PRECAUTIONS TO BE EXERCISED IN USING ORGANIC INSECTICIDES ON VEGETABLE CROPS

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In presenting this subject at this time it is my purpose to call attention to the dangers involved in the use of the organic insecticides available since 1945 and to emphasize the precautions which should be rigidly practiced in the use of these insecticides.

Everyone is aware that the effectiveness of an insecticide depends upon its ability to kill insects. Most growers also know that these effective insecticides are harmful to man. Two of the oldest insecticides, nicotine and arseneate of lead, are violent poisons and have caused human deaths when carelessly handled. It is my firm opinion that we should not discard these materials simply because they are capable of causing human death in careless hands. No one advocates discontinuing the use of automobiles. Yet automobiles are directly responsible for thousands of human deaths each year. If, then we are to continue to use these poisonous insecticides we must constantly and carefully practice the necessary precautions.

In 1925 the apple growers of the United States were forcibly reminded of their responsibility for excessive residues of arsenicals on their apples by the refusal of the British Government to allow entry into England to apples carrying a residue in excess of tolerances established earlier. In 1926 the celery growers of the Sanford area were amazed to find one morning that their unwashed celery could not be shipped to market because it had been found to be carrying arsenical residue in excess of the established residue tolerances. The use of arsenicals in vegetable production has been discontinued since the introduction of synthetic organic insecticides beginning in 1945. Since information upon which to base the establishment of tolerance for organic insecticides has not been available no tolerance levels for these materials has been established. Thus growers have had a period of several years during which they have not worried about insecticidal residues on their crops. This period is rapidly drawing to a close because the Pure Food and Drug Administration has called a hearing in January for the purpose of gathering information which will be used in establishing tolerance levels for the various insecticides. As many of you know, some canners and food processors have already declared that vegetables known to have been treated with some insecticides will not be purchased. In addition to his responsibility to the consumers of vegetables, the grower has a responsibility to his laborers and himself to consider in the use of these poisonous insecticides. It is time for vegetable growers to again begin to think seriously of these responsibilities.

Considerable time is required to accurately evaluate the potential dangers of insecticide residues, involving as it does studies of acute and chronic oral and external surface toxicity, biochemical studies with special emphasis on absorption, distribution and excretion, and the pathological effect of various poisons upon the organs of the body. Of course, these studies must be conducted upon laboratory animals and for this reason the exact effect of these materials upon humans cannot be accurately determined. However, as accidents occur a knowledge of the reaction of the human body is gradually built up to supplement the knowledge gained from laboratory studies.

With the above factors in mind I shall briefly review the information accumulated on the toxic effects of the organic insecticides. A number of research workers have been intensively studying the many phases of the problems of toxicity of these materials. Practically all of the information given below has been taken from two papers published by
Lehman. In the following discussion it should be remembered that the statements refer to reactions of laboratory animals produced by chemicals of high purity as such or in an innocuous solvent. There are thousands of formulations of probably not more than twenty-five insecticides. The solvents, diluents, wetting agents and carriers used in these formulations may be solely responsible for injuries and it is often impossible to determine which of these ingredients should be incriminated. For this reason chemicals of high purity were used in the laboratory experiments.

At the present time there are three insecticides derived from vegetable sources in common use. These are derris, pyrethrum and nicotine. The insecticidal quality of derris is due to a number of constituents, the principal one being rotenone. Rotenone applied to the skin occasionally produces a mild irritation which persists about twenty-four hours after the removal of the causative agent. Irritation of the mucous membranes of the nose and eye are caused by contact but no permanent injury has been reported. Rotenone is not absorbed by the skin. The fatal dose is probably quite large. It has been shown that finely powdered rotenone is about six times as poisonous as coarse crystals and that the intravenous toxicity is three to eight thousand times the oral toxicity. It has also been shown that finely powdered rotenone has a toxicity of approximately the same order as intravenous injections. It can be seen that the inhalation of finely ground rotenone or derris can be very serious.

The active constituents of pyrethrum are called pyrethrins. The highest concentrations in commercial use are twenty percent pyrethrum extracts in oil. The single acute oral dose is quite large in animals. Household preparations of pyrethrum are usually in kerosene. Toxic effects following the accidental swallowing of these preparations would be due to the effects of the kerosene.

Nicotine is a very volatile liquid alkaloid. Nicotine 80 contains 80 percent of the alkaloid. The other liquid form of nicotine on the market contains 40 percent nicotine sulfate. Nicotine alkaloid penetrates the skin very readily while the sulfate does not. For this reason nicotine 80 is very dangerous to handle. Nicotine is one of the most rapid and deadly poisons known to man.

The remaining insecticides are known as synthetic organic chemicals. These include lethanes, DDT, TDE, methoxychlor, clordane, benzene hexachloride, toxahene, tetra ethyl pyrophosphate, parathion, Compound 118 and Compound 497. The latter two materials are so new that they have not yet been given names and they are not at present on the market.

There are four materials on the market which have as their active ingredients aliphatic thiocyanates. These four materials are grouped together under the name lethanes. The lethanes are dissolved in refined kerosene at concentrations of 2 and 3 percent of the active ingredient. Thus the local effects produced by the lethane solutions are due to the kerosene. Concentrated solutions containing 50 percent lethanes are also available. A small dose of these concentrates taken internally will result in death within a few minutes.

This brings us to the DDT group which also includes TDE (Rothane) and methoxychlor. DDT crystals do not affect the skin but solutions of DDT are absorbed through the skin and multiple exposures by spilling the solutions of DDT on the body are hazardous. The amount of DDT required to cause death by a single dose taken internally by man is not known. Methoxychlor is only slightly irritating to the skin when applied in the crystalline form. Like DDT, solutions of Methoxychlor are absorbed through the skin. Rothane, like Methoxychlor, is slightly irritating to the skin and oil solutions are absorbed through the skin.

Chlordane is a complex chemical compound composed of several closely related chemicals. Concentrated commercial chlordane is moderately irritating to the skin but in insecticidal dilutions this property is lost. Chlordane in solution is absorbed through the skin. Chlordane is rated to be about five times as poisonous as DDT.

Benzene hexachloride is another of the complex chlorinated hydrocarbon compounds. The
The gamma isomer of Benzene hexachloride is the principal insecticidal agent and the combination with the other three isomers is a skin irritant. The damage caused is in direct proportion to the amount of the gamma isomer in the mixture. Repeated application of benzene hexachloride increases the toxic effect by 200 fold. When taken internally three of the isomers of benzene hexachloride act as central nervous stimulants while the other isomer acts as a depressant. Benzene hexachloride is rated as about twice as poisonous as DDT.

Toxaphene is a chlorinated derivative of camphene which is a by-product of naval stores manufacture. Toxaphene is moderately irritating to the skin and it can be absorbed through the skin in dangerous quantities. Toxaphene is about four times as poisonous as DDT when taken internally.

The two important members of the organic phosphate group are tetra ethyl pyrophosphate known as TEPP and parathion. TEPP is the most dangerous of all of the insecticides because it is rapidly absorbed through the skin and is capable of causing death in very small quantities. As little as one small drop splashed into the eye may be fatal. A number of deaths have resulted from the breathing of the dust or spray mist of Parathion.

To the present time only preliminary results from the investigations of Compounds 118 and 497 have been reported. These preliminary results indicate that both of these compounds are readily absorbed through the skin and that they are very poisonous to man.

From the standpoint of the single acute dose these insecticides have been tentatively classified in the order of their relative hazards to public health. This arrangement with the most poisonous material first follows: TEPP—Parathion Compound 497—Nicotine—Compound 118—Chlordane—Toxaphene—DDT—Rotenone—Lethane 384—Lethane 384 special—Benzene hexachloride—Lethane 60—Thanite—Rothane—and Methoxychlor. The toxicity of pyrethrum and the inert activators N-propyl isome and piperonyl butoxide is so low that the danger from taking an injurious amount of these materials appears to be very small.

The matter of chronic toxicity or the eating of small quantities of these chemicals as residues on one or more food substances is quite a different problem. One of the complicating factors is that many of our foods, particularly vegetables, may carry small amounts of these poisons as residues. An attempt has been made to evaluate the relative dangers from these poisons as spray residue contamination of food. This comparative rating has been made under the assumption that a single item of food is contaminated. The rating is expressed in parts per million of the smallest amount of the insecticide which will cause toxic effects. This rating is as follows:

- Rotenone—5 parts per million.
- Pyrethrins—10 parts per million.
- TEPP—Rapidly decomposes; known decomposition products not considered hazardous.
- Parathion—2 parts per million.
- DDT—Less than 1 part per million if all the food is contaminated; 5 parts per million if only one item of food is contaminated.
- Benzene hexachloride—Similar to DDT.
- Chlordane—Similar to DDT.
- Toxaphene—Probably 5 parts per million.
- Rothane—Probably 5 parts per million.
- Methoxychlor—Probably 10 parts per million.
- N-propyl isome—10 parts per million.
- Piperonyl butoxide—10 parts per million.

A very considerable amount of information has been accumulated on the amount of DDT residue remaining on vegetables grown in other states and treated with the various formulations of this insecticide. It is necessary that as soon as possible this type of information be gathered for vegetables grown in Florida. The information available from work done in other states does not apply to Florida grown vegetables because our vegetables are produced under entirely different temperature, sunlight and rainfall conditions. These factors greatly influence the amount of insecticidal residues remaining on vegetable crops as well as the concentration and number of applications of the insecticide and the length of the period between the last application and harvest. The Experiment Station now has two chemists, one
located at the Everglades Station and one at
the Central Florida Station, studying these
residue problems. Through the work of these
chemists cooperating with the entomologists
of these Stations information is being gathered
as rapidly as possible.

In the meantime there are precautions that
vegetable growers can and should put into
practice, to safeguard the health of vegetable
consumers, his laborers and himself. These
precautions are separated into two groups;
those for the protection of consumers of
vegetables and those for the protection of the
grower and his laborers. Under the first group:

(1) Do not use greater concentrations of
the insecticide than is required.

(2) Familiarize yourself with the insect to
be controlled and make no more applications
than necessary.

(3) Keep your crops free of insects during
the early stages of growth and usually no
insecticide application will be required within
30 days of harvest.

(4) Do not apply parathion or any of the
chlorinated hydrocarbon insecticides within
30 days of harvest.

(5) If an application of an insecticide is
required within 30 days of harvest use TEPP
or pyrethrum.

Under the second group:

(1) Do not spill liquid insecticides on
clothing or the body.

(2) After completing a spray or dust op-
eration take a bath and change to fresh
clothing.

(3) Avoid the dust or spray mist pro-
duced by the application of insecticides.

(4) Read the labels on the container to
become familiar with the chemical being used.

(5) In transferring insecticides from the
container to the spray or dust machinery,
stand on the up wind side of the machinery.

(6) If insecticides are accidentally spilled
upon the clothing or the body, remove the
clothing immediately and scrub the body vig-
orously with soap and water.

(7) In case symptoms resulting from the
use of insecticides develop see a doctor im-
mediately.

(8) While spraying or dusting wear a suit-
able gas mask. The ordinary dust mask is not
effective.

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COMPATABILITY OF SPRAY MATERIALS

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Florida's mild climate makes possible the
growing of winter vegetables, but also pro-
vides ideal conditions for the development of
many insect pests throughout the annual cycle.
The Gulf and Atlantic Ocean, which keep our
summer temperatures down and our winter
temperatures up, also keep air humidity at a
high level and thus favor the development of
various plant disease organisms. And our
heavily leached soils are all low in one or
more of the nutrients essential to heavy pro-
duction of vegetable crops. Certain of these
nutrients can be supplied economically in small
amounts to the foliage of growing crops by
means of sprays.

It is possible to apply these insecticides,
tungicides and nutrients separately, of course,
and we know pretty well what we can expect
from them when applied in this manner. We
also know from experience and from reports
by manufacturers that certain combinations
of materials are reasonably safe and effective.
And we know that it is cheaper to apply them
in combination.

Much valuable testing is done by commer-
cial companies long before their products ap-
pear on the market. Some of these companies