In general, the lowest levels of contamination by weed seeds, other crop seeds or inert matter are prescribed for fruit and vegetable seeds and the highest for tropical grass species.

THE INFLUENCE OF HERBICIDE RESIDUES ON THE ACCEPTABILITY OR SALE VALUE OF PRODUCE

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Much has been written and spoken about the potential or possible dangers of chemical residues. A considerable amount of this has been alarmist in nature, and unfortunately the news media has been inclined to concentrate on the sensational aspects rather than the dull but re-assuring facts. This is possibly not the fault of the media because the general public seems to prefer the sensational and sadistic.

Many diligent and competent people spend their time analysing for pesticides in foods, assessing their findings, and implementing their conclusions with regulations designed to guard the purity of food supplies. It has been no accident, but rather the result of just such endeavours, that the levels of pesticide residues in the food supply, in spite of the use of millions of pounds of pesticide chemicals each year, has remained within safe levels.

Normally, when one is invited to write on any aspect of pesticide residues, it is necessary to review the problem, pronounce on its seriousness, deduce its origin, predict its implications, and propose action which will eliminate the problem with the least possible disruption to our way of life. In the case of herbicides, however, I know of no instance where, in recent years, residues have affected the acceptability of raw agricultural commodities or food or have interfered with their sale value. This happy position is certainly not equally true in the case of insecticide and fungicide residues. You may well ask why the distinction.

Although there are no completely reliable statistics on world consumption of pesticides, it is generally conceded that

the total is of the order of 700 000 tonnes annually. Herbicides represent more than 300 000 tonnes of this total. In the United States, total pesticide consumption exceeds 375 000 tonnes, of which 59% is used by farmers. Of the total of 163 000 tonnes of herbicides consumed in the United States, 63% or 102,000 tonnes is used by farmers. The bulk of this is used on grain crops with a lesser amount being used on fibre, oilseed and pasture crops and for the control of unwanted vegetation on rangelands. The following is an indication of the approximate amounts of each class of herbicide consumed in the U.S.A. in 1971.

Triazines	29 000 tonnes	Benzoics	4 500 tonnes
Amides	22 000 "	Ureas	3 000 "
Phenoxy compounds	17 000 "	Miscellaneous herbicides	20 000 "
Carbamates	8 000 "		

It will be recognized that many of these compounds are relatively stable and long acting and that they are used in close association with raw agricultural commodities. Notwithstanding this, the U.S. Food and Drug Administration, which has regularly monitored the total diet of the average American consumer for all forms of residues, has found only insignificant amounts of herbicide residues. Only 0.8% of all samples of food examined have been found to contain herbicide residues and then only in trace amounts.

Whereas only 3 of the 360 composite samples of the total diet were found to contain 2,4-D, 2,4-DB, CIPC, and chlorthal-dimethyl residues at well below 0.01mg/kg, 251 of the 360 samples contained cadmium, 245 of the 360 contained bromides, and 55% of all samples contained DDT and its metabolites.

It has been estimated that the intake of herbicide residues by the average American consumer is at the rate of 0.00008 mg per kg per day. The acceptable daily intake for 2,4-D recommended by the Joint FAO/WHO Meeting of Experts on Pesticide Residues is 0.3 mg/kg/day or somewhere in the range of 3000 times the average consumption in the U.S.A.

It is recognized that the level and intensity of herbicide usage is greater in the U.S. than in most other countries, and therefore it can be assumed that relatively little herbicide occurs in raw agricultural commodities produced in Australia or elsewhere.

The likelihood of herbicide residues occurring in food can be judged from the recommendations of the National Health and Medical Research Council. Of the 265 pesticides for which maximum residue limits have been recommended, 56 are herbicides

but only 4 of these have recommendations for finite maximum residue limits. The remaining 52 have recommendations for a limit "at or about the limit of determination". This is an indication that the scientific data evaluated by the Pesticides and Agricultural Chemicals Sub-committee of NHMRC has indicated that there is usually no residue or that the residue level is insignificantly small. In addition, the NHMRC recommendations list 105 substances which are deemed unlikely to produce residues in food when used in accordance with good agricultural practice and when used as directed. Thirty seven of the 105 compounds listed are herbicides.

The U.S. Environment Protection Agency has registered 102 herbicides for varying uses. Of these, 82 have been granted tolerance for residues in food and feed commodities, but of these, 65 have tolerances at low or negligible levels. Only 17 of the 85 compounds have any residue tolerances at limits above 0.5 mg/kg.

The Joint FAO/WHO Meeting of Experts on Pesticide Residues which has evaluated 117 compounds on which it has published monographs reviewing the toxicology, chemistry and residue data available has so far decided that only 6 herbicides justify the evaluation. These are amitrole, 2,4-D, diquat, DNOC, paraquat and 2,4,5-T.

The Codex Committee on Pesticide Residues, composed of representatives of some 80 Governments, has at each of its 8 sessions, considered pesticide residues which should be given priority on account of problems in national and international trade or of public health concern. With the exception of those herbicides already evaluated by the Joint FAO/WHO Meeting, it has been generally agreed that there is no justification for assigning priority to any herbicide because none is reported to have given rise to problems of concern to the Committee.

The reason why herbicides do not create residue problems is partly bound up in the nature of the chemicals themselves, partly in the metabolic processes in plants and animals, and partly in the manner in which herbicides are used. Herbicides are generally used in accordance with the concept of "good agricultural practice in the use of pesticides". This is defined as "the officially recommended or authorized usage of a pesticide necessary under practical conditions at any stage of production, storage, transport, distribution and processing of agricultural commodities, bearing in mind the variations in requirements within and between regions, and which takes into account the minimum quantities necessary to achieve adequate control, applied in a manner so as to leave a residue which is the smallest amount practicable and which is toxicologically acceptable".

Practical considerations necessitate that herbicides used in crops should be selective or that they should be used selectively. When a crop plant has a physiological tolerance to a herbicide it is because the plant metabolises the herbicide rapidly and utilizes the fragments in its growth processes. Where a crop plant is not physiologically resistant, it is usually possible to use a herbicide in such a manner as to prevent contact or uptake by the plant. This is achieved in perennial crops by carefully applying herbicides with relatively poor solubility to weeds and the soil surface, by using directed sprays in row crops, or by pre-emergent treatment of broad-acre crops. In any event, little or no residues reach those plant parts used for food, fibre or feed.

A number of herbicides which are normally applied to pasture or forage plants result in significant amounts of herbicide remaining on the plants or plant parts used for animal feed. To the best of my knowledge, all such herbicide applications result in no or only insignificant amounts of herbicide being transferred to foods of animal origin. Many of the best known herbicides, if administered to livestock in relatively large amounts, are either not absorbed or are metabolized rapidly without being transferred to meat, milk or eggs.

Largely because of emotion generated for political purposes during the Vietnam war, considerable effort has been made to discredit the use of 2,4,5-T on the grounds that it might present an environmental hazard and that its residues might be unsafe to people. Whilst the debate and litigation have not yet been settled, I am not aware of any legal or trade problems resulting from the occurrence of 2,4,5-T residues. Some emotion has apparently been generated in Scandinavia and northern Europe concerning the possible effect of 2,4,5-T brush-killer sprays used for the control of undergrowth in forests on the acceptability of forest berries which are picked for consumption and marketing. Such berries have been shown to contain significant amounts of both 2,4-D and 2,4,5-T residues and there appears to be adequate information on which to establish a maximum residue limit for 2,4,5-T in such berries.

In 1958, considerable damage was done to the cranberry industry when traces of amitrole residues were found in commercial cranberries from the use of amitrole herbicides. Because it was known that massive doses of amitrole given daily for long periods affected the thyroid function of laboratory animals, it was concluded that the residues found in cranberries might be detrimental to the health of consumers. Certainly such use of amitrole cannot be regarded as good

agricultural practice because under the conditions in which cranberries are grown, amitrole residues persist at significant levels for unacceptably long periods. However, the emotion generated by this incident has caused questions to be asked concerning other uses of amitrole which have been shown not to give rise to residues in raw agricultural commodities and foods. Because of this concern, the Joint FAO/WHO Meeting of Experts on Pesticide Residues evaluated amitrole in 1974, and published a series of recommendations which make it clear that when used in the approved manner, there is no risk of residues occurring in foods. Toxicological studies have shown that at moderate rates of administration, amitrole has no adverse effect upon laboratory animals, and there appears to be ample justification for the conclusion that the negligible residues which might arise from adventitious uptake of amitrole by some crops is quite without hazard to consumers.

The absence of problems relating to residues of herbicides in crops and foods has apparently caused national regulatory authorities to be less demanding in their requirements for the registration of herbicides than they are in the case of insecticides and fungicides. This has stimulated the chemical industry to invest a great deal more capital and effort in herbicide research than in research into other pesticides. While there has been a noticeable decline in the number of new insecticides and fungicides developed in recent years, the number of new herbicides is increasing daily. This augurs well for those involved in weed science.

7. LEGISLATION