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Recent Advances and Possibilities in Agricultural Research

by T. R. NARAYANAN,
B. Sc. (Ag.), M. A. (Cantab),
Plant Physiologist, Agricultural Research Institute, Coimbatore

The title in no way implies any disparagement of extension or publicity work, but merely wishes to emphasise the need for more and better research. There is an old saying in Tamil "You can take up in the ladle, only what is left in the pot" and it is the primary duty of every research worker to do his bit in keeping the pot always full.

As mentioned in the Memoirs of the Agricultural Department, there is a real need for a constant examination of the programme of research and developmental work to meet the changing needs of the country from time to time. The memoirs, a substantial volume of which was recently published, serves as a convenient review of the work done so far, i. e. till 1948, but it is already more or less out-dated by the recent developments and achievements, even in our own department.

Agricultural research is a vast field of many specialised sciences, which have all one common object, of improving crop production. There is of course never any doubt about such research being essential, but what is not always remembered is that it should also be quite a continuous process and there can never be a stage when one can rest on his oars and allow the current of publicity to carry him through. It is obviously impossible to exhaust or even to indicate the possible lines of development in all fields of agricultural research, and so the present paper will merely outline the scope for further knowledge in just a few aspects.

Agricultural Research may be grouped into five main classes:

(1) Agronomic,
(2) Genetic,
(3) Chemical,
(4) Physiological and
(5) Pathological.

(1) *Agronomic:* Tillage and other cultural operations, spacing and rotation of crops come in this class.

(2) *Genetic:* These include fundamental cytological studies, hybridisation work, both inter-specific and intra-specific and subsequent selection and fixation of desirable pure types, followed by trials to assess the yielding potentialities, culminating in the evolution of improved strains and varieties.

(3) *Chemical:* All studies relating to plant nutrition, the availability of nutrient elements in different soils, their uptake by crop plants under different seasonal conditions and systems of cropping, the inter-relations of nutrients within the plant system, how best to detect, determine and rectify nutrient deficiencies, and the formulation of optimum fertilizing schedules for various crops; all these come under this head.

In recent times the importance of micro-nutrients is being recognised, not only in maintaining proper growth but also in regard to the possibilities of utilising them to increase productivity as well.

As one of the incidental benefits, (though as yet only to a very small extent) of the armaments race in atomic weapons, we may mention the use of radioactive isotopes in the study of plant nutrition problems. In the more advanced countries of the West and even in the East - (as in Japan for instance), these "tagged" elements are being utilised to trace the paths of uptake of nutrients like phosphorus, in crop plants at different stages of growth and very valuable information has already been secured. Thus, by using radioactive P^{32} it is found 80% of the total uptake of phosphorus by wheat plants was from the added fertilizer and only 20% was taken up from the soil reserves. The phosphorus also gets transferred from leaves and stems into the earheads as the plants mature. Another valuable observation was that fertilized plants are able to take up more of soil phosphorus than unfertilized plants. The ability to utilise soil phosphorus varies with different crop-plants ; thus tomato seedlings are unable to utilise the *P* "fixed" in soils, whereas other crops like Sudan grass could utilize a certain proportion of the soil-fixed phosphorus.

Radioactive isotopes are also useful in determining root development and zones of active root growth in plants far more rapidly than was ever possible by the older imbibition methods. Radioactive Nitrogen (N^{15}) has been useful in nitrogen fixation

studies and (C^{14}) is used in photosynthetic researches and carbohydrate metabolism. As another interesting use of radioactive isotopes may be cited the finding that lemon juice was the most active of all substances tested, to remove phosphorus residues from the teeth, although the actual pH of the fruit juice or of any other mouthwash had very little effect upon the phosphorus depletion from teeth.

From the narrow chemical viewpoint, we may cite as recent advances, the use of liquid ammonia and urea as nitrogen fertilizers, various new methods of making rock phosphate more easily utilizable by plants, and a spurt of research on soil conditioners. the best-known being Krilium. Similar ion-exchange resins have recently gained prominence in de-salting brackish water and thereby even for reclamation of saline and alkaline soils.

In analytical methods, some of the older tools have been improved and perfected as in spectrochemical research. Among the newer tools should be mentioned chromatography, in the detection and estimation of numerous plant products ranging from amino-acids to growth-hormones, in even very small quantities of plant material. The use of labour-saving devices and standardised methods in Western laboratories enables them to handle analytical samples nearly 4 to 5 times what we are able to get through in our laboratories. These devices are simple and relatively inexpensive and need only some thought and skill.

The purpose of the foregoing list is merely to stress the fact that we in South India have a very long way to go before we can expect to emulate the tempo and output of research that exists in other countries. There is also a very great and urgent need to carry out adequate soil-nutrient surveys in different tracts and regions in the Madras State, in order to plan manurial experiments in a more intelligent and purposeful manner, wherefrom better results may be expected in quicker time.

(4) *Plant Physiology:* Being a sort of border-land science it is rather difficult to demarcate where exactly plant chemistry ends and physiology begins, and hence the present distinction is chiefly one of convenience.

Thus the problem of nutrient deficiencies in crop plants is one that is being tackled in other countries both by the chemist and the plant physiologist. When the shortage of nutrient elements falls below a certain critical level the plant develops a characteristic

pattern of visual symptoms on the foliage and other parts of the plant and very often these are known by the term of physiological diseases or physiological disorders. As typical examples we may cite "frenching" or "little leaf disease" on various fruit trees caused by zinc deficiency and "die back" due to copper deficiency. Before these deficiencies get acute, there is usually a preliminary symptomless stage, which is detectable only by careful chemical analysis.

The usual methods of correcting such "deficiency disorders" are by supplying the deficient nutrients in a suitable form and manner, either as soil dressings or foliar sprays, or by injection methods. In view of the complexities of physiological balance and interrelations between different nutrient elements, whereby an excess of one element leads to deficiency symptoms of another element (e. g. Manganese toxicity stimulating iron chlorosis] symptoms and Magnesium deficiency being induced by excess of potash manuring) a great deal of systematic and painstaking research is necessary before we can suggest remedial measures for our South Indian crops and conditions. Here again, there is a real need to carry out adequate soil-nutrient surveys over the entire State as has been done in Australia, New Zealand and many other countries, so that we may be able to programme and test out various remedial measures, before recommending suitable remedies for general adoption.

Growth Hormones: A very wide variety of quite remarkable effects have been obtained in recent years on plant growth and development, by the use of chemicals that go by the name of growth-regulating substances. To recount only a few of these effects, we may cite weed control by selective herbicides, induction of better rooting in cuttings, prevention of fruit-shedding, (e. g. Button-shedding in coconut), improvement of fruit-set, induction of seedless fruiting as in tomatoes, prolonging dormancy in tubers (like potatoes) as well as breaking the dormancy when needed for planting purposes, regulation of flowering and fruiting as in pineapples, to stagger the ripening and thereby prolong the fruiting season, hastening the ripening of fruits like bananas and citrus and prevention of cold storage disorders like "Brown spot" etc.; these are some of the remarkable effects obtainable. Some of these chemicals, like benzatriazole for example, causes a breakdown of apical dominance and induces extensive morphological modifications in the leaves and leafstalks - but this occurs only when the chemical is applied to the soil in which the plants are growing; as foliar applications, even at very high concentrations upto 1000 p. p. m. have no effect at all.

Obviously a vast field of research lies here, wherefrom practical results may be expected in a number of aspects closely related to increased crop production.

The problem of drought resistance is of very great importance in crop production, but it must be admitted that we are no nearer any solution to this problem as yet, because in spite of considerable study in various countries we do not have any recognised or generally applicable criterion for an objective assessment of drought resistance. In view of its complexity, real progress may be expected only after intensive studies are carried out under rigid control of environmental conditions like moisture, light, and temperature, and internal factors like nutrient levels etc.

5. *Pathology:* The same is the position with regard to disease-resistance. This takes us on to the next group. Both against insect pests and fungus diseases we have in recent years developed a variety of chemicals that are more effective than the traditional old-time remedies of Bordeaux mixture and fish-oil sprays, but here again there still exists a real need to intensify research. The scope and possibilities of systemic insecticides against insect pests of the stem-boring type, the interrelations between different pests (e.g. mites increasing when jassids on *Bhendi* are reduced by D. D. T.), these require a good deal more of study.

Against fungus diseases like paddy blast, the search for resistant strains is a continuous one and we are still only on the fringe of the subject.

In the field of virus research we have hardly any information, beyond perhaps the occurrence of such virus diseases on specific crops. Advances in protein chemistry and the electron microscope are being put to use in other countries to investigate virus diseases, but in India and South India in particular, we have yet to make up a time-lag of nearly thirty years.