Report of Standing Committee on Fertilizers and Irrigation.

BY PROF. E. R. FLINT.

Mr. President, Ladies and Gentlemen:

I take it that it is the province of this committee to present any progress that has been made during the year, in regard to fertilization and irrigation, in so far as it is of interest to the horticulturist, particularly of the State of Florida.

While I cannot announce anv startling discoveries for the year in the matter of fertilization, nevertheless there is undoubtedly a constant and steady accumulation of experience and experimental data which is gradually leading to the point of making plant fertilization more nearly an exact science than it has been, or perhaps it would be nearer the truth to say, to a point where we begin to realize that, as it varies so with every varying condition, it never can be an exact science.

In regard to practical results and progress in our own State, the Florida Experiment Station has just published the results of an extensive experiment on the fertilization of the pineapple and has reached some interesting and valuable results, which are to be presented in another paper. Fertilizer experiments are also in progress on the orange, cotton and potatoes.

If we review the work done by the various experiment Stations on fertilization, for the past year, it seems to me that we must be lead to the belief that not only every State, but every county, every farm and indeed every portion of that farm requires more or less special or individual treatment to get the best results. A universal formula for any particular crop is not possible. Such a formula may serve as a basis, but no intelligent plant grower should rest content with this, but should constantly seek to so modify it that it will best meet his own individual conditions, and the more intelligently and conscientiously he does this, the more economically and profitably he will be able to fertilize his land. It is for this reason that Stations and Agricultural papers are always advocating home mixing, and that fertilizer dealers are advertising, more and more, the various plant food ingredients rather than mixed fertilizers. A mixed fertilizer will always find some sale because there are many that will not take the trouble to do their own mixing, and I would not in any way imply that they are not of value, as every reputable dealer aims to supply what is needed and in the best form, as it is in the results obtained that he gets his best advertising, and I think we have no reason to complain of the dealers in our own State.

I believe, in the past that we have become accustomed to place too much reli-

ance on published formulas which have been made up from the analysis of the soil and the crop, and have contented ourselves with these data. The subject of animal nutrition and feeding is naturally one of considerable complication and difficulty, as compared with plant feeding, but I think that we shall eventually come to believe that the more intimate questions of plant nutrition, approach it in this respect. To be sure we are concerned in furnishing only a very small percent of the total plant food that is required, as by far the larger part is obtained from the air, but that part is just as essential to the growth of the plant as the other. If the problem was merely one of determining just how much potash, phosphoric acid and nitrogen was removed in the crop and was required for the additional growth for the year, it would be easily solved. But in practice, this is found to be wholly inadequate for crops like the orange and from eight to ten times as much as the amount so indicated by the above figures seem to be required to keep the plant up to the best condition of quality and quantity of fruit. Where does this excess go to, and how can we economize by reducing this discrepancy to a minimum without lowering the results we wish to obtain?. To answer this question, I think we must turn from the chemical side of the question to the physical one, or, in other words, study the physical and mechanical conditions of our soils to find a solution.

There are various sources of loss of plant food in the soil, and reasons why the plant does not get all that we apply, with which we are acquainted. One of the most evident of these is the leaching of the material through the soil and carrying it away from the area of the root system of the plant. The rapidity of this leaching increases markedly as we pass from a clay to a sandy soil. Now, on our Florida soils there is no question but that leaching goes on to a very great extent. It is of course desirable that we have our plant food in a soluble form as it is only in this condition that the plants can make use of it. If we apply it in this condition, or in such compounds that it rapidly becomes so, it is conceivable and no doubt to a large extent true, that with the first soaking of the soil with rain it is carried away to a large extent beyond the reach of the plant (speaking particularly of our loose, sandy Florida soils.). Now can we prevent this serious and expensive loss? At present the method of overcoming this seems to be to supply sufficient to allow for this loss and to feed the plant too. which is one reason why we have to apply from eight to ten times the amount removed by the crop, and that would seem, from all rational and scientific standpoints, to be necessary. In other words, we apply say from one to two tons to the acre, expecting and knowing that we shall lose a large part of it, when perhaps 200 to 300 pounds is all the crop needs and makes use of. If such conditions held in any technical line. you may be sure the manufacturer would take immediate steps to prevent this loss. If the farmer can stand this constant drain and still make a profit, there must indeed be money in farming. I believe, however, that we can control this loss to a considerable extent. According to the usual practice, we make one or two applications of fertilizers a year to the crop and expect it to save and make use

of what it can out of this, for the next six months more or less, although its food is being rapidly carried out of its reach, and I have no doubt but that the amount of available plant food within access of the plant roots, during the last few months of such a period, is exceedingly small. In other words, we give it a surfeit of food in one meal and then starve it for some months. Does not the remedy in this lie in our dividing up our applications, making several of them through the season, keeping our plants supplied with avaliable food in small amounts, as required. I believe that such a practice would result in a considerable saving and that a smaller amount of fertilizer so applied, would produce the results of one or two large applications. To get the best results such a system of applying fertilizers should be accompanied with means of irrigating, so that, with each small application, if there were not sufficient rainfall, just enough water could be applied to bring the food into solution, but not enough to leach through the soil. It is true that the proper carrying out of such a system would involve some initial expense, but to the progressive farmer of today, who aims to get the best results at the least expense, and can look ahead on his balance sheet, it will eventually save money.

Another source of loss, which however is largely temporary, and with the present system of applying fertilizers perhaps more beneficial than otherwise, is the chemical changes that the fertilizing material undergoes in the soil, tending in general, to pass from a soluble to a less soluble form. This would be obviated, to a considerable extent, by the system just suggested.

The belief in the value of a chemical soil analysis as an indication of what is necessary to add to that soil in order to make it fertile, is rapidly loosing ground, and attention is being turned more particularly to the bacteriology of the soil, the various conditions of acidity and alkalinity, the changes of the humus in the soil etc., and when the present lines of investigations shall have advanced further, we may hope for a more practical and intimate knowledge of the relation existing between the chemistry of the soil and the fertilization of plants.

Present methods of soil analysis are aiming to determine the plant food that is actually available to the plant, rather than the total amount of such material in the soil. These methods should give a much better idea of what is needed than the methods formerly employed.

The farmer has two valuable and inexpensive means of improving his soil and thereby cutting down his fertilizer expenses, which I do not think are practised nearly to the extent that they should be, and these are, the plowing under of green crops and the growing of leguminous crops as a source of nitrogen. As the natural sources of fertilizing material become less abundant and more expensive, in the future, these means will be more appreciated and used. It is a striking fact that is noticeable as we review the developement and advancement of civilization, with its ever increasing necessities and requirements, that no sooner does an urgent emergency arise for anything that may contribute to the comfort and welfare of mankind, than some discovery is made that supplies that demand. Up to the present time. we have lived in a time when nature, by the exploration

and opening up of new countries and the discoveries of great deposits of valuable mineral material, has supplied everything needed with a lavish hand. Nor has man been at all backward in using, with the greatest freedom and often times with the most inexcusable wastefulness, the resources which have been so bountifully given to him. The time has already arrived, however, when we begin to look into the future and speculate as to what is going to happen to posterity when we shall have exhausted the resources which we are now drawing on with ever-increasing freedom to supply the constantly growing demands. That the crude material stored in the earth, which has grown to be so indispensable to our welfare, will eventually be exhausted, no one can doubt, and in fact it is possible to calculate approximately, with the present rate of use, when many of our natural resources will be exhausted, a period in many instances surprisingly and almost alarmingly short. We must then, console ourselves with the above mentioned fact, that some discovery will be made which will enable us to get along as well or better without them.

Let us consider for a moment, the situation in regard to the future supply of fertilizing materials and see what is being done to provide for the time when we shall have exhausted the great deposits that have proved of such inestimable value to agriculture. First in regard to potash. It is calculated that the present consumption of potash, for all purposes, is over three million tons a year and that it is constantly growing. Practically all of this comes from the great Stassfurt deposits in Germany. As minor sources of supply we have wood ashes and cotton seed hull ashes, which are limited. About 2000 tons of muriate of potash are annually made in the south of France from sea water and the Scottish manufacture of kelp yields perhaps 1000 to 1200 tons yearly as a by-product. There are a few other minor sources of supply, such as nitrate of potash, wool washings and beet sugar residues. Leaving out these minor sources, which supply but a very small part of the total demand, we have as practically the sole source, the great potash deposits at Strassfurt, Germany. Although the yearly output of this great collection of mines is now nearly four million tons a year and is steadily increasing, the supply seems almost inexhaustible, so that it will at least be many, many years before mankind will find itself face to face with the problem of its potash supply, which has become so essential to successful agriculture, and the necessity for which will grow greater as the population increases, virgin soils are robbed of their natural fertility, and intensive farming becomes more and more a necessity. Let us hope that when that times comes, some means will have been found or new discoveries made, which will supply the deficiency.

In regard to phosphoric acid the natural supplies may be summed up in general, in the deposits of phosphate rock, phosphatic guanos, bones and slag. The great guano deposits which have been drawn upon so heavily in the past will be exhausted before a great many years, and although smaller gauno islands may from time to time be discovered, the supply from this source must gradually diminish. The conditions which allow the accumulation of such deposits, which require many years to form will probably never

be repeated to the extent they have been, so that this source, when exhausted, will probably never be replaced. The phosphatic deposits, as those through the southeastern portions of the United States are large and will give an abundant supply for a long time, but they are not inexhaustible. The source of supply from bones etc, which however, is insufficient to supply the demand, can be counted upon as a steady source, and the same applies to slag, a by-product in iron smelting. Viewed as a whole, there is nothing alarming in the present situation of the potash and phosphoric acid supply.

In regard to nitrogen, the fact confronts us that we are continually using up this element of plant food without an adequate return to the soil. The constant cropping of the land, combined with our present system of sewerage disposal, which prevents the return to the soil of such a large and legitimate nitrogen supply, the fact that so many crops are sold away from the land, are sufficient to indicate the loss, without considering the destruction of nitrogen compounds by denitrifying bacteria, the leaching of the soil and other sources of loss. The world's supply of the two richest sources of nitrogen, guano and saltpeter, is being rapidly exhausted. At the present rate of consumption of the latter, one billion tons a year, it will be exhausted, as claimed by some, in 30 years. New methods for the production of nitrogen compounds available for fertilizing purposes may be discovered, and some efforts have already been made in that direction with electricity, but this does not promise sufficient as yet to count on it to any extent to relieve the situation.

Nature has provided, to a certain extent, for the return of nitrogen to the soil. Arising from the chemical changes going on, on the surface, there are always traces of ammonia compounds and compounds of nitrous and nitric acids in the air, which are washed down by rains. Electrical discharges in the air bring small amounts of the free nitrogen into combination so that it may be returned to the soil by the rain. In 1891 it was discovered that there were certain micro-organisms in the soil which could bring the free nitrogen of the air into combination without the aid of any other plant life. Experimentation on this line has been undertaken to make practical use of these organisms but so far without result.

The fact that leguminous plants had a very beneficial effect on the soil is a very old observation and they have been used for this purpose without the knowledge of the reason for this. It was demonstrated in 1895 that there was actually an increase in nitrogen after such a crop. It was also noticed that these plants would grow in a soil that contained practically no nitrogen. Hellriegel, in 1886 announced that leguminous plants derived their nitrogen from the atmosphere and in 1888 Wilfarth and Hellriegel demonstrated that the growth of such plants in a nitrogen-free soil, occured after the development of nodules on the roots. Previous to this time, although these nodules had been noticed, they had been considered as a diseased condition of the roots. When the true solution of the question began to appear, it was easily demonstrated that a leguminous plant, grown in a soil absolutely free from nitrogen, as in pure quartz sand that had been heated to redness, and watered with a solution devoid of nitrogen in any

form, would produce a normal growth when the nodules were present, but if they were not present they would quickly die. It was indeed proved that a legume growing in a poor sandy soil provided with nodule-forming bacteria, will be even more vigorous and produce a better crop than plants growing in a moderately rich soil devoid of the bacteria. A great many recent field experiments in all parts of the country have proved this beyond a doubt.

One of the most striking experiments was that of Prof. J. F. Duggar at the Alabama Experiment Station in 1895 and 1897. On one field where hairy vetch had not been grown previously and the fertilizer used contained phosphoric acid and potash without any nitrogen, the yield was but 235 pounds of hay per acre. On a similar plot, treated in a similar manner with the exception of the addition of some soil from an old field containing the proper bacteria, the yield of hay was 2540 pounds per acre. or an increase of over 2000 pounds. This beneficial effect is not confined to the leguminous crop itself, but is imparted to the crops following such plants and this has become so universally accepted and so many times proved, that every recognized system of rotation includes some leguminous crop in its course. The fact is tersely stated by T. E. Neal, from results of experiments at the Deleware Experiment Station, that $100 invested in clover seed returned four times as much as the same amount invested in nitrate of soda. It is estimated in this country that the average amount of nitrogen added to the soil by legums is 122 pounds per acre. When it is remembered that a high grade nitrate of soda contains only about 15 per cent. of nitrogen, while much that is on the market often contains considerable less, it will be seen that a crop of legumes is equal to from 800 to 1000 pounds of nitrate of soda per acre, which at the present price of this fertilizer, is equal in value to from $20 to $25.

We thus see a possible future solution of the question of the nitrogen supply, at least. The horticulturist of Florida, as well as in other states, in order to meet the gradually extending competition, has got to take advantage of every possible means of furnishing the fertilization necessary to secure the best results, at the lowest price consistent with efficiency, but in doing this he must be careful that he does not deteriorate the quality of his fruit. Every poorly fertilized grove means poor fruit which in turn is a menace to the reputation of the whole crop, which up to the present time at least, has justly and easily held first place. We must however, seek always to improve our fruit, so that we may not only meet, but keep ahead of the competition that is bound to develope from the West Indies etc. The geographical position of Florida is such, that I believe she can and will meet this competition, especially in the quality of her fruit.