ANNEX

SOME GUIDELINES FOR EXPRESSING SOIL AND PLANT ANALYSES

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The following rules* are proposed to minimize the incorrect use of significant digits in expressing measurements.

1. The last digit in a number is assumed uncertain by ±1. For example, 1.53 mg kg^{-1} means that the concentration has a value between 1.52 and 1.54 mg kg^{-1}.

2. Retain no digits beyond the first uncertain one. Common soil and plant analyses have an uncertainty of 1% or more.

3. In adding or subtracting, retain only as many decimal places in the result as there are in the component with the least number of decimal places.

   Example:
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    1.203
   14.12
    5.4
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   20.7
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4. In multiplying or dividing, the answer should have a relative uncertainty that is of the same order as that of the least precise factor.

   Example: $5.132 \times 20.1 \times 0.1141 = 11.8$

5. Retain in the mean the same number of significant digits as the observations upon which it is based. Or better, the uncertainty of the mean should correspond approximately to its standard deviation.

Some applications of these rules to soil and plant analyses are illustrated in Table 1. Some common SI units are in Table 2.

*Adapted from W. J. Blaedal and V. W. Meloche, 1957.

Table 1. Suggestions for expressing soil and plant analyses.

Measurement	Maximum No. of significant digits	Examples
pH (soil suspension)	2 for values <10	6.1
	3 for values >10	10.3
pH (soil solution)	3 for values <10	6.12
	4 for values >10	10.12
Eh (soil)	2	0.24 V
Eh (solution)	3	0.107 V or 107 mV
EC	2 for values <1	0.75 dS m^{-1}
	3 for values >1	7.83 dS m^{-1}
Bulk density	3 for values >1	1.23 Mg m^{-3}
	2 for values <1	0.92 Mg m^{-3}
Water content	3	0.253 kg kg^{-1} 0.253 m^3 m^{-3}
Particle size	2	23% clay
Total N, organic C, P, K, Fe, Mn, Cu, Zn	3	0.234%, 841 mg kg^{-1}
Available P and B	2	0.85 mg kg^{-1} 5.2 mg kg^{-1}
Available Cu and Zn	2	0.65 mg kg^{-1} 3.1 mg kg^{-1}
Exchangeable cations, CEC, TEB	3	0.152 mol kg^{-1} or 15.2 meq 100 g^{-1}
Elements (conc. in soil solution)	2 for values <100	0.45 mg L^{-1} 8.2 mg L^{-1} 79 mg L^{-1}
	3 for values >100	323 mg L^{-1}

Table 1. (cont'd.)

Measurement	Maximum No. of significant digits	Examples
Elements (conc. in plant)		2.34%
N, P, K, Na, Ca, Mg, S	3	0.13%
Fe, Mn	2 for values <100	78 mg kg^{-1}
	3 for values >100	856 mg kg^{-1}
B, Cu, Zn	2	5.3 mg kg^{-1}
		24 mg kg^{-1}
Plant height	2 for values <100	89 cm
	3 for values >100	116 cm
Shoot weight (green, per pot)	2 for values <100	74 g
	3 for values >100	115 g
Shoot weight (dry, per pot)	3	15.4 g
		121 g
Grain yield (per pot)	3	65.2 g
		132 g
Grain yield (per ha)	2	6.4 t ha^{-1}
		6.4 Mg ha^{-1}
Straw yield (per pot)	2 for values <100	84 g
	3 for values >100	135 g
Straw yield (per ha)	2	7.2 t ha^{-1}
		7.2 Mg ha^{-1}

Table 2

SOME COMMON SI UNITS

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Quantity	Unit	Symbol
Absorbed dose	gray	Gy
Acceleration	meter per second	$m\ s^{-1}$
Activity	becquerel	Bq
Angle		
plane	radian	rad
solid	steradian	sr
Area		
pot	centimeter squared	cm^2
leaf	meter squared	m^2
land	hectare	ha
Cation exchange capacity	mole per kilogram	$mol\ kg^{-1}$
Concentration		
in solution	mole per liter (molecular wt. known)	$mol\ L^{-1}$
	gram per liter (molecular wt. unknown)	$g\ L^{-1}$
in plant or soil material	mole per kilogram (molecular wt. known)	$mol\ kg^{-1}$
	gram or milligram per kilogram (molecular wt. unknown)	$g\ kg^{-1}$ $mg\ kg^{-1}$
fertilizer	kilogram per hectare	$kg\ ha^{-1}$
Density	megagram per meter cubed	$Mg\ m^{-3}$
Dose equivalent	sievert	Sw
Electric capacitance	farad	F
Electric field	volt per meter	$V\ m^{-1}$
Electric charge or quantity	coulomb	C
Electrical conductivity	decisiemen per meter	$dS\ m^{-1}$

Quantity	Unit	Symbol
Electric current	ampere	A
Electrical potential	volt	V
Electrical resistance	ohm	Ω
Energy, work, quantity of heat	joule	J
Evapotranspiration	millimeter per day	$mm\ d^{-1}$
Exposure	coulomb per kilogram	$C\ kg^{-1}$
Force	newton	N
Frequency	hertz	Hz
Heat capacity	joule per kelvin or joules per degree Celsius	$J\ K^{-1}$ $J\ °C^{-1}$
Hydraulic conductivity		
lab	centimeter per sec	$cm\ s^{-1}$
field	meters per day	$m\ d^{-1}$
Illuminance	lux	lx
Irradiance	watt per meter squared	$W\ m^{-2}$
Length	millimeter	mm
	centimeter	cm
	meter	m
	kilometer	km
Luminance	candela per meter squared	$cd\ m^{-2}$
Luminous flux	lumen	lm
Luminous intensity	candela	cd
Mass		
lab, greenhouse)	milligram	mg
)	gram	g
)	kilogram	kg
field)	tonne (1000 kg) or	t
)	megagram (10^6 g)	Mg
Photosynthetic rate	mg per meter squared sec	$mg\ m^{-2}\ s^{-1}$

Quantity	Unit	Symbol
Power, electric or mechanical	watt	W
Pressure or stress	pascal	Pa
Radioactivity	becquerel	Bq
Specific heat	joule per kilogram kelvin	$J\ kg^{-1}\ K^{-1}$
Specific volume	cubic meter per kilogram	$m^3\ kg^{-1}$
Surface tension	newton per meter	$N\ m^{-1}$
Temperature	degree Celsius or kelvin	°C K
Thermal conductivity	watt per meter kelvin	$W\ m^{-1}\ K^{-1}$
Transpiration rate	milligram per meter squared second	$mg\ m^{-2}\ s^{-1}$
Velocity	meter per sec kilometer per hour	$m\ s^{-1}$ $km\ h^{-1}$
Volume		
Solids	meter cubed centimeter cubed millimeter cubed	m^3 cm^3 mm^3
Liquids	liter milliliter	L mL
Viscosity		
dynamic	pascal second	Pa s
kinematic	meter squared per second	$m^2\ s^{-1}$
Water potential or pressure	joule per kilogram	$J\ kg^{-1}$
Wave length	nanometer (Angstrom is obsolete)	nm
Wave number	1 per meter	m^{-1}
Yield		
grain plant	gram per plant tonne or megagram per ha	$g\ plant^{-1}$ $t\ ha^{-1}$ $Mg\ ha^{-1}$