Entrant's Report

Harvest 2021

Grower Information

YEN ID: Example Report

Province / State: Ontario/Michigan

Country: Canada/USA

Crop: Winter Wheat

Variety: 25R46

The 2021 YEN pilot saw completed entries from **43** fields.

- The average grain yield for the Great Lakes YEN 2021 pilot was **115.04 bu/ac** across all farms including Ontario, Michigan and Ohio.
- The average yield potential (determined using crop modeling) was **220.24 bu/ac** and the average % of potential yield achieved was **52.54%** across all farms including Ontario, Michigan and Ohio.
- Your entry yield of **Insert Value** bu/ac ranked **Insert Rank** for absolute field yield within all YEN field entries.
- Your entry represents **Insert Value**% of an estimated yield potential of **Insert Value** bu/ac at your site in 2021, which ranked **Insert Rank** for achieving the highest percent of potential yield within all YEN field entries.

Table 1. Grain yield in bushels per acre for top 3 entries in Great Lakes YEN plus your entry.

Rank	Grain yield (bu/ac)
1	**152.75**
2	151.31
3	148.61
xx	**xxx.xx**

Table 2. Top three entries for percent of yield potential plus your entry.

Rank	% Yield Potential
1	**73.68**
2	66.96
3	66.57
x	**xx.xx**

CONTENTS

Our detailed analysis of your yield result is provided in the following pages, including comparisons with other YEN entries from data taken throughout the field season. We hope that this helps you to identify aspects of your management and growing conditions that offer possible routes to further enhance yield on your land.

Our approach in this report is to consider yield potentials and growing conditions for crops in the 2020-21 season, then the agronomy of your crop, its development, the basic resources (light, energy & water) available to it, its success in capturing these and in converting them to grain. Lastly, we use grain analysis to provide a post-mortem analysis on your crop's nutrition.

Contents

Potential Grain Yields

To estimate potential yields we assume a theoretically 'perfect' variety grown with 'inspired' management on your land with its 2020-21 weather, achieving:

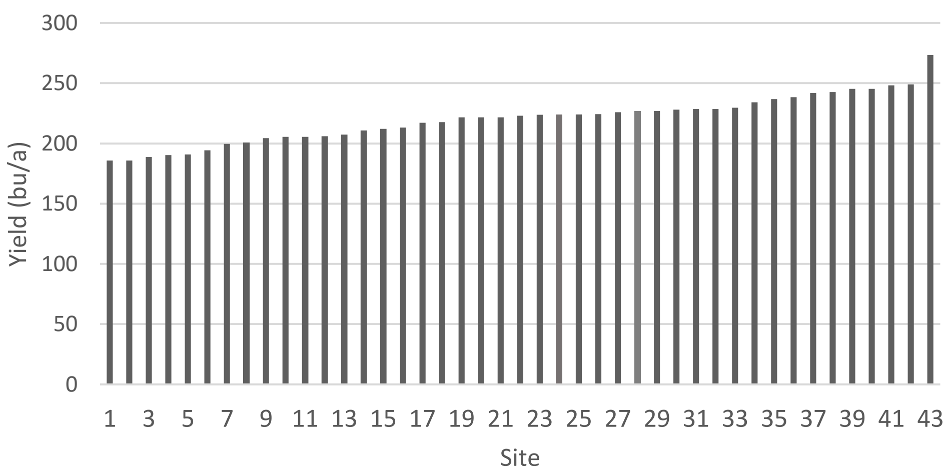
(1) **70% capture of light energy** from greenup to flowering and **95% capture of light energy** from flowering to maturity.
(2) **A conversion efficiency of 1.54 tonnes of biomass per terajoule** of captured light energy.
(3) **A harvest index of 0.58** meaning 58% of biomass is converted to harvested grain.

Biomass accumulation in (2) is constrained by water availability using the following rule:

(4) **Capture of all the available water** held in the soil to 1.5 m depth (or to rock if less) plus all rainfall from April to July. Crop must have access to 18 mm of water per tonne of biomass. Crop biomass (2) is scaled down if water availability is insufficient.

2021 Potential Yields

The table below shows the potential grain yields in 2021. They ranged from 185.84 bu/ac to 273.48 bu/ac.



***Your entry highlighted in orange.**

Summary

The 2020-2021 competition:

- Congratulations and thank you for providing the information necessary to complete this report; the collective efforts of all the Great Lakes YEN contributors serve to maximize the value of what can be reported and the deductions that can be made for everyone – we call this 'share-to-learn'.
- We have 43 entries in our first pilot Great Lakes YEN. The more participants we have, the more robust and confident we can be in the comparisons we make, both at the individual 'benchmarking' level, and when analyzing the whole set of data.
- The winning percent potential was 73.7%.
- The highest grain yield in 2021 was 152.8 bu/ac.

- In terms of physiology, results over more than 8 years of the YEN in the UK show that high yields tend to be associated with high ear numbers and high total biomass; the latter is more important than high harvest index in explaining high yields. This indicates the importance of striving for better light and water capture.
- Winter wheat was off to a great start in 2020-2021 with good tiller numbers going into winter.
- However, a relatively dry spring and summer across much of the arable area of the Great Lakes region in 2021, particularly through June, meant that late growth, grain set and grain filling were all disappointing.

Summary of Your Entry

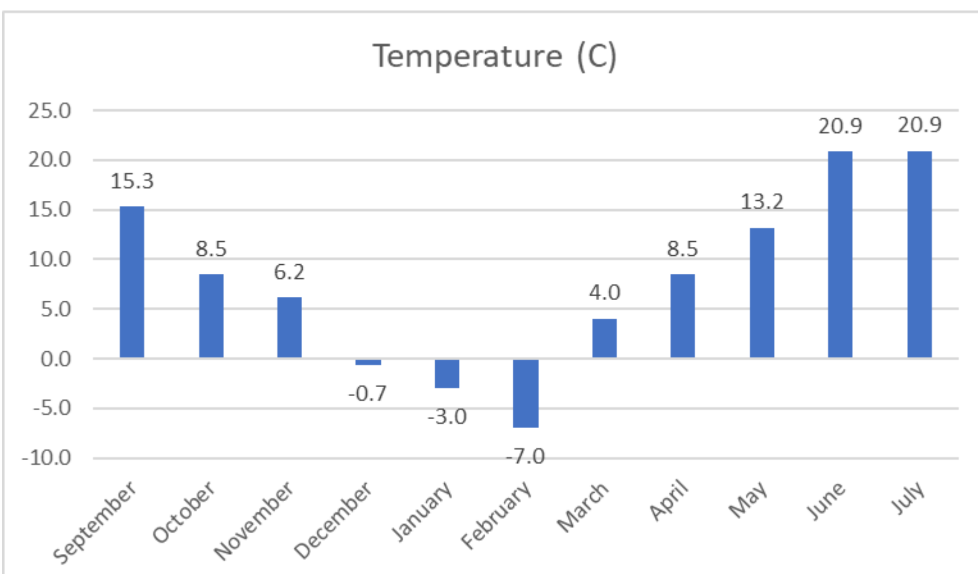
- High YEN yields have generally been associated with high biomass production high heads per metre square and high nitrogen applications and uptake.
- Our target for annual light interception by annual crops (whether sown in autumn or spring) is 70%, compared with 77% achieved by crops in this region this year.
- YEN entries had a range of protein levels from 8.17% to 13.69%. Lower protein levels indicate the crop may have not been adequately fertilized.

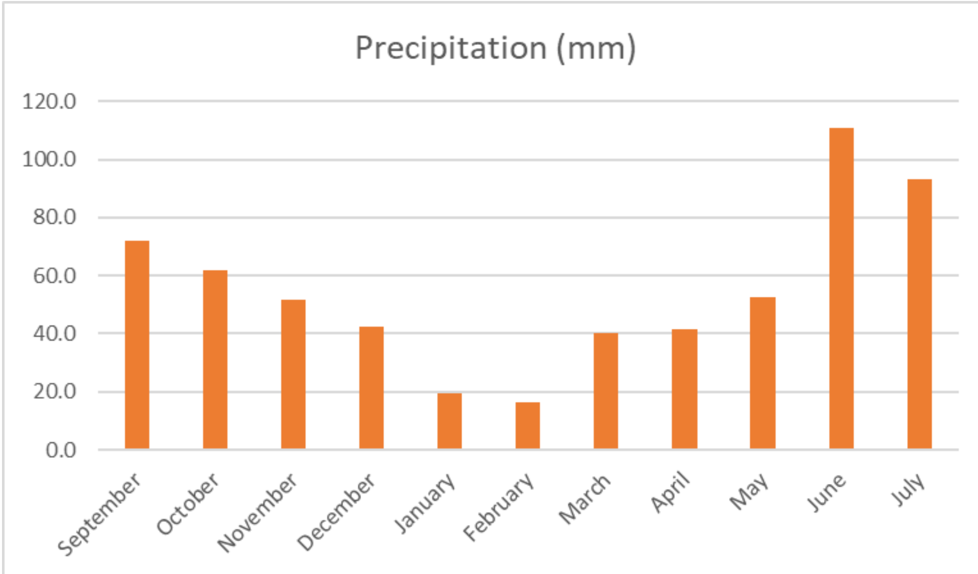
Growing Conditions

2020-2021 Weather

The tables below show the average monthly temperatures and rainfall for the Great Lakes region in the 2020-2021 growing season. Data in these tables are an average of all locations across the region. There was a great deal of variability from farm to farm not captured in these tables.

The key defining features of the season were a warm winter, with minimal freeze-thaw events resulting in minimal losses over winter. March was warm and bright, while April turned cold and dry for many. May was cool, dry and cloudy in the beginning of the month but more seasonal temperatures and bright sunlight closed out the month. June was warm with increased rainfall particularly during the later growth stages. July remained wet for much of the region resulting in a delayed harvest and lower quality for many.





Overall crop progress

Conditions for fall seeding were excellent with most fields being well established before going into winter. Fields tillered well.

Winter was mild with minimal snow coverage in the south but more as you moved east and north providing insulation against cold temperatures. Very few damage reports from winterkill were reported.

With the warm dry weather in March, root development and growth resumed but things turned cold again resulting in nutrient deficiencies across the growing region, particularly manganese.

For March, April and May disease and insect levels were relatively low. However, some regions did experience high levels of powdery mildew early in the growing season. Cold temperatures delayed herbicide and fungicide applications and once the weather warmed, applications resumed. These cold temperatures also meant crop progression slowed.

In the early days of June, some areas experienced cold temperatures resulting in some frost injury, particularly in areas that were at pollination development. Quickly the temperatures warmed again and fungicide applications were made in a timely manner during pollination to protect against fusarium head blight. Applications at this stage were also made to manage powdery mildew that continued to make it's way up the crop canopy. Insects were a concern in some regions with aphids, cereal leaf beetle and thrips being found. However, for the most part, the level of insect feeding/damage was below thresholds. At the end of June, much of Michigan and Ontario experienced a significant thunderstorm that resulted in the wheat lodging in many fields. Some fields did manage to stand back-up, but many fields remained flat right through to harvest. Where PGRs were used the lodging was often delayed or reduced.

The rainfall at the end of June continued well into July making for a very challenging harvest. The persistent rain delayed harvest for many and in fields that were physiologically mature, sprouting and alpha amylase production began to become an issue. While falling numbers were good at the beginning of harvest, they quickly began to fall and remained that way right through to the end of harvest. The various challenges across the great lakes region resulted in variable yields across the board.

Site overview

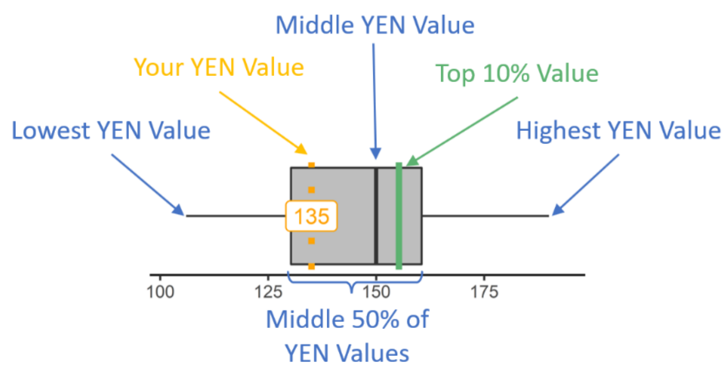
Farm descriptions of topsoil and subsoil stone content, texture and depth allow us to estimate soil water holding capacity and, along with summer rainfall, to estimate the water available to each crop; this is critical in estimating potential yields.

Topsoil analyses provided through the lab tell us texture, organic matter, OM activity and nutrient status. These are summarized in the following benchmarking charts and indicate any possible nutritional limitations to yield.

Topsoil textures generally agreed well with farm-defined topsoil textures. A&L labs (Michigan) and Honeyland (Ontario) determines soil organic matter by 'loss on ignition'. Beware that SOM by other methods can give somewhat lower values. A few sites showed low values for soil pH, P, K and Mg. These merit further checks, initially through grain analysis (see later).

YEN Benchmarking charts – What do they mean?

YEN is much more than a competition – it provides a full set of metrics whereby you can gauge the performance of your crop against all other YEN crops. This has proved to provide the prime value of the YEN to many participants. We do this with benchmarking charts. Benchmarking charts compare your value with everyone else's in 2021. The key to these charts is as follows:



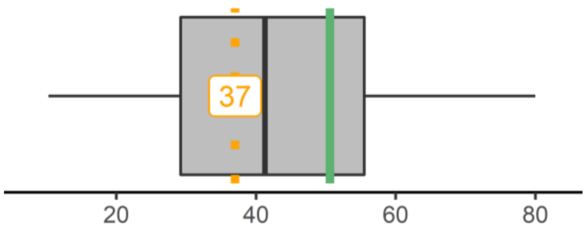
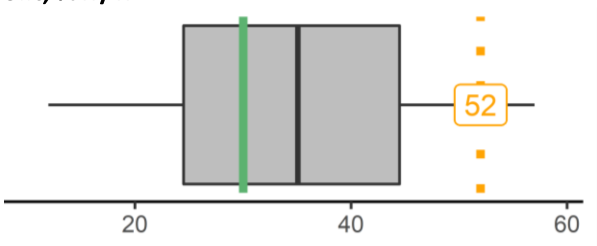
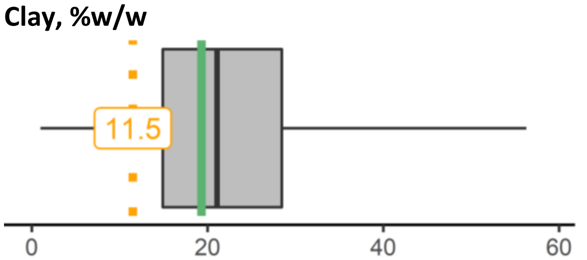
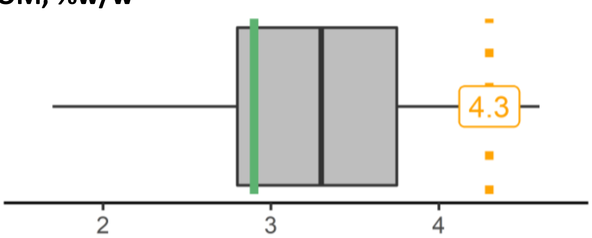
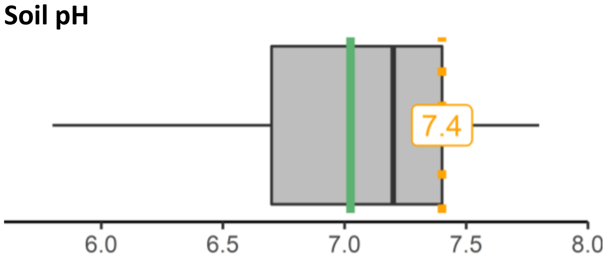
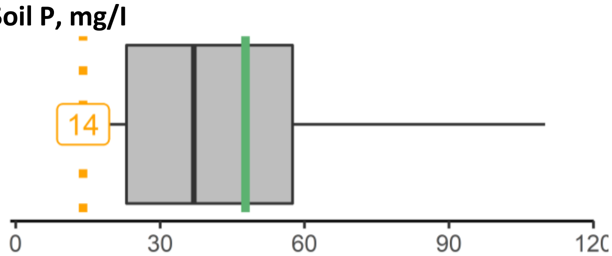
The 'whiskers' show the range of YEN values in 2021 and the box shows the middle half of YEN 2021 values, with a line for the median-value. The yellow dashed line is your value and the green line is the average value of the top 10% of the highest yield potential achieved.

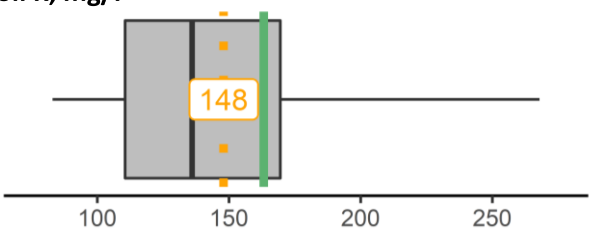
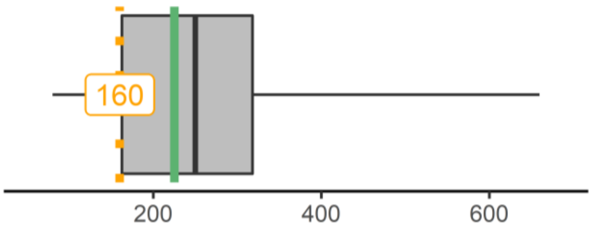
Nutritional status

Through grain analyses, YEN data indicate that Great Lakes cereal crops often experience deficiencies of one or more nutrients that we test for. The YEN provides comprehensive leaf analyses on two occasions, stem elongation and flag leaf emergence.

Eight soil traits are reported on the next page, then the leaf analyses are reported on subsequent pages. No critical thresholds or benchmarks are shown for leaf analyses because these change through a crop's life and are still uncertain. However, the benchmarking diagrams should enable you to compare your YEN crop with all other YEN entries, analyzed at the same time.

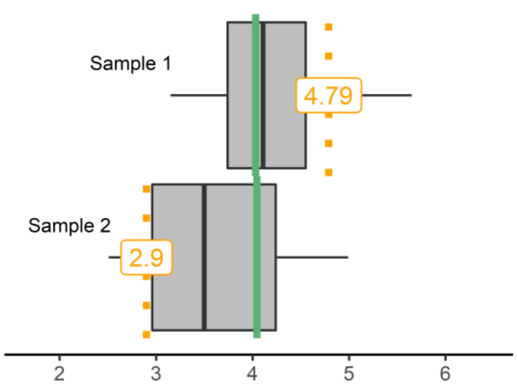
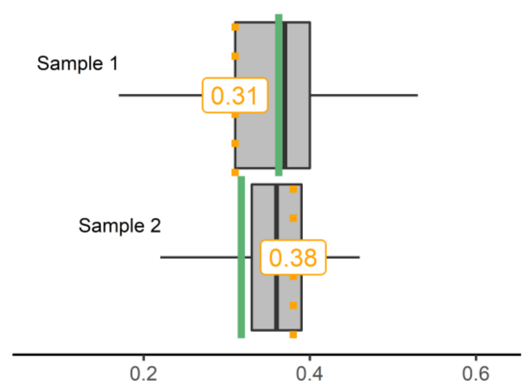
Soil Analysis

Sand, %w/w 	Soils with high sand content hold the least water and soils with high silt content tend to hold the most water.
Silt, %w/w 	Soils with mostly silt and sand, hence less clay, tend to be relatively weak, and so are more difficult to manage with a stable structure.
Clay, %w/w 	Soils with high clay content hold much water but part of this is held too tightly for crop use. Nutrients within this unavailable water tend to be less available than nutrients in lighter soils.
SOM, %w/w 	A&L/Honeyland labs determine soil organic matter by loss on ignition.
Soil pH 	High pH soils may require that special attention is paid to micro-nutrient levels.
Soil P, mg/l 	Soil p values greater than 20 ppm (Bray P1/Olsen) are considered sufficient. Use grain P to check if P was sufficient. If lower soil tests and lower grain accumulation better crop performance would be possible with added P at planting.

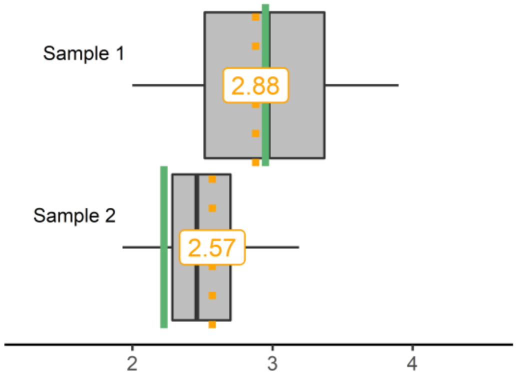
Soil K, mg/l	
	Soil potassium analysis provides a reliable check on whether K supplies are likely to be deficient for average crops. However, high yielding crops require very large amounts of K.
Soil Mg, mg/l 	Magnesium is a key component of chlorophyll so deficient plants show striking inter-venial yellowing. Temporary deficiencies often occur in dry conditions.

Leaf Tissue Analysis

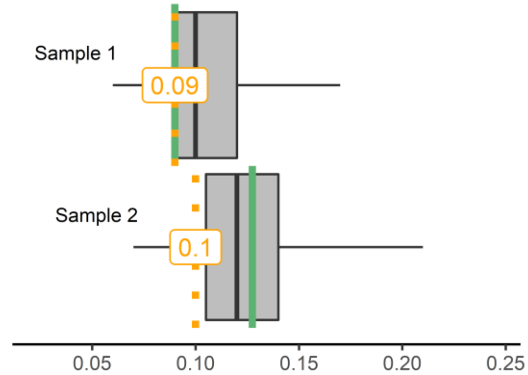
Tissue analyses were performed by Honeyland Ag and A&L Labs on samples of the newest fully expanded leaf early at GS 30-31/Feekes 4.0-6.0 and late at GS 39/Feekes 9.0. In these diagrams the early sample is on top (Sample 1). Late sample is on the bottom (Sample 2).

N (%, DM)	P (%, DM)
	

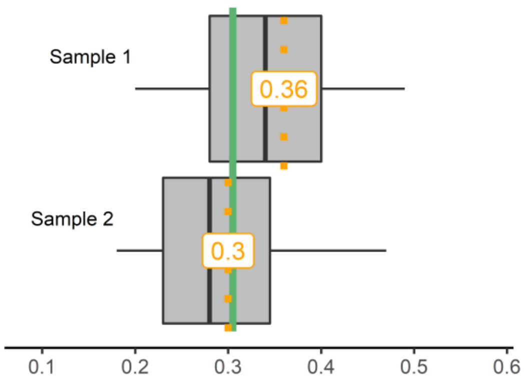
K (%, DM)



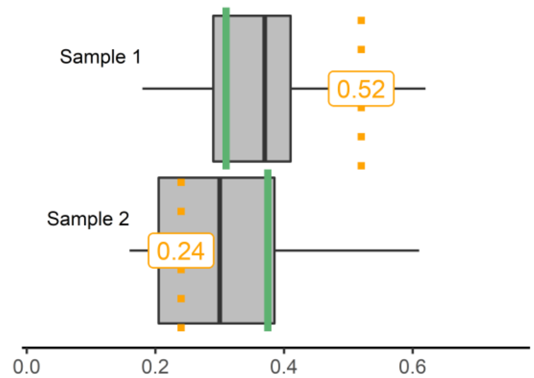
Mg (%, DM)



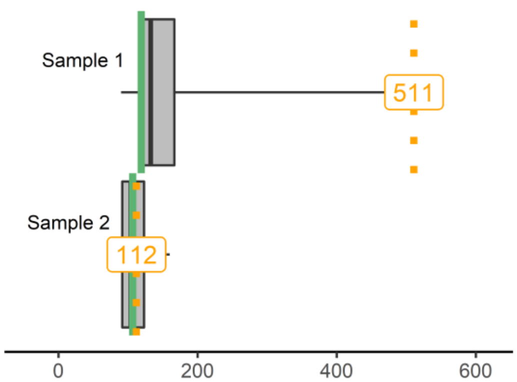
S (%, DM)



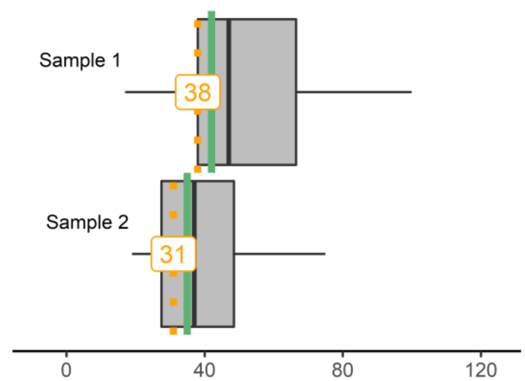
Ca (%, DM)



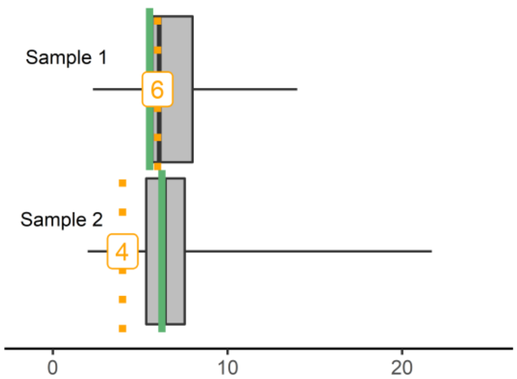
Fe (ppm)



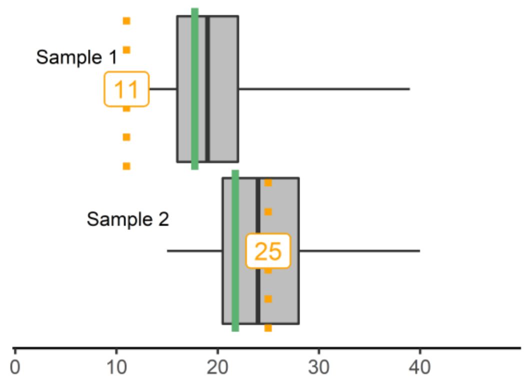
Mn (ppm)



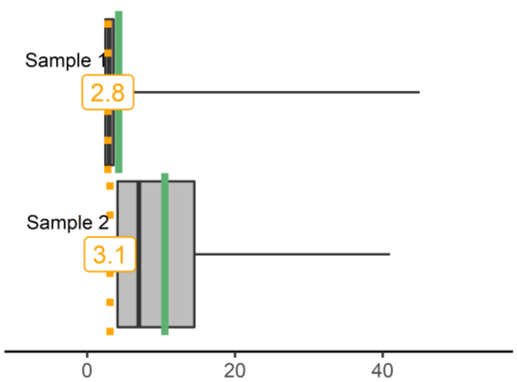
Cu (ppm)



Zn (ppm)



B (ppm)



Agronomy

Analysis of Great Lakes YEN data accumulated over the last year has shown that, although season has the largest effect on yields, farms are relatively consistent in their performance. Hence it should be possible to learn from the best performing farms, and we can highlight the management practices that are associated with high yields. In summary, we are concluding that:

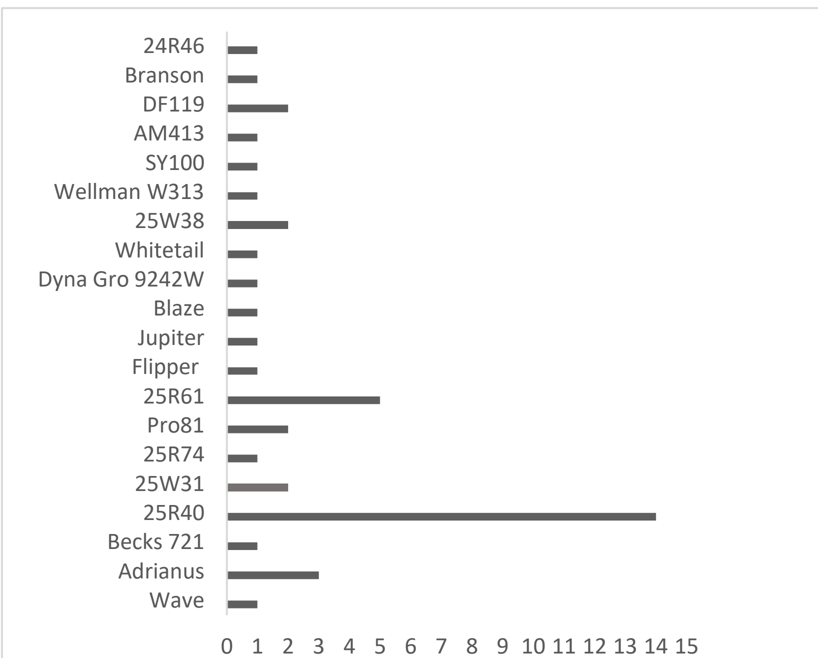
- 150 bu/ac is possible almost anywhere! High yields are not restricted to just one part of the Great Lakes region.

- Attention to detail is important. Aspects of this that appear significant include:
  - Planting date
  - Fertility - applying manure and/or phosphate
  - Adequate N use, including multiple applications
- Other High Yield Associations include:
  - Weather: dry, bright autumns and winters, bright springs and cool summers
  - Nutrition: most crops suffer some deficiencies.

The following charts show how the management of your entry related to all other Great Lakes YEN entries in 2021.

Varieties

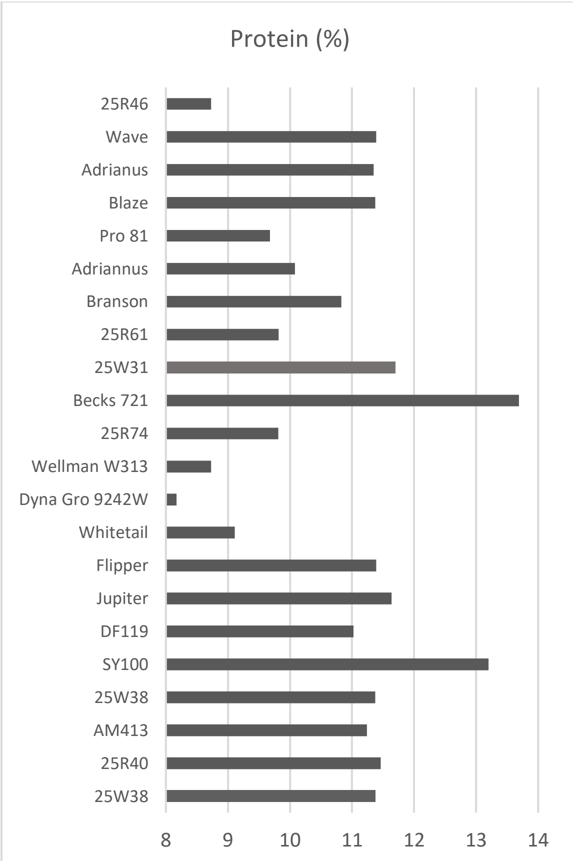
YEN entries in 2021 included 20 different varieties!

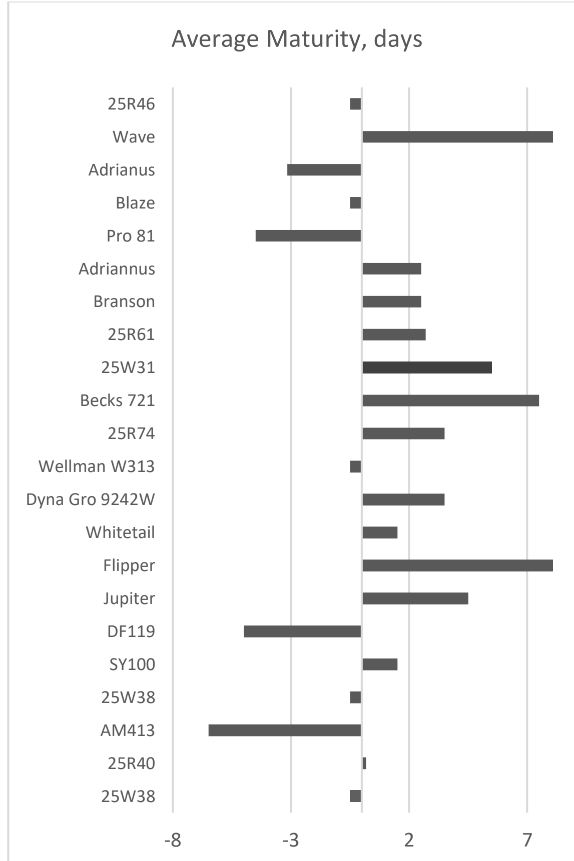


- Protein: YEN entries had a range of protein levels from 8.17% to 13.69%.

- Maturity: The average flowering date was 153 (June 2).

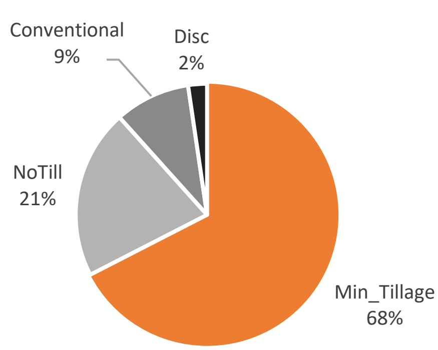
- Grain Fill: The grain fill period extends from flowering to hard dough. The average grain fill period in days for: MI = 28.9, OH = 20.0, ON = 42.7.



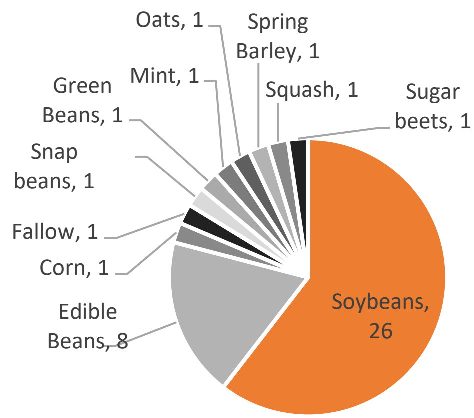


Orange segments or benchmarking charts in the following diagrams show the agronomy of your crop, if known, compared to all other Great Lakes YEN entries.

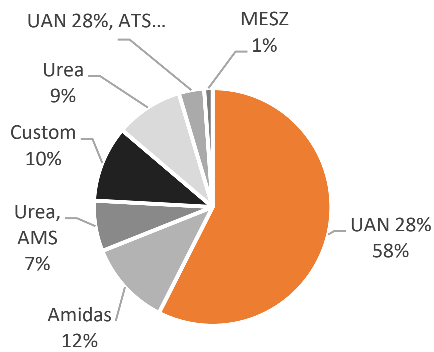
Cultivation Strategy:



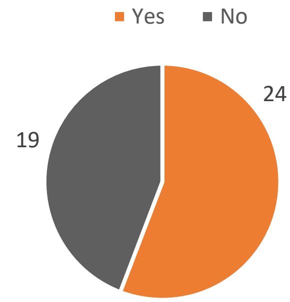
Previous Crop:



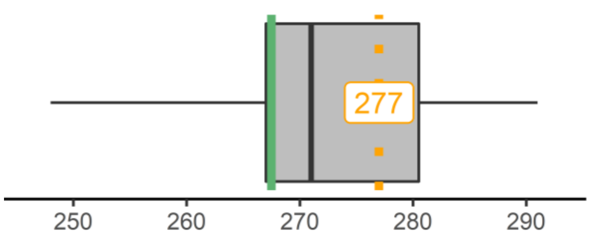
Form of Nitrogen Applied:



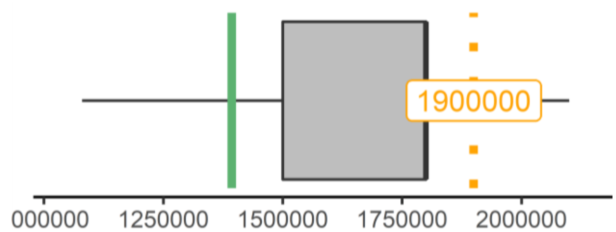
History of manure or organic amendments applied:



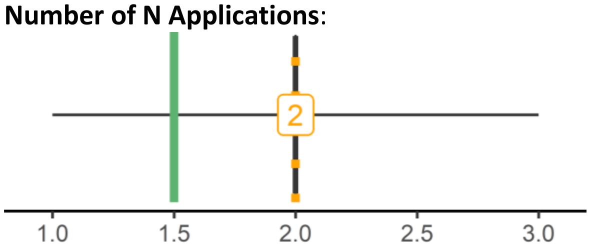
Seeding Date (Julian):



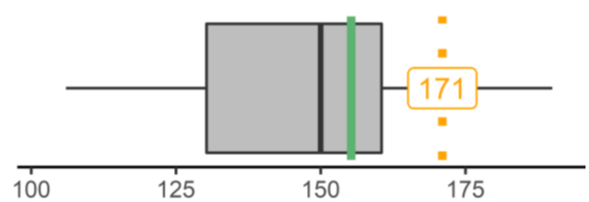
Seeding Rate (seeds/acre):



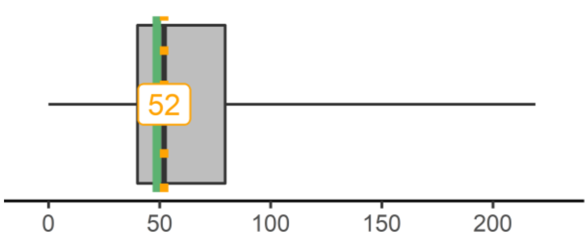
Number of N Applications:



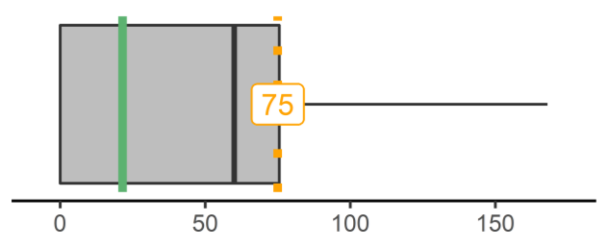
Total actual N applied (lbs/acre):



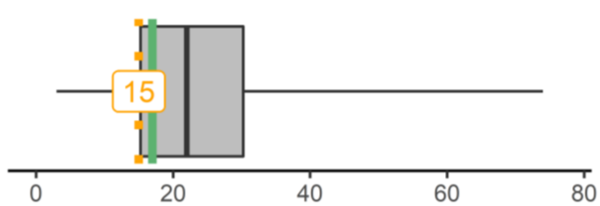
Total P2O5 Applied (lb/ac):



Total K2O Applied (lb/ac):



Total SO3 applied (lb/ac):



Crop Protection

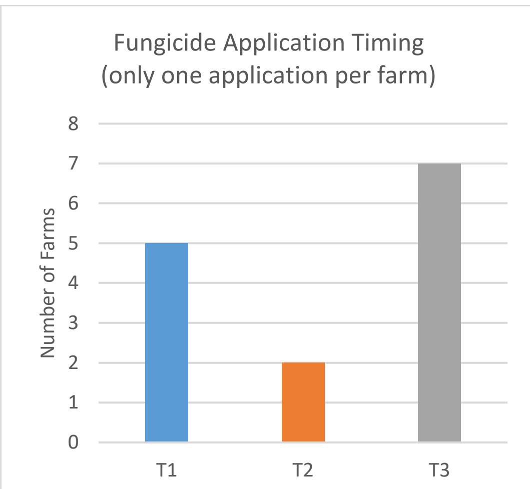
Number of Farms Making Crop Protection Applications

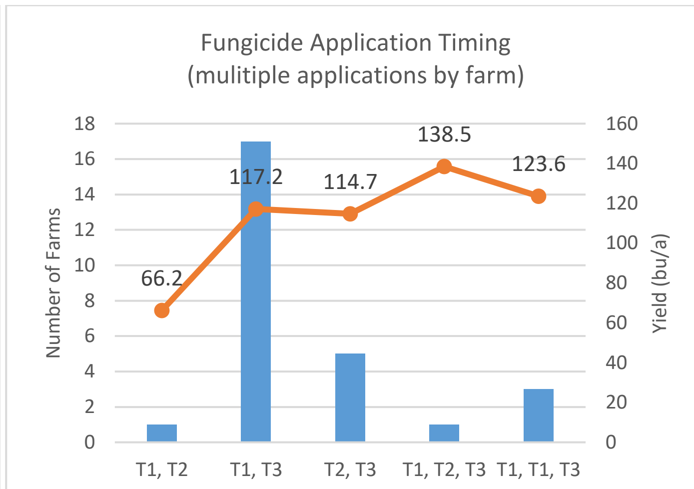
Every farm in the YEN made at least one application of fungicide. More farms in Ontario applied PGR's. Only farms in Michigan applied insecticides.

Fungicide	PGR	Insecticide
18-MI	4-MI	13-MI
2-OH	2-OH	0-OH
23-ON	14-ON	0-ON

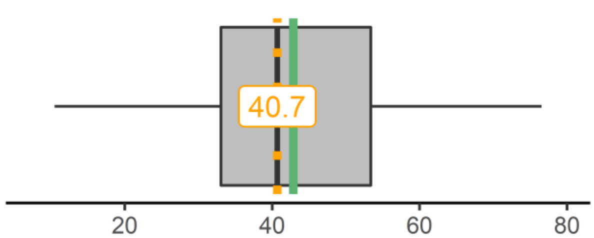
Fungicide Application Timing

Few farms made only single applications of fungicide. Most farms used some combination of T1 (early), T2 (boot/flag) or T3 (anthesis). The chart on the right shows the average yield of each combination of timings.

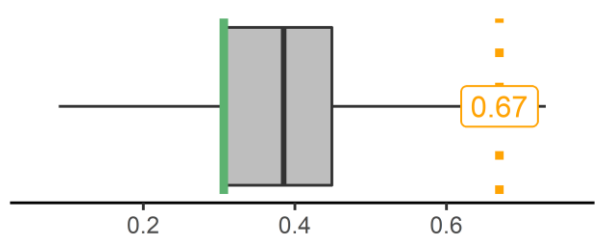




Crop protection spend/ac:



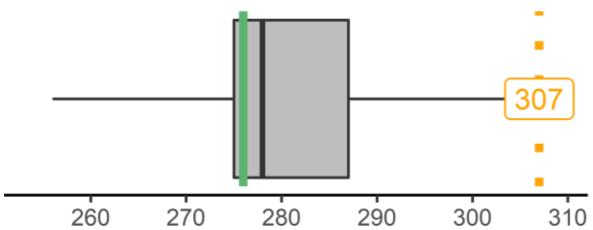
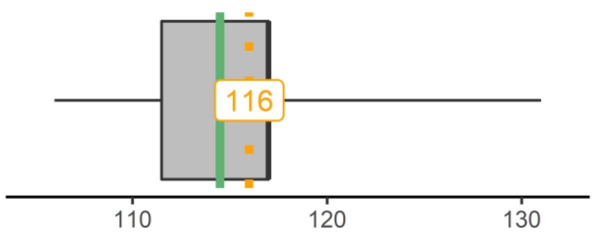
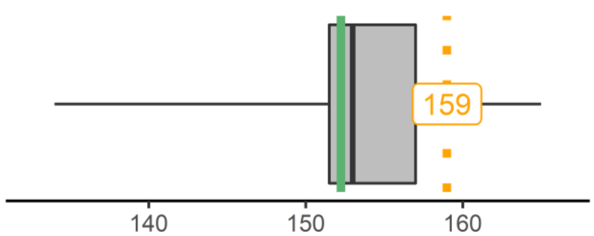
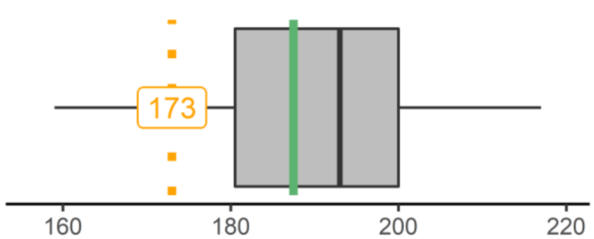
Crop protection spend per bu of grain:

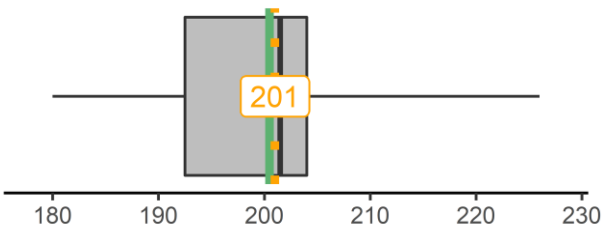
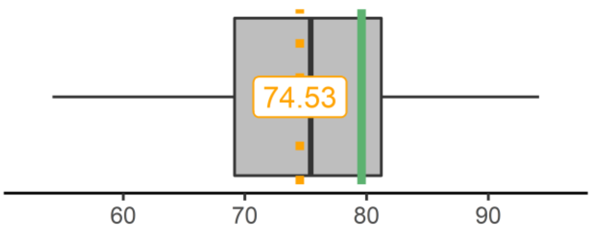


Crop Development

The following charts show how your entry developed through the 2020-21 season, compared to all other Great Lakes YEN entries. The stages of emergence (GS10/Feekes 1.0), start of stem extension (GS31/Feekes 6.0), flowering (GS61/Feekes 10.5.1) and physiological maturity (GS87/Feekes 11.2) determine the lengths of the key growth phases:

- Emergence to tillering, GS10-GS31 (Feekes 1.0 – 6.0) – when tillers and main root axes are formed,
- Tillering to stem elongation, GS31-GS61(Feekes 6.0 – 10.5.1) – when yield-forming leaves, ears and stems are formed, including soluble stem reserves
- Stem elongation to senescence, GS61-GS87 (Feekes 10.5.1 – 11.2) – when grains are filled, both with new assimilates and reserves redistributed from stems.

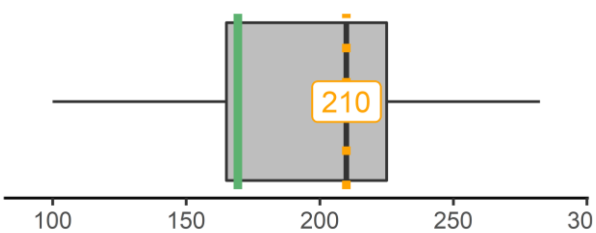
<table>
<tr><td>Emergence date (Julian):

</td><td>Winter wheat fields were all sown in the fall, mostly within their optimum seeding date range.</td></tr>
<tr><td>Stem Extension (GS 31/Feekes 6.0): 116=April 26

</td><td>GS 31 means the end of tiller production and the start of tiller survival. This year it was early to average timing.</td></tr>
<tr><td>Flowering date (GS 61/Feekes 10.5.1):

</td><td>At GS 61 crop construction and grain set finish and grain filling begins.</td></tr>
<tr><td>Hard Dough (GS 87/ Feekes 11.2):

</td><td>Ideally, for high yields, canopies would stay mostly green for 45 days after flowering.</td></tr>
</table>

Harvest Date: 200=July 23 	Harvest was normal to late this year due to prolonged wet conditions.
Crop Height (cm): 	Crop height was lower than average this year. Likely due to weather conditions during stem elongation phase.

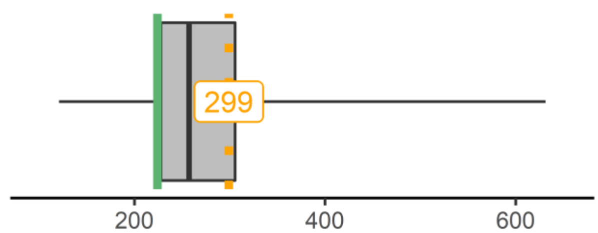
Resources & Their Capture

Water Capture

Soil water holding capacity (mm):



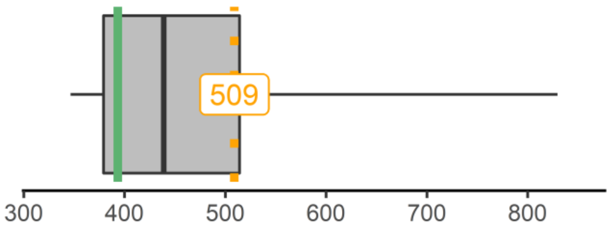
Rainfall April – July (mm):



The soil water holding capacity quoted here assumes roots could access all soil water to 1.5 m. If sufficient roots didn't reach this depth, soil-available water would be accordingly less.

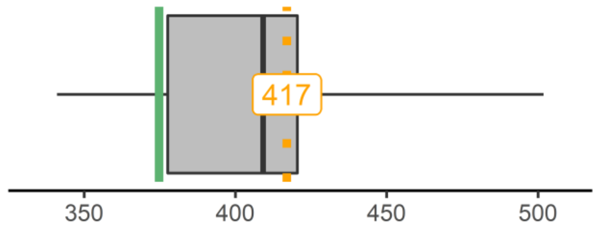
While we cannot yet measure water captured by crops individually, by assuming your crop's conversion of water to total biomass was 'normal' (18 mm water for each t/ha biomass), we have made crude estimates below of the likely success of your crop's root system in capturing water.

Total water available (mm):



The water available to your crop was 509.0 mm, sufficient to support 28.3 t/ha biomass.

Estimate use of available water (mm):



Capture of available water exceeding 100% suggests deeper rooting than the estimated maximum.

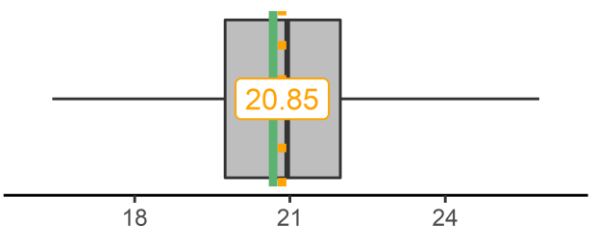
Summary: A high yielding crop, growing 20 t/ha of biomass (so yielding 169.88 bu/ac grain at 58% harvest index), would need to capture ~360 mm water from soil plus summer rain. This year many crops, especially those that did not receive heavy rainfall throughout May and June, needed to capture much of their soil held water, and water supplies were probably inadequate for some crops.

Energy Capture

The benchmarking charts show what the weather conditions meant for light energy available for this entry and other entries in 2021. Solar radiation has been divided into periods that roughly equate to the three key phases of crop development defined by your crop's development stages, reported earlier:

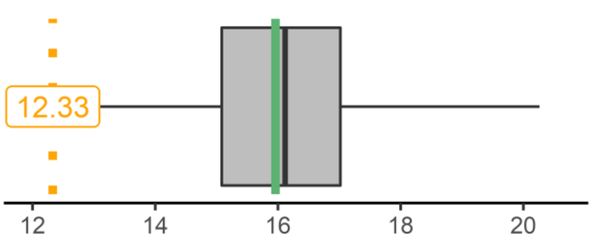
- Emergence to tillering – when tillers and main root axes are formed,
- Tillering to stem elongation – when yield-forming leaves, ears and stems are formed, including soluble stem reserves
- Stem elongation to senescence – when grains are filled, both with new assimilates and reserves redistributed from stems.

Incident Solar Radiation Total – (TJ/ha/year):



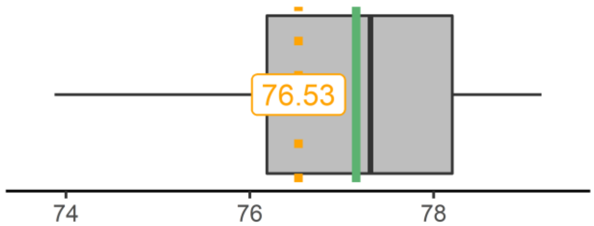
The total solar radiation this site received was 20.85 TJ/ha, compared to 20.77 TJ/ha Ontario/Michigan average.

Intercepted Solar Radiation Total – (TJ/ha/ green-up to maturity):



While we cannot yet measure light capture by YEN crops individually, by assuming your crop's conversion of light-energy was 'normal' (1.54 t/TJ), we have made a crude estimate of the likely success of your crop's canopy in capturing total light-energy from green-up to maturity.

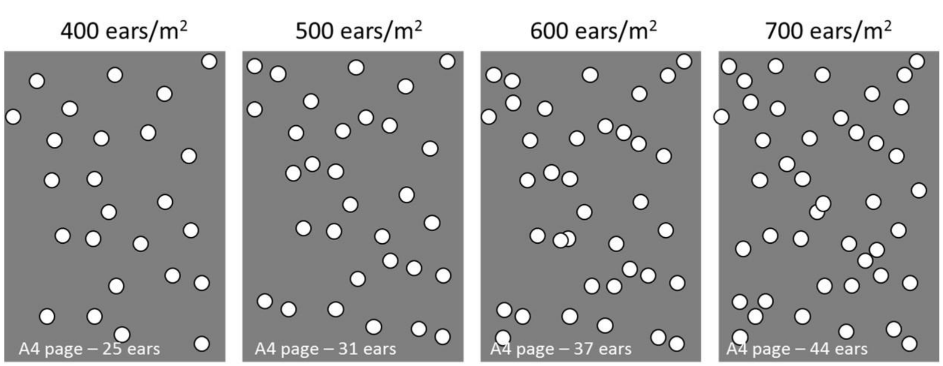
Estimated % solar radiation captured:



We take the biophysical limit for annual light interception as 76.5%. The benchmark wheat crop intercepts 75% of light from greenup to flowering and 95% from flowering to maturity.

Image of this entry

Images are a very efficient way of collecting lots of information. An overhead photo taken during grain filling gives an impression of canopy size, nutrition and health, as well as providing an independent assessment of ears per m2 (see diagram below). An overhead photo taken at the start of stem extension is similarly useful.



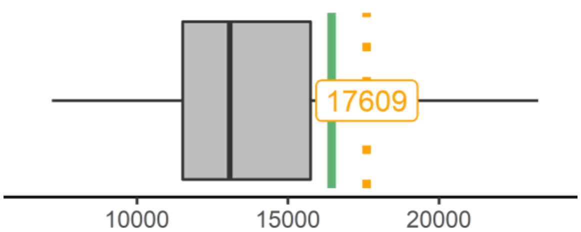
Yield Analysis

Yield Information

The whole-crop samples that were collected just prior to harvest were all analyzed for their components and results are shown in the following charts, assuming that each sample was representative of the whole area from which grain yield was determined.

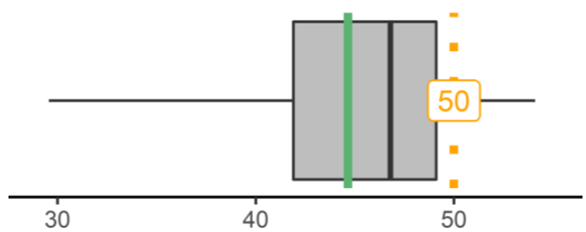
Total biomass production indicates the success with which a crop captured its key resources, light-energy and water, and the harvest index (the proportion of total biomass that was harvestable) indicates how this biomass was apportioned to grain. Since grain growth happens last, harvest index also indicates how late growth related to early growth. Your grain yield (expressed as bu/ac and % of potential) is shown below along with biomass and harvest index, in relation to all other Great Lakes YEN entries.

Total Biomass (lb/ac):



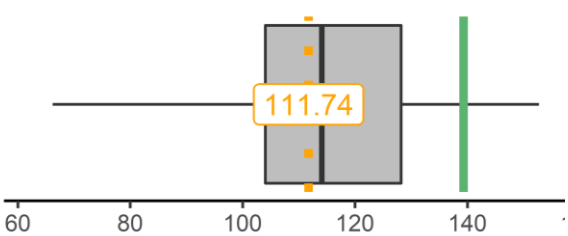
YEN biomass values in 2021 are generally high. High biomass often related to high yields.

Harvest Index (%):



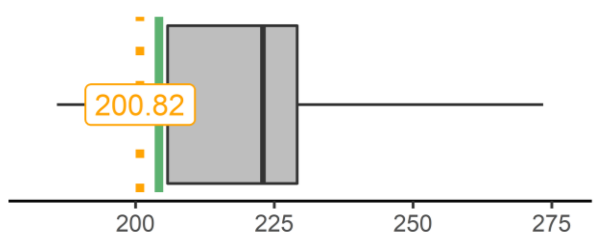
Harvest index is the percentage of total biomass that was harvestable as grain; values were low to average in 2021.

Grain yield (bu/ac):



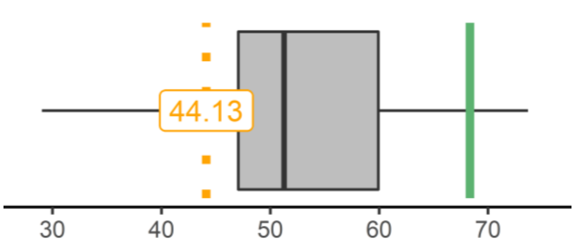
YEN yields averaged 111.74 bu/ac in 2021.

Grain Yield potential (bu/ac):



YEN yield potentials express the light energy and water available for your entry this year converted to bu/ac.

% Yield potential:

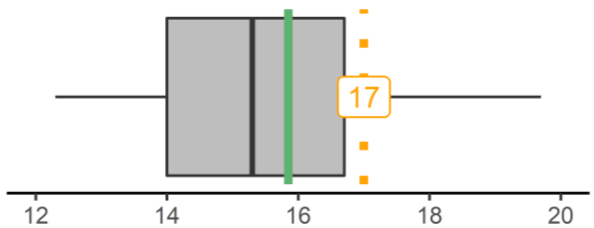


Yields achieved by YEN entrants in 2021 averaged 44.13% of potential.

Yield Components

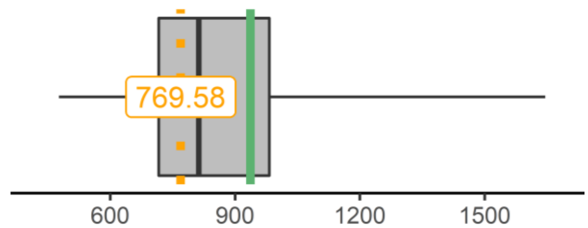
Whole crop yield analysis can also tell us about the history of your crop because the different components are determined sequentially. Comparing components of yield for your crop in the following charts with those of other YEN entrants should help to indicate the stage(s) through the season at which your crop deviated from normal.

Spikelets, #/ear:



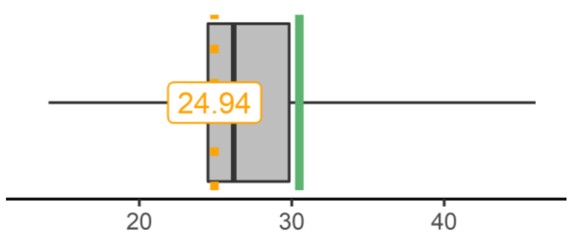
Spikelet numbers are determined between GS30/Feekes 5.0 (ear at 1cm) and GS 31/Feekes 6.0 (1st node). Numbers are not crucial because grains per spikelet is flexible and can compensate.

Heads, #/m2:



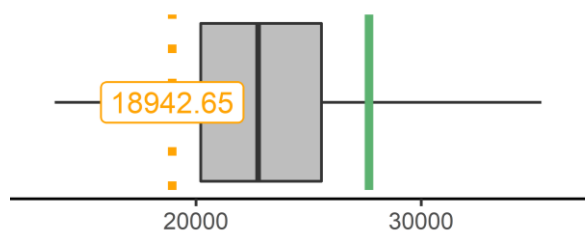
Ear numbers were high in 2021. High yielding crops tend to have many ears. Ear numbers under 400 per m2 cannot be fully compensated by grains/ear or TGW.

Grains, #/head:



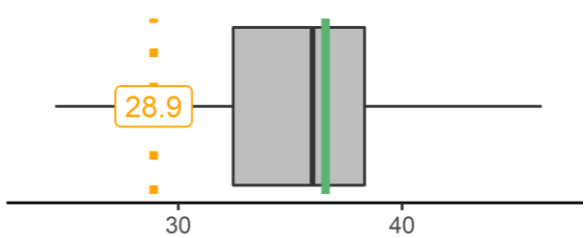
Grains per ear were low in 2021. Grain set often compensates for variation in ear numbers, so grains/m2 relates better to yield.

Grains, #/m2:



Grain numbers were average to high this year. High numbers of grains (>25,000/m2) are normally necessary for very high yields.

Combine TGW, g (15% MC):



Thousand grain weights (TGW) were small in 2021.

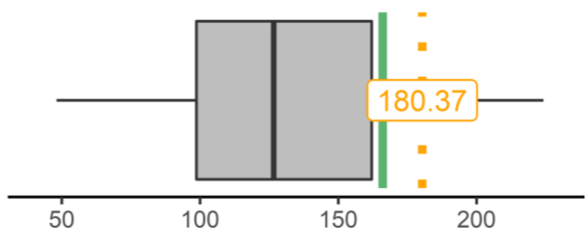
Test Weight (lb/bu):

Min	Max	Mean	Your Value
55.2	64.8	60.1	58.7

Crop Nutrition Post Mortem

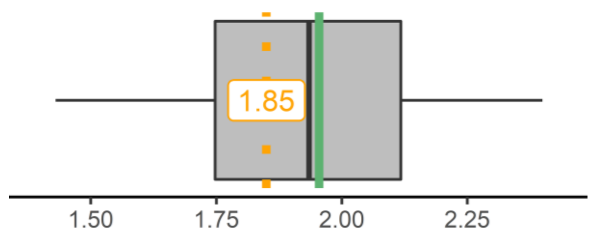
- 43 grain and soil samples were analyzed in 2021.
- N and S are primarily used to form endosperm proteins. These, and the mineral nutrients in grain (contained mainly in the bran or germ), may usefully be taken to reflect the nutritional history and status of the crop through its life. The literature suggests 'critical' concentrations in grain for a few nutrients, but for all nutrients it is possible to relate their individual levels to both all other nutrients in the sample, and all other YEN samples, hence indicating which nutrients were most limiting.
- Grain protein levels can be compared to those reported in the Ontario Cereal Crop Committee Performance Trials or Michigan Wheat Variety trials for the same variety. If the observed protein level is significantly more or less than we attribute this to the level of nitrogen nutrition of the crop.
- Reliable low limits (deficiency levels) in grain are only available for N, S and now P. However, from the following benchmarking charts, you should be able to identify the nutrient(s) most likely to have limited your crop by comparing with the mid-level in all the other YEN samples.

Crop N uptake, lb/ac:



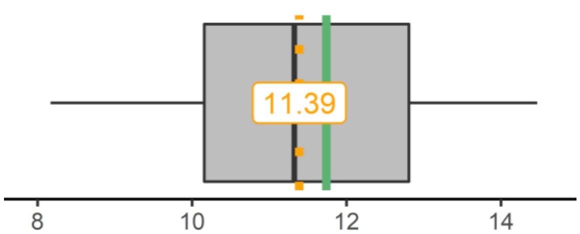
Uptake of 160 lbs/acre N is required to build a canopy that fully intercepts light (ADAS).

Grain N, %



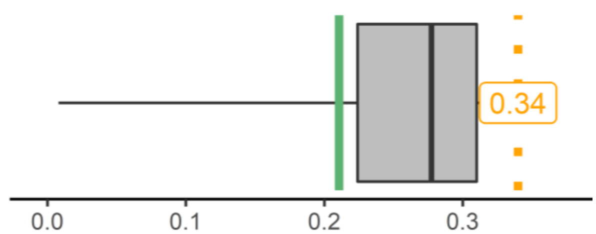
The majority of N in wheat grains is held in the endosperm as the storage proteins, gliadins (providing dough extensibility) and glutenins (providing dough elasticity).

Grain protein, %



Low protein indicates a likelihood of inadequate N supply.

Grain P, %



Recent work has shown grain P analysis can provide a useful check on sufficiency of phosphorus. Values less than 0.32 indicate a need for further checks on P supply and capture.

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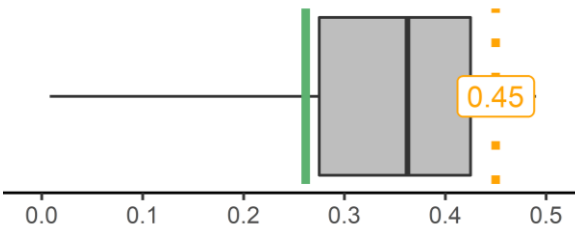
<tr>
<td>

Grain K, %



A standard value of 0.54 potassium (k) in grain. Values less than 0.38 indicate a need for further checks on K nutrition, especially by soil analysis.

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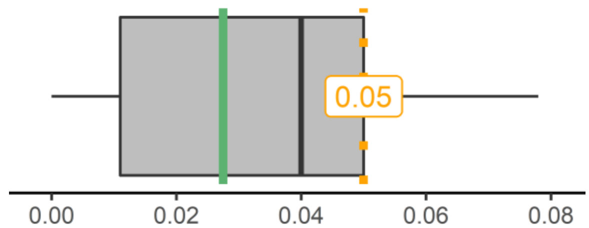
Grain Ca, %



Almost all the crop's calcium remains in the straw at harvest, so grain calcium may not be meaningful.

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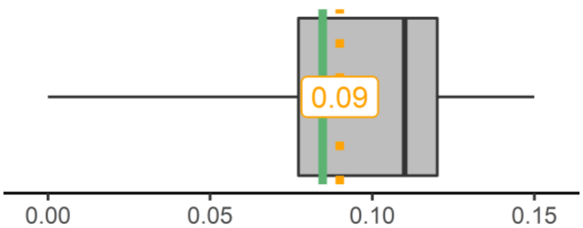
Grain Mg, %



Literature shows low magnesium (Mg) values in grain are <0.08. With further experience, grain Mg levels may provide a useful double check on soil levels and crop symptoms.

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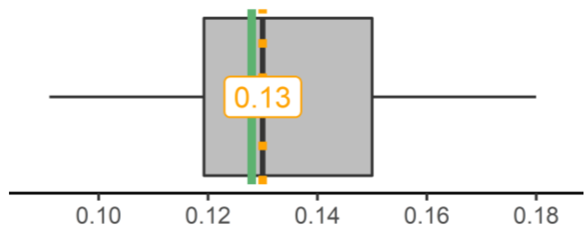
Grain S, %



S is required in proportion to grain protein (especially glutenin) formation. N:S ratio (<17) best indicates sufficiency. Milling varieties need more S than feed varieties.

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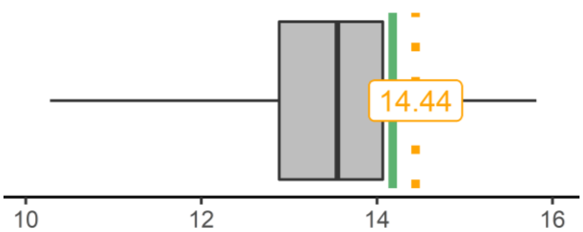
N:S, ratio



The higher the N:S ratio, greater than about 17, the more likely the crop is to have suffered from sulphur deficiency.

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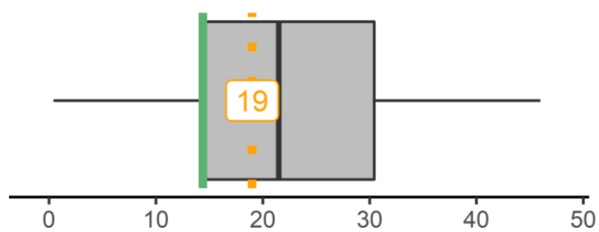
Grain Mn, ppm



Literature shows low manganese (Mn) values in grain are <20 ppm. Further experiences will show whether lower values indicate crops that were deficient.

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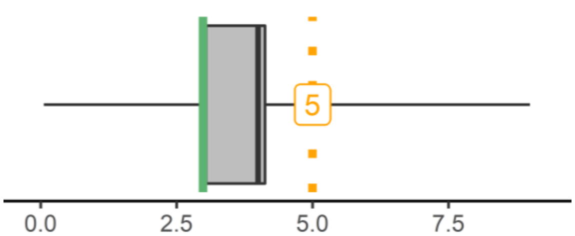
Grain Cu, ppm



Grain copper (Cu) less than 2 ppm indicates possible deficiency.

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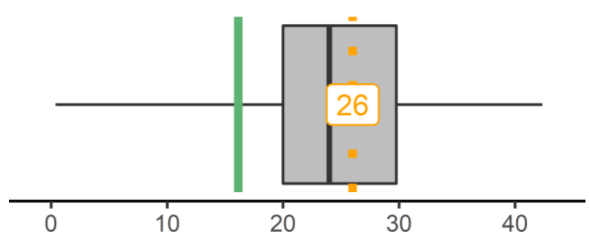
Grain Zn, ppm



Zinc (Zn) values below 15 ppm are low, but whether these should be regarded as limiting is uncertain. Literature show grain zinc is increased by nitrogen availability.

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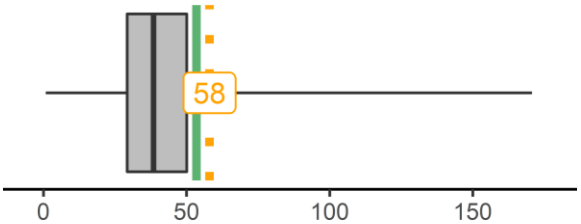
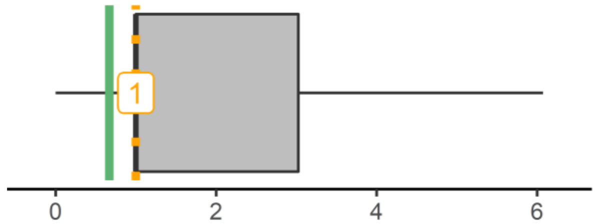
</table>

Grain Fe, ppm	Grain B, ppm
	
While grain iron (Fe) may prove useful with further experience, we currently have no guidelines for its interpretation. High levels may be a result of contamination at grain sampling time.	Grain analysis may not be useful for assessing boron sufficiency.