Spectrum Analytic, Inc.

FERTILIZING RASPBERRIES and OTHER BRAMBLES

Soil Analysis
Plant Analysis
Fertilizer Analysis
Manure Analysis

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Introduction

Raspberries, blackberries, and other similar fruit crops are collectively known as brambles. In many cases, fertilizer and other recommendations for all of these crops may be the same. Perennial plants have the ability to store nutrients from one season to the next. This results in the internal nutrient status of the plants sometimes being somewhat different than would be expected from one season's soil test, or fertilizer program. Because of this, virtually all authorities agree **that producers should take annual leaf samples for nutrient analysis**. Fertilizer programs can then be adjusted by these results.

Establishment

Apply any needed lime (target soil pH is from 5.7 to 6.0) at least one year prior to planting. Apply corrective rates of P_2O_5 and K_2O prior to planting, and thoroughly incorporate into the soil. Apply ½ of the recommended N (see nitrogen section of this paper) prior to planting and the remainder 3 weeks later. Any fertilizer applied after planting should be applied in a 4 ft. wide band over the row, but do not apply fertilizer within 3 to 4 inches of the plants.

Maintenance

Apply the recommended fertilizer to the soil surface in a 4 ft. wide band over the row, but do not apply fertilizer within 3 to 4 inches of the plants. One 4 inch fertilizer band on either side of the row or two-2 inch wide bands on both sides of the row. Apply the recommended P_2O_5 and K_2O in the spring prior to the initiation of new growth. Apply the recommended N (see Nitrogen section of this paper) as follows.

Soil pH

Proper soil pH is critical to success with brambles. They require a soil pH in the range of 5.0 to 6.5; our recommendations program uses a target pH of 5.8. This is a slightly acidic soil, when compared to most other crops.

Lowering the Soil pH

Because of brambles slight acidic soil requirements, they will frequently benefit from soil acidification. This is typically accomplished through the application of sulfur (S). The accompanying table lists some S recommendations for acidifying soil. One note of caution; North Carolina State University recommends that on some of their soils, applications of S greater than about 300 lb/ac/yr have caused excessively large and damaging pH reductions in the soil. These effects would likely be more common on sandy soils and/or soils with a more acid subsoil.

Sulfur (S) is the most economical, though still expensive, way to lower soil pH. This is a biological process where certain soil bacteria convert the elemental S to sulfate sulfur (SO_4-S). During this process, acid is formed. The drawbacks of using elemental S are:

- The soil must have a viable population of the correct bacteria.
- It is a slow process requiring time, soil temperature, and soil moisture.
- It is expensive.

A Spectrum Analytic soil test will include proper S recommendations to lower the soil pH for the listed species. Surface applied S, like lime will not immediately affect the entire root zone. However, applied S may change the soil pH to a greater depth than lime. It is still wise to apply several smaller applications in order to avoid changing the soil pH too much.

Sulfur Effect on Soil pH (lb.-S/acre)

Original pH	Target pH	Soil CEC						
		1	5	10	15	20	25	30
6.0	5.0	110	220	335	450	550	650	885
6.5		274	548	943	1,337	1,644	1,951	2,701
7.0		374	747	1,257	1,766	2,168	2,569	3,547
7.5		469	937	1,547	2,157	2,642	3,127	4,309
8.0		845	1,689	2,024	2,357	2,641	2,924	3,849
6.0	5.5	109	218	272	327	382	436	576
6.5		218	436	545	654	763	872	1,151
7.0		327	654	818	981	1,145	1,308	1,726
7.5		436	872	1,090	1,308	1,526	1,744	2,301
8.0		763	1,526	1,799	2,071	2,344	2,616	3,414
8.5		1,090	2,180	2,507	2,834	3,161	3,488	4,526
7.0	6.0	189	377	472	566	685	804	1,051
7.5		343	686	870	1,054	1,213	1,372	1,825
8.0		682	1,363	1,575	1,786	2,047	2,308	2,980
8.5		1,045	2,090	2,379	2,667	2,956	3,244	4,199
7.0	6.5	50	100	125	150	225	300	375
7.5		250	500	650	800	900	1,000	1,349
8.0		600	1,200	1,350	1,500	1,750	2,000	2,545
8.5		1,000	2,000	2,250	2,500	2,750	3,000	3,871

Adapted from the Western Fertilizer Handbook 7th ed.: Nursery Management, 2nd ed. H. Davidson, et al., 1988; the Highbush Blueberry Production Guide (NRAES-55), Northeast Regional Agricultural Engineering Service, M. Pritts and J. Hancock ed., 1992.; and Vegetable Growing Handbook, W. E. Splittstoesser, 1979.

In situations where the drawbacks of using elemental S are a problem, other materials may be better. The following table lists some other options and conversion rates.

Material	Chemical Formula	Percent Sulfur	lbs of Material to Equal 100 lbs of Sulfur
Elemental Sulfur*	S	90.0	110
Sulfuric Acid	H_2SO_4	32.0	306
Sulfur Dioxide	SO_2	50.0	198
Iron Sulfate	$FeSO_4.7H_2O$	11.5	896
Aluminum Sulfate	$Al_2(SO_4)_3$	14.4	694
Ammonium Sulfate*	$(NH_4)2SO_4$	23.7	422

*Note: The acidifying effect of elemental sulfur is caused by sulfur oxidizing bacteria. These bacteria must be present in the soil, in sufficient amounts, in order to have the desired effect. If a soils pH is above 7.2 in its natural state, it may not have a large population of sulfur oxidizing bacteria. In these cases it may be helpful to inoculate it by adding some soil from another source that is naturally acid. Also, the pH change caused by the bacterial oxidation of sulfur may be relatively slow (12 months or more) since they are dependent on sufficient soil moisture and temperature to accomplish efficient sulfur oxidation. The other products listed produce a chemical acidifying effect, independent of soil organisms and may be faster and more dependable than elemental sulfur.

Caution: Some authorities recommend that no more than 300-350 lbs. of S (or its equivalent)/acre/year is applied to established stands. This is because some data on low CEC soils with acid sub-soils indicate that high rates of S can cause a temporary excessively low pH. In this research, the trees were severely damaged and many died. Not all authorities report this effect and in our personal experience with high pH clay soils (high CEC), higher rates of S in a single application can be made. If your soil has a low CEC (less than 10), and has an acid sub-soil you should limit annual applications to no more than the equivalent of 350 lb. S/acre. Monitor these situations with annual soil tests plus additional S applications as needed until the desired soil pH is reached.

Raising the Soil pH

Calcium carbonate recommendations assume that the lime will be thoroughly mixed in the top 7 inches of soil. This is not possible with established brambles, so ***the lime rate should be adjusted proportionately to reflect the volume of soil that the lime will be mixed with***. Surface applied lime will typically affect only the top 2 – 3 inches in the first 6 -12 months, and the rates should be adjusted proportionally (use only 28% to 42% of the recommended rate, respectively). On very sandy soil (lower CEC); surface applied lime will tend to affect soil to a deeper depth. Split applications of a lower rate of lime will eventually increase the soil pH of the entire root zone with less chance of over-liming the soil surface. Recommendations should also be adjusted to account for the particle size of the lime source. Finer particle sizes react quicker and require lower rates to change the soil pH in a given amount of time. Re-test the soil annually to monitor the change in soil pH.

Sample Lime Recommendations
(lbs/acre of 100% $CaCO_3$)

Original Soil pH	Target Soil pH	Soil Buffer pH (BpH)				
		5.0	5.5	6.0	6.5	7.0
4.5	5.5	16,827	12,981	9,136	5,290	1,444
4.5	6.0	20,227	15,602	10,987	6,353	1,728
4.5	6.5	22,891	17,656	12,420	7,185	1,950
5.0	6.0	16,795	12,949	9,104	5,258	1,412
5.0	6.5	20,195	15,570	10,946	6,321	1,696
5.5	6.0	-	9,205	6,470	3,735	999
5.5	6.5	-	12,940	9,095	5,249	1,403
6.0	6.5	-	-	6,468	3,732	997

Converting $CaCO_3$ Recommendations to Local "Ag Lime"

1. **Tillage Depth Adjustment Factors:** Multiply Spectrum Analytic recommendation for $CaCO_3$ by the factor listed across from appropriate plow depth.

Effective Tillage Depth in Inches	Multiplying Factor
0–3	0.40
6	0.86
7	1.00
8	1.14
9	1.29
10	1.43
11	1.57
12	1.71

2. **Lime Type/Purity Adjustment Factors:** Select most appropriate lime type or purity and multiply the results of step 1 by the factor listed across from appropriate type or purity.

Lime Type, Purity or Analysis	Multiplying Factor
90% to 110% CCE/TNP	1.00
80% to 89% CCE/TNP	1.17
70% to 79% CCE/TNP	1.33
60% to 69% CCE/TNP	1.54
50% to 59% CCE/TNP	1.81
100% pure $CaCO_3$ (40% Ca)	1.00
Dolomitic Lime	
• 50% $CaCO_3$ + 50% $MgCO_3$ (22% Ca + 15% Mg)	0.92
• 75% $CaCO_3$ + 5% $MgCO_3$ (31% Ca + 7% Mg)	0.96
Other Materials	
• Calcium oxide (burnt lime)	0.56
• Calcium hydroxide (hydrated lime)	0.74
• Granulated slag	1.00

Adjustments for Lime Grind Fineness: Select the multiplying factor across from the applicable screen size, and multiply the results of step 2 by that factor.

Per Cent Passing Through Screen		Multiplying Factor
100-Mesh	60-Mesh	
80-100%	95-100%	0.80
60-79%	70-94%	0.85
40-59%	50-69%	1.00
30-39%	50-69%	1.25
20-29%	30-39%	1.45
10-19%	20-29%	1.70
0-9%	0-19%	2.00

Nitrogen (N)

- **Summer Bearing Plants:** Apply 50%to 75% of the N in early spring and 25% to 50% 30 to 60 days later.
- **Fall Bearing Plants:** Apply 33% of the N in early spring, 33% 30 to 60 days later, and 33% in mid to late summer, prior to fruiting (do not apply N after Mid-August).

TOTAL ANNUAL N RECOMMENDATION							
		(Lbs/acre)					
Type	**Bramble Year**	**Non-Irrigated**			**Irrigated**		
		Sand	**Loam**	**Clay**	**Sand**	**Loam**	**Clay**
Primocane-Fruiting Brambles (Everbearing/Fall bearing) with no summer crop.	**1**	60	60	60	60	60	60
	2	70	65	50	90	80	75
	3+	100	90	80	120	100	90
Summer-Bearing Red Raspberries, and Thornless Blackberries	**1**	60	60	60	60	60	60
	2	75	70	65	80	75	70
	3+	85	75	70	100	90	80
Summer-bearing Black & Purple Raspberries, and Thorny Blackberries	**1**	60	60	60	60	60	60
	2	70	65	60	70	65	60
	3+	75	70	65	80	70	65
Note: 20.0 lb. N/acre equals 0.5 lb. N/100 ft. of row in typical plantings							

Phosphorus (P) and Potassium (K)

As mentioned earlier, each fertilizer application should be based on annual leaf analysis from the previous season plus the performance of the crop. Because of this, the initial P and K recommendations are intended primarily as the starting point for further refinement through leaf analysis results. Precise P_2O_5 and K_2O recommendations are based on the soil nutrient levels, CEC, and other factors. As such, they are too large for this paper. The following table is a general guide to this program.

Phosphorus and Potassium Recommendations		
Soil Test Status	**P_2O_5 (lb./acre)**	**K_2O (lb./acre)**
Low	150	190
Medium	120	150
Good	90	120
High	30	30

Secondary and Micronutrients

Some information has suggested that the responsiveness of raspberries to secondary and micronutrients can be categorized as seen in the table below. However, it should be remembered that all of these nutrients are essential, and their availability to all plants is determined by many factors other than simple response tables. It is very possible for a particular soil to have a critical need for a low response nutrient, and have no need of a high response nutrient. Use soil tests and leaf analysis to identify the need for these nutrients.

BRAMBLE RESPONSE TO SECONDARY AND MICRONUTRIENTS							
Calcium	**Magnesium**	**Sulfur**	**Boron**	**Copper**	**Iron**	**Manganese**	**Zinc**
Medium	Medium	Low	Medium	Medium	High	High	Low

Calcium (Ca)

Calcium is rarely deficient in either soils or in plant tissue. When Ca uptake is a problem, it is typically associated with very acid soils, or sand. Where the soil is acid, the recommended amount of lime will normally provide adequate Ca to the crop. In situations where additional Ca is recommended by a soil test, using gypsum (calcium sulfate), and fertilizer sources of Ca should be applied. Foliar Ca products are available where small, quick corrections are needed.

Magnesium (Mg)

Magnesium is somewhat like Ca, in that it is not often deficient, and where deficiencies occur, they are often associated with acid soils. Where acid soils are causing an Mg uptake problem, it is advisable to apply the recommended amount of a dolomitic lime. Where the soil does not need lime, anywhere from 10 to 60 lb. Mg/acre may be applied to the soil, depending on the severity of need. Foliar Mg can be applied at 1.0 lb. Mg/acre in 100 gal. of water, using Epsom salts (Magnesium sulfate).

Sulfur (S)

There is very little information in the literature about the need for sulfur by brambles. However, S is still an essential element, and where needed, a soil application of from 20 to 50 lb. S/acre should correct any problem. Keep in mind that S will leach slowly in the soil, so it may need to be applied annually on very sandy soils.

Boron (B)

Where B is lacking, a soil application of 1.0 to 1.5 lb. B/acre should correct any problems in that season. Boron is highly mobile in the soil. And is present in very small amounts, so a field with low B will likely need annual applications of this nutrient. Foliar B applications are typically in the range of 0.1 to 0.15 lb. B/acre, or about 10% of the soil application.

Copper (Cu)

Where Cu is lacking, soil applications of from 5.0 to 10 lb. Cu/acre should correct any problem. Producers must understand that Cu will accumulate in the soil from repeated applications, so at some point the soil test Cu level should increase to a sufficient level. It is possible to increase the soil Cu to excess and damaging levels from indiscriminate applications.

Manganese (Mn)

Manganese is rarely deficient in brambles. However, where the soil pH is about 7.0 or higher, Mn deficiency is likely. Broadcast soil applications of Mn are normally not very effective or efficient because the soil has a large capacity to “fix”, or tie-up Mn. The most efficient method of soil application is in a narrow band beneath the soil surface, and within about 3 inches of the root feeding zone. By this method of application, the required rates of the nutrient are from 4.0 to 8.0 lb. Mn/acre, depending on soil Mn level and pH. If this soil application method is not feasible, then multiple foliar applications per season will be required. Typical effective rates range from 1.0 to 2.0 lb. Mn/acre.

Zinc (Zn)

Brambles are not considered to be especially responsive to Zn. However, it is becoming more common to find soils with inadequate levels of Zn. Zinc can be supplied to the crop efficiently by soil applications, either broadcast or banded. Suggested broadcast rates range from 5.0 to 20 lb. Zn/acre, with the most efficient annual rates being from 5.0 to 10 lb. Zn/acre. Where banding is possible, rates of from 1.0 to 3.0 lb. Zn/acre are normally effective. It is possible to build-up the soil test level of Zn. This is not always possible or practical with many micronutrients, but single applications of 15 lb./acre or somewhat more, have been found to correct Zn shortages for many years after a single, large application. Foliar applications are also an option at rates of 0.5 lb. Zn/acre in at least 20 gal./acre. At 100 gal./acre of spray, an alternative rate is 8.34 lb. of 36% Zinc sulfate (36% Zn) for an elemental rate of 30 lb. Zn/acre, which equals a 0.36% Zn concentration in that solution.

Iron (Fe)

Brambles are a high response crop for Fe, however most soils already contain substantial amounts of available Fe. Therefore, the producer should not expect to see a frequent need for Fe. However, when Fe is needed, the response should be significant. It is not normally efficient or very effective to apply Fe fertilizer to the soil. Like Mn, Fe is easily and strongly fixed by the soil. Foliar application is the preferred method of fertilization. Typically effective foliar rates of Fe are about 1.0 lb. Fe/acre from iron sulfate solutions, or various brands of chelated Fe products at their label rate.