Why Invest in a Seed Test?

Seed is the foundation of every crop and the best way to determine its quality is through a simple seed test. Without a seed test, once a seed issue is realized, significant costs will have been incurred and yield potential of that crop or from re-seeding another crop will have declined. Environmental conditions in the year the seed is grown impact its quality. Seed grown and harvested in a drought year can have significant quality impacts, just as seed grown in a wet year. Furthermore, seed quality can change after long periods of storage and, therefore, seed testing is a meaningful investment and planning tool ahead of every season.

Seed Test Interpretation

Germination

Germination describes the percent of seed that are likely to germinate under optimal and standardized oxygen, light, moisture and temperature conditions. Germination is an accredited test; cereals undergo a brief cold period to break dormancy and are then tested at 20°C for *seven* days. There is no pre-chill requirement in chickpea, lentil or pea crops but temperature is also held at 20°C with final counts performed at *seven* days later. At the end of this test period, seeds are evaluated and placed into various germination categories including fresh, hard, abnormal, and dead seeds.

- **Fresh** seeds fail to germinate. These seeds will imbibe water regularly and initially appear to be capable of germination but then remain dormant. Fresh seeds may be viable, but cannot be confirmed.

- **Hard** seeds fail to germinate. The seed coats of hard seeds will not be penetrated by water and remain intact at the end of the test period.

- **Abnormal** seeds germinate, but do not have adequate plant structures to maintain healthy growth such as missing roots or shoots.

- **Dead** seeds cannot produce any part of a seedling. They may imbibe water and crack the seed coat but will die before they will produce seedling. Higher levels of seed-borne disease usually correlate to a higher percentage of dead seeds.

The germination test is useful, as it tells us the maximum potential of the seed lot under optimal conditions. This information can be used to determine if, under ideal growing conditions, a particular seed source should be planted at all. However, germination is only a single component of seed quality. When germination is poor, a different seed source may be selected. When germination is good, the decision to plant a seed lot should not be based on germination alone. Germination is largely influenced by late-season environmental conditions, and harvest weather that is too cold, too wet, too hot or too dry can all reduce germination.

Germination can also be negatively impacted by applications of pre-harvest glyphosate and therefore it is not recommended to plant seed that has been treated with pre-harvest applications of glyphosate as chemically damaged seed may show lower germination values, poor root development, and higher than acceptable levels of seedling mortality. Exceptional circumstances may result in a desire to test seed that has been treated with pre-harvest glyphosate that was applied at the proper timing. Seed labs can estimate germination of seed treated with pre-harvest glyphosate if the germination test is done in soil. Submitting a seed sample that received pre-harvest glyphosate will result in abnormal seedling development, inaccurate results, and the seed lab will have to redo the test, costing extra. The risks mentioned above are still valid, so it is recommended to source seed elsewhere instead of using treated with pre-harvest glyphosate.

Vigour

The vigour test measures a seed lot's ability to produce normal seedlings under adverse conditions. Unlike the germination test that is ran under optimal conditions, vigour is most often measured using a cold stress test which evaluates the seedlings' ability to withstand cool temperatures (5ºC for seven days), and accompanying stress that may be typical of early spring planting. Vigour in a seed lot is important because it may provide insight into how seedlings will perform under challenging conditions. Seed lots with higher vigour seed lots may have faster and more uniform seedling emergence in low temperature soils or other stressful conditions.

Low vigour values may also provide an early warning of diminishing seed quality as seed lots will begin to drop in vigour before germination values start to fall. Conditions of seed development, maturation, storage, and seed aging all impact vigour. Seeds developed under moisture stress, nutrient deficiency, or extreme temperatures are often characterized by light, shriveled, and low-vigour seed. Similar to germination, vigour will also be negatively impacted by mechanical damage or improper storage.

The vigour test is not standardized among seed labs. While the cold stress test is common, the parameters and the stress used may vary between labs. Vigour tests from different labs should not be compared directly.

Seed-borne Pathogens

Fungal screening for seed-borne pathogens is an important component of assessing seed quality as these diseases can have negative impacts on crop establishment, overall plant health, and ultimately crop yield. Evaluation of seed-borne pathogens is particularly important for diseases that have high rates of seed-to-seedling transmission. For example, *Ascochyta rabiei* carried on chickpea seed is readily transmitted to the seedling and can be highly destructive to the crop. Therefore, only chickpea seed lots with low infection levels (<0.3%) are acceptable for planting. Even if this threshold is met, a seed treatment is still recommended as the likelihood of missing an infected seed is very high and even a very small percentage of *Ascochyta*-infected chickpea seed can result in significant seedling infection.

Seed treatments are an excellent tool to help protect cereal and pulse seedlings against early-season soil and seed-borne pathogens. Seed treatment selection should be based on the targeted pathogens of concern and should be applied by means to ensure thorough seed coverage and according to label instructions. Some seed treatments may not be compatible with certain seed-applied rhizobium inoculants, so it is recommended to consult with manufacturers for compatibility information. It is important to note that seed treatments alone cannot compensate for a poor seed lot and some seed lots simply have too high of disease levels to be used as a seed source. Guidelines have been developed to help inform decisions of acceptable thresholds for seed-borne pathogens, but guidelines are only guidelines. Soil moisture and temperature conditions following planting will also influence what infection levels are tolerable in a given year or location. There are no hard rules on acceptable levels of disease due to each producer having a unique situation, and acceptable level of risk.

> A chickpea seed lot with an *Ascochyta* infection of 0.1% (one infected seed in 1,000 seeds) and a planting density of three to four plants ft^2 poses the risk of 175 infected chickpea seedlings per acre. Such a level of early infection for an aggressive disease like *Ascochyta* can have a devastating impact on chickpea crops.
>
> 400 seeds are evaluated in a chickpea disease screen for *Ascochyta* and, therefore, a single seed with *Ascochyta* would result in an infection of 0.25%

Table 1. Guidelines for seed-borne disease thresholds in cereal and pulse crops[1].

Major Pathogen	Threshold	Crop(s)	Comments
---Cereals---			
Common Root Rot *Cochliobolus sativus*	N/A	Barley, Durum, Oats, Wheat	Thresholds indicate the level at or above which a fungicidal seed treatment is recommended. A fungicidal seed treatment may be warranted at lower levels if there are additional risk factors. Combined disease levels should be considered when considering seed treatment options.
Seedling Blight/Root Rot *Fusarium spp.*	10%	Barley, Durum, Oats, Wheat	
Fusarium graminearum	2%[2]	Barley, Durum, Oats, Wheat	
Loose Smut *Ustilago nuda*	2%	Barley	True loose smut in barley is specified in the *Seeds Act* with a maximum of 2% allowable. Loose smut requires a systemic seed treatment for control.

---Pulses---			
Ascochyta spp.	0.3%	Chickpeas	Seed-to-seedling transmission of *Ascochyta rabiei* is high in chickpea; seed with levels above 0.3% should not be used. Seed treatment is always recommended even if seed levels are 0%.
	10%	Field Peas	Up to 10% infection should not significantly affect establishment of field peas.
		Lentils	A seed treatment should be used if infection levels are close to or exceed 5% for lentils grown in Brown and Dark Brown soil zones. Lentil seed with levels exceeding 10% should not be planted at all. Any level of seed-borne Ascochyta spp. is unacceptable for lentils grown in Black soil zone.
Anthracnose *Colletotrichum truncatum*	N/A	Lentils	Seed-to-seedling transmission of anthracnose is very low in lentil and infected residue provides a greater inoculum risk; however, it is still important to plant clean seed and accept zero tolerance in being planted into a field that has never grown lentil.
Seedling Blight/Root Rot *Fusarium spp.*	10%	Chickpeas Field Peas Lentils	Thresholds for seed-borne Fusarium has not been established in pulses, but caution is warranted as levels reach 5%. Total *Fusarium* + *Botyris* + *Sclerotinia* should not exceed 10%. Up to 10% infection of *Botrytis* + *Sclerotinia* only should be tolerable but significant seedling blight may occur at lower levels in absence of seed treatment.
Grey Mold *Botrytis spp.*	10%	Chickpeas Field Peas Lentils	
White Mold *Sclerotinia spp.*	10%	Chickpeas Field Peas Lentils	

[1]Adapted from Saskatchewan Ministry of Agriculture guidelines
[2] Additional information on thresholds for Fusarium graminearum is available from the Saskatchewan Ministry of Agriculture

Thousand Kernel Weight

The thousand kernel weight (TKW) is a measure of seed size and represents the weight, in grams, of 1,000 seeds. Seed weight may also be reported, which is the weight of a single seed, in milligrams, and is numerically equivalent to TKW. Most crops have a typical TKW range but it is important to note that TKW is unique to each individual seed lot and can vary substantially between varieties, fields, and growing seasons. For instance, smaller and lighter seed with lower TKWs is often a consequence of a drought season when limited moisture resources did not allow for optimal seed fill.

Measuring the TKW of a seed lot is important for calculating the optimal seeding rates for pulse and cereal crops as it provides a more precise measurement of seeds sown compared to bushels or weight. Providing that all seed quality factors are equal between two seed lots, the seed source with the higher TKW will require a heavier seeding rate to achieve the same optimal plant stand. This is because the bigger the seed, the higher the TKW and the fewer seeds per pound. Therefore, for the same weight (i.e. 60 pounds) of seed, fewer potential plants are being put in the ground.

Optimal Plant Stands and Seeding Rate Calculations

Targeted Plant Population

Plant population is an important factor for the establishment of competitive, high-yielding cereal and pulse crops. Optimal plant stands differ by crop, environment, and management factors but care should be taken to target appropriate plant densities for each individual crop and farm operation.

Table 2. Summary of target plant populations for select cereal and pulse crops

Crop	Plant Population Target (Range) plants ft^{-2}	Typical TKW Range grams
	Cereals	
Barley	22 (20–24)	30–50
Durum	20 (20–24)	41–45
Oat	24 (20–30)[1]	30–45
Wheat	24 (20–24)	30–40
	Pulses	
Chickpea	4 (3–4)	220–425
Field Pea	8 (7–9)	125–300
Lentil	12 (10–14)	25–80

[1]While a plant population of 20–30 plants ft^{-2} is usually recommended, research has consistently shown the benefits of increased seeding rates, particularly in the presence of weeds such as wild oats. Next to early seeding, seeding rate is one of the most powerful strategies available for reducing weeds.

Calculating Seeding Rate

Once the desired plant population is determined the seeding rate can easily be calculated based on specific seed quality parameters of each individual seed lot. Although this calculation is fairly straightforward, the seedling survivability rate can be difficult to estimate and will vary among farms and across growing season. As a general rule of thumb for cereal and pulse crops, expected seedling survivability is approximately 5–15% lower than the germination rate with a lower survivability rate anticipated under adverse growing conditions.

Factors to consider when assigning seedling survivability include:

- Seeding date
- Soil temperature, moisture, and texture
- Seed handling and seeding speed
- Seeding depth
- Seed placed fertilizer
- Seedling pests such as insects and soil-borne pathogens

Seeding rate (lbs/ac)=

$$\frac{\left(\frac{Desired}{plant\ population\ ft^2}\right)\left(\frac{TKW}{g}\right)}{\frac{seedling\ survival\ rate\ in\ decimal\ form}{10.4}}$$

Increased seeding rates will be required to overcome low seedling survivability; however, it is important to recognize that not all issues of poor quality seed can be corrected by increased seeding rates. For instance, large differences in vigour and germination values in a seed lot can be exacerbated by increasing seeding rates which may impose greater variability in establishment and lead to a more uneven plant stand. Similarly, increasing seeding rate to overcome low germination of a seed lot with a high pathogen load will simply introduce more disease into the field.

Value of Seed Testing in a Dry Year

Seed grown during a dry year typically boasts lower disease levels relative to an average or wet season, but reductions in seed-borne pathogen load do not guarantee high quality seed. Particularly impacted are germination, vigour, and TKW with potential reductions in all categories.

- **TKW**: When seeds do not have adequate moisture resources during grain fill, final seed production is typically much lower than expected crop averages

- **Vigour**: Production of gibberellin hormone, responsible for regulating seed maturity and dormancy, is typically reduced under drought conditions and seed may demonstrate higher than anticipated levels of dormancy and lower vigour as a result. Grain, particularly pulses, harvested during very hot and dry conditions can be susceptible to micro-cracking on the seed coat leading to reductions in vigour before germination levels are noticeably affected.

- **Germination**: mechanical damage from typical harvest and handling activities is often increased under hot and dry conditions, especially when seed moisture content is low and air temperatures are high. Such damage to the seed coat can have a significant negative impact on germination levels with pulse crops being the most prone to seed coat cracking and splitting.

Initial seed testing reports from the fall of 2021 are indicating low germination in some crops, particularly in field pea. Field pea samples experienced high levels of mechanical damage during harvest operations and some labs are reporting majority of pea samples with sub-optimal germination levels.

Be wary of sub-par germination and vigour values on post-harvest seed tests. Germination and vigour levels can continue to decrease over winter while being stored and are also likely to be further compromised with further seed coat damage induced through additional handling during storage transfer and cleaning. It is a recommended practice to get seed tested again in the spring for germination, vigour, and TKW.

Provincial Seed Survey

Each year, the Saskatchewan pulse and cereal commissions partner with commercial seed testing laboratories to complete an annual survey of seed-borne pathogens measured on seed grown in Saskatchewan during the previous season. All labs that offer seed testing services to Saskatchewan growers are invited to participate in the annual survey with anonymous reporting of results amalgamated by crop district from all participating labs. Interim seed quality data, collected from the time of harvest to the end of December, are summarized and communicated to growers, agronomists, researchers, and industry during the winter months, ahead of the next crop season. These interim results provide insights into seed quality trends and identify potential hotspots for seed-borne pathogens across the province. A final summary of results, including data from seed samples analyzed after the interim results, is reported at the end of May. This final summary is submitted for publication in the Canadian Phytopathological Society Canadian Plant Disease Surveys. This publication of the provincial survey provides a record of seed-borne pathogen trends in pulse and cereal crops and allows for continued tracking of diseases over time.

Acknowledgments

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Thank You to our Long-Time Lab Partners

for their continued volunteer participation in the annual seed survey!

20/20 Seed Labs Inc. never stop growing	**Nisku, Alberta** 1- 507-11 Avenue Nisku, AB T9E 7N5 Phone: 1.877.420.1810 www.2020seedlabs.ca
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PDSL	**Weyburn, Saskatchewan** 1105 Railway Ave, Weyburn, SK S4H 3H5 Phone: 1.306.842.7375 www.pdsl.net
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Pulses: 2021 Interim Results

The interim results of commercial plate tests for seed-borne pathogens of lentil, field pea, and chickpea samples reveal a high number of pathogen-free seed samples from across the province. Results to-date suggest an overall decrease in mean severity and infection levels of seed produced during the 2021 growing season compared to results from 2020 and is among the lowest mean infection levels and highest percentage of pathogen-free samples in the past seven years.

- Greater than 96% of lentil samples were free of seed-borne pathogens; samples that did have detectable levels of *Ascochyta*, Anthracnose, or *Botryti*s had a mean infection level below 1%
- Seed-borne *Sclerotinia* was not detected on any pulse samples.
- Seed-borne *Botrytis* was detected on less than 1% of lentil and field pea samples, but was identified on 9.7% of chickpea samples; mean infection levels were 0.5% or lower for all pulse samples.
- Seed-borne *Ascochyta* was detected on 25.1% of field pea samples, but mean infection levels (1.1%) were well below critical threshold levels.
- 27.1% of chickpea samples had detectable levels of seed-borne *Ascochyta*. On average, the level of infection was 1.3% and exceeded the critical threshold of 0.3%.

Distribution of submitted samples and crop districts reporting seed-borne pathogens varies across the province. Although the maps created by the Saskatchewan Ministry of Agriculture can help identify areas of lower risk of seed-borne disease, testing of individual seed lots is still recommended.

Table 3. Average percent of pathogen-free pulse seed samples and average infection levels measured in samples with disease analyzed as of December 28, 2021.

Crop	Number of Samples	Pathogen	Pathogen-free samples	Mean Infection[1]
			(%)	
Lentils	449	*Ascochyta*	99.8	0.3
		Anthracnose	96.6	0.7
		Botrytis	99.6	0.4
		Sclerotinia	100	0.0
Field Peas	402	*Ascochyta*	74.9	1.1
		Botrytis	99.2	0.5
		Sclerotinia	100	0.0
Chickpeas	59	*Ascochyta*	72.9	1.3
		Botrytis	90.3	0.3
		Sclerotinia	100	0.0

[1] Mean infection level of non-pathogen free seeds

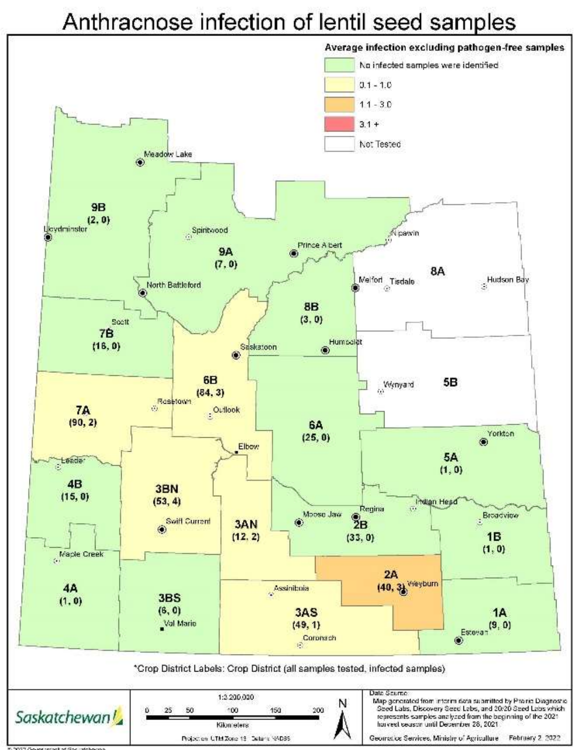


Figure 1. 2021 Interim Seed Test Result for Seed-Borne Anthracnose in Lentil. Source: Saskatchewan Ministry of Agriculture

Figure 2. 2021 Interim Seed Test Result for Seed-Borne *Ascochyta* in Field Pea. Source: Saskatchewan Ministry of Agriculture

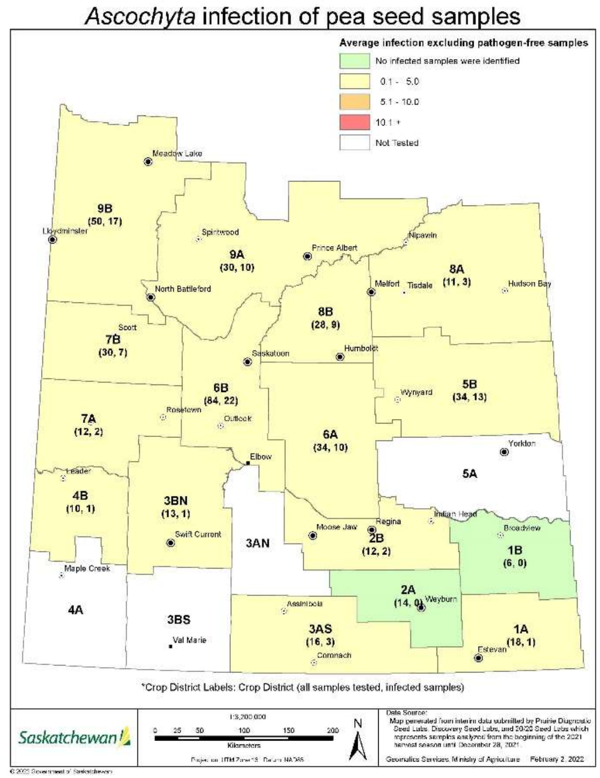
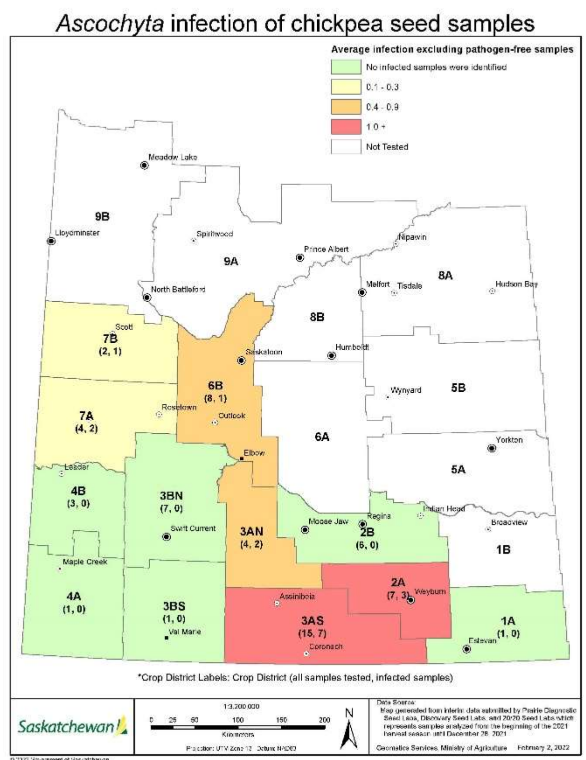


Figure 3. 2021 Interim Seed Test Result for Seed-Borne *Ascochyta* in Chickpea. Source: Saskatchewan Ministry of Agriculture



Cereals: 2021 Interim Results

The interim results of commercial plate tests for seed-borne fusarium pathogens reveal very low mean infection levels barley, durum, oat, and wheat samples tested as of December 28, 2021. The percentages of total *Fusarium spp*. and *F.graminearum*-free samples are trending higher across all cereal samples relative to the two prior seasons.

- *F.graminearum* was not detected on oat samples.
- *F.graminearum* was detected on less than 4% of barley, and wheat samples, but was identified on 20.1% of durum samples; mean infection levels were 1.1% or lower for all cereal samples
- The highest percentage of total *Fusarium spp.*-free samples were in durum (44.7%), followed closely by wheat (41.6%); durum and wheat also had the lowest mean infection levels of total *Fusarium spp.*, 1.7% and 2.3%, respectively.
- The majority of oat samples (94.6%) had detectable levels of total *Fusarium spp.* with a mean infection level only slightly lower than that measured in 2020 (7.5%).
- 81.1% of barley samples reported a detectable level of total *Fusarium spp*.; however, the mean infection level to date is below those measured in 2020 or 2019.

Table 4. Average percent of pathogen-free cereal seed samples and average infection levels measured in samples with disease analyzed as of December 28, 2021.

Crop	Number of samples	Total *Fusarium*		*Fusarium graminearum*	
		Pathogen Free Samples	Mean Infection[1]	Pathogen Free Samples	Mean Infection[1]
		(%)			
Barley	339	18.9	3.4	96.4	1.0
Durum	367	44.7	1.7	79.9	1.1
Oats	149	5.4	7.0	100	0.0
Wheat	752	41.6	2.3	96.8	0.9

[1] Mean infection level of samples with disease

Despite overall low levels of *Fusarium*-infected cereal seed lots being reported in interim results, seed quality does vary by crop districts as detailed by maps created by the Saskatchewan Ministry of Agriculture and it is recommended that seed lots should be tested on an individual basis.

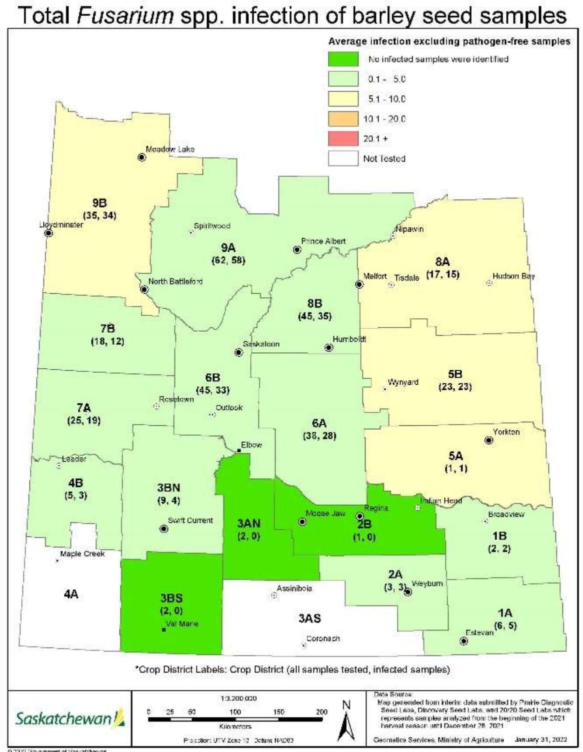


Figure 4. 2021 Interim Seed Test Result for Total Seed-Borne *Fusarium* in Barley. Source: Saskatchewan Ministry of Agriculture

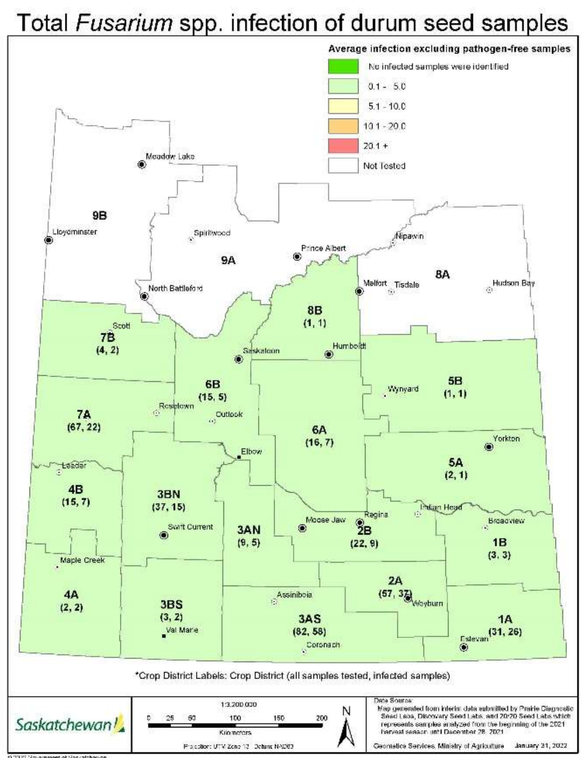


Figure 5. 2021 Interim Seed Test Result for Total Seed-Borne *Fusarium* in Durum. Source: Saskatchewan Ministry of Agriculture

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Figure 6. 2021 Interim Seed Test Result for Total Seed-Borne *Fusarium* in Oat. Source: Saskatchewan Ministry of Agriculture

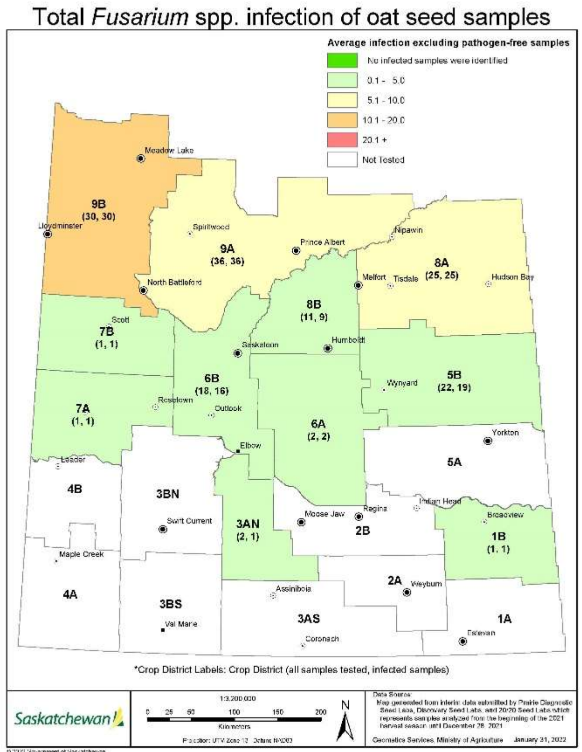
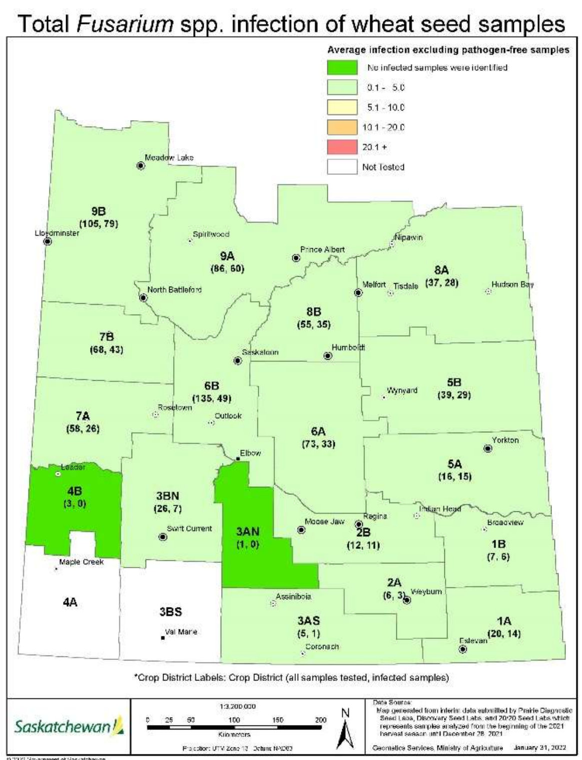


Figure 7. 2021 Interim Seed Test Result for Total Seed-Borne *Fusarium* in Wheat. Source: Saskatchewan Ministry of Agriculture



Seed Test for Crop Success

Seed is arguably the most valuable input for any crop and ensuring its quality is of utmost importance, regardless of the season. Although interim seed survey results show historically low levels of mean pathogen infection and high proportions of disease-free seed, other seed quality parameters such as germination and vigour may have been compromised due to increased levels of mechanical damage during a season characterized by extended periods of extremely hot and dry conditions. Seed testing in the fall is a great way to evaluate the seed quality potential of the seed source on farm, but seed testing for germination, vigour, and TKW should also be repeated in the spring to ensure no significant changes have resulted after extended storage and further handling. Final seed test results should be used to fine-tune seeding rate calculations to target optimal plant stands and help get the crop off to the best start possible in the spring.