https://doi.org/10.29321/MAJ.10.A04173

Modern Trends in Agriculture — Atom in Agriculture

By S. VENKATACHALAM and
Dr. A. MARIAKULANDAI
Chemistry Section,
Agricultural Research Institute,
Coimbatore.

Introduction: Though it may appear paradoxical it can still be said that the birth of the atomic age has brought peace and prosperity to us, peace in the sense that the first atomic explosion brought the end of World War II and the fear of the atom bomb is keeping off another major war; and prosperity in the sense that tools like radio–active isotopes have been of immense help in the field of medicine and biology. Thus it has helped the diagnosis and alleviation of human suffering in the field of medicine and in the economic use of fertilisers and in solving problems of Plant nutrition in the field of Agriculture.

Radioactive tracers: During the past ten years the use of radioactive isotopes has attracted the attention of scientists. Particularly since an abundant supply of artificial radio isotopes was possible as a result of atom bomb production in America, its use has widely spread not only in America, but in other countries also. The isotope of an element has the same chemical properties but varies in mass. The radioactive isotope has in addition, radiation. For instance P. 32 emitting P. ray (election particle) is a radioactive isotope of P. 31. The radioactive isotope P. 32 is more in use since it has an half life of 14·3 days while K. 42 the radioactive isotope of K. 41 has only 12·4 hours half life. The radioactive isotope of Nitrogen is very short lived, the half life being only 9 minutes. The half life of the isotope used must be sufficiently long so that decay does not remove tracer faster than it can be extracted and assayed. The production of the radioactive isotopes is accomplished by neutron bombardment.

The central feature in tracer methodology is the preparation of labelled samples of elements involved in biological processes. With such samples it becomes possible to distinguish and trace any molecule or atomic grouping the behaviour of which is of interest in connection with biological function. A direct approach to many

important problems in intermediary metabolism had been denied to biologists because it is necessary to discern the biological wanderings of a given atomic grouping once it had disappeared into the organism. In the lablled sample the tracer specimen will undergo the same chemical reactions as the normal samples of the element with which it may be mixed while still remaining distinguishable because of the difference in mass or radio activity. The general procedure in tracer methodology involves the preparation of the labelled compound, into the biological system and later separation and determination of the labelled elements in various fractions. The method is based on the validity of the assumptions viz. (1) that elements exhibit consistancy of isotopes composition and (2) that chemical identity of isotopes is maintained. In case of the first assumption it may be noted that minor fluctuations have been reported for some elements only such as carbon, oxygen, potassium and in particular hydrogen. In the case of the second it holds good only in the case of hydrogen for which extreme isotope mass ratios exist.

There are at least two merits in the utilization of istopes. Firstly, they enable us to exactly trace these elements which we gave or applied purposely. Suppose we wish to measure the availability of phosphatic fertilizers for crop plants, the usual experimental method would be to lay out plots receving that fetilizer and the check. By substracting the amount of P_2O_5 absorbed by the check plot from that of the treated plot we would obtain "the availability of phosphoric acid" of the pertinent fertilizer. By using P32 there is no necessity for the check plot. The mere determination of P32 absorbed from the labelled fertilizer is sufficient to deduce definite conclusion on the availability concerned. The second point is the outstandingly high sensitivity of the detection of radiation through the use of Geiger Muller counter, and its simplicity which is in striking contrast to the microchemical analysis. For example 10^{-17}g. of K. 42 can be detected by the Geiger Muller Counter while the limit for microchemical analysis is only 10^{-6}g.

Highly interesting results have been achieved in the field of Agriculture through the use of these isotopic tracers. To cite a few, using P32 it has been found that wheat utilizes 48–68% P from fertilizers previously believed to be only 10–12%, that the tobacco plant does not utilize any P from the fertiliser added, and that in placement of phosphates, if placed in contact with roots P32 appears in leaves within 20 minutes, if placed 3–4 cm. below seed, P32 appears

in leaves in 2 to 3 days after germination and if placed 5–6 cm. away from seed, it is absorbed in 3–4 weeks. Using C 14 labelled Co. 2 for sugar beets it was found that sugar moves downwards at the rate of 70 cm. per hour along phloem and penetrates even smallest rootlets. In the case of herbaceous plant, organic acids formed in roots from carbonic acid in soil moves upwards at the speed of 3 cm. per minute and penetrate green fruit, growing apices and leaf laminae. Using N 15 in ammonium sulphate for rye it was found that protein material is constantly being renewed in plants some lasting only a few hours and that more than half the nitrogen in chlorophyll is replaced in 2 to 3 days. The enormous possibilities of tracer methods cannot be summarised adequately in any treatise. Even a casual survey of the literature reveals that despite a shortage of tracer material and general unavailability of assay instrumentation much literature has already accumulated.

In India, we are just on the very elementary stage in the use of radioactive isotopes. Some work has been started at the Indian Agricultural Research Institute only recently. However, in the field of plant nutrition and soil chemistry the modern Scientific worker in India as in other countries looks up only to the use of the radioactive tracers for solving his problems.