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Nutrient Recommendations for Vegetable Crops Grown in Michigan: ***THE STRUCTURE***

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This bulletin presents the framework for the nutrient recommendations for vegetable crops given in the new MSU nutrient recommendation program. A subsequent bulletin will provide more management information to complement basic details of the recommendations for individual crops.

Plant growth is dependent on nutrients (essential elements) taken up from the soil by their roots. Soils in Michigan tend to be naturally low in available nitrogen (N), phosphorus (P) and potassium (K), three primary nutrients required by crops. Additions of these elements are necessary when the available levels are inadequate to grow good quality yields. Over time available levels of P and K have increased as the result of additions so the amounts required have changed. Analysis of the soil (soil testing) provides an indication of the relative nutrient availability. Through studies conducted in greenhouses and in fields throughout Michigan the amounts of P and K needed relative to the soil test levels have been established for many vegetable crops. Recommendations for other vegetable crops are based on their similarity to crops with established fertility responses.

Response of crops to additions of P and K is a continuous function. When inadequate amounts are present in the soil, crops respond to P and K additions by increases in biomass and/or vegetable produce production according to the general response curve shown in Figure 1. Recommendations given in this bulletin follow the **buildup**, **maintenance** and **draw down** philosophy presented in the "Tri-State Fertilizer Recommendation" bulletin, E-2567. These recommendations provide for

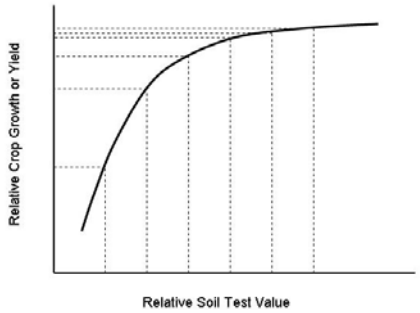

Figure 1. Relative growth or yield response to increasing soil test levels.

buildup of available P and K levels when the soil test level is below the critical soil test value (Figure 2). At the critical value crop yield will be near 95 to 97% of maximum. **Maintenance** recommendations (amount equal to crop removal) are given to keep the available P and K at the optimum level. Beyond the maintenance zone, recommendations are less than crop removal to allow **draw down** of soil nutrient levels to occur.

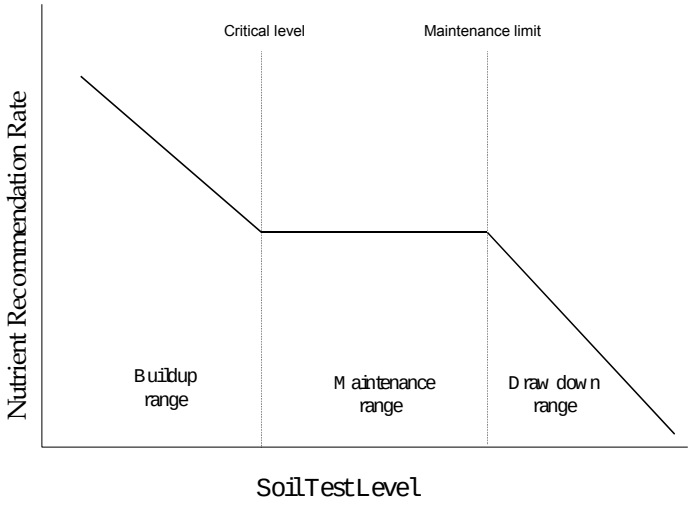

Figure 2. Nutrient recommendation approach for phosphorus and potassium.

Crop yield plays an important role in these recommendations. In the buildup zone the amount of P or K recommended is a combination of the amount required to build up the level in the soil to the optimum range plus the amount that will be removed in the harvested portion of the crop. It is very important to provide realistic yield goals to the MSU Soil and Plant Nutrient Lab to receive nutrient recommendations that are economically and environmentally sound. Table 1v provides a guide for amounts of nitrogen (N), phosphate (P_2O_5) and potassium (K_2O) removed in the harvested portion of the major vegetable crops grown in Michigan. The exact amounts may vary with stage of maturity, environmental conditions and crop type or variety.

Table 1v. Nutrient removal in harvest portion of several Michigan vegetable crops.

Crop	Unit	N	P_2O_5	K_2O
		----------lb----------		
Asparagus crowns		13.4	4.0	10.0
Asparagus, new planting	ton	13.4	4.0	10.0
Asparagus, established	ton	13.4	4.0	10.0
Beans, snap	ton	24.0	2.4	11.0
Beets, red	ton	3.5	2.2	7.8
Broccoli	ton	4.0	1.1	11.0
Brussels Sprouts	ton	9.4	3.2	9.4
Cabbage, fresh market	ton	7.0	1.6	6.8
Cabbage, processing	ton	7.0	1.6	6.8
Cabbage, Chinese	ton	7.0	1.6	6.8
Carrots, fresh market	ton	3.4	1.8	6.8
Carrots, processing	ton	3.4	1.8	6.8
Cauliflower	ton	6.6	2.6	6.6
Celeriac	ton	4.0	2.6	6.6
Celery, fresh market	ton	5.0	2.0	11.6
Celery, processing	ton	5.0	2.0	11.6
Cucumber, pickling				
-hand harvest	ton	2.0	1.2	3.6
-machine harvest	ton	2.0	1.2	3.6
Cucumber, slicers	ton	2.0	1.2	3.6
Dill	ton	3.5	1.2	3.6
Eggplant	ton	4.5	1.6	5.3
Endive	ton	4.8	1.2	7.5
Escarole	ton	4.8	1.2	7.5
Garden, home	ton	6.5	2.8	5.6
Garlic	ton	5.0	2.8	5.6
Ginseng	ton	4.6	1.2	4.6
Greens, Leafy	ton	4.8	2.0	6.0
Horseradish	ton	3.4	0.8	6.0
Kohlrabi	ton	6.0	2.6	6.6
Leek	ton	4.0	2.6	4.8
Lettuce, Boston, bib	ton	4.8	2.0	9.0
Lettuce, leaf	ton	4.8	2.0	9.0
Lettuce, head	ton	4.8	2.0	9.0
Lettuce, Romaine	ton	4.8	2.0	9.0
Market Garden	ton	6.5	2.8	5.6
Muskmelon	ton	8.4	2.0	11.0

Table 1v. (Continued).

Crop	Unit	N	P_2O_5	K_2O
		----------lb----------		
Onion, dry bulb	ton	5.0	2.6	4.8
Onion, green	ton	5.0	2.6	4.8
Pak Choi	ton	7.0	1.6	6.8
Parsley	ton	4.8	1.8	12.9
Parsnip	ton	3.4	3.2	9.0
Peas	ton	20.0	4.6	10.0
Pepper, bell	ton	4.0	1.4	5.6
Pepper, banana	ton	4.0	1.4	5.6
Pepper, hot	ton	4.0	1.4	5.6
Pumpkin	ton	4.0	1.2	6.8
Radish	ton	3.0	0.8	5.6
Rhubarb	ton	3.5	0.6	6.9
Rutabagas	ton	3.4	2.6	8.1
Spinach	ton	10.0	2.7	12.0
Squash, hard	ton	4.0	2.2	6.6
Squash, summer	ton	3.6	2.2	6.6
Sweet Corn	ton	8.4	2.8	5.6
Sweet potato	ton	5.3	2.4	12.7
Swiss Chard	ton	3.5	1.2	9.1
Tomato, fresh market	ton	4.0	0.8	7.0
Tomato, processing	ton	4.0	0.8	7.0
Turnip	ton	3.4	1.2	4.6
Watermelon	ton	4.8	0.4	2.4
Zucchini	ton	4.6	1.6	6.6

*values used for some crops are estimates based on information for similar crops.
**1 ton = 20 cwt.

Nitrogen recommendations are based on crop need and may vary with the crop yield. Response to nitrogen varies with growing conditions. At this time a standard N recommendation is given that will support excellent yields of the vegetable crops. Recommendations are 40 to 50 lb/A less on organic (muck) soils than mineral soils due to the release of nitrogen from the organic matter. Credit for nitrogen available from a previous legume crop or application of animal manure or compost will reduce the amount of supplemental nitrogen needed. Table 2v presents nitrogen recommendations for vegetable crops grown on mineral and organic soils.

Table 2v. Nitrogen recommendations for vegetable crops grown on mineral and organic soils.

Crop	Mineral Soil	Organic Soil	Crop	Mineral Soil	Organic Soil
	-------lb N/A------			-------lb N/A------	
Asparagus crowns	80	40	Lettuce, Boston, bib	100	60
Asparagus, new planting	80	--	Lettuce, leaf	100	60
Asparagus, established	50	--	Lettuce, head	140	90
Beans, snap	40	20	Lettuce, Romaine	140	90
Beets, red	100	40	Market Garden	140	90
Broccoli	140	90	Muskmelon	100	
Brussels Sprouts	140	90	Onion, dry bulb	190	140
Cabbage, fresh market	140	90	Onion, green	130	80
Cabbage, processing	140	90	Pak Choi	120	70
Cabbage, Chinese	120	90	Parsley	100	50
Carrots, fresh market	100	60	Parsnip	100	50
Carrots, processing	120	60	Peas	40	20
Cauliflower	140	90	Pepper, bell	100	--
Celeriac	150	100	Pepper, banana	100	--
Celery, fresh market	200	150	Pepper, hot	100	--
Celery, processing	200	150	Pumpkin	80	40
Cucumber, pickling			Radish	50	20
-hand harvest	100	60	Rhubarb	100	--
-machine harvest	60	20	Rutabaga	100	50
Cucumber, slicers	80	40	Spinach	170	120
Dill	60	20	Squash, hard	80	40
Eggplant	120	--	Squash, summer	80	40
Endive	100	60	Sweet Corn	120	70
Escarole	100	60	Sweet potato	60	--
Garden, home	140	90	Swiss Chard	100	50
Garlic	120	70	Tomato, fresh market	120	--
Ginseng	50	--	Tomato, processing	80	--
Greens, Leafy	100	50	Turnip	90	40
Horseradish	100	50	Watermelon	100	--
Kohlrabi	140	90	Zucchini	80	40
Leek	150	100			

Phosphorus recommendations take into consideration the soil test level and the crop yield. The buildup portion of the recommendation is based on building the soil up to the critical value (yield is 95 to 97 % of maximum). Buildup assumes that on average it takes 20 pounds P_2O_5 to increase the soil test 1 ppm P or 5 lbs/A per year over four years. The P buildup recommendations are given in Table 3v. The maintenance plateau for most vegetable crops ranges from 25 to 35 ppm on mineral soils. For organic soils the plateau length is 15 ppm. Maintaining the soil test P value in this maintenance zone helps insure that P will not limit crop yield. When the soil test P value is above the maintenance zone the soil P level should be drawn down. The recommendation is less than crop removal and goes to zero 10 ppm beyond the maintenance zone for mineral soils. The critical levels (CL), maintenance plateau length (PL) and draw down length (DDL) are given in Table 4v for vegetable crops grown on mineral and organic soils.

Equations used to calculate the amount of P_2O_5, in lb/A, for each segment are as follows:

Mineral Soils:

Buildup: lb P_2O_5/A = ((CL – ST) * 5) + (YP * CR)
Maintenance: lb P_2O_5/A = (YP * CR)
Draw down: lb P_2O_5/A = (YP * CR) – (((YP * CR) * (ST – (CL + PL))/ DDL)

Organic Soils: lb P_2O_5/A = ((CL – ST) * 2) + (YP * CR)
lb P_2O_5/A = (YP * CR)
lb P_2O_5/A = (YP * CR) – (((YP * CR) * (ST – (CL + PL))/ DDL

where:
CL = critical soil test value (ppm)
ST = soil test value
YP = yield potential or goal
CR = nutrient removal in harvest portion of crop (lb/unit of yield)
PL = maintenance plateau length
DDL = draw down length; recommendation is phased to zero

Table 3v. Phosphorus buildup recommendations. Mineral soils.

P Soil Test ppm	Buildup Recommendations CL Values			
	15	20	25	30
	----------lb P_2O_5/A----------			
5	50	75	100	125
10	25	50	75	100
15	0	25	50	75
20	0	0	25	50
25	0	0	0	25
30	0	0	0	0
35	0	0	0	0
40	0	0	0	0
45	0	0	0	0
50	0	0	0	0

CL = critical P soil test level (value).

Table 4v. Values for key factors used in calculating the phosphorus recommendations for vegetable crops grown on mineral and organic soils.

Crop	Mineral Soil			Organic Soil		
	CL	PL	DDL	CL	PL	DDL
	----------ppm----------			----------ppm----------		
Asparagus crowns	30	30	10	100	15	15
Asparagus, new planting	40	20	10	--	--	- -
Asparagus, established	30	20	10	--	--	--
Beans, snap	30	30	10	70	15	15
Beets, red	40	30	10	100	15	15
Broccoli	40	30	10	130	15	15
Brussels Sprouts	40	30	10	100	15	15
Cabbage, fresh market	40	30	10	100	15	15
Cabbage, processing	40	30	10	100	15	15
Cabbage, Chinese	40	30	10	100	15	15
Carrots, fresh market	35	25	10	100	15	15
Carrots, processing	35	25	10	100	15	15
Cauliflower	40	30	10	130	15	15
Celeriac	45	35	10	120	15	15
Celery, fresh market	45	35	10	120	20	20
Celery, processing	45	35	10	120	20	20
Cucumber, pickling	40	30	10	100	15	15
-hand harvest	40	30	10	100	15	15
-machine harvest	40	30	10	100	15	15
Cucumber, slicers	40	30	10	100	15	15
Dill	40	30	10	100	15	15
Eggplant	40	30	10	--	--	--
Endive	35	25	10	100	15	15
Escarole	35	25	10	100	15	15
Garden, home	40	35	10	130	30	20
Garlic	40	35	10	120	15	15
Ginseng	30	20	10	--	--	--
Greens, Leafy	35	25	10	70	15	15
Horseradish	40	30	10	100	15	15
Kohlrabi	40	30	10	120	15	15
Leek	40	30	10	100	15	15
Lettuce, Boston, bib	35	25	10	100	15	15
Lettuce, leaf	35	25	10	100	15	15
Lettuce, head	35	25	10	100	15	15
Lettuce, Romaine	35	25	10	100	15	15
Market Garden	45	35	10	120	20	20
Muskmelon	40	30	10	--	--	--
Onion, dry bulb	45	35	10	120	15	15
Onion, green	45	35	10	100	15	15
Pak Choi	40	30	10	100	15	15

Table 4v. (Continued).

Crop	Mineral Soil			Organic Soil		
	CL	PL	DDL	CL	PL	DDL
	----------ppm----------			----------ppm----------		
Parsley	35	25	10	100	15	15
Parsnip	35	25	10	100	15	15
Peas	30	20	10	---		
Pepper, bell	40	30	10	---		
Pepper, banana	40	30	10	---		
Pepper, hot	40	30	10	---		
Pumpkin	35	25	10	100	15	15
Radish	35	25	10	70	15	15
Rhubarb	40	30	10	---		
Rutabaga	35	25	10	70	15	15
Spinach	35	25	10	100	15	15
Squash, hard	35	25	10	100	15	15
Squash, summer	35	25	10	100	15	15
Sweet Corn	35	25	10	70	15	15
Sweet Potato	35	25	10	---		
Swiss Chard	40	30	10	100	15	15
Tomato, fresh market	45	35	10	---		
Tomato, processing	45	35	10	---		
Turnip	30	20	10	70	15	15
Watermelon	40	30	10	---		
Zucchini	35	25	10	100	15	15

[1]CL = critical P soil test value
[2]PL = maintenance plateau length
[3]DDL = draw down length

Potassium recommendations take into consideration the soil test level and the crop yield. The buildup portion of the recommendation also takes into account the cation exchange capacity (CEC) of the soil. The amount of potassium required to increase the available soil potassium level and reach the critical level (yield is 95 to 97 % of maximum) varies with the CEC. The buildup portion of the K recommendation is given in Table 5v. The maintenance plateau for most vegetable crops is 30 ppm for mineral soils and 40 ppm for organic soils. In this zone the potassium recommendation equals crop removal. When the soil test K value is above the maintenance zone, crops should be allowed to use residual soil K and draw down the soil K level. The recommendation is less than crop removal. In mineral soils the K_2O recommendation goes to zero 20 ppm beyond the upper maintenance soil test value for mineral soils. The critical levels (CL), maintenance plateau length (PL) and draw down length (DDL) are given in Table 6v for vegetable crops.

Equations used to calculate the amount of K_2O, in lb/A, for each segment are as follows:

Mineral Soils:

Buildup: lb K_2O/A = [(CL – ST) * ((1 + (0.05 x CEC))] + (YP * CR)

Maintenance: lb K_2O/A = (YP * CR)

Draw down: lb K_2O/A = (YP * CR) – [((YP * CR) * (ST – (CL + PL))/ DDL)]

Organic Soils: lb K_2O/A = ((CL – ST) * 1.5) + (YP * CR)

lb K_2O/A = (YP * CR)

lb K_2O/A = (YP * CR) – (((YP * CR) * (ST – (CL + PL))/ DDL

where:
- CL = critical soil test (ppm) … for mineral soils CL = 75 + (2.5 x CEC)
- CEC = cation exchange capacity (me/100g soil)
- ST = soil test value
- YP = yield potential or goal
- CR = nutrient removal in harvest portion of crop (lb/unit of yield)
- PL = maintenance plateau length
- DDL = draw down length; recommendation is phased to zero

Table 5v. Potassium buildup recommendations.
Mineral soils.

K Soil Test ppm	Buildup Recommendation CEC me/100 g			
	4	8	12	16
CL	85	95	105	115
	----------lb K_2O/A----------			
10	90	119	152	189
20	78	105	136	171
30	66	91	120	153
40	54	77	104	135
50	42	63	88	117
60	30	49	72	99
70	18	35	56	81
80	6	21	40	63
90	0	7	24	45
100	0	0	8	27
120	0	0	0	0
140	0	0	0	0
160	0	0	0	0
180	0	0	0	0
200	0	0	0	0

CL = critical K soil test level (value).

Table 6v. Values for key factors used in calculating the potassium recommendations for vegetable crops grown on mineral and organic soils.

Crop	Mineral Soil *CL = 75+(2.5*CEC)* PL	Mineral Soil DDL	Organic Soil CL	Organic Soil PL	Organic Soil DDL
	-----ppm------		----------ppm----------		
Asparagus crowns	30	20	260	30	30
Asparagus, new planting	30	20	--	--	--
Asparagus, established	30	20	--	--	--
Beans, snap	30	20	200	40	30
Beets, red	30	20	300	60	40
Broccoli	30	20	320	40	40
Brussels Sprouts	30	20	320	40	40
Cabbage, fresh market	30	20	240	40	40
Cabbage, processing	30	20	240	40	40
Cabbage, Chinese	30	20	240	40	40
Carrots, fresh market	30	20	220	40	60
Carrots, processing	30	20	220	40	60
Cauliflower	30	20	320	40	40
Celeriac	30	20	320	40	40
Celery, fresh market	30	20	210	50	200
Celery, processing	30	20	210	50	200
Cucumber, pickling					
-hand harvest	30	20	240	40	40
-machine harvest	30	20	240	40	40
Cucumber, slicers	30	20	240	40	40
Dill	30	20	240	40	40
Eggplant	30	20	--	--	--
Endive	30	20	220	40	60
Escarole	30	20	220	40	60
Garden, home	30	20	350	50	50
Garlic	30	20	240	40	40
Ginseng	40	20	--	--	--
Greens, Leafy	30	20	200	40	30
Horseradish	30	20	260	30	30
Kohlrabi	30	20	240	40	40
Leek	30	20	240	40	40
Lettuce, Boston, bib	30	20	220	40	60
Lettuce, leaf	30	20	220	40	60
Lettuce, head	30	20	200	40	60
Lettuce, Romaine	30	20	200	40	60
Market Garden	30	20	300	60	40

Table 6v. (Continued).

Crop	Mineral Soil *CL = 75+(2.5*CEC)*		Organic Soil		
	PL	DDL	CL	PL	DDL
	-----ppm------		----------ppm----------		
Muskmelon	30	20	--	--	--
Onion, dry bulb	30	20	300	60	40
Onion, green	30	20	320	40	40
Pak Choi	30	20	240	40	40
Parsley	30	20	220	40	30
Parsnip	30	20	220	40	60
Peas	30	20	--	--	--
Pepper, bell	30	20	--	--	--
Pepper, banana	30	20	--	--	--
Pepper, hot	30	20	--	--	--
Pumpkin	30	20	200	40	30
Radish	30	20	200	40	30
Rhubarb	30	20	--	--	--
Rutabagas	30	20	240	40	40
Spinach	30	20	300	60	40
Squash, hard	30	20	200	40	30
Squash, summer	30	20	200	40	30
Sweet Corn	30	20	200	40	30
Sweet potato	30	20	--	--	--
Swiss Chard	30	20	300	60	40
Tomato, fresh market	30	20	--	--	--
Tomato, processing	30	20	--	--	--
Turnip	30	20	200	40	30
Watermelon	30	20	--	--	--
Zucchini	30	20	200	40	30

[1]CL = critical P soil test value Mineral Soil
[2]PL = maintenance plateau length
[3]DDL = draw down length

Organic soils have bulk densities that are much lower than mineral soils. On average organic soils will have field bulk densities between 0.65 and 0.70, but may vary considerably. Soil test values for organic soils are calculated on a volume basis. In general, multiplying the soil test value in ppm by 1.5 will approximate pounds per acre to a depth of 6 2/3 inches. Hence, the critical soil test values for organic soils are higher than for mineral soils.

Recommendations for the micronutrients boron (B), copper (Cu), manganese (Mn) and zinc (Zn) are based on the responsiveness of the crop (Table 7v) and/or the soil test value and soil pH. The B recommendation for high response crops is 3 lb/A. For medium response crops the recommendation is 1.5 lb/A. Copper recommendations are given only for organic soils. Mineral soils generally contain adequate copper. The critical Cu soil test value (1 *N* HCl) for mineral soils is 0.5 ppm.

Recommendations for Mn, Zn and Cu are calculated from the following equations:

Mn Rec = (6.2 * pH) – (0.35 * ST) -36 mineral soil
= (8.38 * pH) – (0.31 * ST) -46 organic soil

Zn Rec = (5.0 * pH) – (0.4 * ST) -32 mineral and organic soils
Cu Rec = (6 – (0.22 * ST) organic soil

Table 7v. Micronutrient responsiveness factors for vegetable crops.

Code	Crop	Boron	Copper	Manganese	Zinc
201	Asparagus crowns	0	0	0	0
202	Asparagus, new planting	0	0	0	0
203	Asparagus, established	0	0	0	0
205	Beans, snap	0	0	1	1
206	Beets, red	1	1	1	0.5
208	Broccoli	1	0.5	0.5	0
209	Brussels Sprouts	0.5	0.5	0.5	0
211	Cabbage, fresh market	0.5	0.5	0.5	0
212	Cabbage, processing	0.5	0.5	0.5	0
213	Cabbage, Chinese	0.5	0.5	0.5	0
215	Carrots, fresh market	1.0	0.5	0.5	0
216	Carrots, processing	1	0.5	0.5	0
218	Cauliflower	1	0.5	0.5	0
219	Celeriac	1	0.5	0.5	0
221	Celery, fresh market	1	0.5	0.5	0
222	Celery, processing	1	0.5	0.5	0
	Cucumber				
224	- pickling-hand harvest	0	0.5	1	0.5
225	- pickling-machine harvest	0	0.5	1	0.5
226	Cucumber, slicers	0	0.5	1	0.5
228	Dill	0	0	0.5	0.5
229	Eggplant	0.5	0.5	0.5	0.5
231	Endive	0.5	1	1	0.5
232	Escarole	0.5	1	1	0.5
234	Garlic	0	0.5	1	0.5

Table 7v. (Continued).

Code	Crop	Boron	Copper	Manganese	Zinc
235	Ginseng	0	0	0.5	0.5
237	Greens, leafy	0.5	1	1	0.5
238	Horseradish	0.5	0	0.5	0
240	Kohlrabi	0.5	0.5	0.5	0
241	Leek	0.0	1	1	1
243	Lettuce, Boston, bib	0.5	1	1	0.5
244	Lettuce, leaf	0.5	1	1	0.5
245	Lettuce, head	0.5	1	1	0.5
246	Lettuce, Romaine	0.5	1	1	0.5
248	Market Garden	0.5	0.5	1	0.5
249	Muskmelon	0.5	0.5	1	0.5
251	Onion, dry bulb	0	1	1	1
252	Onion, green	0	1	1	1
254	Pak Choi	0.5	0.5	0.5	0
256	Parsley	0.5	0.5	1	0.5
257	Parsnip	1	0.5	0.5	0
259	Peas	0	0	1	0
261	Pepper, bell	0	0	0.5	0
262	Pepper, banana	0	0	0.5	0
263	Pepper, hot	0	0	0.5	0
265	Pumpkin	0.5	0	1	0.5
266	Radish	0.5	0.5	1	0.5
268	Rhubarb	0	0	0.5	0.5
269	Rutabagas	1	0.5	0.5	0.5
270	Spinach	0.5	1	1	1
271	Squash, hard	0	0	1	0.5
272	Squash, summer	0	0	1	0.5
274	Sweet Corn	0.5	0.5	1	1
275	Sweet Potato	0	0.5	1	0.5
277	Swiss Chard	0.5	0.5	0.5	0.5
279	Tomato, fresh market	1	0.5	0.5	0.5
280	Tomato, processing	1	0.5	0.5	0.5
282	Turnip	1	0.5	0.5	0.5
284	Watermelon	0.5	0	0.5	0.5
286	Zucchini	0.5	0	0.5	0.5

Responsiveness is relative to when the soil contains low available levels of the micronutrient.
1.0 = highly responsive; 0.5 = medium; 0.0 = low.

The **lime requirement** of a soil will depend on the crops being grown and the buffer capacity of the soil. The target soil pH values for vegetable crops grown on mineral and organic soils are listed in Table 8v. The buffering capacity of mineral soils is determined with the SMP buffer analysis. The lime recommendations, based on the SMP buffer pH (lime index), are presented in Table 9v. In sandy weakly buffered soils the SMP buffer pH underestimates the lime need. When the lime index indicates little or no lime is needed and the soil water pH is 0.3 to 0.5 unit less than the target pH the recommendation will be 1.0 ton/acre, and if the soil water pH is 0.6 unit or more below the target pH then the lime recommendation will be 2.0 tons/acre. Lime recommendations for organic soils are based on the water pH of the soil.

Table 8v. Target soil pH values for vegetable crops grown on mineral and organic soils.

Crop	Mineral Soil	Organic Soil	Crop	Mineral Soil	Organic Soil
Asparagus crowns	6.8	6.0	Lettuce, Boston, bib	6.5	5.5
Asparagus, new planting	6.8	--	Lettuce, leaf	6.5	5.5
Asparagus, established	6.8	--	Lettuce, head	6.5	5.5
Beans, snap	6.5	5.8	Lettuce, Romaine	6.5	5.5
Beets, red	6.5	5.5	Market Garden	6.5	5.5
Broccoli	6.5	5.5	Muskmelon	6.5	5.8
Brussels Sprouts	6.5	5.5	Onion, dry bulb	6.5	5.3
Cabbage, fresh market	6.5	5.5	Onion, green	6.5	5.3
Cabbage, processing	6.5	5.5	Pak Choi	6.5	5.8
Cabbage, Chinese	6.5	5.5	Parsley	6.5	5.3
Carrots, fresh market	6.5	5.3	Parsnip	6.5	5.3
Carrots, processing	6.5	5.3	Peas	6.5	5.3
Cauliflower	6.8	5.8	Pepper, bell	6.5	5.5
Celeriac	6.8	5.8	Pepper, banana	6.5	5.5
Celery, fresh market	6.8	5.8	Pepper, hot	6.5	5.5
Celery, processing	6.8	5.8	Pumpkin	6.5	5.5
Cucumber, pickling			Radish	6.5	5.3
-hand harvest	6.5	5.5	Rhubarb	6.0	--
-machine harvest	6.5	5.5	Rutabagas	6.5	5.3
Cucumber, slicers	6.5	5.5	Spinach	6.5	5.5
Dill	6.5	5.5	Squash, hard	6.5	5.8
Eggplant	6.0	--	Squash, summer	6.5	5.8
Endive	6.0	5.3	Sweet Corn	6.5	5.3
Escarole	6.0	5.3	Sweet potato	6.0	--
Garden, home	6.5	5.3	Swiss Chard	6.5	5.3
Garlic	6.5	5.3	Tomato, fresh market	6.5	--
Ginseng	6.5	--	Tomato, processing	6.5	--
Greens, Leafy	6.5	5.3	Turnip	6.5	5.3
Horseradish	6.5	5.5	Watermelon	6.0	--
Kohlrabi	6.5	5.8	Zucchini	6.5	5.8
Leek	6.5	5.5			

Table 9v. Tons of limestone needed to raise the pH of mineral soils to 6.0, 6.5 or 6.8 according to the Lime Index and to raise the pH of organic soils to 5.3 as related to the soil pH.

	Mineral Soil			Organic Soil	
Lime	Raise Soil pH to:			Soil	Raise pH
Index	6.0	6.5	6.8	pH	to 5.3
	----------tons/A----------			----------tons/A----------	
70	0.0	0.0	0.0	5.3	0.0
69	0.0	0.6	0.8	5.2	0.7
68	1.2	1.6	1.8	5.1	1.4
67	1.9	2.5	2.9	5.0	2.1
66	2.7	3.5	3.9	4.9	2.8
65	3.5	4.4	4.9	4.8	3.5
64	4.3	5.3	5.9	4.7	4.2
63	5.1	6.3	6.9	4.6	5.0
62	5.8	7.2	8.0	4.5	5.6
61	6.6	8.2	9.0	4.4	6.3
60	7.4	9.1	10.0	4.3	7.1

Recommendations are based on the following equations.

Mineral Soils:

To pH 6.0: $XL = 54.2 - 0.78 * LI$

To pH 6.5: $XL = 65.5 - 0.94 * LI$

To pH 6.8: $XL = 71.2 - 1.02 * LI$

Organic Soils:

$XL = 37.6 - 7.1 * pH$

where:

XL = Lime recommendation in tons/acre

LI = Lime Index

pH = Soil pH