it is sometimes attacked with mildew and should be promptly sprayed with Bordeaux mixture.

The manuring should be done each time the vine is started for a new crop. About 1 lb. of potash, 2 of bone meal and 10 of oil cake should suffice for an average sized vine at each application.

When the main trunk gets old and the vine shows lack of vigour, it can be renovated by saving any strong new shoot from the base and retaining only half the usual wood on the old trunk for fruiting. In the subsequent year the new shoot can take the place of the old trunk and be treated as a newly planted vine.—*Madras Mail.*

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PLANT AND SOIL RESEARCH

BY

SIR JOHN RUSSEL, F.R.S.

Opening the discussion on soil fertility and its control, Sir John Russell, F.R.S., defined a fertile soil as one which satisfies all the conditions of plant growth, adequately supplying plant nutrients, water, warmth, air for the roots, space for the roots, free from undesirable substances or harmful reaction. The supply of plant nutrients affects crop production in two ways. Other conditions being favourable the amount of plant growth is increased with increasing supply of nutrients up to a certain point. The relationship is not simple; it can be expressed by two factors, one being the minimal amount on the crop of the particular nutrient, and the other the supply of the nutrient already present in the unmanured soil. Some degree of proportionality between the various nutrients is necessary, but there is no evidence that the ratios are narrow. These relationships are much affected by the water supply. In general, nutrients are most effective when there is a good water supply, and the water is most effective when there is a good nutrient supply. A good water supply thus economises the nutrients, and conversely a good nutrient supply economises water. For fruit the relationships are somewhat different, fruiting and growth being in some ways antagonistic. These relationships are important in irrigation practice.

The second way in which nutrients affect the plant is to change its composition, habit of growth, and response to external conditions, including the attacks of insect and fungus pests. So long as the proportion between the different nutrients is such as to give a normal plant, variations in the total amounts have but little effect on composition or habit of growth; the individual plants may be larger or smaller, but the material of the plant is not much affected. As soon, however, as the proportion of any one element falls too low, certain characteristic effects are produced on the plant, which may profoundly alter its reaction to external conditions, and its chemical composition, and therefore its agricultural value.

In certain conditions any of the elements may thus be in deficiency. Considerable investigation has been made to discover the effects of these

deficiencies, and also their symptoms, so that the agricultural expert might be in a position to recognise them. Large excess of certain of the elements relative to the others also produces characteristic effects, which are being studied.

In humid regions deficiency of nitrogen relative to the other elements is common, the result of the ready solubility of the soil nitrates. This reduces the rate of growth and the total amount of growth, but otherwise has little effect on the composition or character of the plant. Nitrogen deficiency is closely linked with the organic matter content and the micro-biological activity of the soil. In the lecturer's experience it does not occur in dry regions.

Phosphate deficiency may arise anywhere, but especially on soils derived from rocks containing little or no animal remains. It reduces the root activity of plants and the tillering of cereals and brings about certain chemical changes profoundly affecting the quality of the produce. Phosphate starved grass is innutritious to animals inducing phosphate deficiency diseases which have been much studied by Theiler, du Toit, and Green in South Africa.

Iron deficiency is, perhaps, more common than is usually recognised. B. C. Aston first found it in certain New Zealand soils, and traced it to a persistent anaemia of cattle, from which they suffered greatly, and finally died. This was in a wet region on somewhat acid soil, sufficiently light to allow of ready leaching out of the iron from the surface layer. A similar disease is said to occur elsewhere in similar conditions, and may have the same cause. Unfortunately, no easily recognisable symptoms in the vegetation have been observed, but analysis of the ash at once reveals the deficiency of iron. A like deficiency may occur in dry regions; possibly some of the fertilising effect of sulphur in these conditions may arise from an effect on the iron compounds in the soil.

To manganese deficiency has been attributed a disease of oats, and to magnesium deficiency a chlorosis of tobacco.

Potassium deficiency is usually found only in relation to nitrogen excess. When the ratio of nitrogen to potassium becomes large, the plant is considerably altered; its leaves become very dark green, liable to die in discoloured patches, liable also to attack by certain fungi; the percentage of starch or sugar in the storage organs falls off, and the percentage of nitrogen compounds correspondingly increases. The grain of barley suffers in malting quality, the tubers of potatoes suffer in cooking quality, and the roots of sugar beet not only contain less sugar, but yield a more impure juice.

Calcium deficiency is in a different category, being closely linked up with the exchangeable bases in the soil, and with the whole body of its physical and chemical properties. It is most liable to occur in wet regions, where it results in an acid soil. It may occur in dry regions, however, especially where sodium chloride is present, and the sodium has displaced some of the calcium.

When this replacement has proceeded beyond a certain stage, the properties of the soil are drastically altered, making it unsuitable for many agricultural crops. This change is of great importance in irrigation areas, and it is an important factor in the evil effects of overwatering.

Mr. C. G. T. Morrison discussed some factors controlling soil fertility, dealing with:

variations in soil composition; the soil as a succession of changing horizons; change in horizon character with season; the content in exchangeable bases, and in degree of saturation of definite horizons varies through the year; the effect of loss of water upon the pH content of soil suspensions, and upon the exchangeable bases content of the soil; the possible effect of dehydration upon soil fertility.

In a paper on 'Physical factors and their control', Dr. B. A. Keen, Dr. W. G. Ogg, and Prof. N. M. Comber pointed out that the soil moisture is undoubtedly the most important physical factor in plant growth. Measures of control seek, as far as possible, to maintain it at its optimum value, which lies between the deleterious extremes of excess (waterlogging) and deficiency (drought). Methods of soil treatment to encourage rapid drainage of excess water are quite well understood, but there is still very considerable divergence of opinion as to how far it is possible, by appropriate methods of cultivation, to conserve soil moisture in regions of deficient rainfall. It is frequently stated that the preservation of a mulch of dried soil is an effective means of conserving from evaporation the water in the soil below the mulch. On the other hand, extensive work on the influence of moisture on crop production in the Great Plains area of America has led to the conclusion that the loss from a mulched surface is practically the same as from an unmulched one; the effect of cultivation is to prevent weed growth, and hence transpiration losses, and the mulch is, in fact, only incidental. The theory on which the supposed action of a mulch is based likens the soil to a mass of fine capillary tubes up which water can ascend from the free water table to the surface. The mulch is supposed to break these channels, and thus to prevent water in liquid form from rising higher than the bottom of the mulch. Work at Rothamsted and elsewhere has shown this idea to be incorrect, and has also demonstrated that the distance to which water can ascend above the free-water table is much less than that predicted by the laws of capillary rise.—*Tropical Agriculture.*