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Atomic Weights and Mole Ratios

ELEMENT NAME	SYMBOL	ATOMIC WEIGHT
Aluminum	Al	26.97
Boron	B	10.82
Calcium	Ca	40.08
Carbon	C	12.01
Chlorine	Cl	35.46
Cobalt	Co	58.94
Copper	Cu	93.54
Fluorine	F	19.00
Hydrogen	H	1.01
Iodine	I	126.92
Iron	Fe	55.85
Magnesium	Mg	24.31
Manganese	Mn	54.94
Molybdenum	Mo	95.94
Nickel	Ni	58.69
Nitrogen	N	14.01
Oxygen	O	16.00
Phosphorus	P	30.98
Potassium	K	39.10
Sodium	Na	23.00
Sulfur	S	32.06
Zinc	Zn	65.37

Mole Ratio

The Mole Weight of a molecule equals the sum of the atomic weights in the molecule.

Example: Sulfuric Acid H_2SO_4: (1.01 X 2) + 32.06 + (16 X 4) = 98.08

Mole Ratio refers to the ratio between the molecules of two reacting chemicals and can be used to calculate the weight of the chemicals used and the products formed in any chemical reaction.

Example: NH_3 (Mole Weight 17.04) + H_3PO_4 (Mole Weight 98.01) = $NH_4H_2PO_4$ (Mole Weight 115.05)

For Chemically Pure Materials, at a Mole Ratio of 1, 17 Pounds of Nitrogen will react with 98 Pounds of Phosphoric Acid to produce 115 pounds of Mono-Ammonium Phosphate.

If two molecule reacts with one molecule in the reaction, the Mole Ratio increases to two.

Example: 2 NH_3 + H_3PO_4 = $(NH_4)_2$ HPO_4 (Di-ammonium Phosphate)

Conversion Factors, Chemical (Ammonia through Calcium)

TO CONVERT	TO	MULTIPLY	BY
Ammonia, NH_3	Nitrogen, N	Ammonia, NH_3	0.8224
Ammonium Nitrate, NH_4NO_3	Nitrogen, N	Ammonium Nitrate, NH_4NO_3	0.3500
Ammonium Sulfate, $(NH_4)_2SO_4$	Nitrogen, N	Ammonium Sulfate, $(NH_4)_2SO_4$	0.2120
Dia. Ammo. Phos., $(NH_4)_2HPO_4$	Nitrogen, N	Dia. Ammo. Phos., $(NH_4)_2HPO_4$	0.2121
Mono. Ammo. Phos., $NH_4H_2PO_4$	Nitrogen, N	Mono. Ammo. Phos., $NH_4H_2PO_4$	0.1218
Potasium Nitrate, KNO_3	Nitrogen, N	Potasium Nitrate, KNO_3	0.1386
Sodium Nitrate, $NaNO_3$	Nitrogen, N	Sodium Nitrate, $NaNO_3$	0.1648
Nitrate, NO_3	Nitrogen, N	Nitrate, NO_3	0.2259
Nitrogen, N	Ammonia, NH_3	Nitrogen, N	1.2159
Urea, $(NH_2)_2CO$	Nitrogen, N	Urea, $(NH_2)_2CO$	0.4665
Available Phosphate, P_2O_5	Phosphorus, P	Available Phosphate, P_2O_5	0.4364
Bone Phosphate Lime, $Ca_3(PO_4)_2$	Phosphorus Pentoxide, P_2O_5	Bone Phosphate Lime, $Ca_3(PO_4)_2$	0.4576
Boron, B	Boron Trioxide, B_2O_3	Boron, B	3.2181
Boron Trioxide, B_2O_3	Boron, B	Boron Trioxide, B_2O_3	0.3106
Borax, $Na_2B_4O_7.10H_2O$	Boron, B	Borax, $Na_2B_4O_7.10H_2O$	0.1134
Boron, B	Borax, $Na_2B_4O_7.10H_2O$	Boron, B	8.8142
Borax, $Na_2B_4O_7.10H_2O$	Boron Trioxide, B_2O_3	Borax, $Na_2B_4O_7.10H_2O$	0.3651
Boron Trioxide, B_2O_3	Borax, $Na_2B_4O_7.10H_2O$	Boron Trioxide, B_2O_3	2.7389
Boric Acid, H_3BO_3	Boron, B	Boric Acid, H_3BO_3	0.1749
Boron, B	Boric Acid, H_3BO_3	Boron, B	5.7178
Calcium Oxide, CaO	Calcium, Ca	Calcium Oxide, CaO	0.7147
Calcium, Ca	Calcium Oxide, CaO	Calcium, Ca	1.3992
Calcium Carbonate $CaCO_3$	Calcium. Ca	Calcium Carbonate $CaCO_3$	0.4005
Calcium, Ca	Calcium Carbonate, $CaCO_3$	Calcium, Ca	2.4973

Conversion Factors, Chemical (Calcium Sulfate through Sodium Molybdate)

TO CONVERT	TO	MULTIPLY	BY
Calcium Sulfate, $CaSO_4$	Calcium, Ca	Calcium Sulfate, $CaSO_4$	0.2994
Calcium, Ca	Calcium Sulfate, $CaSO_4$	Calcium, Ca	3.3967
Cobalt Oxide, CoO	Cobalt, Co	Cobalt Oxide, CoO	0.7865
Cobalt, Co	Cobalt Oxide, CoO	Cobalt, Co	1.2715
Copper Sulfate, $CuSO_4$	Copper, Cu	Copper Sulfate, $CuSO_4$	0.3981
Copper, Cu	Copper Sulfate, $CuSO_4$	Copper, Cu	2.5118
Copper Oxide, CuO	Copper, Cu	Copper Oxide, CuO	0.7989
Copper, Cu	Copper Oxide, CuO	Copper, Cu	1.2519
Epsom Salts, $MgSO_4.7H_2O$	Magnesium, Mg	Epsom Salts, $MgSO_4.7H_2O$	0.0987
Ferric Oxide, Fe_2O_3	Iron, Fe	Ferric Oxide, Fe_2O_3	0.6994
Ferrous Sulfate, $FeSO_4$	Iron, Fe	Ferrous Sulfate, $FeSO_4$	0.3676
Copperas, $FeSO_4.7H_2O$	Iron, Fe	Copperas, $FeSO_4.7H_2O$	0.2009
Gypsum, $CaSO_4.2H_2O$	Sulfur, S	Gypsum, $CaSO_4.2H_2O$	0.1862
Iron, Fe	Ferric Oxide, Fe_2O_3	Iron, Fe	1.4298
Iron, Fe	Ferrous Sulfate, $FeSO_4$	Iron, Fe	2.7201
Magnesium, Mg	Epsom Salts, $MgSO_4.7H_2O$	Magnesium, Mg	10.1356
Magnesium Oxide, MgO	Magnesium, Mg	Magnesium Oxide, MgO	0.6031
Magnesium, Mg	Magnesium Oxide, MgO	Magnesium, Mg	1.6581
Manganese, Mn	Manganese Oxide, MnO	Manganese, Mn	1.2912
Manganese Oxide, MnO	Manganese, Mn	Manganese Oxide, MnO	0.7745
Manganese, Mn	Manganese Sulfate, $MnSO_4$	Manganese, Mn	2.7485
Manganese Sulfate, $MnSO_4$	Manganese, Mn	Manganese Sulfate, $MnSO_4$	0.3638
Molybdenum Oxide, MoO_3	Molybdenum, Mo	Molybdenum Oxide, MoO_3	0.6665
Molybdenum, Mo	Molybdenum Oxide, MoO_3	Molybdenum, Mo	1.5004
Sodium Molybdate, $Na_2MoO_4.2H_2O$	Molybdenum, Mo	Sodium Molybdate, $Na_2MoO_4.2H_2O$	0.3965

Conversion Factors, Chemical (Potash through Zinc)

TO CONVERT	TO	MULTIPLY	BY
Potash, K_2O	Potassium, K	Potash, K_2O	0.8302
Potassium, K	Potash, K_2O	Potassium, K	1.2045
Potash, K_2O	Potassium Chloride, KCl	Potash, K_2O	1.5829
Potassium Chloride, KCl	Potash, K_2O	Potassium Chloride, KCl	0.6318
Potash, K_2O	Potassium Nitrate, KNO_3	Potash, K_2O	2.1466
Potassium Nitrate, KNO_3	Potash, K_2O	Potassium Nitrate, KNO_3	0.4659
Potash, K_2O	Potassium Sulfate, K_2SO_4	Potash, K_2O	1.8499
Potassium Sulfate, K_2SO_4	Potash, K_2O	Potassium Sulfate, K_2SO_4	0.5406
Phosphorus, P	Available Phosphoric Acid, P_2O_5	Phosphorus, P	2.2914
Phosphoric Acid, H_3PO_4	Phosphorus Pentoxide, P_2O_5	Phosphoric Acid, H_3PO_4	0.7242
Phosphorus Pentoxide, P_2O_5	Phosphoric Acid, H_3PO_4	Phosphorus Pentoxide, P_2O_5	1.3808
Phosphorus Pentoxide, P_2O_5	Phosphorus, P	Phosphorus Pentoxide, P_2O_5	0.4364
Phosphorus, P	Phosphorus Pentoxide, P_2O_5	Phosphorus, P	2.2914
Sulfur, S	Sulfur Diaoxide, SO_2	Sulfur, S	1.9981
Sulfur, S	Sulfur Trioxide, SO_3	Sulfur, S	2.4969
Sulfur Diaoxide, SO_2	Sulfur, S	Sulfur Diaoxide, SO_2	0.5005
Sulfur Trioxide, SO_2	Sulfur, S	Sulfur Trioxide, SO_2	0.4005
Sulfur Quadoxide, SO_4	Sulfur, S	Sulfur Quadoxide, SO_4	0.3333
Sulfuric Acid, H_2SO_4	Sulfur, S	Sulfuric Acid, H_2SO_4	0.3269
Zinc Oxide, ZnO	Zinc, Zn	Zinc Oxide, ZnO	0.8034
Zinc, Zn	Zinc Oxide, ZnO	Zinc, Zn	1.2447
Zinc Sulfate, $ZnSO_4$	Zinc, Zn	Zinc Sulfate, $ZnSO_4$	0.4049
Zinc, Zn	Zinc Sulfate, $ZnSO_4$	Zinc, Zn	2.4695

Note: All calculations are based on chemically pure materials. The factors for commercial materials will vary from the values shown.

Conversion Factors, Boron Materials

PRODUCT (Trade Name)	% CONTAINED		POUNDS MATERIAL REQ. FOR		BORAX Equivalent
	As B	As B_2O_3	1 Pound B	1 Pound B_2O_3	
Borax, $Na_2B_4O_7.10H_2O$	11.34	36.50	8.82	2.74	100
Fertilizer Borate, 68	21/13	68.00	4.73	1.47	186
Fertilizer Borate, 65	20.19	65.00	4.95	1.54	178
Fertilizer Borate, 48	14.91	48.00	6.71	2.08	132
Fertilizer Borate, 46	14.29	46.00	7.00	2.17	126
Fertilizer Borate, 44	13.67	44.00	7.31	2.27	120
Fertilizer Borate, Granular	14.29	46.00	7.00	2.17	126
Borate, 50	15.53	50.00	6.43	2.00	137
Tronabor	14.29	46.00	7.00	2.17	126
Solubor	20.50	66.00	4.87	1.52	181
Frit B-32, Granular	10.00	32.20	10.00	3.10	88
Ulexite (Turkish)	12.00	38.64	8.33	2.59	106

FACTORS:

B X 3.2199 = B_2O_3	B_2O_3 X 0.3106 = B
Borax X 0.1134 = B	B X 8.8164 = Borax
Borax X 0.3651 = B_2O_3	B_2O_3 X 2.7386 = Borax

Borax Equivalent

Formerly, it was quite common for the Boron content of a fertilizer to be expressed in terms of its "BORAX" content, meaning "Borax ($Na_2B_4O_7.10H_2O$)". Other Borate materials were rated as to whether they contained more or less Boron than Borax, which was given a rating of 100. Materials containing more Boron than Borax were rated above 100, meaning that less of the material was required to furnish the same amount of Boron as 100 pounds of Borax. Similarly, materials containing less Boron than Borax were rated below 100.

The Borax Equivalent of a material can be calculated by dividing the Boron, (B) content of the material by the Boron, (B) of Borax, which is 11.34%.

For example, the Borate Equivalent of Fertilizer Borate, 68 is 186. It requires only 53.76 pounds of this material to supply the same amount of Boron (B) as would be obtained from 100 pounds of Borax. This is calculated by dividing 100 by 186 (the Borate equivalent of Borate 68) and then multiplying by 100.

PROOF:

100.00 #	Borax	X B	0.1134	=	11.34 # (Boron)
53.76 #	Fert. Borate, 68	X B	0.2113	=	11.34 # (Boron)

(The small difference is due to rounding numbers)

Conversion Factors, Micronutrient Materials

PRODUCT (Trade Name)	ELEMENT Supplied	% CONTAINED		POUNDS OF MATERIAL REQUIRED FOR :	
		As Element	As Oxide	One Pound Element	One Pound Oxide
Cobalt Sulfate ($CoSO_4$)	Co	Co 16.6	CoO 21.1	6.02	4.74
Copper Oxide (Cu)	Cu	Cu 70.0	CuO 87.6	1.43	1.14
Copper Oxide (Cu)	Cu	Cu 50.0	CuO 62.6	2.00	1.60
Copper Sulfate ($CuSO_4$)	Cu	Cu 25.2	CuO 31.5	3.97	3.17
Ferric Sulfate ($Fe_2(SO_4)_3$)	Fe	Fe 20.0	Fe_2O_3 28.6	5.00	3.50
Ferrous Sulfate (Fe_2SO_4)	Fe	Fe 21.0	Fe_2O_3 30.0	4.76	3.33
Hampene 5% Chelete EDTA	Fe	Fe 5.0	Fe_2O_3 7.1	20.00	14.10
Hampol 5% Chelate, HEDTA	Fe	Fe 5.0	Fe_2O_3 7.1	20.00	14.10
Manganous Oxide (MnO)	Mn	Mn 48.0	MnO 62.0	2.08	1.61
Manganese Sulfate (70% $MnSO_4$)	Mn	Mn 25.5	MnO 32.9	3.92	3.04
Tri-Basic Manganese Sulfate	Mn	Mn 53.0	MnO 68.4	Contains one part sulfate to three parts oxide.	
Tecmangam ($MnSO_4$)	Mn	Mn 27.3	MnO 35.2	3.66	2.84
Sodium Molybdate ($Na_2MoO_4.2H_2O$)	Mo	Mo 39.0	MoO_3 58.5	2.56	1.71
Zinc Sulfate ($ZnSO_4$)	Zn	Zn 36.0	ZnO 44.8	2.77	2.23
Zinc Sulfate Granular ($ZnSO_4$)	Zn	Zn 18.0	ZnO 22.4	5.55	4.46
Zinc Oxide (ZnO)	Zn	Zn 50.0	ZnO 62.2	2.00	1.61

Note: Fe is the chemical symbol for the element Iron.

Zinc Oxide materials containing from 20 to 78 percent Zinc (Zn) are available. The most commonly used material has an analysis of 50% Zn. Micronutrient mixtures which contain various amounts and combinations of Boron, Copper, Iron, Manganese, and Zinc can be obtained from several companies.

Conversion Factors, Physical (Acres through Meters)

TO CONVERT	TO	MULTIPLY	BY
Acres	Hectares	Acres	0.4050
Acres	Square Feet	Acres	43,560.0000
Bushels	Cubic Feet	Bushels	1.2440
Centimeters	Feet	Centimeters	0.0328
Centimeters	Inches	Centimeters	0.3940
Centimeters	Meters	Centimeters	0.0100
Centimeters	Millimeters	Centimeters	10.0000
Cubic Feet	Gallons	Cubic Feet	7.4805
Cubic Feet	Cubic Inches	Cubic Feet	1,728.0000
Cubic Feet Water	Pounds Water	Cubic Feet Water	62.4270
Cubic Feet	Liters	Cubic Feet	28.3200
Gallons Water	Pounds Water	Gallons Water	8.3453
Gallons	Liters	Gallons	3.7850
Hectares	Acres	Hectares	2.4710
Inches	Centimeters	Inches	2.5400
Kilograms	Ounces	Kilograms	35.2740
Kilograms	Pounds	Kilograms	2.2050
Kilograms/Hectares	Pounds/Acre	Kilograms/Hectares	0.8920
Kilometers	Feet	Kilometers	3,280.8400
Kilometers	Miles	Kilometers	0.6214
Liters	Gallons	Liters	0.2642
Miles	Feet	Miles	5,280.0000
Meters	Feet	Meters	3.2810
Meters	Inches	Meters	39.3700
Meters	Yards	Meters	1.0940

Conversion Factors, Physical (Miles per Hour through Yards)

TO CONVERT	TO	MULTIPLY	BY
Miles Per Hour	Kilometers Per Hour	Miles per Hour	1.6090
Millimeters	Feet	Millimeters	0.0033
Millimeters	Inches	Millimeters	0.0394
Pounds	Grams	Pounds	453.5924
Pounds	Kilograms	Pounds	0.4536
Pounds/Acre	Kilograms/Hectare	Pounds/Acre	1.1211
Quintals, Metric	Pounds	Quintals, Metric	220.4620
Quintals, (Metric) / Hectare	Pounds/Acre	Quintals, (Metric) / Hectare	89.2060
Square Feet	Square Meters	Square Feet	0.0929
Square Miles	Acres	Square Miles	640.0000
Square Miles	Square Kilometers	Square Miles	2.5900
Temperature (0C) + 17.78	Temperature (0F)	Temperature (0C) + 17.78	1.8000
Temperature (0F) - 32	Temperature (0C)	Temperature (0F) - 32	0.5555
Tons, Metric	Tons, Short	Tons, Metric	1.1025
Tons, Metric	Pounds	Tons, Metric	2,205.0000
Tons, Long	Tons, Short	Tons, Long	1.1200
Tons, Long	Pounds	Tons, Long	2,240.0000
Tons, Short	Tons, Metric	Tons, Short	0.9072
Tons, Short	Tonnes, Canadian	Tons, Short	0.9072
Tons (Metric) / Hectare	Tons (Short) / Acre	Tons (Metric) / Hectare	0.4464
Tons (Short) / Acre	Tons (Metric) / Hectare	Tons (Short) / Acre	2.2397
Tonnes, Canadian	Pounds	Tonnes, Canadian	2,205.0000
Yards	Meters	Yards	0.9144
Yards	Inches	Yards	36.0000

Conversion Factors, Flow Rates

TO CONVERT	TO	MULTIPLY	BY
Cubic Feet Per Second	Gallons Per Minute	Cubic Feet Per Second	448.800
Cubic Feet Per Second	Million Gallons Per Day	Cubic Feet Per Second	0.6460
Cubic Feet Per Second	Acre-Inches Per 24 Hours	Cubic Feet Per Second	23.800
Cubic Feet Per Second	Acre-Feet Per 24 Hours	Cubic Feet Per Second	1.948
Gallons Per Minute	Cubic Feet Per Second	Gallons Per Minute	0.00223
Gallons Per Minute	Million Gallons Per Day	Gallons Per Minute	0.00144
Gallons Per Minute	Acre-Inches Per 24 Hours	Gallons Per Minute	0.053
Gallons Per Minute	Acre-Feet Per 24 Hours	Gallons Per Minute	0.00442
Million Gallons per Day	Cubic Feet Per Second	Million Gallons per Day	1.547
Million Gallons per Day	Gallons Per Minute	Million Gallons per Day	694.400
Million Gallons per Day	Acre-Inches Per 24 Hours	Million Gallons per Day	36.840
Million Gallons per Day	Acre-Feet Per 24 Hours	Million Gallons per Day	3.070
Acre-Inches Per 24 Hours	Cubic Feet Per Second	Acre-Inches Per 24 Hours	0.042
Acre-Inches Per 24 Hours	Gallons Per Minute	Acre-Inches Per 24 Hours	18.860
Acre-Inches Per 24 Hours	Million Gallons per Day	Acre-Inches Per 24 Hours	0.0271
Acre-Inches Per 24 Hours	Acre-Feet Per 24 Hours	Acre-Inches Per 24 Hours	0.0833
Acre-Feet Per 24 Hours	Cubic Feet Per Second	Acre-Feet Per 24 Hours	0.504
Acre-Feet Per 24 Hours	Gallons Per Minute	Acre-Feet Per 24 Hours	226.300
Acre-Feet Per 24 Hours	Million Gallons per Day	Acre-Feet Per 24 Hours	0.3259
Acre-Feet Per 24 Hours	Acre-Inches Per 24 Hours	Acre-Feet Per 24 Hours	12.000

To Calculate the Amount of Water Applied to a Field:

$\frac{\text{Cubic Feet per Second X Hours}}{\text{Acres}}$	equals	Acre-Inches per Acre
$\frac{\text{Gallons per Minute X Hours}}{\text{450 X Acres}}$	equals	Acre-Inches per Acre

Conversion Factors, Miscellaneous

AREA MEASUREMENTS	AREA MEASUREMENTS
1 Link ……..... 0.66 Feet	9 Square Feet …. 1 Square Yard
25 Links ……..... 16.50 Feet	4,840 Square Yards …... 1 Acre
1 Rod …….. 25.00 Links	43,560 Square Feet ……. 1 Acre
100 Links …….. 1.00 Chain	640 Acres …….. 1 Square Mile
144 Square Inches ……. 1 Square Foot	1 Square Mile …….. 1 Section
66 Feet …….. 1 Chain	1 Square Mile ... 2.59 Square Kilometers
80 Chains …….. 1 Mile	

VOLUME MEASUREMENTS	VOLUME MEASUREMENTS
1,728 Cubic Inches ……. 1 Cubic Foot	1 Cord Wood ..……. 128 Cubic Feet
1 Cubic Foot ……... 7.4805 Gallons	231 Cubic Inches ……... 1 Gallon
27 Cubic Feet ……... 1 Cubic Yard	1.244 Cubic Feet ……. 1 Bushel
1 Cord Wood ……..... 4 ft X 4 ft X 8 ft	

DRY MEASUREMENTS	DRY MEASUREMENTS
2 Pints ……. …….. 1 Quart	4 Pecks …….. 1 Bushel
8 Quarts …….. 1 Peck	16 Ounces Avoirdupois ….. 1 Pound

LIQUID MEASUREMENTS	LIQUID MEASUREMENTS
1 Pint ……..... 16 Fluid Ounces	4 Quarts …….. 1 Gallon (US)
2 Pints ……..... 1 Quart	1 Gallon (US) ... 0.8327 Gallons Imperial
1 Level Tea Spoon ……. 1/6 Ounce	1 Quart …….. 2 Pounds (Approx.)
1 Level Table Spoon ….. 1/2 Ounce	1 Gallon …….. 8 Pounds (Approx.)
1 Level Cup….. 8 Ounces (Approx.)	1 Pint ……..... 1 Pound (Approx.)

Conversion Factors, Temperature

DEGREES CELSIUS (^{o}C)	DEGREES FAHRENHEIT (^{o}F)
-30	-22
-20	-4
-10	14
0	32
10	50
15	59
20	68
25	77
30	86
35	95
40	104
45	113
50	122
55	131
60	140
65	149
70	158
75	167
80	176
85	185
90	194
95	203
100	212

Note:

Degree Celsius (^{o}C) is also called Degree Centigrade (^{o}C).
Water freezes at 0 degrees (0 ^{o}C) Centigrade or 32 degrees (32 ^{o}F) Fahrenheit
Water boils at 100 degrees (100 ^{o}C) Centigrade or 212 degrees (212 ^{o}F) Fahrenheit

Conversion Formulas:

To convert Degrees Fahrenheit to Degrees Centigrade
^{o}C = 5/9 (^{o}F - 32) 5/9 = 0.555555

To convert Degrees Centigrade to Degrees Fahrenheit
^{o}F = 9/5 (^{o}C) + 32 9/5 = 1.8000

Material Bulk Densities In Pounds Per Cubic Foot

MATERIAL	TYPICAL ANALYSIS	BULK DENSITY
Ammonium Nitrate	34-0-0	56--64
Ammonium Sulfate (Coarse)	21-0-0	64--68
Urea	46-0-0	46--48
Normal Superphosphate (Granular)	0-20-0	68--75
Triple Superphosphate (Granular)	0-46-0	66--70
Monoammonium Phosphate	11-50-0	57--60
Diammonium Phosphate	18-46-0	55--58
Murate of Potash (Coarse)	0-0-60	69--71
Muriate of Potash (Granular)	0-0-60	66--68
Sulfate of Potash (Granular)	0-0-50	85--93
Potassium Nitrate	13-0-44	78--81
Sul-Po-Mag®	22% K_2O -- 11% Mg	94--100
Sodium Borate	14.7 % B	70--80
Copper Sulfate	25.2 % Cu	75--85
Copper Oxide	50 % Cu	100--110
Manganese Sulfate	27.1 % Mn	80--90
Manganese Oxide	55 % Mn	130--150
Zinc Sulfate	36 % Zn	80--90
Zinc Oxide	50 % Zn	100--110
Granular Fertilizer or Blend Base	Various	65--75

Note: Bulk densities are a function of the physical properties of a material and products produced by different companies with the same chemical analysis will probably have different bulk densities. In the metric system, bulk density is shown as Kilograms per Cubic Meter.

Application Rates, Field Crops

RATE PER ACRE	RATE PER HECTARE
100 Pounds	112 Kilograms
200 Pounds	224 Kilograms
300 Pounds	336 Kilograms
400 Pounds	448 Kilograms
500 Pounds	560 Kilograms
600 Pounds	672 Kilograms
700 Pounds	784 Kilograms
800 Pounds	986 Kilograms
900 Pounds	1008 Kilograms
1000 Pounds	1120 Kilograms
2000 Pounds	2240 Kilograms

Note: Kilogram per Hectare weight rounded to the nearest kilogram.

APPLICATION RATE CALCULATION FACTORS		
1 Acre-foot of soil	equals	4,000,000 pounds (approximately)
1 Ton per acre	equals	20.8 grams per square foot
1 Ton per acre	equals	1 pound per 21.78 square feet
1 Ton per acre	equals	25.12 quintals per hectare
100 Square feet	equals	0.002296 acre
1 Gram per square foot	equals	96 pounds per acre
1 Pound per acre equals	equals	0.0104 grams per square foot
1 Pound per acre	equals	1.12 kilograms per hectare
100 Pounds per acre	equals	0.2296 pounds per 100 square feet
Tons per acre-foot	equals	0.00136 parts per million
Cubic feet per second	equals	0.002228 X gallons per minute
Parts per million X 0.00136	equals	1 ton per acre-foot
Kilograms per 48 square feet	equals	tons per acre
Pounds per square foot X 21.78	equals	tons per acre
Pounds per square foot X 43,560	equals	pounds per acre
Grams per square foot X 96	equals	pounds per acre
1 Ton per acre to a 6 inch depth	equals	1 gram per 1000 grams of soil

Application Rates, Home Gardens

RATE PER ACRE	RATE PER 100 SQUARE FEET
100 Pounds	3.5 Ounces
200 Pounds	7.5 Ounces
300 Pounds	11.0 Ounces
400 Pounds	14.75 Ounces
500 Pounds	1 Pound 2.5 Ounces
600 Pounds	1 Pound 6.0 Ounces
700 Pounds	1 Pound 10.0 Ounces
800 Pounds	1 Pound 13.0 Ounces
900 Pounds	2 Pounds 1.0 Ounces
1000 Pounds	2 Pounds 5.0 Ounces
2000 Pounds	4 Pounds 10.0 Ounces
MEASURES (APPROXIMATE)	
1 Level Teaspoon equals 1/6 Ounce	
1 Level Tablespoon equals 1/2 Ounce	
1 Level Cup equals 8 Ounces	
1 Pint equals 1 Pound	
1 Quart equals 2 Pounds	
1 Gallon equals 8 Pounds	
AREA MEASUREMENT	
100 Square Feet equals an area 10 feet by 10 feet	
A full step or "pace" by the average person is approximately 3 feet.	

Plants Per Unit Area

SPACING IN FEET	NUMBER PER ACRE	NUMBER PER 1000 SQUARE FEET
1 by 2	21,780	500
1 by 3	14,520	333
1 by 4	10,890	250
1.5 by 2	14,520	333
1.5 by 3	9,680	222
2 by 3	7,260	167
2 by 4	5,445	125
3 by 4	3,630	83
3 by 5	2,904	67
3 by 6	2,420	56
4 by 4	2,722	62
4 by 6	1,815	42
6 by 6	1,210	28
6 by 8	907	21
8 by 8	680	16
10 by 10	436	10
12 by 12	302	6.9
15 by 15	194	4.4
16 by 16	170	3.9
18 by 18	134	3.1
20 by 20	109	2.5
25 by 25	70	1.6
30 by 30	48	1.1
40 by 40	27	Less than 1

Common Abbreviations

Name	Abbreviation
Inch	in
Foot or Feet	ft
Yard	yd
Chain	ch
Rod	rd
Mile	mi
Kilometer	km
Meter	m
Centimeter	cm
Tea Spoon	tsp
Table Spoon	tbsp
Cup	c
Liter	L or l
Bushel	bu
Peck	pk
Gallon	gal
Quarts	qt
Pints	pt
Ounces	oz
Cubic Inch	in^3
Cubic Yard	yd^3
Cubic Meters	m^3
Hectare	ha
Square	sq
Gram	g

Chemical Compatibility of Blend Materials

						X			= INCOMPATIBLE
						L			= LIMITED COMPATIBILITY
						OK			= COMPATIBLE
UREA									
X	AMMONIUM NITRATE								
OK	**OK**	AMMONIUM SULFATE							
OK	**L**	**OK**	TRIPLE SUPER PHOSPHATE						
OK	**L**	**OK**	**OK**	SINGLE SUPERPHOSPHATE					
OK	**OK**	**OK**	**L**	**L**	DIAMMONIUM PHOSPHATE				
OK	**OK**	**OK**	**OK**	**OK**	**OK**	MONOAMMONIUM PHOSPHATE			
OK	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	POTASSIUM CHLORIDE		
OK	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	POTASSIUM SULFATE	
OK	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	**OK**	K-MAG ®

(Chart Courtesy TVA) Original Chart.

Mixtures containing only Ammonium Nitrate and K-Mag® or Urea and K-Mag® may cake if stored for long periods in bags.

Critical Humidity's of Fertilizer Salts and Mixtures at 30° C (86° F) (Values are Percent Relative Humidity)

CALCIUM NITRATE												
46.7	AMMONIUM NITRATE											
23.5	55.0‡	SODIUM NITRATE										
37.7	46.3	72.0‡	UREA									
–	18.1	45.6	70.0‡	AMMONIUM CHLORIDE								
–	51.4	51.9	57.9	75.0‡	AMMONIUM SULFATE							
–	62.3	–	56.4	71.4	75.0‡	DIAMMONIUM PHOSPHATE (DAP)						
–	59*	–	62*	–	72*	70.0‡	POTASSIUM CHLORIDE					
22.0	67.9	66.9	60.3	73.5	71.3	70*	70.0‡	POTASSIUM NITRATE				
31.4	59.9	64.5	65.2	67.9	69.2	–	78.6	70.0‡	MONOAMMONIUM PHOSPHATE (MAP)			
52.8	58.0	63.8	65.2	–	75.8	78*	72.8	59.8	70.0‡	MONOCALCIUM PHOSPHATE (TRIPLE)		
46.2	52.8	68.1	65.1	73.9	87.7	78*	–	87.8	88.8	80.0‡	POTASSIUM SULFATE	
76.1	69.2	73.3	71.5	71.3	81.4	77*	–	87.8	79.0	–	75.0‡	K-Mag®
–	<40*	–	42.5*	–	52.5	62.5*	–	–	–	62.5*	–	62.5*

* Approximate values obtained from tests run by TVA using IMC Materials. Other values from literature.

‡ Values for fertilizer materials. These differ from values obtained when using pure salts. Critical Relative Humidity is the value of the relative humidity of the surrounding air above which a fertilizer will absorb moisture and below which it does not. The higher the Critical Relative Humidity the better the material stores under high humidity conditions.

Links to other sections of the EFFICIENT FERTILIZER USE MANUAL

History • MEY • Soil • pH • Nitrogen • Phosphorus • Potassium • Secondary • Micronutrients • Fluid-Dry • Sampling • Testing • Site-Specific • Tillage • Environment • Appendices • Authors