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Fertilizer Grades and Ratios For Minnesota

Recommended Rates of Application

C. O. ROST, PAUL M. BURSON,
E. R. DUNCAN, and H. E. JONES

Commercial fertilizers have an important place in any soil fertility and conservation program in Minnesota. They will not take the place of liming, good crop rotations, farm and green manures, or erosion control, but they should be used in addition to these basic soil management practices.

It must be understood that there is no best fertilizer for any crop on all soils, nor is there any best fertilizer for all crops on certain soils. Soils that need fertilizers most are, of course, those that were originally low in fertility or those that have been heavily cropped or poorly managed.

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FERTILIZER experiments and demonstrations in Minnesota show a definite need for commercial fertilizer.The kind and amount depend upon the state of fertility of the soil and the crops to be grown. It is not a case of, should fertilizer be used?—but instead—what kind and how much? *When in doubt about the fertilizer to use, have the soil tested.* If the soil is acid, as it may be in the eastern one-third of Minnesota, and clover or alfalfa are to be sown, lime should always be applied. Fertilizer alone will not produce its full benefit when lime is needed. Fertilizers properly used will increase yields, improve the quality of crops, hasten maturity, and improve the feeding value of the crops for livestock.

PLANT FOODS SUPPLIED IN FERTILIZERS

The three plant foods normally supplied in commercial fertilizers are nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O). Lack of **nitrogen** is shown by a stunted growth of plants with leaves that are yellowish instead of dark green. Nitrogen is found naturally in the organic matter in the soil. To a major degree nitrogen can be produced on the farm by using good crop rotations, which provide for the regular use of inoculated legumes other than soybeans that take nitrogen from the air, and by better handling of farm manure. Minerals such as phosphate and potash cannot be produced on the farm and must be supplied from an outside source.

Phosphorous is the fertilizer element usually most lacking in Minnesota soils. Its importance in general farming is indicated by the fact that low crop production more often results from the lack of phosphorus than from any other element. Phosphorus can be supplied to animals through mineral feeds. In the long run, however, the solution to the problem rests with the application of phosphate fertilizer to the soil, either alone or in combination with nitrogen and potash, depending on the soil requirements.

Potassium is usually found in soils in much larger quantities than phosphorus, but recent experiments have shown that crop yields may be further increased on some soils if potash is included in the fertilizer.

FERTILIZER GRADES

Fertilizer materials are mixed or combined to give varying percentages of nitrogen (N), phosphoric acid (P_2O_5), and potash (K_2O). For example, fertilizer materials may be combined to give a fertilizer which contains 3 per cent of nitrogen, 18 per cent of phos-

phoric acid, and 9 per cent of potash. This is expressed as 3-18-9, and constitutes a *fertilizer grade.* In a fertilizer formula the first figure always stands for the per cent of water-soluble nitrogen, the second for the per cent of available phosphate, and the third for the per cent of water-soluble potash. If one or more of the constituents are not included in the fertilizer, their place in the formula is shown by a zero. Thus 0-20-10 contains no nitrogen, 20 per cent phosphate, and 10 per cent potash. Twenty per cent superphosphate is represented by the formula 0-20-0, and ammonium nitrate by 32-0-0 since it contains 32 per cent nitrogen and no phosphate or potash.

Since the figures in the fertilizer formula represent per cent, they express the number of pounds of available plant food in each hundred pounds of fertilizer. By adding the three figures together you obtain the total number of pounds of plant food contained in each hundred pounds, and this figure multiplied by 20 gives the pounds of plant food in one ton of fertilizer. The 3-18-9 fertilizer contains 30 pounds of plant food per hundred pounds, or 600 pounds per ton.

In 1949 the State Legislature passed a fertilizer law which limits the sale and distribution of fertilizer. The law provides that no superphosphate containing less than 18 per cent available phosphoric acid nor any mixed fertilizer in which the sum of the guarantees for nitrogen, available phosphoric acid, and soluble potash totals less than 27 per cent shall be offered for sale, sold, or distributed in this state except for complete fertilizers containing one-fourth or more of nitrogen in water-soluble form of plant and animal origin, in which case the total nitrogen, available phosphoric acid, and soluble potash need not total more than 24 per cent.

The advantages of using high-analysis fertilizers include less material to handle, lower freight costs, lower cost per pound of plant food, and less frequent filling of hoppers on the machines that apply the fertilizers.

FERTILIZER RATIOS

The fertilizer ratio is the relationship existing between the percentages of nitrogen, phosphoric acid, and potash. It is obtained by dividing the figures in the formula by the smallest figure. For example, the ratio for 3-18-9 is 1-6-3, the result of dividing the figures by 3, the smallest figure in the formula. A 4-24-12 also has a 1-6-3 ratio and in this case is obtained by dividing by 4, which is the smallest figure. Thus a number of fertilizer grades have the same ratio and the only difference between them is the number of pounds of plant food they contain. In the list of recommended grades given below, the fer-

tilizer ratios are shown along with the "minimum grade" of each ratio.

Fertilizer manufacturers are interested in increasing the amounts of plant foods in fertilizers and new high-analysis grades will appear from time to time.

RECOMMENDED FERTILIZER RATIOS AND GRADES FOR MINNESOTA

The following fertilizer grades and ratios constitute the recommended grades for Minnesota:

Fertilizer ratio	Minimum grade	Higher grades
1-0-0*	16-0-0	32-0-0
0-1-0	0-20-0	0-46-0†
0-0-1	0-0-50	0-0-60
0-1-1	0-14-14	0-20-20
0-1-2	0-10-20	0-12-24
0-1-3	0-9-27	0-12-36
0-2-1	0-20-10	0-30-15
1-1-1	10-10-10	.....
1-2-2	7-14-14	8-16-16
1-2-0	10-20-0	.....
1-3-0	8-25-0	.....
1-3-2	5-15-10	.....
1-3-6	3-9-18	4-12-24
1-4-0	6-24-0	11-48-0
1-4-2	4-16-8	5-20-10, 6-24-12
1-4-4	3-12-12	5-20-20
1-6-3	3-18-9	4-24-12

* The 1-0-0, 0-1-0, and 0-0-1 ratios represent fertilizers containing only nitrogen, only phosphate, and only potash, respectively.

† Includes all grades of triple superphosphate fertilizer ranging from 43 per cent to 48 per cent P_2O_5.

RECOMMENDED RATES OF APPLICATION FOR DIFFERENT CROPS

The most effective use of commercial fertilizer in a good soil management program is to fertilize the crop rotation by applying the fertilizer when the legume or legume-grass mixture is seeded with the small grain or flax crop. Increases in the yield of the grain or flax crops the first year may often pay the entire cost of the fertilizer. However, the greatest benefit from the fertilizer can come the second year and later in better yields and quality of the hay and pasture crop, and in turn, build up soil organic matter resulting in better yields of crops to follow. The fertilization in the hill or row of crops such as corn, potatoes, etc., should be considered as supplemental to this basic treatment of fertilization of the rotation.

1. Corn

(Fertilizer in hill or along row)

Fertilizers with nitrogen	
Grade	Pounds per acre
3-18-9	125
3-12-12	175
4-24-12	100
6-24-12	100
4-16-16	125
5-20-20	100
6-12-12	150
8-16-16	125
11-48-0	50
Fertilizers without nitrogen	
0-20-20	100
0-20-10	100
0-46-0	50
0-20-0	100

Fields low in organic matter and which have not grown legumes or received manure during the last two years. Select a fertilizer containing 4 per cent or more of nitrogen.

Sandy soils which were not in legumes the preceding year or will not be manured for the next crop. Select fertilizers containing 4 per cent or more of nitrogen.

Fields of medium fertility which have grown legumes within the past two years and/or which have received adequate applications of manure. Use fertilizers containing approximately 4 per cent of nitrogen.

Fields with high organic matter content and known to be high in fertility. Apply fertilizers with low amounts of nitrogen or those containing only phosphate or only phosphate and potash.

It is a general practice among farmers to apply fertilizers for corn in the hill or along the row. This method of application should be supplemental to fertilization of the rotation. Adequate minerals for the rotation should be applied with the companion crop seeded to legumes (see small grains and flax). *In case the fertilizers are broadcast the rates given above should be at least doubled.*

2. Small Grains

(Fertilizer broadcast)

Fertilizers with nitrogen	
Grade	Pounds per acre
3-18-9	300
3-12-12	400
4-16-16	300
5-20-20	250
4-24-12	200
6-24-12	200
6-12-12	300
8-16-16	250
10-10-10	200
11-48-0	100
16-20-0	125
Fertilizers without nitrogen	
0-20-10	250
0-20-20	250
0-20-0	250
0-46-0	125
0-30-15	200

The rates recommended above are for small grains seeded alone or with legume or legume-grass mix-

tures as in the fertilization of the rotation. Small grains have not shown any consistent responses to potash in the fertilizer mixtures in Minnesota. The western third of the state shows less response than the other areas. Therefore, straight phosphate, nitrogen, or nitrogen-phosphate are most generally recommended, except when legumes such as alfalfa or other legume mixtures are seeded, potash may be included in the fertilizer mixture.

Sandy soils and soils of low fertility which have a relatively low organic matter content. Use fertilizers containing 8 per cent or more of nitrogen. Such fertilizers should be applied broadcast and worked into the soil at the time of seeding. This amount of nitrogen in the fertilizer *cannot* be safely applied with a combination fertilizer-grain drill in which the fertilizer comes in direct contact with the seed. If fertilizer spouts are removed from the shoe, fertilizer may be applied with the drill.

Soils fairly well supplied with organic matter and of fair to good fertility. Apply a fertilizer grade containing from 3 to 4 per cent of nitrogen.

Soils well supplied with organic matter and of relatively high fertility. Use a fertilizer containing no nitrogen but use phosphate or both phosphate and potash

Use of nitrogen fertilizers. Small grain yields may be improved by the addition of nitrogen fertilizers, such as sulfate of ammonia or ammonium nitrate. Such treatments may be made as broadcast applications immediately before or immediately after seeding. The application of nitrogen fertilizers will usually be more beneficial on fields of medium to low fertility. In any case, the rate of application should ordinarily not exceed 20 pounds of total available nitrogen per acre if legumes or legume-grass mixtures are being seeded. Otherwise the rate may be increased to as much as 40 pounds of available nitrogen per acre.

3. Flax

(Fertilizer broadcast)

Fertilizers with nitrogen

Grade	Pounds per acre
3-18-9	350
3-12-12	500
4-24-12	250
6-24-12	250
6-12-12	300
5-20-20	300
8-16-16	250
6-30-0	200
8-24-0	250
9-36-0	200
10-20-0	200
11-48-0	125
16-20-0	125

Fertilizers without nitrogen

0-20-20	300
0-30-15	200
0-20-10	300
0-20-0	300
0-46-0	125

Recommendations for high-lime or so-called "alkali soils" are given on page 11.

Recent experiments have shown that flax responds to applications of nitrogen as well as to phosphate or phosphate and potash. However, as nitrogen stimulates weed growth, care must be exercised. On fields known to be weedy no nitrogen or only a relatively small amount should be applied.

The rates recommended above are for flax seeded alone or with a legume or legume-grass mixtures.

Soils two or more years away from legumes and manure and fairly free of weeds. Use fertilizer grades containing nitrogen which will supply up to 20 pounds of nitrogen and 40 pounds of phosphate in the western third of the state and a fertilizer containing the same amounts of nitrogen and phosphate as above with some potash in the eastern two thirds.

Soils like the preceding group but weedy. Use fertilizer grades supplying 10 pounds or less of nitrogen per acre. For amounts of phosphate and potash follow the recommendations in the preceding paragraph.

Soils which have grown a legume or received manure during the past two years. Use recommended fertilizer grades containing no nitrogen.

4. Legume Hays

(Fertilizer broadcast)

Grade	Pounds per acre		
0-46-0	100	0-20-10	250
0-20-0	250	0-14-14	400
0-20-20	250	0-30-15	250

Legume hays are best fertilized by applying the fertilizer at the time of seeding. This will improve the stand as well as the yield. However, top-dressing established stands of legume hays with phosphate or phosphate-potash mixtures in late summer or early spring will increase the yields and is recommended.

5. Pastures and Meadows

(Fertilizer broadcast)

Fertilizers with nitrogen			
Grade	Pounds per acre		
Sulphate of ammonia (20-0-0)	150	5-20-10	300
Nitrate of soda (16-0-0)	250	5-20-20	300
Cyanamid (21-0-0)	150	**Fertilizers without nitrogen**	
Ammonium Nitrate (32-0-0)	100	0-20-0	300
11-48-0	150	0-46-0	150
16-20-0	150	0-20-10	300
10-20-0	200	0-30-15	200
8-16-16	250	0-14-14	500
		0-20-20	300

Permanent pasture and meadow soils need fertilizer to produce a good stand and yield of legumes and grasses.

Pastures to be renovated. Apply the phosphate or phosphate-potash fertilizers when renovation is being done so that the fertilizers can be thoroughly worked into the soil. Renovation should be done either *early in the fall, very late in the fall, or very early in the spring* with all the seedings being made very early in the spring. It is best to apply the fertilizer, especially those containing nitrogen, as near the time of seeding as possible or at the time the seedbed is finally prepared, just ahead of seeding. Nitrogen fertilizers can be top-dressed without renovation if the application is made in early fall or in very early spring.

Stony soil that cannot be renovated. The most effective treatment is a nitrogen fertilizer. If the sod contains considerable legumes top dress with phosphate or phosphate-potash in addition to the nitrogen.

6. Potatoes

(Fertilizer drilled beside row)

Grade	Pounds per acre
Fertilizers with nitrogen	
3-9-18	350
4-12-24	250
3-12-12	400
8-16-12	250
4-16-16	300
4-24-12	200
6-24-12	200
5-20-20	250
6-12-18	350
Fertilizers without nitrogen	
0-14-14	400
0-20-20	250
0-20-10	250
0-30-15	175
0-20-0	250
0-46-0	125

Since potatoes require relatively large amounts of minerals, the percentage of phosphate and potash in potato fertilizers should be substantial. Need for nitrogen will vary with conditions.

In the Red River Valley. On heavy soils use superphosphate (0-20-0 or 0-46-0) or phosphate-potash (0-20-10). On dark-colored sandy soils use a phosphate-potash fertilizer (0-14-14 or 0-20-20).

Sandy and light-colored soils which have grown legumes and/or received manure within one year. Select fertilizers with medium amounts of nitrogen (3-9-18, 4-16-16) or others of similar ratio.

Sandy soils which have not grown legumes or received manure, and soils known to have a low level of fertility. Use high nitrogen, high potash fertilizers (4-12-24, 8-16-16) or others of similar ratio.

Soils which have grown legumes within two years and/or have received applications of manure. Use fertilizers with low percentage of nitrogen or with none (4-24-12, 3-12-12, 0-20-20, 0-20-0).

7. Sugar Beets

(Fertilizer drilled beside row)

Fertilizers with nitrogen		Fertilizers without nitrogen	
Grade	Pounds per acre	Grade	Pounds per acre
3-12-12	350	0-14-14	350
4-16-16	250	0-20-20	200
5-20-20	200	0-20-10	200
4-24-12	175	0-30-15	125
6-24-12	175	0-46-0	100
		0-20-0	200

Sugar beets, like potatoes, require ample supplies of phosphate and potash for their best growth.

Red River Valley. Use fertilizers containing phosphate or phosphate and potash.

Soils with medium amounts of organic matter but which have grown legumes or received manure. Fertilizers with low to medium amounts of nitrogen or those containing only phosphate and potash.

8. Market Garden and Canning Crops

(Hill or row application. Increase rate 1½ times if fertilizer is broadcast)

Fertilizers with nitrogen			
Grade	Pounds per acre	6-12-18	250
3-12-12	300	8-16-16	200
3-18-9	300	**Fertilizers without nitrogen**	
3-9-18	300	0-14-14	350
4-12-24	300	0-20-10	300
4-24-12	250	0-20-20	300
6-24-12	250	0-30-15	250
4-16-16	250	0-20-0	300
5-20-20	300	0-46-0	150

Market garden and canning crops require relatively high levels of fertility if maximum yields are to be obtained. Since the cash acre-return is higher than obtained from ordinary farm crops, higher fertilizer costs are justified.

Very sandy soils and light-colored soils regardless of productivity. For nonlegumes use high nitrogen fertilizers and for legumes such as beans and peas use low nitrogen fertilizers or those containing only phosphate and potash.

Soils of relatively high fertility level but on which legumes have not been grown and for which manure is not available. For nonlegumes use fertilizers containing moderate to high amounts of nitrogen. For legumes use fertilizers containing phosphate and potash.

Soils high in organic matter and with medium to high fertility. Select fertilizers with medium amounts of nitrogen or, in the case of leguminous crops such as inoculated beans and peas, those containing no nitrogen.

9. Small Fruits

(Fertilizer broadcast)

Fertilizers with nitrogen		Fertilizers without nitrogen	
Grade	Pounds per acre	Grade	Pounds per acre
3-18-9	400	0-30-15	350
8-16-16	300	0-20-10	500
4-16-16	400	0-20-20	500
5-20-20	325	0-14-14	700
20-0-0	200	0-20-0	500
32-0-0	150	0-46-0	250

10. Tree Fruits

Apples

Ammonium sulfate
Cyanamid
Nitrate of soda
Ammonium nitrate*

- Orchards 2 to 6 years of age, 2 pounds per tree
- Orchards 7 to 15 years of age, 5 pounds per tree
- Orchards 16 years or over, 10 pounds per tree

Stone fruits

Ammonium sulfate
Cyanamid
Nitrate of soda
Ammonium nitrate*

- Orchards 2 to 6 years of age, 1½ pounds per tree
- Orchards 7 years and over, 4 pounds per tree

Broadcast applications for apples and stone fruits

4-12-8	500 pounds per acre broadcast
3-18-9	500 pounds per acre broadcast
4-16-16	500 pounds per acre broadcast
5-20-20	400 pounds per acre broadcast
10-10-10	300 pounds per acre broadcast

* Use ⅝ as much ammonium nitrate as ammonium sulfate or cyanamid.

11. Crops Grown on Peat Soils

(Fertilizer broadcast. Reduce rates by one half if fertilizer is applied in or along the row)

Crop	Grade	Pounds per acre
Corn for grain	0-20-20	300
Corn for ensilage Hay Small grains Small fruits	0-10-20	350
	or	
	0-12-24	300
Pasture	0-10-20	250
	or	
	0-12-24	200
Potatoes	0-9-27	400
	or	
	0-12-36	300
Onions, carrots, rutabagas, and truck crops	3-9-18	1,000
	3-12-12	1,000
	5-20-20	750
	0-9-27	800
	0-12-36	600

Peat soils are composed largely of undecayed plant residues and are very low in phosphate and potash. In most cases they are relatively unproductive without fertilization.

12. High Lime (Alkali) Soils

(Fertilizer broadcast. Reduce rates by one half if fertilizer is applied in the hill or along the row)

Fertilizers with nitrogen*

Grade	Pounds per acre
3-9-18	300
4-12-24	225
6-12-18	300
3-12-12	400
4-16-16	300
5-20-20	250
8-16-16	250

Fertilizers without nitrogen†

0-20-20	250
0-14-14	400
0-12-24	200
0-10-20	250
0-12-36	150

* Fertilizers suitable for applications on the entire field where spots occur.

† Fertilizers suitable for direct application to the individual spots.

The high lime or so-called "alkali soils" consist of light-gray rims along the sides of slight depressions. These soils occur in southern, southwestern, and west central Minnesota. They are characterized by the occurrence of free lime at or near the surface. It is this material that gives the gray color in the soil.

Experiments have shown that these areas are deficient in both phosphate and potash. The deficiency of potash is especially prominent and critical. Because of their light-gray color the spots are usually very evident a few days after plowing. An effective way to increase the productivity of these spots is to broadcast a phosphate-potash mixture relatively high in potash before the seedbed is prepared. Following this, the soil should be given the same fertilizer treatment as used on the entire field. After treatment these soils should give as good yields as the remainder of the field. *No agricultural lime should ever be applied on these soils.*

13. Home Gardens

(Fertilizer broadcast)

Manure or compost	4 bushels per 100 square feet (10 feet x 10 feet)
4-12-4 4-16-16 5-10-5 5-20-20 8-16-16	3 pounds per 100 square feet

Manure is one of the best garden fertilizers. In addition to furnishing the best source of organic material, manure is an excellent source of nitrogen and potash but is low in phosphate. Compost may be used the same as manure. The nutrient balance of the manure and compost can be improved by a supplementary application of commercial fertilizers.

Commercial fertilizers should be used on gardens when manure or compost is not available and to reinforce light applications of manure or compost. A number of specialty fertilizers manufactured especially for gardens are now on the market. When using commercial fertilizer on the home garden, spread it on top of the plowed or spaded soil before planting and work it to a depth of 1 or 2 inches with a hoe, rake, or other suitable garden tool. Manure or compost should be plowed or spaded into the soil.

14. Lawns

(Fertilizer broadcast)

Ammonium sulfate	½-¾ pound per 100 square feet
Ammonium nitrate	⅓-½ pound per 100 square feet
4-12-4 5-10-5	3 pounds per 100 square feet
6-2-0	4 pounds per 100 square feet
8-8-6 10-10-10	3 pounds per 100 square feet
Soybean meal	4 pounds per 100 square feet

The fertilizer manufacturers and dealers do have other grades of mixed fertilizers available that are recommended for lawns and may be applied at the rates shown above.

Lawns respond to fertilizers which are well-supplied with nitrogen. Good results may be obtained by spreading any one of the lawn fertilizers early in the spring and following this with an application of a nitrogen fertilizer during late July or August. The fertilizer may be spread broadcast over the lawn and then washed in with the hose.

In many cases weeds are responsible for the poor and unsatisfactory appearance of lawns. There are a considerable number of chemical weed eradicators now on the market. The use of one of these, along with the addition of good seed, fertilizer, and black soil as top-dressing, may improve many lawns.

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