Optimal and Critical Nutrient Concentrations in Rice Tissue

Background

Nutrient deficiencies or toxicities can be hard to determine visually. Knowing the nutrient concentration in the plant can greatly facilitate understanding problems in the field. Table 1 provides some overall guidelines as to what is optimal, low or excessive (and therefore possibly toxic) for rice plant tissues.

*Table 1. Optimal, critical and excessive or toxic nutrient concentration for rice at differ crop stages (panicle initiation - PI). Data source (Dobermann and Fairhurst, 2000; Williams 2010 in "()"). *see note on nitrogen in text.*

Element	Growth stage	Plant part	Optimum Range	Critical level for deficiency	Critical level for excess or toxicity
Nitrogen*	Tillering-PI	Y-leaf	2.9-4.2% (3.2-3.6%)	<2.5% (<3.2%)	>4.5%
	Flowering	Flag-leaf	2.2-2.5% (2.8-3.2%)	<2.0% (<2.8%)	
	Maturity	Straw	0.6-0.8%		
Phosphorus	Tillering-PI	Y-leaf	0.2-0.4%	<0.10%	>0.50%
	Flowering	Flag-leaf	0.2-0.3%	<0.18%	
	Maturity	Straw	0.1-0.15%	<0.06%	
Potassium	Tillering-PI	Y-leaf	1.8-2.6%	<1.5%	>3.0%
	Flowering	Flag-leaf	1.4-2.0%	<1.2%	
	Maturity	Straw	1.5-2.0%	<1.2%	
Zinc	Tillering-PI	Y-leaf	25-50 ppm	<20 ppm	>500 ppm
	Tillering	Shoot	25-50 ppm	<10 ppm	>500 ppm
Sulfur	Tillering	Y-leaf		<0.16%	
	Tillering	Shoot	0.15-0.30%	<0.11%	
	Flowering	Flag-leaf	0.10-0.15%	<0.10%	
	Flowering	Shoot		<0.07%	
	Maturity	Straw		<0.06%	
Silica	Tillering	Y-leaf		<5%	
	Maturity	Straw	8-10%	<5%	
Magnesium	Tillering-PI	Y-leaf	0.15-0.30%	<0.12%	>0.5%
	Tillering-PI	Shoot	0.15-0.30%	<0.13%	
	Maturity	Straw	0.20-0.30%	<0.10%	
Calcium	Tillering	Y-leaf	0.2-0.6%	<0.15%	>0.7%
	Tillering-PI	Shoot	0.3-0.6%	<0.15%	
	Maturity	Straw	0.3-0.5%	<0.15%	
Iron	Tillering	Y-leaf	75-150 ppm	<70 ppm	>300 ppm
	Tillering	Shoot	60-100 ppm	<50 ppm	
Manganese	Tillering	Y-leaf	40-700 ppm	<40 ppm	>800 ppm
	Tillering	Shoot	50-150 ppm	<20 ppm	
Copper	Tillering	Y-leaf	7-15 ppm	<5 ppm	>25 ppm
	Maturity	Straw		<6 ppm	>30 ppm
Boron	Tillering	Y-leaf	6-15 ppm	<5 ppm	>100 ppm
	Maturity	Straw		<3 ppm	>100 ppm
Aluminum	Tillering	Shoot	15-18 ppm	<5 ppm	>100 ppm

Some Considerations

Table 1 is based on data largely from Asia. That said, most values presented align very close to what would be expected in California. The main difference is in the leaf nitrogen levels, where the optimal N concentration or the critical level may be a bit higher for California. This may be due to the higher yield potential for California.

Nutrient concentrations in the plant vary among tissues (leaves, stems, etc.) and over time. Therefore, it is important to sample the correct plant tissue at the correct time.

Importantly, when trying to determine a problem, a nutrient's optimal and critical concentration assumes that all other nutrients are at optimal levels. Therefore, if more than one nutrient is deficient and/or toxic, it may not be possible to accurately determine the problem.

One disadvantage with determining a problem using plant tissue is that many times it cannot be corrected in the current season. Often the problem is noticed late in the season and it can take further time to get lab results. Nevertheless, the information is valuable for the next season.

Sampling Plant Tissue

- The Y-leaf is the uppermost fully extended leaf with a visible collar (Fig. 1). The flag-leaf is the top-most leaf below the panicle (Fig. 1). That said the flag-leaf can be taken in the later stages of booting before the panicle has emerged.
- When taking a sample, do not take the sample from just one small area, but get a representative sample from across the area in question. Take at least 20-30 leaf samples.
- When there are areas of your field with a problem and other areas that look good, take separate plant samples from both the problem and the good areas for analysis. This will further help determine what the problem may be.
- There needs to be enough tissue material for analysis and this may depend on the lab to which the samples are being sent. Be sure to follow the instructions provided by the laboratory for sampling, handling, and packaging the material before sending to the laboratory.

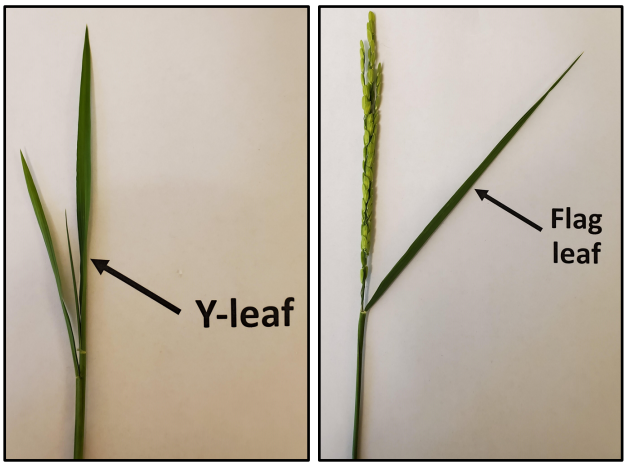

Figure 1. Rice Y-leaf and flag-leaf. Flag leaf is taken at flowering.

For more on this topic:

- ✓ Dobermann, A. and T.H. Fairhurst. 2000. Rice: Nutrient Disorders and Management. International Rice Research Institute
- ✓ Williams, J.F. 2010. Rice Nutrient Management in California. University of California, Agriculture and Natural Resources. Publication 3516
- ✓ Agronomy Research and Information Center-Rice: rice.ucanr.edu

Agronomy Research and Information Center

http://agric.ucdavis.edu/

University of California Cooperative Extension

Author(s): Bruce Linquist

2020