# Examples of leaf deficiencies and conditions associated with high pH.

## By Bob Bors.

The purpose of this article is to show some of the symptoms that can occur on haskap leaves that may be due to nutritional deficiencies or other conditions such as herbicide damage, sunburn or mildew.

In early August of 2018, leaves were gathered from healthy and unhealthy plants and submitted to ALS labs for tissue analysis. The Haskap fields at the University of Saskatchewan range from 8.0 to 8.4 pH. When soils are that alkaline availability of potassium (K), iron (Fe), manganese (Mn), and boron (B) can be severely limited. Nitrogen (N), copper (Cu), and zinc (Z) also become less available (see figure 1).

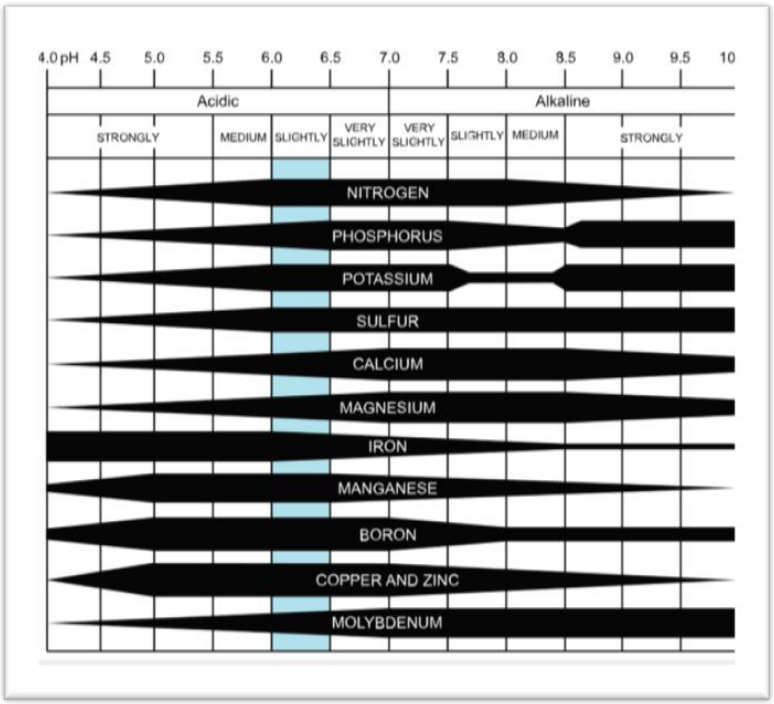



*Figure 1. Availability of nutrients needed by plants at various pH levels. Versions of this figure appear in virtually every soil science textbook. By CoolKoon - Own work, CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=68239761*

Leaf analysis shows that in most cases below there are multiple deficiencies. Some of the plants looked healthy but would benefit from better soil nutrition. Some of the photos show physiological problems or conditions in addition to deficiencies.

It is important to recognize that some nutrients have different mobility in soils than in plants (See table 1). Some nutrients bind to soil colloids and don't move through the soil profile. Mobile nutrients are compounds that can be dissolved in water, can be leached out of the root zone and need to be replenished. Some nutrients are more mobile within a plant; if a deficiency occurs they will move out of older leaves and translocate to the growing points and younger leaves. This results in older leaves

showing more severe symptoms. Nutrients that are less mobile will stay in the older leaves and the youngest leaves will suffer and look poorly, if there is a deficiency.

*Table 1. . Mobility in soils and plants of nutrients with lower availability in high pH soils. Adapted from: https://nrcca.cals.cornell.edu/soilFertilityCA/CA1/CA1_print.html*

| | | Mobility in plants | | | |
|---|---|---|---|---|---|
| | | Immobile | Somewhat Mobile | Mobile | Very mobile |
| Mobility in Soil | Immobile | Fe, Cu, Z | K, Mg | NH4+ | |
| | Somewhat mobile | Ca, Mo | | | P |
| | Mobile | Mn | | NO3- | |
| | Very mobile | B | | S | |

Leaves in the top parts of each photo (starting page 4) are organized with the youngest on top and oldest on the bottom for 4 sets of leaves. Farther down are many leaves randomly sampled from the same plant. The example in figure 2 shows a nitrogen deficiency where older leaves are more yellow because nitrogen has translocated to younger leaves. If a plant was highly deficient in a mobile nutrient at the start of the growing season perhaps all the leaves would look poorly including the top most leaves.

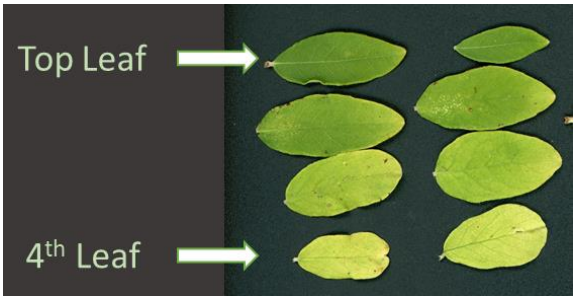


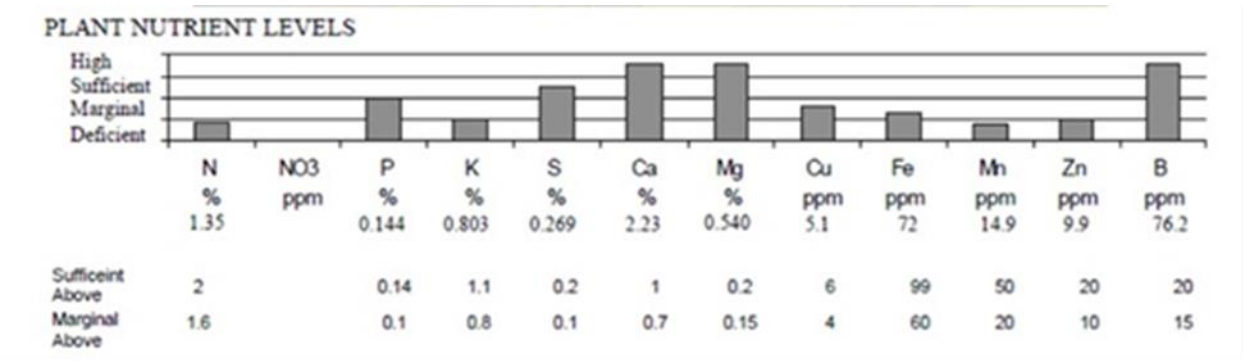

*Figure 2. Leaves shown in the photos in this section are laid out in a specific sequence. The topmost leaf is youngest followed by the 2nd, 3rd, and 4th leaf along the stem. This was done because some deficiencies may be more readily seen at the top of branches and others may be seen more the base of branches.*

The leaves shown below grew in soils that tended to be low in nitrogen and sulfur but were sufficient in most other nutrients. It is therefore surprising to see that some leaf tissues were deficient in minerals that were in adequate levels in the soil. Some of the leaves that looked heathy had similar leaf analysis to leaves that looked unhealthy. Likely some of this difference is due to genetics.

The photos that follow are from seedlings and not named varieties. Also included are scans of disorders likely caused by other situations such as herbicide or sunburn damage.

At the bottom of each page is part of the leaf analysis report provided by ALS labs in 4 sections.

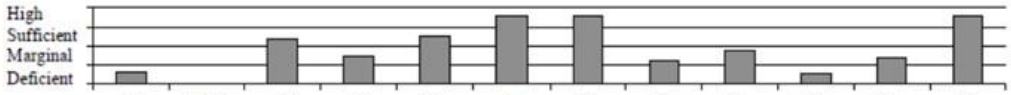
- The top row has a bar graph that categorizes nutrient levels as high, sufficient, marginal, or deficient. In a general way, this is based on studies with Apple trees done by various researchers and it is assumed that other fruit crops might have similar levels of nutrient needs. This part of the report is likely the most useful. One can quickly see what nutrients are high and low.
- The 2nd row shows the exact amount of a nutrient found in the leaf tissue. Units used are % or ppm. This row gives more exact information about what was in the leaf tissue.
- The 3rd row shows a number that any value above it would be considered sufficient and anything below it would be considered marginal.
- The 4th row shows a number that any value above it would be considered marginal and anything below it would be considered deficient. Rows 3 & 4 give the theoretical values based on apples and help explain how the lines were drawn for the bar graph.




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.35 | | 0.144 | 0.803 | 0.269 | 2.23 | 0.540 | 5.1 | 72 | 14.9 | 9.9 | 76.2 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

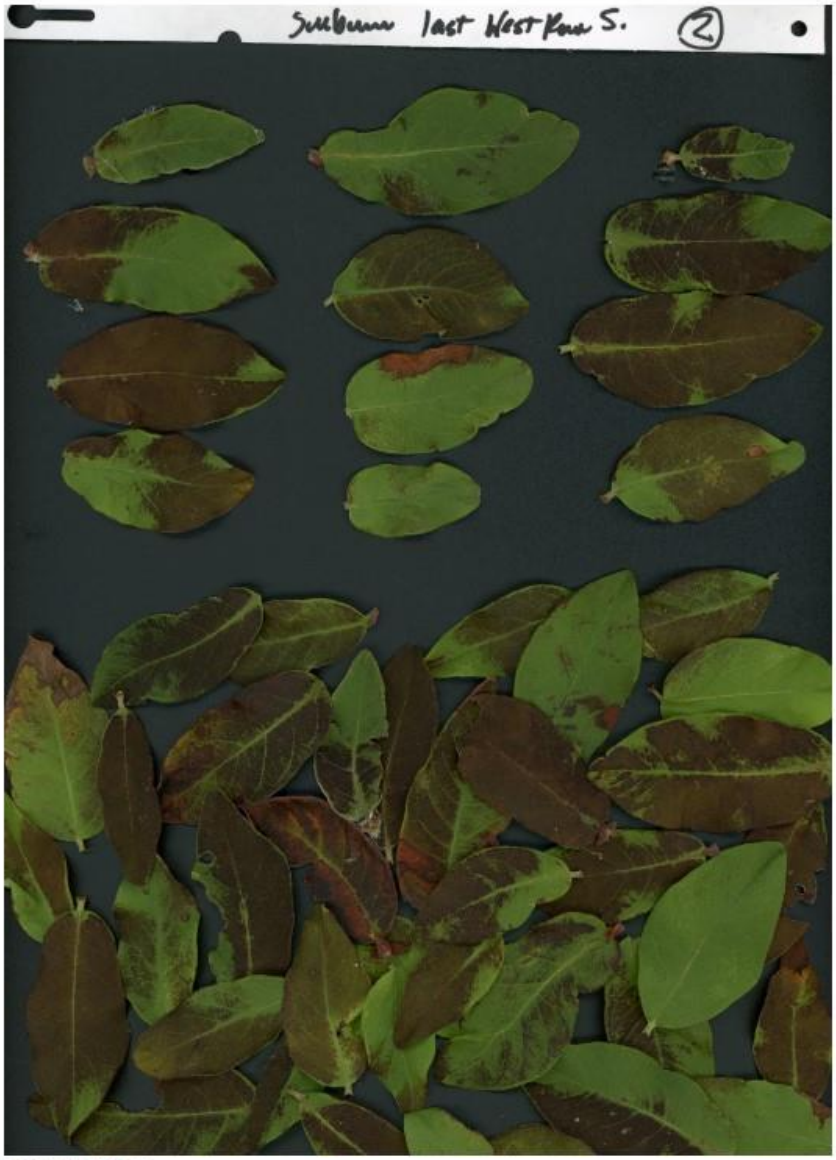
Leaf Scan #1: These leaves show symptoms of low N, but Mn is also deficient. At the bottom left leaves were gathered from the base of the plant. Leaves on the bottom right were gathered from the top. It would've been interesting to analyze these 2 types of leaves separately to verify that more nitrogen was likely in the top leaves.

PLANT NUTRIENT LEVELS

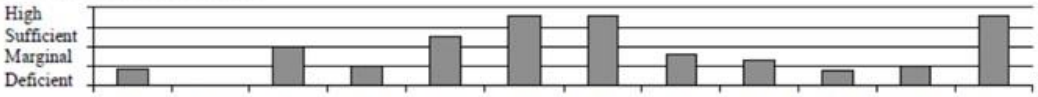



| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.02 | | 0.166 | 0.942 | 0.275 | 2.98 | 0.641 | 4.4 | 89 | 9.7 | 13.8 | 77.6 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #2. These leaves show sunburn which is a physiological condition.

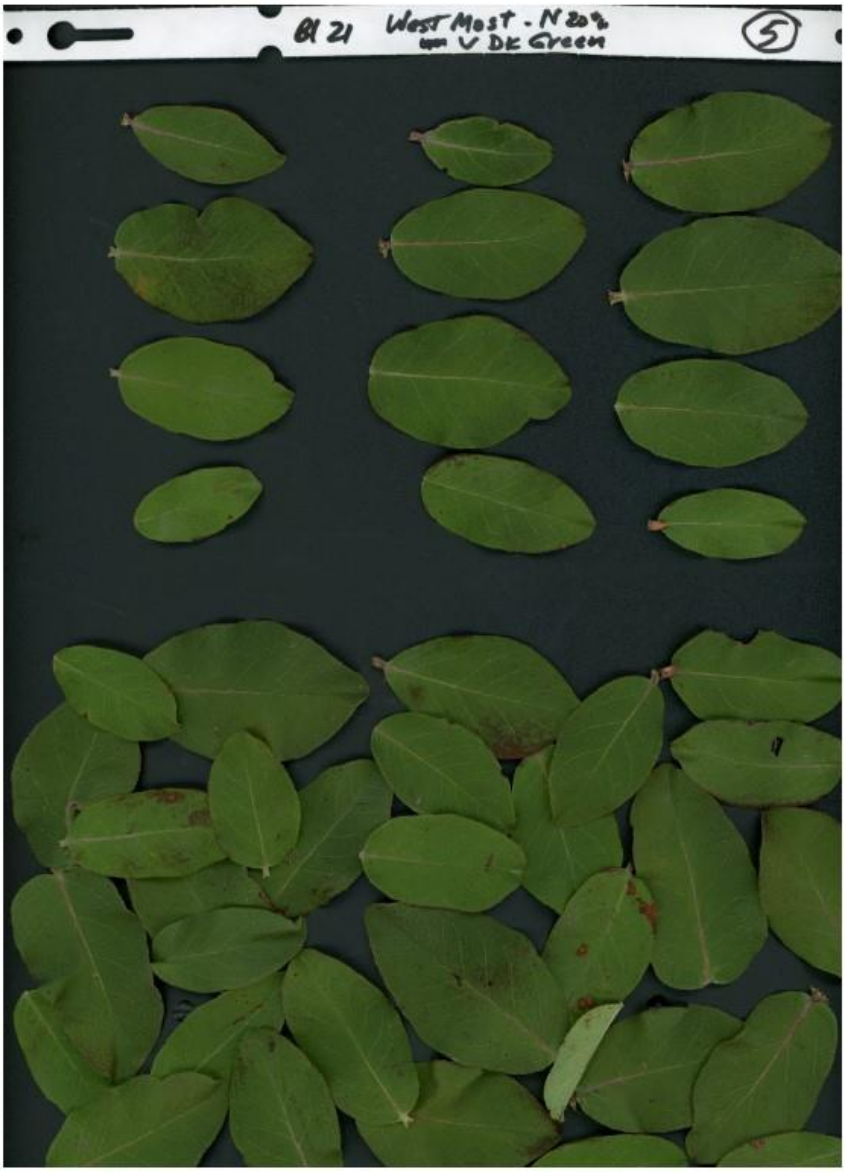



PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.35 | | 0.144 | 0.803 | 0.269 | 2.23 | 0.540 | 5.1 | 72 | 14.9 | 9.9 | 76.2 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #3. These leaves appeared healthy and were usually dark green.

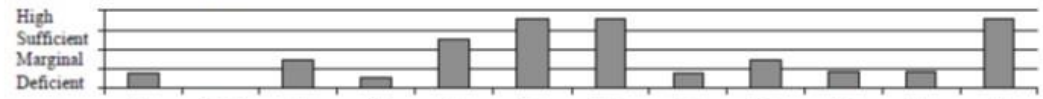



PLANT NUTRIENT LEVELS


| | N | NO3 | P | K | S | Ca | Mg | Cu | Fe | Mn | Zn | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | ppm | % | % | % | % | % | ppm | ppm | ppm | ppm | ppm |
| | 1.38 | | 0.175 | 0.732 | 0.256 | 2.08 | 0.548 | 3.5 | 74 | 19.1 | 10.4 | 62.0 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

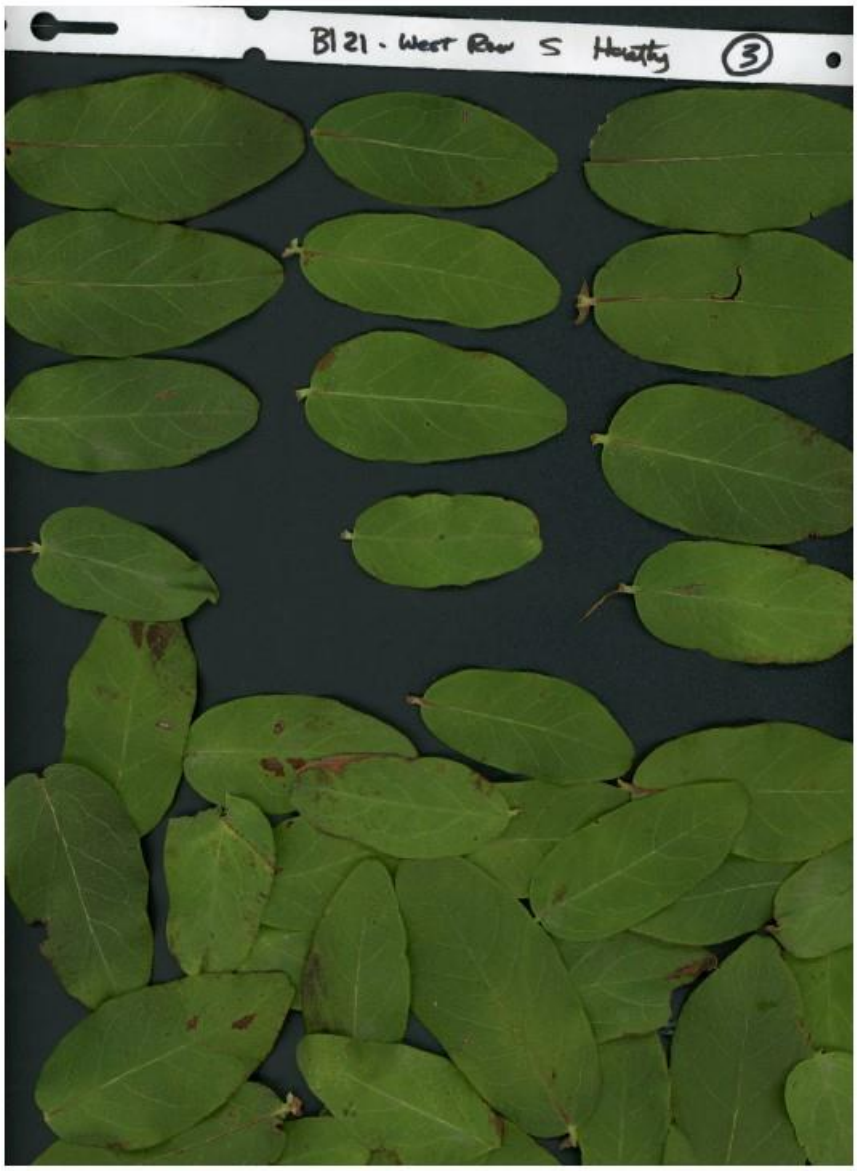
Leaf Scan #4. The occasional brown spots on these leaves are likely caused by rubbing against branches during windy periods. Otherwise the leaves look rather healthy.


PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.28 | | 0.120 | 0.428 | 0.411 | 3.04 | 0.871 | 3.2 | 77 | 16.7 | 8.5 | 71.6 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

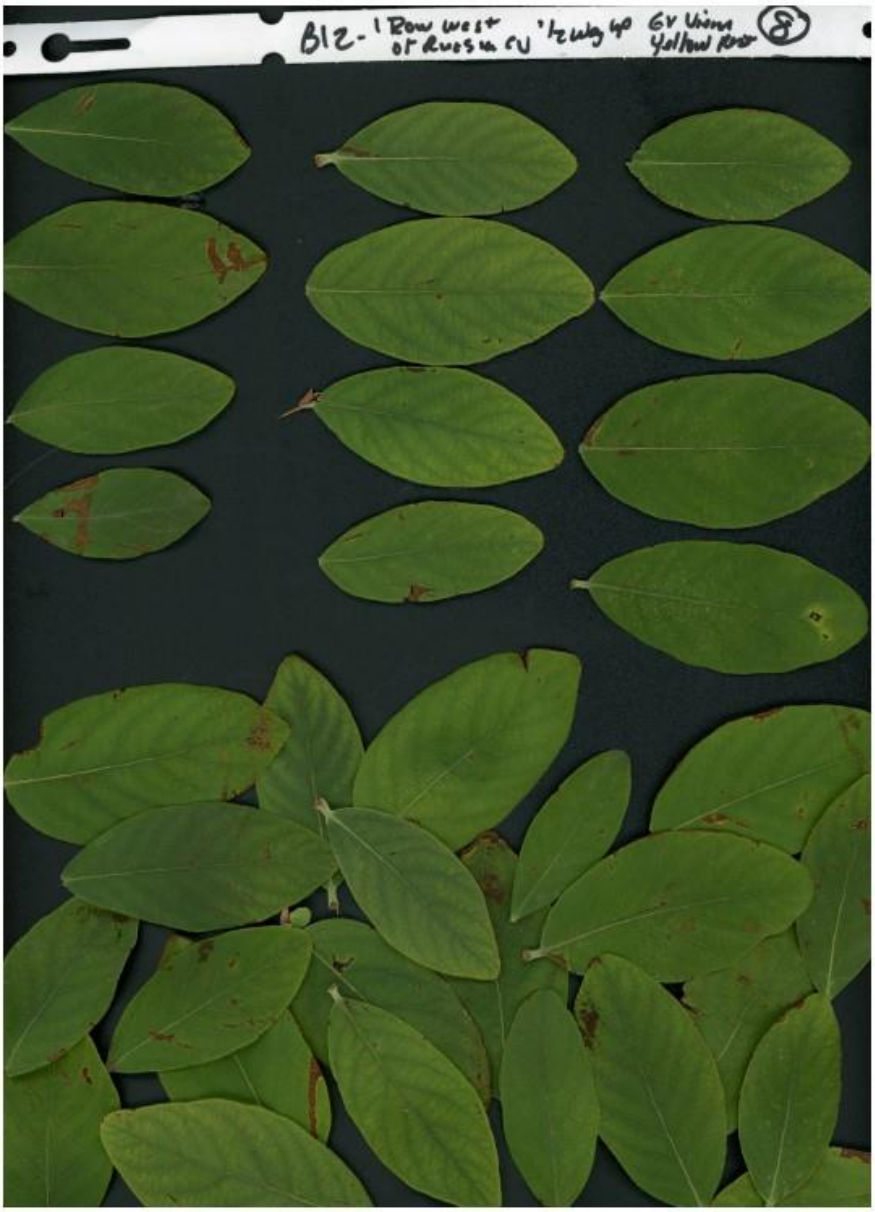
Leaf Scan #5. The leaves look pretty healthy except for a slight tint of bronze which can be associated with potassium deficiencies.



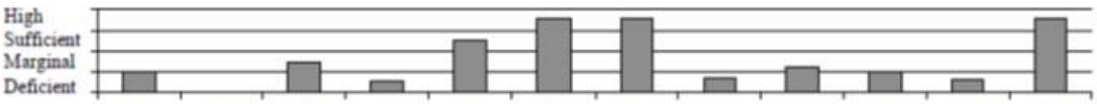

PLANT NUTRIENT LEVELS


| | N | NO3 | P | K | S | Ca | Mg | Cu | Fe | Mn | Zn | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | ppm | % | % | % | % | % | ppm | ppm | ppm | ppm | ppm |
| | 1.23 | | 0.116 | 0.923 | 0.226 | 1.83 | 0.617 | 5.7 | 55 | 24.6 | 10.2 | 57.9 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #6. These leaves show 'interveinal chlorosis', i.e. green veins with the rest of the leaves being yellow. The plant has deficiencies in nitrogen and potassium as well as several micronutrients.

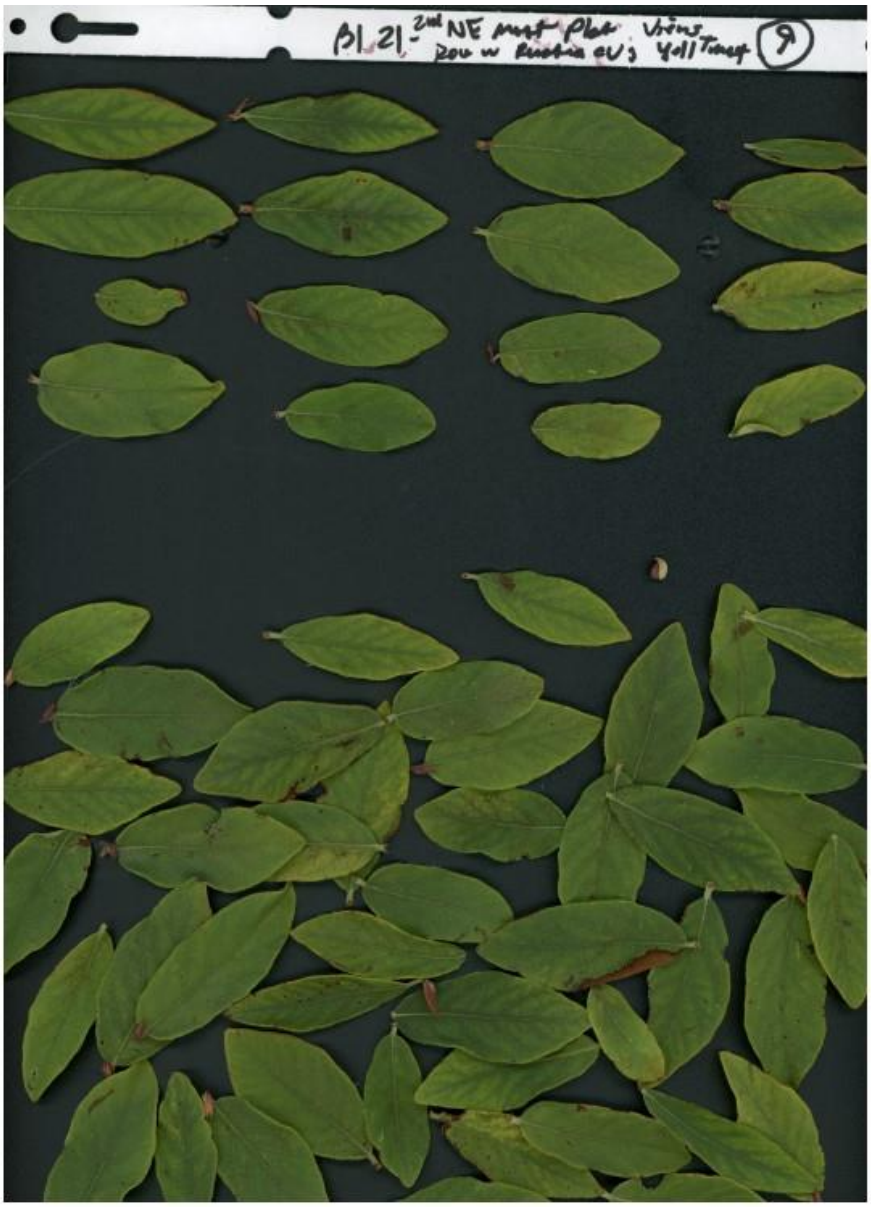


PLANT NUTRIENT LEVELS

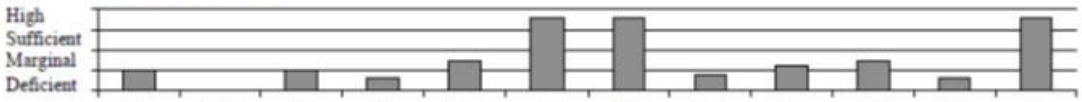



| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.55 | | 0.117 | 0.387 | 0.209 | 2.66 | 0.949 | 2.9 | 68 | 20.2 | 6.3 | 72.3 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #7. A trifecta of deficiencies. NPK are all at low levels as well as half of the micronutrients.



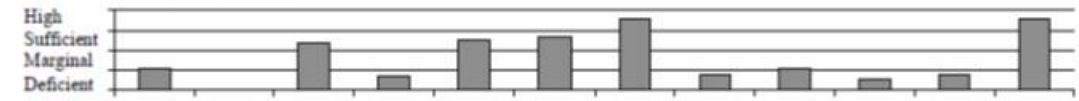
PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.52 | | 0.099 | 0.466 | 0.153 | 2.49 | 0.864 | 3.1 | 68 | 32.8 | 6.0 | 57.7 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

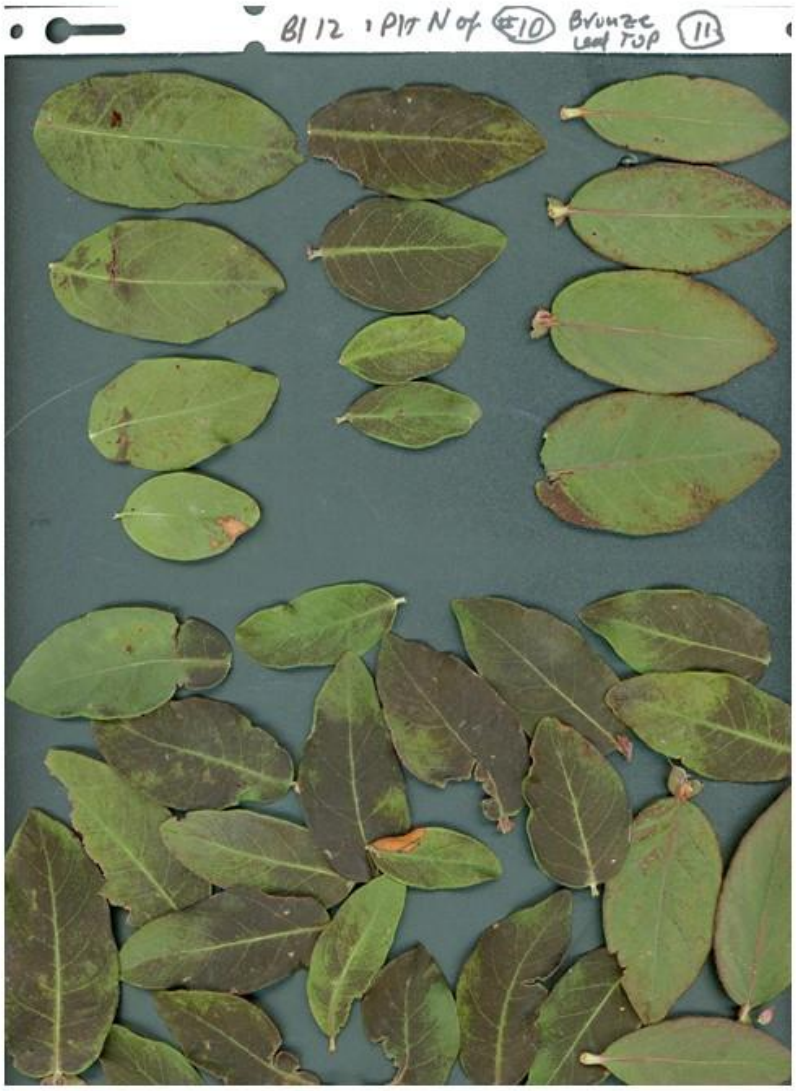
Leaf Scan #8. Similar symptoms to the previous 2 scans, except there is more green around the veins. These leaves had higher levels of phosphorus compared to the leaves in scans #6 and #7.


PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.63 | | 0.163 | 0.547 | 0.214 | 1.75 | 0.495 | 3.2 | 63 | 11.6 | 7.5 | 68.5 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

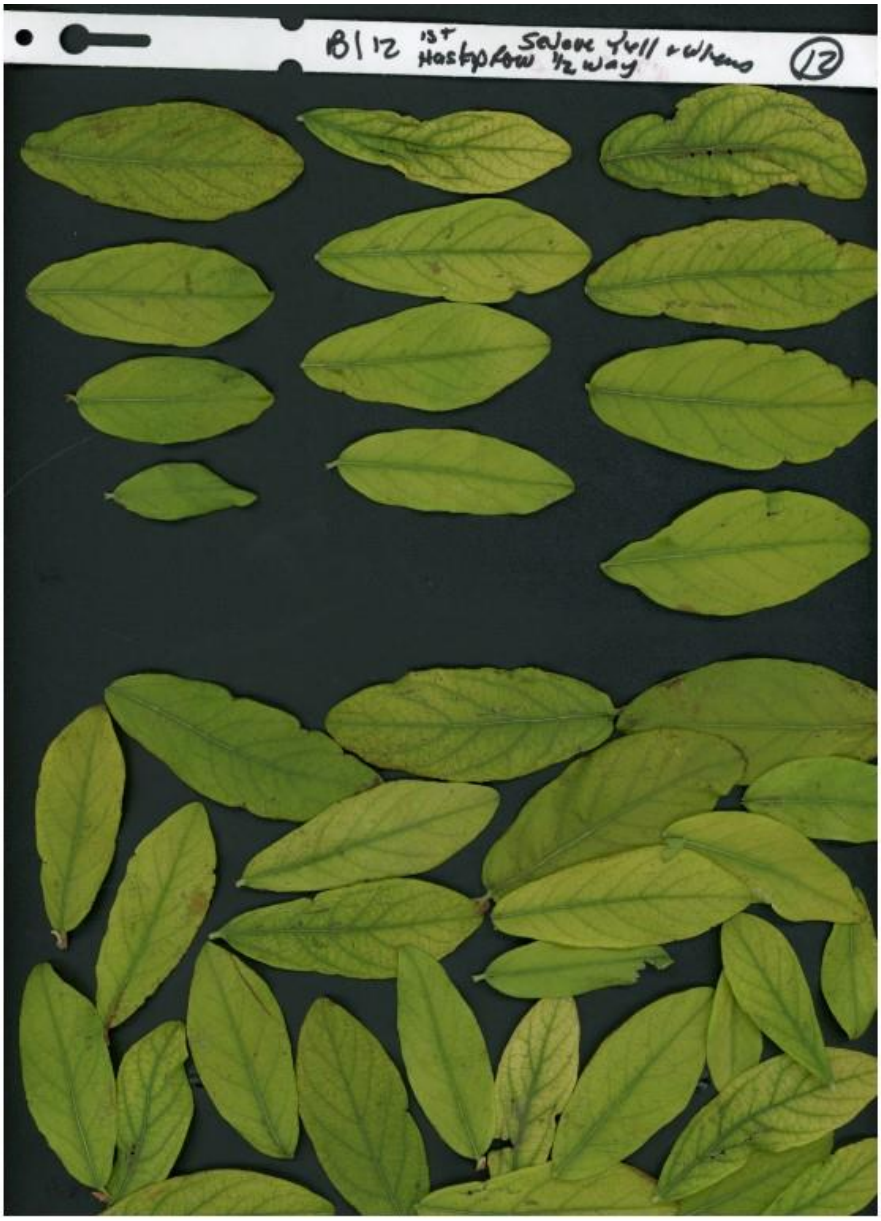
Leaf Scan #9. These leaves have a bronze look about them that doesn't quite look like sunburn because most leaves have bronzing throughout. Nutrient analysis differs from leaf scan #8 by having much more iron, but otherwise looks very similar.




PLANT NUTRIENT LEVELS


| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.62 | | 0.135 | 0.814 | 0.181 | 2.23 | 0.599 | 4.0 | 111 | 11.9 | 8.3 | 87.1 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

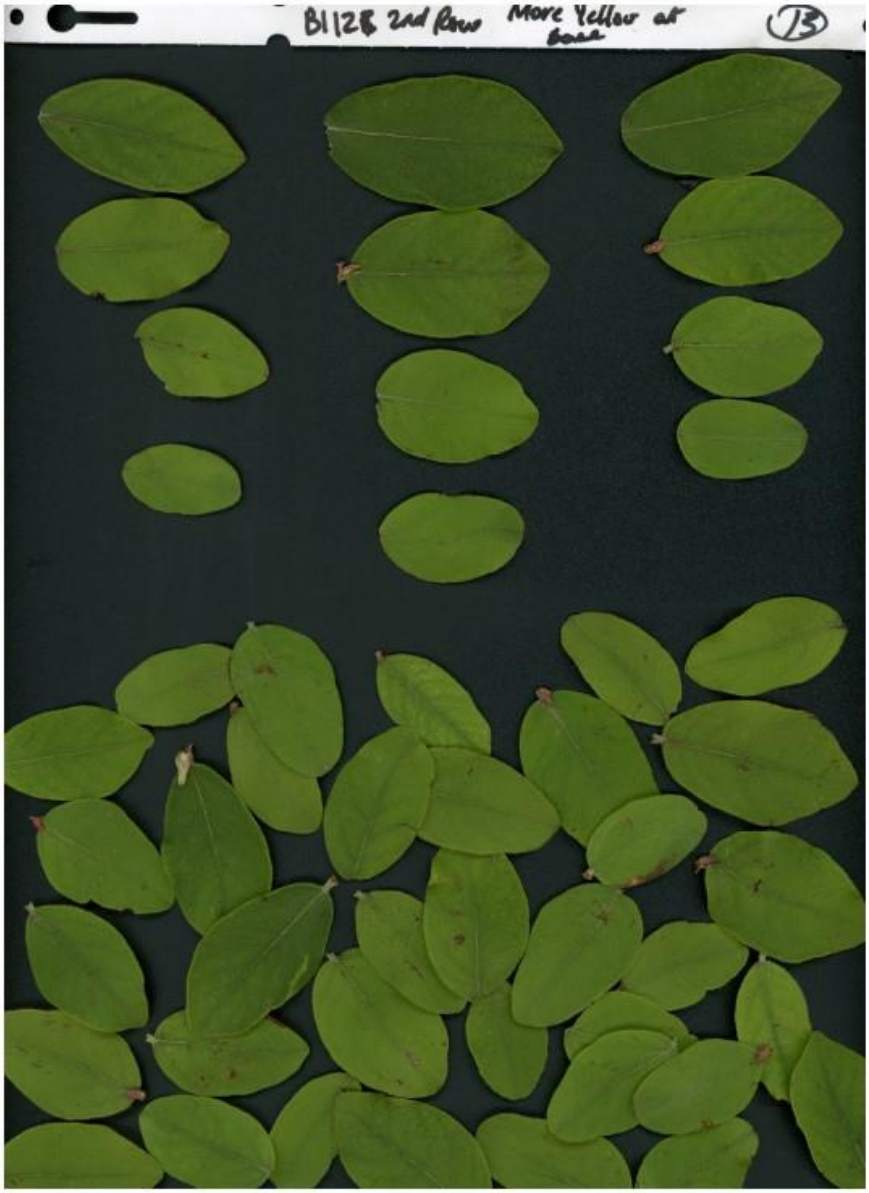
Leaf Scan #10. The severe yellowing with only slightly green veins in these leaves make them look worse than leaves in scans #6 and 7. Since micronutrient levels are higher in these leaves perhaps this genotype is more susceptible to deficiencies.



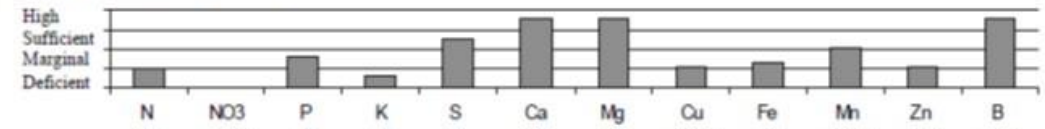

PLANT NUTRIENT LEVELS


| | N | NO3 | P | K | S | Ca | Mg | Cu | Fe | Mn | Zn | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | % | ppm | % | % | % | % | % | ppm | ppm | ppm | ppm | ppm |
| | 1.62 | | 0.135 | 0.503 | 0.253 | 3.14 | 0.899 | 4.6 | 100 | 46.6 | 14.8 | 70.3 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #11. These leaves are a little bit more yellow at the base. Veins are beginning to be a bit more green than the rest of the leaves.




PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.53 | | 0.123 | 0.504 | 0.236 | 2.93 | 0.896 | 4.0 | 71 | 54.8 | 10.3 | 67.9 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #12. These leaves look much worse than many of the other examples. Levels are marginal for many of the micronutrients. These leaves have much lower calcium than any of the previous examples.


PLANT NUTRIENT LEVELS

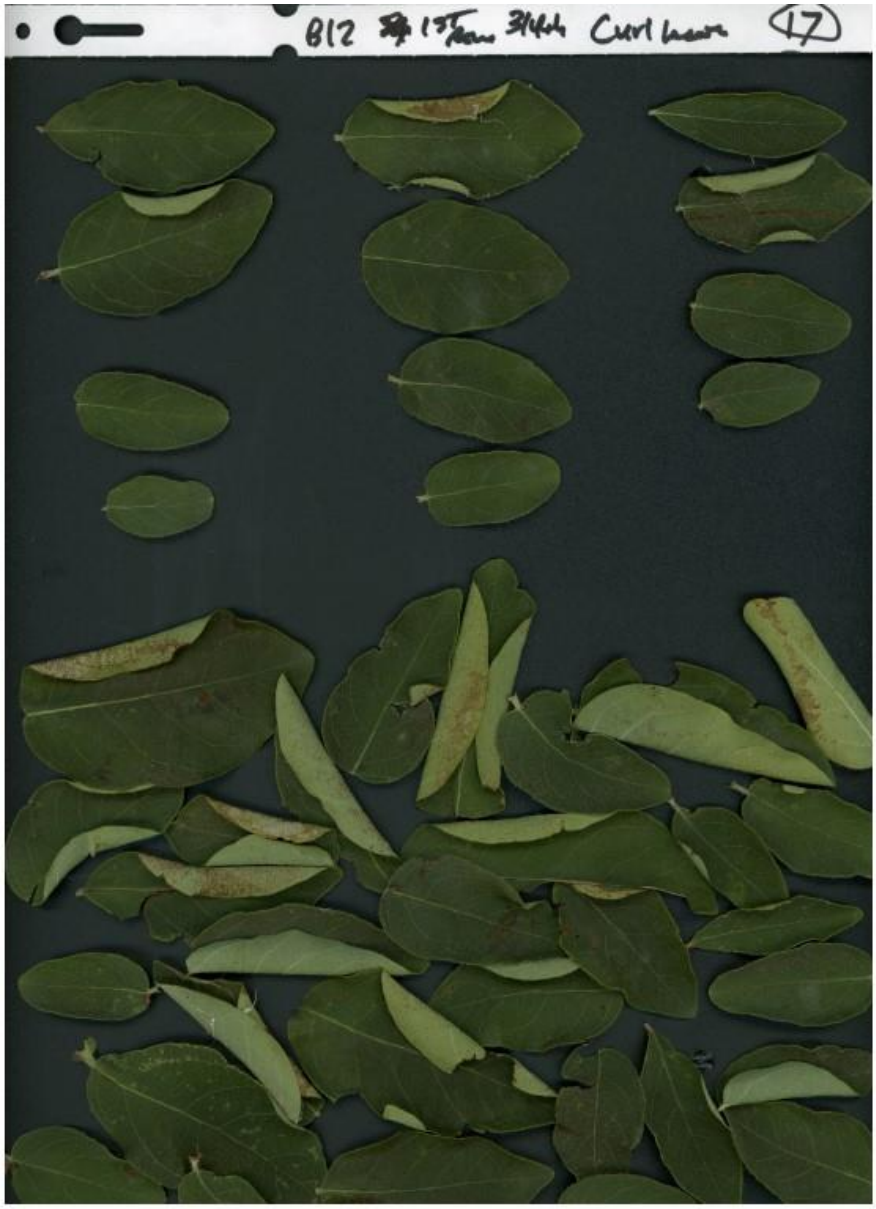

| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.80 | | 0.132 | 1.10 | 0.234 | 0.950 | 0.414 | 6.8 | 96 | 25.8 | 10.7 | 42.2 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #13. Another example of low N and K, and other micronutrients. The leaves are lighter green with darker veins.

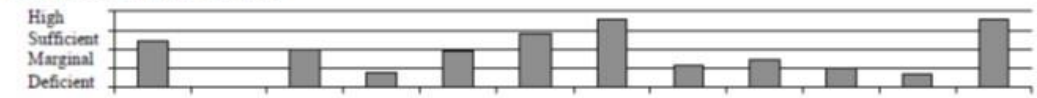

PLANT NUTRIENT LEVELS


| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.46 | | 0.159 | 0.549 | 0.213 | 2.06 | 0.707 | 4.1 | 69 | 31.6 | 7.7 | 81.0 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #14. These leaves have a bronze colour. Unlike many of the previous examples, nitrogen levels are sufficient. The curling of the leaves could be due to the beginning stages of powdery mildew.

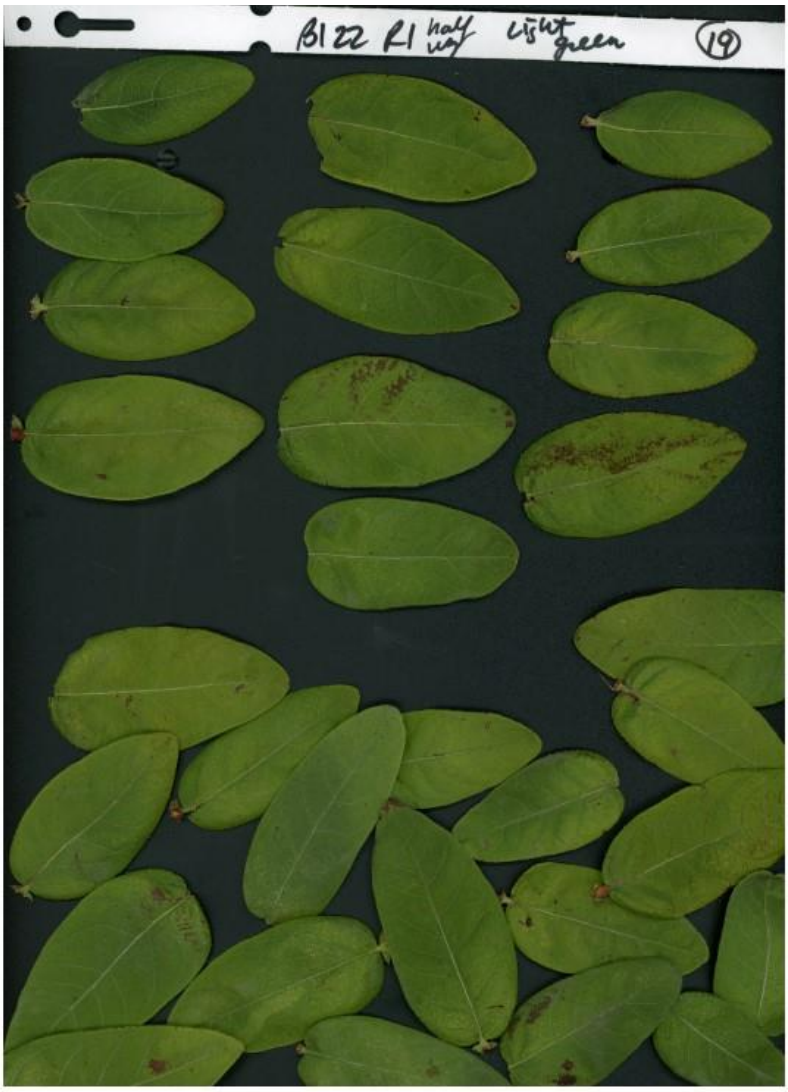



PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.42 | | 0.144 | 0.616 | 0.190 | 1.84 | 0.683 | 4.2 | 80 | 20.4 | 7.4 | 50.1 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

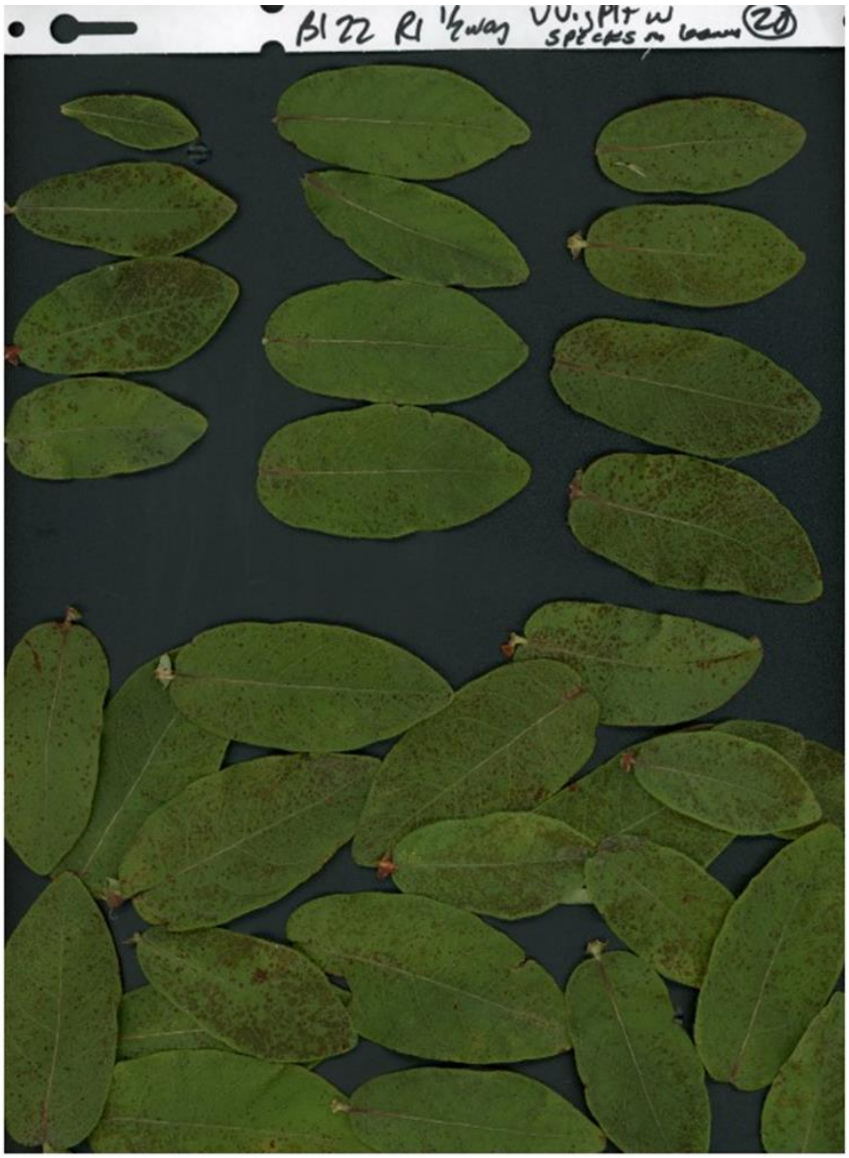
Leaf Scan #15. These leaves are more uniformly light green. N and K levels are deficient but several of the micronutrients levels are a bit higher than previous leaf scans. These leaves had higher iron levels than previous examples.



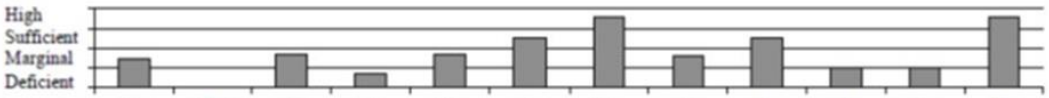

PLANT NUTRIENT LEVELS


| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.27 | | 0.139 | 0.393 | 0.279 | 2.48 | 0.826 | 5.4 | 134 | 28.1 | 17.8 | 88.3 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #16. These leaves came from a plant listed as extremely vigourous and was 1 of the tallest seedlings in its field. It was also very strange that it had brown spots on most of its leaves. The spots did not seem to be caused by any disease or insect.

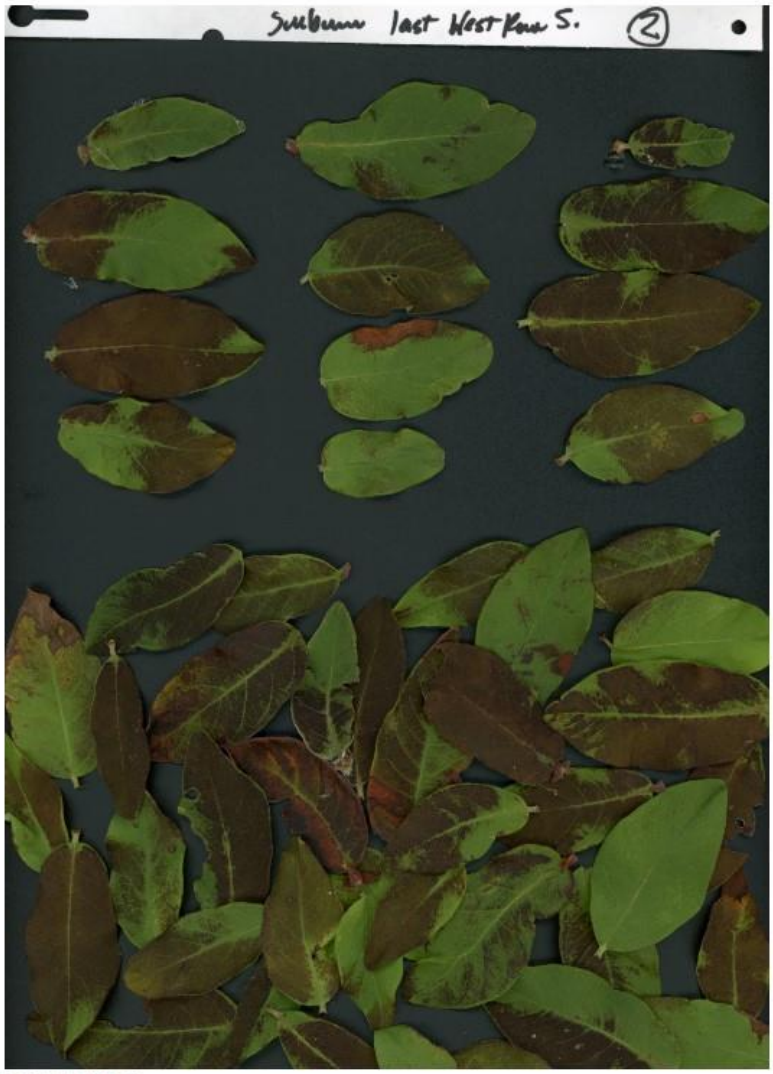


PLANT NUTRIENT LEVELS

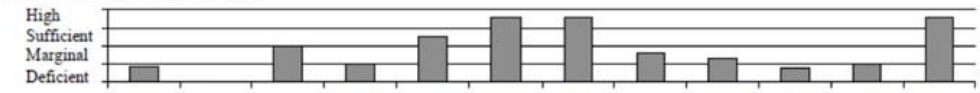



| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.80 | | 0.126 | 0.535 | 0.165 | 1.59 | 0.683 | 5.2 | 143 | 19.0 | 10.0 | 80.7 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #17. These leaves show severe symptoms of sunburn. Some seedlings seem to be more susceptible. With sunburn, leaves that are more exposed to light turn more brown and leaves that are partly shaded will have brown and green patches. Regardless of the sunburn, these leaves have multiple deficiencies.

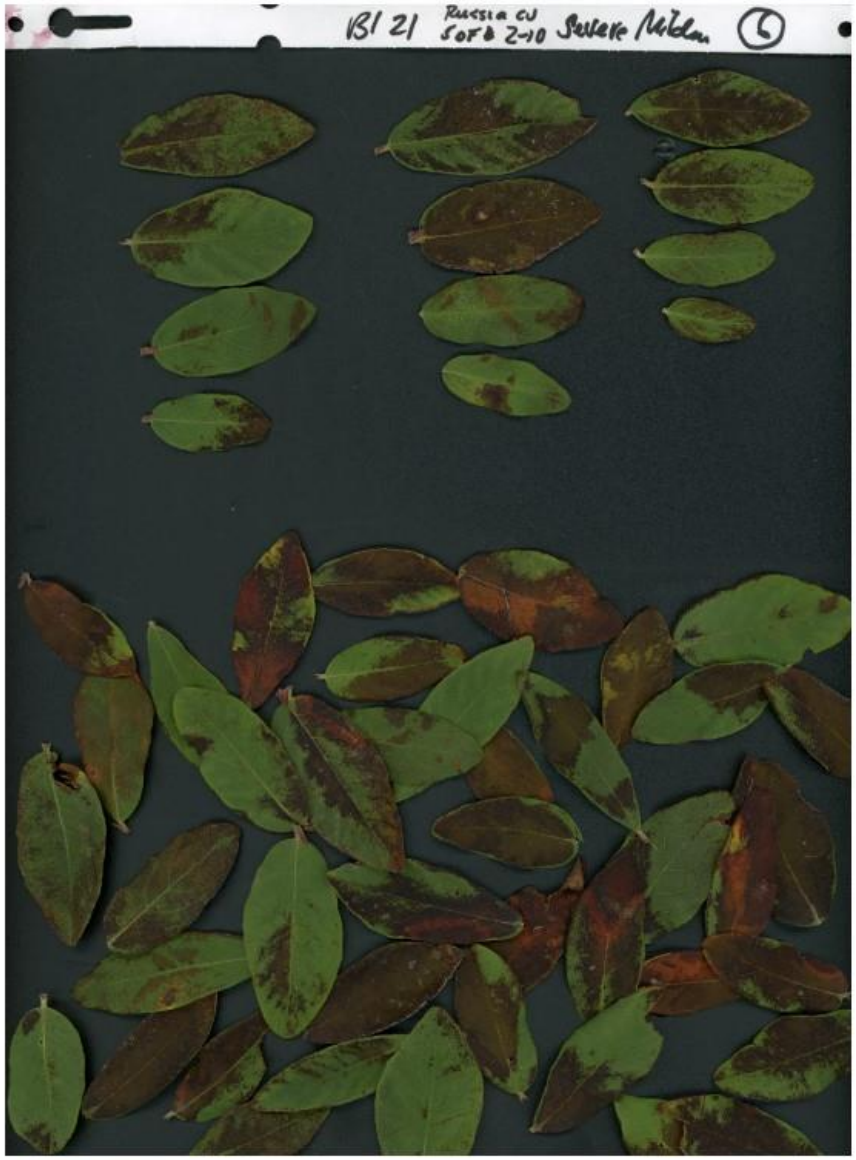



PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.35 | | 0.144 | 0.803 | 0.269 | 2.23 | 0.540 | 5.1 | 72 | 14.9 | 9.9 | 76.2 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

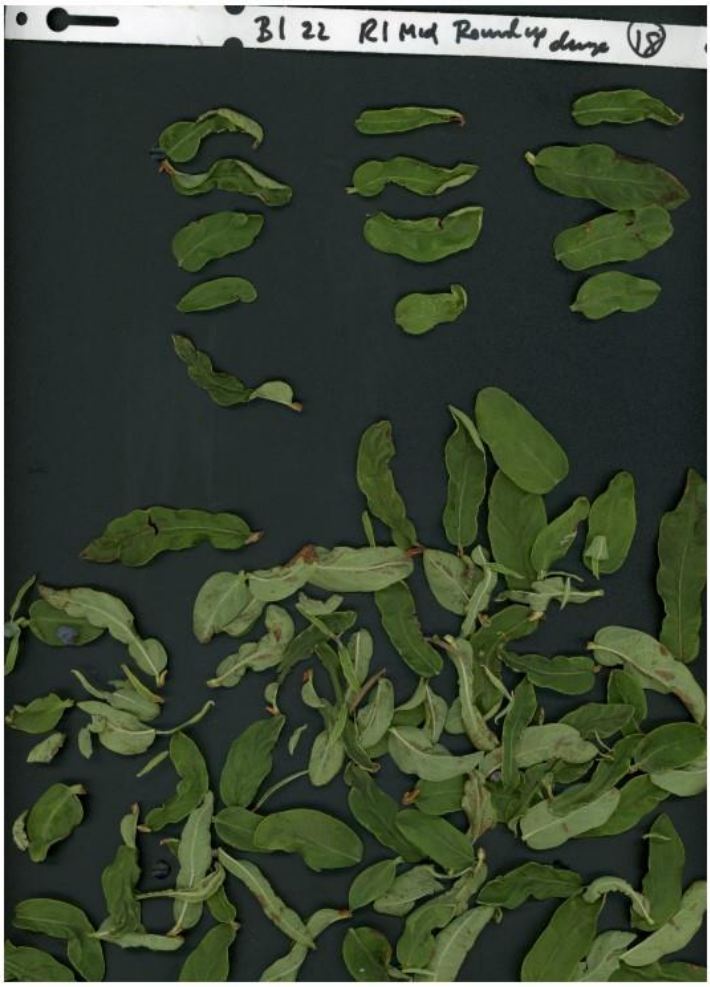
Leaf Scan #18. Another case of sunburn but also signs of mildew. Similar to leaf scan #17, these leaves had multiple deficiencies.



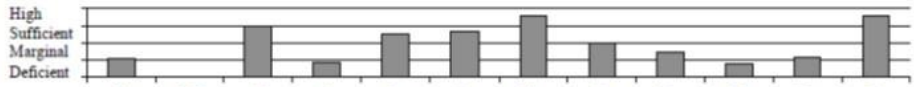

PLANT NUTRIENT LEVELS


| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.27 | | 0.116 | 0.455 | 0.366 | 3.44 | 0.771 | 3.2 | 82 | 14.8 | 8.4 | 47.6 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

Leaf Scan #19. The curling of these leaves was caused by Glyphosate drift from the next field over. The leaves had low levels of N, K, and several micronutrients.




PLANT NUTRIENT LEVELS




| | N % | NO3 ppm | P % | K % | S % | Ca % | Mg % | Cu ppm | Fe ppm | Mn ppm | Zn ppm | B ppm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.64 | | 0.207 | 0.687 | 0.305 | 1.74 | 0.765 | 6.4 | 78 | 16.2 | 11.5 | 75.4 |
| Sufficeint Above | 2 | | 0.14 | 1.1 | 0.2 | 1 | 0.2 | 6 | 99 | 50 | 20 | 20 |
| Marginal Above | 1.6 | | 0.1 | 0.8 | 0.1 | 0.7 | 0.15 | 4 | 60 | 20 | 10 | 15 |

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