Crop Production and Soil Management Series

COOPERATIVE EXTENSION SERVICE

UNIVERSITY OF ALASKA FAIRBANKS

FGV–00244

Soil testing can provide an estimate of plant nutrient availability in a soil. However, soil testing cannot predict the quantity of nutrients a plant or crop will actually use because many factors other than soil fertility levels are involved in plant nutrition. Only through plant tissue analysis can we assess the plant's nutritional status and determine how well the soil is supplying the plant's nutritional requirements. Plant tissue analysis cannot replace a good soil testing program; however, plant tissue analysis can provide additional information on plant nutrient status not obtained from soil analysis.

In theory, plant tissue testing is quite simple. Plant samples from a eld are collected and the nutrient levels determined a er the plant tissue has been digested or extracted in a solution. Generally, only those plant portions growing above ground are sampled, although underground parts are sometimes sampled. Frequently, only speci c plant parts (leaves or petioles, for example) are sampled. A er nutrient levels are measured, the plant's nutritional status can be determined by comparing the measured levels with standard levels that have been previously determined through eld research. Alternatively, when a eld contains both healthy and unhealthy plants, samples can be taken from both and a comparison of nutritional levels can be made. Nutritional problems frequently can be identi ed by this process.

In reality, there are a number of factors that make plant tissue testing far more complicated than suggested. Plant nutrient concentrations are a ected by plant age, plant part and sometimes by variety even in a healthy plant. ese in uences must be taken into consideration.

As a plant ages, the proportions of the various types of structures change. Young plants are very succulent, with a high proportion of water in the tissues. When the plant gets older, water content decreases,

the petiole is the conducting tissue where nutrients travel from the stem to the leaf. e recommended plant part for sampling should be determined for each speci c plant (see Table 1.)

If a eld contains both healthy and unhealthy plants, these sampling guidelines are less critical. One can remove a sample from both healthy and unhealthy plants, making sure that the same plant part is taken in both. e healthy plant can be used as the standard value to compare against the unhealthy plant. is type of comparison may be less ideal than it appears because the physiological age of the two plant groups di er. It is not uncommon for an unhealthy plant to mature at a di erent rate than a healthy one. For example, an unhealthy plant may bloom much earlier than its healthy counterpart. erefore, although two plants may have been planted at the same time in the same eld, their physiological age, or stage of development, may not be the same. is can make direct comparison di cult. It is helpful if soil samples are collected from healthy and unhealthy areas when tissue samples are collected.

Plant tissue samples should be taken from plants representative of the sampling area. Dead or damaged plants, those with insect or disease problems, those at the end of rows or in edge rows, or plants that di er signi cantly from those in the rest of the planting should not be sampled. Plants that have been recently sprayed with foliar fertilizers should be avoided. It is important that at least the recommended number of plants is sampled to ensure that a representative sample is obtained. If the recommended sample size is 25 mature leaves, all leaves should be taken from separate plants. In addition, the sampled plants should be randomly selected from a eld, not concentrated in one area.

Try to sample clean leaves. Plants analyzed for iron or aluminum should rst be washed quickly in a mild (2 percent) detergent solution. Fresh tissue samples must be dried rapidly at 150° to 175°F until all water is removed (a kitchen oven on the warm setting will su ce). Drying at higher temperatures may destroy plant tissues; drying at

Alfalfa	12	Top 6 inches	Prior to bloom
Barley	25	Whole top1	Emergence of head from boot
Beets	20		

			%		
Nitrogen		3.00–4.50	4.5–5.0	3.50–4.50	3.50–5.00
Phosphorus	0.25–0.50	0.20–0.60	0.36–0.45	0.45–0.80	0.40–0.60
Potassium	1.50–3.00	2.20–3.00	2.00–2.50	5.50–6.20	6.00–9.60
Calcium	1.00–1.80	2.00–2.60	0.50–1.00	2.00–2.80	1.40–2.25
Magnesium	0.30–0.60	0.21–0.60	0.20–0.30	0.35–0.80	0.36–0.70
Sulfur	—	0.26–0.30	0.25–0.50	—	—
			ppm		

Broccoli	Mid–growth	Midrib of YML[1]	>9000	>4000	>5.0
	First buds		>7000	>4000	>4.0
Brussels sprouts	Mid–growth		>9000	>3500	>5.0
	Late growth	Midrib of YML	>7000	>3000	>4.0
Chinese Cabbage	Heading	Midrib of wrapper leaf	>9000	>3500	>4.0
Carrot	Mid–growth	Petiole of YML	>10000	>4000	>6.0
Cauliflower	Head forming	Midrib of YML	>9000	>5000	>4.0
Celery	Mid–growth	Petiole of YML	>9000	>5000	>6.0
	Near mature		>6000	>3000	>5.0
Head Lettuce	Heading	Midrib of	>8000	>4000	>4.0
	Harvest	wrapper leaf	>6000	>2500	>2.5
Potato	Early–season	Petiole of fourth	>19000	>2000	>12.0
	Mid–season	leaf from the	>15000	>1600	>9.0
	Late season	growing tip	>8000	>1000	>6.0

[1] YML – youngest mature (fully expanded) leaf.

Nutritional diagnoses can give important information about the condition of a crop; however in the case of an annual crop, it may be too late to e ectively remedy nutritional problems. Nevertheless, even when irreparable damage has been done, diagnostic nutritional information can be extremely valuable. If tissue analyses reveal shortages of nutrients routinely applied in a fertilization program (nitrogen, phosphorus or potassium), this may be an indication that the fertilization regime being used is inadequate for that crop.

e next time the crop is grown at that location, fertilizer application rates should be adjusted. If tissue analyses reveal shortages of secondary or micronutrients, soil test information should be consulted and consideration should be given to various means of correcting the problem before the eld is planted again. When dealing with perennial crops, adjusting fertilization practices can be made at almost any time. Action taken late in the season may not improve that season's yield, but performance in subsequent years should be enhanced.

Information from plant tissue tests cannot replace that from soil tests; the two practices provide complementary data. By combining information from the two sources, one gets a clearer picture of the ability of a soil to provide adequate nutrition and of the crop to use nutrients. Both should be considered integral parts of a complete nutrient monitoring program.

The information contained in Tables 1–3 was derived from the following publications:

Dow, A.I. 1980. Critical nutrient ranges in Northwest crops. Western Regional Extension Publication No. 43.

Evanylo, G.K. and G.W. Zehnder. 1988. Potato growth and nutrient diagnosis as affected by systemic pesticide growth stage. *Communications in Soil Science and Plant Analysis* 19:1731–1745.

Gardner, B.R. and J.P. Jones. 1975. Petiole analysis and the nitrogen fertilization of Russet Burbank potatoes. *American Potato Journal* 52:195–200.

Geraldson, C.M. and K.B. Tyler. 1990. Plant analysis as an aid to fertilizing vegetables. In *Soil Testing and Plant Analysis*, ed. R.L. Westerman. Madison, WI: Soil Science Society of America.

Jones, J.B. Jr., B. Wolf, and H.A. Mills. 1991. *Plant Analysis Handbook*

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