

# Methods of Applying Fertilizer



A new method of applying fertilizer in large amounts is with attachment on plow. Note band of fertilizer in the bottom of the furrow.

By W. H. PIERRE

**H**OW CAN WE use our limited supplies of fertilizer most effectively? Not only is this a question in the minds of many farmers now, but it is an important problem from the standpoint of the nation's total production.

The efficient use of fertilizer requires more than just "getting it on the soil." Just as the efficiency of a car, measured in miles per gallon, is determined as much by the adjustment of the carburetor or the manner in which the gas enters the cylinder head as by the quality of the gasoline, so also is the return from fertilizers often determined as much by the method and time of application as by the kind that is used.

## Five Methods of Applying

There are five general methods of applying fertilizer. These are:

- (1) Broadcasting before seeding,
- (2) drilling in narrow bands before or at time of seeding,
- (3) applying in hill or row at time of planting row crops,
- (4) top-dressing while the crop is on the ground and
- (5) applying fertilizer at time of plowing.

In determining which of these methods will be most effective for

a given condition the question to be answered is which method applies the fertilizer in such a manner that plant roots can take up as large a proportion of it as possible when needed by the crop. Ordinarily, this means getting the fertilizer at least 2 inches deep, so that it may be near the plant roots and below the periodically dry surface.

Nitrogen fertilizers move readily down into the soil with the soil water. In general, however, fertilizers containing phosphorus or potassium tend to remain where placed in the soil and move downward very slowly. So it is important where the fertilizer is placed, because the fertilizers used in the state consist largely of phosphates or phosphate-potash mixtures.

## With Small Grain, Legumes

Small seeded legumes, such as clover and alfalfa, respond well to fertilizers. Moreover, good stands and growth of legumes help to supply nitrogen for the other crops in the rotation. For this reason, much of the fertilizer used in the rotation should ordinarily be applied at the time of seeding the legume, or the legume-nurse crop combination.

## Drill or Broadcast?

The most effective method of applying phosphate or mixed fertilizer to legume seedings, either with or without small grain nurse crop, is by the use of the combi-

nation grain-fertilizer drill. (See illustration.) The drill delivers the fertilizer in narrow bands along the drill rows and places it approximately 2 inches deep. Moreover, the fact that the fertilizer is in bands means that more of it remains available to the crop than when applied broadcast. Very few farmers, however, have fertilizer drills. The common method of applying fertilizer for small grain and legume seedings, therefore, is broadcasting by means of a regular fertilizer spreader, an endgate seeder, or a low-type lime spreader. Of these, the latter two are most commonly used. (See illustration.)

## Spread Evenly, Disk Well.

Broadcasting, as often done, is a relatively inefficient method of spreading fertilizer. In the first place, fertilizer spread with an endgate seeder or lime spreader is often spread unevenly, especially if it is applied during windy weather and if not enough care is taken to overlap sufficiently. It is quite common to see fields where the clover, alfalfa or other crop appears in streaks due to uneven distribution of the fertilizer. An example of uneven broadcasting of fertilizer on a hemp crop in northern Iowa is shown in the accompanying picture. Note that the hemp is over twice as tall in the strips that had received the largest amount of fertilizers.

The regular fertilizer spreader which drops the fertilizer on the ground spreads it quite uniformly. It is therefore much to be pre-

Distributing fertilizer with an endgate seeder or lime spreader often brings results such as in this hemp field. Note the uneven growth of the crop in the background up over the hill.



ferred to the endgate seeder or rotary type lime spreader which scatters the fertilizer in a wide strip.

Another problem with a broadcast application is that the fertilizer is often not worked deep enough into the soil. Ordinarily, one should disk at least twice after the fertilizer is broadcast.

## Fertilizing Row Crops

Much work has been done in different parts of the country on the best methods of applying fertilizer for row crops. In the eastern part of the Corn Belt, corn is generally fertilized, and in recent years considerable fertilizer has been used on corn in northeastern Iowa. Soybeans respond poorly to fertilizer and, therefore, receive very little. On the other hand, the sugar beet crop, grown on a relatively small acreage in north-central Iowa, responds very well to fertilizers and is generally fertilized.

**Row Versus Broadcast Methods.** The two most common methods of applying fertilizer for corn and other row crops in Iowa are (1) broadcasting and (2) row or hill application. Of these two methods, the row or hill method of application is much more efficient.

The row or hill application is made at the time of planting the corn by means of a fertilizer attachment on the corn planter which distributes the fertilizer in

One of the most effective methods of applying fertilizer is with a combination grain-fertilizer drill.

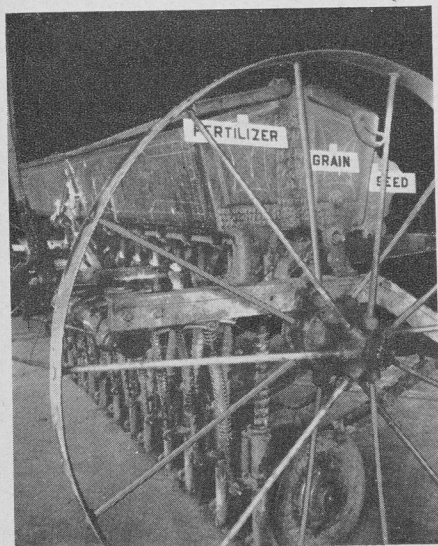


TABLE 1. COMPARISON OF ROW, BROADCAST, AND OF PLOWED-UNDER METHODS OF FERTILIZATION ON YIELD OF SUGAR BEETS.

Amount of fertilizer and method of application	Yield in tons per acre			
	0-20-0 fertilizer	0-20-20 fertilizer	Average	Increase
No fertilizer	.....	.....	10.3	.....
125 pounds, in row	12.6	13.1	12.85	2.55
125 pounds, broadcast	11.6	11.9	11.75	1.45
250 pounds, broadcast	12.5	13.0	12.75	2.45
500 pounds, broadcast and plowed under	12.6	13.3	12.95	2.65

two narrow bands on either side of the seed. (See illustration.) By proper adjustments, the fertilizer can be placed as deep as the seed or in a position where it is readily available to the young plant.

Many field tests have shown that only about one-half as much fertilizer is needed when applied in the hill or row as when applied broadcast. This is well illustrated in some data we obtained with sugar beets on Webster silty clay loam near Kanawha in 1942. (See table 1.) As an average for the two fertilizers tried, it was found that 125 pounds applied in the row increased the yield 2.55 tons per acre; whereas the same amount of fertilizer broadcast increased the yield only 1.45 tons. You will note in table 1 that it took twice as much fertilizer when applied broadcast as when applied in the row to get the same yield increase.

There are several reasons why the fertilizer is more efficient when applied in the hill or row than when broadcast. One reason, as previously mentioned, is that the fertilizer is applied deeper in the soil. The other very important reason is that phosphorus and potassium fertilizers rapidly combine with the soil, to form compounds less soluble and therefore less available to plants. This process is known as "fixation."

Fixation is much greater when the fertilizer is broadcast than when applied in the hill or row. This is what would be expected because the fertilizer comes in con-

tact with much more soil when broadcast. A greater proportion of the fertilizer, therefore, combines with the soil and becomes less available to plants. In other words, the action of the soil on the fertilizer is something like the action of a dry sponge on water. A small amount of water absorbed by a large sponge is held much more tightly and cannot be squeezed out as readily as the same amount of water taken up by a small sponge.

Ordinarily, the amount of fertilizer applied in the hill or row for corn is quite small, the average rate probably not exceeding 100 pounds per acre. This means, of course, that there is less residual effect on the succeeding crops than if twice as much fertilizer had been applied broadcast. It is ordinarily much better, however, to apply the smaller amount of fertilizer for corn in the row and to apply more fertilizer to the legume seeding that often follows corn in the rotation than to expect the legume crop to depend for part of its needs on the amount left over from the corn crop. For example, it would be much better in a 3-year rotation of corn, oats and clover to apply 100 pounds of fertilizer for corn in the hill and 200 pounds for oats seeded to a legume than to apply 200 pounds for corn broadcast and have only 100 pounds left for the oats and clover seeding.

**Problems in Hill Fertilization.** One point that needs to be





When small amounts of fertilizer are being used, they give best results if applied in the hill or row with a planter attachment. The fertilizer should go into the soil at least as deep as the seed is being planted.

checked when applying fertilizer by means of the attachment to the corn planter is to see that the adjustments are such that the fertilizer is not left on the surface. The fertilizer should be placed in the soil, preferably as deep as the seed.

Many of the early corn planter attachments for distributing fertilizer were not very satisfactory because they allowed fertilizer to come in contact with the seed. This often caused a reduction of stand, especially in a dry year. The attachments that have been on the market for about the past 10 years, however, distribute the fertilizer in narrow bands on either side of the seed and are very satisfactory.

**Side Dressing.** Where a larger amount of fertilizer is used than is applied at planting time, an application is sometimes made along the row after the plants are up or are still small. The fertilizer can be applied by means of a fertilizer attachment to the cultivator, the fertilizer being delivered immediately back of the cultivator shovels nearest the row. (See illustration.) This method has been used to a limited extent in Iowa to apply potassium fertilizers on high-lime or so-called "alkali soils" and it can also be used in applying nitrogen fertilizers. The advantage of this method is that the amount of fertilizer can be varied, depending on the stand that is obtained and the growing conditions. If the stand is poor or the soil very

dry there is less likelihood of returns from fertilizer than with a good stand and a favorable soil moisture condition.

### Plowing Under Fertilizer

During recent years there has been considerable interest in the possibility of plowing under fertilizer for corn and soybeans when large amounts are needed. An at-

tachment for the plow which distributes the fertilizer in a narrow band at the bottom of the plow furrow has been placed on the market. (See illustration.)

During 1943 and 1944 we carried on several experiments to study the comparative value of plowing under and broadcasting large amounts of fertilizer for corn and soybeans. Some of the data for corn are shown in table 2. These results show that placing a 5-10-5 fertilizer in a narrow band at the bottom of the plow furrow resulted in larger increases in yield than broadcasting the fertilizer after plowing, the average difference being 5.1 bushels per acre. In the case of the experiment in Delaware County on O'Neil loam where the yield was nearly 9 bushels higher with the "plow-under" method, the difference may be due in part to the fact that the fertilizer applied after plowing was not disked into the soil but the field merely harrowed.

In these two experiments we also found that 100 pounds of fertilizer in the hill gave an average increase of 6.5 bushels, whereas 800 pounds of the same fertilizer plowed under gave an increase of 15.3 bushels. Apparently, the

TABLE 2. YIELDS OF CORN FROM SMALL AMOUNT OF FERTILIZER IN HILL AS COMPARED TO LARGE AMOUNTS BROADCAST OR PLOWED UNDER.

Field	Yield of corn (Bu/A) with different fertilizer treatments				
	None	100 lbs. in hill	800 lbs. broadcast after plowing	800 lbs. at bottom of plow furrow	100 lbs. in hill + 800 lbs. at bottom of plow furrow
O'Neil Loam Delaware County (1943)	45.4	52.2	55.3	64.1	62.4
Carrington Silt Loam Linn County (1943)	76.3	84.5	86.8	90.3	88.4
Carrington Silt Loam Linn County (Residual effect in 1944)	89.1	92.0	100.1	97.0	94.2
Average of two fields (1943)	61.9	68.4	71.1	77.2	75.4
Increase in yield over check		6.5	10.2	15.3	13.5

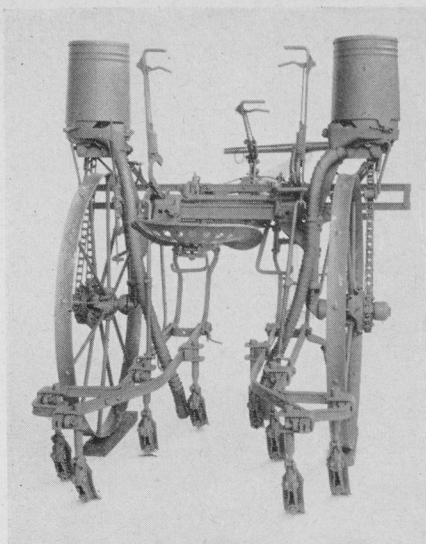
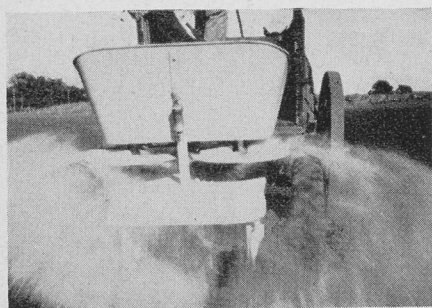
large amount of fertilizer plowed under was sufficient to get maximum yields, for the addition of another 100 pounds in the hill failed to give an increase.

The residual effect of the fertilizer on the yield of corn in 1944 was measured on the field in Linn County and found to be between 5 and 8.1 bushels per acre where 800 pounds of fertilizer had been used in 1943 and none used in 1944. The total increase for the 2 years was 21.9 bushels where 800 pounds had been plowed under, 21.5 bushels where the same amount of fertilizer was broadcast after plowing, and 11.1 bushels where 100 pounds of the same fertilizer was applied in the hill in 1943.

The question has been raised as to what results might be expected from broadcasting the fertilizer on the surface **and then plowing it under**. Our work during the past 2 years indicates that this method is satisfactory where large amounts of nitrogen fertilizers are used. It is not likely to be very satisfactory, however, for the common fertilizers used in Iowa, which consist mainly of phosphorus or phosphorus-potash combinations, especially if relatively small amounts are applied. This has been well shown by some experiments conducted at the Indiana and Ohio stations.

Where only small amounts (100 to 200 pounds per acre) of phosphate or mixed fertilizer are used, however, as in ordinary practice, it should be applied in the hill or row with planter attachment if it is to be used most efficiently. Even where the fertility of the soil is such that plowing under of fertilizer is economical, the use of a

One of the most common methods of applying fertilizer is with an end-gate seeder or a low lime spreader.



Side-dressings of fertilizer are sometimes applied to row crops by use of attachments to cultivators.

part of the fertilizer in the hill or row would generally seem desirable to promote early growth.

On the basis of the results that have been referred to as well as of work in other Corn Belt states it appears that the plowing under of fertilizer for corn in a band at the bottom of the furrow may be an efficient method where a relatively large amount of fertilizer, especially of nitrogen fertilizers, is needed.

### Top-Dressing

The broadcasting or drilling of fertilizers while a crop is on the ground, usually a close growing crop, is referred to as top-dressing. The efficiency of this method depends primarily on the type of fertilizer needed and on the soil conditions.

**Top-dressing of Nitrogen Fertilizers.** Since nitrogen fertilizers applied on the surface readily move downward into the soil with rains, top-dressing is often an efficient method of applying nitrogen in close growing crops. Under Iowa conditions there are three major places where nitrogen top-dressings can often be made to advantage if the soil has received insufficient amounts of nitrogen through legumes or manure. These are: (1) On permanent non-leguminous pastures, (2) on bromegrass grown without legumes for

seed production purposes, and (3) on wheat or oats.

An example of the response that may be obtained on wheat and oats is shown by results we obtained in western Iowa during 1944, a wet season. The average increase in yield in these experiments from a top-dressing of 100 pounds of ammonium sulfate per acre was 4.9 bushels on four fields of wheat and 7.7 bushels on 11 fields of oats. With permanent pastures, the main value of the nitrogen top-dressing is in obtaining earlier grazing. Bluegrass pastures fertilized with nitrogen often are ready 1 to 2 weeks earlier than unfertilized pastures.

### Top-Dressing of Phosphorus or Phosphorus-Potassium Fertilizers.

Because phosphorus and potassium fertilizers tend to combine with the soil, they move downward into the soil relatively slowly when applied as top-dressings. For this reason, the top-dressing of phosphorus and potassium fertilizers is usually not as efficient as applying the fertilizers at the time of seeding, when it can be incorporated deeper into the soil. Moreover, since these fertilizers are usually beneficial in the early growth of the plants, applications made at seeding time will help more to establish legume stands than will top-dressings at a later date.

Where alfalfa stands are kept for several years, however, top-dressings may sometimes be used effectively in maintaining the stand and increasing the yields. In northwestern Iowa, for example, top-dressings of phosphate fertilizer at the rate of 300 pounds per acre on alfalfa fields where the growth was very poor because of extreme phosphorus deficiency were found to markedly increase the yields. These soils, however, were all neutral or alkaline. Since acid soils combine more readily with phosphorus, or have greater "phosphorus fixation," top-dressing is not as efficient on acid as on alkaline or neutral soils.

For greatest efficiency, therefore, as much as possible of the phosphate needs of such leguminous crops as alfalfa and red clover should be incorporated with the soil at the time of seeding.