NOTE: This publication is currently out of print, originally published by the Cooperative Extensions Service, Washington State University.

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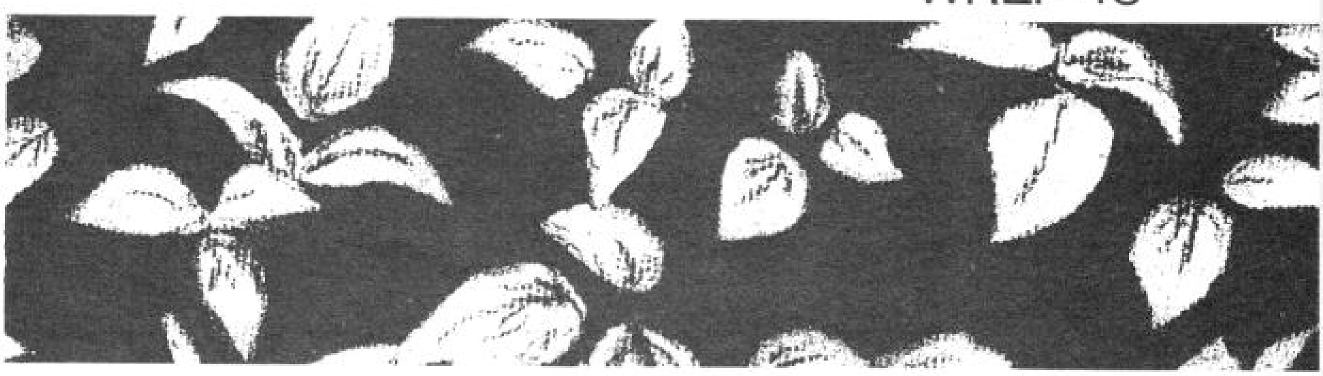
WREP 43



Critical Nutrient Ranges in Northwest Crops

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Along with soil testing, plant analysis has become a valuable and important tool with respect to soil fertility and plant nutrition. Its use as an on-farm tool for improved plant nutrition has greatly increased in recent years in the Northwest and throughout the United States. The primary function of soil testing is to predict fertilizer needs. For annual crops, the primary function of plant analysis is to diagnose problems or to determine or monitor the nutrient status during the growing season. In some cases, diagnosis can be made early enough to correct deficiencies during the current season. A good example is the monitoring of nitrate-N (NO_3-N) in potato petioles and the application of required N through sprinkler systems. Plant analysis can be useful for the prediction of nutrient needs in perennial crops, usually for the year following the time of sampling and analysis.

CONCEPTS

Concepts on soil fertility and crop nutrition began more than 150 years ago. During and since that time it has become well established that there is generally a good relationship between concentration of a nutrient in a crop and growth and yield of that crop. This is well illustrated in figure 1, which shows the relationship between P in alfalfa plants and average yields of irrigated alfalfa from 30 trials in Washington. Note that the relationship is good, but that there is a scattering of points around the eye-fitted curve.

As the nutrient supply (and the nutrient concentration) increases only slightly, the yield increases very sharply resulting in a nearly vertical line (figure 2). The line bends to the right and straightens again to a horizontal line, where increases in nutrient concentration have no effect on yield. The nearly vertical line is the zone of deficiency; the horizontal line, the zone of adequacy. Beyond the zone of adequacy is the zone of excess or of toxicity.

CNC vs CNR

The critical nutrient concentration (CNC) can be defined as the concentration that is either barely deficient or barely adequate for maximum growth. The word "concentration" implies a point on the curve, as indicated in figure 2.

Since the CNC is more or less theoretical, and very difficult to pinpoint, we suggest the use of CNR rather than CNC, and that the definition of CNR can be: THAT RANGE OF CONCENTRATIONS ABOVE WHICH WE ARE REASONABLY SURE THE CROP IS AMPLY SUPPLIED AND BELOW WHICH WE ARE REASONABLY SURE THE CROP IS DEFICIENT. Thus, within the CNR is a range of uncertainty.

SAMPLING

Sampling is, no doubt, the most critical part of the tissue sampling-testing program. Important factors are time of sampling, choice of tissue, and handling of samples.

Time of sampling

Since nutrient levels change with time—in some cases quite rapidly—the growth stage becomes critical. If interpretation is to be accurate and meaningful, the stage of growth at the time of sampling must be accurately noted. Equally important, the growth stage must coincide with the stage designated from research as the one for which the CNR has been established.

The importance of sampling at the proper growth stage is illustrated in table 1. All sampling was done during a 1-month period of June 6 to July 7. One can easily see (1) the rapid changes in nutrient concentration within the 1-month period, and (2) the fallacy of sampling during growth stage 1 or 3 and using for interpretation, the CNR based on stage 2.
Usually a designated time of sampling has been "early season," "mid-season," or "late season." Note that all three growth stages shown in table 1 were during "early season." It is important to sample during a precisely designated stage of growth rather than a generalized period with reference to the growing season. Furthermore, one should avoid the use of a calendar date or even a certain number of days after planting.

Seasonal monitoring

In many, if not most, cases, the purpose of a plant sampling-testing program is "predictive," i.e., a certain nutrient level at a given time during the season should predict whether or not that level will result in reduced yield at harvest. The accuracy of prediction is enhanced by "monitoring," i.e., by taking samples periodically during the season. Frequently the real objective is to prevent the concentrations of nutrients from reaching critical or deficiency levels.

Seasonal monitoring then considers the changes (usually downward) in nutrient level during the season. If during the season CNRs have been established by research, then an interpretive guide, such as the generalized one illustrated in figure 3, can be established. The intermediate zone in the figure could correspond to the CNR.

Choice of tissue

The choice of tissue is very important because of differences in nutrient level among various plant parts. But, more important, some plant

Table 1. Nutrient levels in potato petioles during three early-season growth stages and the CNR values for growth stage 2.

Growth stage	NO_3-N	P	K	Mg	Zn
	%	%	%	%	ppm
1	2.7	.41	9.5	.56	38
2	2.0	.25	9.2	.71	21
3	1.4	.18	7.8	.80	14
CNR	1.6-2.0	.25-.30	8.0-9.5	.15-.20	10-20

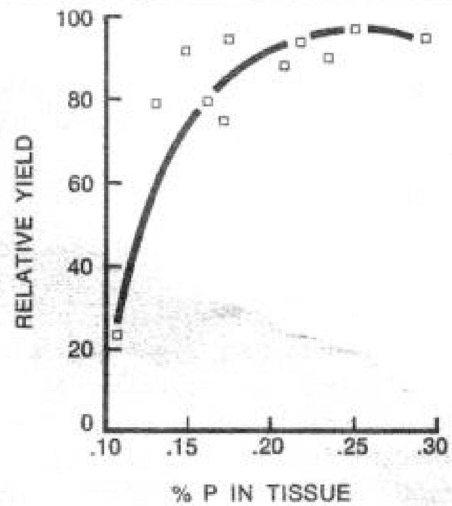

Fig. 1. Relationship between P in tissue and relative yield of alfalfa in 30 experiments.

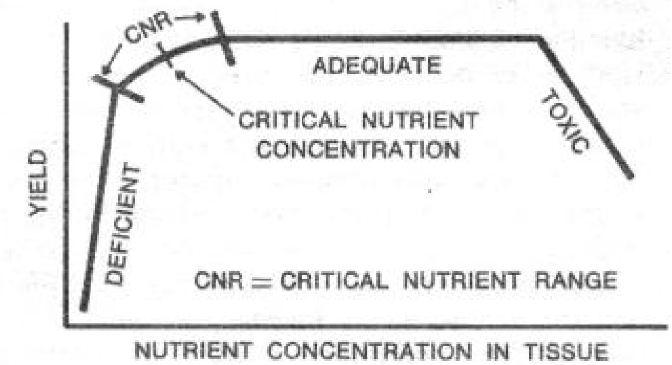

Fig. 2. Relationship between nutrient concentration in tissue and growth of a crop.

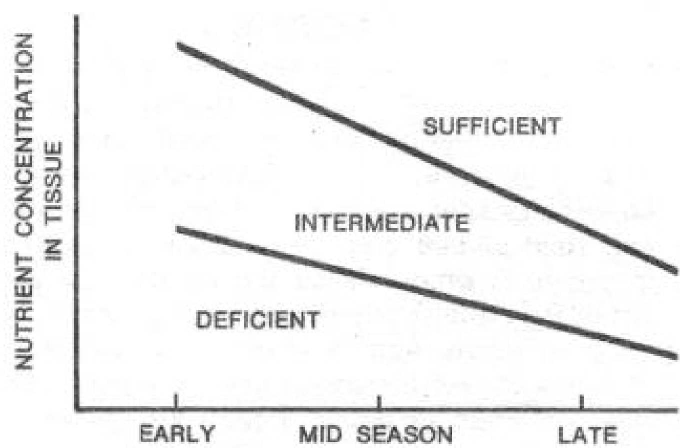

Fig. 3. Generalized interpretative guide for tissues sampled at different times during the growing season.

parts are more sensitive to treatment or nutrient changes than others. The more sensitive tissue is the one to use. This is determined by research. In general, petioles are best for macronutrients and leaf blades for micronutrients, but there are exceptions.

As a rule, the youngest fully expanded leaves are selected for sampling and divided into blades and petiole. Sometimes both parts are analyzed for nutrients, but usually one or the other is discarded.

The number of leaves required depends to some degree on the size of the leaves, but usually leaves should be taken from 20 to 50 plants.

1980 REVISED TABLES*

As explained in the previous section, we have avoided the use of specific critical nutrient concentrations and have used, instead, critical nutrient ranges. Thus, except where information is available on excessive concentrations, in each case, there will be only two numbers.

The user of these data should recognize the limitations of plant tissue analysis. Concentration of nutrients in a plant are a result of both plant growth and nutrient supply. Consequently, the concentration of a given nutrient is meaningful only if all other growth factors are adequate. Thus, if the supply of N is limiting growth, the tissue concentration of elements such as P, K, and Zn are not valid indications of the potential supply of these elements.

Unless stated otherwise, all analytical values are for the total element.

Unless stated otherwise, plant material was dried at 60°-70°C.

*This section was prepared by the Northwest Soil and Plant Test Work Group, compiled and edited by: A. I. Dow; E. H. Gardner, Soil Scientist, Oregon State University; and C. G. Painter, Extension Soil Specialist, University of Idaho. The following persons contributed to the development of the tables: Oregon—Hugh Gardner and Robert Stebbins; Idaho—Robert McDole and Charles Painter; Utah—Paul Christensen; Montana—Neil Christensen; and Washington—A. I. Dow and R. B. Tukey.

FIELD CROPS

ALFALFA

Nutrient	Time or growth stage	Plant part	CNR[1]	Excess (above)	Reference[2]
P	1/10 bloom	tops, upper ¾	0.2-0.25%	——	W-17,20
P	1/10 bloom	whole tops	0.2-0.25%	——	I-9
P	1/10 bloom	tops, upper 2/3	0.2-0.3 %	——	O-5
P	——	tops	0.15-0.25%	——	U-3
P	pre-bloom-1 month	whole tops	— 0.30%	——	O-14
P	1/10 bloom	top ½ of shoots	— 0.30%	——	O-11
P	pre-bloom	top ½ of shoots	0.25-0.30%	——	O-8
PO_4-P	1/10 bloom	mid stem	0.08-0.10%	——	W-14
K	1/10 bloom	tops, upper ¾	1.0-1.8 %	——	W-17
K	1/10 bloom	tops, upper 2/3	1.4-1.8 %	——	O-5
S	1/10 bloom	tops, upper ¾	0.20-0.27%	——	W-16
S	early bloom	tops, upper ¾	— 0.22%	(N/S ratio=11)	W-19
S	1/10 bloom	tops, upper 2/3	0.19-0.21%	——	O-5
S	1/10 bloom	whole tops	0.19-0.21%	——	I-12
SO_4-S	1/10 bloom	whole tops	0.08-0.10%	——	I-12
B	1/10 bloom	apical 1 in.	20-25 ppm	——	W-2
B	1/10 bloom	upper 3-4 in.	20-30 ppm	——	W-16
B	1/10 bloom	tops, upper 2/3	10-20 ppm	——	O-5
Zn	1/10 bloom	top ½ of shoots	10-14 ppm	250 ppm	W-4,10
Mn	pre-bloom-1 month	whole tops	——	350 ppm	O-14
Mo	1/10 bloom	tops, upper ½	0.3-0.5 ppm	——	O-13
Mo	1/10 bloom	tops, upper 2/3	0.1-0.2 ppm	——	O-5

[1]CNR=Critical Nutrient Range. Single figures indicate beginning of sufficiency range.
[2]I=Idaho; O=Oregon; U=Utah; W=Washington. See reference section following tables.

BARLEY

Nutrient	Time or growth stage	Plant part	CNR[1]	Excess (above)	Reference[2]
NO_3-N	3-4 leaf	below ground stems	0.06-0.07%	——	I-11
Zn	after heading June 9	leaves 2nd node below head	20-25 ppm	——	W-36
Zn	33 days	whole tops	——	250 ppm	W-10
Mn	early tiller	flag leaf	18-20 ppm	——	O-18
Cu	tillering	leaves	—4.0 ppm	——	O-15

BEANS

N	June	recently exp. trifoliate leaves	4.0-5.0 %	——	W-28
N	1st trifoliate lf. fully exp.	whole tops	3.0-4.0 %	——	I-9
P	harvest	whole tops	0.25-0.30%	——	W-20
P	June-July	recently exp. trifoliate leaves	0.25-0.35%	——	W-29
P	1st trifoliate lvs. fully exp.	whole tops	0.20-0.30%	——	I-9
K	July 10	whole tops	2.6-3.2 %	——	W-21
Zn	mid season	youngest mature leaf	20-25 ppm	——	W-8
Zn	bud stage	whole tops	——	300	W-10

CLOVER, RED (Forage)

P	1/10 bloom	tops, upper ½	—0.25%	——	O-11

CLOVER, SEED

S	pre-bloom	leaf & petiole	0.18-0.20%	——	O-21
Mo	pre-bloom	leaf & petiole	0.3-0.5 ppm	——	O-21

CLOVER, SUBTERRANEAN (Forage)

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	late bloom	leaflets and petiole	—0.25%	——	O-3, 11
S	late bloom	leaflets and petiole	—0.20%	——	O-3

CLOVER, WHITE (Forage)

P	½ bloom	tops, upper ½	0.30-0.35%	——	O-11

CLOVER (WHITE)-GRASS (50/50)

P	6 in. height	tops	0.35-0.40%	——	O-4
K	6 in. height	tops	1.5-2.0 %	——	O-4

CORN, FIELD

P	early silk	early leaf	0.20-0.22%	——	I-9
PO_4-P	early silk	early leaf	0.12-0.13%	——	I-9
K	silking	whole leaf opposite & below ear	1.7-2.0 %	——	W-21
Zn	pollination	6th leaf from bottom	15-20 ppm	——	W-37

GRASS, ORCHARD (Pasture)

N	12 in. height	tops	3.5-4.0 %	——	O-1

GRASS, ORCHARD AND PER RYE

P	6 in. height	tops	0.35-0.40%	——	O-4
K	6 in. height	tops	1.8-2.2 %	——	O-4

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
GRASS, ORCHARD AND TALL FESCUE					
S	harvest early bloom	tops	0.10-0.15%	—	W-13
HOPS					
P	early bloom	1st leaf sidearms	0.18-0.25%	—	W-9
Zn	early bloom	1st leaf sidearms	12-20 ppm	—	W-9
MINT					
N	early bloom	1st unbranched stem from top	2.0-3.0 %	—	W-13
P	early bloom	1st unbranched stem from top	0.3-0.4 %	—	W-13
K	early bloom	1st unbranched stem from top	2.0-3.0 %	—	W-13
Zn	early bloom		20-25 ppm	—	W-11
OATS					
NO_3-N	3-4 leaf	below ground stems	0.06-0.07%	—	I-11
Mn	early tiller	flag leaf	22-25 ppm	—	O-18
PEAS					
P	late bloom	tops	0.20-0.25%	—	W-15
PO_4-P	4-8 node	leaves 3rd node from top	0.08-0.10%	—	W-2
POTATOES					
N	34-45 days after planting	leaf & petiole 3 from top	6.0-6.5 %	—	W-2
NO_3-N	early tuber set 50-60 days	recently mature petiole 4 or 5 from top	1.5-1.8 %	—	I-1,2,3,8
NO_3-N	64-74 days	recently mature petiole 4 or 5 from top	1.8 %	—	I-2
NO_3-N	78-88 days	recently mature petiole 4 or 5 from top	1.1 %	—	I-2
NO_3-N	92-102 days	recently mature petiole 4 or 5 from top	0.8 %	—	I-2
NO_3-N	tubers ¾ in. diam.	petiole 4 or 5 from top	1.6-2.1 %	—	W-13,25
NO_3N	¾ in. tuber	4th petiole	1.5-1.9 %	—	O-10
NO_3N	30 days after ¾ in. diam.	petiole 4 or 5 from top	1.2-1.6 %	—	W-13
NO_3N	60 days after ¾ in. diam.	petiole 4 or 5 from top	0.9-1.2 %	—	W-13
P	tubers ¾ in. diam.	petiole 4 or 5 from top	0.35-0.45%	—	W-13,25
P	¾ in. tuber	4th petiole	0.30-0.35%	—	O-7
P	¾ in. tuber	4th petiole	0.30-0.35%	—	O-10
P	2 in. tuber	4th petiole	0.10-0.15%	—	O-10
P	30 days after ¾ in. diam.	petiole 4 or 5 from top	0.2 -0.3 %	—	W-13
P	60 days after ¾ in. diam.	petiole 4 or 5 from top	0.10-0.2 %	—	W-13
PO_4P	early tuber set 50-60 days	petiole 4 or 5 from top	0.14-0.16%	—	I-1,8

POTATOES (cont'd.)

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
K	¾ in. tuber	4th petiole	9.5-11.0%	—	O-10
K	early tuber set 50-60 days	petiole 4 or 5 from top	7.0-8.0 %	—	I-1
K	tubers ¾ in. diam.	petiole 4 or 5 from top	9.5-11.0%	—	W-13,25
K	30 days after ¾ in. diam.	petiole 4 or 5 from top	9.0-10.0%	—	W-13,25
K	60 days after ¾ in. diam.	petiole 4 or 5 from top	8.0-9.0 %	—	W-13,25
K	35-45 days	leaves include petiole 3 node from top	4.5-5.0 %	—	W-2
Zn	early bloom	mid-stem	15-20 ppm	—	W-7
Zn	early tuber set 50-60 days after planting	petiole most recently mature 4 or 5 from top	10-20 ppm	—	I-1
Zn	½ in. tuber	4th petiole	10-15 ppm	—	O-5
Zn	¾ in. tuber	4th petiole	22-25 ppm	—	O-7
Zn	1.5-2.0 cm tuber	4th petiole	20-25 ppm	—	O-7
Mn	¾ in. tuber	4th petiole	30-35 ppm	—	O-7

SORGHUM

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
Zn	June 9	2nd leaf below head	15-25 ppm	—	W-36

SOYBEANS

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
Zn	early bloom	leaf w/petiole youngest mature	15-25 ppm	—	W-36

SUDANGRASS

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	July-August	stem & leaf	0.25-0.30%	—	W-20
P	September	stem & leaf	0.20-0.25%	—	W-20
K	harvest	whole plant	1.6-2.4 %	—	W-21
Zn	June 9	2nd leaf below head	15-25 ppm	—	W-36

SUGARBEETS

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N/S	Aug. 19	recently mature petiole	—11	—	W-23
NO_3-N	July 15-30	recently mature petiole	0.4-0.5 %	—	I-9
NO_3-N	July & Aug.	recently mature petiole	0.1 %	—	I-9
NO_3-N	July 1	petiole youngest fully mature leaf	1.5-2.0 %	—	W-28
NO_3-N	July 15	petiole youngest fully mature leaf	0.5-1.0 %	—	W-28
NO_3-N	Aug. 1	petiole youngest fully mature leaf	0.2-0.5 %	—	W-28
NO_3-N	Aug. 30	petiole youngest fully mature leaf	0.1 %	—	W-28
P	July & Aug.	petiole youngest fully mature blade	0.2 %	—	I-13
P	June 25	recently mature petiole	0.25-0.30%	—	W-20

SUGARBEETS (cont'd.)

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
PO_4-P	July 5	young petiole fully mature leaf	0.10%	—	I-13
PO_4-P	Aug. 25	young petiole fully mature leaf	0.06%	—	I-13
S	Aug. 19	recently mature blade	0.25-0.30%	—	W-23
B	mid season	recently mature blade	20-40 ppm	100	W-19
Zn	Aug. 19	recently mature blade	10-20 ppm	—	W-5
Zn	July 1-15	recently mature petiole	8-12 ppm	—	I-6

TREFOIL, BIRDSFOOT

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	1/10 bloom	top ½ of shoots	0.32-0.35%	—	O-11

WHEAT

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	boot	top two leaves	2.3-2.7 %	—	O-17,20
N	jointing	total tops	2.5-3.0 %	—	O-17,20
NO_3-N	3-4 leaf	underground stems	0.25-0.35%	—	I-7
NO_3-N	joint	1st 2 in. above ground	0.08-0.15%	—	I-7
P	early head	tops	0.21-0.23%	—	I-9
P	head	total tops	0.15-0.20%	—	W-13
P	early boot	total tops	0.15-0.20%	—	W-13
P	boot	two top leaves	0.25-0.30%	—	O-17,20
P	jointing	total tops	0.32-0.40%	—	O-17,20
P	12 weeks	total tops	0.30%	—	O-2
PO_4-P	boot	whole plant with crown	0.08-0.10%	—	I-9
K	early boot	total tops	1.5-2.0 %	—	W-13
K	boot	two top leaves	1.5-1.7 %	—	O-17,20
K	head	total tops	1.25-1.75%	—	W-13
K	jointing	total tops	2.0-2.5 %	—	O-17,20

SPRING GRAIN

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
PO_4-P	boot	whole plant with crown	0.08-0.10%	—	I-9

TREE CROPS

APPLES

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	Early August	mid-terminal leaves	1.7-2.0 %	3.0	W-3,31,38
P	Early August	mid-terminal	-0.1 %	—	W-31
K	Early August	mid-terminal	0.8-1.5 %	—	W-3,31
Ca	Early August	mid-terminal	-1.2 %	—	W-31
Mg	Early August	mid-terminal	0.2-0.3 %	—	W-3,31
SO_4-S	Early August	mid-terminal	0.01-0.025%	—	W-3,31
B	Early August	mid-terminal	20-25 ppm	100	W-31,37
Zn	Early August	mid-terminal	15-20 ppm	—	W-3,31
Mn	Early August	mid-terminal	25-30 ppm	200	W-31,37
Fe	Early August	mid-terminal	-100 ppm	—	W-31
Cu	Early August	mid-terminal	5-6 ppm	—	W-31

APPLES, YOUNG, NONBEARING, RED DELICIOUS

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	Early August	mid-terminal	-.20%	—	W-13
K	Early August	mid-terminal	1.0-1.5 %	—	W-13
Zn	Early August	mid-terminal	15-20 ppm	—	W-13

CHERRIES

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	Early August	mid-terminal	2.0-2.5 %	3.5	W-31
P	Early August	mid-terminal	-0.1 %	——	W-31
K	Early August	mid-terminal	0.8-1.5 %	——	W-31
Ca	Early August	mid-terminal	-2.0 %	——	W-31
Mg	Early August	mid-terminal	0.2-0.6 %	——	W-31
SO_4-S	Early August	leaves, immature	0.01-0.025%	——	W-31
B	Early August	mid-terminal	20-25 ppm	100	W-3,31
Zn	Early August	mid-terminal	15-20 ppm	——	W-3,31
Mn	Early August	mid-terminal	25-30 ppm	——	W-3,31
Cu	Early August	mid-terminal	5-6 ppm	——	W-31

CHERRIES, YOUNG, NONBEARING

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	Early August	mid-terminal	0.20%	——	W-12
K	Early August	mid-terminal	1.2-2.8 %	——	W-12
Zn	Early August	mid-terminal	10-15 ppm	——	W-12

PEACH

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	Early August	mid-terminal	2.5-3.0 %	3.5	W-31
P	Early August	mid-terminal	-0.1 %	——	W-31
K	Early August	mid-terminal	0.8-2.5 %	——	W-31
Ca	Early August	mid-terminal	-3.0 %	——	W-31
Mg	Early August	mid-terminal	0.2-0.6 %	——	W-31
SO_4-S	Early August	leaves, immature	0.01-0.025%	——	W-31
B	Early August	mid-terminal	20-25 ppm	——	W-31
Zn	Early August	mid-terminal	15-20 ppm	——	W-31
Mn	Early August	mid-terminal	25-30 ppm	200	W-31, U-4
Fe	Early August	mid-terminal	100 ppm	——	W-31
Cu	Early August	mid-terminal	5-6 ppm	——	W-31

PEACH, YOUNG, NONBEARING

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	Early August	mid-terminal	-0.20%	——	W-13
K	Early August	mid-terminal	1.5-2.0 %	——	W-13
Zn	Early August	mid-terminal	15-20 ppm	——	W-13

PEARS

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	Early August	mid-terminal	1.7-2.0 %	——	W-30,37
P	Early August	mid-terminal	-0.1 %	——	W-30,37
K	Early August	mid-terminal	0.8-1.5 %	——	W-30,37
Ca	Early August	mid-terminal	-1.2 %	——	W-31
Mg	Early August	mid-terminal	0.2-0.3 %	——	W-31
SO_4-S	Early August	leaves, immature	0.01-0.025%	——	W-31
B	Early August	mid-terminal	20-25 ppm	80	W-31
Zn	Early August	mid-terminal	15-20 ppm	——	W-31
Mn	Early August	mid-terminal	25-30 ppm	200	W-31,37
Cu	Early August	mid-terminal	5-6 ppm	——	W-31
Fe	Early August	mid-terminal	-100 ppm	——	W-31

PEARS, YOUNG, NONBEARING

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
P	Early August	mid-terminal	-0.15%	——	W-31
K	Early August	mid-terminal	1.0-1.5 %	——	W-13
Zn	Early August	mid-terminal	15-25 ppm	——	W-13

PRUNE—PLUM

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	Early August	mid-terminal	2.0-2.5 %	3.5	W-31
P	Early August	mid-terminal	-0.1 %	——	W-31
K	Early August	mid-terminal	0.8-1.5 %	——	W-31
Ca	Early August	mid-terminal	-1.5 %	——	W-31
Mg	Early August	mid-terminal	0.2-0.6 %	——	W-31
SO_4-S	Early August	leaves, immature	0.01-0.25%	——	W-31
B	Early August	mid-terminal	20-25 ppm	——	W-31
Zn	Early August	mid-terminal	15-20 ppm	——	W-31
Mn	Early August	mid-terminal	25-30 ppm	——	W-31
Fe	Early August	mid-terminal	-100 ppm	——	W-31
Cu	Early August	mid-terminal	5-6 ppm	——	W-31

VEGETABLE CROPS

ASPARAGUS

N	May-June	7-in. spear	-6.0 %	——	W-13
P	May-June	7-in. spear	-0.85%	——	W-13
P	September	12-in. tips ferns	-0.25%	——	W-13
K	May-June	7-in. spear	3.0 %	——	W-13
B	May-October	ferns	40-55 ppm	200	W-13
Zn	early bloom	ferns	20-30 ppm	200	W-13

BEANS, SNAP

P	2-3 trifoliate leaf stage	recently mature trifoliate leaf	0.20-0.30%	——	O-23
K	2-3 trifoliate leaf stage	early bloom	1.0-1.5 %	——	O-23

BEETS, GARDEN

B	½-in. diam.	recently mature	50-60 ppm	——	O-16

CORN, SWEET, CANNING

P	9-weeks	leaves	-0.35%	——	O-6
Zn	6-weeks	whole tops	25-30 ppm	——	O-6
Zn	silking	1st leaf below primary ear	-15 ppm	——	O-6
Mn	6-weeks	whole tops	——	350-400 ppm	O-9

CORN, SWEET, SEED

N	early silk	leaf opposite ear	2.0-2.5 %	——	I-4
P	early silk	leaf opposite ear	0.27-0.34%	——	I-4
K	early silk	leaf opposite ear	1.5-2.0 %	——	I-4

VINEYARDS AND BERRIES

GRAPES, CONCORD

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
NO_3-N	August	recently mature petiole	0.015-0.045%	——	W-38
P	August	recently mature petiole	0.1-0.2 %	——	W-38
K	August	recently mature petiole	0.6-1.2 %	——	W-38
Mg	August	recently mature petiole	-0.15%	——	W-38
B	August	recently mature petiole	25-40 ppm	——	W-38
Zn	August	recently mature petiole	25-50 ppm	——	W-38
Mn	August	recently mature blade	-75 ppm	——	W-38
Fe	August	recently mature blade	15-25 ppm	——	W-38

RASPBERRIES

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	July-August	leaves	1.8-2.2 %	——	W-38
P	July-August	leaves	0.2-0.3 %	——	W-38
K	July-August	leaves	1.1-1.4 %	——	W-38
Mg	July-August	leaves	0.2-0.6 %	——	W-38
B	July-August	leaves	20-30 ppm	——	W-38
Zn	July-August	leaves	20-30 ppm	——	W-38
Mn	July-August	leaves	20-30 ppm	——	W-38

STRAWBERRIES

Nutrient	Time or growth stage	Plant part	CNR	Excess (above)	Reference
N	bloom	recently mature leaves	-2.0 %	2.5	W-38
P	bloom	recently mature leaves	0.13-0.21%	——	W-38
K	bloom	recently mature leaves	1.2-2.0 %	——	W-38
Zn	bloom	recently mature leaves	15-20 ppm	——	W-38
Mn	bloom	recently mature leaves	—70 ppm	——	W-38

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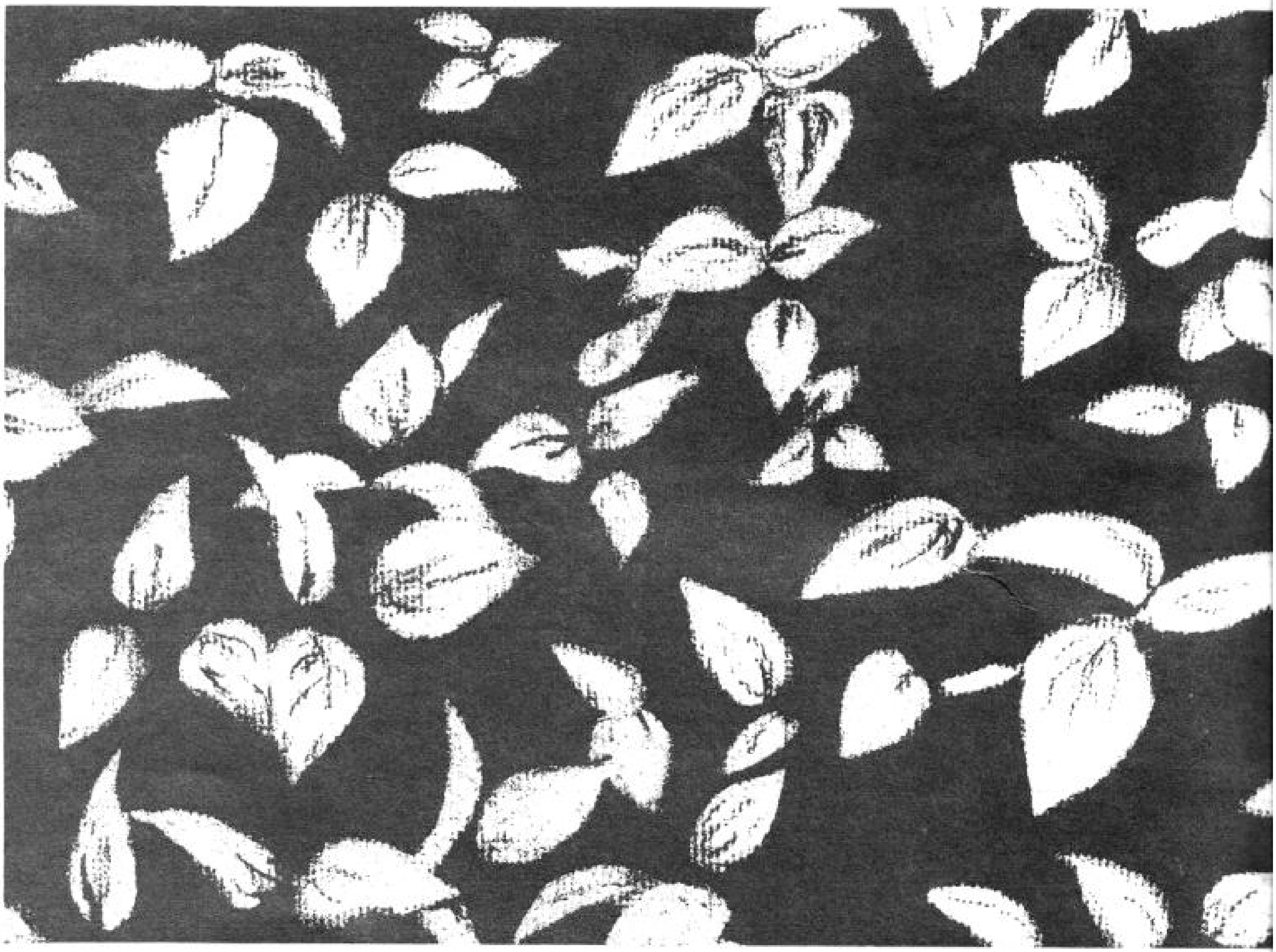
See tables for application of reference information.



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