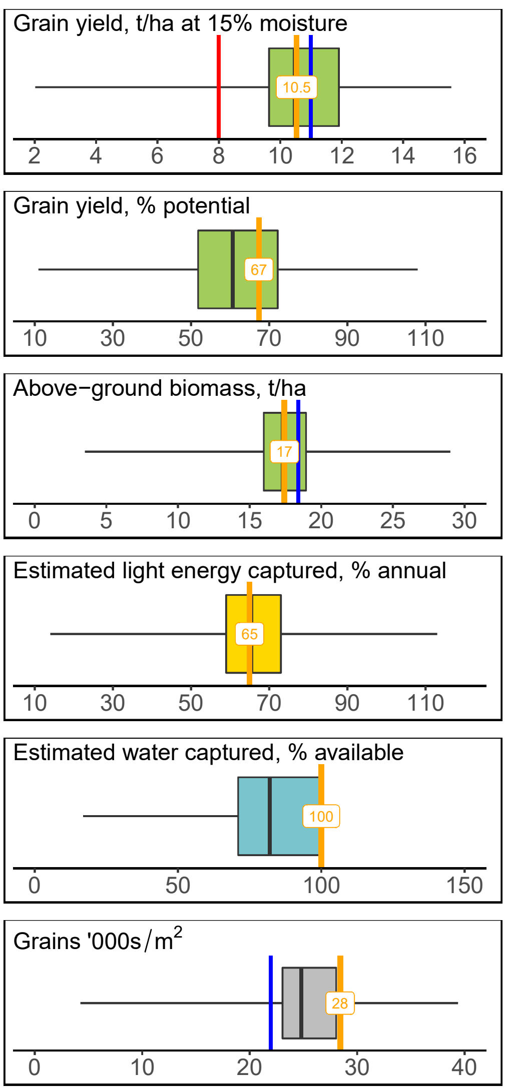
Entrant’s Report

Harvest 2021

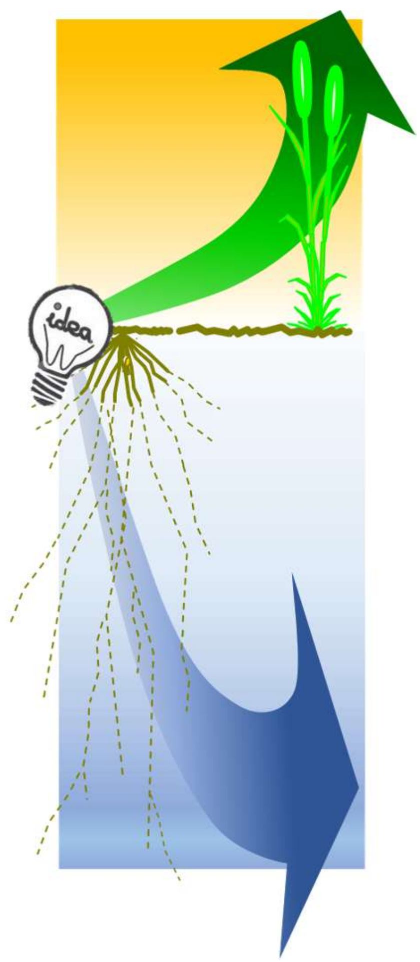
YEN User ID: [redacted]	Field/Site name: [redacted]
Entrant name: [redacted]	Location: [redacted]
Main contact email: [redacted]	Incident energy 2020-21: 32 TJ/ha
Sponsor/supporter [redacted]	Available water: 350 mm
Sponsor/Supporter email: [redacted]	Crop: Winter Wheat
	Variety: RGT Gravity

SUMMARY: YEN entries were completed from 203 cereal crops this year of which 42 spring barley or oats entries are reported separately. Headline results for your entry are shown in benchmark diagrams below. Your yield of 10.5 t/ha ranked 72nd within all YEN entries. This represents 67% of its estimated yield potential of 15.6 t/ha, which ranked 50th within all YEN entries in 2021 of all 141 wheat and 20 other cereal entries.



Overall yield rank:
72nd

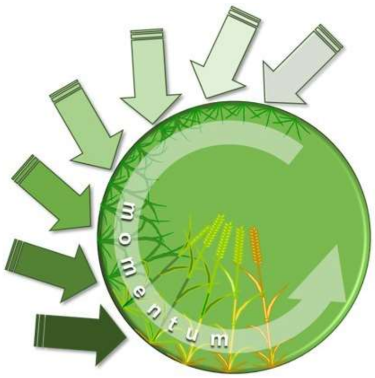
Overall potential yield rank:
50th



CONTENTS

Our detailed analysis of your yield result is provided in the following pages, including comparisons with other YEN entries and with benchmarks taken from the AHDB Wheat Growth Guide and the AHDB Nutrient Management Guide (RB209). We hope that this helps you to identify aspects of your husbandry and growing conditions that offer possible routes to further yield enhancement on your land.

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



"The YEN exists to help you to enhance your yields."

The key to high yields amongst YEN entries has been called 'momentum' – maximising growth by avoiding setbacks. So, our approach to enhancing yields is to work out what limits growth – light energy, water, nutrients, or storage capacity – and then develop ideas to build better canopies, better roots, more storage, or better nutrition.

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

(i) **60% capture of light energy** through this season (including some in August), and its conversion to 1.4 tonnes of biomass per terajoule, or

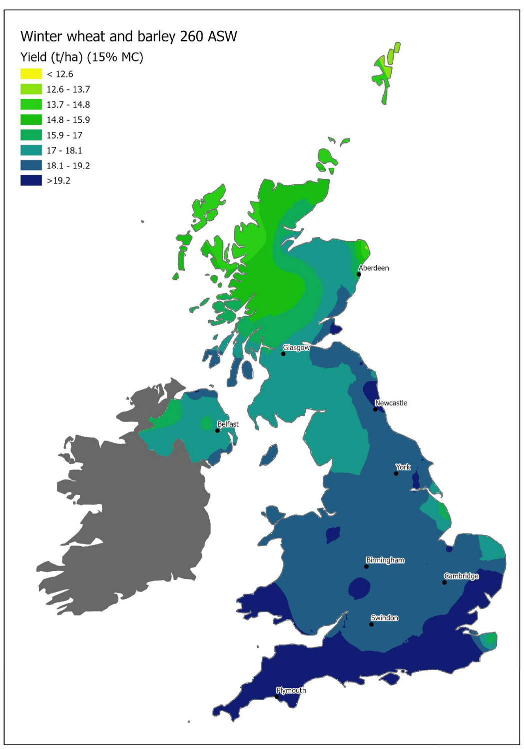
(ii) **Capture of all the available water** held in the soil to 1.5 m depth (or to rock if less) plus all rainfall from April to July, and conversion of each 18 mm into a tonne of biomass per hectare. Our model of potential yield estimates potential growth on a daily basis; this identifies impacts of water limitation more precisely than the cruder monthly estimates we made in previous YEN reports.

Taking the lesser of these two biomass amounts, we assume that a maximum of 60% can be used to form grain, this is the 'harvest index'. Note that we assume average temperatures for the UK, and no damage from waterlogging, frost, heat, or lodging.

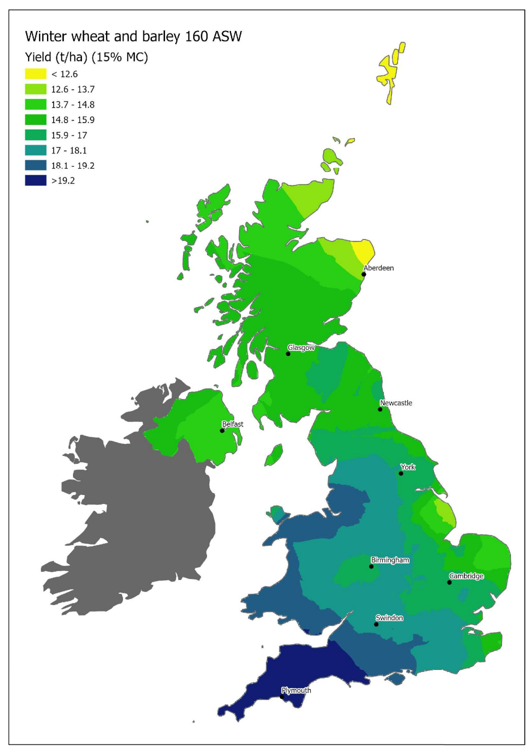
The maps below show the potential grain yields for autumn sown cereals on retentive and light soils in 2021 . For this we assume deep soils with no irrigation. Potential yields in arable areas ranged from 12 t/ha upwards so, on most soils, high yields were theoretically possible almost everywhere.

2021 Potential yields

2021 Autumn sown on retentive soil (260 mm AWC)



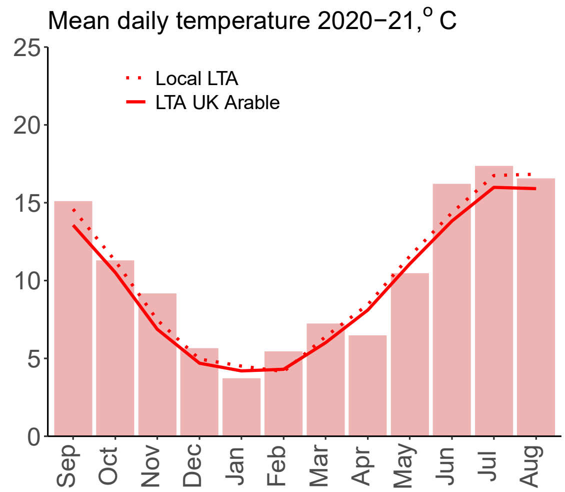
2021 Autumn sown on retentive soil (160 mm AWC)

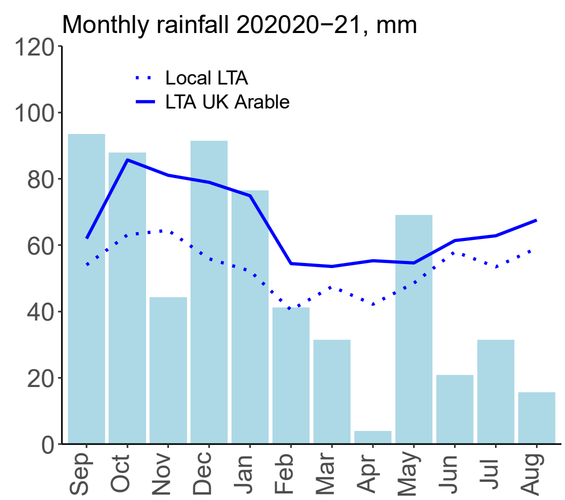


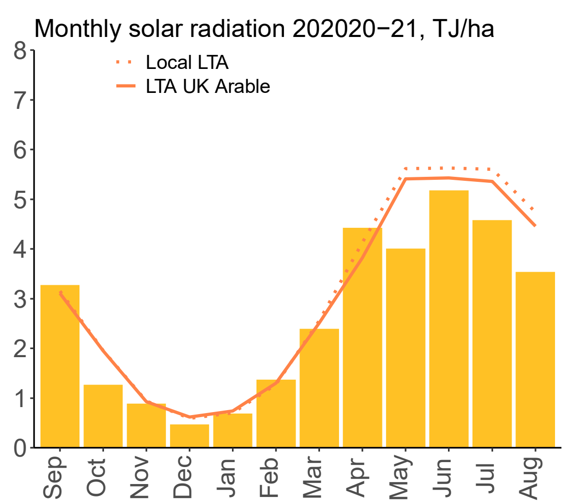
We are using weather data from DTN™ in 2021. Note we do not have long term met data from DTN so cannot show a map of long-term average yield potentials.

The adjacent graphs show the monthly temperatures, rainfall and total solar radiation for your area in 2020-21 compared to your regional long-term average (LTA) and the average for all UK arable areas (1981-2010, from the Met Office).

- Autumn cereal establishment was much less problematic in 2020 than in 2019. Autumn was generally warm, with a wet October in the south so sowing here was sometimes delayed until the drier November.
- Black-grass thrived in winter wheats that could not be treated with residual herbicides after drilling.
- More aphids carried BYDV this winter than previously but aphid migration and spread in many winter cereals was restricted by the high October rainfall and BYDV incidence in spring was generally low.
- In England and Wales, winter temperatures were average, but cool in Scotland. This was coupled with wet conditions, especially in the east of England.
- Yellow rust was seen in some wheat crops prior to pre-stem extension and, despite frequent frosts in April, yellow rust continued to develop, with susceptible varieties needing treatment.
- Much of the UK had a sunny, cool spring. A dry and cold April across the UK restricted spread of net blotch, rhynchosporium and cereal aphids.
- Pre-emergence herbicide applications were less effective in spring crops, but weed emergence was also hampered.
- On the whole, summer was dry (except in the far south) and warm. This limited septoria disease progress, resulting in relatively low disease pressure prior to T1.
- In contrast, rainfall was above average in May, spreading septoria onto the newly emerged yield-forming leaves.
- Cleavers also responded to May rains and grew well.
- Further rainfall in June and July led to a lot of fusarium and enabled septoria to spread further, and high levels tested product persistence towards the end of the season.
- Cereal aphids were variable but generally too low to justify treatment.
- For much of the Midlands and south of the country, the summer was not bright, and August was dull.
- Late season Ramularia infections were seen in spring barley crops and some ergot was reported.
- Overall, crop development ran close to normal through to August when frequent rain showers caused some late brackling or lodging and commonly delayed harvest, often until September.

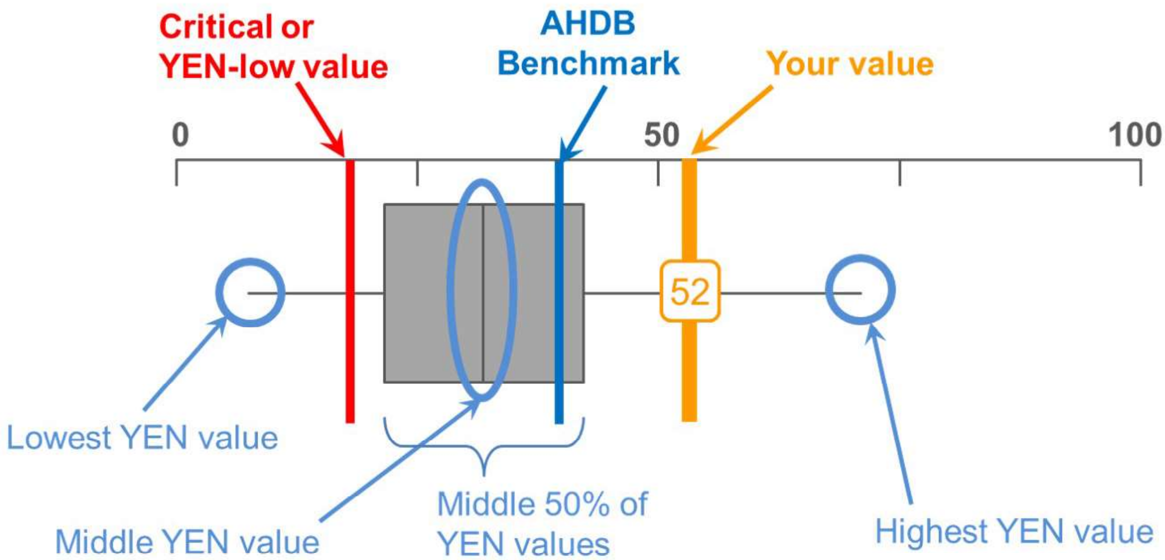






YEN Benchmarking charts – What do they mean?

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 provided the principle value of YEN to most participants. We do this with benchmark charts. These compare your value with everyone else's in 2021 and with standard benchmarks and critical values, if available and appropriate. The key is as follows:



The 'whiskers' show the range of YEN values in 2021 whilst the grey box shows the middle half of values, with a line for the mid-value. The orange line shows the value for your entry, and the red line is a limit beyond which yield may be adversely affected; crops with values beyond this merit further investigation. Blue dashed lines indicate benchmark values e.g. from the AHDB's Wheat Growth Guide (these relate to a feed wheat with slow development yielding 11 t/ha). Benchmark charts throughout this report summarise data provided for all YEN 2021 winter wheat crops (they exclude barley, oats, rye and spring wheats).
Note that 'Dynamic Benchmarking' is available to all YEN members via the YEN website. This means you can compare your own yield or grain nutrient data with subsets of all other YEN crops selected by crop type, soil type, location or year back to 2013.

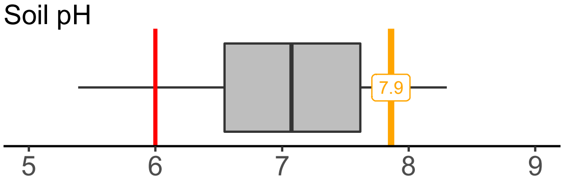
Soil description and nutrition analysis

Your soil's capacity to hold available water is critical in determining your potential yields. We rely on entrants describing the soil where their YEN entry grew, we can use the UK Soil Observatory map viewer to check whether this complies with the surrounding land.

Good soil descriptions are vital in allowing us to estimate soil water holding capacity and, along with summer rainfall, the water available to your crop (see Benchmark charts in the section on 'Resources & their Capture').

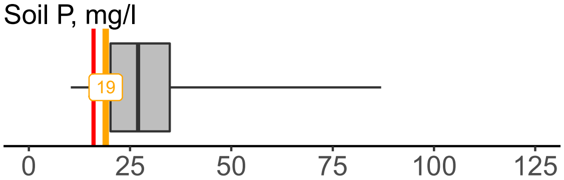
Topsoil analyses provided by NRM also tell us about soil status for pH, P, K and Mg, as reported on the next page. A few sites show low values for soil pH, P, K or Mg. If these are unexpected, they may need further checks, either by repeating soil analysis and by checking both leaf and grain analyses later in this report. Previous YEN leaf and grain nutrient data have indicated that UK cereal crops often experience deficiencies in one or more nutrients, and sometimes this is despite soil levels being satisfactory. So, by combined use of soil, leaf and grain analysis, the YENs now help to diagnose whether nutrient shortfalls are arising from poor supply, or poor capture by the root system.

Soil pH



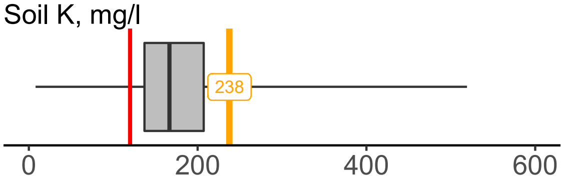
High pH soils may require that special attention is paid to phosphorus (P) and micro-nutrient levels in leaf and grain (see later).

Soil P, mg/l



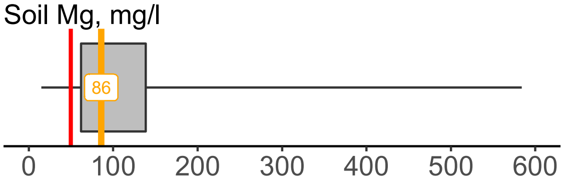
Only a small difference separates P Index 0 (<=9) and 2 (>=16). High yields are possible at P index 1 but fresh P is also usually required. Use grain P (see page 20) to check if P was sufficient.

Soil K, mg/l



Soil potassium (K) analysis checks on whether K supplies are likely to have been deficient for average crops. However, high yielding crops require very large amounts of K.

Soil Mg, mg/l



Magnesium (Mg) is a key component of chlorophyll so deficient plants show striking inter-veinal yellowing. Temporary deficiencies often occur in springs with dry topsoils.

AGRONOMY

This section considers how your variety and husbandry decisions related to others entering the YEN in 2021. Note that the multi-year YEN dataset suggests that the individual effects on grain yield of variety choice or husbandry decision are relatively small; it is how these decisions (and other factors) are combined into the overall strategy on each farm that is responsible for the level of yield that tends to be achieved. Hence it should be possible to learn from the best performing farms. In summary, we are concluding that:

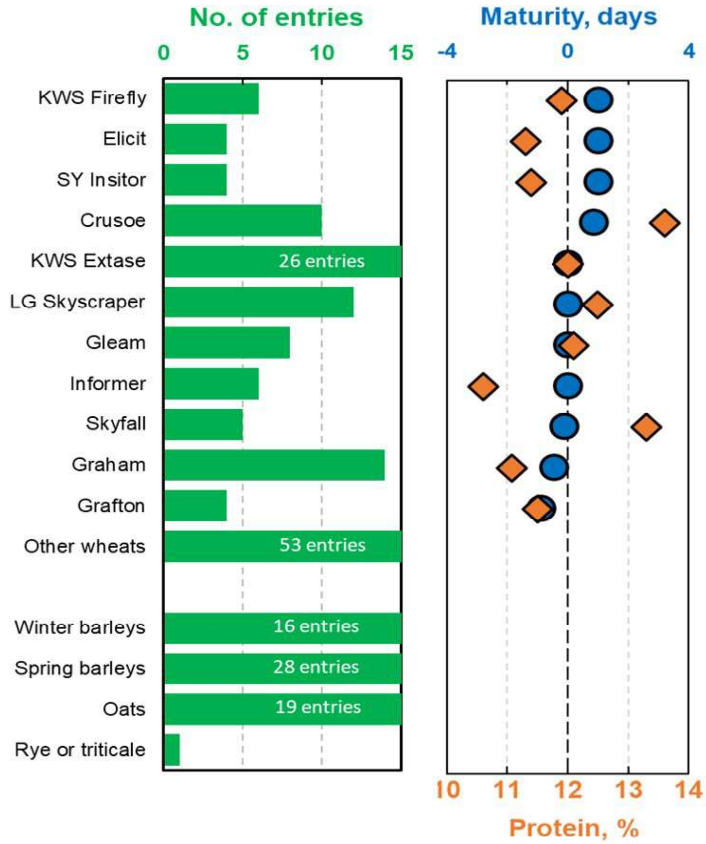
- **15 t/ha is possible almost anywhere!** High yields are not restricted to just one part of the UK.
- **Attention to detail** is important.
- **Large yields come from large crops** … i.e. taller crops with more fertile shoots
- **Best yielding seasons** had dry, bright autumns and winters, bright springs and cool summers
- **Good nutrition is hard:** most crops suffer nutrient deficiencies, especially of P.

Variety choice

Cereal YEN entries in 2021 included 45 different wheat varieties, 23 barleys, 8 oats, and 1 hybrid rye. (Note that spring barley and oats entries are now reported and benchmarked separately from wheat and the other cereals.) Out of >200 entries, 29% of entrants used a variety that was new to the YEN this year! Also, out of all 77 varieties that YEN entrants used, 42 were new this year! Thus, variety choice is a key way that YEN entrants seek to drive yield enhancement.

The most chosen wheat varieties are compared in the figure below for their maturity and grain protein levels, as reported in the AHDB's 'Recommended Lists for cereals and oilseeds' (RL). The range of maturity was less in 2021 than in previous years of YEN. Note that late maturity (and low grain protein) both associate with high yields. Note that the protein contents quoted here are the norms from the AHDB RL [the lower protein content; not the 'Protein content – milling spec'].

- Your variety was RGT Gravity, which according to the AHDB Recommended List (or alternative source for some varieties) has standard duration to maturity and has an average grain protein content of 11.2%

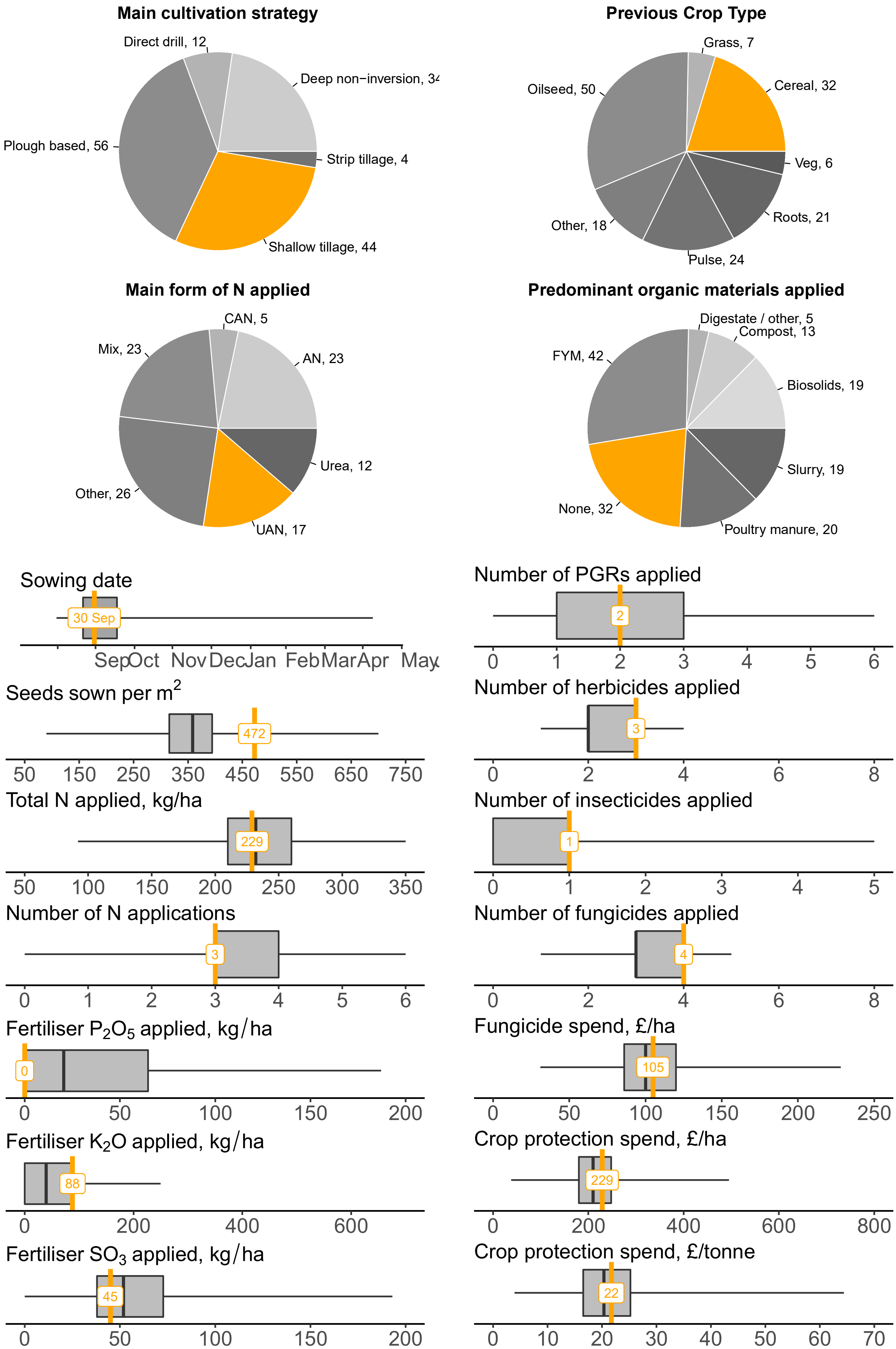


For all varieties, the protein content quoted is the normal (lower) protein content quoted from the AHDB's 2020/21 Recommended List (Summer edition) – not the 'Protein content – milling spec'.

Husbandry factors

The following diagrams use orange segments or orange bars to indicate the agronomy of your crop, if known, so you can see how this relates to all other YEN entries. Analysis of all YEN entries since 2013 shows the following associations with grain yield (note that these do not necessarily imply causes – it may just be that farms with high yields also happen to have these traits):

- Soil type - better yields on more retentive soils, e.g. with more silt
- Soil analysis - better yields with more soil P, but K & Mg not significant
- Previous crop - better yields after OSR and veg. than after sugar beet or wheat
- Sowing date - less grain by 0.25 t/ha per month delay
- Seed rate - minus 0.7 t/ha per 100 more seeds / m2 sown
- Organic manure - use ~0.3 t/ha more grain if used, with poultry or digestate being best
- N fertiliser use - 7 kg more grain per kg N (about 'break-even' in £/ha) or 0.23 t/ha more per N application
- Forms of N fertiliser - some but not all liquid products are associated with less yield
- P, K, S, micronutrient or biostimulant use - no significant associations
- PGR use - 0.35 t/ha more grain per PGR application
- Seed treatment use - significant associations (but not a simple story!)
- Fungicide use - 0.22 t/ha more grain per fungicide application
- Insecticide or Herbicide use - no significant associations

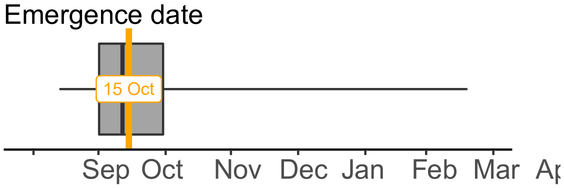

Main cultivation strategy
Direct drill, 12
Deep non−inversion, 34
Strip tillage, 4
Shallow tillage, 44
Plough based, 56
Previous Crop Type
Grass, 7
Cereal, 32
Veg, 6
Roots, 21
Pulse, 24
Other, 18
Oilseed, 50
Main form of N applied
CAN, 5
AN, 23
Urea, 12
UAN, 17
Other, 26
Mix, 23
Predominant organic materials applied
Digestate / other, 5
Compost, 13
Biosolids, 19
Slurry, 19
Poultry manure, 20
None, 32
FYM, 42
Sowing date
30 Sep
Sep Oct Nov Dec Jan Feb Mar Apr May
Number of PGRs applied
2
0 1 2 3 4 5 6
Seeds sown per m2
472
50 150 250 350 450 550 650 750
Number of herbicides applied
3
0 2 4 6 8
Total N applied, kg/ha
229
50 100 150 200 250 300 350
Number of insecticides applied
1
0 1 2 3 4 5
Number of N applications
3
0 1 2 3 4 5 6
Number of fungicides applied
4
0 2 4 6 8
Fertiliser P2O5 applied, kg/ha
0
0 50 100 150 200
Fungicide spend, £/ha
105
0 50 100 150 200 250
Fertiliser K2O applied, kg/ha
88
0 200 400 600
Crop protection spend, £/ha
229
0 200 400 600 800
Fertiliser SO3 applied, kg/ha
45
0 50 100 150 200
Crop protection spend, £/tonne
22
0 10 20 30 40 50 60 70

CROP DEVELOPMENT

The following charts show how your entry developed through the 2020-21 season, compared to all other YEN entries and Benchmarks. The cardinal stages of emergence (GS10), start of stem extension (GS31), flowering (GS61) and full senescence (GS87) determine the length of each phase for growth:

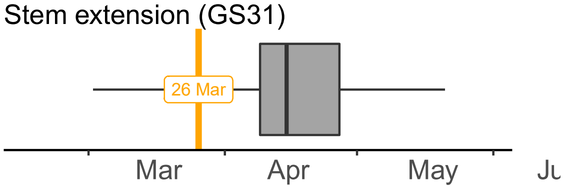
- Foundation, GS10-GS31 – when tillers and main root axes are formed,
- Construction, GS31-GS61 – when yield-forming leaves, ears and stems are formed, including soluble stem reserves
- Production, GS61-GS87 – when grains are filled, both with new assimilates and reserves redistributed from stems.

Emergence date



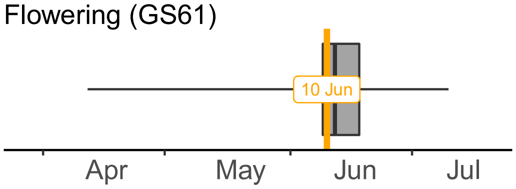
Sowing dates of winter wheats entered in YEN 2021 ranged from August to November but on average sowing and emergence dates were normal (Two entries were spring wheats).

Stem extension (GS31)



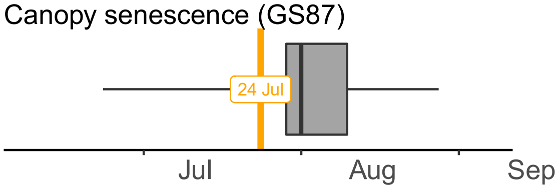
With cold weather in January and April stem extension tended to start about a week later than normal.

Flowering (GS61)



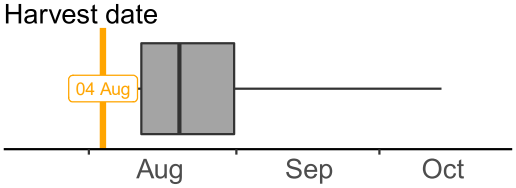
Continuing cool weather in May caused average flowering date to also be somewhat delayed. The large geographic spread of entries caused the large range in flowering dates.

Canopy senescence (GS87)



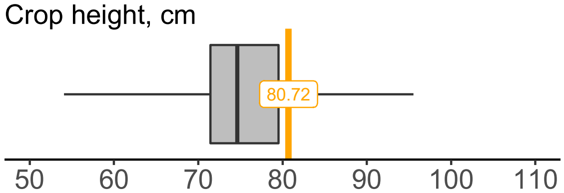
Senescence was a few days later than normal, even though June and July were relatively warm.

Harvest date



Harvest dates ranged from August to October! With the very difficult rain pattern in August, average harvest date was a fortnight later than normal.

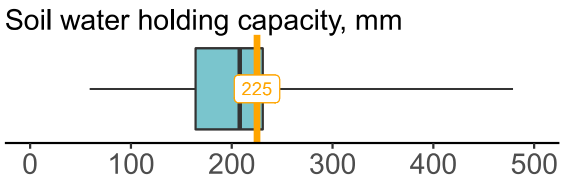
Crop height, cm

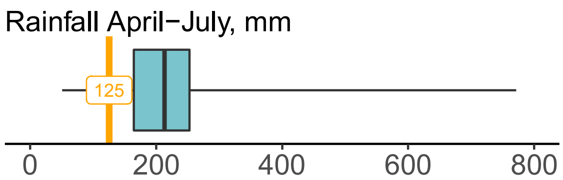


We measure height on the harvest 'grab' samples, and omit samples which look to have been cut above ground level. On average wheat crops were a little taller than normal in 2021.

With normal sowing and emergence, and delays in stem extension, flowering and senescence compared to normal, the foundation phase was slightly extended in 2021, whilst the construction and production phases were normal. Scope for early crop growth was thus slightly better than normal in terms of time, but growth will ultimately have depended on resource availability in each phase.

Water availability and capture



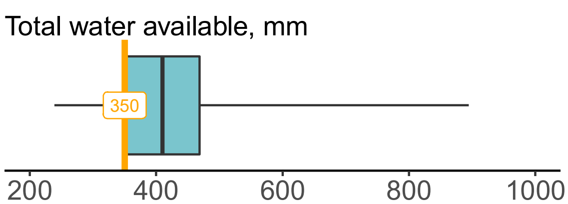


YEN 2021 update!

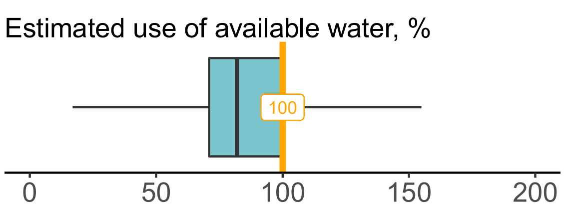
Estimation of subsoil-held water is difficult. In previous YEN reports all subsoil water held to 15 bar suction was taken as 'available'. This year, more conventionally, we only include water held to 2 bar suction. Thus, subsoil water estimates are ~25% less in 2021, but more farms are achieving >100% water capture, suggesting either very efficient rooting, or a need for more accurate soil descriptions!

As is usual, all UK soils refilled with water over-winter in 2021. Water available to each crop through the summer included all this soil water plus the summer rainfall (April to July). Deep soils hold water to a great depth; we assume roots can access all easily held water to a depth of 1.5 m (or to rock, if shallower). If enough roots didn't reach to this depth, capture of soil-available water would have been accordingly less.

Whilst we cannot yet measure water captured by YEN crops individually, by assuming your crop's conversion of water to total biomass was 'normal' (20 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 is the sum of your soil's water-holding capacity and your summer rainfall (both shown above).



Average water use is normally greater than was achieved in 2020; small water use will sometimes have been due to less demand for canopy transpiration (e.g. because crop developed faster and matured earlier) or otherwise due to worse rooting.

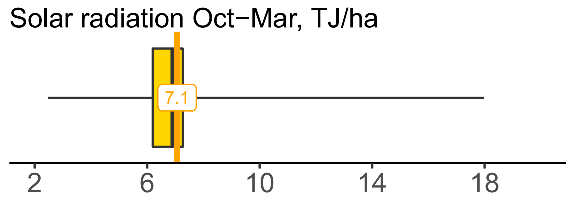
If your estimated use of available water exceeds the total water available, this may be good news! It either suggests that your crop's roots were more efficient than normal, or that your soil description was overly pessimistic: i.e. your soil apparently managed to provide more water than we estimated was possible from your soil's texture, stone content and depth.

A high yielding crop, growing say 20 t/ha of biomass (so yielding 12 t/ha grain at 51% harvest index), would need to capture ~400 mm water from soil plus summer rain. Given that most of the UK's arable area often receives only 200-250 mm summer rainfall (from April to July), a large proportion of the water for high yielding crops must come from that held in the soil since the winter, mainly in the subsoil.

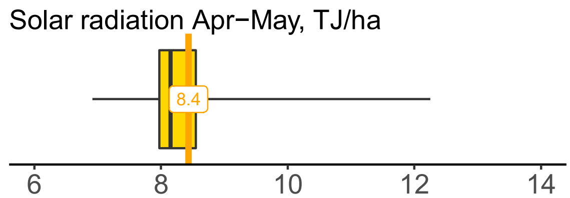
Energy capture

The benchmarking charts below show how 2021 weather affected light energy available for this entry and other YEN crops. Solar radiation has been divided into periods that roughly equate to the three key phases of crop development reported above:

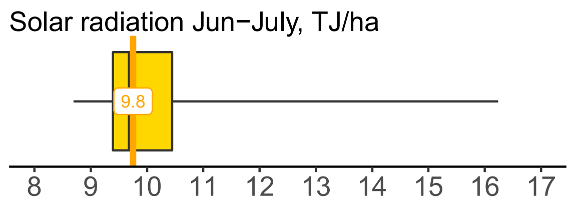
- Foundation – when tillers and main root axes are formed,



- Construction – when yield-forming leaves, ears and stems are formed, including soluble stem reserves

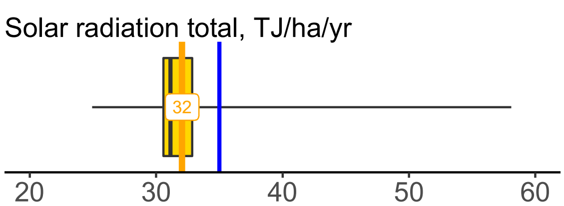


- Production – when grains are filled, both with new assimilates and reserves redistributed from stems.

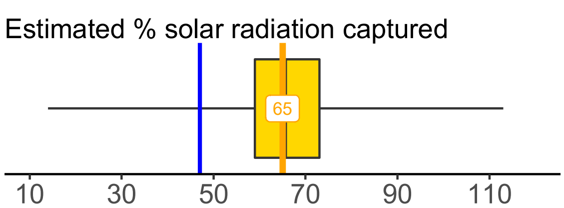


Solar radiation in September 2020 and August 2021 has been omitted, because few crops were green during those months, but crops could have achieved greater total biomass, and possibly also grain biomass, if they maintained green canopies during any part of these two months.

Whilst we cannot yet measure light capture by YEN crops individually, by assuming your crop's conversion of light-energy was 'normal' (1.2 tonnes/TJ), we have made a crude estimate below of the likely success of your crop's canopy in capturing total light-energy for the 12 months of this season.



Total solar radiation across YEN entries in 2021 was ~2 TJ/ha/year less than normal; it varied from 25 TJ/ha/year mainly in the north to 39 TJ/ha/year mainly in the south.

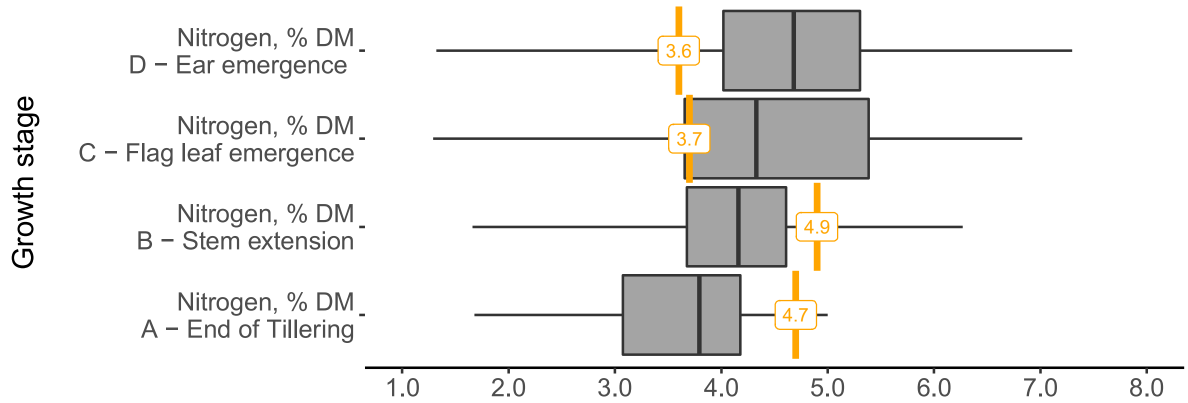


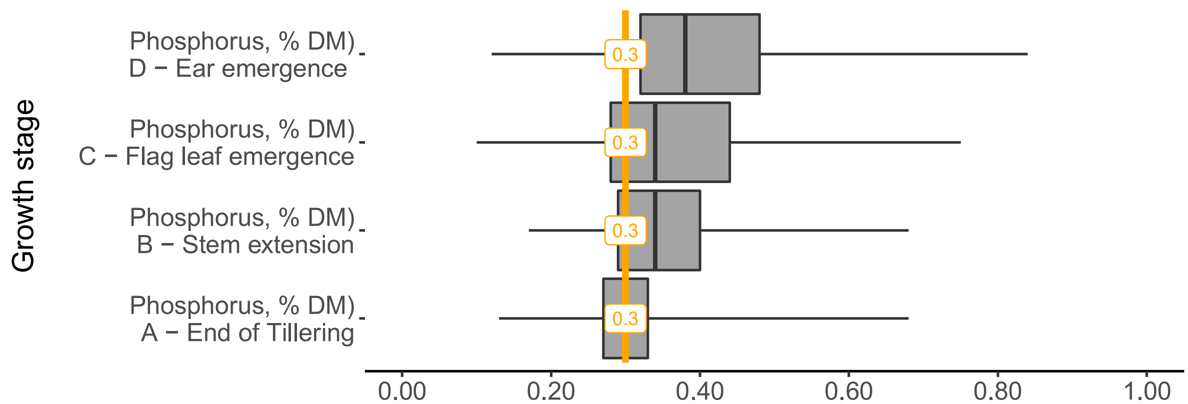
Due mainly to shorter crop lifetimes, average light capture was poor this year at 37%. The benchmark wheat crop yielding 11 t/ha intercepts 47% of annual solar radiation.

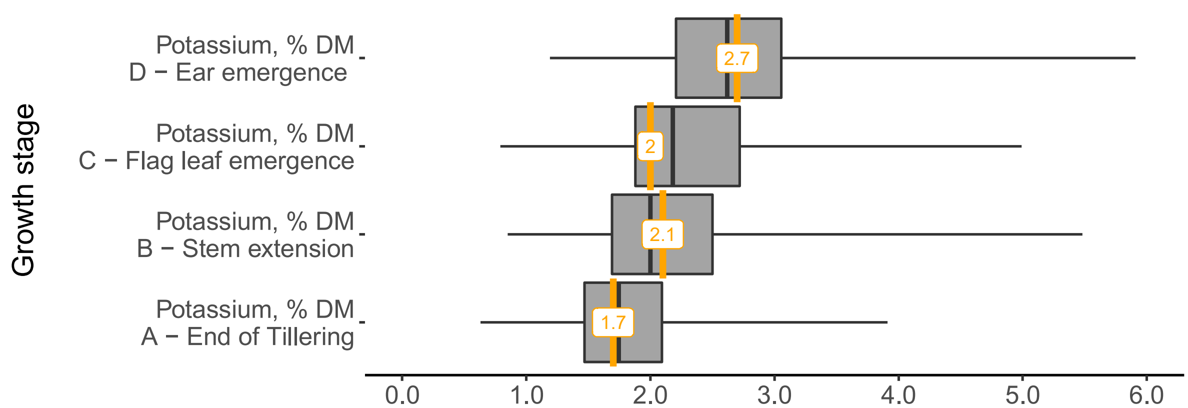
Nutrient capture

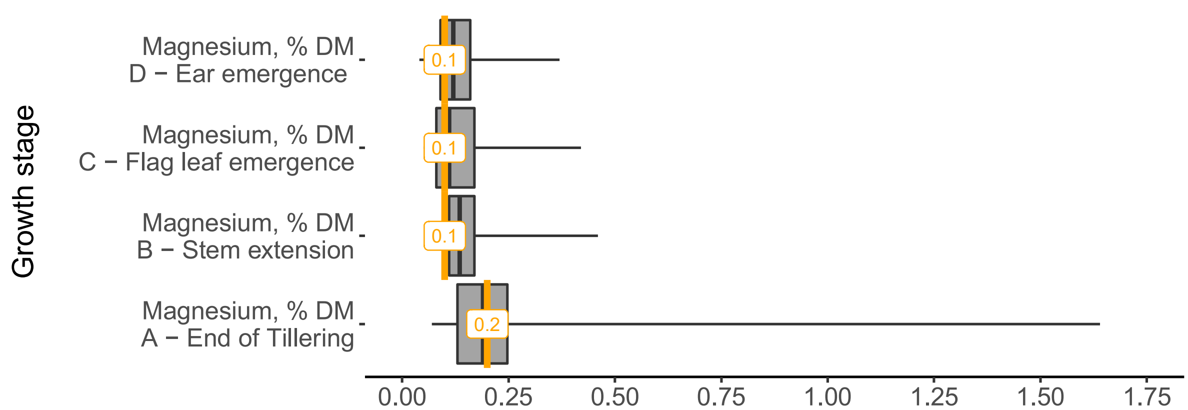
Whether nutrient capture was sufficient to support full conversion of light and water is best deduced from nutrient concentrations in crop tissues – both leaves (next three pages) and grains (later section). No critical thresholds or benchmarks are shown for leaf analyses because these change through a crop's life and are still uncertain. However, the benchmarking diagrams should enable you to compare your crop's levels with all other YEN entries in 2021, analysed at the same time.

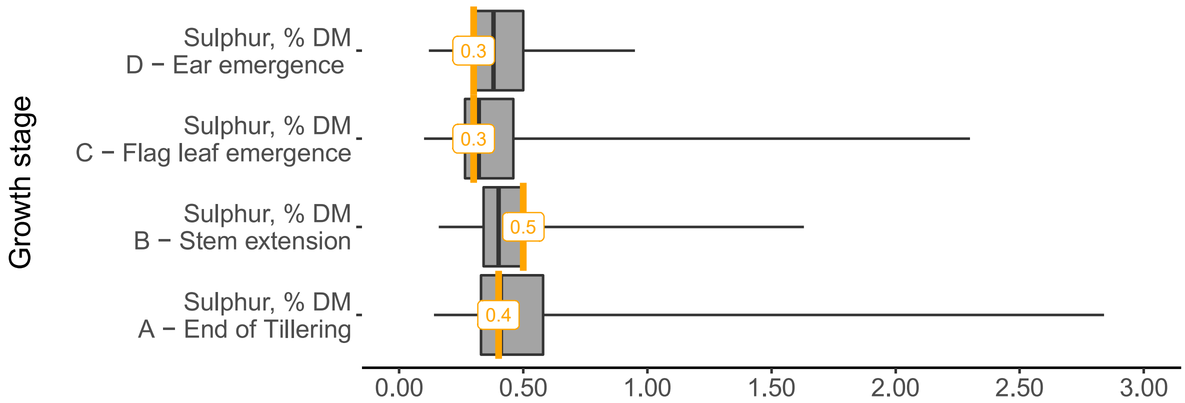
Lancrop Laboratories provide leaf analyses for YEN. Samples are of the newest fully expanded leaf.

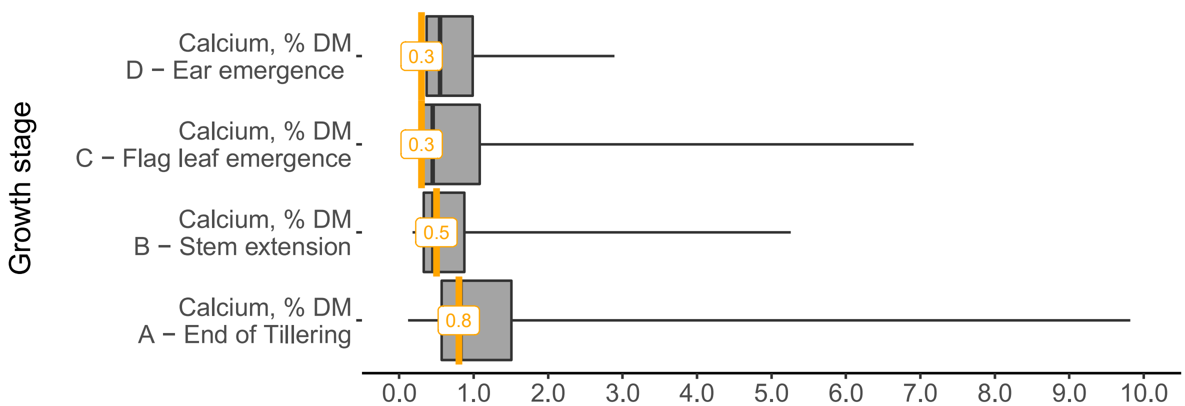

Growth stage
Nitrogen, % DM
D − Ear emergence
Nitrogen, % DM
C − Flag leaf emergence
Nitrogen, % DM
B − Stem extension
Nitrogen, % DM
A − End of Tillering
3.6
3.7
4.9
4.7
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

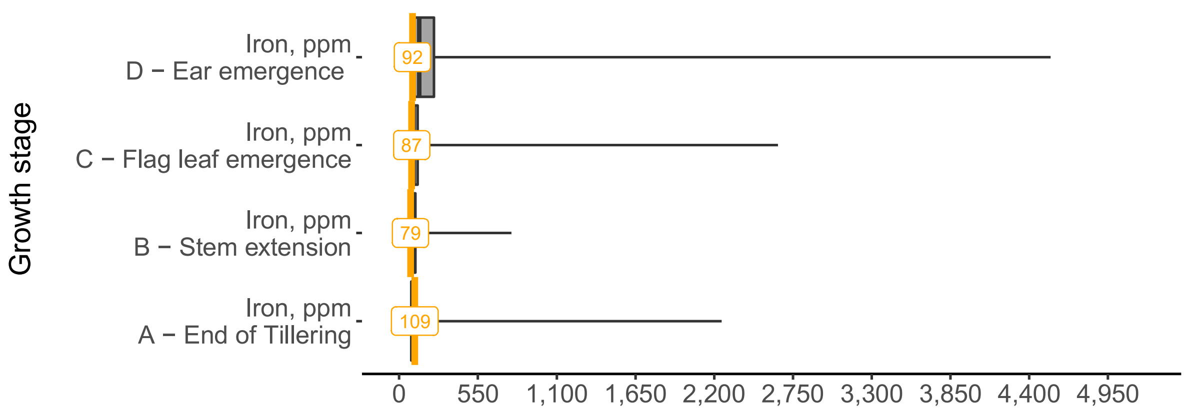

Growth stage
Phosphorus, % DM)
D − Ear emergence
Phosphorus, % DM)
C − Flag leaf emergence
Phosphorus, % DM)
B − Stem extension
Phosphorus, % DM)
A − End of Tillering
0.3
0.3
0.3
0.3
0.00
0.20
0.40
0.60
0.80
1.00

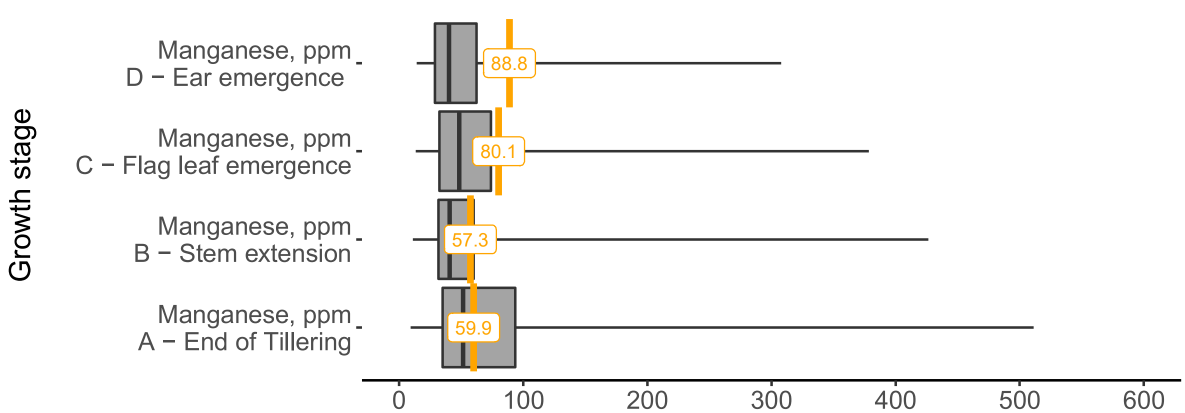

Growth stage
Potassium, % DM
D − Ear emergence
Potassium, % DM
C − Flag leaf emergence
Potassium, % DM
B − Stem extension
Potassium, % DM
A − End of Tillering
2.7
2
2.1
1.7
0.0
1.0
2.0
3.0
4.0
5.0
6.0

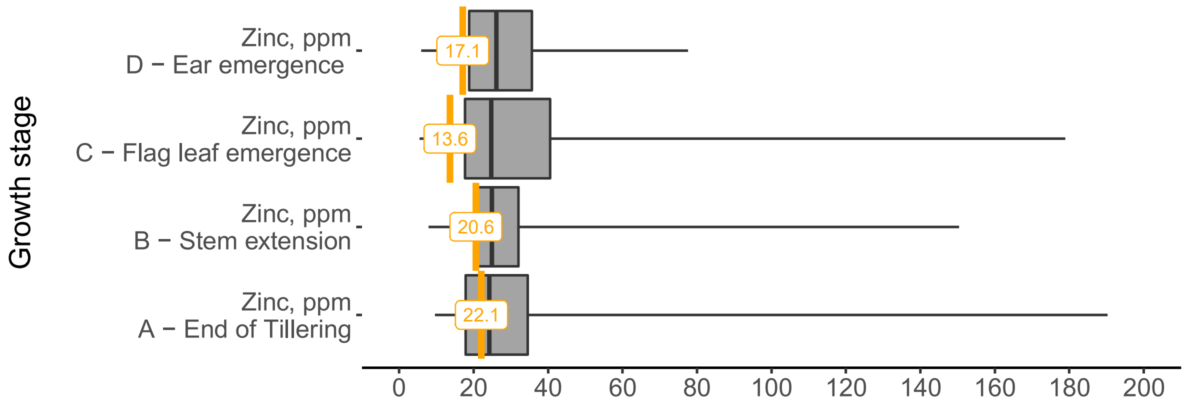

Growth stage
Magnesium, % DM
D − Ear emergence
Magnesium, % DM
C − Flag leaf emergence
Magnesium, % DM
B − Stem extension
Magnesium, % DM
A − End of Tillering
0.1
0.1
0.1
0.2
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75

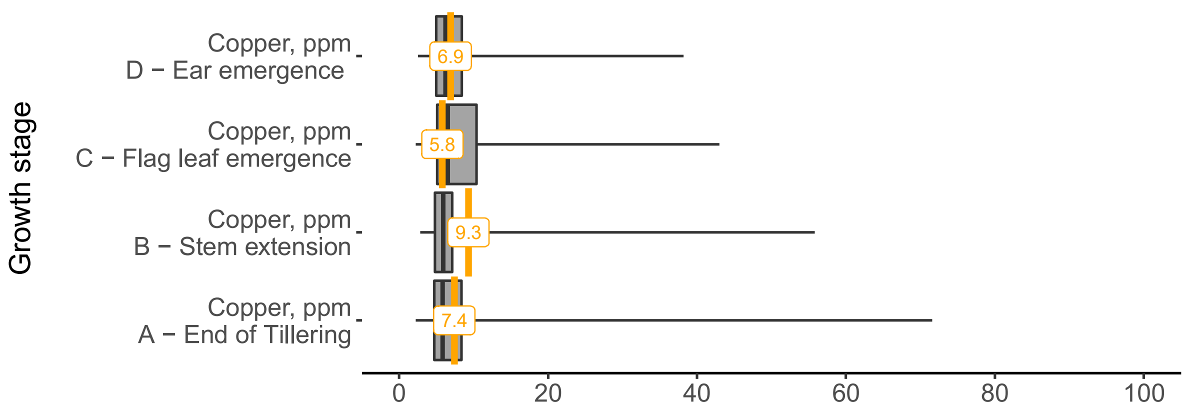

Growth stage
Sulphur, % DM
D − Ear emergence
Sulphur, % DM
C − Flag leaf emergence
Sulphur, % DM
B − Stem extension
Sulphur, % DM
A − End of Tillering
0.3
0.3
0.5
0.4
0.00 0.50 1.00 1.50 2.00 2.50 3.00

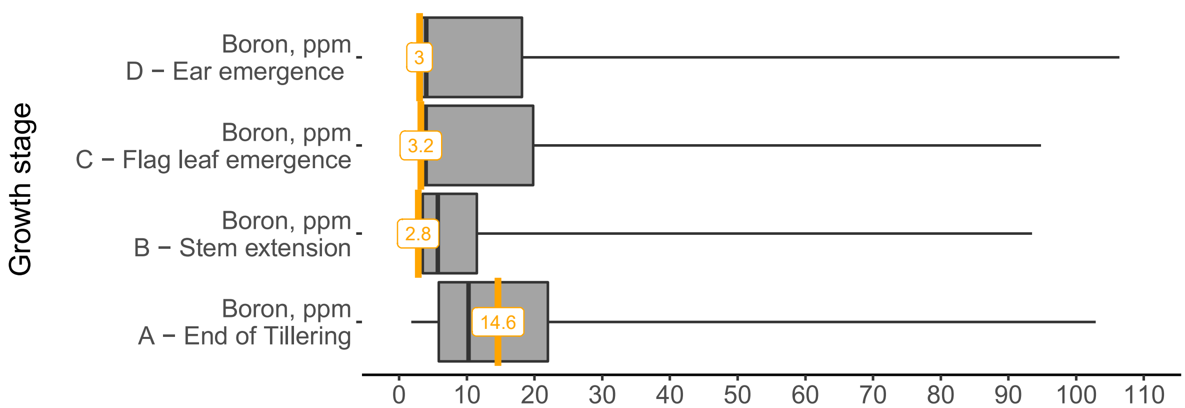

Growth stage
Calcium, % DM
D − Ear emergence
Calcium, % DM
C − Flag leaf emergence
Calcium, % DM
B − Stem extension
Calcium, % DM
A − End of Tillering
0.3
0.3
0.5
0.8
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0


Growth stage
Iron, ppm
D − Ear emergence
Iron, ppm
C − Flag leaf emergence
Iron, ppm
B − Stem extension
Iron, ppm
A − End of Tillering
92
87
79
109
0 550 1,100 1,650 2,200 2,750 3,300 3,850 4,400 4,950


Growth stage
Manganese, ppm
D − Ear emergence
Manganese, ppm
C − Flag leaf emergence
Manganese, ppm
B − Stem extension
Manganese, ppm
A − End of Tillering
88.8
80.1
57.3
59.9
0 100 200 300 400 500 600


Growth stage
Zinc, ppm
D − Ear emergence
Zinc, ppm
C − Flag leaf emergence
Zinc, ppm
B − Stem extension
Zinc, ppm
A − End of Tillering
17.1
13.6
20.6
22.1
0 20 40 60 80 100 120 140 160 180 200


Growth stage
Copper, ppm
D − Ear emergence
Copper, ppm
C − Flag leaf emergence
Copper, ppm
B − Stem extension
Copper, ppm
A − End of Tillering
6.9
5.8
9.3
7.4
0 20 40 60 80 100


Growth stage
Boron, ppm
D − Ear emergence
Boron, ppm
C − Flag leaf emergence
Boron, ppm
B − Stem extension
Boron, ppm
A − End of Tillering
3
3.2
2.8
14.6
0 10 20 30 40 50 60 70 80 90 100 110

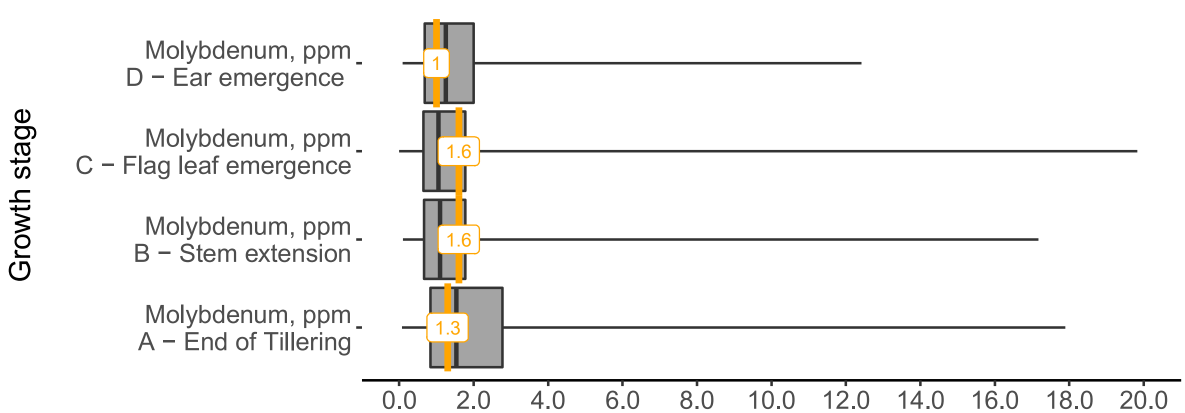
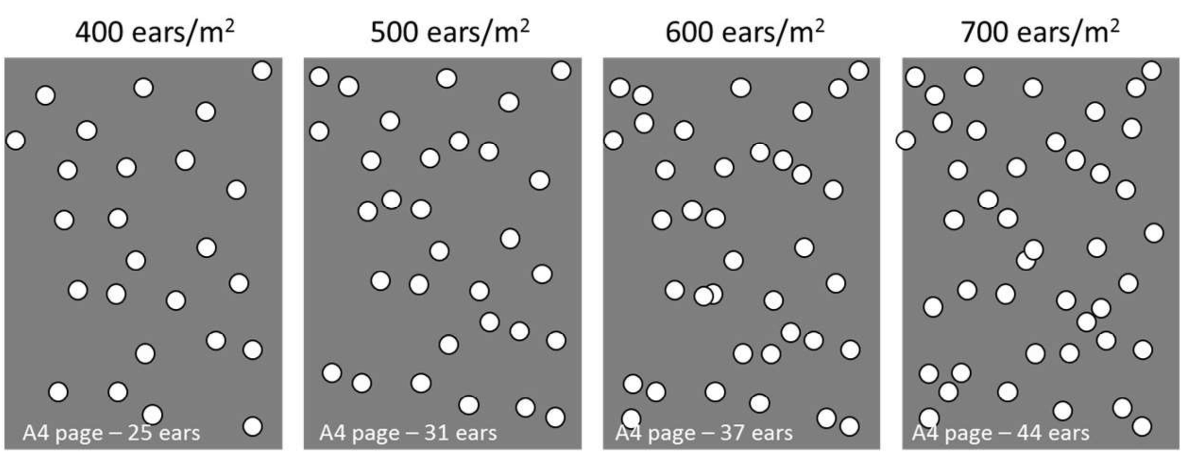

Growth stage
Molybdenum, ppm
D − Ear emergence
Molybdenum, ppm
C − Flag leaf emergence
Molybdenum, ppm
B − Stem extension
Molybdenum, ppm
A − End of Tillering
1
1.6
1.6
1.3
0.0 2.0 4.0 6.0 8.0 10.0 12.0 14.0 16.0 18.0 20.0

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 m^2 (see diagram below). An overhead photo taken at the start of stem extension is similarly useful.

An A4 sheet of paper in your image can help to assess ear numbers per m^2, as shown here:

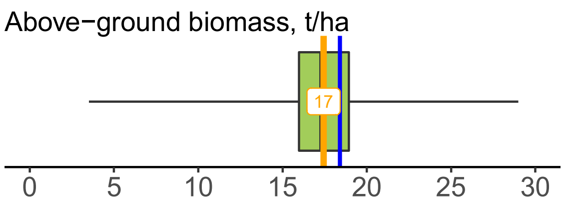


Yield formation

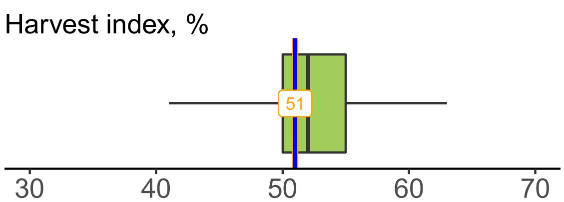
The whole-crop samples that YEN entrants provide all have their components counted and weighed and results are shown in the following charts, assuming that each sample was representative of the whole area from which grain yield was determined. [All area-related values are derived from the validated grain yield.]

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.

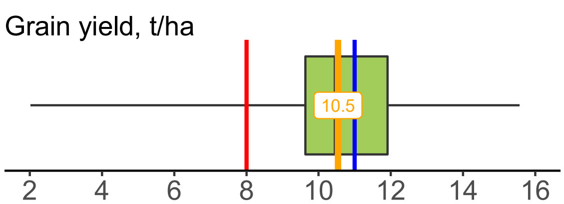
Your grain yield (expressed as t/ha and % of potential) is shown below along with biomass and harvest index, in relation to all other YEN entries and to the AHDB Benchmark grain yield of 11.0 t/ha.



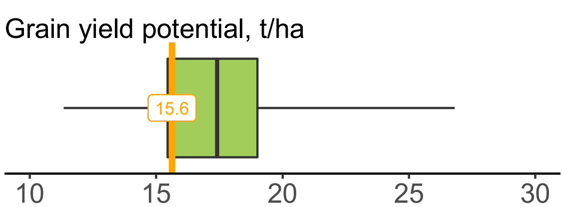
Due to the dull summer, YEN entries in 2021 had less biomass on average than the YEN norm. YEN experience has been that high biomass relates to high yields.



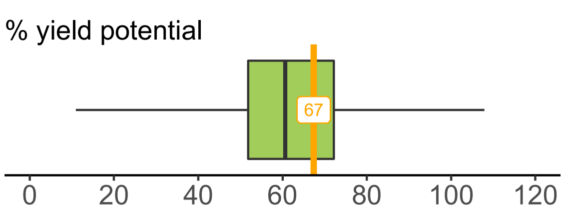
Harvest index is the percentage of total biomass that was harvestable as grain; values were a little low in 2021. Years with high fertile shoots tend to have low harvest index.



YEN yields averaged 10.7 t/ha in 2021; this compares to 10.3t/ha in 2016 (least), and 12.7 t/ha in 2015 (most). Some trials entries in 2021 showed very low yields.



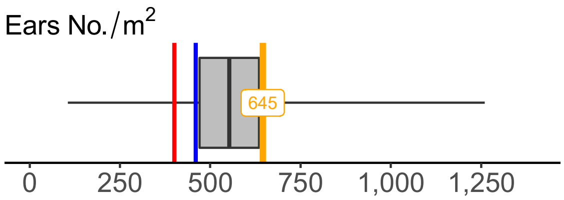
YEN yield potential reflects light energy and water available at your site this year, expressed in t/ha. Because we assumed less soil-held water in 2021, yield potentials were less in 2021 than previously.



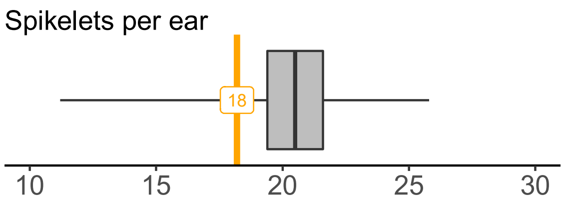
Yields achieved by YEN entries in 2021 averaged 65% of their new lower estimated potentials. Several entries just exceeded 100% of their estimated potential.

Yield components

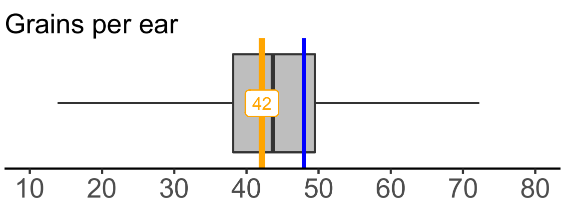
Grab sample analysis tells the story of your crop because the different yield components are determined sequentially, first shoots, then ears, then grains per ear, then grain wight. Comparing your yield components with those of other YEN entrants should indicate the stage(s) through the season at which your crop deviated from others and from normal (represented by the AHDB Benchmarks, blue lines).



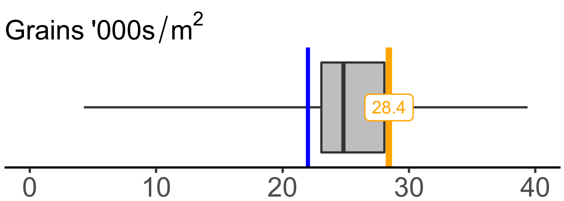
Ears per m^2 depend on plant establishment, then tillering, and then the survival of each shoot during stem extension to form an ear. With good establishment and cool bright spring conditions average ear numbers in 2021 were as high as ever!



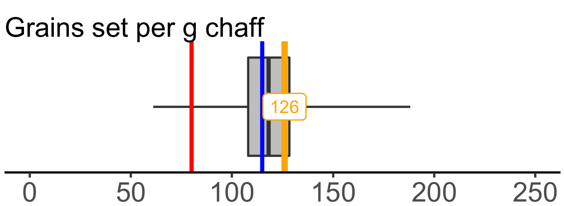
Spikelet numbers are determined between GS30 (ear at 1cm) and GS31 (1st node). Numbers are crucial for barley but not wheat because wheat is flexible in the number of grains it sets per spikelet.



Grains per ear were a little less than normal in 2021, partly in compensation for high ear numbers, but also because May was dull.



Grain numbers per m^2 were better than normal this year. Most ear numbers were high enough (>25,000/m^2) to enable very high yields.



Grains/g chaff indicates conditions around flowering were good for photosynthesis. The average of 118 grains/g chaff this year is normal. Less than 80/g is poor.

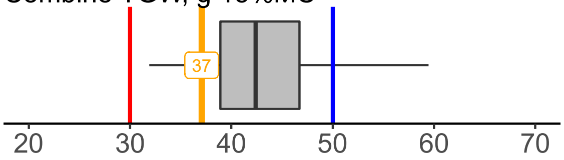
Grain formation and size

We use your combine-harvested grain sample to provide the analysis of grain size and grain filling on the next page. Grain filling depends mainly on photosynthesis after flowering, therefore it largely relies on the health and longevity of the green canopy, but sugars stored in the stem can also provide 2-4 t/ha of assimilates for grain growth and most of the protein from senescing leaves is also redistributed to form grain protein (benchmark 1.1 t/ha).

We have not measured stem sugars in YEN so far, but it is possible to assess them using a refractometer (giving a so-called Brix reading). It is likely that stem storage was less than the benchmark of 2.7 t/ha in 2021, because May was dull.

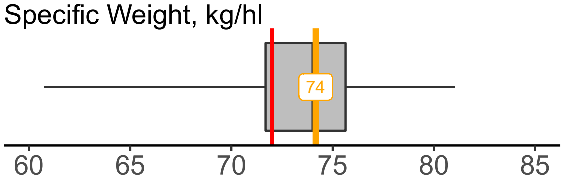
If grain number per m^2 is low (see above), or if conditions during early grain-fill are limiting, final grain filling, hence yield, may be constrained even if later conditions are good – this is sometimes described as 'sink' limitation. We try to use analysis of grain volume and grain density to deduce whether crops were sink limited.

Combine TGW, g 15%MC



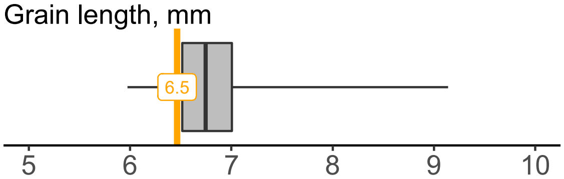
Average thousand grain weights (TGW) were disappointing (7% less than normal) in 2021 probably because June and July were not bright, and were warm.

Specific Weight, kg/hl



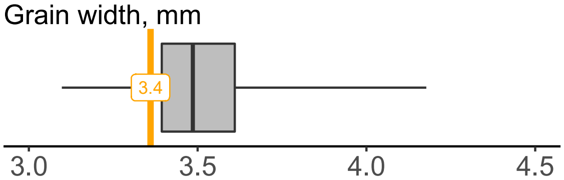
Specific weight is a quick indicator of flour extraction and shows weights of bulk grain for storage & transport. As with TGW, values were relatively low in 2021.

Grain length, mm



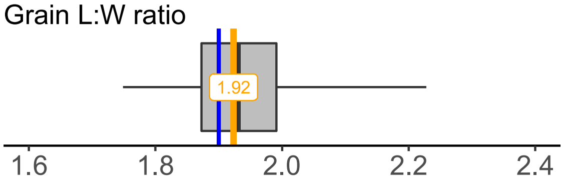
Grain length is set before grain width and tends to indicate potential grain storage capacity. Grain length was slightly more in 2021 than in recent years.

Grain width, mm



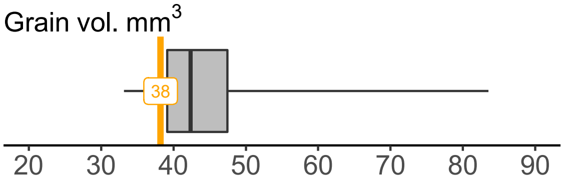
Grain width reflects the success with which grain storage capacity is filled. On average it was less than normal in 2021.

Grain L:W ratio



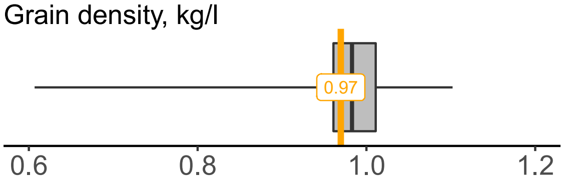
Average grain L:W ratio was high in 2021, supporting the conclusion that assimilate supply for grain filling did not fully fill the grains' potential storage capacity.

Grain vol. mm^3



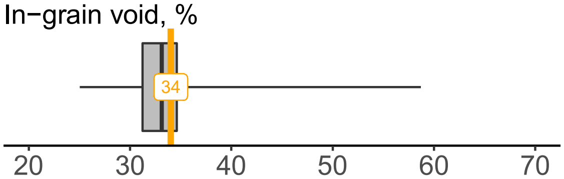
Grain volume here is the product of length and cross-sectional area, assuming grains are ovoid, so this volume includes the grain's 'crease'.

Grain density, kg/l



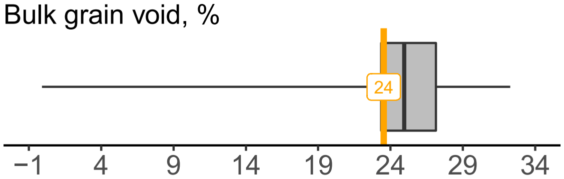
Low density grains indicate that grain filling was not constrained by storage capacity (volume) – so they were not 'sink limited'. Average grain density in 2021 was the 2nd lowest of all YEN years.

In−grain void, %



The density of starch, the main grain constituent, is 1.5, so it is possible to estimate the proportion of grain volume, including the crease, that was unfilled. The mid-value of 33% here is in-line with most YEN years. (Just 2017 was higher than this.)

Bulk grain void, %

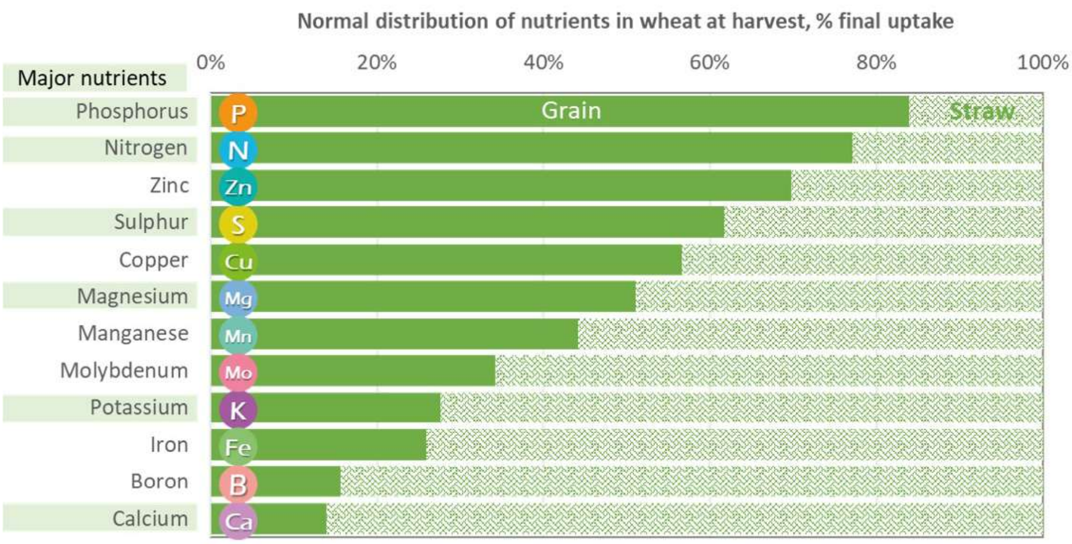


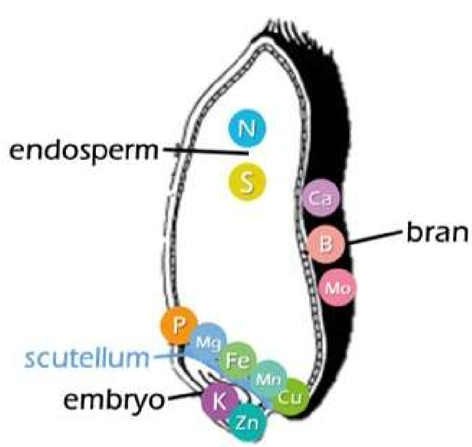
Did you know more than half of a load of grain is air?! High specific weight is achieved by having both dense grains and small voids between grains (under standard packing conditions). Bulk void is affected by grain shape and packing.

CROP NUTRITION POST-MORTEM

The YEN has trail-blazed use of grain analysis to provide overall post-mortems on a crop's nutrition.

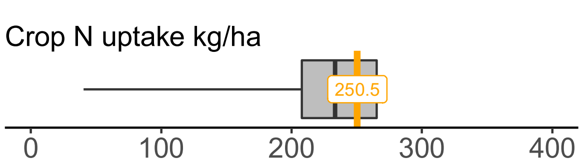
- Results from >900 YEN cereal samples analysed up to last year suggest that nutrient deficiencies are very common (using the 8 critical values that we know so far); >80% of crops showed deficiencies, and >50% showed two or more deficiencies! Phosphorus deficiency has been most common.
- YEN Nutrition was therefore launched in 2021 to help to remedy these deficiencies – further details and registration are available here
- Crop nutrients differ in how they are shared between grain and straw at harvest. The graph below shows how different crop species store most of their N & P in the grain but most of their K in the straw (as estimated from analyses of feed materials).





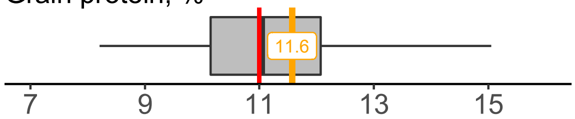
A wheat grain showing where each of the 12 essential nutrients is most concentrated.

- This year we are using YEN-low values (i.e. lower quartiles from all past YEN data – the boundary between the bottom quarter and top three-quarters of all YEN values since 2013) as comparators (red lines) for all nutrients in all crops. We find YEN-low values to be very similar to known critical thresholds of N, P, S and Mn in wheat, as well as to less certain critical values of K, Mg, Cu & Zn, so we assume they can be applied for all nutrients in all crops.
- The following benchmarking-charts and YEN-low values provide the best means of identifying the nutrient(s) most likely to have limited your crop.
- Critical grain protein (or N% x 5.7) levels are variety-dependent so it's best to compare your value with the value reported in the AHDB Recommended List for that variety. If the observed protein level is significantly less or more than the RL value, we take this to indicate that this crop was under- or over-supplied with nitrogen.



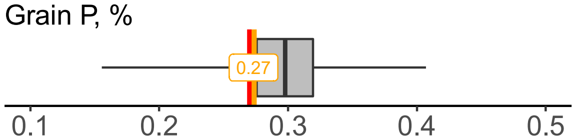
Total crop N uptake can be useful in judging the efficiency of your N management. Compare your to a typical wheat crop which captures ~60 kg/ha N from the soil plus 60% of its fertiliser N.

Grain protein, %



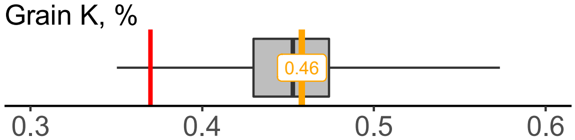
Protein (N% x 5.7) <11% indicates a likelihood of inadequate N supply for an average feed wheat. A variety's protein value given on the AHDB RL probably provides the best critical value for N (see earlier page).

Grain P, %



Recent research has shown grain P analysis can provide a useful check on sufficiency of phosphorus. Many past YEN values have been less than 0.32% indicating the difficulty of ensuring good P supply and capture.

Grain K, %

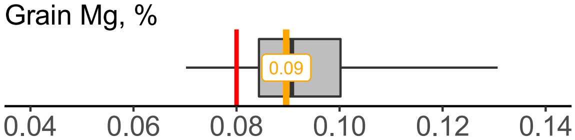


RB209 assumes a standard value of 0.54% potassium (K) in grain. Values less than 0.38% indicate a need for further checks on K nutrition, especially by soil analysis but also by analysing leaves.

Grain Ca, %

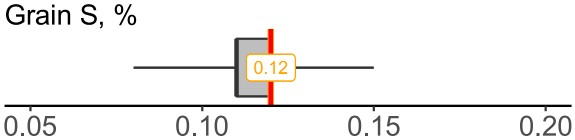
Calcium nutrition relates to the crop's use of water. However, almost all the crop's calcium remains in the straw at harvest, so we are yet to learn whether grain calcium can tell us about the crop's water status.

Grain Mg, %



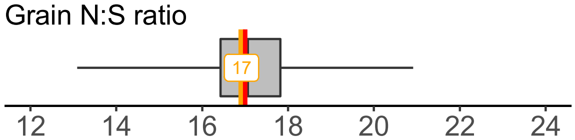
Literature shows low magnesium (Mg) values in grain are <0.08%. YEN data from previous years show high grain Mg has been associated with high grain yields.

Grain S, %



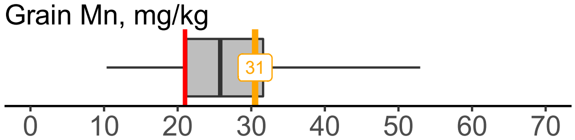
S is required in proportion to grain protein formation (especially for gluten). Milling varieties need more sulphur than feed varieties.

Grain N:S ratio



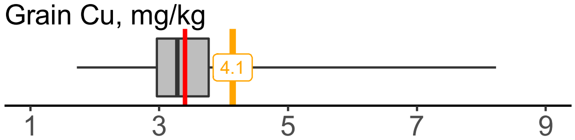
A high N:S ratio (greater than about 17) indicates the crop was affected by sulphur deficiency. Many crops had high N:S ratios in 2021.

Grain Mn, mg/kg



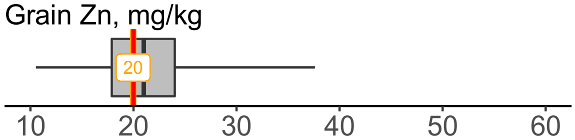
Literature shows low manganese (Mn) values in grain are <20 mg/kg. Several crops from 2021 showed low grain manganese, so leaf Mn of these should be checked – see page 13.

Grain Cu, mg/kg



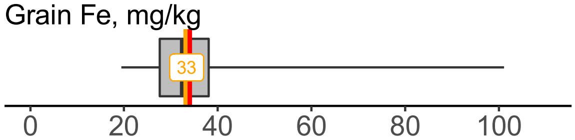
Grain copper (Cu) less than 2 mg/kg indicates possible deficiency. Very few samples were this low in 2021.

Grain Zn, mg/kg



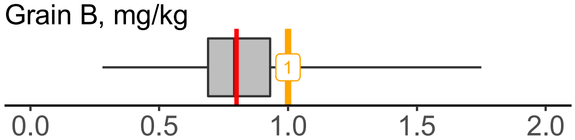
Zinc (Zn) deficiency has been rare in YEN crops. Values below 15 mg/kg are considered deficient. Grain zinc appears to inter-relate with nitrogen availability.

Grain Fe, mg/kg



We currently have no guidelines for grain iron (Fe) interpretation. Average Fe has been around 40 mg/kg in previous years of YEN.

Grain B, mg/kg



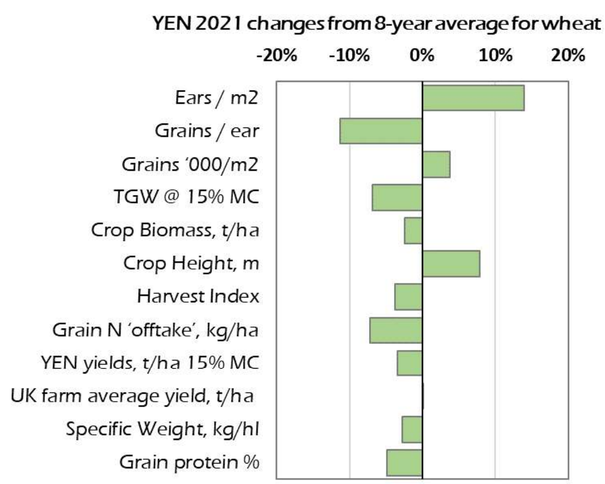
Most Boron is kept in the straw. Previous YEN boron values have varied hugely with season, so grain analysis may not be useful for assessing boron sufficiency.

The 2020-21 competition:

- Many congratulations for providing the information necessary to complete this report; the collective efforts of all YEN contributors serve to maximise the value of what can be reported and the deductions that can be made for everyone – we call this approach 'learning by sharing' and believe that the whole industry would benefit by making this approach their normal practice.
- The number of participants in Cereal YEN this year was similar to last year, but entries were more diverse; more barleys and oats, and crops from all over the UK, and from abroad, including New Zealand (harvested in March!). Nevertheless, all these data are invaluable; the more data we have, the more robust and confident we can be in the comparisons we make, both when 'benchmarking' and when analysing associations within the whole set of data.
- This was the 9th year of YENs. As last year, the winning field yield in 2021 was 15.6 t/ha (in Lincolnshire). As each YEN year passes and as more YENs develop, we are increasingly struck by the farm-to-farm differences; some farms are consistently achieving high yields, and several farms have achieved YEN Awards over several seasons. It is evident that a 'farm factor' is playing a big part in governing yield levels. This gives real value to being a YEN participant – through having an opportunity to compare with and learn from others who consistently perform very well.
- Estimated UK farm average yields in 2021 were slightly better than the 5-year average for each of the cereals; YEN yields far exceeded farm averages, except for spring barley:

Cereal yields in 2021	Winter wheat	Winter Barley	Spring Barley	Oats
AHDB farm yield estimate, t/ha	8.1	7.0	6.1	5.7
Change from previous 5 years	+2%	+2%	+7%	+6%
Average YEN yield in 2020, t/ha	10.7	8.5	6.9	7.6
Change from previous 5 years	+1%	NA	NA	NA

- In terms of physiology, results over all eight years of the YEN continue to 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.
- In 2021, a promising autumn, winter and spring was followed by a disappointingly dull summer leading to unrealised potential, and poorly filled grains. This disappointment probably affected large YEN crops more than average farm crops. The low harvest index was probably associated with high shoot numbers so that stem growth was enhanced in May, and crops were generally tall. But then grain filling was reduced by warm and dull June and July conditions.
- In summary, the Cereal YEN included some outstanding crops in 2021, with many crops that could have broken yield records, but they didn't because the summer was dull.



Comments on the next page are generated automatically from your data, with the aim of high-lighting features of your crop which may point out routes to yield-enhancement on your land.

SPECIFIC COMMENTS ON THIS ENTRY

Resource capture, growth and yield:

- High YEN yields have generally been associated with high biomass production. Your yield arose from a normal total biomass and a normal harvest index.

- Our target for annual light interception by annual crops (whether sown in autumn or spring) is 60% compared with 65% achieved by this crop.

Crop Nutrition:

- Your soil is estimated to be pH 8. High pH soils may require that special attention is paid to micro-nutrient levels.

- Your grain is estimated to have had 0.27% P. Less than 0.3% indicates a need for further checks on P nutrition.

Review of Oilseed YEN 2020-21

Out of 43 entries in 2021 gross output of oilseeds (mainly oilseed rape) ranged from 2.5 t/ha to 6.7 t/ha. On average this was 41% of potential yield which ranged from 6.5 t/ha to 12.6 t/ha. Crops generally established well, with adequate moisture minimizing CSFB damage but a wet winter and a dry, cold April challenged some crops. At harvest, seeds/m^2 was below the average of previous seasons, whilst average TSW was better. The winning September drilled crop demonstrated how high yielding crops set many seeds and fill these well through a good supply of water and prolonged canopy life.

Update on Wheat Quality Competition

The YEN Wheat Quality Award, sponsored by UK Flour Millers, will take place again in 2022. All Group 1 wheat entries which provided a large grain sample are entered and the best will be short-listed. Following breadmaking analysis and assessment the winners will be announced during the AHDB Milling Wheat Conference on Tuesday 22nd February 2022. There will be in person or online attendance options. Look out for more information in the coming weeks on the AHDB events pages.

AHDB events

Several AHDB Monitor Farms entered the YEN competition for 2021 and YEN will be included in a number of upcoming monitor farm meetings, please visit the AHDB website for more details. The AHDB Agronomist's Conference takes place on 7th December 2021 at the Peterborough Marriott Hotel. Attendance is either in-person or online.

YEN Nutrition

YEN Nutrition was initiated last year because YEN data have indicated that the majority (>80%) of crops have inadequate nutrition, one way or another. This new YEN connects anyone – farmers, advisors, suppliers and academics in the UK or abroad – seeking to improve nutrition of any grain crop – cereal, oilseed or pulse. Membership begins with grain analysis and grain nutrient benchmarking on six or more fields. Further details are available here.

YEN Technical Webinars

Please join us for a series of technical webinars and register for these events if you haven't already done so:

The 2021 YEN Awards - 25th November 2021, 3:30pm to 5:30pm

Register here for the YEN Awards

Cereal YEN Technical Webinar - 6th December 2021, 3:30pm to 6.00pm

Register here for Cereal YEN Technical Webinar

Oilseed YEN Technical Webinar - 8th December 2021, 3:30pm to 6.00pm

Register for the Oilseed YEN Technical Webinar

CONTACTS

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Or email yen@adas.co.uk for general enquiries. @adasYEN

YEN SPONSORS

The YEN was initiated by industry and is entirely industry funded. We are most grateful to all our sponsors. They not only provide funding but they are fundamentally involved in management of the YEN and in supporting individual farms in making their YEN entries. The YEN would not exist without them!

Visit www.yen.adas.co.uk for sponsors' details, news updates and to register for 2021.