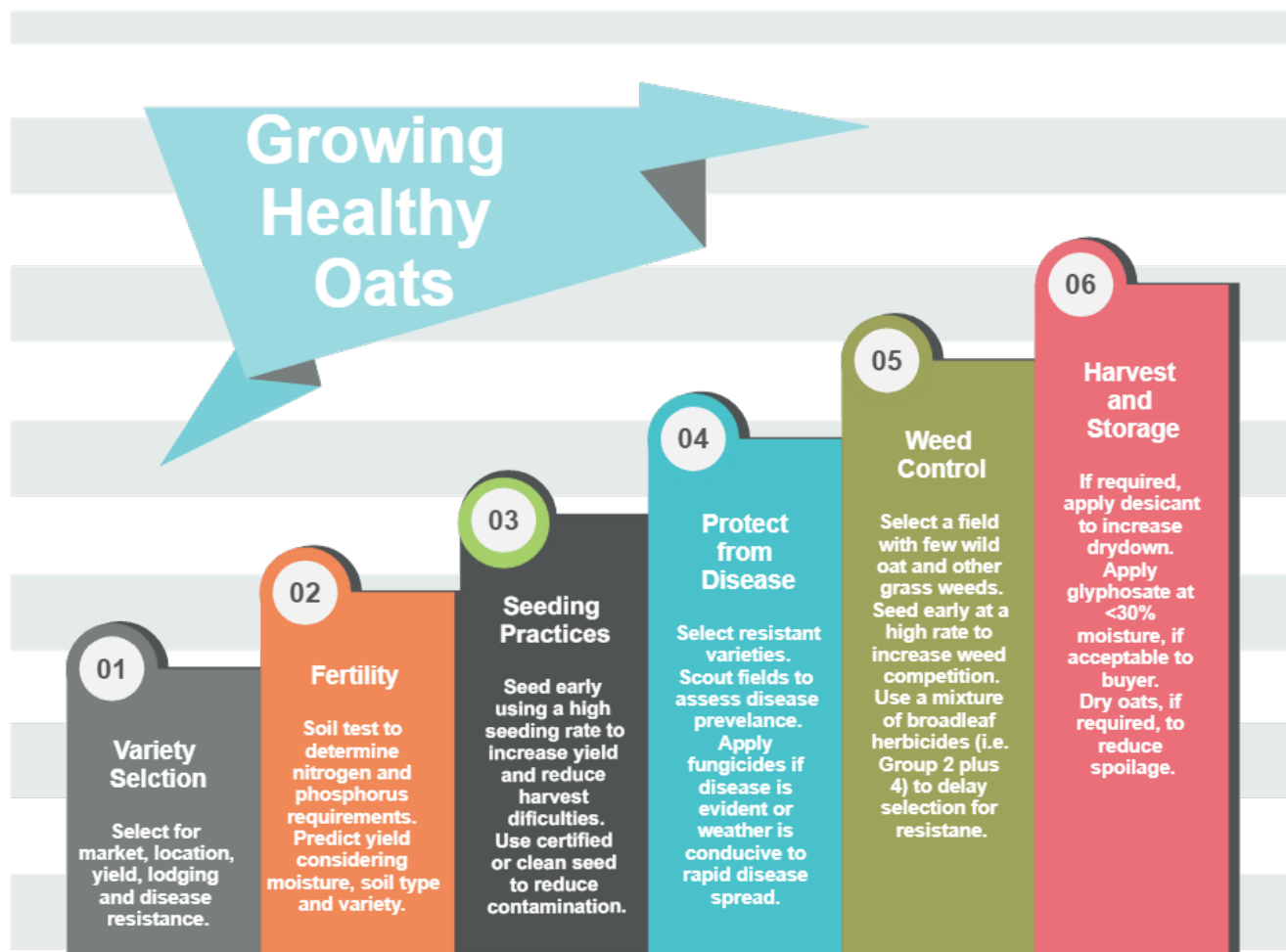


# Growing Healthy Oat on the Canadian Prairies

**A Manual for Western Canadian Oat Growers**





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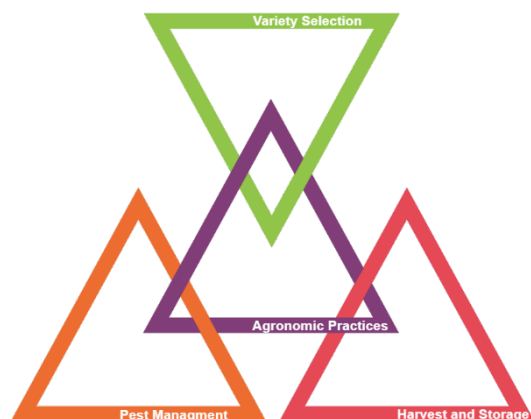
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# Growing Healthy Oat



While oat represents only ~ 1.3% of the total world grain production, it is a vital part of the Canadian cropping rotation. Canada is the largest exporter of oat in the world. Canada has a premier reputation for quality production that is sustained by research funded by Prairie Oat Growers Association (POGA), as well as public funding from the Federal and Provincial governments and by the private companies that contribute to breeding, marketing of oat varieties, processing of oat and production of traditional and novel oat products.

Oat is grown for three primary markets:

- milling oat (human consumption),
- performance oat (pony oat), and
- feed oat,

each with specialized variety choices and economic considerations.

The human food market for oat is increasingly important. In addition to the traditional uses of milled oat (Figure 1.1), oat is being processed for an array of products to meet the demand for gluten free, plant based, and non-dairy milk alternatives. The health benefits of oat are widely recognized. Oat-specific soluble fibres, such as Beta Glucans ( $\beta$ -glucans), maintain and reduce blood cholesterol and aid in balance of blood glucose. Oat has a high content of unsaturated fatty acids, especially present in the endosperm, which reduces the risks of heart and vascular diseases. Oat starch has a low glycemic index, which is favourable for weight control while oat-

specific polyphenols and avenanthramides have antioxidant and anti-inflammatory properties.

There are many new oat food products contain oat ingredients available that are being rapidly adopted by health-conscious consumers (Figures 1.2 and 1.3).



**Figure 1.1.** While milled cereals continue to be an important market for oat, many other products are being developed. Oat products that contain more than 4%  $\beta$ -glucan can be labelled Heart Healthy.





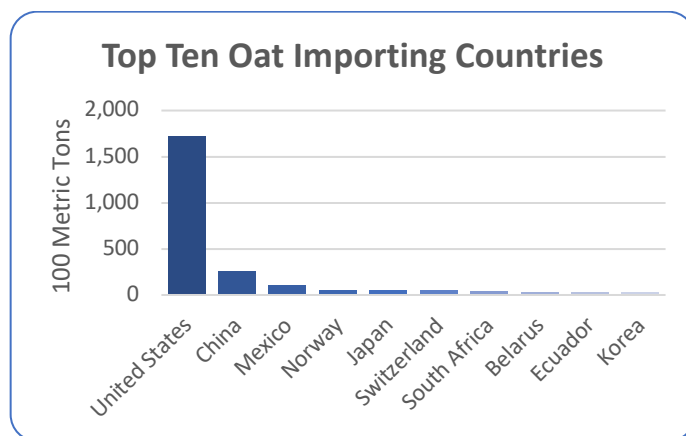


**Figure 1.2.** Oat milk is just one of the many new oat products gaining acceptance across the world.



**Figure 1.3.** An example of a food ingredient made from oat is Oatrim, a fat replacement product that is being used in many processed products to reduce fat.

Canadian oat are exported around the world (Figure 1. 4), with the USA being the most significant market.



**Figure 1.4.** Top ten oat importing countries.

Performance or pony oat are also a specialized market, primarily for high end race or competitive horses (Fig 1.5). In this market, the visual appearance of the oat is important along with other parameters ([Stoney Plain Seed Cleaning Association](#)). Oat should be plump and white in color. Performance oat is marketed in Western USA, Japan, Malaysia and Korea to specialized buyers. High yielding feed oat varieties can be a choice for some oat growers and finally, oat that does not achieve quality standards can default to the lower-value feed market.



**Figure 1.5.** Pony or performance oats also have specific quality standards.



## Purpose of the manual

The purpose of the manual is to promote production practices that allow oat growers to profitably produce high quality oat for domestic and international markets

The Oat Growers Manual aims to provide best management principles, practices and resources to contribute to sustainability and profitability for oat growers. A multi-pronged approach is needed to improve oat yield and quality. Practices are grouped into four sections:

- [variety selection](#),
- [agronomic practices](#),
- [pest management](#) and
- [proper harvest and storage](#).

For optimal profitability and healthy crops, these practices must be implemented together. The advantages of choosing the best variety can be obliterated by late seeding, inadequate fertility or poor storage of grain.

The manual attempts to provide clear and concise advice that can be easily accessed by growers. A healthy crop will contribute to:

- reduced need for chemical inputs
- a sustainable crop rotation and
- high quality oat for healthy food and animal feed.

### Meeting the Goals of the Strategic Plan

Production of this manual was mandated by the Prairie Oat Growers Association (POGA). [National Oat Strategy Document](#)

that states that the industry requires “...agronomic recommendations that can be clearly communicated to producers. Plots show high yield potentials, but there are still low yields on many farms. It is time to encourage more investment into agronomics. The pillar to *Improve Oat Agronomy* needs greater action, and it was felt all parts of the value chain could contribute meaningfully to progress. Improvements in clear, concise recommendations and using multiple channels to convey them could have the most immediate results on oat yields. More ambitious goals to improve agronomy testing and extension are also in the longer-term plan. By using better strategies for knowledge transfer, including existing networks from other crops, it is possible to increase impact on the ground.”

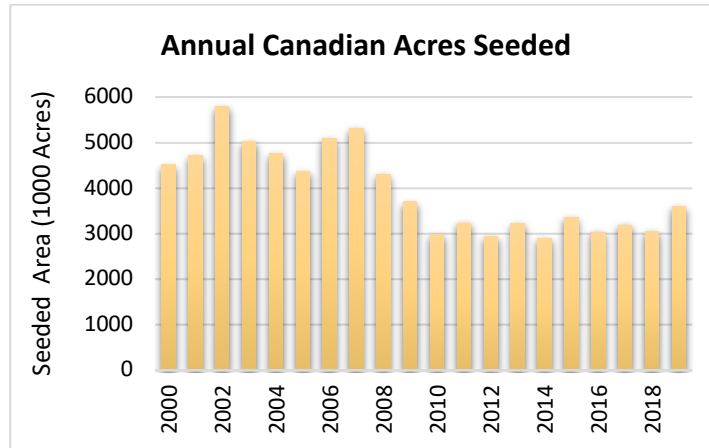
### Recent trends in the Canadian oat industry

While oat acres declined in Canada between 2000 and 2010, acres have remained essentially constant from 2010 through 2019 (Figure 1.6), Canadian production has increased though due to increased yields (Figure 1.7). This demand is due to an increase in oat exports as well as increased oat milling capacity in Canada.

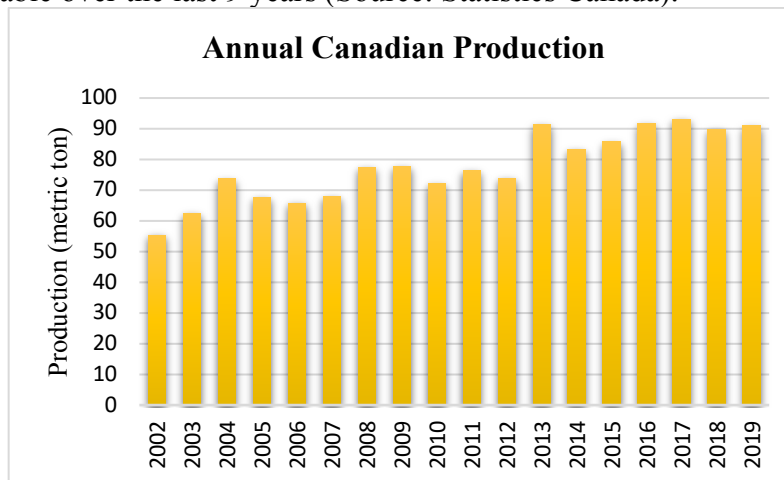
Overall Canadian production has increased (Figure 1.8) and the export of oat has increased and stabilized (Figure 1.9).

The trends suggest that while oat may have suffered from competition for acres with other crops such as canola and wheat in the past, oat growers have continued to develop agronomic practices and oat breeders have continued to provide growers with better oat varieties.

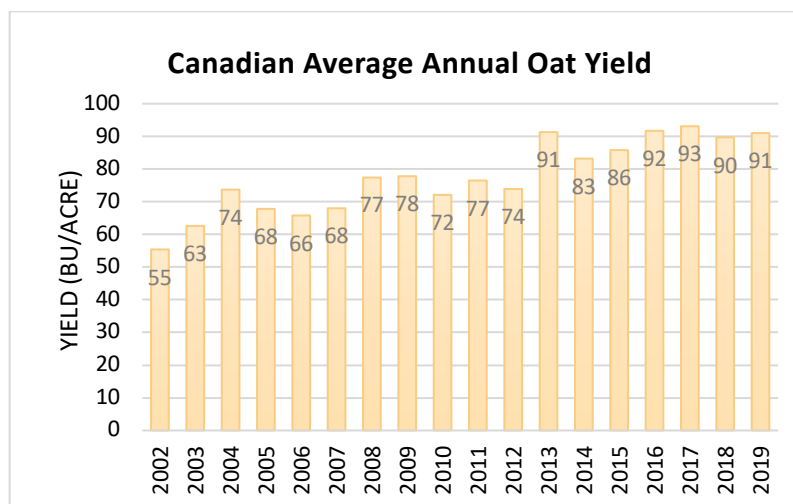




**Figure 1.6.** Seeded acres of oat have been decreasing from highs in the early 2000's but have been relatively stable over the last 9 years (Source: Statistics Canada).

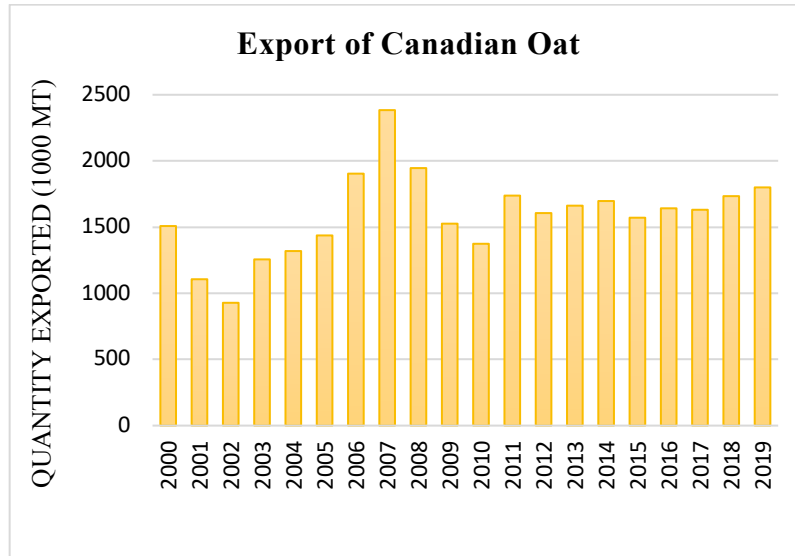


**Figure 1.7.** Oat yield has been generally increasing from 2000 to 2019 (Source: Statistics Canada).



**Figure 1.8.** Annual Canadian production has been generally increasing from 2000 to 2019 (Source: Statistics Canada).





**Figure 1.9.** The exports of oat from Canada, 2000 to 2019. (Source: Statistics Canada).

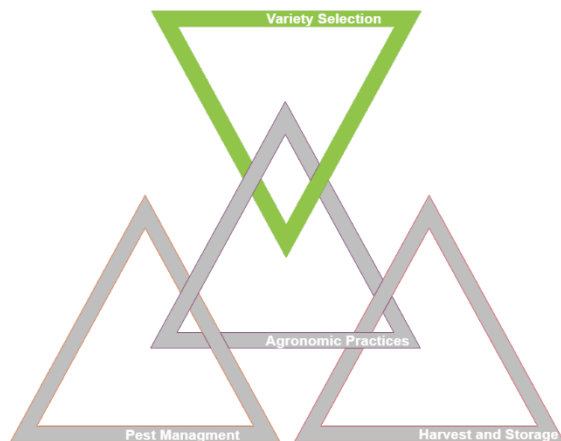
## References

Webster, F.H.; Wood, P.J. Oats: Chemistry and Technology; American Association of Cereal Chemists: St. Paul, MN, USA, 2011.

Statistics Canada. [Table 32-10-0359-01 Estimated areas, yield, production, average farm price and total farm value of principal field crops, in metric and imperial units](#)

DOI: <https://doi.org/10.25318/3210035901-eng>





## Variety selection for targeting markets and profitability

Oat variety choice impacts grain marketing, grain yield and quality, and the management practices required to optimize performance in a particular soil and moisture regimes. Variety selection establishes the potential of the oat crop and deserves considerable attention.

### Fit for purpose

Variety selection should first consider the specific market being targeted.

In the Western Canadian prairie variety guides, oat varieties are listed according to their intended purpose, including:

- General purpose
- Milling
- Feed
- Forage oat
- Hullless oat

Additionally, local or specialty oat buyers may have **varietal preferences**. Growers pursuing a particular market should consult with buyers prior to variety selection.

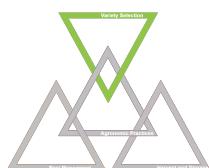
A good place to locate a buyer is to use the [POGA Oat Buyers List](#), which includes the contact information for potential buyers. For milling oat, “Preferred” or “Approved” variety lists are available from many oat millers.

**Many oat buyers have variety preferences. Communicate with the buyer before selecting a variety.**

### Regional suitability

Different varieties are suited to different regions (Table 2.1). Alberta growers favor AC Morgan while Saskatchewan and Manitoba growers prefer CS Camden and Summit, likely because of the overall performance of these varieties.

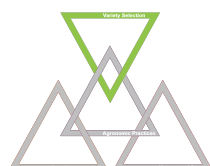
Generally, oat grows well in the dark brown to black to grey and dark grey soil regions of the prairies. They grow best under cool temperatures and are less drought tolerant than barley or wheat (Drought management fact sheet: BC Ministry of Agriculture).





**Table 2.1.** Varieties grown in the Prairie Provinces in 2019. ([Source](#) Canadian Grains Commission)

	<b>% of Total Area Seeded with Milling Oats in Western Canada in 2019</b>			
<b>Milling Oat Cultivars</b>	<b>Alberta</b>	<b>Saskatchewan</b>	<b>Manitoba</b>	<b>Western Canada</b>
CS CAMDEN	2.25	17.81	15.44	35.50
AC MORGAN	11.71	9.05	0.60	21.36
SUMMIT	0.06	4.82	14.37	19.25
SOURIS	0.00	1.59	2.69	4.29
TRIACTOR	0.01	3.68	0.08	3.77
CDC RUFFIAN	0.41	2.42	0.03	2.86
DERBY	1.32	0.65	0.00	1.97
CDC DANCER	0.02	1.49	0.23	1.73
PINNACLE	0.00	0.53	0.93	1.46
ORE3542M	0.20	0.24	0.85	1.29
CDC MINSTREL	0.03	1.03	0.01	1.07
LEGGETT	0.00	0.69	0.34	1.03
CDC ORRIN	0.03	0.79	0.00	0.82
CDC MORRISON	0.01	0.51	0.17	0.69
ORE3541M	0.00	0.05	0.59	0.64
FURLONG	0.00	0.00	0.33	0.33
TRIPLE CROWN	0.00	0.00	0.25	0.25
RONALD	0.00	0.00	0.22	0.22
CDC BIG BROWN	0.03	0.00	0.17	0.20
STRIDE	0.01	0.08	0.07	0.16
CDC WEAVER	0.00	0.11	0.00	0.11
AC ASSINIBOIA	0.00	0.00	0.11	0.11
CDC ARBORG	0.03	0.05	0.02	0.10
CDC NORSEMAN	0.06	0.00	0.03	0.09
OTHER	0.15	0.06	0.09	0.30
Total Milling	16.34	46.04	37.62	100



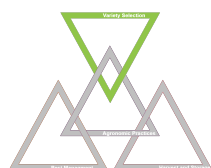
Regions differ in precipitation, disease pressure, growing degree days, and soil type, all of which affect the yield potential of oat varieties. To determine regional suitability, variety performance is assessed in replicated, multi-year regional field trials conducted across the prairies. Grain yield, test weight, % hull, % plump seed, maturity, height and resistance to lodging, stem and crown rust and smut are tested relative to a check variety, at time of writing, AC Dancer, or Summit were check varieties in different tests. Varieties can only be directly compared to the check grown in that trial, and indirectly relative to the check variety. This is because all varieties are not necessarily grown every year in every trial. After four to five years of trials, provincial regional variety testing provides relevant data on the performance of oat varieties suitable for a particular area. While results from regional variety testing are available in all provincial seed guides, regional comparisons differ between provinces. In [Manitoba](#), yield results are summarized by the location of the variety trials ([see example below](#)). Growers should choose a location with similar climate to their own ([Seed Manitoba Variety Selection Tool](#)). In [Saskatchewan](#), yields and quality parameters are averaged over areas 1&2, and 3&4 ([see example below](#)). Growers should choose the area they are located in for variety comparisons ([SaskSeed 2020](#)). In [Alberta](#), relative yield and quality comparisons are made on the basis of high yielding vs lower yielding environments ([Alberta Seed Guide Spring 2020](#)) ([see example below](#)). The location of high and low yielding sites can vary year by year.

## Agronomic traits and disease resistance

Yield is an important factor to consider when selecting a variety as indirectly it suggest the regional fit of the variety. Depending on the region, limiting factors such as days to maturity or lack resistance to crown rust or lodging should also be considered in the final selection of an oat varieties. For example, northern Alberta growers may be more concerned with days to maturity, while Manitoba growers may be more affected by crown rust.

Additional variety descriptions are often available from seed companies. Table 2.1 provides links to recently registered varieties **Is AC Morgan too good of a variety in Alberta?**

In Alberta, AC Morgan is seeded on over 80% of the oat acres (Table 2.1). It is high yielding with lodging resistance. It is not favored in areas with higher disease pressure because it has limited crown rust or stem rust resistance. **It is not a preferred milling variety as it fails to meet the minimum 4%  $\beta$ -glucan required for millers to be able to label their products with the Heart Healthy label.** AC Morgan has been hard to displace from its position as the number one variety in Alberta, despite the limited marketing options. The following research conducted in Alberta suggests some newer varieties have similar yields and increased marketability.



## Research report - Alberta variety trials

### **Increase the Oat Acres in Alberta by Finding a High Yielding Oat Variety that maximizes Producer Income and Meets the Demands of the Millers. 2018 and 2019. Research reports submitted to POGA.**

Alberta has been fortunate to have reliable, high yielding and lodging resistant varieties that has been widely grown. AC Morgan, released in 1999 has had superior agronomic traits, compared to other varieties. Unfortunately, **it has had low  $\beta$  glucan levels and has not been favored by millers.**  $\beta$ -glucan levels are strongly associated with variety, and not strongly influenced by location or agronomic practices.

“Oat production has been in decline in Alberta due to lack of markets and non-competitive pricing with other crops” (Note: oat acres in Alberta have trended upwards since 2017).

“Many major millers will not accept oat from Alberta or look to Alberta only after Manitoba and Saskatchewan’s supply is gone, because the main two oat varieties grown in Alberta, Morgan and Derby contain low amounts of Beta-Glucan ( $\beta$ -glucan). A minimum of 4%  $\beta$ -glucan is required for millers to be able to label their products with the Heart Healthy Claim and both Morgan and Derby are consistently below that amount”

Research conducted in Peace River and Westlock, Alberta showed that some recently released varieties have equaled or surpassed Morgan in yield, without sacrificing milling quality  $\beta$ -glucan levels. Seabiscuit performed very well at both locations in 2016 staying in the top 3 varieties for yield and averaged above 4.5% of  $\beta$ -glucan content. Ruffian was continuously the highest yielding variety in the Peace region in 2016 and 2017 and in Westlock in 2017 too. However, Ruffian has the lowest levels of  $\beta$ -glucan at both location in year 2016 as well as 2017. In 2018 OT3087 was added to the trials and had high yield and high  $\beta$ -glucan and high test weight. In 2019 in Peace River, CS Camden, AC Arborg and CDC Seabiscuit yielded higher than AC Morgan, while in Westlock, AC Summit yielded similar to AC Morgan and OT3087 had higher yields.

**Summary** Newer varieties have the potential to yield equal to or greater than AC Morgan, with  $\beta$ -glucan content suitable for milling.

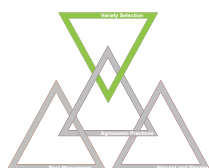
## Value of field demonstrations

Being able to see varieties growing in the field, especially under local conditions is an excellent way to confirm your decision to purchase a variety (Figure 2.1). Side by side comparisons of varieties, along with conversations with other growers, agents and extension personnel could be very useful to understand the merits of each variety. In addition, agronomists will be able to assist growers to understand the most important agronomic traits for oat in that region.

To find a trial or demonstration in your area:

- contact a seed company agent and arrange to attend a field day or demonstration,
- contact a local seed grower or
- attend local field days and producer meetings.

The Prairie Oat Growers Association works with local breeders who host field days and tours of research farms. [The POGA Oat Scoop](#) is an excellent resource for summer tour locations.

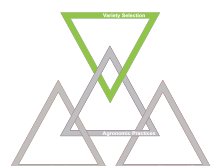




**Figure 2.1.** Field trials with varieties growing side by side in your area are a great way to assess new varieties under regional growing conditions (photo courtesy of L. Hall).

**Table 2.2.** Newly registered varieties, year of release and links to further information as of 2019.

Variety	Experimental Number	Year of Registration	Seed Company	Further Information
CS CAMDEN	SW090317	2014	Canterra Seed	<a href="#">Technical Bulletin</a>
AAC ORAVENA#	OT8003	2014	Fedoruk Seeds	<a href="#">Link to Fedoruk Seed</a>
CDC NORSEMAN	OT3066, SA091413	2015	SeCan	<a href="#">Technical Bulletin</a>
ORE3541M	OT6008	2017	SeCan	<a href="#">Technical Bulletin</a>
ORE3542M	OT6009	2017	SeCan	<a href="#">Technical Bulletin</a>
ORE6251M	OT6007	2017	NA	<a href="#">Link to Oat Advantage Info Sheet</a>
CDC ARBORG	OT3085, SA112243	2017	FP Genetics	<a href="#">Info Sheet</a>
AAC BANNER	OA1367-3	2017	SeCan	<a href="#">Technical Bulletin</a>
CDC Endure	OT3087, SA120157	2019	Alliance Seed	<a href="#">Link to Alliance Seeds</a>
CDC Skye	OT3091, SA131995	2019	NA	NA
# Organic production				



## Where to find a certified seed grower

Seed growers are listed in provincial seed guides.

[Alberta Seed Guide](#), [SaskSeed](#), [Seed Manitoba](#)

### Certified seed

After a new variety is developed by breeders, and the variety is registered with the Canadian Food Inspection Agency (CFIA), seed of that variety is multiplied, promoted and distributed by the seed company to commercial farmers. Seed is grown following the standards set by the Canadian Seed Growers Association (<http://seedgrowers.ca/>) and requirements in the Seeds Act, and approved by CFIA. Purchase of certified seed guarantees the purest genetics, meaning the seed is assured to be the named variety, with a known germination rate, and free of noxious weed seeds.

### Plant breeders rights (PBR)

As of February, 2015, all new PBR-designated varieties are protected under the new PBR legislation (UPOV91).

Authorization is required to produce, reproduce, sell, clean/condition, stock, import or export all seed of UPOV91 PBR-protected varieties. Proof of legitimately acquiring the seed of a protected variety is required for all subsequent utilization or processing of the variety. Everyone in the processing chain in Canada is now accountable under UPOV91.

In the provincial seed guides, varieties protected under UPOV78 have the following symbol:



while varieties protected under UPOV91 have the symbol.



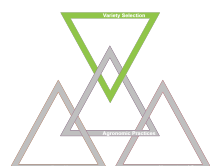
The use of symbols such as ▲ or ★ in the seed guides indicates that an application for PBR has been accepted and the variety has provisional protection.

For more information on Plant Breeders' Rights, please see: <https://pbrfacts.ca/>.

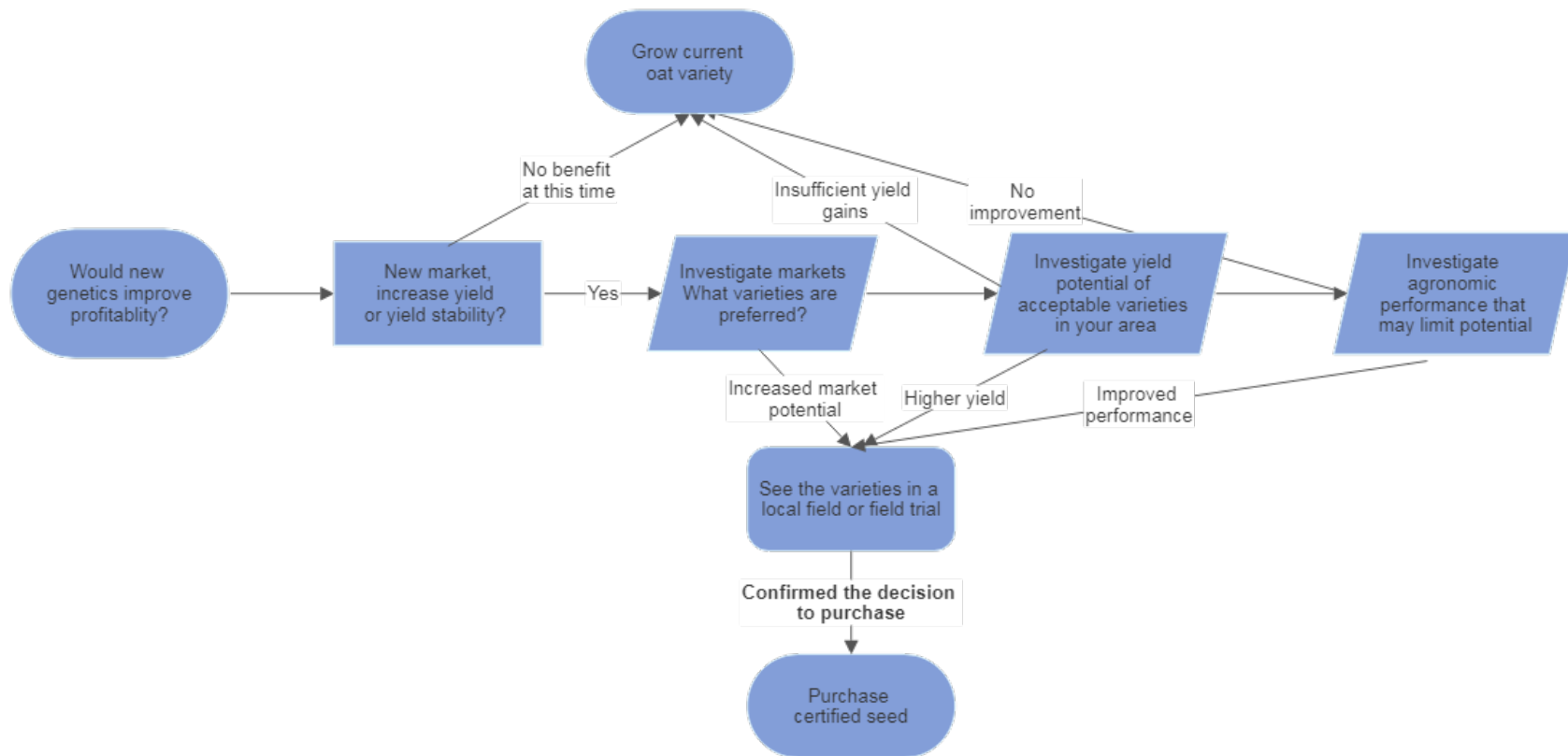
### The decision to grown a new oat variety

The decision to grow or trial a new oat variety is a major one and there are several factors that should be addressed (Figure 2.2):

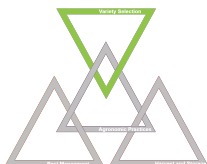
- Determine if a new variety increases yield stability, changes market potential or increases yield potential.
- Determine the target market. Often specific markets prefer specific varieties.
- Determine which variety will have the best yield and agronomic package. The level of disease and lodging resistance needed will depending on conditions in your particular region.
- Finally, it is a good idea to see the variety grown in the field in your region – either in a field demonstration or neighbouring farm.







**Figure 2.2.** The decision to purchase a new oat variety is significant. It should be based on a good understanding of the preferences of the market, the potential for yield, yield stability and the ability to avoid crop losses due to disease, late maturity or lodging. This decision tree suggests one method for determining if a variety change would be useful and the sequence to select a new variety.

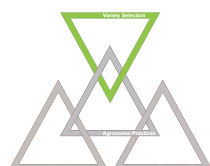


Comparison of Location Specific Variety Recommendations for Manitoba, Saskatchewan and Alberta.

**Figure 2.3.** Yield comparisons from [Seed Manitoba, 2019. The Seed Variety Tool Report allows the grower to compare variety yield, agronomic properties and disease resistance separately.](#)

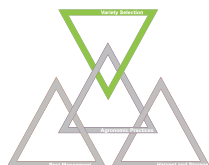
#### Yield Comparisons

Variety	2018 Yield (bu/acre)							
	Beausejour	Brandon	Dauphin	Hamiota	Melita	Roblin	St. Adolphe	Stonewall
CDC Arborg	186	180	185	138	144	143	146	89
CDC Dancer	153	166	162	117	134	132	119	83
ORe3541M	170	144	129	130	138	124	130	79
ORe3542M	159	140	160	136	132	138	119	77
Summit	181	182	165	145	129	125	132	82
<b>Varieties being tested for adaptability in Western Canada</b>								
Akina	178	182	194	144	127	128	155	85
Kara	172	157	200	136	132	130	120	81
<b>Varieties supported for registration &amp; being tested for adaptability in Western Canada</b>								
CFA1502	—	—	203	149	—	—	132	—
OT3087	—	—	198	131	—	—	148	—
<b>SITE GRAND MEAN (bu/acre)</b>	171	164	177	136	134	131	133	82
CV %	8.2	6.8	3.6	5.7	4.1	11.2	7.0	4.4
LSD (bu/acre)	—	20	11	13	—	—	16	6
Sign Diff	No	Yes	Yes	Yes	No	No	Yes	Yes
<b>Seeding Date</b>	08-May	09-May	04-May	05-May	02-May	15-May	03-May	21-May
<b>Harvest Date</b>	13-Aug	17-Aug	31-Aug	12-Aug	08-Aug	24-Aug	07-Aug	06-Sep



**Table 2.3.** An example of a disease resistance variety comparison table produced by the [Seed Variety Tool Report for Manitoba](#). Data is available for most but not all varieties, for example, see [CDC Arborg](#) below.

Variety	Site Years Tested	Predicted Yield (% of check) LSD Yield: 5.5 % )	Lodging resistance rating	Maturity in days	Test weight in lb/bu	Height in inches	Crown rust	Barley yellow dwarf virus	Stem rust	Smut
Summit		100	G	96	40	32	I	I	I	R
Akina	8	105.3	G	-4	0.1	1	R			R
CDC Arborg	7	106.3								
CDC Big Brown	18	95.8	G	-1	-1	2	R	MS	MS	R
CDC Dancer	7	93.2	G	-3	0	6	I	MS	I	R
CDC Endure	3	105.4								
CDC Minstrel	35	97.8	VG	0	-1	4	MS	MS	I	R
CDC Morrison	5	91.1	VG	-2	-2	0	MS	I	I	R
CFA1502	3	104.6								
Furlong	6	91.7	G	-1	0	9	S	MR	I	R
HiFi	4	97.8	G	-3	-1	7	I	MR	I	MS
Jordan	4	98.7	VG	2	-3	4	I	MR	I	R
Kara	8	104	G	-3	0.9	0	MR			MR
Leggett	38	96.3	G	0	-1	1	R	MS	I	R
ORe3541M	7	96.2								
ORe3542M	7	98.3								
Souris	26	95.3	G	-4	0	1	MS	MS	MR	R
Stride	14	95.6	VG	-2	0	6	R	I	MS	R
Triactor	26	108.5	VG	-1	-2	4	MR	MS	S	I



**Figure 2.4.** An example of the variety comparisons in the SaskSeed, 2020.

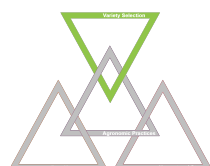
## Oat

### Main Characteristics of Varieties

Variety	Years Tested	Yield (% CDC Dancer)		Test Weight (g/0.5L)	% Hull	Hull Colour	% Plump	Relative Maturity <sup>1</sup>	Height (cm)	Resistance To <sup>2</sup>			
		Area 1 & 2	Area 3 & 4							Lodging	Stem Rust	Crown Rust	Smut
CDC Dancer 🌾	8	100	100	253	19.8	White	86	M	103	G	I	I	R
CDC Arborg 🌾	4	114	119	250	20.1	White	85	M	108	VG	S	I	R
CDC Boyer §	8	99	100	232	23.3	White	85	M	105	G	I	I	MS
CS Camden 🌾	7	113	114	242	24.3	White	82	L	94	VG	S	MS	I
Derby	8	98	102	247	22.9	White	79	M	107	G	S	S	MS
CDC Haymaker 🌾	5	92	95	225	24.9	White	87	VL	111	G	S	S	MR
AAC Justice 🌾 §	7	111	107	255	22.4	White	75	L	101	G	I	I	R
Leggett 🌾	7	103	104	256	22.0	White	82	L	96	G	I	R	R
CDC Minstrel 🌾	7	106	107	245	21.0	White	92	L	98	VG	I	MS	R
AC Morgan	8	104	108	236	25.1	White	82	L	101	VG	S	S	I
CDC Morrison 🌾	6	101	94	248	24.4	Yellow	83	L	95	VG	I	MS	R
CDC Nasser §	7	109	107	233	21.8	White	79	VL	106	G	MS	S	R
CDC Norseman 🌾	7	109	107	241	20.0	White	81	M	102	G	S	MR	MS
ORe3541M 🌾	5	104	98	257	21.5	White	90	L	93	VG	S	R	R
ORe3542M 🌾	5	106	99	247	22.5	White	95	L	93	VG	S	R	R
CDC Orrin 🌾	6	108	109	253	23.2	White	91	L	103	G	MS	S	R
Pinnacle 🌾	8	113	109	244	23.6	White	89	VL	101	F	I	S	R
CDC Ruffian 🌾	7	114	110	247	20.4	White	88	L	95	G	S	I	R
Souris 🌾	7	108	103	253	21.5	White	72	M	98	VG	MR	MS	R
Stride 🌾 §	7	110	107	255	22.9	White	80	L	103	G	I	R	R
Summit 🌾	7	104	105	256	21.6	White	81	M	94	G	I	I	R
Triactor 🌾	7	114	118	240	22.8	White	80	L	99	G	S	MR	I
<b>Varieties being tested for adaptability in Western Canada</b>													
Akina 🌾	4	114	111	242	22.5	White	---	M	95	G	---	R	R
Kara 🌾	4	116	112	247	23.2	White	---	M	88	G	---	MR	MR

<sup>1</sup> Maturity Rating M = 96 days.

<sup>2</sup> Resistance ratings: R = Resistant; MR = Moderately Resistant; I = Intermediate Resistance; MS = Moderately Susceptible; S = Susceptible.



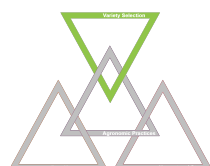
**Figure 2.5.** An example of variety comparisons for Alberta using yield categories, ([Varieties of Cereal and Oilseed Crops for Alberta](#)). The grower chooses the growing conditions (low, medium and high, based on expected yield) rather than the region.

2020 CEREAL & OILSEED CROPS FOR ALBERTA												
Variety	Overall Station Years of Testing	Overall Yield	Yield Category (% CDC Dancer):				Agronomic Characteristics:					
			Low < 70 (bu/ac)	Medium 70 - 100 (bu/ac)	High 100 - 130 (bu/ac)	V. High > 130 (bu/ac)	Maturity Rating (Days +/- CDC Dancer)	Test Weight (lb/bu)	TKW (g)	Height (cm)	Resistance to Lodging	Tolerance to Smuts
MILLING												
Varieties tested in the 2019 trials (Yield and agronomic data only directly comparable to CDC Dancer)												
CDC Dancer (bu/ac)		101	48	84	110	150						
CDC Dancer☺	173	100	100	100	100	100	98	41	37	106	G	R
CDC Arborg☹	35	118	XX	XX	126	114	2	41	41	109	VG	R
CDC Endure☹	24	117	XX	XX	124	113	2	41	41	106	VG	R
CDC Ruffian☺	62	110	110	110	115	106	4	41	40	97	G	R
CS Camden☹	51	111	XX	109	113	108	2	40	40	97	VG	I
ORe3541M☹	35	103	XX	XX	107	102	1	41	41	101	VG	R
ORe3542M☹	35	106	XX	XX	111	103	2	40	42	99	VG	R
Previously tested varieties												
CDC Dancer☺		100	100	100	100	100	98	41	37	106	G	R
AC Juniper†	80	104	102	104	106	105	0	41	38	104	VG	I
AC Morgan	86	113	114	110	117	114	3	40	41	104	VG	I
Akina☹	30	109	XX	103	114	111	3	40	39	99	VG	R
CDC Minstrel☺	61	104	103	103	105	105	4	39	38	102	VG	R
CDC Norseman☹	27	101	XX	100	101	XX	0	41	38	107	G	MS
CDC Orrin†☺	52	109	113	107	107	XX	3	41	40	106	G	R
CDC Seabiscuit†☺	30	111	124	106	108	108	3	39	41	103	G	MR
Derby†	79	101	103	102	96-	105	4	41	39	109	G	MS
Kara☹	33	111	XX	102	116	110	3	41	41	95	VG	MR
Triactor†☺	47	110	109	108	114	110	3	38	38	102	G	R
FEED												
Varieties tested in the 2019 trials (Yield and agronomic data only directly comparable to CDC Dancer)												
AC Mustang	60	114	120	115	114	110	3	42	38	116	G	I
Previously tested varieties												
CDC Nasser	31	116	132	107	115	110	4	39	36	107	G	MR
FORAGE												
Previously tested varieties												
CDC Dancer☺		100	100	100	100	100	98	41	37	106	G	R
CDC Baler	42	99	96	106	96	XX	4	40	43	109	XX	S
CDC Haymaker	28	104	XX	103	105	XX	4	39	40	110	F	MR

The Alberta Seed Guide states “Yield rankings among varieties can change substantially due to growing conditions. To reflect these differences, results from a test site that produced high yield in a particular year are placed into the database for ‘high’ yielding environments. The same site may contribute to the ‘low’ yield category in a different year, when yields are low. Consistent performance over all Yield Test Categories indicates that a variety has environmental responses similar to the check and may have good yield stability over a wide range of environments. Scientific studies conducted on variety performance in Western Canada have shown that Yield Test Category analysis provides a more reliable indication of yield performance than results organized by geographic region.

The yield comparison tables have several features:

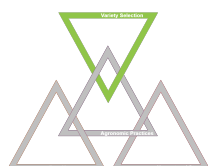
- Overall actual yield of the check variety or varieties (bushels/acre) based on all data available to the testing program is provided along with the number of station years of testing.

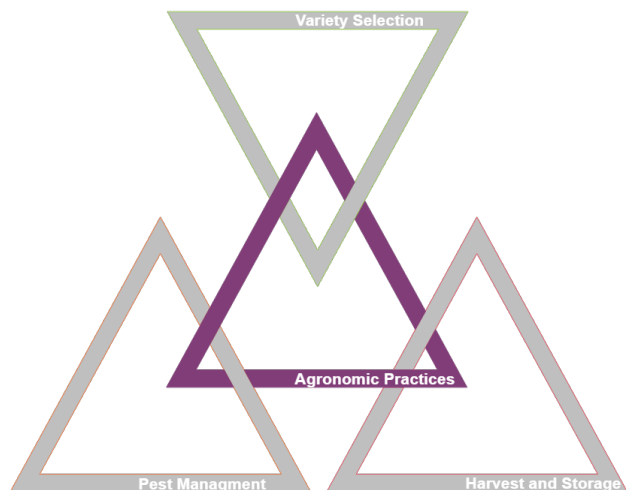




- The range in yield for each Yield Test Category is defined.
- Actual yield of the check variety or varieties in each Yield Test Category is reported.
- For varieties with sufficient data, the Overall Yield and Performance in each Yield Test Category is expressed relative to the check.

To make effective use of the yield comparison tables, producers should set a realistic yield target for the season and determine where it fits within the Low, Medium, High or Very High Yield Test Categories. This approach facilitates matching of variety choice to expected productivity levels and is similar to that used when making decisions on other levels of inputs. Please note that the actual yield levels are based on small plot trials, which may be 15 to 20 per cent higher than yields expected under commercial production.” Alberta Seed Guide Spring 2019.





## Agronomic practices for enhancing yield and quality of oat

Traditional rules of thumb for oat agronomy are changing in light of higher yielding, disease-resistant varieties with improved lodging resistance that require higher nutrient levels to reach their full potential. Routinely, there are reports of oat yielding 150 toward 200 bushels per acre under the best growing situations. The standard 34 lb/bu oat is a target long left behind as grain quality continues to rise. Nutritional properties of oat have improved as well. Plant breeding, selecting from available variation, has resulted in the stacking of desirable health traits in the grain. Research is currently underway to determine the effectiveness of tailoring a specific agronomic package (nutrients, fungicides, plant growth regulators (PGR)) for each variety. Also note, that as of 2020 some PGRs (Manipulator 620) are now registered for oats but growers should check with their buyers before applying any product to ensure that product is permitted. The era of variety-specific agronomy for oat production is upon us. Yan et al (2017) and others have reported varieties respond differently to nitrogen rate.

Along with the oat breeding improvements, oat agronomy has become a key partner in the success of oat and continues to build momentum for outstanding results. Overall, studies on agronomic practices in oat and

productivity are limited compared to major cereal crops such as wheat and barley. Herein we present the results from key studies, but results should be considered in light of their location(s) and the limited repetition of agronomic studies for oat.

### Field selection

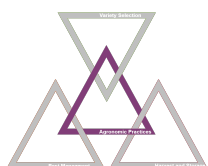
Oat yield the best in the black and grey wooded soil zones due to the higher moisture content of the soil. Select fields with good drainage, sandy loam to heavy clay soil textures. Oat is well adapted to no-till fields where retention of non-cereal stubble and snow and improved soil water infiltration provide increased soil moisture.

### Crop rotation

There is considerable evidence that diversification of crops leads to higher yields, reduces disease pressure and improves nutrient utilization. Repeated

Avoid fields with

- Cereal stubble
- Heavy wild oat populations
- Herbicide residues that may affect oat



planting of oat in the same field will lead to a build-up of diseases and weeds, both are difficult to control in oat.

Avoid fields with a history of heavy wild oat pressure. Wild oat is a significant source of [downgrading](#). Avoid fields with a history of residual herbicides that may affect the growth of oat. Some herbicide affect oat crops two years after application (Table 3.1). Additionally, many wild oat herbicides affect oat in the year of application and should be considered if oat is replanted after a crop seeding failure.

**Table 3.1.** Herbicides with residual effects on oat two years after application ([2019 Saskatchewan Guide to Crop Protection](#)). Avoid fields where these products have been applied.

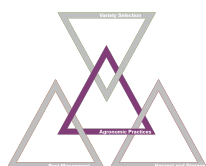
- Avadex
- Command
- Edge
- Fortress MicroActive
- Imazamethabenz\*
- Metribuzin
- Metsulfuron \*, \*\*
- Pulsar
- Trifluralin

\*Brown and Dark Brown soils

\*\* Soil pH 7 to 7.9

Avoid fields planted in cereal crops the previous year to reduce disease pressure, reduce volunteer cereals that cannot be controlled in oat crops and optimize yields. Back to back rotation with other cereal grains increases the risk of plant disease and weed pressure. As well, an oat sample may be [downgraded](#) because volunteer cereal grain that cannot be controlled in oat crops. More desirable rotational crops include: canola, hayfields, peas, lentils, soybeans, and/or other legumes. Pulses give the oat crop a strong yield potential by providing nutrients and reducing disease risk. Because of the wild oat control achieved in canola crops, they may be preferable to pulses as a rotational crop, if wild oat are present. Corn falls between the desirable rotational crops listed above and cereal grains. Corn can increase the risk of some plant diseases and crop residues tie up nitrogen early in the season.

Cereal crops benefit from being in rotation with other cereals, compared to back-to-back rotations (Table 3.2).



**Table 3.2** Relative yield of major crops sown on selected stubble types in rotation in Manitoba 1994-1998 (from Manitoba Crop Insurance Corporation) (\* insufficient data)

	Stubble Type					
	Wheat	Barley	Oat	Canola	Flax	Peas
	Relative % yield (crop on own stubble=100%)					
Wheat	100	109	110	118	114	120
Barley	115	100	110	119	122	122
Oat	114	103	100	124	123	115
<i>Brassica napus</i> canola	114	115	117	100	118	128
Flax	148	148	146	133	100	*

Planting crops in a yearly rotation, such as oat/soybeans/wheat/corn, helps to prevent the buildup of many destructive organisms. Keeping disease organisms and insects at low levels reduce the risk of unexpected yield loss and the need for pesticide applications.

## Seeding

Seeding is the most critical operation of the year (Figure 3.1) and the decisions made at seeding can affect yield, grain quality, time of harvest and harvest management.

Seeding factors are frequently linked. For example, the time of seeding and seed density both affect crop maturity and influence harvest management.

### Seed treatments

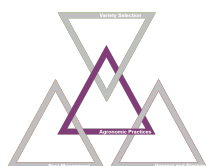
Seed treatments may be used to prevent seed and soil borne diseases, especially smut. The practice of applying a seed treatment is a farm decision and should be based on the level of risk associated with seed or soil borne diseases.



**Figure 3.1.** Seeding depth and seed treatments affects seedling health.

Soil borne diseases such as root-rots are likely to pose greater risks under cool, wet growing conditions in the spring. Hullless oat are more susceptible to seed diseases than hulled oat and seed treatments are recommended.

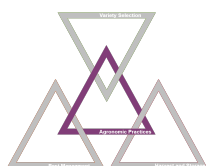
There are several of seed treatments available for disease and wireworm control. There are many seed treatments registered for oat in 2019 (Table 3.3) ([Sask Guide to Crop Protection](#)).



PRODUCTS	OATS							
	DISEASES							INSECTS
	<i>Alternaria alternata</i> (seed-borne)	<i>Aspergillus</i> spp., <i>Penicillium</i> spp.	<i>Cochliobolus sativus</i> (seed rot, damping-off)	Common root rot ( <i>Cochliobolus sativus</i> )	<i>Fusarium</i> spp.	<i>Pythium</i> spp.	<i>Rhizoctonia</i> spp.	Smuts ( <i>Ustilago hordei</i> , <i>U. avenae</i> , <i>U. kolleri</i> )
<i>Allegiance FL</i>						•		
<i>Alias 240 SC</i>								•
<i>Belmont 2.7 FS</i>						•		
<i>Cover 2</i>		•	•	• <sup>1</sup>	•	•	•	
<i>Cruiser 5FS</i>								
<i>Cruiser Vibrance Quattro</i>		•		• <sup>1</sup>	•	•	•	•
<i>Insure Cereal</i>			•	• <sup>1</sup>	•	•		•
<i>Insure Cereal FX4</i>			•	• <sup>1</sup>	•	•		•
<i>INTEGO Solo Fungicide</i>						•		
<i>Metlock CT</i>				• <sup>1</sup>	•	•	•	
<i>Niplt INSIDE 600 Insecticide</i>								
<i>Niplt SUITE Cereals OF Seed Protectant</i>								
<i>Rancona Pinnacle</i>		•	•	• <sup>1</sup>	•	•		•
<i>Rancona Trio</i>		•	•	• <sup>1</sup>	•	•	•	•
<i>Raxil MD</i>			• <sup>1</sup>	• <sup>1</sup>	•	•		•
<i>Raxil PRO</i>		• <sup>3</sup>	•	• <sup>1</sup>	•	•	• <sup>1</sup>	•
<i>Raxil PRO Shield</i>		• <sup>3</sup>	•	• <sup>1</sup>	•	•	• <sup>1</sup>	•
<i>Sombrero 600 FS</i>								•
<i>Stress Shield 600</i>								•
<i>Vibrance Quattro</i>	•	•	• <sup>1</sup>	• <sup>1</sup>	•	•	•	•
<i>VitaFlo Brands</i>		• <sup>4</sup>		• <sup>1</sup>	•	•		•

1. suppression only
2. winter wheat only
3. control of seed-borne *Aspergillus* spp. and suppression of seed-borne *Penicillium* spp.
4. and *Alternaria* spp.

**Table 3.3** Seed treatments registered for oat (2019) and the diseases/insects controlled ([Saskatchewan Guide to Crop Protection](#)). Always refer to the most current crop protection guides. Products may be deregistered or new products released or oats can be included on products previously registered on other crops. Read the label(s) to ensure you are using pesticides safely.



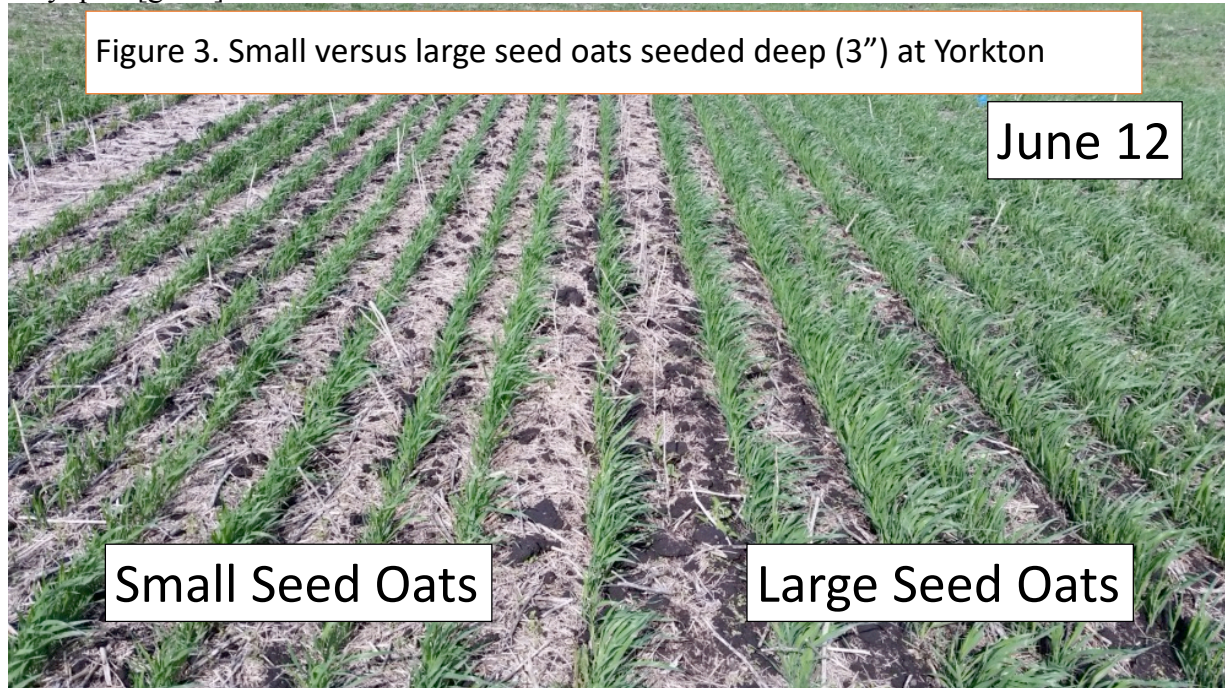


### Seed size

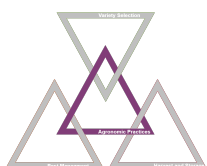
The relative importance of seed size of a seeded oat crop has been a topic of conversation for many years. Greenhouse studies indicate that larger seed is more vigorous and more competitive with wild oat (Willenborg et al. 2005).

“Our results clearly demonstrate the importance of initial caryopsis [grain] size to the outcome of wild oat-oat competition, and suggest that the ability of oat to exhibit both an increased competitive response and effect to wild oat competition may be a product of specific crop traits such as caryopsis [grain] size.”

As the experiments on seed size were conducted in a greenhouse, the authors comment that: “further investigation is needed to examine the response of oat-wild oat competition to oat caryopsis [grain] size and genotype under field conditions. “ In research conducted at Yorkton and Indian Head, SK, seed size increased early oat vigor, as expressed in biomass, but did not result in significant differences in yield (Figure 3.2 Hall and Holzapfel. 2018.).



**Figure 3.2.** Seed size comparison trial (Hall and Holzapfel. 2018. Oat Vigour Improves with Larger Seed Size. Report submitted to Saskatchewan Oat Development Commission.)



### Time of seeding

Early seeding can result in increased yield and test weight (see research paper below). Early harvest may also result in higher quality in regions that are prone to frequent fall moisture.

The time of seeding relative to weed emergence is arguably the most important factor affecting weed competition. In fields where wild oat populations are low (see crop rotation above), early seeding can effectively reduce wild oat competition. Delaying seeding (often practiced by organic growers), is an alternative strategy

for weed control. A delay in seeding can allow for pre-seeding control of weeds by tillage or herbicides. However, for wild oat, the strategy is not as effective as with early emerging weeds like kochia. Wild oat emerges relatively late and continues to emerge over 4 to 6 weeks. A better strategy is to select another field with lower wild oat pressure.

Seed early to increase yield and avoid late harvest.

**RESEARCH PAPER (2004):** Canadian Journal of Plant Science (2004) 84: 431-442

“Early seeding dates improve oat yield and quality in the eastern prairies”

### AUTHORS:

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1 Agriculture and Agri-Food Canada, Indian Head Research Farm

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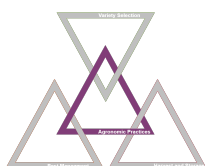
3 Potash & Phosphate Institute of Canada

4 Private Consultant

### INTRODUCTION:

“Traditionally, oat (*Avena sativa* L.) was the last crop seeded on farms in western Canada. Oat could be planted last and still be harvested or used as fodder depending on needs. The late seeding allowed farmers the opportunity to control wild oat (*Avena fatua* L.) in tame oat with tillage prior to planting. The harvested oat tended to be consumed locally with little attention paid to quality.”

“There have been many changes in cropping practices on the prairies since the early studies in western Canada, the most significant being the introduction of one-pass seeding and fertilizing conservation tillage systems. These new production systems increase the amount of winter precipitation that is captured by the soil, resulting in higher yield and economic return. This increase in available water may increase the yield and quality of oat since oat requires more water than the other cereals.”



## SUMMARY:

In this study, conducted during 1998 to 2000, 3 locations were used: Brandon, Indian Head, and Melfort. AC Medallion, AC Juniper, CDC Boyer, and CDC Pacer were the varieties tested. Four seeding dates were chosen: early May, mid-May, early June and mid-June, and the target dates of these were May 01, May 15, June 01 and June 15.

## RESULTS AND DISCUSSION:

- Delayed seeding decreased the yield of all four varieties.
- Disease resistance matters as it maintains plant health and the ability to continue using moisture for growth, while susceptible varieties suffer a decline during mid-summer dampness.
- “Two [related (1968 & 1990)] studies found that higher temperatures during development reduced seed yield.”
- “Delayed seeding increased thin seed percentage at most locations;”
- “Results from this study clearly show that oat producers can grow more high-quality oat if seeding is conducted in the first 2 weeks of May.”

### Seeding depth

Seed should be planted deep enough to reach soil moisture and never deeper than 8 cm (3"). In direct seeding and where seedbed moisture is optimum, seed depth should be targeted at 2-3 cm (0.75" – 1.25"). Emergence generally decreases with increased seeding depth and deeper seeding has been associated with increases of some seedling diseases in other cereal crops.

### Row spacing

Oat is usually seeded with a row spacing of 18-30 cm (7.5-12 inches). Research over a number of years has demonstrated that there is very little differences in yields within these row spacings. However, wider row spacings may result in an increased problem with wild oat and other weed species in oat. As there is no chemical control for many grassy weed species, care must be taken when using wider row spacing. In addition, wider row spacing may result in difficulty managing swaths in dry conditions as there may not be enough stubble to hold the swath off the ground.

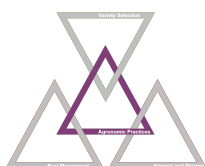
### Seeding rate


While a plant population of 20-30 plants/ft<sup>2</sup> (215 to 320 plant/m<sup>2</sup>) is usually recommended, research has consistently shown the benefits of increased seeding rates. Next to early seeding, seeding rate is one of the most powerful strategies available for reducing weeds.

#### Reasons to increase seeding rate:

- High fertility
- Optimum moisture
- Deep seeding
- Late seeding (to reduce tillers)
- Wild oat present

Li et al. (2018) (Figure 3.3) reported that a seeding rate of approximately 44 plants/ft<sup>2</sup> (473 plants/m<sup>2</sup>) decreased weed biomass by more than 50% and increased oat yield. In addition, a high seeding rate reduces the tillers/plant and decreases the time to maturity (Hall and Holzapfel. 2018. Oat Vigour Improves with Larger Seed Size.



**ARTICLE**

## Exploring agronomic strategies to improve oat productivity and control weeds: leaf type, row spacing, and planting density

Pufang Li, Fei Mo, Defeng Li, Bao-Luo Ma, Weikai Yan, and Youcai Xiong

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**Abstract:** The trade-off between crop production and weed control is a fundamental scientific issue, as it is frequently influenced by individual crop competitive ability, population density, and planting pattern. A 2 yr field study was conducted to examine the relationship between planting density and row spacing, using two contrasting oat varieties. On average, high planting density (480 plants m<sup>-2</sup>) reduced weed biomass at oat maturity by 59% in 2012 and by 56% in 2013, when compared with a low density (120 plants m<sup>-2</sup>). The droopy-leaf variety suppressed weed biomass by up to 69% and weed density up to 72%, compared with the erect-leaf variety. In a drier year, the greatest grain yield was achieved with the droopy-leaf variety under the intermediate density, while in 2013, the erect-leaf variety under the high density had similar yield to the droopy-leaf variety at the intermediate density. A general trend was that increasing plant density suppressed weed infestation, and promoted crop biomass and yield. The droopy-leaf variety exhibited a strong competitive ability under the intermediate planting density, while the erect-leaf variety had a strong competitive ability under the high density. Taken together, there was a complex variety-by-environment interaction to achieve the balance between crop production and weed suppression, which was mediated by growing-season conditions.

*Key words:* competitive ability, ideotype, oat, plant density, row spacing, weed suppression.

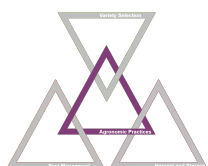
**Figure 3.3.** Except from Li et al. (2018), planting density reduces weed biomass.

### *Seeding rate calculator*

Optimal seeding rates vary among varieties and are based on kernel weight. Both germination and seedling survival needs to be considered. A field mortality rate of 20 to 30% should be expected ([May et al. 2004](#)). Seeding rates can be calculator using a

phone app, for example [Seed Calculator from Beyond Agronomy](#), or online.

A [seeding rate calculator](#) from Alberta Agriculture and Forestry is available to assist oat growers to obtain the desired plant density (Figure 3.4). Enter the plant density required, the 1000 kernel weight of the variety, the germination rate, and row spacing. It is also important to note that the emergence rate of oat is not the same as the germination rate (see below).





## Oats, Milling Seeding Rate Calculator Results

Crop : Oats, Milling Variety : [Triactor](#) 1000 Kernel Weight : 39 grams

Seed **156.0 lb/ac** of Oats, Milling to obtain 30 live plants per square foot. Your seeder must be [calibrated](#) so that each opener drops **108.3 grams** of seed per **100 feet** of travel or **27.8 seeds** per foot of row, based on a **8 inch** row spacing.

(This seeding rate is based on your assigned values of 30 plants/ft<sup>2</sup>, 90% germination, 20% seedling mortality, and 8 inches rowspacing.)

To seed **160 acres** you require **24,960 lbs / 11,322 kg** of seed.

Desired plant density (plants/ft <sup>2</sup> )	<input type="text" value="30"/>	Enter plant density in the 15 to 50 range.
Germination rate (%)	<input type="text" value="90"/>	Enter germination rate in the 65 to 100 range.
Emergence mortality (%)	<input type="text" value="20"/>	Enter emergence mortality rate in the 0 to 50 range.
Row Spacing (inches)	<input type="text" value="8"/>	Enter row spacing in the 3 to 14 inches range.
1000 kernel weight	<input type="text" value="39"/>	Normally ranges between 25 and 55 grams.
Acres to be planted, if known	<input type="text" value="160"/>	
Price ( lb), if known	<input type="text" value="0.00"/>	

**Figure 3.4.** An example of a seed rate calculator and the parameters required. ([Alberta Agriculture and Forestry 2019](#))

**RESEARCH PAPER (2004):** Canadian Journal of Plant Science (2004) 84: 431-442

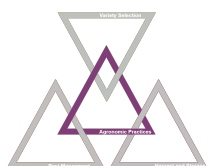
### **“Early seeding dates improve oat yield and quality in the eastern prairies”**

W. E. May, R. M. Mohr, G. P. Lafond, A. M. Johnston, and, F. C. Stevenson

#### **EXTRA NOTES:**

A field mortality rate of 5% was used to adjust the target plant population to 300 plants per square metre (~28 plants per square foot) of viable seeds (including adjustment for germination). *Interpretation: While the researchers used a mortality rate of 5%, this was insufficient to provide adequate plant populations.*

**“However, field mortality for the experiment ranged from 18 to 33% .... Our results indicate that oat seeding rate recommendations should factor a field mortality rate of 20 to 30% in order to achieve a target plant population.”**



## Fertility

### Soil testing

Soil sampling and soil testing is essential to measure soil nutrient levels and other chemical and physical soil properties that will influence crop growth. Soil testing should be used to determine fertilizer applications on specific fields. Where soil tests are not available, general recommendations may be followed. However, field history, cultural practices and inherent fertility of the field must be considered when using general recommendations.



### Soil water

Water is a critical nutrient for crop growth. The soil available water at planting is critical for seed germination, stand establishment and early plant growth but precipitation during a growing season plays a greater role in determining oat yield than soil available water at seeding. Available soil moisture also interacts with nitrogen levels to affect lodging in oat. Under irrigation, growing season water demands are slightly lower for oat than for spring wheat (17 inch or 430 mm for oat compared to 18 inches and 460 mm for spring wheat) ([Irrigated Crop Recommendations, Agri-Facts, Alberta Agriculture](#)).

As stated above, oat is well suited for no-till or reduced tillage where water retention is

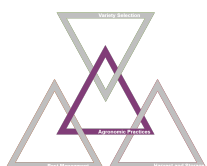
maximized by snow trapping and enhanced water infiltration into the soil profile.

### Nitrogen

In most fields in western Canada, nitrogen (N) is the most yield limiting nutrient. The amount of N fertilizer required to achieve optimum yield depends on:

- soil nitrate-N ( $\text{NO}_3\text{-N}$ ) levels
- N mineralization potential of the soil during the growing season
- soil moisture at the time of seeding
- expected precipitation during the growing season
- oat variety.

These conditions can vary greatly from year to year and with the previous rotational crop. Requirements for N fertilizer increase when the soil test nitrate level is low or when soil moisture or in-season precipitation is high. Soil test for nitrate-N to a depth of 24 inches (60 cm) and measuring the amount of stored soil moisture are required when determining optimum fertilizer nitrogen rates. The more moisture that is received, the higher the yield potential and a higher requirement for nitrogen is needed to achieve that yield. Generally, a 100 bushel/acre (3584 kg/ha) oat crop will require total nitrogen (soil N plus N fertilizer) of 97-117 lbs/acre (110-131 kg/ha). Soil test recommendations will provide nutrient recommendations specific to target yields, location and moisture levels. Nitrogen rates above optimum levels may cause increases crop lodging and decrease yield (May et al. 2017). Increasing nitrogen rates also resulted in statistically significant declines in test weight, kernel weight and the percentage of plump kernels, all detrimental crop quality measurements. In studies conducted in eastern Canada, Yan et al. (2017) reported that yields increased with nitrogen rates up to 134 lb/acre (150 kg/ha) and that varieties responded differently to nitrogen. Location (environment) also influenced the results. However in Yan et al.





(2017), test weight, kernel weight and the percentage of plump kernels was not measured, but they noted that  $\beta$ -glucan content was not affected by nitrogen levels. Research conducted by Ma et al. (2017), and May et al. (2017) both concluded that



optimum oat yields, without reductions in kernel weight and plumpness, were achieved when the soil + fertilizer N level were approximately 89 lbs/acre (100 kg/ha) (Figure 3.5).



**Figure 3.5** On the left are oat with a total of 71.4 lb/ac (80 kg/ha) soil + fertilizer nitrogen, while on the right are oat grown with 110 kg/ha soil + fertilizer nitrogen (photo courtesy of Dr. Chris Willenborg).

Ma et al. (2017) reported that variety choice was critical to both yield potential and susceptibility to lodging. High yielding varieties with lodging resistance are most likely to respond favorably to increased nitrogen rates.

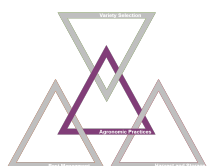
Nitrogen for organic production can be added to the soil by producing crops that are able to “fix” their own nitrogen (legume crops such as alfalfa, clovers or pulses) and working the crop residue into the soil (plow-down). Livestock manure is also a good source of nitrogen.

### Phosphate ( $P_2O_5$ )

About 80% of prairie soils are considered phosphorus (P) deficient. Soil P availability to plants can be assessed by soil sampling and testing to determine plant available soil P. However, response to phosphate in oat (increase in yield) is inconsistent and often does not correspond to soil test levels.

Crop response to applied P fertilizer depends on the level of plant available P already in the soil, as well as soil moisture and temperature conditions early in the growing season.

Previously, an application of phosphate at 18-28 lbs/acre (20-30 kg/ha) with half this



amount applied with the seed, was considered adequate to produce optimum yields.

Chris Holzapfel, from AAFC, Indian Head, was quoted as saying “research has shown that oat response to phosphorus fertilizer application can be inconsistent, but maintaining P levels is important from a long-term soil quality perspective. The crop in his demonstration presumably removed over 44 lbs P<sub>2</sub>O<sub>5</sub> per acre (49 kg/ha) in the highest yielding treatments.

“When you are removing that level of phosphorus from the soil ([Table 3.4](#)), you need to be replacing it or you will be drawing down the soil residual phosphorus reserves. You are fertilizing the soil as much as you are trying to feed the crop.”

Situations where oat yields may respond to phosphate fertilizers include:

- Fields that have not received phosphate fertilizers in past 5 years
- Fields newly broken or broken from legume forage production
- Crops grown on fallow
- Cold, wet soils
- Sandy or gravelly soils

Phosphate for organic production can be added to the soil by applying rock phosphate. Rock phosphate has a very low solubility so it is not readily available. Therefore, it should be used as a part of a long-term program. Another strategy is to include using buckwheat as a plough-down crop. Buckwheat has been shown to have the ability to accumulate phosphate and make it available following a plough-down.

Livestock manure is also a very good source of phosphate.

### **Potassium (K<sub>2</sub>O)**

Potassium helps in the building of protein, photosynthesis, grain quality and reduction of diseases. It also may increase straw strength. The response of oat to potassium

usually occurs when soil test levels are below 280 lbs/acre (250 kg/ha). Potassium deficient soils tend to be light textured (sand to sandy-loam), alkaline, carbonated and imperfectly to poorly drained in their natural state. Organic soils are also frequently deficient in potassium.

An application of 15 lbs/acre (17 kg/ha) of potassium chloride (0-0-60), seed row applied may result in a positive crop response in cold, wet soils even when soil test levels are sufficient. Applications made at levels higher than 18 lbs/acre (20 kg/ha) should be side-banded or broadcasted to avoid damage to seedling plants.

Potassium for organic production can be added from a number of sources including wood ash, greensand (glauconite), and potassium sulphate, which will also add sulphur to the soil. Livestock manure is also a very good source of potassium.

### **Sulphur (S)**

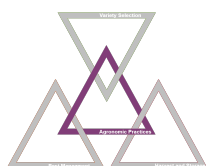
Sulphur is essential for production of protein and oil. It promotes activity and development of enzymes and vitamins as well as helping in chlorophyll formation. The oat crop requires sulphur in a fairly high level in comparison to other crops. It is required at lower levels than canola but about the same per acre levels as wheat.

Deficiencies of sulfur appear similar to nitrogen deficiencies as pale, stunted plants. Often sulphur deficiencies appear as isolated spots in a field due to extreme variability across a field. This may also result in misleading results from soil tests if a high-sulphate area is inadvertently sampled.

An application of 9–15 lbs/acre (10–18) kg/ha of a sulphate fertilizer will be sufficient in most soils, especially if it is part of a well-balanced sulphur program.

Applications of elemental sulphur may not provide adequate levels of sulphur, especially if applied in the seed-row.

Sulphur for organic production can be added from a number of sources including some



sources of potassium sulphate. This will also add potassium to the soil. Other sources include gypsum (calcium sulphate) and some sources of elemental sulphur. Livestock manure may be a good source of sulphur.

### **Micronutrients**

There are a number of nutrients classified as micro-nutrients that are essential to plant growth. When deficient, these may cause a reduction in crop productivity. Normally, micronutrients are not deficient in western Canadian soils.

Of all the micronutrients, oat is most susceptible to a deficiency of manganese. Manganese deficiencies mainly occur in organic soils, high-pH soils or sandy soils low in organic matter. A manganese deficiency in oat results in a disorder known as Grey Speck (Figure 3.6). Oat show manganese deficiency as a general yellowing and stunting, occasionally with grey specks on the leaves. A foliar application of manganese will cure a manganese deficiency where it occurs.



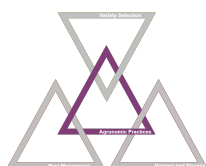
**Figure 3.6** Grey speck symptoms on oat.  
From [Producing milling oat in western Washington: Guide to grain quality optimization and marketing](#). Winkler and Murray (2017).

## **Agronomic interactions**

Cultivar choice and agronomic decisions are closely linked. Varieties respond differently to nitrogen levels (Yan et al 2017) but increasing nitrogen can be detrimental to test weight and may increase lodging which can increase harvest difficulties and is detrimental to crop yield and quality. The environment, especially available moisture influences all outcomes.

In areas with adequate moisture, a lodging resistant variety should be chosen, but in some cases, favored varieties may not have sufficient  $\beta$ -glucan to meet quality standards ([see comments on AC Morgan above](#)). High yielding varieties that are disease and lodging resistant will only perform well when sufficient nutrients, including water, are available.

The interactions of agronomic, variety choices and environment can be confusing but scientific research addresses the probability of success by conducting multiple trials, in multiple years and location. Some practices are usually the best. Variety choice is key, Early seeding and increased seeding rates make oat more competitive and reduce tiller numbers. These practices can reduce wild oat competition while avoiding harvest management difficulties.



**RESEARCH PAPER (2004):** Canadian Journal of Plant Science (2004) 84: 1025-1036

“Effect of nitrogen, seeding date and cultivar on oat quality and yield in the eastern Canadian prairies”

**AUTHORS:**

William E. May, Ramona M. Mohr, Guy P. Lafond, Adrian M. Johnston, and F. Craig Stevenson.

**INTRODUCTION:**

As the portion of the oat crop increases for the human consumption segment, yield and quality, especially test weight, are important production parameters for a profitable oat crop. “The grower has to strike a balance between test weight and yield when optimizing N rate because the value of the oat is a function of both grain yield and quality.”

**SUMMARY:**

In this study, conducted from 1998 to 2000, 4 locations were used; one in Manitoba and three in Saskatchewan. The locations were: Brandon, Indian Head; Canora; and Melfort. Three seeding dates were used, early May, mid May and early June, along with the two cultivars AC Assiniboia and CDC Pacer. The four nitrogen rates used were 15, 40, 80 and 120 kg N/ha.

**RESULTS AND DISCUSSION:**

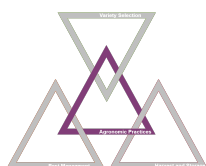
Panicles per plant was the yield component that accounted for most of the yield increase achieved from increasing rates of nitrogen. Kernel weight was the yield component that decreased with increasing N. Physical seed quality tended to be highest with early seeding and low N rates.

Across site-years, the overall grain yields increased with increasing N supply, but the increase levelled off at the rate of 100 kg N ha<sup>-1</sup>. The optimum N rate was found to involve a trade-off between yield and quality.

**Nutrients removed by oat crops**

The total amount of plant nutrients removed from the soil by a crop depends on the yield. The greater the yield, the more nutrients are utilized. Removal of nutrients has implications for the subsequent crops. Based on equal seed yields per unit area, whole barley, wheat and oat plants extract about the same combined quantities of nitrogen

(N), phosphorus (P<sub>2</sub>O<sub>5</sub>), potassium (K<sub>2</sub>O), and sulphur (S) from the soil, but considerably less than canola. When only the seed is removed, and all straw is left on the field, oat removes the least amount of nutrients from the soil (except for sulphur) compared to barley, wheat or canola (Table 3.4).





**Table 3.4.** Nutrients used by crops\*in lb/acre.

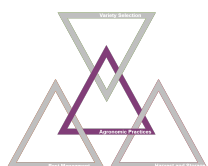
<b>Crop</b>	<b>Crop Component</b>	<b>N</b>	<b>P<sub>2</sub>O<sub>5</sub></b>	<b>K<sub>2</sub>O</b>	<b>S</b>
<b>Wheat</b> (48 bu/ac)	Seed	70.5	28.5	18.7	4.5
	Straw	28.5	6.2	57.1	7.1
	Total	99.0	34.8	75.8	11.6
<b>Barley</b> (60 bu/ac)	Seed	58.0	21.4	19.6	4.5
	Straw	30.3	8.0	65.1	7.1
	Total	88.3	29.4	84.8	11.6
<b>Oat</b> (84 bu/ac)	Seed	51.7	21.4	15.2	7.1
	Straw	35.7	13.4	62.5	8.9
	Total	87.4	34.8	77.6	16.1
<b>Canola</b> (57 bu/ac)	Seed	107.1	50.9	25.9	18.7
	Straw	62.5	23.2	108.0	15.2
	Total	169.5	74.1	133.8	33.9

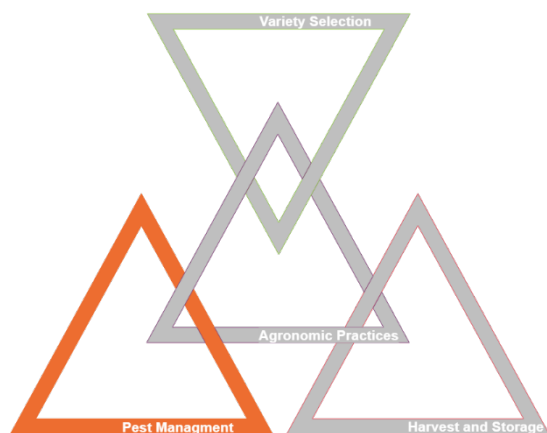
(To convert to kg/ha by multiplying by 1.12. Canola yield is extremely high, but in order to make the comparison, it was left at the same weight as the other grains).

\*Source: Western Canada Fertilizer Association.

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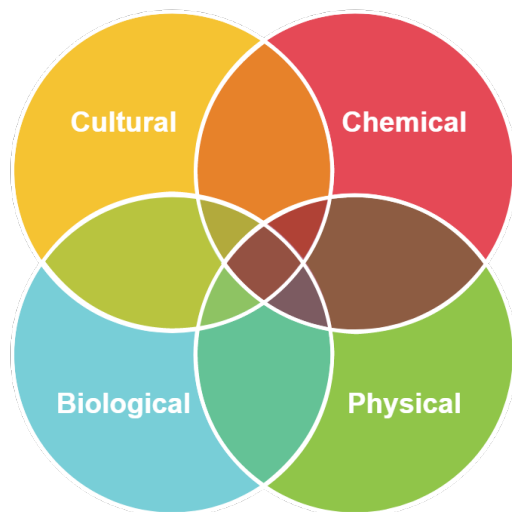
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Pest management, including control of weeds, insects and diseases is an essential requirement for oat production in western Canada. Integrated pest management, the use of multiple methods of pest control is the cost effective and reduces the selection of pesticide resistance.

Pest management is linked to both variety selection and agronomy. Variety selection is a key factor in protecting the crop from diseases, while agronomy is essential for the management of weeds.

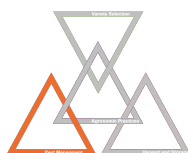


## Pest management

### Cereal staging

Accurate crop staging is essential to ensure crop safety and the optimal performance of crop protection products and agronomic supplements including herbicides, insecticides, in-crop applications of Urea Ammonium Nitrate (UAN), plant growth regulators (PGRs) and foliar fungicides. Cereal staging is similar for oat, wheat and barley crops.

The Ontario agriculture website has excellent photographs and description of how to stage cereals using the Zadocs scale ([A Field Guide to Cereal Staging](#)), while Alberta has developed a BBCH staging guide ([Cereal Staging Guide](#)) (Figure 4.1). Both have excellent photographs to guide growers to locate the main stem and to determine the stage of your cereal crop. Growth stages overlap because each tiller can be at a different growth stage. Accurate staging is based on the main stem, which has the most advanced development. Staging is *not* based on the average of all tillers.



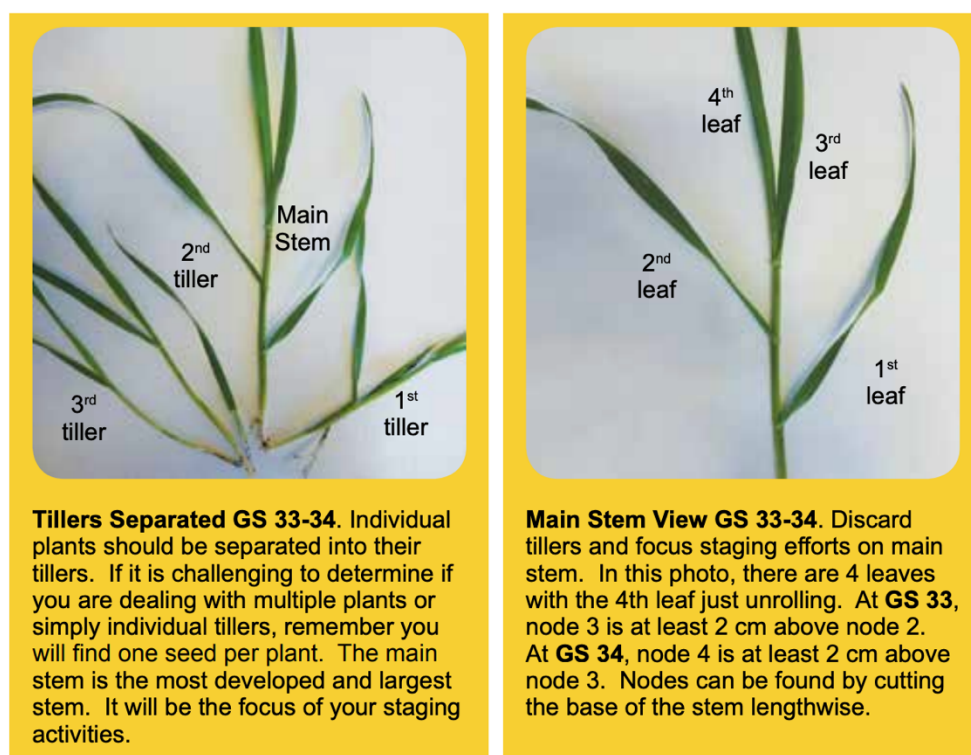


Figure 4.1. An example of crop staging from the [Cereal Staging Guide, Alberta Agriculture and Forestry](#).

## Weed management

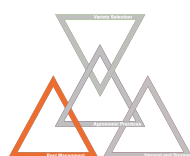
### Grassy weeds

Grassy weed management strategies are much more difficult than for broadleaf weeds in an oat crop. Growers should consider increasing seeding rates, using weed control (tillage or herbicide) prior to seeding and varying seeding dates. There are a limited number of herbicides registered to control grassy weeds. Lorox/linuron are registered for controlling barnyard grass and suppression of green foxtail.

### Wild oat

Wild oat is the most serious weed concern for oat growers (Figure 4.2). Wild oat is highly competitive with oat crops. Increasing numbers of wild oat increases the yield loss of oat. Wild oat does not emerge early in the spring (making pre-seeding

applications of glyphosate less effective) and it continues to emerge over 4 to 6 weeks. The earlier the emergence, relative to the oat crop, the higher the yield loss. Wild oat seeds can last in the seed bank over many years and the [awn on the wild oat](#) can assist the seed to 'find' soil depressions and aid in weed establishment. Wild oat has been selected for resistance to many common grass herbicides, making control in rotational crops difficult. Finally, wild oat seed contamination can be a reason for down grading in some markets. Using a single strategy for wild oat is insufficient but there are a number of integrated weed management strategies available to manage wild oat.







**Figure 4.2.** Wild oat is the most difficult weed to control in oat.



### ***Cultural weed Control***

Choose fields with low wild oat populations (see crop rotation). Wild oat control in most rotational crops can effectively deplete wild oat populations. However, because of herbicide resistant wild oat, the reliability of herbicides is decreasing for many growers. Grow a competitive oat variety and manage the agronomy in the field to increase the vigor of the oat crop.

Increase the oat seeding rate in order to have a more competitive crop. Increasing the seeding rate has several benefits, including increasing crop competition, reducing the tillers and thus [increasing the uniformity of maturity](#).

Seed oat early to increase the competitive advantage of the crop. Early seeding has many advantages, including reducing the yield losses of oat and earlier maturity.

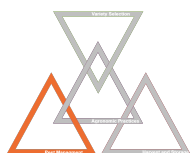
Delaying seeding until wild oat have emerged and are controlled has been advised previously but has serious consequences. The strategy to delay seeding reduces yield and can delay harvest. Because wild oat continues to emerge over 4 to 6 weeks, this strategy is not recommended.

Fertilize the crop, not the wild oat. Applying fertilizer in precision bands adjacent to the seed row in order to make the crop as competitive as possible or use a delayed release seed placed N to keep nutrients for later crop stages.

Consider seeding oat with a larger seed size. [\(See research article below\)](#)

### ***Chemical weed control***

There are no selective herbicides than can remove wild oat from oat crops, either pre-seeding or for in crop applications. Pre-plant herbicide to control emerged wild oat can be less effective because of the relatively late



seed emergence and extended germination period.

### **Physical weed control**

Direct seeding has been shown to reduce the density of wild oat. Seeds left on the soil surface are removed by seed predation from

insects and birds. Additionally, wild oat seeds are not buried by tillage. The mulch that covers most of the soil reduces light reaching wild oat seeds, reducing germination. Post seeding tillage to control emerged wild oat is an option for organic production.

## **RESEARCH PAPER (2005): Crop Science 45: 1410-1416 (2005)**

“Oat Caryopsis Size and Genotype Effects on Wild Oat-Oat Competition”

### **AUTHORS:**

Christian J. Willenborg, Brian G. Rossnagel, and Steven J. Shirtliffe

### **INTRODUCTION:**

“Wild oat competition causes extensive yield and quality losses in... oat”

“Traditionally, wild oat was controlled by delaying planting so that emerged wild oat could be controlled by tillage. However, delayed planting of oat causes substantial declines in grain yield, test weight, plump seed and groat percentage with a corresponding increase in thin seed percentage.”

“A key component of integrated weed management systems is to grow competitive varieties.”

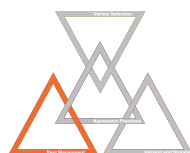
“Our main objective was to assess the relative importance of oat caryopsis [grain] size and genotype in affecting wild oat-oat competition in the greenhouse....We conducted this study in a greenhouse because it provided us with a high degree of experimental control, repeatability, and precision, allowing us to isolate the effects of seed size on oat competitive ability.”

### **SUMMARY:**

This greenhouse study was conducted in 2002 and 2003 at the University of Saskatchewan in Saskatoon. AC Assiniboia, CDC Boyer and CDC Orrin were the varieties used. All seed was sourced from the same location. The seed groupings LARGE, MEDIUM and SMALL were determined on the basis of the groat size to eliminate the effects of the size of the hull.

### **RESULTS AND DISCUSSION:**

“Oat derived from large caryopses [grain] produced 17% more biomass and 15% more panicles per m<sup>2</sup> than plants derived from small caryopses, irrespective of genotype or wild oat competition. Similarly, plants established from medium-seeded caryopses produced 11% more biomass and 9% more panicles than from plants established from small caryopses.” *It was noted that statistically, the results for medium and large seed were not significantly different from each other.*



## Broadleaf weeds

Broadleaf weed management strategies include increasing seeding rates, tillage prior to seeding and varying seeding dates. There are also a number of herbicides available for weed control in oat.

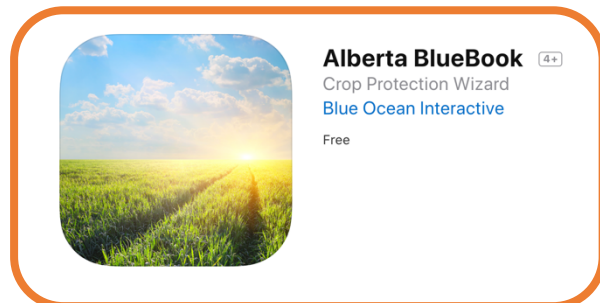
Herbicides containing 2,4-D should be avoided on oat as it has been shown to cause a considerable yield reduction. Products containing dicamba should be used according to the crop stage restrictions on the label. Application of dicamba products under stress conditions, such as drought, should be avoided.

Chemical control options are available in the provincial crop protection guides and in an app for the [Alberta BlueBook](#).

[2019 Alberta guide to crop protection](#)

[2019 Saskatchewan guide to crop protection](#)

[2019 Manitoba guide to crop protection](#)



## Disease management

There are four diseases of oat that typically affect the crop each season.

The two major ones, stem rust and crown rust, sweep into Manitoba and eastern Saskatchewan each year when the weather is favourable.

Moisture and temperature are the drivers of disease and when established in a field, the pathogen will spread from plant to plant. Breeding for resistance to these diseases is time consuming and costly. Furthermore, sources of new plant resistance, the means

Each spring in Canada, spores of this fungus and stem rust are blown in from winter, oat-

by which the oat plants defend themselves, are more difficult to find and incorporate into breeding programs. In any crop, there is a finite source of resistance genes. The crown rust fungus for instance continues to evolve and develop new races that are able to overcome genetic resistance. Therefore, resistant varieties become susceptible to crown rust as new races develop.

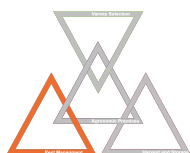
Some diseases are regionally specific. Know what diseases are common in your area.

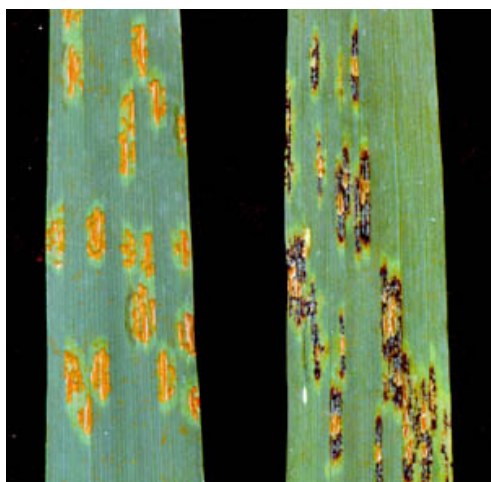
### Crown rust (*Puccinia coronata*)

Crown rust, sometime called “leaf rust”, generally is the most widespread and destructive disease of oat in western Canada. Crown rust can reduce yields, lower test weights and groat percentage, and increase lodging through a weakening of the stem. “Annual yield losses resulting from crown rust in the eastern prairie region (Manitoba and eastern Saskatchewan) were reported to average 5% during 2001 to 2005” (Menzies et al. 2019).

Crown rust is identified by the pustules on the leaf producing yellow-orange spores that infect leaves primarily (Figure 4.3). As the crop approaches maturity, a black spore stage (teliospores or “resting spores”) may also be found on the oat leaves, appearing as a black or dark brown ring around the yellow-orange pustules.

These black spores are the overwintering stage, although in western Canada they generally do not survive the cold. The name “crown rust” comes from the microscopic look of those teliospores which have a crown like structure on their surface. producing regions in the southern United States (Figure 4.4).

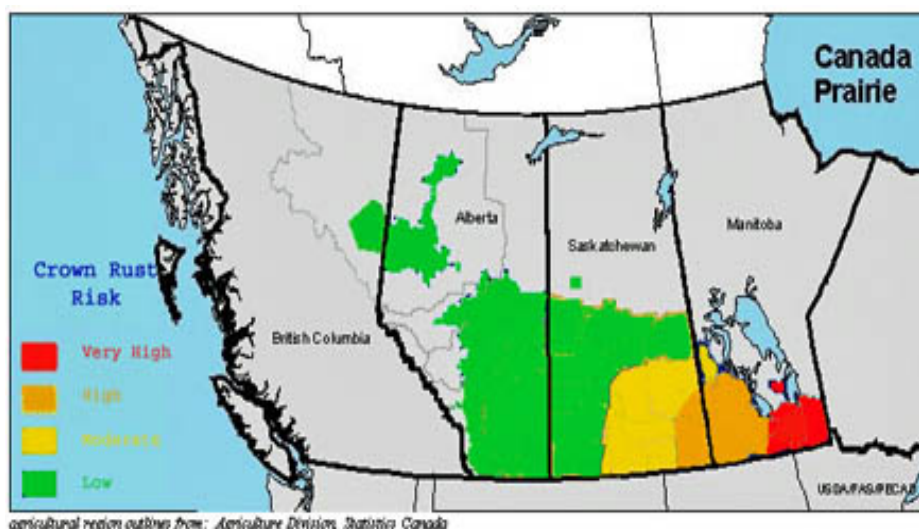




**Figure 4.3.** Crown rust pustules on oat leaves, with yellow orange spores.



**Figure 4.4.** Movement of crown rust spores from the US to Canada.



**Figure 4.5.** The relative risk of crown rust across western Canada

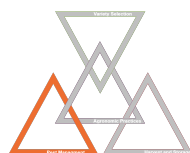
The Red River Valley in Manitoba is the first area to receive the spores from the south, (Figure 4.5) and the crown rust infections will gradually spread to the western Prairie depending on weather conditions.

“Ideal conditions for oat crown rust are mild to warm daytime temperatures, so sunny days at about 20 C to 25 C, and moderate nighttime temperatures around 15 C to 20 C, along with good dews and adequate moisture.” – Albert Tenuta, plant

pathologist, Ontario Ministry of Agriculture, Food and Rural Affairs.

#### **Management of crown rust**

More than 500 distinct races of *Puccinia coronata* have been identified. The highly variable race structure creates a challenge to breed oat lines with effective and stable resistance. However, growing varieties with disease resistance is an effective and economical method of controlling crown rust. Refer to the latest oat variety selection guide to select varieties resistant to prevalent races of crown rust.



Seeding early will allow the crop to develop past the most susceptible stage in the areas where the risk of crown rust is greater. Crown rust may also be controlled using fungicides (Figure 4.12). Refer to the most recent edition of provincial Crop Protection Guide for details of the registered fungicides with which crown rust can be controlled.

**Stem rust (*Puccinia graminis* f. sp. *avenae*)**

Stem rust epidemics are infrequent on the Canadian prairies, but they have the

potential of being serious in southern Manitoba if the oat crop is planted late and winds blow spores in from the south. Spores of the fungal pathogen stem rust, like those of crown rust, drift northward seasonally from the U.S. in a weather dependent manner.

Stem rust and crown rust are distinguished fairly easily on the basis of spore color (Figure 4.6).



**Figure 4.6.** Stem rust spores are red in colour, while crown rust spores are a yellow-orange.



The coloured and dusty pustules erupt on the plants and release hundreds of thousands of spores to the air which may infect neighbouring plants and produce new pustules within 7 to 10 days. These colourful mid-summer spore types are replaced in August with a mass of black overwintering teliospores. As mentioned earlier, winter temperatures in western Canada are too cold generally for the spores to survive.

### ***Management of stem rust***

Control of stem rust, as with crown rust, can be economically accomplished by using resistant varieties. Refer to the latest selection guide to determine the level of resistance in available varieties to the prevalent races of stem rust. Stem rust resistance in oat varieties is generally more stable than for crown rust resistance. Stem rust resistance at first however, was more difficult to breed into the oat crop.

Stem rust may also be controlled using fungicides (Figure 4.12). Refer to the most recent edition of your provincial Crop Protection Guide for details of the registered fungicides with for controlling stem rust.

### **Barley yellow dwarf virus**

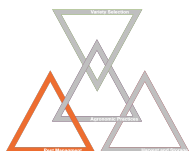
Barley yellow dwarf (BYDV) is a virus that can cause significant yield loss in oat in western Canada. As the name implies, the barley yellow dwarf virus also infects barley as well as wheat. It is transmitted from plant to plant by several species of grain aphids (Figure 4.7). These aphids usually acquire the virus when feeding on infected plants in the southern half of the U.S. and then are carried to northern oat fields in winds and by storm fronts. The disease potential greatly depends on the northward movement of these aphids from southern fields.

Additionally, aphids can overwinter in winter wheat or grasses of field edges that form a green bridge for the aphids.

Barley yellow dwarf-infected plants normally are first seen along edges of fields. The leaves turn a yellow red to reddish brown. The entire leaf blade may die prematurely (Figure 4.8). The plants generally are stunted and heads of infected plants often are severely blasted and seed is low in test weight.

### ***Barley yellow dwarf management***

Oat varieties have some tolerance but there are no resistant varieties to BYDV. Early planting can be helpful in reducing damage caused by BYDV.





**Figure 4.7.** Aphids, seen on the oat florets above, are the carrier of barley yellow dwarf.



**Figure 4.8.** Barley yellow dwarf is characterized by yellow red to reddish brown leaves.



### **Loose smut (*Ustilago avenae*) and covered smut (*Ustilago kolleri*)**

Smuts of oat have not been serious problems in western Canada (Figure 4.9). As with loose smut in barley, this disease can be controlled with seed treatment.

Most oat varieties are resistant to smut and provide good control of this fungal disease. Consult crop protection guide for details of the registered seed treatments.

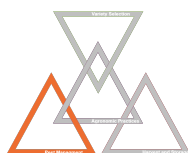


**Figure 4.9.** Smut on oat can be prevented with seed treatments.

### **Fungal leaf spots**

Leaf spots on oat can be caused by a fungal pathogen known as *Septoria avenae* blotch. The disease is prevalent in eastern Canada but is of minor importance in western Canada. A crop rotation which puts two

years or so between oat crops will help reduce the carryover of this disease organism. Several fungicides are registered for the control of leaf spots (Figure 4.10). Refer to the most recent edition of your provincial Crop Protection Guide for details of the registered products.





**Figure 4.10.** Fungal leaf spot on oat.

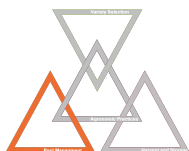
#### **Blast**

Florets are the developing flower structure on an oat panicle which typically forms two seeds. Oat blast occurs when the florets do not develop completely and sterility results (Figure 4.11). When blast is observed, the florets are seen as white, skinny and empty. Frequently, blast is due to high temperatures and moisture stress occurring at the time of panicle differentiation. As blast is a stress related condition in oat, diseases may contribute to the problem.

Early planting reduces the likelihood of blast while late seeding and high seeding rates may favour the occurrence of blast.



**Figure 4.11.** Blast in oat is characterized by white, skinny, empty florets.



## Fusarium

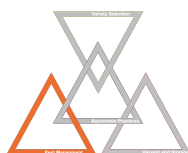
Fusarium head blight (FHB) is a fungal disease that is known to affect oat as well as other cereals (Bailey et al. 2003). Compared to wheat and barley, oat is less affected by the disease and may be more resistant. The causal agent can be one or a complex of several *Fusarium* species. In wheat, *Fusarium graminearum* was most prevalent while in barley *F. graminearum* and *F. poae* was prevalent. In oat, *F. poae* was most prevalent. Yield losses may be in the form of poor seed fill, floret sterility or impaired seed germination (Bailey et al. 2003). FHB is difficult to detect in standing oat crops. The major concern is the presence of mycotoxins on harvested seeds (Tekauz et al. 2004).

Deoxynivalenol or DON is the most common mycotoxin and is a risk to human and animal health, and can result in a lower grading for oat. FHB is of highest concern in Manitoba and Saskatchewan with limited economic importance in Alberta (Tekauz et al. 2008). This disease is most common in the black soil zone, associated with high rainfall. The spread of disease is assisted by rainfall during crop flowering but can also occur via wind and planting of infected seed (Canadian Grain Commission, 2010).

## Chemical control of diseases of oat

The decision to grow a disease resistant variety is a tool for a successful growing season on the farm. Fungicides are also an important tool for the protection of a significant investment during the crop production season. Many growers choose to apply a fungicide even on a variety that shows good disease resistance. The two can work together for success, and starting with a disease resistant variety is like a backup-plan (see Research Report below). Should the weather be such that getting to the field to spray a fungicide is not possible, the oat crop with its disease resistance, will provide a good safeguard for your investment.

A number of fungicides are registered for use on oat. Many growers consider applying fungicide when the yield potential and value of the crop is high, when leaf diseases in the area develop early in the season and also if the long-range weather forecast is for continued moist weather ([see research report below](#)). Refer to the most recent edition of your provincial Crop Protection Guide for details of the registered products.



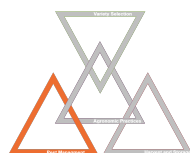
Fungicides	OAT				
	Suppression of Fusarium Head Blight	Powdery Mildew ( <i>Blumeria graminis</i> )	Crown Rust ( <i>Puccinia coronata</i> )	Stem Rust ( <i>Puccinia graminis</i> f. sp. <i>avenae</i> )	Septoria Leaf Blotch Complex
<i>Acapela</i>		•	•		
<i>Bravo 500</i>					
<i>Bumper 432 EC</i>			•		•
<i>Caramba</i>	•		•		•
<i>Co-Op Pivot</i>			•		•
<i>Dithane Rainshield</i>					
<i>Echo 720</i>					
<i>Evito 480</i>					
<i>Fitness</i>			•		•
<i>Folicur 250EW</i>			•	•	
<i>Headline EC</i>			•		
<i>Hornet 432 F</i>			•	•	
<i>Kingpin 75 WDG</i>					
<i>Manzate Pro-Stick</i>					
<i>Mpower Spade</i>					
<i>Nexicor</i>			•		
<i>Palliser</i>			•	•	
<i>Penncozeb 75DF</i>					
<i>Pivot 418EC</i>			•		•
<i>Priaxor</i>			•		
<i>Proline 480SC</i>			•		
<i>Propel</i>			•		•
<i>Nufarm Propiconazole Fungicide</i>			•		•
<i>Propi Super 25 EC</i>			•		•
<i>Prosaro 250EC/Prosaro XTR</i>			•	•	•
<i>Quilt</i>			•		•
<i>Regalia Maxx</i>					
<i>Tilt 250E</i>			•		•
<i>TopNotch</i>			•		•
<i>Trivapro</i>			•	•	•
<i>Twinline</i>			•		
<i>Vertisan</i>				•	

**Figure 4.12.** Chemical control options for oat diseases (Alberta Guide to Crop Protection, 2019). Please consult the most recent crop protections guide. Links for Saskatchewan and Manitoba are listed below.

[2019 Alberta guide to crop protection](#)

[2019 Saskatchewan guide to crop protection](#)

[2019 Manitoba guide to crop protection](#)



**RESEARCH PAPER (2014):** Canadian Journal of Plant Science (2014) 94: 911-922

“Are fungicide applications to control crown rust of oat beneficial?”

**AUTHORS:**

W.E. May, N. Ames, R.B. Irvine H.R. Kutcher, G.P. Lafond, and S.J. Shirtliffe.

**INTRODUCTION:**

Crown rust causes significant damage to the Canadian oat crop and the organism continues to evolve. Plant breeding efforts continue to develop varieties that defend the crop against the disease. “Currently, prophylactic fungicide applications are recommended to oat growers by industry agronomists, even in the absence of symptoms. Our objectives were to determine the influence of seeding date, cultivar and fungicide application on oat yield and quality in Saskatchewan and Manitoba.”

**SUMMARY:**

In this study, conducted from 2009 to 2011, 6 locations were chosen: two in Manitoba and four in Saskatchewan. The locations were: Portage la Prairie, Brandon, Indian Head, Canora, Melfort, and Saskatoon.

AC Morgan, CDC Orrin, CDC Boyer, and Leggett were the varieties tested. With respect to crown rust resistance, they are categorized as very susceptible, susceptible, partially resistant and resistant, respectively.

One fungicide was used in the study, the pyraclostrobin compound Headline®.

“These results indicate that prophylactic fungicide applications are unlikely to provide yield improvement when early planting is combined with even a moderately disease-resistant cultivar.”

“The only cultivar that consistently benefited from fungicide application was AC Morgan. Seeding in mid-May with even a moderately crown rust susceptible cultivar eliminated any benefit from fungicide application. In conclusion, it is recommended that growers seed early with a crown-rust resistant cultivar to avoid the need to apply a fungicide on their oat crops.”

## Insect management

Oat are not targeted by a great number of insects. Insects such as cutworms, wireworms and grasshoppers can all cause damage to oat. Aphids may also affect oat more so as a vector for Barley Yellow Dwarf Virus than any actual impact on yield or quality. Refer to the most recent edition

of your provincial for details of the registered products for specific insect control.

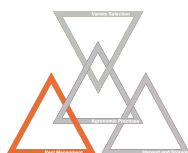
[2019 Alberta guide to crop protection](#)

[2019 Saskatchewan guide to crop protection](#)

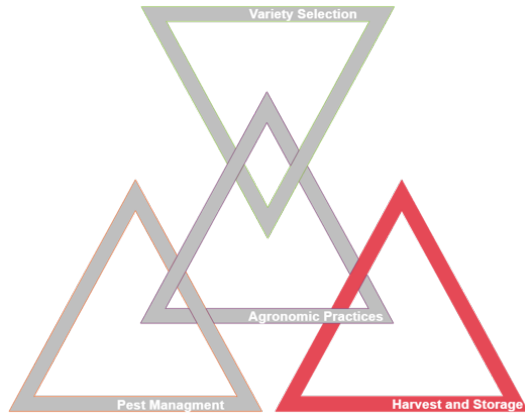
[2019 Manitoba guide to crop protection](#)

## References

Menzies, J.G., Xue, A., Gruenke, J., Dueck, R., Deceuninck, S. and Chen, Y., 2019. Virulence of *Puccinia coronata* var *avenae* f. sp. *avenae* (oat crown rust) in Canada during 2010 to 2015. Canadian Journal of Plant Pathology, pp.1-13.







## Harvest and storage of oat

Seed yield and quality losses can be minimized with proper harvesting and handling techniques. Harvesting is done when temperatures become cooler, days shorten and humidity increases with snowfall always possible. Urgency at harvest can sometimes lead to poor decisions and impact your bottom line.

Poor timing of harvest or poor storage can lead to down grading of oat due to:

- Green seed
- Frost damage
- Damaged by mechanical harvesting
- Mildew
- Sprouted seed

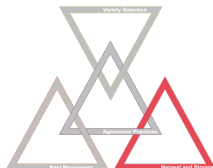
## Glyphosate controversy

Considerable concerns about glyphosate have been raised, primarily in Europe. The International Agency for Research on Cancer (IARC) classified glyphosate a “probable carcinogen” while the European Food Safety Authority (EFSA) concluded that it was safe.

In Canada, the Canadian Food Inspection Agency (CFIA) along with the United States Department of Agriculture, and World Health Organization have concluded that glyphosate residues in food is safe at levels below its Maximum Residue Level (MRL).

The MRLs for glyphosate in grains, including oat, have been established by the CFIA and are set at 15 ppm, lower than the 30 ppm established in the USA. In a recent survey of grain, residues of glyphosate has been identified in grain and other food products, but usually at levels below the MRL (<https://inspection.gc.ca/food/chemical-residues-microbiology/food-safety-testing-bulletins/2017-04-13/executive-summary/glyphosate-testing/eng/1491846907641/1491846907985>).

In Canada, glyphosate continues to be a valuable product for pre-seeding, pre-harvest weed control and harvest management and weed management for glyphosate resistant crops. However, in several European countries, glyphosate use may soon be restricted. This issue warrants vigilance as it may affect grain marketing in the future.



## Pre-harvest herbicides for oat harvest management

Depending on product choice, or combinations, pre-harvest herbicide applications have two purposes: control of perennial weeds and harvest management benefits (desiccation) (Table 5.1).

Desiccation helps to make plants within a field more uniform and thus hasten the harvest process. For harvest management, drier straw will increase the speed and efficiency of harvest, especially when: yields are high; if seeding rates were low; or if the crop was seeded late. Application timing for herbicides is critical. Early application of a desiccant herbicide such as diquat on an immature crop will stop the crop from maturing.

Glyphosate is the only herbicide applied pre-harvest that will effectively control many

perennial weeds and accelerate the dry down of the crop. However, it will not speed up grain maturity. Glyphosate applied too early can result in reduced crop yield and quality, and leave unacceptable herbicide residues in seeds (Table 5.1).

Only three herbicides and four products are registered for pre-harvest crop management in oat (Table 5.1). They differ in the speed of dry down, and their level of weed control. There are special considerations for glyphosate because of the potential for herbicide residues in grain (see below).

Glyphosate use restrictions can vary with the market. It is critical to talk to your buyers in advance of applying glyphosate.

**Table 5.1** Herbicides registered for pre-harvest use on oat.

Product	Drying speed	Weed control	Grain moisture at application
<a href="#">Aim</a> * (carfentrazone)	Rapid	No	Not specified
<a href="#">Glyphosate</a> (several suppliers)	Slow	Yes	<30%
<a href="#">CleanStart</a> * (carfentrazone /glyphosate)	Intermediate	Yes	<30%

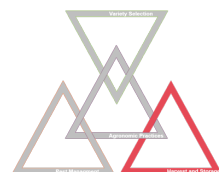
\*Higher water volume increases efficacy

## Glyphosate residues in oat following pre-harvest application

Glyphosate residues in oat grain can occur when glyphosate is applied pre-harvest when grain has not dried down sufficiently. The glyphosate label specifies that grain must be less than 30% moisture prior to application (Figure 5.1).

A recent study conducted in Saskatchewan led by Christian Willenborg, addressed the question: “Does application of pre-harvest

glyphosate adversely impact oat yield and quality?” Trials were conducted at two locations in SK, 2016-2017. They compared glyphosate pre-harvest (900 g ae ha<sup>-1</sup>) with direct cut (no glyphosate) and swathing at 60% to 20% seed moisture content. They measured oat physical and functional quality, and glyphosate residues, including yield, plumpness, test weight, β-glucan,





flaking, groat %, etc. There were no significant differences in yield between the pre-harvest, direct cut oat, and swathed crops at 20%, 30%, and 40% moisture content (Figure 5.2). However, there were significant differences in yield at higher (40% - 60%) seed moisture content (Fig. 5.3).

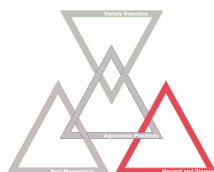
The author's found that the use of glyphosate in 2016 did not exceed the Canadian or USA MRLs, but in 2017 seed with glyphosate applied early at 50% moisture, exceeded the MRL's (Figure 5.3). The glyphosate label specifies that

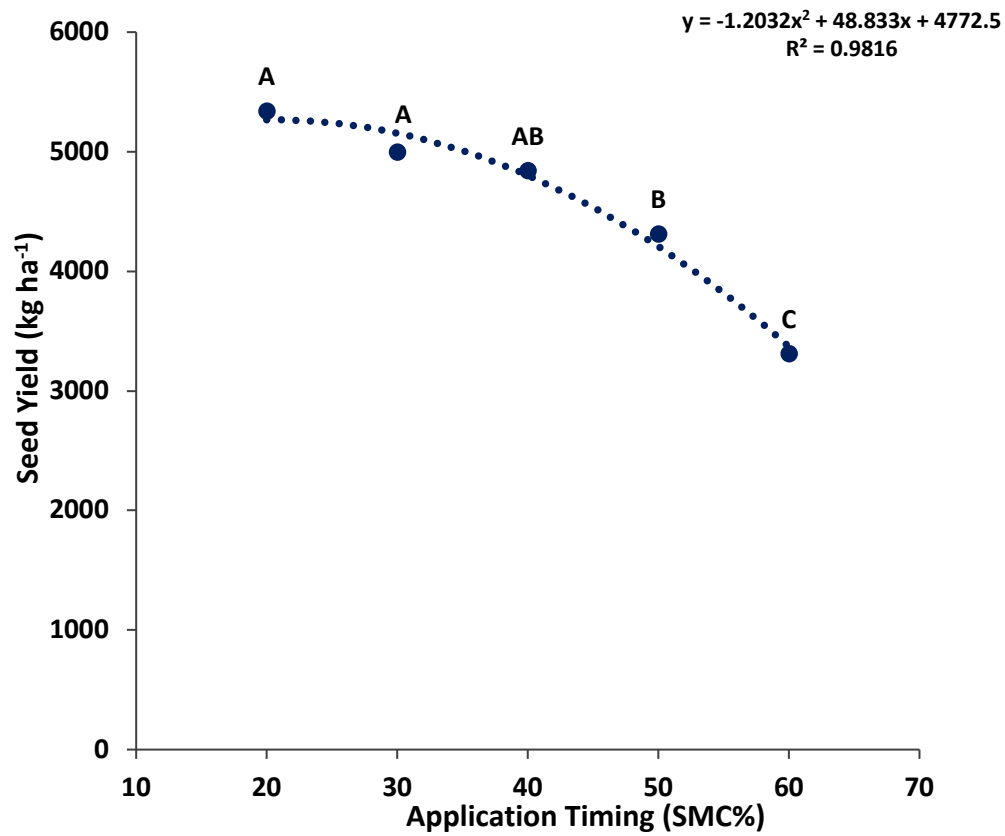
glyphosate should only be applied when seed moisture is less than 30%.

Glyphosate applied pre-harvest did not negatively influence yield, residues, or any physical quality parameters when applied at the appropriate rate and timing.

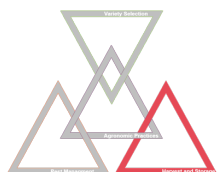


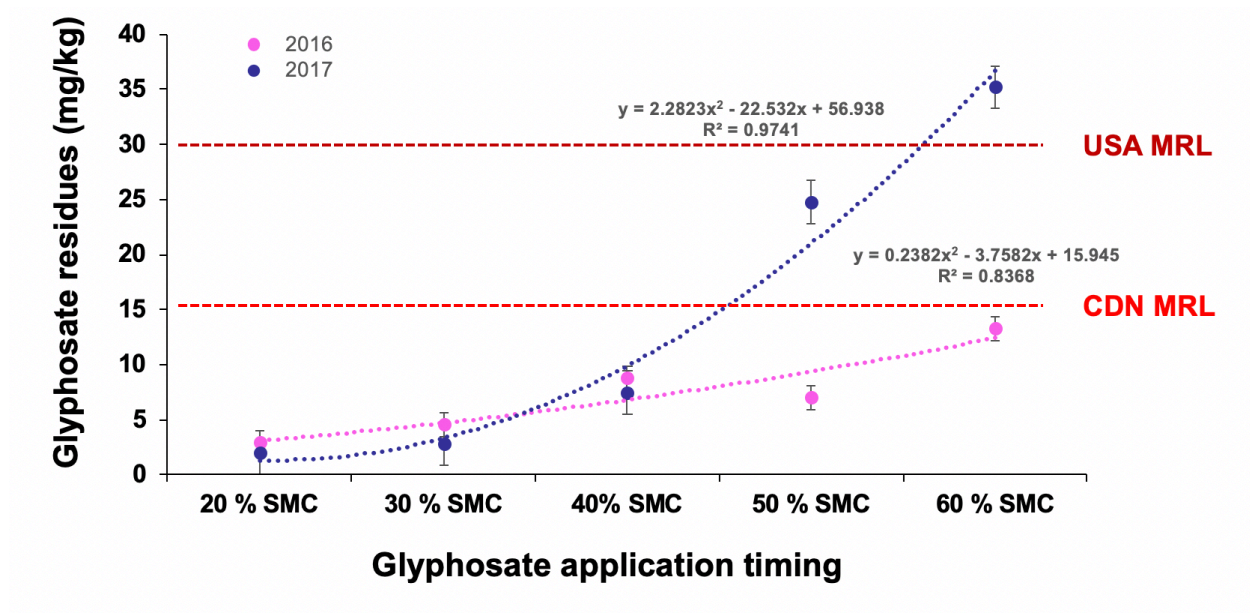
**Figure 5.1.** Oat seeds at 30% SMC (seed moisture content). (Photo curtesy of Shawna Mathieson).





**Figure 5.2.** Application timing of glyphosate at different seed moisture content (SMC) levels impacts seed yield (2016-2017, SK). Willenborg et al., unpublished data, used with permission.





**Figure 5.3.** Glyphosate residues at various seed moisture content (SMC) levels. In 2017 but not 2016 glyphosate residues exceeded the Canadian and USA MRLs at > 40% moisture (Willenborg et al., unpublished data).

An agronomic practice that increased glyphosate residues was low seeding rates (presumably through uneven crops with more or greener tillers) (Figure 5.4).



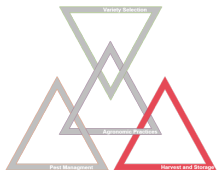


**A**



**B**

**Figure 5.4.** The effect of seeding rate on oat dry down. Variety Pinnacle planted at 250 seed/m<sup>2</sup> (A) and 500 seeds/m<sup>2</sup> (B). Notice the change in color and increase in uniformity evident in the second photo. (photo curtesy of Christian Willenborg)



## Harvesting

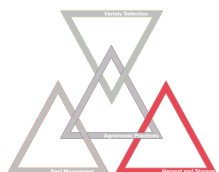
Timing of harvest is critical to avoid damage to oat hulls, thereby reducing quality and yield. Oat should be swathed when kernel moisture content is between 30% to 36% to avoid negative impacts on groat yield and test weight ([May et al 2005](#)).

Oat is ready to swath when the panicle has turned yellow or brown and the least mature

kernels have turned a cream colour (Figure 5.5). Oat left too long in the field can weather, lose quality and shatter during storms.



**Figure 5.5** Harvest management issues in oat can be reduced by early seeding and higher seeding rates.





**RESEARCH PAPER:** Canadian Journal of Plant Science (2005) 85: 839-846

“Oat quality and yield as affected by kernel moisture at swathing”

**AUTHORS:**

William E. May, Ramona M. Mohr, Guy P. Lafond, and F. Craig Stevenson.

**INTRODUCTION:**

“Oat grown in western Canada is typically swathed and then combined. If the oat crop is swathed too early, seed yield and quality decline; however, if swathing is delayed, harvest losses increase.”

**SUMMARY:**

In this study, conducted from 1997 to 2000, 2 locations were used: one in Manitoba and one in Saskatchewan. The locations were: Brandon and Indian Head.

Calibre and AC Assiniboia were the varieties examined, and the oat crop was swathed at 5 levels of seed moisture content: 50, 41, 32, 23 and 14%.

**RESULTS AND DISCUSSION:**

“There was an increase in yield as swathing was delayed with most of the yield increase occurring between a kernel moisture of 50 and 41%. Therefore, a kernel moisture content of 41% or less resulted in highest yields.”

“Kernel weight, plump seed and groat yield were optimized when kernel moisture was between 36 and 30% moisture content.”

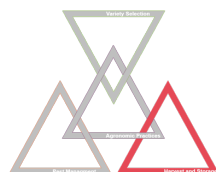
“After 30% kernel moisture was reached, no improvement in oat yield and quality occurred when swathing was delayed any further.”

Straight combining oat may be an option but growers should ensure no green hulls are present at the time of harvest or the oat will not make milling grade. If the oat crop is left too long in the field before straight cutting, weather may cause the stems to break down and reduce yield.

Prevent damage to oat hulls by reducing cylinder speeds to around 900 r.p.m. and allowing wider concave clearances. Oat buyers discount oat with a high percentage

of de-hulled kernels, so growers should aim for less than five per cent de-hulled kernels through harvest, storage and delivery.

As mentioned previously, growers should be cautious about using a pre-harvest glyphosate application on oat. Not all buyers accept oat that had an application of pre-harvest glyphosate. Some markets also have strict limits on the allowable glyphosate residues in oat, which could affect their saleability.



## Safe storage of oat

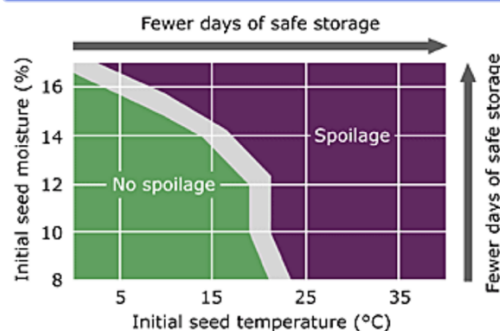
Once the grain is in the bin, the next step is to ensure that quality is retained (Figure 5.6). Several factors during storage can lead to down grading, including heating, mildew and excreta ([see below](#))



**Figure 5.6.** Oat in the bin

If the grain is tough or damp it must be dried to prevent spoilage. Oat spoilage occurs when initial temperatures range from 0 C to 21 C with respective moisture levels from eight to 17 per cent. The Canadian Grain Commission has safe storage guidelines for storing grain on its website (Fig. 5.7).

**Safe storage chart for oats**



Oats: spoilage occurs when initial temperature ranges from 0°C to 21°C with respective moisture from 17% to 8% moisture content.

**Figure 5.7.** Safe storage chart for oat.

<https://grainscanada.gc.ca/en/grain-quality/manage/manage-storage-prevent-infestations/prevent-spoilage.html>

Considerable information is available on efficient and effective grain drying. For a detailed understanding of grain drying, the following is a link to the Ron Palmer YouTube video: [Natural Aeration Grain Drying - Farming Smarter Conference 2013](https://www.youtube.com/watch?v=IFy1-uf5nCc&t=2390s) <https://www.youtube.com/watch?v=IFy1-uf5nCc&t=2390s> or a shorter version here from Ron Palmer [Dry Your Grain Without Running Your Fans Constantly](#) [Oat history on the northern great plains](#)



## Grain grading factors for oat

All samples are visually inspected to determine if they are commercially clean prior to dockage assessment. Dockage is assessed to the nearest 0.1%.

For example:

- 95.0% Oat, No 1. CW
- 4.0% domestic mustard seed, No 1 CAN Oriental
- 1% dockage

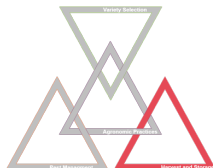
Dockage is defined under the Canada Grain Act as “any material intermixed with a parcel of grain, other than kernels of grain of a standard of quality fixed by or under this Act for a grade of that grain, that must and can be separated from the parcel of grain before that grade can be assigned to the grain.”

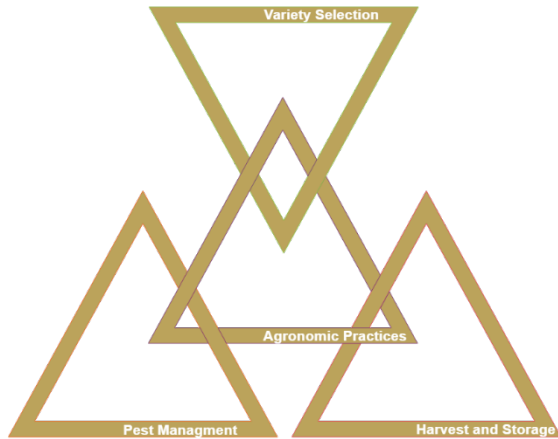
Oat grading factors (not in order of importance)

- Barley
- Cereal grains other than barley and wheat
- Color
- Contaminated grain
- Covered smut and false loose smut
- Damaged
- Earth pellets
- Ergot
- Excreta
- Fertilizer pellets
- Fireburnt
- Foreign material
- Frost damage
- Fusarium damage
- Green
- Heated
- Hulled and hullless
- Large seeds
- Mildew
- Odor
- Rotted

- *Sclerotinia sclerotiorum*
- Soft earth pellets
- Sprouted
- Stones
- Test weight
- Total damage and foreign material
- Treated seed
- Variety (hullless)
- Wheat
- Wild oat

A complete list of grading factors for No. 1-4 CW can be assessed at the [Canadian Grain Commission](#). Please note, most oats are graded at a 2CW in Western Canada.



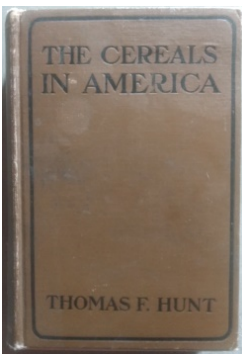


## Appendix

### History of oat growing and breeding in Canada

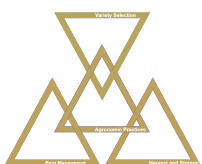
#### The impact of plant breeding

The quoted page from the book below puts into perspective, the value of the effort of crop improvement through breeding. The improvement continues to this day in oat for western Canada and is a permanent resource for prairie farms (Figure 6.1).



**Figure 6.1.** The Cereals in America

“The importance of Plant Breeding. – The individual plant is the result of two forces: environment (climate, soil, fertilizer, culture, etc. ) and heredity (parents, grandparents, etc.). The increased yield of a crop by modification of environment, although a necessary process to successful agriculture, can only be accomplished by an expense more or less considerable. Heredity, however, is a silent force, which acts without expense. If a plant be discovered that would produce because of the force of inheritance only one grain of maize more on each ear than at present, it would be capable of increasing the maize crop of the United States five million bushels of maize, not next year alone but for years to come. This is the significance of improved seed.



[Luther Burbank:] ‘The vast possibilities of plant breeding can hardly be estimated. It would not be difficult for one man to breed a new rye, wheat, barley, oat or rice which would produce one grain more to each head, or a corn which would produce an extra kernel to each ear, another potato in each plant, or an apple, plum, orange or nut to each tree. What would be the result? In

five staples only in the United States alone the inexhaustible forces of Nature would produce annually without effort and without cost:

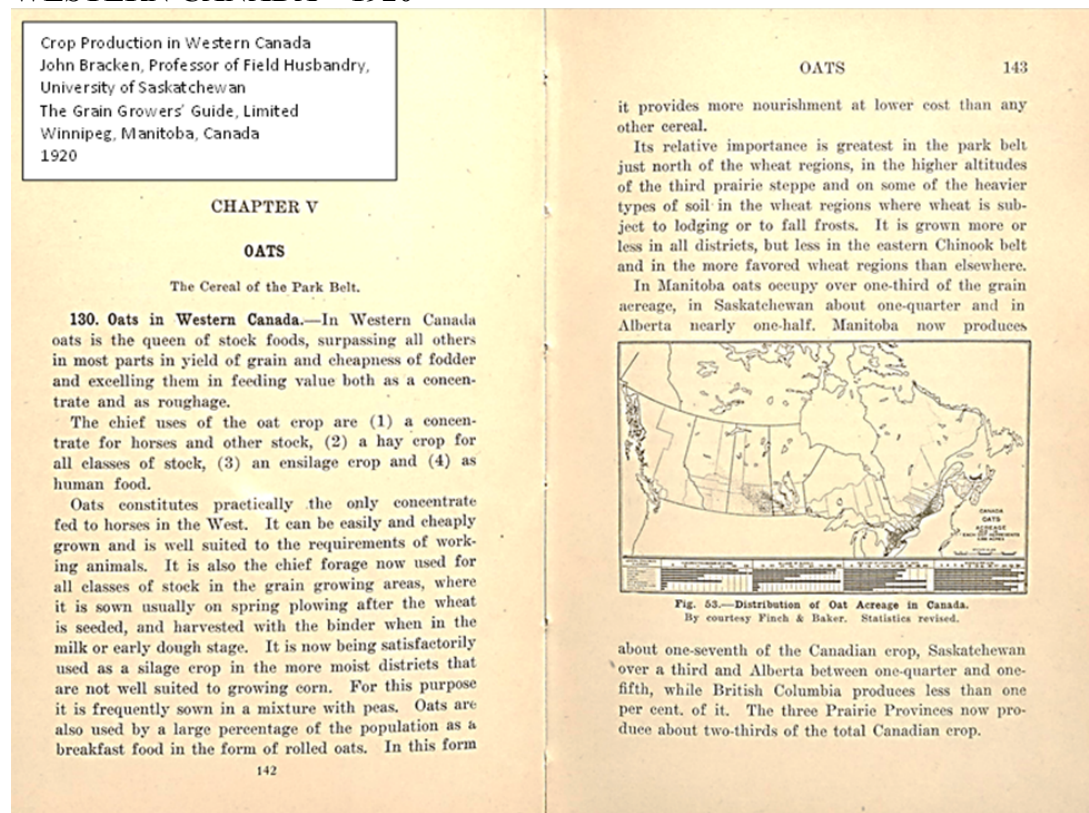


- 5,200,000 extra bushels of corn,
- 15,000,000 extra bushels of wheat,
- 20,000,000 extra bushels of oat,
- 1,500,000 extra bushels of barley
- 21,000,000 extra bushels of potatoes.

But these vast possibilities are not alone for one year, or for our own time or race, but are beneficent legacies for every man, woman or

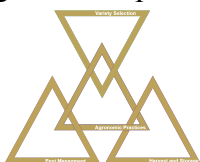
child who shall ever inhabit the earth.”

## WESTERN CANADA – 1920



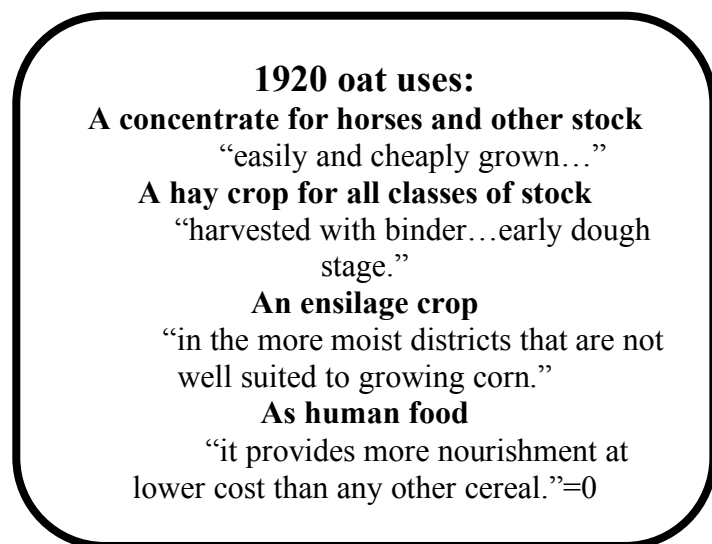
**Figure 6.2.** Crop production in 1920

In this 1920 account of oat production in western Canada, it is clear that oats were a powerful component on the farm at this time in Canadian history. It is in fact the original biofuel driving agricultural productivity. Notice also the prioritized uses of oats of which food is at the bottom:





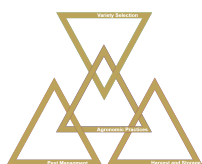
“In Manitoba oats occupy over one-third of the grain acreage, in Saskatchewan about one-quarter and in Alberta nearly one-half.”



**Figure 6.3** 1920 uses for oat, in priority order

## References

The Cereals in America. 1904. Thomas F. Hunt (Professor of Agronomy in Cornell University),



## Climate change and oat

The world is changing and the climate with it. As we look back over numerous crop years, the good and the bad, the wet and dry, we see changes. It is too difficult on a local level to predict the weather of an upcoming crop season, even if larger global trends are seen.

Below are some quotes from 2011 and 2012 that speak of doom and gloom in the future for crops unless urgent work toward adaptation takes place. In reality, the adaptation of our crop varieties is always taking place. Every year in oat breeding for instance, a new 10 to 12-year breeding/development cycle begins again. All oat breeding early generation genetic material is subjected to the climate, good or bad,... all the time. If there are changes to the climate, noticeable to us or not, the plants that are part of the breeding program are responding and the best are being selected. The breeding process is an excellent tool for adaptation in all our crops. And yes, it is true that the weeds are adapting too.

**The Western Producer** – December 22<sup>nd</sup>, 2011 – Sean Pratt

“Chicago – Farmers can expect a continued trend toward wetter and warmer growing seasons and more weather volatility in the

years ahead, according to two American weather experts.

“If you’re going to be farming in the future, your experience with weather and climate are going to be different than anybody who has been farming the last 30 to 40 years,” said Charlie Walthall, national program leader for climate change at the U.S.

Department of Agriculture’s Agricultural Research Service.

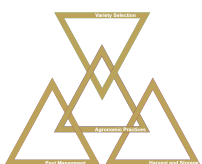
“Crops are not being bred to take advantage of the additional carbon dioxide in the air, but weeds are thriving under those conditions..”

*Further...*

**The Manitoba Co-operator** – January 5<sup>th</sup>, 2012 – Daryll E. Ray and Harwood D. Schaffer

“We have not bred the variety of crops to take advantage of higher carbon dioxide in the atmosphere,” Walthall said.

“Cary Fowler, executive director of Global Crop Diversity Trust says: ‘I don’t think that people have begun to grapple with the enormity of the problem (of climate change)...agricultural crop adaptation really isn’t even on the agenda. All our efforts at the macro-level are clearly going to fail as the crops die in the field.’”



# Variety registration in western Canada

In western Canada, the Prairie Recommending Committee for Oat and Barley (PRCOB) is responsible for coordinating the yearly testing and evaluation of barley and oat candidate

cultivars. This effort is made for the purpose of developing variety recommendations to be passed on to the Variety Registration Office of the Canadian Food Inspection Agency.

## Startup and purpose

Excerpts from the:

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### PRAIRIE REGISTRATION RECOMMENDING COMMITTEE FOR GRAIN MINUTES OF THE FIFTH MEETING February 21-22, 1994, Calgary Alberta

The variety registration system originated with the 1923 amendment to the *Seeds Act* that required all agricultural and vegetable varieties to be tested for merit and licensed by the Minister of Agriculture. An amendment to the Act in 1937 exempted vegetables and herbs from the licensing requirement. A 1993 amendment to the *Seeds Regulations* exempted lawn, turf, reclamation and ground cover species as well as home garden potatoes from the registration requirement because of the highly subjective nature of determining merit in varieties of these crops.

The initial reason for establishing licensing was to permit only those varieties exhibiting merit to be sold in Canada. Since 1928, the Minister has had the authority to refuse to license a variety if it is found to possess inferior qualities that would impair its commercial value or fail to fit into the grain grading system. As a result of the 1992 regulatory review, it is clear that merit remains the overriding principle for retaining the variety registration system. The mandate of the system is:

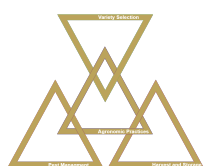
- to ensure that new varieties meet current requirements for resistance to economically important diseases,
- to ensure high quality products for processors and for consumers and
- to ensure that agronomically inferior or unadapted varieties are excluded

## Oat developmental flow

Varieties of oat do not appear out of “thin air”. The contributors to development of oat in western Canada, are Agriculture and Agri-Food Canada, Provincial government initiatives, Universities, private industry and also individuals. These efforts date back to the beginnings of farming on the prairies. Influences and development initiatives these days come also from European, South

American, American, Australian sources etc., which make contributions to the western Canadian oat scene.

Beginning with a desire to overcome some agronomy challenge, emerging changes in field production machinery or challenges within the ecosystem of the oat crop, oat developers and breeders choose parental plants for combinations to meet the need.





**Figure 6. 4.**Oat breeding research trials  
From the initial hand pollination between oat plants of interest, 6 or 7 years or seasons pass by with selections being made to guide a group of plants in a genetic population toward entry into the Western Cooperative

Oat Registration Trial (WCORT). Two years in the WCORT allow breeders, collaborators, competitors and interested industry parties to have a look at the attributes of a concentrated set of promising oat lines. Three more years or so will follow as successful oat candidates are field increased to be ready for a certified seed release to oat growers.

For those first 6 to 7 years of the breeding process, adaptation to local climate and geography, and continuing influence climate change, fixes the characteristics of an oat variety. The best adapted move forward. A full cycle of variety development extends beyond those initial years to approximately 10 to 12 years. This is a normal, expected, and productive cycle that needs, due to the amount of work involved, to take time. The final judgement of the success of a variety is the grower and the market.

