

Lime and Fertilizer Recommendations for Reclamation of Surface-Mined Spoils

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Basis of Recommendations

Recommendations contained in this publication are based on spoil tests values from testing methods used in the Central laboratories operated under supervision of the Kentucky Agricultural Experiment Station. Spoil test values obtained by other methods should not be used when making recommendations using this publication.

Recommended fertilizer rates have been made on rather limited data and they are to be considered as the best available and may be revised without notice. These fertilizer rates are based on assumed "average" climatic conditions and for "average" spoils. Rates should be adjusted upward or downward to reflect deviations from these "average" conditions. These recommendations were designed for two management or reclamation objectives: (1) establishment of grass-legume cover for erosion control only; (2) establishment of grass-legume cover for erosion control *and* hay-pasture production.

The recommended fertilizer rates are for the annual needs by the hay-pasture crop and will not bring about a rapid increase in test values for phosphorus (P) and potash (K). By using these rates, it may likely take 4 years or more of annual fertilization to significantly increase test levels of either P or K. All fertilizer and lime recommendations are made on the assumption that *representative spoil samples* were properly taken. If spoil sampling procedures are questionable, estimated needs of lime and fertilizer are much less accurate.

Soil Buffer Test for Lime Requirements

The Central Testing Laboratories of the University of Kentucky Division of Regulatory Services at Lexington make a buffer pH test on all samples having a water pH below 6.0. The buffer test is reported in terms of *buffer pH*. *This buffer pH is not the same as the water pH reading.*

For determining how much lime is required to raise the pH of the spoils to 5.5 and 6.4 refer to Table 1. *Table 1 is used only for buffer pH readings.* These lime rates assume that a high quality agricultural limestone meeting fineness standards of the Department of Agriculture will be used and that soil acidity arising from additional oxidation of sulfides will be negligible. Adjustments should be made to increase lime rates if lime with a low neutralizing ability or of coarser grind is used. If hydrated lime is applied, use 3/4 of the rate determined from Table 1. If the area being reclaimed is known to be high in sulfides, a sulfide test should be obtained and the amount of lime increased accordingly. The

length of time that the spoils have been exposed prior to sampling will determine the amount of sulfides that have undergone oxidation. Additional research is being conducted by the Agronomy Department to evaluate the relationship between lime rates and unoxidized sulfides and the rate of oxidation.

All lime should be incorporated into the spoils to a depth of at least 6 inches before revegetation. Applications of lime on the surface are not as effective but may be used in topdressing of reclaimed spoils in which a relatively good overall cover is present. However, if there are small (1/2 acre or larger) acidic areas in otherwise good spoils that have adequate cover, then, when these small areas are to be reseeded, the added lime should be incorporated and not just top-dressed.

Lime Requirement

The buffer pH method for determining the lime requirement will be used when pH readings are less than 6.0. For lime rates refer to Table 1. If the objective is only to establish cover for prevention of erosion until trees are established, enough lime should be applied to lime spoils to raise the pH to at least 5.5, as required by the Division of Reclamation. If the objective is for hay-pasture production, as well as erosion control, lime the spoils to a pH of at least 6.4.

Lime Requirement for Highly Acidic Spoils

When lime rates of 25 tons/acre or more are indicated, the spoils may require special treatment during reclamation since they are usually difficult to revegetate. Normally such spoils should not be used for hay and pasture production. Total sulfide analysis should be obtained for these highly acid spoils. Check with your County Extension Agent for assistance in obtaining these analyses. If total sulfide analysis cannot be obtained, a higher risk in obtaining successful permanent vegetation exists. These spoils may require additional lime before adequate cover can be obtained. An alternate plan may be desirable, such as adding at least 25 tons of lime per acre, incorporating it and retesting the spoils by obtaining new samples in 4 to 6 months. A cover crop should be seeded during this period to reduce erosion, and this may serve as a mulch to further aid in establishing permanent vegetation. Resample the area and retest to determine lime and fertilizer requirements. Be sure to incorporate any needed lime based on the new test before seeding. However, if this alternate plan is not used and sulfide tests are not available, apply 1.5 times the lime rate given in Table 1.

Table 1. Limestone rates for spoil-buffer pH readings.*

Buffer pH Readings	Agricultural limestone (Tons/Acre) required to adjust spoil pH to:	
	5.5	6.4
6.7 - 6.3	1 - 2	2 - 4
6.3 - 5.9	2 - 4	4 - 6
5.9 - 5.3	4 - 6	6 - 8
5.3 - 5.0	6 - 8	8 - 11
5.0 - 4.5	8 - 11	11 - 15
4.5 - 4.0	11 - 15	15 - 25
below 4.0	15 - 25**	>25**

* If water pH reading is 6.0-6.4, use 2-4 T/A when hay or pasture production is planned.

**When lime rates are 25 or more Tons/Acre, refer to section on Lime Requirements for Highly Acidic Spoils.

When to Apply Lime

For best results in establishing new seedlings, lime should be applied and incorporated at least 2 to 4 weeks before seeding. However, for moderately acid spoils, where up to 8 tons lime per acre are required, immediate seeding following lime incorporation may be more desirable from a moisture viewpoint and time of year (seeding date). Under these circumstances, however, increase lime rate 0.5 to 1 ton per acre to compensate for the reduced reaction time.

When large lime rates (10-25 tons/Acre) are required, a longer period should be allowed. For lime rates exceeding 25 T/A, refer to section *Lime Requirement for Highly Acidic Spoils*. Topdressing of lime in amounts indicated in Table 1 to bring pH to 6.4 is recommended for hay and pasture production in which legumes comprise greater than 25% of the stand. The reason for raising and maintaining pH above 6.4 is to encourage long-term, top production of legumes. A lime rate corresponding to the pH 5.5 value may be used for hay and pasture production where legumes are less than 25% of the stand.

Because of the potential release of acids from the oxidation of sulfide minerals in the spoils, lime requirement tests should be made annually for the first few years of production.

Fertilizer Recommendations

Recommendations for two reclamation objectives are found in the tables to follow. These management conditions are: (1) establishment of vegetative cover for erosion control only; and (2) establishment of grass-legume stands for erosion control and hay-pasture production.

Elemental and Oxide Values for P and K

Soil test values for phosphorus and potassium are reported as pounds of elemental P and K per acre. Fertilizer recommendations are made on the oxide basis-lbs phosphate (P₂O₅) or potash (K₂O) per acre.

The following factors are for use in converting elemental and oxide values:

To convert from:	To:	Multiply by:
P ₂ O ₅	P	0.44
P	P ₂ O ₅	2.29
To convert from:	To:	Multiply by:
K ₂ O	K	0.83
K	K ₂ O	1.20

Fertilizer Recommendations without Samples Being Tested

If fertilizer recommendations must be made without spoil samples being tested, assume low or very low levels of P and K. Apply the minimum fertilizer rates listed in the current *Manual on Kentucky Reclamation* published by Kentucky Department of Natural Resources and Environmental Protection, Frankfort, KY (Division of Reclamation). Fertilizer rates listed for low test results for P & K are the minimum levels required at the time of preparation of this report, December 1974.

Table 2. Requirement for new seedlings.

Test level (lbs/A)	lbs P ₂ O ₅ and K ₂ O to apply per acre			
	Surface cover ¹		Hay and pasture ²	
	P ₂ O ₅	K ₂ O	P ₂ O ₅	K ₂ O
very low (below 10 P; 50 K)	120-140	30-60	150-200	60-90
low (10-30 P; 50-125 K)	100-120	0-30	100-150	30-60
medium (31-60 P; 126-200 K)	50-100	0	50-100	0-30
high (above 60 P; 200 K)	0-50	0	0-50	0

¹ If soil tests are very low, retesting is recommended prior to planting trees since additional P₂O₅ may be needed to maintain surface cover.

² For alfalfa production, increases rates 20-40 lbs P₂O₅/A and 20-40 lbs of K₂O/A.

Fertilizer Recommendations When Test Values for Phosphorus are Medium or High

The Division of Reclamation has certain minimum fertilizer recommendations for all spoils regardless of the natural fertility level of the spoil material. Recommendations based on fertility tests of spoils take into account these levels of fertility and hence, in cases in which medium or high test levels are obtained, the recommendations based on Table 2 are different from the legal requirements. The operator must obtain permission from the Division of Reclamation to use these lower fertilizer rates.

Fertilizer Recommendations for New Seedlings

NITROGEN

For fail seeding, apply 60 lbs of nitrogen (N) per acre. An additional 30 lbs N/A should be top-dressed the following spring if the area is being seeded for hay-pasture production. However, if a cover crop has been used, the spring topdressing should be delayed until after the cover crop has matured so that competition by the cover crop for this added nitrogen is reduced. For spring seeding, apply 60 lbs N/A at seeding and an additional 30 lbs N/A in the fall if the area is for hay-pasture production. It is recommended

that, for seedlings in which the objective is only surface cover, an additional 30 lbs N/A be applied during the spring of the second growing season. For hay-pasture production, see Table 3 for recommendations for annual topdressing of P and K after the establishment year.

PHOSPHORUS and POTASH

Use Table 2 to determine fertilizer recommendations. If medium or high test levels of either P or K are obtained, recall that the operator must obtain permission to use fertilizer rates lower than the minimum levels required by the Division of Reclamation.

BORON

For spoils with a stable pH above 6.4 that are to be seeded to alfalfa for hay and pasture production, boron may become limiting. Apply boron amounts recommended in Extension publication AGR 1, "Lime and Fertilizer Recommendations," or check with your county agent.

Annual Topdressing of P and K on Reclaimed Spoils for Hay and Pasture Production

Top production for hay and pasture can best be obtained if test levels of phosphorus and potash are in the medium-high to high range and maintained at these levels. The reason for raising and maintaining pH above 6.4 is to encourage long-term top production of legumes.

For lime requirements refer to Table 1 and section *When to Apply Lime*.

NITROGEN:

A split application of nitrogen is recommended. Top-dress with 30-75 lbs N/Acre between February 15 and May 1 and an additional 30-50 lbs N/Acre between August -1 and September 30. The above nitrogen rates are recommended for hay-pasture production in which legumes make up less than 50% of the stand. For stands dominated with legumes, apply N (at the lower end of the recommended range) for at least the first 2 years of production. Native nitrogen levels in spoils are essentially zero and will remain very low until a sod-is developed. Nitrogen rates *may* be increased 25-50 lbs N/Acre on the best spoils (silty or decomposed shales) which have slopes of less than 6% *when* increased production is needed and when the forage is predominately grasses.

For good stands of Bermuda grass on spoils with pH above 5.5, the high end of the range of nitrogen rates given above for grasses should be used if production is needed. Nitrogen should be applied at the low end of this range for the first two years even if harvest of forage is not made in order to develop a good sod. For production, split application of nitrogen is recommended, and should be made about May 1 and Aug. 15. If additional production is needed, an additional application could be made about June 15 following a graze down or clipping.

PHOSPHORUS and POTASH

See Table 3 for phosphorus and potash recommendations.

BORON

For spoils with a *stable* pH above 6.4 and which are in alfalfa-grass mixture, apply elemental Boron if deficiency symptoms are present at rates recommended in Extension publication AGR 1, "Lime and Fertilizer Recommendations."

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Table 3. Fertilizer requirements for hay and pasture maintenance.

Test level (lbs/A)	lbs P ₂ O ₅ and K ₂ O to apply per acre			
	legume or le-gume grass		grass	
	P ₂ O ₅	K ₂ O	P ₂ O ₅	K ₂ O
very low (below 10 P; 50 K)	150	60-90	120	60
low (10-30 P; 50-125 K)	75-15	30-60	60-120	30-60
medium (31-60 P; 125-200 K)	0-75	0-30	0-60	0-30
high (above 60 P; 200 K)	0	0	0	0

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