

NEWS & VIEWS

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Nutrient Balance in the Western U.S.

NUTRIENT BALANCE should be the goal of every crop grower. It leads to higher yields and quality, better efficiency of inputs, and more profits. Soil and tissue testing information helps guide us toward this goal and, when used regularly, points out long-term trends toward or away from balance.

Table 1 presents the amount of nitrogen (N), phosphorus (P) and potassium (K) removed in the harvested portion of selected crops. This is the amount that must be replaced to maintain a long-term *status quo*. Both P and K are presented as oxide equivalents (P_2O_5 and K_2O , respectively) to facilitate comparisons between crop removal and fertilizer use.

It is important to understand that the values in **Table 1** are not recommended rates per unit of production, but merely quantities of nutrients removed in harvested product. It may be possible to farm some highly fertile soils for years (even decades) before their ability to adequately supply certain nutrients is diminished. Other soils may be depleted in just a few years. However, soil fertility levels should never be allowed to drop to the point that yields are threatened. In general, soils with more clay and organic matter are better buffered. That is, it takes longer to deplete these soils of their available nutrients. And, logically, fields intensively managed for higher yields are more rapidly depleted.

The ratios of $N:P_2O_5:K_2O$ removed by type of crop as shown in **Table 1** are given in **Table 2**. Only the **Field Crops** grouping averages more N removal than K_2O . This is because the grouping is dominated by grains, and relatively little K is removed in grain compared to N and P. Much of the K taken up by these crops is returned to the soil in crop residue after harvest. Sugarbeets remove substantially more K_2O than N, which is typical for crops

Table 1. Nutrients removed in the harvested portion of the crop¹.

		N	P_2O_5	K_2O
Field Crops				
Barley	lb/cwt	2.3	0.83	0.73
Canola	lb/cwt	3.8	2.09	1.0
Corn (grain)	lb/cwt	1.3	0.79	0.52
Corn (silage)	lb/ton	8.3	3.6	8.3
Cotton (lint)	lb/bale	31	12	17
Grain sorghum	lb/cwt	1.5	0.75	0.38
Oats	lb/cwt	2.5	0.78	0.62
Rice	lb/cwt	1.2	0.64	0.40
Safflower	lb/cwt	5.0	1.2	3.8
Sugarbeets	lb/ton	4.0	1.50	6.6
Wheat,				
10% protein	lb/cwt	1.8	0.80	0.67
12%		2.1		
14%		2.5		
Vegetable Crops				
Broccoli	lb/cwt	0.44	0.17	0.42
Cabbage	lb/cwt	0.39	0.092	0.36
Celery	lb/cwt	0.19	0.11	0.50
Lettuce	lb/cwt	0.24	0.075	0.50
Potatoes	lb/cwt	0.35	0.15	0.56
Squash	lb/cwt	0.42	0.10	0.60
Sweet potatoes	lb/cwt	0.52	0.23	1.0
Tomatoes	lb/ton	2.5	0.92	5.7
Fruit and Nut Crops				
Almonds (in shell)	lb/ton	130	50	170
Apples	lb/ton	6.0	3.6	17
Cantaloupe	lb/ton	7.3	2.3	13
Grapes	lb/ton	8.3	3.0	13
Oranges	lb/ton	8.8	1.8	11
Peaches	lb/ton	6.3	2.7	8.0
Pears	lb/ton	5.7	1.7	6.3
Prunes	lb/ton	6.0	2.0	8.7
Forage Crops				
Alfalfa*	lb/ton	56	15	60
Bermudagrass	lb/ton	50	12	47
Bromegrass	lb/ton	36	13	59
Clover*-grass	lb/ton	50	15	60
Fescue	lb/ton	40	19	53
Orchardgrass	lb/ton	50	17	62
Sorghum-sudan	lb/ton	41	16	59
Timothy	lb/ton	38	14	62
Vetch*	lb/ton	56	15	46

*Legumes obtain most of their N from the air.

¹Values are approximations. Actual nutrient removal may vary by 30% or more.



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producing high quantities of carbohydrate. Seed contains a high concentration of P; therefore, relative P removal is greatest in this group.

The other groupings are fairly similar in that they all show more removal of K_2O than N and similar ratios between P_2O_5 and K_2O .

Table 2. Nutrient removal ratios by crop type.

Type of crop	N: P_2O_5 : K_2O
Field crops	1.57:0.62:1.00
Vegetable crops	0.52:0.19:1.00
Fruit and nut crops	0.72:0.27:1.00
Forage crops	0.82:0.27:1.00

This information takes on more meaning when compared to the fertilizer consumption ratios for the U.S. and the western states (**Table 3**). Although the N: K_2O ratio in the west has decreased sharply since 1980, from 9.26:1.00 to 5.16:1.00, it is still very wide...compared to actual crop removal near 1:1 or <1:1 (more K required than N) for most crops. Clearly, many growers continue to rely heavily on native soil K to produce their crops.

This is also true for the U.S. as a whole, but to a lesser degree than in the west (**Table 3**). However, the gap between N and K_2O is actually widening for the U.S. when, in fact, it should be narrowing to better fit crop needs. The N: K_2O ratio has increased from 1.83:1.00 in 1980 to 2.48:1.00 in 2000.



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Table 3. Fertilizer consumption ratios (N: P_2O_5 : K_2O) for the U.S. and western states.

Year	United States	Western States ¹
1980	1.83:0.87:1.00	9.26:3.25:1.00
1985	2.07:0.84:1.00	8.24:2.80:1.00
1990	2.14:0.84:1.00	6.68:2.47:1.00
1995	2.28:0.86:1.00	5.50:2.06:1.00
2000	2.48:0.87:1.00	5.16:1.75:1.00

¹Arizona, California, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming

There appears to be better overall balance between N and P_2O_5 comparing crop removal to fertilizer use. Most ratios (N: P_2O_5) for both crop removal and fertilizer consumption presented in **Tables 2 and 3** are in the 2.5:1.0 to 3.0:1.0 range. However, the range for the U.S. has widened from 2.1:1.0 in 1980 to 2.8:1.0 in 2000.

The above information clearly indicates that many growers, and especially western growers, are mining their soils of K. This is not necessarily a bad practice as long as the K supply continues to be adequate for optimum yield and quality. However, it is important to monitor these soils so they do not slip into a deficient situation where crop yields and quality are compromised. Cotton soils of the San Joaquin Valley of California were heavily mined of K for several decades before it was realized that mid-season K deficiency was robbing yields. In fact, the soils had been so seriously mined of K that some had become strong K-fixers, requiring heavy fertilizer applications for several consecutive years to correct the problem.

Ideally, soil fertility of non-mobile nutrients such as P and K in most agronomic situations should be kept in the non-responsive zone (high, not excessive) to achieve maximum production potential. ■

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