Preparing Mixed Fertilizers on the Golf Course

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Commercial fertilizers are usually mixtures of materials containing nitrogen, phosphoric acid, and potash. These so-called complete fertilizers may be bought ready mixed or their ingredients may be bought and mixed on the golf course. The fertilizer industry in the United States is based largely on factory-mixed goods, but the practice of home mixing has always had its advocates. A list of the common fertilizers adapted for golf course use, with their approximate analyses, will be found on page 58 of this number of the Bulletin.

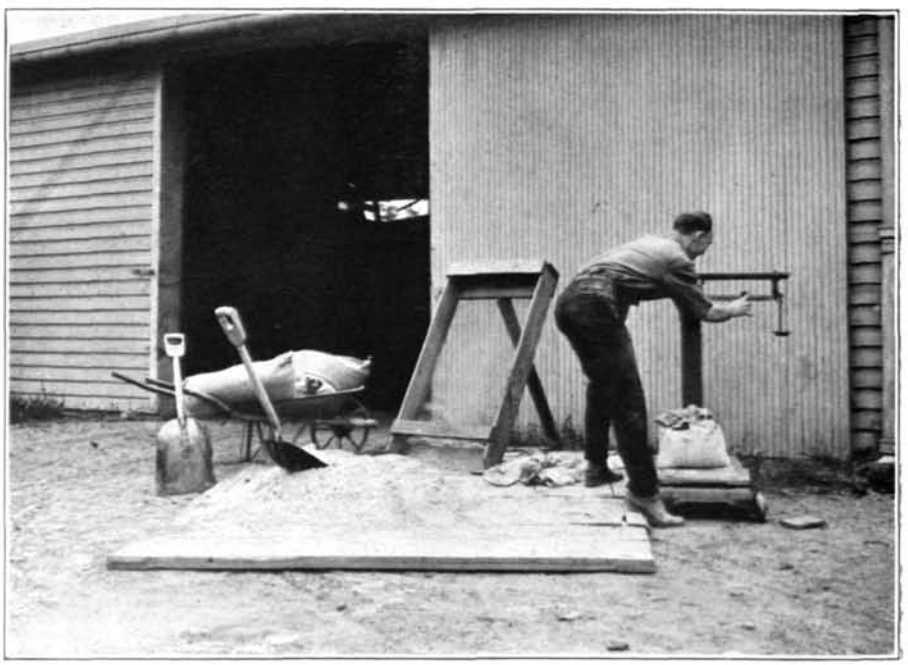
Mixing fertilizers on the golf course is a simple process and requires no great amount of labor

For one thing, home mixing is often more economical and affords the greenkeeper an opportunity to prepare fertilizer mixtures adapted to special needs. He thus not only learns more about fertilizer materials but can select them himself. In many cases it is important to know what form of nitrogen to use. For example, in some cases a large proportion of a quick-acting nitrogen carrier is essential; for others, a more slowly acting one, which allows the nitrogen to become available gradually throughout the season, is desirable. The greenkeeper can, for example, purchase sulphate of ammonia or nitrate of soda and be certain that he is obtaining high-grade materials.

In some localities there is an opportunity to buy so-called open-formula* mixed fertilizers. The company states plainly the ingredients used in making the fertilizer and the pounds of each ingredient in a ton of the mixed product. This system of selling takes away one

*The Association of Official Agricultural Chemists has given the following definitions of terms used in this article: (1) Fertilizer formula: The term formula shall be interpreted as expressing the quantity and grade of the crude stock materials used in making a fertilizer mixture. For example, 800 pounds of 16-per-cent superphosphate, 800 pounds of 9-20 tankage, and 400 pounds of sulphate of potash-magnesia. (2) Analysis: The word analysis, as applied to fertilizers, shall designate the percentage composition of the product expressed in terms of nitrogen or ammonia, phosphoric acid, and potash in their various forms. (3) Unit: A unit of plant food is 20 pounds, or 1 per cent of a ton.

of the reasons for preferring to do home mixing. Undoubtedly home mixing is a good thing for many individuals, both financially and educationally, and should be considered where economy is necessary or desirable. It has proved satisfactory in many parts of the country.



When materials in bulk or in bags of various weights are to be used, scales become necessary in the home mixing of fertilizers. With care in weighing out the ingredients, especially when the usual fertilizer materials are employed, it is possible on the golf course practically to duplicate any of the standard fertilizer mixtures

In the purchase of fertilizer materials good business judgment should be used. Wide competition should be sought and prices procured not only from local merchants but from large fertilizer firms in the home state and adjoining states. Lists of firms may be obtained from the state agricultural experiment stations, the United States Department of Agriculture, and golf association service bureaus. Advice should be sought from local green sections or the United States Golf Association Green Section. Best prices can be obtained for cash. Materials should be bought well in advance, as this not only insures a better price but allows the use of labor in the winter when it is often not occupied profitably. Mixing may be done when the weather is too inclement for outside work.

The mixing of the materials is comparatively simple. Any tight floor or a wagon box may be used, and tools at hand may be employed. The materials are spread in layers, usually the most bulky first, and are thoroughly shoveled together. The mixture is passed through a screen, and any lumps present are broken up with a tamper or the back of a shovel. The writer has found a very large long-handled mortar hoe a convenient tool for mixing, but its purchase especially for this purpose is not necessary. Where large amounts are to be mixed it would probably pay to buy a rotary mixer, such as is sold

for concrete mixing. The stirring should be continued until the materials are uniformly mixed and show no streaks of color, after which the product may be bagged and stored in a dry place until applied.

To avoid caking and losses of plant-food elements, certain ingredients should not be used together in a mixture. The accompanying diagram shows materials which may and may not be safely combined.

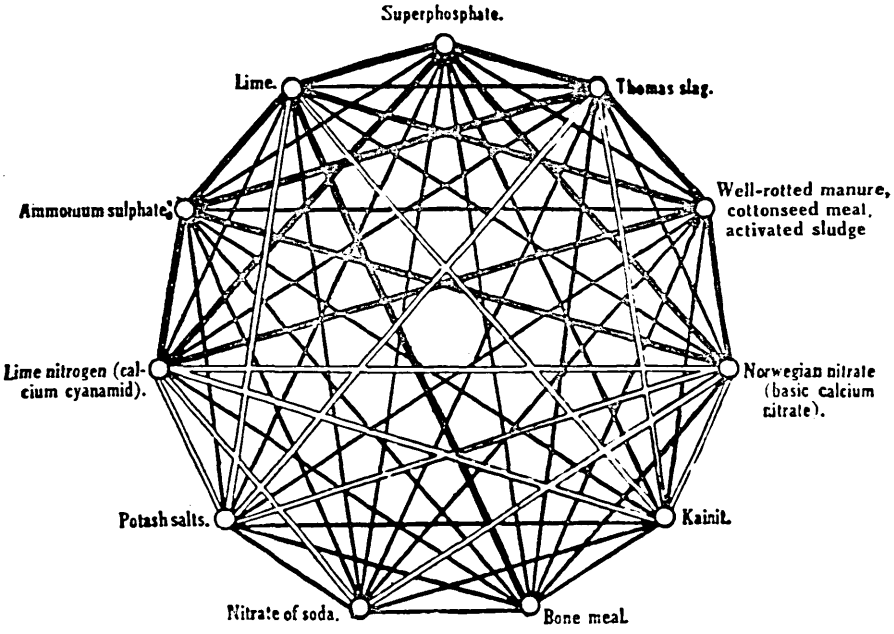


Diagram indicating what fertilizer materials may and may not be safely mixed. The heavy lines unite materials which should never be mixed, the double lines those which should be applied immediately after mixing, and the narrow single lines those which may be mixed at any time

When making high-analysis mixtures with concentrated materials it is well to include at least 100 to 200 pounds, per ton of the mixture, of some organic material, such as fish scrap, animal tankage, activated sludge, or cottonseed meal, as a conditioner. This holds good especially when the mixture is to be stored.

One of the easiest ways to start home mixing is to duplicate a formula already in use. A beginner should select a mixture which he has used successfully on his course, get a price on the mixed goods, and then find out what a home mixture of similar analysis will cost.

In making up fertilizer formulas it is well first to decide what percentages are required and then what materials shall be used. Start with the phosphoric acid (P_2O_5). Superphosphate is almost universally used as a source of the phosphoric acid in ordinary-strength fertilizers. With 16-per-cent goods, if 8 per cent of phosphoric acid is desired in the mixture, the procedure would be as follows: If the whole mixture were superphosphate, it would contain 16 per cent of phosphoric acid; as 8 per cent is desired, make 8/16 (½), or 1,000 pounds to a ton, of the mixture superphosphate; if 6 per cent is wanted, 6/16, or 750 pounds to a ton, would consist of this material. Similarly with nitrogen, if sulphate of ammonia contains 20 per cent of nitrogen and 2 per cent of nitrogen is desired,

2/20 (1/10) of the mixture, or 200 pounds in a ton, will be needed. Similarly also with potash, if muriate of potash (potassium chloride) containing 50 per cent of potash is used and 5 per cent of potash is desired, 5/50 (1/10) of a ton (200 pounds) of muriate of potash is needed.

Any other material may be used in a similar manner. It is not necessary for the greenkeeper to be exact down to the fraction of a per cent, as fertilizer application is not an exact science and a slight variation in the calculation will not materially alter the value of the mixture.

Fertilizer materials are often used to advantage also without mixing. Examples are superphosphate, basic slag, sulphate of ammonia, and nitrate of soda.

The following table will be of help in calculating home mixtures. In making ton lots, to get 1 per cent use amounts shown in the first column, for 2 per cent use those in the second column, and so on:

Quantities of Fertilizer Ingredients to be Used to Give Definite Percentages in a Ton of Mixture*

Ingredient	1%	2%	3%	4%	5%	6%	7%	8%	9%	10%
Carriers of nitrogen (N):	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
Nitrate of soda (15% N)	133	266	400	532	666	800	933	1,066	1,200	1,333
Sulphate of ammonia (20% N)	100	200	300	400	500	600	700	800	900	1,000
Cottonseed meal (7% N)	285	571	856	1,142	1,428	1,714	2,000	.....	.....	.....
Dried blood (10% N)	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Fish scrap (8% N)	250	500	750	1,000	1,250	1,500	1,750	2,000	.....	.....
Activated sludge (5½% N)	364	727	1,093	1,455	1,818	.....	.....	.....	.....	.....
Carriers of phosphoric acid (P_2O_5):										
Superphosphate (16% P_2O_5)	125	250	375	500	625	750	875	1,000	1,125	1,250
Superphosphate (20% P_2O_5)	100	200	300	400	500	600	700	800	900	1,000
Double superphosphate (40% P_2O_5)	50	100	150	200	250	300	350	400	450	500
Ground bone† (23% P_2O_5)	87	174	261	348	435	522	609	696	783	869
Carriers of potash (K_2O):										
Sulphate of potash (50% K_2O)	40	80	120	160	200	240	280	320	360	400
Muriate of potash (50% K_2O)	40	80	120	160	200	240	280	320	360	400
Kainit (12½% K_2O)	160	320	480	640	800	960	1,120	1,280	1,440	1,600
Manure salts (20% K_2O)	100	200	300	400	500	600	700	800	900	1,000

To make up a ton of a 4-8-4 mixture in which the nitrogen is two-thirds in the form of sulphate of ammonia and one-third in organic form from cottonseed meal, the phosphoric acid is from 16-per-cent superphosphate, and the potash is from 50-per-cent muriate of potash (potassium chloride), the following materials would be used:

	Pounds
Sulphate of ammonia	268
Cottonseed meal	380
Superphosphate (16 per cent)	1,000
Muriate of potash	160
Filler (ground dried peat)	192
Total	2,000

Since the fertilizer materials add up to 1,808 pounds, 192 pounds of a filler is added. This filler may be a conditioner as well, and often has some fertilizer value in itself. Dried peat, ground phosphate rock, ground limestone, or even sand may be used. The total is so near 2,000 pounds that it may be considered unnecessary to bother with a filler. When the total of the mixture is appreciably less than 2,000 pounds, it may be perfectly satisfactory to use a smaller quantity of fertilizer to the acre rather than to dilute with filler. Thus, if you are making

*Where the combined materials do not total 2,000 pounds a filler may be used to bring up the mixture to that weight.

† Ground bone also carries nitrogen.

a ton of 4-8-4 mixture, in which the sum of the materials used is 1,500 pounds without filler, by using three-fourths of the normal application the filler can be omitted.

The mixture just given is a good general fertilizer. Its nitrogen is in different degrees of availability. The cottonseed meal in this mixture, besides its fertilizer value, is an excellent conditioner. A mixture such as this will spread well, and when properly stored should remain several months in good condition for applying. It is possible to make other mixtures which would have the same ratio of nitrogen, phosphoric acid, and potash, such as 5-10-5, 8-16-8, 10-20-10, and even 15-30-15. As the number of units increases, however, the difficulty of keeping the mixture in condition and of distributing it evenly in the soil or on the turf may increase.

A 7-6-5 mixture may be made of the following materials:

	Pounds
Sulphate of ammonia	400
Nitrate of soda	270
Cottonseed meal	285
Superphosphate	750
Muriate of potash	200
Filler and conditioner (ground dried peat and such)	95
Total	2,000

This mixture is high in quickly available nitrogen.

Fertilizer mixtures may be readily modified to suit various needs. Suppose a greenkeeper can purchase to advantage a concentrated fertilizer analyzing 15-30-15 but desires to use a fertilizer distributer which he thinks more suited to a lower-grade mixture. He also prefers, for local conditions, a greater proportion of nitrogen. He may combine 1 ton of the 15-30-15 analysis commercial fertilizer, 1,500 pounds of sulphate of ammonia, and 2,500 pounds of inert material, such as sand or sandy soil, and thus have 3 tons of approximately 10-10-5 goods. Other concentrated mixtures may be used in a similar manner.

Following is a 12-6-4 mixture made up in two different ways, one with the nitrogen partly in organic form and the other in inorganic form:

12-6-4 Mixture With Organic Base

	Pounds
Urea (46 per cent N)	180
Meat meal (10 per cent N)	300
Cottonseed meal (7 per cent N)	1,027
Phosphate of ammonia (13 per cent N and 48 per cent P_2O_5)	333
Muriate of potash (50 per cent K_2O)	160
Total	2,000

12-6-4 Inorganic Mixture*

	Pounds
Sulphate of ammonia	1,200
20-per-cent superphosphate	640
Muriate of potash	160
Total	2,000

*This mixture should be used soon after mixing as it may become lumpy.

Following are two simple but useful golf course mixtures:

12-8-4 Mixture With Organic Base

	Pounds
Sulphate of ammonia	1,040
Raw ground bone meal (4 per cent N)	800
Muriate of potash	160
Total	2,000

6-12-4 Inorganic Mixture*

	Pounds
Sulphate of ammonia	600
20-per-cent superphosphate	1,240
Muriate of potash	160
Total	2,000

Usually the mixing of fertilizers on the golf course will show a profit, but the greenkeeper will have to investigate and determine what the materials and mixed goods cost in his community and then make his decision. The United States Golf Association Green Section is in a position to help the greenkeeper regarding proper mixtures for his turf and is always pleased to be of assistance.

Fertilizer Production, Consumption, and Costs

Circular 129, published in January, 1931, by the United States Department of Agriculture, entitled "Survey of the Fertilizer Industry," contains information of value to all who are concerned with the use of fertilizers. Some of the more interesting facts and figures contained in the circular are herewith presented.

WORLD PRODUCTION OF INORGANIC NITROGEN (NET TONS)

	1909	1913	1917	June 1, 1923, to May 31, 1924	June 1, 1928, to May 31, 1929
By-product ammonia	233,200	377,300	400,400	346,400	469,700
Chilean nitrate	330,000	429,000	431,200	372,200	539,000
Air fixation	6,050	93,500	374,000	444,500	1,315,600

The modern fertilizer industry, the circular states, is only 80 years old. Although various waste materials have been used from earliest times, without special treatment, to improve the productivity of the soil, the production of commercial fertilizer as it is known today dates back only to about 1850, the year in which superphosphate was first made in the United States. Before that, in 1830, Chile commenced to export nitrate of soda, a natural product requiring little special treatment. In 1840 the acid treatment of insoluble phosphate rock to render it soluble and thus available for use as fertilizer, was invented in Europe. The by-product coke oven, rendering possible the recovery of nitrogen as sulphate of ammonia as a by-product of the coke industry, was introduced into the United States from Europe in 1893. Later, as the concentration of the meat-packing industry into large units led to the general utilization of its by-

*This mixture should be used soon after mixing as it may become lumpy.