THE "WHY" OF FALL MANURING

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Farmers have known for centuries of the beneficial effects produced by adding manure to their soils. They have found that under ordinary conditions the use of barnyard and often green manure is the cheapest and surest way of increasing crop yields from their farms. Practical experience has taught us much about the proper practices to follow in the use of manure. Field and laboratory experiments at various experimental stations have explained the reasons for these practices and have indicated modifications by which increased returns may be secured. Thus for Colorado conditions it has been shown by Robertson and Gardner (Through the Leaves, March, 1926) that fall application of manure gives higher yields of sugar beets than does spring application.

Let us examine certain facts about manure which guide its use on the farm. The composition and value of manure will vary with the kind of animal, the kind of feed, the kind and amount of bedding used, the proportion of dry matter in the manure, and the manner of storage. One ton of ordinary barnyard manure, however, will usually contain about 1500 pounds of moisture and 500 pounds of dry matter. In this dry matter are found about 10 pounds of nitrogen, 2 or 3 pounds of phosphorus, and 8 pounds of potassium. The value of manure does not depend alone upon these three plant food elements, but also upon the remainder of the dry matter. This will become clear when we consider that the increased crop yield caused by manure is due mainly to two effects which it brings about in the soil. These are: (1) It improves the physical condition of the soil and makes it a more suitable medium for the growth of plant roots; (2) It adds plant foods to the soil, and thus makes it possible for crops to produce more growth. Neither of these beneficial effects is very great immediately after manure is added to the soil. They show up only after it decomposes.
The reason for this is to be found in the chemical nature of the substances found in manure and the changes which they undergo during decomposition.

We may consider first the importance of decomposition of manure upon making available the plant foods which it contains. Manure is an extremely complex substance. In it the plant nutrients are found combined with the elements carbon, hydrogen, and oxygen in such a way that they can not be absorbed by plants. We say that they are unavailable. To make them available, the nitrogen, phosphorus, and potassium must be split off or liberated from the complex substances and changed into simpler forms which can be absorbed by plant roots. This action is brought about by the millions of tiny organisms living in the manure and the soil. These organisms belong principally to the group of bacteria, fungi, and actinomycetes, and because of their small size we refer to them collectively as microorganisms. It will be interesting to trace the action of these microorganisms in making nitrogen available to plants.

Plants are able to absorb nitrogen best when it is either in the ammonia or nitrate form. In manure we find that there are very small amounts of either of these and that most of the nitrogen is in the protein form. Before the full value of manure in increasing crop yield can be secured, its nitrogen must then be changed to ammonia or nitrate. When the proteins are decomposed their nitrogen is first liberated as ammonia. This process is called ammonification and may take place either in the manure pile or the soil. If it takes place in soil the ammonia is immediately acted upon by the nitrifying bacteria and changed to the nitrate form of nitrogen. Because of the activity of these bacteria nitrate is the only form of available nitrogen found in ordinary field soils. This change is called nitrification and it is the final step in making the manure nitrogen available to plants. It may take place in the manure pile also, but only slowly and only to the depth to which air penetrates.
We have seen, then, that manure nitrogen passes through the processes of ammonification and nitrification to form the available nitrate commonly found in the soil. Of these two processes ammonification must always take place first. Consequently the rate at which manure nitrogen becomes available to plants depends upon the rate at which it is liberated as ammonia. Here we must take into account also the nutrition of the microorganisms themselves. They, like the crop plants, require nitrogen for their growth. This is of great practical importance because they take whatever nitrogen they need from the ammonia which is formed and recombine it into the protein of their own bodies. The amount of ammonia which they need depends upon the amount of growth which they can make. This, in turn, depends upon the proportion of non-nitrogenous organic matter present in the manure. In a very strawy manure which is low in nitrogen and high in non-nitrogenous matter the microorganisms may at the beginning actually use all the ammonia which is formed and leave none for plants. In such a manure no ammonia will appear for plant use until most of the strawy material has been decomposed away and the original microorganisms have died. Their dead cells are then decomposed by new microbes and a portion of their nitrogen liberated as ammonia. This tying up of nitrogen in microbial bodies is apt to occur only where excessive amounts of bedding have been used and the manure is very strawy. It may occur also with green manures which are low in nitrogen. It is always temporary but may extend over several months.

From the above discussion it is seen that rendering available the nitrogen and other plant nutrients in manure is a gradual process and takes place only as the manure as a whole is decomposed. The manure, therefore, should be incorporated into the soil long enough ahead of crop planting for the soil microorganisms to change sufficient nitrogen into the available form to meet the demands of the crop. With the Colorado growing season there is insufficient time for this if manure application is delayed until spring. It is particularly
the case for long season crops which must be seeded as early as possible. This then is the explanation for the increased yields which are obtained when manure is plowed into the soil in the fall.

When a farmer has completed the change from spring to fall manuring he will find that the practice of composting will increase the returns to be secured from manure. Under the Colorado system of livestock feeding, the principal accumulation of manure takes place during the winter and early spring months. If the manure is allowed to remain in a thin layer over the surface of the feed-lot, rainfall will percolate through and carry with it part of the plant food. Also, since ammonia is quite volatile under these conditions a portion of it may be lost to the atmosphere. To prevent this, the manure should be placed in piles 5 or 6 feet high and allowed to stand during the summer months. Manure treated in this way slowly decomposes and there is an accumulation of ammonia which is not lost to the air. The composted manure will consequently give a quicker stimulus to crops in the field. This is especially noticeable with strawy manure. An added advantage of composting is that most of the weed seeds will be killed due to the heating and lack of air in the manure pile. These advantages will more than repay the small amount of extra labor required in piling the manure.