Lab Proficiency from Analyte Report Cards in the Magruder Program

There have been significant changes in the Magruder program that began with the 2015 March sample. There is a new data reporting web site with user login and password entry where labs enter data collected on monthly samples. New method codes have been developed that better reflect methods being used and will help the Magruder committee evaluate method performance. Another important change exists in the types of statistical reports summarizing the data collected. There are general reports summarizing data from all labs and lab-specific report cards with data focusing on a lab's performance. There are two categories of general and lab-specific report cards. One category groups and analyzes data for an analyte regardless of method to test the analyte. The other category groups and analyzes data from specific methods. This article provides information on lab-specific reports that group data by analyte (referred to as Analyte Report Cards). The next newsletter will have an article on general reports with data grouped by analyte from all labs. Proceeding newsletters will have articles on reports with data grouped by method.

Laboratories provide a method code for every result entered into the Magruder web site. Each method code consists of three numbers before a decimal and two numbers following the decimal. The three numbers identify the analyte and the two numbers identify the method used. The reports that group data by the three numbers are Analyte Reports. These are the reports a lab should use to evaluate their proficiency in testing the analyte. The names of these reports in the data reporting website through the user login are shown below.

Analyte All Tests Report
Analyte Statistical Summary
Analyte Report Cards

The first two are general reports summarizing data from all labs and the last type includes lab-specific reports for each lab submitting data. The general reports are also provided at the Magruder home page (www.magruderchecksample.org) where the All Tests Report and Statistical Summary are combined and accessed via the "analyte report" link for each sample. Instructions on how to access the reports in the data reporting website are provided on the Magruder home page at the "data entry instructions" and "training videos" links.

An Analyte Report Card for lab 0481 and sample 150311 is shown below. The first column shows the three digit analyte number in the method code and the second column displays the textual description of the analyte with the reporting unit in parentheses. If the analyte was guaranteed in the sample, the analyte group number is green and the guaranteed value is shown with the reporting unit. The method used to test the analyte is shown in the next to last column as the method code.

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Sample # 150311: Grade 6-9-22

Analyte Report Card for Lab Code 0481

Proficiency Testing For 17 Analytes — **Issue Date : 04/30/2015**

Analyte Group	Analyte Group (Units)	Lab 0481 Data		Analyte Values				Magruder Z Score	Lab 0481 Method	Flag
		Value	range	Rob Mean	Rob SD	R-bar	# Tests			
001	Ammoniacal Nitrogen (%)	4.760	0.1000	4.738	0.1644	0.0729	24	0.13	001.10	0
010	Total Nitrogen (6%)	4.825	0.0700	4.795	0.0770	0.0497	68	0.39	010.12	0
020	Total Phosphorus as P2O5 (%)	7.935	0.0500	8.114	0.2245	0.1095	50	-0.80	020.20	0
050	Soluble Potassium as K2O (22%)	[19.60]	0.4000	20.99	0.8004	0.3301	82	-1.74	050.99	0
131	Water Soluble Magnesium (%)	10.65	0.1000	1.124	0.1126	0.0296	12	84.61	131.00	2
148	Total Sulfur (12%)	9.915	0.1300	10.23	0.5069	0.1899	35	-0.62	148.01	0
151	Acid Soluble Arsenic (ppm)	21.45	0.1000	25.01	2.480	1.058	18	-1.44	151.00	0
165	Acid Soluble Boron (0.45%)	0.3350	0.0100	0.3424	0.0328	0.0116	43	-0.22	165.00	0
181	Acid Soluble Cadmium (ppm)	10.60	0.4000	11.19	0.6640	0.2665	20	-0.89	181.00	0
190	Water Soluble Chlorine (18%)	16.16	0.2100	16.19	0.2999	0.1343	21	-0.12	190.00	0
191	Acid Soluble Chromium (ppm)	32.00	0.0000	34.43	5.082	1.636	16	-0.48	191.00	0
221	Acid Soluble Copper (%)	0.0515	0.0010	0.0501	0.0047	0.0034	31	0.29	221.00	0
241	Acid Soluble Iron (0.1%)	[0.3850]	0.0100	0.4406	0.0490	0.0153	59	-1.13	241.00	0
251	Acid Soluble Lead (ppm)	140.0	8.000	125.5	12.19	5.611	21	1.19	251.00	0
261	Acid Soluble Manganese (0.05%)	0.0290	0.0000	0.0362	0.0041	0.0027	56	-1.76	261.11	0
291	Acid Soluble Nickel (ppm)	11.00	2.000	12.14	1.607	0.9750	17	-0.71	291.00	0
325	Water Soluble Zinc (%)	1.035	0.1100			0.1100	1			

Interpreting Z Scores: Red indicates a normally distributed Z value >3 or <-3 (requires action), Orange = Z between 2 and 3 or -2 and -3 (warning) and Green = Z < 2 and >-2 (OK at 95%). Flags indicate data usage: 0 = Used, 1 = rejected for duplicates too far apart, 2 = rejected as extreme outlier and a 4 flag indicates rejected due to 0 value/s submitted. Robust statistics not used if < 6 labs reporting, in this case the Z Scores are included for information only (Grey). Square brackets indicate that [your value] is lower than the Robust Analyte value less the Investigational Allowance. Method or Analyte codes in light green indicate a guaranteed analyte. Individual lab values may be below detection limits but are reported solely for the purpose of this Proficiency Testing program.

The third and fourth columns provide the average and range for the lab's two results for the analyte. The fifth to eight columns provide data from all the other labs for the analyte. A statistical analysis is utilized to ensure outlying data does not have excessive influence and provides a robust mean (Rob Mean) and standard deviation (Rob SD) from all other lab results. The R-bar is the average difference between two results from all other labs and # Tests are the number of labs reporting test results for the analyte.

Accuracy is an indicator of a lab's proficiency in determining a concentration for an analyte that is the true concentration. The robust mean is taken as the true concentration in determining accuracy. The Magruder Z score is a value that scores the lab's proficiency for accuracy. The Z score provides an indication of where the individual lab value lies with respect to the bell curve describing the robust data distribution from all other lab values. A value between – x and +x indicates the lab value is within x standard deviations on the bell curve. A Z score value of 0 indicates the lab value is the same as the robust mean. Z scores between -2 and +2 are shown in green and are considered acceptable lab values with respect to results obtained from all other labs. Z scores less than -3 and greater than +3 are shown in red and indicate action should be taken to evaluate why the lab's value deviated so much from the values of all other labs. Values between 2 and 3 standard deviations (>-3 and <-2 or >2 and <3) are shown in orange and is a warning the lab value deviates significantly from other lab values. These values do not require immediate action, but the lab's score on the analyte should be focused on in future reports to monitor lab proficiency in testing this analyte and to make modifications if consistent warning Z scores occur.

Accuracy is one indicator of lab proficiency in testing the analyte. Precision is another indicator of proficiency. Precision is a measure of the reproducibility of the lab's procedure. Precision is evaluated by the lab range which is the difference between the two results reported for an

analyte. The R-bar value is the average range of two results amongst all labs. A lab range value below the R-bar value indicates the lab's two reported results were closer together than the average from all labs, while a range value above the R-bar value indicates the two reported results were further apart than the average from all labs. As the range gets lower, reproducibility and precision for testing the analyte becomes greater.

The second page of the Analyte Report Card is shown below. This page displays a box and whisker plot comparing the lab's Z score (black dot) for an analyte compared to the Z scores of all other labs (box and whiskers). The box encompasses the central 50% of Z scores and the whisker spans the central 90% of Z scores for this test. The number of labs providing a result for the analyte considered in the determination of Z scores is shown on the bottom of the graph. The purple dash is median Z score from all other labs. The green and red lines depict Z scores defining ranges where Z score is acceptable (-2 to +2), Z score is at a warning level (between -3 to -2 or 2 to 3), or Z score is at an action level (less than -3 or greater than 3). The method code used by the lab is shown on the top of the graph with method codes in brackets depicting guaranteed analytes. The guaranteed analytes are shown in the table on the right with the 3 digit analyte number and the robust mean (robust analyte value) for all lab results.

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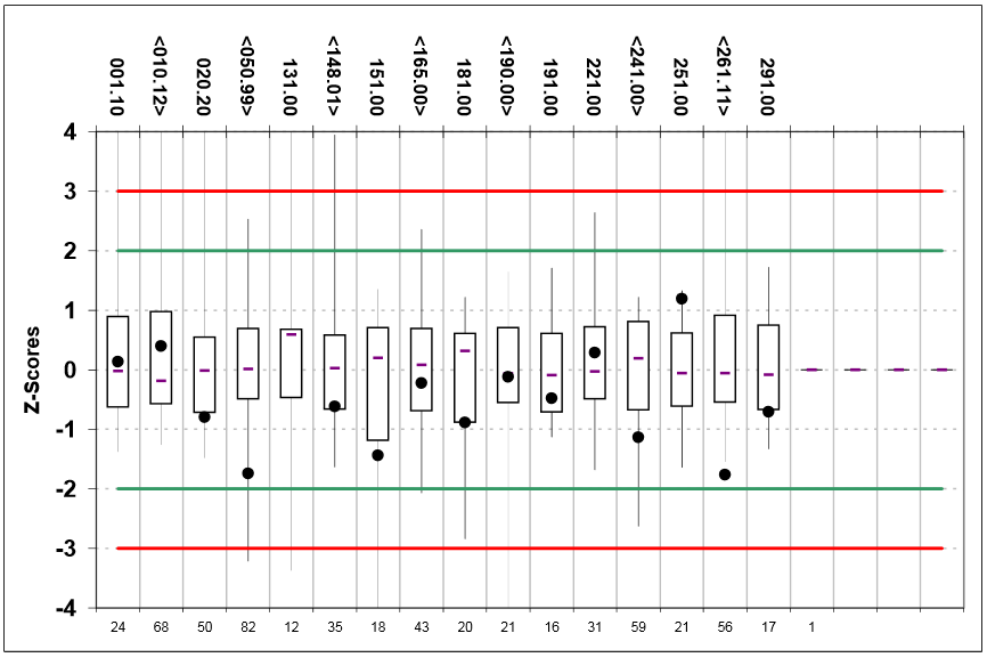
Sample # 150311: Grade 6-9-22
Analyte Report Card for Lab Code 0481
Z-Score Box Plot and Guarantees

Proficiency Testing For 17 Analytes **Issue Date : 04/30/2015**

Z-Score Box and Whisker Plots for Lab # 0481 <guaranteed analyte>



Guaranteed in This Sample			
Analyte	Code	Value*	IA
N	010	4.795	0.506
P2O5	041	8.048	0.680
K2O	050	20.995	1.115
Mg	121	1.273	0.264
S	148	10.230	0.711
B	165	0.342	0.054
Cl	190	16.190	1.000
Fe	241	0.441	0.049
Mn	261	0.036	0.009
Zn	321	1.393	0.144

* Value is the Robust Analyte Value estimated using the primary Analyte Codes for this sample.

Notes: The Methods you used are indicated above and the # Labs involved are below the Box and Whisker.
Your Z-Score is indicated by the Dot. If you do not see a Dot your score is off the chart.
Dots between the Green lines are acceptable Z-Scores. Dots outside the Red lines are actionable.
The Bar, Box and Whisker represent Median, 25% to 75% percentile and 5% to 95% percentile respectively.

A measure of the lab's accuracy in determining an analyte concentration has been described to be determined from a Z score. The lab value for guaranteed analytes can also be evaluated to determine if it falls within the investigational allowance (IA) defined by the American Association of Plant Food Control Officials (AAPFCO). The IA captures natural errors historically associated with sampling and laboratory variability. When the lab result is less than the guarantee by more than the IA value, AAPFCO would consider that analyte to be deficient. Only guaranteed values that fall below the IA are evaluated. For the purpose of determining if a lab value lies within the IA, the robust mean in the table next to the box and whisker plots is considered to be the guaranteed concentration of analyte in the fertilizer. The table also shows the IA at the robust mean concentration as defined by AAPFCO rules.

If a lab value for an analyte is less than the robust mean by more than the IA, the value is presented in square brackets as shown for Soluble Potassium as K_2O (050) and Acid Soluble Iron (241) on the Analyte Report Card on the first page. Notice for K_2O the Z score indicates a value that is considered acceptable but the lab value (19.60%) is slightly below the concentration at the lower range of the IA (19.88% = 20.995% – 1.115%). The IA indicators are provided as additional information for labs to monitor. If there are only one or a very few labs below the IA, the labs should consider their lab value as a Z score warning and seek improvement in analysis of the analyte if consistently outside the IA. On the other hand, if there are several labs exceeding the IA there may be an issue with method performance resulting in greater variation than allowed for by the AAPFCO defined IA. The number of labs exceeding IAs can be determined in the Analyte All Tests report which will be discussed in a subsequent article on statistical reports.

Next article:
Analyte Statistical Summary and Analyte All Tests Reports in the Magruder Program