

Conversions of Parts per Million on Soil Test Reports to Pounds per Acre¹

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Soil testing and the resulting fertilization recommendations are critical for 4R nutrient stewardship (Hochmuth et al. 2022; Liu et al. 2022; Wang et al. 2022), particularly for applying fertilizers at the RIGHT rate in commercial vegetable production. It is just as critical that test results and fertilization recommendations are understood by growers. UF/IFAS soil test reports use parts per million (ppm) to report soil-extractable plant nutrients. The UF/IFAS fertilizer recommendations use pounds of nutrient per acre. Growers also operate with pounds of a nutrient per acre to apply fertilizers. If growers do not understand the soil test reports and fertilization recommendations, however, they may over- or underfertilize crops. One way to avoid miscommunication is to remember that growers and soil experts sometimes speak different languages.

Nutrients in soil can be classified in several ways (water-soluble nutrients, extractable nutrients, etc.). For fertilization recommendations, soil labs usually use the term *extractable nutrients*. The level of extractable nutrients in a soil sample is determined by the extractant used. This means that when we talk about soil nutrient contents, we need to know what extractant was used to obtain the sample, because different extractants can give totally different values even for the same soil sample. For example, using an extractant (e.g., Mehlich-III) to extract a soil sample can obtain a value of a specific nutrient such as phosphorus, e.g., 50 ppm. This

value means that the tested soil contains 50 mg of Mehlich-III-extractable phosphorus per kg of soil. The phosphorus level of a soil sample will be greater if the extractant Mehlich-III is used than if the extractant Mehlich-I, Bray-1, or Olsen is used. If no extractant is listed on the soil test report, the reported phosphorus level will be relatively meaningless.

The terms *extractant* and *extractable phosphorus* are commonly used and understood in soil labs but may not be understood well by growers. To avoid misunderstandings and over- or underfertilization, we must understand what relationship exists between the numbers of soil test reports, fertilization recommendations, and fertilization practices. How can we compare these numbers? The conversion from parts per million of soil-extractable nutrients on a soil test report to pounds per acre will be helpful for producers. The conversion can, in turn, help to (1) better understand how much extractable nutrient is available in the soil; (2) optimize fertilization practices based on these reports; and (3) minimize over- or underfertilization through optimization of fertilization.

If our soils contain very high levels of phosphorus and calcium but phosphate fertilizers and gypsum are still applied every year, what will happen? The answer is that these applications do not only waste nonrenewable resources but

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also produce phosphate rock in the fertilized field, particularly when soil pH is greater than 6.5. For example, applying 100 to 120 lb P_2O_5 per acre is not only unnecessary but also risky to the environment if a calibrated soil test shows a very high level (e.g., 550 ppm, i.e., 2,520 lb/acre P_2O_5 , which is 25-fold more than what growers usually apply [100 lb/acre P_2O_5] every growing season) of phosphorus existing in the soil. Similarly, 1000 lb gypsum (233 lb calcium) per acre every year should not be applied if the soil test shows a very high level of calcium (e.g., 1,550 ppm). This article provides a simple conversion method for crop consultants, crop advisors, growers, students, and researchers who are interested in nutrient and water management of crop production.

How to Convert Parts per Million to Pounds per Acre

If we assume the plow layer or root zone depth is 6 inches, the total weight of soils in the plow layer can be calculated as:

$$\text{Soil weight per acre} = \text{volume} \times \text{bulk density} \\ = (43560 \text{ ft}^2/\text{acre} \times 0.5 \text{ ft}) \times 92 \text{ lb/ft}^3 \sim 2,000,000 \text{ lb/acre}$$

Because UF/IFAS soil test reports report extractable nutrients in parts per million, we can readily use a factor of 2 to convert the actual number of ppm to pounds of an extractable nutrient per acre. In the above example, the extractable concentrations were reported as 550 ppm of phosphorus and 1550 ppm of calcium. These numbers mean that soil has 1100 pounds of extractable phosphorus per acre and 3100 pounds of calcium per acre. Further, in fertilization of phosphorus and potassium, calcium, etc., their oxides are used. Therefore, the pounds of extractable phosphorus pentoxide (P_2O_5) and potassium oxide (K_2O) need to be calculated by additional conversion factors of 2.2913 and 1.2046 for phosphorus and potassium, respectively. The soil in the above example has 550 ppm phosphorus and hence contains 2,520 pounds of extractable phosphorus pentoxide per acre. The conversion equations are below. More conversions are available in Table 1.

Extractable nutrient (ppm) $\times 2$ = pounds of the extractable nutrient per acre

Extractable phosphorus (ppm) $\times 2 \times 2.2913$ = pounds of the extractable phosphorus pentoxide per acre

Extractable potassium (ppm) $\times 2 \times 1.2046$ = pounds of the extractable potassium oxide per acre

Of course, the amount extracted by the soil test is not directly equivalent to fertilizer-grade nutrients, and the soil chemistry also influences the plant-available nutrient. Because the soil test is used to predict crop response to added nutrients, at these large soil-test values, we can expect little plant response to application of fertilizers. We must consider other actions and management decisions that can create a confusing and inefficient use of nutrients. The right amount of phosphorus and gypsum (calcium) from fertilizer can help plants grow, but too much will form rock phosphate and related compounds, none of which are available to plants. You will find more information on this and related issues in forthcoming EDIS documents.

How to Convert Pounds per Acre to Parts per Million

We can easily use a factor of 0.5 to convert the pounds per acre of a nutrient in its elemental form into ppm. To convert 120 pounds per acre to ppm, just multiply 120 pounds per acre by 0.5, which is to equal 60 ppm. This conversion works for all nutrients reported in these units: macronutrients, such as calcium or magnesium, and micronutrients, such as iron, manganese, zinc, and copper. Again, another factor is needed when converting pounds per acre of phosphorus and potassium in their oxide forms into number of ppm in their elemental forms: 0.4364 and 0.8302, respectively. For example, to convert 100 pounds per acre of phosphate fertilizer (P_2O_5) to ppm of elemental phosphorus, just multiply 100 by 0.5 and then by 0.4364 to get 21.8 ppm of phosphorus. Similarly, 100 pounds per acre of potash fertilizer (K_2O) will increase soil potassium (K) by 41.5 ppm. The conversion equations are below. More conversions are available in Table 2.

Pounds of nutrient applied per acre $\times 0.5$ = increment of the nutrient in soil (ppm)

Pounds of phosphorus pentoxide applied per acre $\times 0.5 \times 0.4364$ = increment of phosphorus in soil (ppm)

Pounds of potassium oxide applied per acre $\times 0.5 \times 0.8302$ = increment of potassium in soil (ppm)

References and Further Information

Hochmuth, G., R. Mylavarapu, and E. Hanlon. 2022. *The Four Rs of Fertilizer Management*. SL411. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <https://edis.ifas.ufl.edu/ss624> (accessed January 16, 2023).

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Table 1. Conversion from ppm on soil test report to pounds per acre for fertilization practices.

Soil test	Pounds per acre				
PPM	P	P ₂ O ₅	K	K ₂ O	Other nutrients
5	10	22.9	10	12.0	10
10	20	45.8	20	24.1	20
15	30	68.7	30	36.1	30
20	40	91.7	40	48.2	40
25	50	114.6	50	60.2	50
30	60	137.5	60	72.3	60
35	70	160.4	70	84.3	70
40	80	183.3	80	96.4	80
45	90	206.2	90	108.4	90
50	100	229.1	100	120.5	100
55	110	252.0	110	132.5	110
60	120	275.0	120	144.6	120
65	130	297.9	130	156.6	130
70	140	320.8	140	168.6	140
75	150	343.7	150	180.7	150
80	160	366.6	160	192.7	160
85	170	389.5	170	204.8	170
90	180	412.4	180	216.8	180
95	190	435.3	190	228.9	190
100	200	458.3	200	240.9	200
105	210	481.2	210	253.0	210
110	220	504.1	220	265.0	220
115	230	527.0	230	277.1	230
120	240	549.9	240	289.1	240
125	250	572.8	250	301.2	250
130	260	595.7	260	313.2	260
135	270	618.7	270	325.2	270
140	280	641.6	280	337.3	280
145	290	664.5	290	349.3	290
150	300	687.4	300	361.4	300
155	310	710.3	310	373.4	310
160	320	733.2	320	385.5	320
165	330	756.1	330	397.5	330
170	340	779.0	340	409.6	340
175	350	802.0	350	421.6	350
180	360	824.9	360	433.7	360
185	370	847.8	370	445.7	370
190	380	870.7	380	457.7	380
195	390	893.6	390	469.8	390
200	400	916.5	400	481.8	400
250	500	1145.7	500	602.3	500
300	600	1374.8	600	722.8	600
350	700	1603.9	700	843.2	700
400	800	1833.0	800	963.7	800

Soil test	Pounds per acre				
PPM	P	P ₂ O ₅	K	K ₂ O	Other nutrients
450	900	2062.2	900	1084.1	900
500	1000	2291.3	1000	1204.6	1000
600	1200	2749.6	1200	1445.5	1200
700	1400	3207.8	1400	1686.4	1400
800	1600	3666.1	1600	1927.4	1600
900	1800	4124.3	1800	2168.3	1800
1000	2000	4582.6	2000	2409.2	2000
Footnote: phosphorus pentoxide (P ₂ O ₅) contains 43.64% of phosphorus; potassium oxide (K ₂ O) contains 83.02% potassium.					

Table 2. Conversion from pounds per acre for fertilization practices to ppm on soil test reports.

Soil test	PPM				
Pounds/acre	P	P ₂ O ₅	K	K ₂ O	Other nutrients
1	0.5	1.1	0.5	0.6	0.5
2	1.0	2.3	1.0	1.2	1.0
3	1.5	3.4	1.5	1.8	1.5
4	2.0	4.6	2.0	2.4	2.0
5	2.5	5.7	2.5	3.0	2.5
6	3.0	6.9	3.0	3.6	3.0
7	3.5	8.0	3.5	4.2	3.5
8	4.0	9.2	4.0	4.8	4.0
9	4.5	10.3	4.5	5.4	4.5
10	5.0	11.5	5.0	6.0	5.0
11	5.5	12.6	5.5	6.6	5.5
12	6.0	13.7	6.0	7.2	6.0
13	6.5	14.9	6.5	7.8	6.5
14	7.0	16.0	7.0	8.4	7.0
15	7.5	17.2	7.5	9.0	7.5
16	8.0	18.3	8.0	9.6	8.0
17	8.5	19.5	8.5	10.2	8.5
18	9.0	20.6	9.0	10.8	9.0
19	9.5	21.8	9.5	11.4	9.5
20	10.0	22.9	10.0	12.0	10.0
21	10.5	24.1	10.5	12.6	10.5
22	11.0	25.2	11.0	13.2	11.0
23	11.5	26.4	11.5	13.9	11.5
24	12.0	27.5	12.0	14.5	12.0
25	12.5	28.6	12.5	15.1	12.5
26	13.0	29.8	13.0	15.7	13.0
27	13.5	30.9	13.5	16.3	13.5
28	14.0	32.1	14.0	16.9	14.0
29	14.5	33.2	14.5	17.5	14.5
30	15.0	34.4	15.0	18.1	15.0
31	15.5	35.5	15.5	18.7	15.5
32	16.0	36.7	16.0	19.3	16.0
33	16.5	37.8	16.5	19.9	16.5
34	17.0	39.0	17.0	20.5	17.0
35	17.5	40.1	17.5	21.1	17.5
36	18.0	41.2	18.0	21.7	18.0
37	18.5	42.4	18.5	22.3	18.5
38	19.0	43.5	19.0	22.9	19.0
39	19.5	44.7	19.5	23.5	19.5
40	20.0	45.8	20.0	24.1	20.0
41	20.5	47.0	20.5	24.7	20.5
42	21.0	48.1	21.0	25.3	21.0
43	21.5	49.3	21.5	25.9	21.5
44	22.0	50.4	22.0	26.5	22.0

Soil test	PPM				
Pounds/acre	P	P₂O₅	K	K₂O	Other nutrients
45	22.5	51.6	22.5	27.1	22.5
46	23.0	52.7	23.0	27.7	23.0
47	23.5	53.8	23.5	28.3	23.5
48	24.0	55.0	24.0	28.9	24.0
49	24.5	56.1	24.5	29.5	24.5
50	25.0	57.3	25.0	30.1	25.0
51	25.5	58.4	25.5	30.7	25.5
52	26.0	59.6	26.0	31.3	26.0
53	26.5	60.7	26.5	31.9	26.5
54	27.0	61.9	27.0	32.5	27.0
55	27.5	63.0	27.5	33.1	27.5
56	28.0	64.2	28.0	33.7	28.0
57	28.5	65.3	28.5	34.3	28.5
58	29.0	66.5	29.0	34.9	29.0
59	29.5	67.6	29.5	35.5	29.5
60	30.0	68.7	30.0	36.1	30.0
61	30.5	69.9	30.5	36.7	30.5
62	31.0	71.0	31.0	37.3	31.0
63	31.5	72.2	31.5	37.9	31.5
64	32.0	73.3	32.0	38.5	32.0
65	32.5	74.5	32.5	39.1	32.5
66	33.0	75.6	33.0	39.7	33.0
67	33.5	76.8	33.5	40.4	33.5
68	34.0	77.9	34.0	41.0	34.0
69	34.5	79.1	34.5	41.6	34.5
70	35.0	80.2	35.0	42.2	35.0
71	35.5	81.3	35.5	42.8	35.5
72	36.0	82.5	36.0	43.4	36.0
73	36.5	83.6	36.5	44.0	36.5
74	37.0	84.8	37.0	44.6	37.0
75	37.5	85.9	37.5	45.2	37.5
76	38.0	87.1	38.0	45.8	38.0
77	38.5	88.2	38.5	46.4	38.5
78	39.0	89.4	39.0	47.0	39.0
79	39.5	90.5	39.5	47.6	39.5
80	40.0	91.7	40.0	48.2	40.0
81	40.5	92.8	40.5	48.8	40.5
82	41.0	94.0	41.0	49.4	41.0
83	41.5	95.1	41.5	50.0	41.5
84	42.0	96.2	42.0	50.6	42.0
85	42.5	97.4	42.5	51.2	42.5
86	43.0	98.5	43.0	51.8	43.0
87	43.5	99.7	43.5	52.4	43.5
88	44.0	100.8	44.0	53.0	44.0

Soil test	PPM				
Pounds/acre	P	P ₂ O ₅	K	K ₂ O	Other nutrients
89	44.5	102.0	44.5	53.6	44.5
90	45.0	103.1	45.0	54.2	45.0
91	45.5	104.3	45.5	54.8	45.5
92	46.0	105.4	46.0	55.4	46.0
93	46.5	106.6	46.5	56.0	46.5
94	47.0	107.7	47.0	56.6	47.0
95	47.5	108.8	47.5	57.2	47.5
96	48.0	110.0	48.0	57.8	48.0
97	48.5	111.1	48.5	58.4	48.5
98	49.0	112.3	49.0	59.0	49.0
99	49.5	113.4	49.5	59.6	49.5
100	50.0	114.6	50.0	60.2	50.0
101	50.5	115.7	50.5	60.8	50.5
102	51.0	116.9	51.0	61.4	51.0
103	51.5	118.0	51.5	62.0	51.5
104	52.0	119.2	52.0	62.6	52.0
105	52.5	120.3	52.5	63.2	52.5
106	53.0	121.4	53.0	63.8	53.0
107	53.5	122.6	53.5	64.4	53.5
108	54.0	123.7	54.0	65.0	54.0
109	54.5	124.9	54.5	65.6	54.5
110	55.0	126.0	55.0	66.2	55.0
111	55.5	127.2	55.5	66.9	55.5
112	56.0	128.3	56.0	67.5	56.0
113	56.5	129.5	56.5	68.1	56.5
114	57.0	130.6	57.0	68.7	57.0
115	57.5	131.8	57.5	69.3	57.5
116	58.0	132.9	58.0	69.9	58.0
117	58.5	134.1	58.5	70.5	58.5
118	59.0	135.2	59.0	71.1	59.0
119	59.5	136.3	59.5	71.7	59.5
120	60.0	137.5	60.0	72.3	60.0
121	60.5	138.6	60.5	72.9	60.5
122	61.0	139.8	61.0	73.5	61.0
123	61.5	140.9	61.5	74.1	61.5
124	62.0	142.1	62.0	74.7	62.0
125	62.5	143.2	62.5	75.3	62.5
126	63.0	144.4	63.0	75.9	63.0
127	63.5	145.5	63.5	76.5	63.5
128	64.0	146.7	64.0	77.1	64.0
129	64.5	147.8	64.5	77.7	64.5
130	65.0	148.9	65.0	78.3	65.0
131	65.5	150.1	65.5	78.9	65.5
132	66.0	151.2	66.0	79.5	66.0

Soil test	PPM				
Pounds/acre	P	P ₂ O ₅	K	K ₂ O	Other nutrients
133	66.5	152.4	66.5	80.1	66.5
134	67.0	153.5	67.0	80.7	67.0
135	67.5	154.7	67.5	81.3	67.5
136	68.0	155.8	68.0	81.9	68.0
137	68.5	157.0	68.5	82.5	68.5
138	69.0	158.1	69.0	83.1	69.0
139	69.5	159.3	69.5	83.7	69.5
140	70.0	160.4	70.0	84.3	70.0
141	70.5	161.5	70.5	84.9	70.5
142	71.0	162.7	71.0	85.5	71.0
143	71.5	163.8	71.5	86.1	71.5
144	72.0	165.0	72.0	86.7	72.0
145	72.5	166.1	72.5	87.3	72.5
146	73.0	167.3	73.0	87.9	73.0
147	73.5	168.4	73.5	88.5	73.5
148	74.0	169.6	74.0	89.1	74.0
149	74.5	170.7	74.5	89.7	74.5
150	75.0	171.9	75.0	90.3	75.0