EFFECTS OF ALDRIN, ISODRIN, DIELDRIN AND ENDRIN ON GERMINATION, GROWTH AND CHEMICAL CONSTITUENTS OF SOME HORTICULTURAL CROP PLANTS

by

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* * *

ABSTRACT

Soil was treated with Aldrin, Isodrin, Dieldrin and Endrin respectively and a number of horticultural crop plants planted in it and the effects were observed and recorded.

Yield increases were obtained with potatoes and carrots under field conditions, the maximum yield being found at the rate of 6.5 lbs. per acre of each compound used.

Growth rates of tomato plants appeared to be slightly stimulated by all the compounds. With radish, on the other hand, Aldrin and Isodrin depressed foiliar growth while Dieldrin and Endrin favoured top growth; this was reflected in top-root ratios.

Dieldrin and Endrin had a definite stimulatory effect on germination of radish seeds grown on treated agar. Maximum stimulation was obtained with Dieldrin and Endrin at 40-200 p.p.m., with Isodrin at 40 p.p.m. and Aldrin at 10 p.p.m. Soil applications of the compounds appeared only slightly to stimulate radish seed germination while tomato seeds were unaffected.

A general depression of sugar content was noted in all crops with all compounds while Vitamin C content of radish was significantly depressed. Aldrin and Isodrin greatly depressed the nitrogen content of radish tops and roots while phosphorus was depressed greatly in the foilage. Dieldrin and Endrin increased nitrogen in radish foilage and roots and had little effect on the phosphorus content.

Aldrin and Dieldrin greatly increased the chlorine content of potatoes but did not affect the dry matter content. Endrim and Isodrin had little effect on the chlorine content of carrots.

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INTRODUCTION

The production of large quantities of highest quality food is a major industry. Agriculture in general has been revolutionized with the advent of modern science. Engineering and physics have designed newer and better machines while from the chemical laboratories, come the modern fungicides and insecticides. At the present, it seems hard to visualize the tremendous effect the development of various organic insecticides will have on production of high quality food.

Since the release of D.D.T. (dichlorodiphenyltrichloroethane) insecticide, many other named and unnamed insecticides have been synthesized in laboratories. These new organic insecticides have a much wider range of effectiveness than the older inorganic insecticides.

Aldrin, Dieldrin, and the recently named newer isomers of Aldrin and Dieldrin, Isodrin and Endrin respectively, are cyclic chlorinated organic insecticides which are in many ways more potent insecticidally than D.D.T. or chlordane.

The value of Aldrin and its isomer, Isodrin, and Dieldrin and its isomer, Endrin, as far as their insecticidal potency is concerned has been amply demonstrated.

The object of this experiment was to investigate the lesser known aspect of these compounds; namely their effect on the plant, rather than on the insect. To date, very little published work exists on the possible effects Aldrin, Isodrin, Dieldrin and Endrin might have on plants.

Attention has been directed mainly to the immediate effects of Aldrin, Isodrin, Dieldrin and Endrin on horticultural crop plants. Their effect, if any, was noted on yield, general top growth, effect on some chemical constituents, and effect on germination of seeds.

Review of Literature:

(a) Effect of chlorinated hydro-carbon insecticides on plants.

Probably some of the most recent work in this field was conducted by Randall (28). He studied effects of chlordane, (a compound closely resembling Aldrin and Dieldrin), D.D.T. and Benzene hexachloride on growth and nodulation of Red clover, Trifolium protense Linn. Stimulation of germination was noticed at certain concentrations. Significant growth and yield differences occurred between insecticide treatments and dosage levels. Size and distribution of nodule formation was affected by the insecticides while the nitrogen and phosphorus levels in the foilage appeared to be unaffected.

Biological assay of the clover plants failed to show any evidence of translocation of the insecticides from roots to foilage.

Effects of chlordane at high concentration have been studied by the writer (33). It was noted that high levels of chlordane used as a soil sterilant reduced Vitamin C content and per cent sugars in radish. Total chlorine analysis of plant tissue showed a positive correlation between amount of insecticide used and amount of chlorine present in the plant tissue.

Nelson (26) reports that 12 lbs. per acre applications of Dieldrin gave onion maggot and smut control and also resulted in very marked stimulation of growth of onions. No phytotoxic reactions were noticed by Kuitert and Tissot(24) when Dieldrin was used to control budworms and hornworms on tobacco while Elmore (13) reports that better stands of lima beans were obtained with Dieldrin combined with Arason than with Spergon alone. Crowell and Morrison (7) however, report that Aldrin and Dieldrin as well as some other similar insecticides have phytotoxic effects on cucurbits if the compounds are applied under relatively moist conditions. Squash varieties belonging to the species Cucurbita maxima appeared more tolerant of the insecticides than other varieties. This suggests that different plants may react quite differently to these compounds. This has been substantiated by Foster (15) who reports that many different effects were observed when using Dieldrin, Aldrin and other organic insecticides in soil with many species of plants.

Numerous reports exist on the effect of some organic insecticides on flavour. Benzene Hexachloride appears to affect the flavour more readily of more crops than any other organic insecticide now used. Howe (20) reports off-flavours of squash when Benzene Hexachloride and Lindane were used to control squash vine borer. Gould et al (18) tested Benzene Hexachloride, chlordane, parathion, D.D.T. and Toxaphene on tomatoes, lima beans, carrots and potatoes and peaches and plums. These were processed according to accepted commercial practises and after three months' storage, sampled by a trained taste panel of twelve persons. The potato was the most susceptible to off-flavours imparted by the insecticides while carrots and lima beans were the least susceptible. These workers concluded that Benzene Hexachloride formulations affected the flavours of all fruits and vegetables while chlordane, parathion, D.D.T., and Toxaphene may impart off-flavours to the edible parts of some of the fruits and vegetables.

Translocation studies carried out at Kansas State College (1) indicate that no Aldrin residues were present in potatoes and tomatoes with soil applications up to five pounds of actual Aldrin per acre and with cabbage, onion and sweet corn, even 100 pounds actual Aldrin per acre gave no residual effects. It should be noted that 100 pounds actual Aldrin per acre is 20 to 50 times the amount required for economical insect control.

(b) The effectiveness of Aldrin, Isodrin, Dieldrin and Endrin against soil-borne insects.

The literature describing the usefulness of the above insecticides in combating various pests is mainly in connection with Aldrin and Dieldrin. The newer sterioisomers, Isodrin and Endrin respectively, are being tested at the present time.

The compounds are extremely insecticidally potent. This is well demonstrated by the fact that 6 to 8 ounces of Aldrin and 3 to 4 ounces of Dieldrin per acre will control army worms while from 1 to 3 ounces of Aldrin or Dieldrin give effective control of grasshoppers. In general, 3 to 10 ounces of Aldrin or Dieldrin per acre will control a large variety of insects (8) and the same amounts of Isodrin and Endrin appear to be equally effective for insect control (14) (23).

Excellent control of turf and soil insects has been reported when using 2 to 5 pounds Aldrin per acre applied to the seed bed and thoroughly mixed with soil (2).

Very favourable control of soil insects, such as southern corn root worm and sand wire worm has been obtained using chlordane and other chlorinated hydro-carbon insecticides in fertilizer mixes, Watts (34) reports successful control of insects with fertilizer mixes containing the insecticides Aldrin, Dieldrin, chlordane, D.D.T. and B.H.C.

Breakey and Gould (5) report highly satisfactory control of wire worm with Dieldrin in Wedgwood Iris bulbs. Bulbs were dipped for 10 minutes and planted in wire worm infested soil. Another report (21) states that 10 pounds of actual Dieldrin gave excellent reduction of wire worm in potatoes in one season while in another test (22) it gave very promising results for control of wire worm and white grubs in potatoes.

Morrison (25) reports that 2 to 4 ounces Dieldrin per 100 pounds of sugar beet seed appeared to be of particular value for wire worm control and Dieldrin seed treatment also gave excellent control of seed-corn maggot.

The insecticide compounds appear to have a very definite place in insect control in wheat fields. A few ounces of chlordane per acre will give satisfactory control of grasshopper. Similarly, Franklin (17) reports that 4 ounces Dieldrin per acre gave 83 per cent control of army cutworm and increased yields 143 per cent over the control plots. In a similar experiment, (16), 1, 2 and 4 ounces Dieldrin per acre again gave 50 to 88 per cent control of army cutworm while yields of wheat were increased by 233 per cent over the control. Other reports (14) state that favourable results could be discerned in wheat fields eight days after application of 8 ounces actual Dieldrin per acre.

As mentioned earlier, the sterioisomers of Aldrin and Dieldrin appear to be equally potent insecticides. Early tests with Endrin (14), isomer of Dieldrin, show excellent control of red-backed, striped, dingy and variegated cutworm at as low as 0.07 pounds actual Endrin per acre in raw treatments or 0.2 pounds in broadcast treatment.

The onion root maggot appears to be completely controlled with the newer organic insecticides. Hanford and Finlayson (19) obtained promising results using 1 ounce Dieldrin per 100 pounds onion seed. At another locality (17) Dieldrin appeared to give the best onion maggot control while Stitt in Washington State (30) reports satisfactory results from the use of the above compounds.

The compounds appear to be useful not only for control of a large variety of soil insects but also for leaf hoppers, beetles, ants, earwigs and other insects which attack foilage.

(c) Methods of Analysis

A complete description of analysis for Aldrin (25) is described under Materials and Methods in this thesis. However, various other methods exist and since the insecticide compounds are relatively new, better methods of analysis are being developed. Methods of analysis might be divided into chemical, physical and biological.

The bioassay method of Dahm and Pankaskie (9) utilizes the housefly as a test insect and permits detection of 1 to 2 micrograms Aldrin. The bioassay method appears to be reasonably applicable to the other three compounds as well and various modified procedures are possible to determine the minimum lethal dose of various test organisms.

Further bioassay methods have been developed, using test organisms, for Aldrin and Dieldrin by Dahm (10) while Terriere and Crowell (32) used the bioassay method to evaluate insecticide residues in potatoes grown in treated soils. Bioassay methods prove valuable where other methods cannot be carried out.

Photometric analysis methods have been devised to detect Aldrin and Dieldrin. These methods employ fairly elaborate procedures and equipment and consequently find only limited application. A method for Aldrin detection has been developed by Danish and Lidov (11) while Danish, Koening and Kuderna (12) later developed a method whereby Aldrin and Dieldrin could be detected by a Photometric analysis method. No photometric analysis methods have at the time of this writing been developed for Isodrin and Endrin.

Total chlorine analysis is a useful method where other methods cannot be used or, as in the case of Isodrin and Endrin, other methods have not yet been devised. A complete description of total chlorine analysis procedure is described under "Materials and Methods."

(d) Pharmacological and Toxicological Aspects of the Compounds.

The manufacturers advise that reasonable precautions be taken by the user, especially with the newer isomeric compounds (8), (14), (23), while experimenters have found that when Dieldrin is used at recommended dosage rates, it is only one-fifth as toxic to the operator as parathion applied at the usual rate (31).

Hearings have been held to establish minimum levels of these compounds as spray residue by Food and Drug Bureaus. Amounts of the compounds must be small to meet standards. Such standards would appear very necessary since Anderson et al (3) reports that 3 p.p.m. of technical Aldrin caused a significant depression of the growth rate of young turkeys. All levels above 25 p.p.m. were highly toxic while at 12.5 p.p.m. a 15% mortality rate in a 42-day feeding period was encountered. Arant (4) experimenting with 3 and 6-week old chickens found that chickens of both age levels died if Aldrin was present at 25 p.p.m. concentration in the feed.

Princi and Spurbeck (27) found that 95 to 105 mg. Aldrin per kilogram of body weight and 65 to 95 mg. Dieldrin may be lethal to dogs. Principle signs of chlordane poisoning were of a neurological nature; the chief pathological changes were damage to the liver and subscrosal hemorrhages.

Examination of 27 humans exposed to the compounds in various manners (in factory or handling) revealed no abnormalities and the experimenters were led to believe that under the conditions of formulation and use, chlordane, Aldrin and Dieldrin would not produce measurable harmful effects among those persons who are continuously exposed to concentrations encountered under ordinary conditions of use. However, ordinary precautions were advised to prevent excessive accidental exposures and skin absorption.

Further toxicological work would appear to be desirable especially with the newer compounds, Isodrin and Endrin. In general, it appears that Aldrin, Isodrin, Dieldrin and Endrin are less hazardous to the user than some of the older insecticides and consequently will probably find relatively wide use.

The experiments described in this thesis were started in the summer of 1952 and completed in the summer of 1953. Greenhouse experiments were conducted during the winter of 1952-53. All work described was carried out in the Horticulture greenhouses and laboratories of the University of British Columbia.

MATERIALS AND METHODS

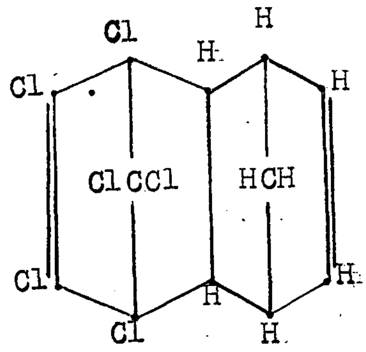
The organic insecticide compounds Aldrin, Isodrin, Dieldrin and Endrin were used as soil insecticides at various rates and their effect on subsequent plant growth and chemical composition studied. The various experiments are fully described in this section of the paper as well as the insecticides.

Description of the Compounds:

Aldrin (1)

Definitions:

Aldrin is the official coined name for an alkali-stable, insecticidal product containing not less than 95% of 1, 2, 3, 4, 10, 10 - hexachloro -1, 4, 4a, 5, 8, 8a - hexahydro -1, 4, 5, 8 - dimethanonaphthalene and not more than 5% of insecticidally active, related chlorinated hydrocarbons. The dimethanonaphthalene compound has an empirical formula $C_{12}H_8Cl_6$ and its planar structural representation is:



Physical and Chemical Properties:

Appearance:

Buff coloured, nearly odourless, crystalline solid.

Melting Point:

On repeated crystallization, Aldrin melts at 101-102°C. The melting point of the commercial product is not less than 90°C.

Solubility:

Aldrin is freely soluble in aliphatic and aromatic solvents and is sparingly soluble in methanol. It is insoluble in water.

Chemical Stability:

Aldrin is stable in the presence of strong organic and inorganic alkalis and is unaffected by hydrated metallic chlorides. It is also unaffected by acids normally encountered in the agricultural chemical field.

Compatibility:

Because of its chemical stability, Aldrin may be freely used with most of the available agricultural chemicals, including fertilizers, herbicides, fungicides and insecticides. It may be used in the presence of alkaline soils, lime, lime-sulphur, Bordeaux mixture and other materials of high pH. When used in combination with acidic insecticides, Aldrin is unaffected unless the acidity of the single-phase solution falls below a pH of 3.

Residual Properties of Aldrin:

The persistence of Aldrin residues on plant material is of relatively short duration as compared with other chlorinated insecticides, chlordane, toxaphene, D.D.T. and Dieldrin. From extensive studies and analyses carried out, results have shown that lindane residues were the least, followed by Aldrin, Chlordane, Dieldrin, toxaphene and D.D.T. in that order.

The volatile nature of Aldrin is indicated in the following table.

Aldrin Residues on Alfalfa treated with

0.5 pounds Aldrin per Acre (11).

Cutting time After Application (days)	P.P.M. Aldrin residue based on Dry Weight of Alfalfa
0	5.80
1	3.60
3	1.50
5	1.00
7	0.12
14	0.00
19	0.07
22	0.00
25	0.00

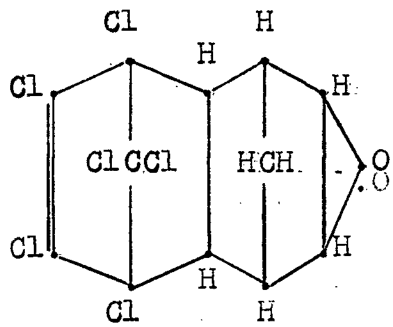
The amounts of Aldrin residue will not be uniform since they depend on a number of factors such as time, frequency and method of application, stage of development of edible crop, wind, rain and temperatures between application and harvest, and other variables.

Dieldrin

Definition: (6)

Dieldrin is the common coined name of a new chemical insect toxicant. The empirical formula of Dieldrin is $C_{12}H_8OCl_6$ and the insecticidal product contains not less than 85 per cent of 1, 2, 3, 4, 10, 10- hexachloro -6, 7- epoxy -1, 4, 4a, 5, 6, 7, 8, 8a - octahydro -1, 4, 5, 8 - dimethanonaphthalene.

Structural Formula:



Stability:

Dieldrin is stable in the presence of organic and inorganic alkalies and also stable to the action of acids commonly encountered in normal conditions of use in the agricultural chemical field. However, it may be affected by strong mineral acids.

Compatibility:

Dieldrin is compatible with all commonly used insecticides and fungicides.

Mammalian Toxicity:

Dieldrin is a toxic material and must be properly used. If used within recommendations and specifications, it can be used without hazard to man, animals or plants. Swine appear to be most resistant while young calves are most susceptible when exposed to sprays containing Dieldrin.

Residual properties:

The residual properties of Dieldrin will give protection to crops for a long period without leaving harmful harvest residues. It is desirable because of its residual action to apply the compound long before harvest.

Isodrin (#711)

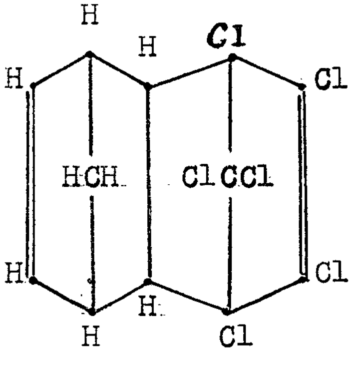
Definitions: (23)

Compound 711 is a sterioisomer of Aldrin, and was developed in the research laboratory of Julius Hyman and Company. It is the numerical designation provisionally given by Julius Hyman and Co. to the insecticidal chemical 1, 2, 3, 4, 10, 10 - hexachloro - 1, 4, 4a, 5, 8, 8a - hexahydro - 1, 4, 5, 8 - endo-endo-dimethanonaphthalene. The formula is identical to Aldrin except that Aldrin is the endo-exo isomer.

Physical and chemical properties:

Empirical formula: $C_{12}H_8Cl_6$

Structural Formula:



The compound is a white, crystalline solid which is slowly decomposed when heated above 100°C. The chlorine atoms of Compound 711 are not removable with the usual alkaline reagents; refluxing of the compound with metallic sodium in isoproponol is required to affect deholegenation. In single phase solutions, strong mineral acids will add to the double bond of Compound 711.

Solubility:

The compound is insoluble in water but is soluble in the usual organic solvents. The solubility of 711 in aromatic hydrocarbons such as benzene and xylene is greater than in paraffinic solvents such as hexane or kerosene.

Residual Action:

The residual activity of Compound 711 appears to be of a duration comparable to that of Aldrin.

Compatibility:

The compound is stable to alkalies and is unaffected by acidic conditions normally encountered in agricultural use. This material is compatible with the commonly used insecticides, fungicides and herbicides.

Phytotoxicity:

Compound 711 produced no adverse effects on plants tested. Corn buds have showed signs of "burn" in one instance but more investigation is under way to determine exactly the cause of burning.

Mammalian Toxicity:

Tests for its oral toxicity to laboratory white rats showed the median lethal dose of the compound to be 12 - 17 milligrams per kilogram of body weight. Subacute and chronic toxicological investigations are under way. It is evident, based on existing information, that the compound, particularly in the more concentrated form, will have to be handled with caution. However, because of its high order of insecticidal effectiveness plus its moderate residual characteristics, the mammalian toxicity is not expected to preclude its use except on food and forage crops near harvest.

Endrin (#269)

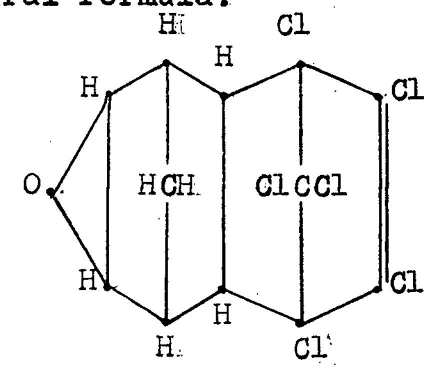
Definitions: (14)

Compound 269 is the numerical designation provisionally given by Julius Hyman and Co. to the insecticidal chemical 1, 2, 3, 4, 10, 10 - hexachlor - 6, 7 - epoxy - 1, 4, 4a, 5, 6, 7, 8, 8a - octahydro - 1, 4, 5, 8 - endo-endo-dimethanonaphthalene. It was developed in the research laboratory of Julius Hyman and Co. and is a sterioisomer of Dieldrin. The formula of 269 is identical to that of Dieldrin except that Dieldrin is the endo-exo isomer.

Physical and Chemical properties:

Empirical formula: $C_{12}H_8Cl_6O$

Structural formula:



Compound 269 is a white, crystalline solid which melts with gradual chemical re-arrangement when heated above 200°C. The chlorine atoms of the compound are not removable with the usual alkaline reagents; refluxing of the compound with metallic sodium in isoproponol is required to effect deholo-genation. Acids cause Compound 269 to rearrange into an insecticidally inactive compound.

Solubility:

The compound is insoluble in water but is soluble in the usual organic solvents. It is more readily soluble in aromatic solvents such as benzene and xylene than in paraffinic solvents such as hexane or kerosene.

Residual Action:

The residual activity of the compound appears to be that of Dieldrin.

Compatibility:

Compound 269 is stable to alkalies and is unaffected by acidic conditions normally encountered in agricultural use. It is also compatible with the commonly used insecticides, fungicides and herbicides.

Phytotoxicity:

The compound produces no adverse effects on plants when used in the recommended dosages. Corn bud and cucumber foilage have shown signs of "burn" in one or two instances but closer investigation is necessary to ascertain what caused this.

General toxicity to Mammals:

Insecticidal formulations containing Compound 269 should be handled with extreme care. Contaminated clothing should be removed and laundered and the compound washed off the skin promptly. During application of the compound, respirators should be worn.

The various experiments conducted are described more or less in the order they were conducted. Field tests were carried out with the four insecticides just described. Carrots and potatoes were chosen on which to conduct the tests.

I. (a) The effect of Isodrin and Endrin on carrots, *Daucus carrota*, var. Chantenay Red Core.

Four different rates of application of the insecticide were used: 0.5, 3.5, 6.5 and 9.5 pounds of actual Isodrin and Endrin per acre and compared to control plots where no insecticide was applied. Treatments were replicated nine times in a randomized block plot design. Individual plots were 24 square feet in area. The compounds were mixed into the top 1 to 2 inches of soil near and in the rows. The seeds were planted with a seeder to ensure uniform stand and planting depth.

Ordinary cultural practises were carried out during the summer and when the carrots were mature they were harvested and weighed and 15 roots were selected at random from the crop of each plot and stored for future chemical analysis in common storage. Total yield (root weight) and top weights were recorded on each plot and the top-root ratios obtained from this recorded data.

The storage time was kept to a minimum in order to make further analysis with relatively fresh material. Roots were cut in pie-section and the pieces thoroughly mixed and finely ground in a vegetable grinder. On a portion of the ground sample the sugar content of expressed juice was determined with a refractomer. From the remaining portion of the freshly ground material 5 gram samples, in duplicate, were added to a given volume of acetone and tightly sealed for carotene estimation. Further, 10 gram samples, also in duplicate, were placed in 40 ml. of .1 N N_aOH for chlorine determination and 20 gram samples were weighed, in duplicate, into previously tared crucibles and dried in an electric drying oven at 60°C to determine the percentage moisture. These dried samples were later ignited and ashed in an electric muffle furnace to determine the percentage ash.

Method for determination of carotene in carrots - the procedure outlined is suitable for carrots only. (Method developed by Booth).

The previously stored samples were transferred with the acetone into a mortar and very finely ground. The coloured liquid was carefully poured off into a separatory funnel and the residue covered with small quantities of 60-30 acetone-petroleum ether extracting solution and ground further. This was continued until no colour remained in the residue. The coloured extract in the separatory funnel was given a gentle swirling motion. The acetone-ether with the dissolved carotinoids forms a definite layer above the colourless acetone-water layer. The acetone-water layer is allowed to run out and the acetone-ether liquid is brought to volume. Aliquots of this solution were read in a Klett-Summerson colourimeter. The standard solution for comparison is a 0.02 per cent potassium dichromate solution which is equivalent to 30 mgms. carotinoids or Vitamin A which has been checked against a sample of pure beta-carotene.

Sample calculation:

Final volume of extracted solution - 55 ml.

Weight of carrot - 5 gm.

Colourimeter reading of Standard -110

" " " unknown -325

10 ml. of original 55 ml. used for reading.

$$\therefore \frac{55}{10} \times \frac{325}{110} \times 0.02 \times \frac{100}{5} = 7.14 \text{ mg. carotinoid}$$

per 100 gms. of carrot, F.W.

The method of analysis for total chlorine:

(As described in A.O.A.C.)

The 10 gms. of sample along with the 40 ml. of N_aOH (.1N) were transferred to large boiling tubes. These were placed in a water bath at 100°C and contents stirred from time to time. The solution should be strongly alkaline. After the pieces of tissue were disintegrated, the contents were allowed to cool and the contents made to 100 mls. Thirty mls. of this suspension were then measured into a boiling tube and 5 ml. of N/50 silver nitrate and 5 ml. concentrated nitric acid were added. The tubes and contents were placed in a water bath at 100°C and left for about 1.5 to 2 hours. A further 5 ml. of silver nitrate and 5 ml. of nitric acid were added and heating continued for about 30 minutes. About 1.5 gm. of chloride free ferric sulphate was added to the tubes and about 40 ml. of distilled water and the tubes and contents heated in the water bath for a few minutes. The tubes are then cooled in running, cold water and the contents titrated with N/50 potassium thiocyanate from a graduated burette. Blank determinations involving every stage of the method were made.

Sample calculation:

10 gm. of plant material were made up to 100 and 30 ml. of this were used for the chloride determination.

Thiocyanate required for blank - - - - 4.90 ml.

" " " unknown - - - 4.25 "

Difference due to chlorine in unknown 0.65 "

Therefore 100 gm. of material contained

$$0.65 \times \frac{35.5}{50} \times \frac{100}{30} \times \frac{100}{10} = 15.4 \text{ mg. chlorides}$$

(1000 ml. potassium thiocyanate react with 35.5 gm. of chlorine, therefore N/50 KCNS will react with $\frac{35.5}{50}$ gms. of chlorine.

In the above procedure, the NaOH brings down chlorides present as NaCl. Upon addition of measured quantities of $AgNO_3$ and HNO_3, $AgNO_3$ reacts with NaCl to form AgCl, a precipitate. Addition of $Fe_2(SO_4)_3$ has no direct effect and does not enter into reactions until the KSCN is added in the titration. KSCN reacts with excess silver ions until these have been exhausted and then reacts with $Fe_2(SO_4)_3$ to give the red or rose end point. Thus, actually the amount of chlorine in the original sample is measured in an indirect manner.

I. (b) A similar field experiment to determine the effects of Aldrin and Dieldrin was conducted using potatoes as test plants. The same plot design was used and identical rates of application. Individual plots were 40 square feet in area and the tubers were planted in rows, with hills being about 1 foot apart.

The insecticides were first mixed with a quantity of soil while this mixture was sprinkled over the trenches. As with carrots, no visible differences in growth could be detected and the usual cultural practises were employed.

The tubers were harvested when mature and the yield of each plot recorded. Twenty-five tubers from the yield of each plot were selected at random and stored in a cool, dry place for further chemical analysis. As with carrots, storage time was kept to a minimum.

The samples were removed from storage and thoroughly washed. Cross-sections were cut and these were ground with a vegetable grinder.

The percentage of sugar was measured on a sample of expressed juice with a refractometer. As quickly as possible, 5 gms. of freshly ground material were transferred to 25 ml. of 0.4 per cent Oxalic acid and covered for Vitamin C determinations. Ten gram samples (duplicate) were added to 40 ml. of 0.1 N NaOH for determination of chlorides.

Duplicate samples of 20 gms. of the freshly ground material were weighed into previously tared crucibles and placed in an electric drying oven at 60°C to determine dry weights. This dry material was later ignited and ashed in an electric muffle furnace to determine percentage ash.

Total chlorine analyses were carried out in a similar manner to that described for carrots.

The method of the Robinson and Stotz (29) Vitamin C analysis procedure was used to evaluate Vitamin C in the potato samples. The method used involves the titration of 2, 6 - dichlorobenzenonindophenal against a standard solution of ascorbic acid and into unknown samples. The ascorbic acid becomes oxidized, reducing the dye to give a characteristic colour.

II. (a) The effect of soil applications of Aldrin, Isodrin, Dieldrin and Endrin (in powder form) on tomatoes - Lycopersicum esculentum, var Vetomold. The experiment was carried out in the greenhouse. Treatments of 0, 10, 20 and 40 pounds of actual compound per acre were replicated three times. The plants were grown in ten inch pots. It would have been desirable to have at least 4 or 5 replications of each treatment but greenhouse space and large diameter pots were at a premium when the experiment was carried out.

Tomato plants started in sand flats and of uniform size as possible were planted in the pots. Weekly growth measurements were made up to 9 weeks (incl.). Number of days till blossoming were recorded and total weight of aerial portion of plants recorded before discarding the plants.

II. (b) An experiment was conducted to determine the effect of soil applications of acetone solutions of Isodrin and Endrin on tomato plants grown in the greenhouse.

Twenty-seven 10-inch clay pots were filled with soil and the soil treated with solutions of Isodrin and Endrin dissolved in acetone respectively.

The pots were set up as three randomized blocks with nine pots in each block. The treatments consisted of rates of applications equivalent to 0 (acetone only) 1, 5, 10, and 20 pounds of actual compound per acre. Each pot was planted at different times, namely 1, 3, 7 and 18 days after treatment with the compounds. The compounds are quite soluble in acetone and it was hoped the maximum uniformity of distribution of the compound could be attained by applying it to the soil in an acetone spray.

Growth rates of the two later series of plantings that survived were taken on a weekly basis and recorded.

III. (a) The effect of Endrin and Isodrin in powder form was evaluated for its effect on germination of tomato seeds in soil treated with the compounds. The rates of application used were the equivalent to 0, 1, 5, 10, and 20 pounds actual compound per acre. The seeds were planted in pots in the greenhouse and each treatment was replicated three times making a total of 27 pots. The tomato seeds were covered at as uniform depth as possible. Two counts were made; one 4 days after seeding and one final count when all seeds should have germinated.

III. (b) Further effects of the compounds on germination of seeds were determined using radish, (Raphanus sativus, var Scarlet Globe), as a test plant.

An experiment was conducted where radish seeds were planted in petri dishes on bacto-agar containing the compounds. Acetone stock solutions were made of Aldrin, Isodrin, Dieldrin and Endrin and the desired quantity of this solution added to water and bacto-agar. This was boiled for some time to drive off all acetone. The compounds were precipitated in the agar in a very fine suspension and this quantity of agar (a measured volume to attain desired concentrations of the compounds) was transferred to sterilized petri dishes. The agar was allowed to cool and solidify at room temperature and then 20 seeds selected at random were placed in each dish. The number of seeds germinating were counted at 48, 72, 168 and 216 hour intervals and recorded. The concentrations used were 40, 200 and 600 p. p. m. of actual compound and these treatments compared with a control agar plate to which no compound had been added. The results from the above experiment were so significant that a replicated experiment using the same concentration and compounds was conducted. Treatments were replicated three times and germination counts made at 48, 72, 96, 120, 144 and 168 hour intervals. Photographs of all treatments were taken at two different stages of development of the seedlings.

III. (c) In another experiment using radish seed, Aldrin, Isodrin, Dieldrin and Endrin were applied to soil in powder form. The radish seeds were grown in flats, 18 x 24" and concentrations of the compounds in the soil equivalent to 0, 1, 5, 10, 20, 40 and 80 pounds of the actual compound per acre were applied and replicated three times. The compounds were sprinkled over the smooth surface of the soil and then thoroughly worked into the top 1 to 2 inch layer.

The flats were planted with 32 seeds selected at random at as uniform depth as possible. The flats were kept in the greenhouse until all seeds appeared to have germinated then were moved outdoors to encourage greater root development.

Germination counts were made 3, 4, 5, 6 days after planting and a final count made sometime later. The leaf diameters of full grown primary leaves were measured. Average plants were selected and an average value of three measurements per plot was used.

The plants were harvested when the roots had reached a desirable (bunching) size and the roots and tops were weighed. Other variation such as colour were also noted. Average sized roots were immediately washed and ground. The sugar content of the expressed sap was measured by means of a refractometer and 5 gms. of freshly ground material was rapidly transferred to 25 ml. of 0.4 per cent Oxalic acid for Vitamin C determinations. The method for Vitamin C analysis used was the same as that previously described for potatoes.

Proximate nitrogen and phosphorus determinations were made of both root and leaf petiole. A modified method was employed in that reagents as recommended by Spurway were used but colour intensities were measured in a Klett-Summerson colourimeter. The following is a detailed outline of the method with sample calculations.

One gram of finely divided plant material was extracted with 10 ml. of a sodium acetate solution (10 gms. per litre) and buffered to pH 5. This is allowed to stand in tightly stoppered test tubes for 24 hours.

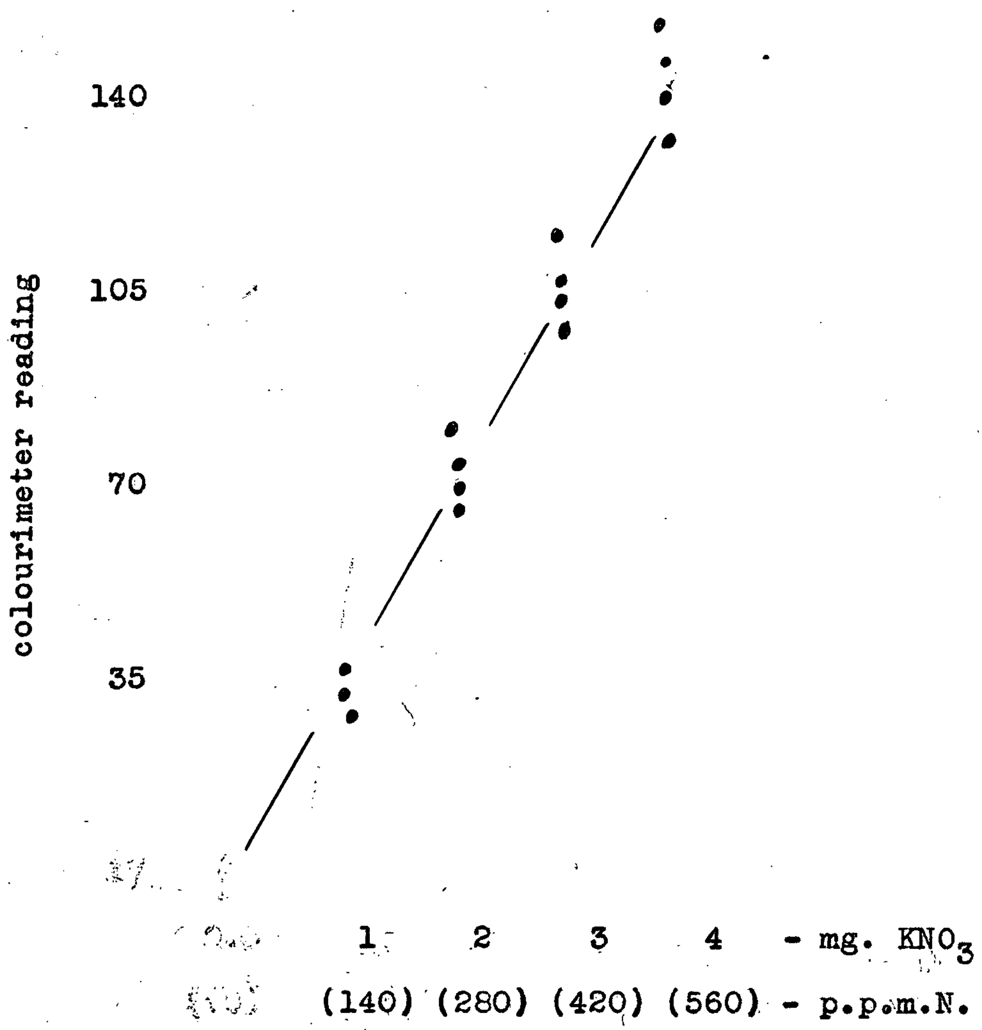
Nitrogen:

One ml. of extract was placed in a colourimeter tube and 6 drops of Diphenylamine solution (0.03 gm. of diphonylamine dissolved in 25 ml. of pure H_2SO_4 free from nitrate) added. The tube and contents were allowed to stand for 5 minutes and then brought to 10 ml. with distilled water and the blue colour which developed read in the colourimeter.

A standard solution was made of KNO_3 so that 1 ml. contained 1 mg. KNO_3, or 1 ml. contained 0.14 mg. N or 140 p.p.m. N. The standard solution received the same treatment as the unknown in that 1 ml. of standard was treated with 6 drops of nitrate reagent and then brought to 10 ml. and read in the colourimeter.

Figure

The behaviour of various concentrations of the standard (KNO_3) used in the nitrogen determinations of radish



• - individual readings made

Sample calculation:

1 ml. standard reads 35 = 140 p.p.m. N.

1 " unknown " 45

$$N \text{ in p.p.m.} = \frac{45}{35} \times 140 = 180 \text{ p.p.m.}$$

Testing for Phosphorus:

One ml. of the plant extract was placed in a colourimeter tube. To this was added 5 drops of molybdate solution (5 gms. of Amem. molybdate, free from arsenic or phosphorus, in 50 ml. of distilled water and warm gently to hasten solution. Filter if solution is turbid) and 3 drops of tin chloride solution (dissolve pure, clean tin pellet in a few ml. of conc. H Cl. Make up to 10-15 ml. with distilled water). The contents were made up to 10 ml. with distilled water and the blue colour read in the colourimeter within 30 seconds.

Sample Calculations:

Standard solution of Na_3PO_4 made up so that 1 mg. of Na_3PO_4 per ml.

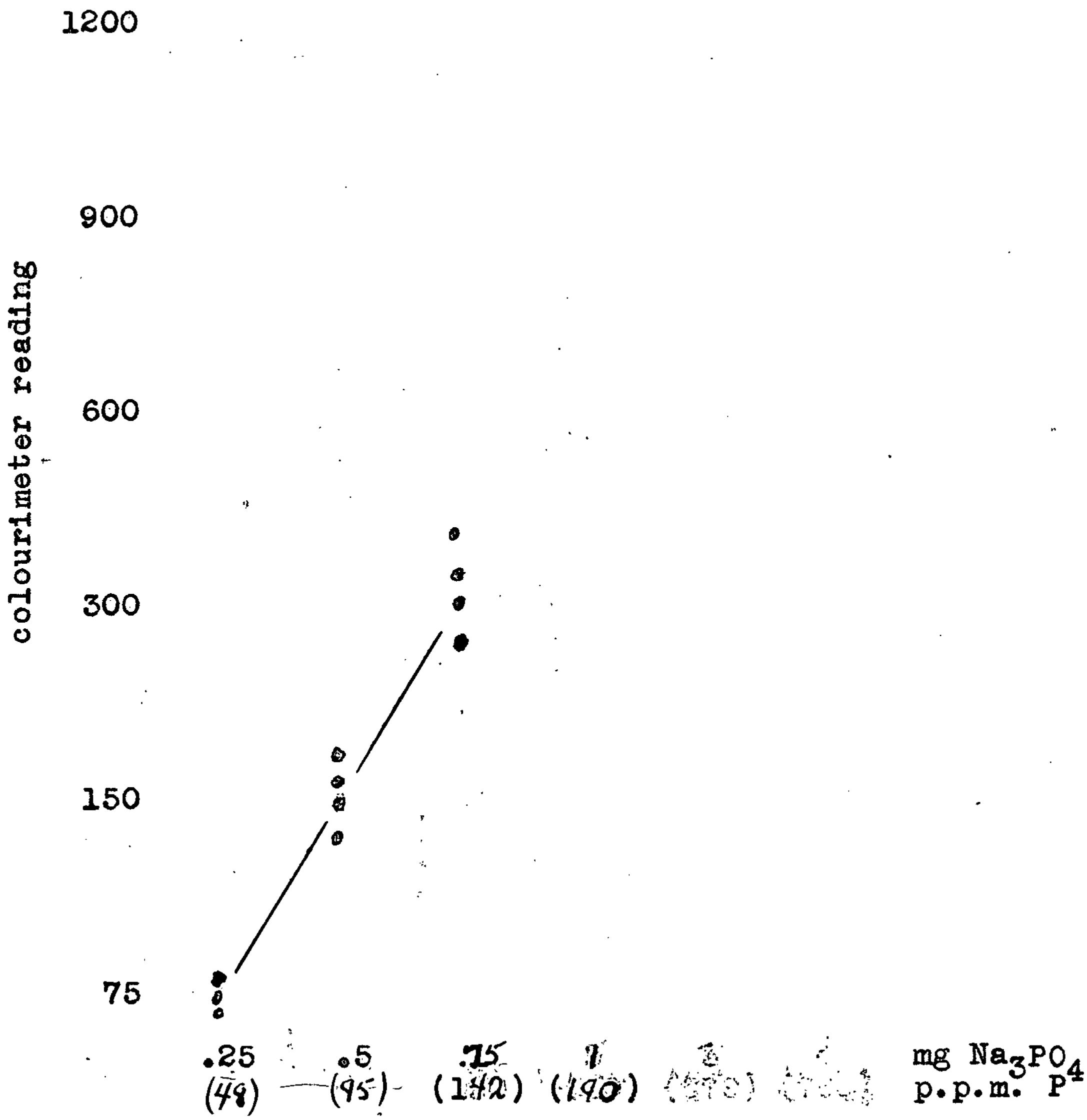
1 ml. standard read 300 which is then equivalent to 0.19 mg. P or 190 p.p.m.

1 ml. of unknown reads 285, therefore the unknown contains $\frac{285}{300} \times 190 = 180$ p.p.m. P.

As for the nitrogen determinations the various concentrations of phosphorus standard were read in the colourimeter and the results plotted on a graph. The result justified the above method and calculation.

Figure

The behaviour of various concentrations of standard (Na_3PO_4) used in the phosphorus determinations of radish



• - individual readings made

RESULTS

The results are presented in tabular form showing the summarized data. The complete data used for statistical evaluation is shown in the appendix in each case. Where it was considered advisable to show trends, graphs have been included.

Table 1

The effect of Aldrin, Dieldrin, Isodrin and Endrin on yield, and top-root ratio of carrot and yield of potato

Treatment	Yield (in ounces)							
Lbs/ac	Aldrin	Dieldrin	Isodrin			Endrin		
	Potatoes		Carrots					
	Tubers	Tubers	Root	Top	R/T	Root	Top	R/T
Control	807	807	1173	296	4.00	1173	296	4.00
0.5	905	851	1264	330	3.98	1312	322	4.13
3.5	1011	963	1318	324	4.09	1418	349	4.09
6.5	1026	904	1323	320	4.14	1322	337	4.07
9.5	960	864	1288	334	3.95	1267	316	4.08

It is noteworthy that with both carrots and potatoes, a consistent stimulatory trend exists and the maximum effect appears to be at the 6.5 pounds per acre application of each compound. The compounds did not affect the top-root ratios. For complete data, see appendix.

Table 2

The effect of Aldrin, Dieldrin, Isodrin and Endrin on yield, top growth and top-root ratio of radish

Treatment Lbs/ac	Yield (in grams)											
	Aldrin			Dieldrin			Isodrin			Endrin		
	Root	Top	T/R	Root	Top	T/R	Root	Top	T/R	Root	Top	T/R
Control*	110	163	1.37	110	163	1.37	110	163	1.37	110	163	1.37
1	123	161	1.31	169[x]	206	1.22	77	131	1.41	169	187	1.12
5	118	129[x]	1.57	147	254[xx]	1.76[xx]	105	147	1.40	155	216	1.40
10	121	137	1.16	131	199	1.56	90	121	1.62	124	202	1.78
20	131	137	1.06	133	242[xx]	1.82[xx]	109	128	1.25	123	214	1.79
40	140[x]	138	1.03[x]	131	232[x]	1.79[xx]	115	152	1.24	132	201	1.60
80	86[x]	109[xx]	1.23	183[x]	186	1.02[x]	99	127	1.45	96	191	1.98

*A standard value obtained by averaging six control plots.

Aldrin - Roots - L.S.D. @ .05 = 28
- Tops - " @ " = 28 @ .01 = 40
- T/R - " @ " = 0.35

Dieldrin - Roots - " @ " = 41
- Top - " @ " = 54 @ .01 = 76
- T/R - " @ " = 0.26 @ .01 = 0.37

Isodrin - Roots - " @ " = --
- Tops - " @ " = --
- T/R - " @ " = --

Endrin - Roots - " @ " = --
- Top - " @ " = --
- T/R - " @ " = --

Note:
X - figures significant at .05 P level
XX - figures significant at .01 P level

For complete separate tables, see appendix.

From Table 2, some effect of the compounds on yield is evident. Aldrin appeared to stimulate yield and the maximum was reached at 40 pounds per acre while at 80 pounds, the yield was markedly decreased. Isodrin had no apparent effect on yield. Dieldrin increased the yield considerably, especially at the 1 and 80 pound treatment level while Endrin stimulated yield at the 1 and 5 pound level and depressed yield at the 80 pound treatment.

In general, Aldrin and Isodrin depressed top growth while Dieldrin and to a lesser extent Endrin greatly favoured top growth. This is further demonstrated in the top-root ratios shown in the above table.

Table 3

The effect of Aldrin, Isodrin, Dieldrin and Endrin on growth of primary leaves of radish. Diameters of leaves are shown in tenths of an inch and are average values of normal plants

Treatment Lbs/ac	Diameters of leaves			
	Aldrin	Isodrin	Dieldrin	Endrin
Control	9.3	9.3	9.3	9.3
1	11.0xx	11.3xx	9.3	10.0
5	10.6xx	11.0xx	10.6	9.3
10	11.0xx	10.3x	10.3	9.6
20	11.3xx	11.3xx	9.6	9.6
40	11.6xx	12.0xx	10.0	8.6
80	10.6xx	12.0xx	9.3	9.0

For complete tables, see appendix.
Aldrin L.S.O. @ .05 = 0.9, @ .01 = 1.2
Isodrin " @ " = 1.1, @ " = 1.5

Table 3 shows that both Aldrin and Isodrin stimulated growth of primary leaves as indicated by leaf diameter measurements whereas Dieldrin and Endrin had little or no effect on growth of primary leaves. This trend did not follow through to maturity but was reversed in that Aldrin and Isodrin depressed top growth and Dieldrin and Endrin favoured top growth.

Table 4

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the weekly growth rate of tomato plants (average of 9 weeks)

Treatment	Growth rate (in inches)			
Lbs./ac	Aldrin	Isodrin	Dieldrin	Endrin
Control	5.20	5.20	5.20	5.20
10	5.52	5.39	5.38	5.60
20	5.64	4.77	5.26	5.50
40	5.78	4.86	4.47	5.41

All compounds tended to increase growth rate with exception of Isodrin.

Table 5

Growth rates of tomato plants planted in soil 3 and 18 days after treatment respectively with acetone solutions of Endrin and Isodrin

Treatment Lbs/ac	Growth rate (in inches) Endrin		Isodrin	
	3 days after planting	18 days after planting	3 days after planting	18 days after planting
Control	2.0	1.3	2.0	1.3
1	1.6^{x}	1.5	1.6^{x}	1.4
5	1.4^{xx}	1.6	1.6^{x}	1.5
10	1.2^{xx}	1.3	1.6^{x}	1.9
20	0.6^{xx}	2.2	1.8	1.8

Endrin L.S.D. - 3 days

@ .05 = 0.37 @ .01 = 0.52

Isodrin L.S.D. - 3 days

@ .05 = 0.4

Planting three days after acetone solution treatment depressed growth whereas when planted 18 days after treatment with acetone solution, a slight growth stimulation appears evident.

Table 6

The effect of Aldrin, Isodrin, Dieldrin and Endrin on time of blossoming of tomato plants.

Treatment	Average no. of days till first blossom opens			
Lbs/ac	Aldrin	Isodrin	Dieldrin	Endrin
Control	90	90	90	90
10	79	83	82	76
20	83	81	80	83
40	79	83	85	90

The compounds appear to hasten blossoming.

Table 7

Effect of Isodrin and Endrin on germination of tomato seeds. Total seeds per plot=10

Treatment	Per cent germination			
	Endrin		Isodrin	
Lbs/ac	4 day count	Final count	4 day count	Final count
Control	17	60	17	60
1	17	68	18	72
5	19	70	16	66
10	17	68	16	66
20	17	62	16	70

Final counts show increased germination.

Table 8

Germination of radish seeds in Aldrin treated soils.

Counts were recorded at 3, 4, 5, 6 and 9 days from planting.

Lbs.Compd./ac	No. of days				
	3	4	5	6	Final
Check	0	28	48	55	65
1	1	43	62	66	71
5	6	46	60	67	74
10	0	41	60	66	73
20	5	40	59	60	70
40	4	32	58	59	71
80	0	39	58	67	71

Although no significance is shown statistically, figures show that the compound tends to hasten and increase germination. Germination is stimulated most at 1 to 20 pound treatment level at all intervals.

Table 9

Germination of radish in Isodrin treatment conditions as in Table 18

Lbs.Compd./ac	no. of days 3	4	5	6	Final
Check	0	28	48	55	65
1	3^{xx}	35	55	63	65
5	2^{xx}	52	63	68	75
10	2^{xx}	43	56	65	73
20	1^{x}	43	61	69	76
40	37^{xx}	46	63	69	74
80	12^{xx}	41	57	65	71

L.S.D. of 3 day column

@ .05 = 1.0, @ .01 = 1.3

Marked significance is present in "3 day" figures while otherwise, a similar trend exists as shown by Aldrin in the previous table. The 40 and 80 pound treatments very markedly stimulated germination, but this difference disappeared in later counts.

Table 10

Germination of radish in Dieldrin treatments.

Conditions as in Table 18.

Lbs. compd./ac	No. of days				
	3	4	5	6	Final
Check	0	28	48	55	65
1	0	18	37	49	71
5	1	30	56	66	75
10	0	31	51	61	65
20	0	17	50	62	75
40	0	20	49	56	66
80	0	18	44	54	66

No trend is evident in the above table.

Table 11

Germination of radish in Endrin treatments.

Conditions as in Table 18

Lbs. compd./ac	No. of days				
	3	4	5	6	Final
Check	0	28	48	55	65
1	0	11	36	55	66
5	0	21	51	68	77^x
10	2	33	51	66	77^x
20	3	39	53	58	65
40	0	27	41	56	64
80	0	29	47	55	58

L.S.D. for final column @ .05 = 12

5 and 10 lb. compd. per acre tends to stimulate germination while lower and higher treatment levels appear to have little or no effect. The 80 pound treatment slightly depressed total germination.

Results of a germination experiment with radish seed using treated bacto-agar as substrate.

Table 12

Effects of Aldrin, Isodrin, Dieldrin and Endrin on germination of radish seed on bacto-agar with various concentrations of the compounds. Number of seeds germinated - Total seeds per plate = 20

Treatment p.p.m. of compd.		Hourly intervals			Total
	48 hrs.	72 hrs.	168 hrs.	216 hrs.	/20
Check	0	1	5	9	9
Aldrin 40	0	0	0	0	0
" 200	0	0	0	0	0
" 600	0	0	0	0	0
Isodrin 40	8	11	14	15	15
200	1	6	11	11	11
600	0	0	4	4	4
Dieldrin 40	13	19	19	19	19
200	10	12	17	18	18
600	0	5	10	12	12
Endrin 40	11	13	17	18	18
200	11	14	18	19	19
600	0	0	3	6	6

Note from the above Table that Aldrin completely inhibited germination even at 40 p.p.m. concentration. Isodrin, Dieldrin and Endrin stimulated germination at 40 and 200 p.p.m. while Isodrin and Endrin slightly depressed germination at 600 p.p.m.

Table 13

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the germination of radish seeds grown on an agar medium containing the compounds at various concentrations. Counts were made at 6 intervals. Number of seeds per dish = 20. Treatments were replicated 3 times while 6 control replications were used

Compound	Time intervals (hrs)	Per cent germination Rate of treatment (p.p.m.)			
		0	40	200	600
Isodrin	48	8	17^{xx}	12^{xx}	0^{xx}
	72	33	49^{xx}	45^{xx}	6^{xx}
	96	37	53^{x}	54^{x}	20^{x}
	120	45	53^{x}	54^{x}	32^{x}
	144	47	53^{x}	54^{x}	37^{x}
	168	47	53^{x}	54^{x}	40
Dieldrin	48	8	20^{xx}	12^{xx}	0^{x}
	72	33	54^{xx}	39	28
	96	37	56^{x}	49	33
	120	45	57	51	37
	144	47	57^{x}	55	41
	168	47	57^{x}	55^{x}	43
Endrin	48	8	16^{x}	11^{x}	2^{x}
	72	33	45	38	26
	96	37	53	41	35
	120	45	54	47	41
	144	47	54	50	44
	168	47	54	50	44
		* 0	10	20	40
Aldrin	48	8	10	3^{xx}	0^{xx}
	72	33	33	17^{xx}	7^{xx}
	96	37	46	31	15^{x}
	120	45	47	41	21^{xx}
	144	47	50	44	27^{x}
	168	47	50	50	30^{x}

* Concentrations of Aldrin were reduced to 10, 20 and 40 p.p.m. since in Table 12, 40,200 and 600 p.p.m. prevented germination.

Isodrin:	L.S.D.	48	hr.	@	.05	= 1.22,	@	.01	= 1.85
	"	72	"	"	"	= 3.41,	"	"	= 5.18
	"	96	"	"	"	=13.4,	"	"	= 20.7
	"	120	"	"	"	= 9.0,	"	"	= 13.7
	"	144	"	"	"	= 9.0,	"	"	= 13.7
	"	168	"	"	"	= 9.0,	"	"	= 13.7
Dieldrin	L.S.D.	48	"	"	"	= 2.6,	"	"	= 3.9
		72	"	"	"	=10.0,	"	"	= 15.5
		96	"	"	"	=14.0,	"	"	= --
		120	"	"	"	=13.4,	"	"	= 20.4
		144	"	"	"	= 7.3,	"	"	= 11.1
		168	"	"	"	= 6.0,	"	"	= 9.1
Endrin	L.S.D.	48	"	"	"	= 6.6,	"	"	= --
Aldrin	L.S.D.	48	"	"	"	= 3.3,	"	"	= 5.0
		72	"	"	"	= 6.0,	"	"	= 9.1
		96	"	"	"	=16.7,	"	"	= 25.3
		120	"	"	"	=12.4,	"	"	= 18.8
		144	"	""	"	=15.9,	"	"	= 24.1
		168	"	"	"	=12.0,	"	"	= 18.1

Isodrin at 40 and 200 p.p.m. stimulated germination while at 600 p.p.m. it inhibited germination up to the 144 hour interval. Dieldrin stimulated germination at 40 and 200 p.p.m. while at 600 p.p.m. it inhibited germination at the 48 hour interval; no inhibition was noticed at later intervals. The effect of Endrin was much the same as that of Dieldrin except not so pronounced.

Aldrin inhibited germination at 20 p.p.m. at the 48 and 72 hour intervals while at 40 p.p.m., inhibition was significant throughout. No stimulation was noticed even at 10 p.p.m. It should be noted from the above Table the Aldrin is distinctly inhibitory when compared with the action of Isodrin, Dieldrin and Endrin on germination.

Photographs of the germinating radish seeds appear in the following pages. In series A, the plates had been seeded 4 days previous to photography while in series B, the plates had been seeded 8 days previous to photographing.

Series A.

Plate 1

Control

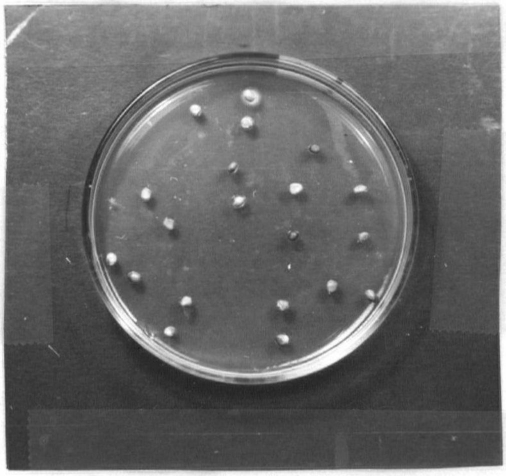
Plate 2.

Aldrin - 10 p.p.m.

Plate 3

Aldrin - 20 p.p.m.

Plate 4



Aldrin - 40 p.p.m.

Note - no seeds have germinated at this concentration

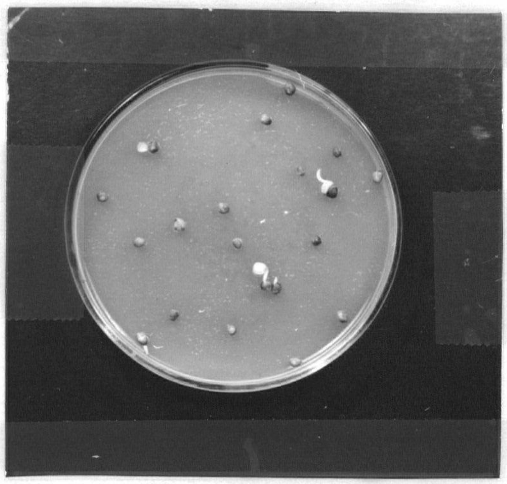
Plate 5

Isodrin - 40 p.p.m.

Plate 6

Isodrin - 200 p.p.m.

Plate 7



Isodrin - 600 p.p.m.

Aldrin at 40 p.p.m. appears to inhibit germination as much or more than Isodrin at 600 p.p.m.

Plate 8

Dieldrin - 40 p. p. m.

Plate 9

Dieldrin - 200 p.p.m.

Plate 10

Dieldrin 600 p.p.m.

Note stimulated germination at 40 and 200 p.p.m. and fair number of germinating seeds at 600 p.p.m.

Plate 11

Endrin - 40 p.p.m.

Plate 12

Endrin - 200 p.p.m.

Plate 13

Endrin - 600 p.p.m.

Endrin appears to act similarly to that of Dieldrin.

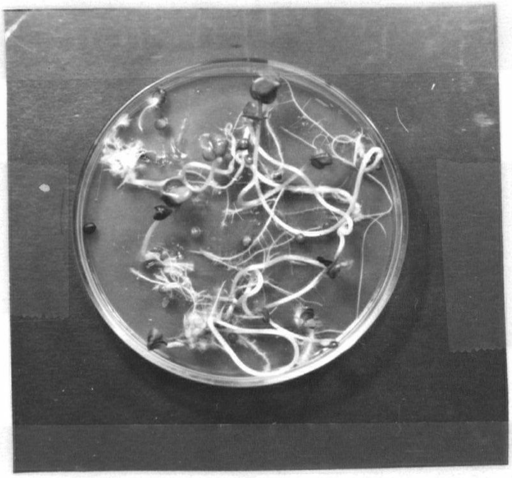
Series B.

Plate 14

Check

The above photograph of a check dish as well as the check in series A were considered average from the check treatments made.

Plate 15



Isodrin - 40 p.p.m.

Plate 16

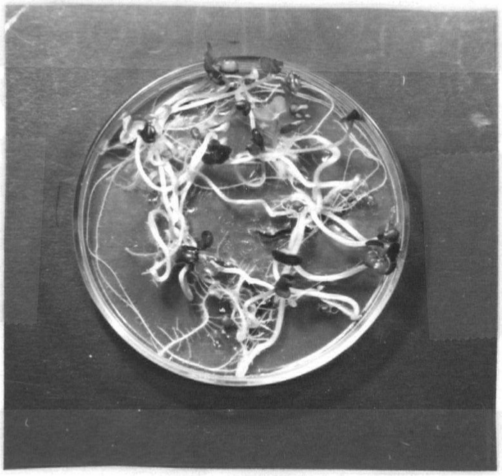
Isodrin - 200 p.p.m.

Plate 17

Isodrin - 600 p.p.m.

Note marked inhibition at 600 p.p.m. level.

Plate 18



Dieldrin - 40 p.p.m.

Plate 19

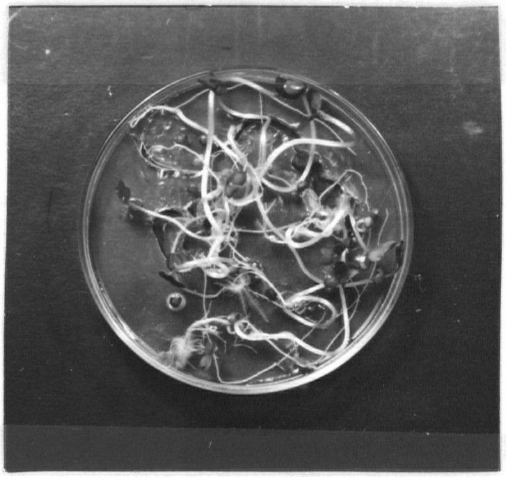
Dieldrin - 200 p.p.m.

Plate 20

Dieldrin - 600 p.p.m.

Note marked growth stimulation at 40 and 200 p.p.m. with reduced growth at 600 p.p.m.

Plate 21



Endrin - 40 p.p.m.

Plate 22

Endrin - 200 p.p.m.

Plate 23

Endrin - 600 p.p.m.

Very little difference is visible between the effects of Dieldrin and its isomer Endrin.

Table 14

The effect of Isodrin and Endrin, and Aldrin and Dieldrin, on the sugar content of carrots and potatoes respectively

Treatment	Per cent Sugar (as measured by refractometer)			
Lbs/ac	Endrin (Carrots)	Isodrin (Carrots)	Aldrin (Potatoes)	Dieldrin (Potatoes)
Control	12.4	12.4	5.75	5.75
0.5	12.7	11.3	5.77	5.07
3.5	11.8	12.0	4.85	5.28
6.5	12.2	11.5	5.53	5.43
9.5	11.7	11.5	5.52	5.55

All compounds appear to reduce sugar content. Endrin and Aldrin did not depress sugar content at 0.5 pounds/acre while Isodrin and Dieldrin definitely depressed sugar content at this concentration.

Table 15

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the sugar content of radish as measured by refractometer

Treatment	Per cent sugar			
Lbs./ac	Aldrin	Isodrin	Dieldrin	Endrin
Control	3.66	3.66	3.66	3.66
1	3.16	2.50^{xx}	3.00^{xx}	2.83^{xx}
5	4.33^{x}	3.16^{x}	2.50^{xx}	3.33
10	3.33	3.16^{x}	3.00^{xx}	3.33
20	3.50	3.16^{x}	2.66^{xx}	3.33
40	3.50	3.33	2.00^{xx}	3.00^{xx}
80	3.00^{x}	3.66	2.33^{xx}	3.83

Although some discrepancies exist in the above Table, the compounds depress sugar content. Isodrin and Dieldrin have the most depressing effect on sugar content.

Table 16

The effect of Isodrin and Endrin on the carotene content of carrots - mgms/100 gms. F.W.

Treatment Lbs/ac	Mgs. Carotene Endrin	Isodrin
Control	3.86	3.86
0.5	3.50	3.57
3.5	3.17	3.46
6.5	3.35	3.66
9.5	3.96	3.64

With one or two exceptions, the compounds tend to depress carotene content slightly.

Table 17

The effect of Aldrin and Dieldrin on the Vitamin C content of potatoes - mgms/100 gms.F.W.

Treatment Lbs/ac	Mgs. Vit. C. Aldrin	Dieldrin
Control	13.7	13.7
0.5	15.1	15.8
3.5	15.9	14.7
6.5	15.4	12.6 (1)
9.5	13.8	14.1

With one exception (1), the compounds seem to have caused a slight increase of Vit. C content at all rates of applications.

Table 18

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the Vit. C content of radish - mgms/100 gms. F.W.

Treatment Lbs/ac	Mgs. Vit. C. Aldrin	Isodrin	Dieldrin	Endrin
Control	15.4	15.4	15.4	15.4
1	15.4	13.8	11.3xx	12.5xx
5	13.8x	12.5xx	13.8xx	8.8xx
10	12.5xx	12.5xx	11.7xx	7.5xx
20	11.9xx	12.5xx	9.6xx	8.4xx
40	10.9xx	8.3xx	8.8xx	8.4xx
80	11.6xx	6.3xx	7.5xx	8.8xx

Aldrin L.S.D. @ .05 = 1.35, @ .01 = 1.89
Isodrin " " " = 2.17, " " = 3.05
Dieldrin " " " = 0.85, " " = 1.19
Endrin " " " = 0.85, " " = 1.19

Aldrin depressed Vitamin C at 5 to 80 pound per acre treatment while Isodrin, Dieldrin and Endrin depressed Vitamin C at all treatment levels.

Table 19

The effect of Isodrin and Endrin and Aldrin and Dieldrin on percentage dry matter of carrots and potatoes, respectively

Treatment	% dry matter			
Lbs/ac	Endrin	Isodrin	Aldrin	Dieldrin
	Carrots		Potatoes	
Control	15.7	15.7	24.5	24.5
0.5	15.6	16.2	24.5	24.5
3.5	15.8	15.8	24.1	24.7
6.5	15.9	16.0	25.3	24.5
9.5	15.6	16.0	24.2	25.6

The compounds appear to have no effect on the dry weight of potatoes and carrots.

Table 20

The effect of Endrin and Isodrin and Aldrin and Dieldrin on the ash content of carrots and potatoes respectively

Treatment Lbs/ac	% ash			
	Endrin	Isodrin	Aldrin	Dieldrin
	carrots		potatoes	
Control	0.7719	0.7719	1.170	1.170
0.5	0.8256	0.8253	1.154	1.118
3.5	0.7383	0.8284	1.175	1.041
6.5	0.8288	0.7651	1.086	1.214
9.5	0.7913	0.7775	1.077	1.216

No definite trends are evident from the above Table and it appears that the compounds have little or no effect on ash content of potatoes and carrots within the range of treatments used.

Table 21

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the nitrogen content of leaves and roots of radish

Treatment	p.p.m. nitrogen							
	Aldrin		Isodrin		Dieldrin		Endrin	
Lbs/ac	Leaf	root	leaf	root	leaf	root	leaf	root
Control	164	186	164	186	164	186	164	186
1	72^{xx}	65^{xx}	88^{xx}	226	320^{xx}	206	171	173
5	57^{xx}	71^{xx}	73^{xx}	86^{xx}	346^{xx}	229	156	153^{x}
10	59^{xx}	65^{xx}	55^{xx}	111^{xx}	413^{xx}	240	173	97^{xx}
20	51^{xx}	69^{xx}	45^{xx}	69^{xx}	460^{xx}	213	176	124^{xx}
40	44^{xx}	80^{xx}	33^{xx}	76^{xx}	400^{xx}	186	473^{xx}	166
80	35^{xx}	77^{xx}	8^{xx}	92^{xx}	126^{xx}	226	293^{xx}	160

Aldrin	L.S.D.	leaf	= @ .05	= 17,	@ .01	= 24
"	"	root	" "	= 21,	" "	= 29
Isodrin	"	leaf	" "	= 26,	" "	= 36
"	"	root	" "	= 20,	" "	= 29
Dieldrin	"	leaf	" "	= 91,	" "	= 128
"	"	root	" "	= --,	" "	= --
Endrin	"	leaf	" "	= 61,	" "	= 86
"	"	root	" "	= 31,	" "	= 44

From the above Table, it is shown that Aldrin and Isodrin greatly reduce the nitrogen content of leaves and roots of radish at all concentrations used while Dieldrin greatly increases nitrogen at all treatment levels except 80 lbs/acre where a reduction is evident. Endrin only increased nitrogen of the leaves at 40 and 80 lb/ac. levels.

Aldrin markedly reduced the nitrogen content of radish roots at all treatment concentrations while Isodrin increased the nitrogen level somewhat at 1 pound per acre but greatly reduced it at all higher treatment levels. Dieldrin seemed to increase the nitrogen content of the roots while Endrin decreased the nitrogen content at 5, 10, and 40 pound per acre treatments.

Table 22

The effect of Aldrin, Isodrin, Dieldrin and Endrin on the phosphorus content of radish leaves and roots

Treatment Lbs/ac	p.p.m. phosphorus							
	Aldrin		Isodrin		Dieldrin		Endrin	
	Leaf	root	leaf	root	leaf	root	leaf	root
Control	182	47	182	47	182	47	182	47
1	163x	64xx	175	62xx	247xx	51	174	50
5	112xx	46	145x	38	173	48	161	36xx
10	80xx	39	114xx	47	133x	54	153	39x
20	92xx	40	113xx	30xx	89xx	48	108xx	42
40	102xx	46	109xx	33xx	166	33x	163	37xx
80	96xx	30xx	98xx	32xx	173	28xx	209	36xx

Aldrin	L.S.D.	- leaves	- @ .05 = 17,	@ .01	= 23
"	"	roots	" " = 11,	" "	= 15
Isodrin	"	leaves	" " = 26,	" "	= 36
"	"	roots	" " = 4,	" "	= 6
Dieldrin	"	leaves	" " = 38,	" "	= 53
"	"	roots	" " = 13,	" "	= 18
Endrin	"	leaves	" " = 36,	" "	= 50
"	"	roots	" " = 6,	" "	= 9

Both Aldrin and Isodrin reduced the phosphorus content in radish leaves while in the roots, the same compounds increased phosphorus at 1 lb/ac concentration; at 80 lbs/ac Aldrin depressed phosphorus in roots while Isodrin reduced phosphorus at 20, 40 and 80 lbs/ac. Dieldrin raised the phosphorus level in the leaves at 1 lb/ac concentration while a reduction is evident at 10 and 20 pound treatment levels. Endrim reduced the phosphorus content at 10 and 20 lb/ac level while a slight increase is noted at 80 lbs. Endrin per acre. Dieldrin depressed phosphorus in the roots at 40 and 80 pound treatment levels while Endrin reduced phosphorus at 5, 10, 40 and 80 pounds per acre.

Table 23

The effect of Isodrin and Endrin, and Aldrin and Dieldrin on the chlorine content of carrots and potatoes respectively - mgm./100 gms. F.W.

Treatment Lbs/acre	Mgs. Chlorine			
	Endrin	Isodrin	Aldrin	Dieldrin
	Carrots		Potatoes	
Control	78.6	78.6	21.5	21.5
0.5	83.0	80.3	38.9[xx]	38.9[xx]
3.5	84.4	82.1	41.3[xx]	41.5[xx]
6.5	89.5	87.1	38.0[xx]	44.8[xx]
9.5	89.8	88.9	48.8[xx]	45.3[xx]

Aldrin L.S.D. @ .05 = 9.67, @ .01 = 12.7

Dieldrin " " " =11.9, @ " = 15.7

It will be noted from the above Table that the compounds (Isodrin and Endrin) only very slightly increase the chlorine content of carrots. In contrast, Aldrin and Dieldrin greatly increased the chlorine content of potatoes at all treatment levels.

DISCUSSION

The foregoing results appear to indicate that the insecticides have some very definite effects on the plants used in the experiments described. Furthermore, it appears that the compounds do not have identical effects on all plants. Some plants may be adversely affected while with others, the compounds appear to have a beneficial effect in that growth is stimulated and yield increases result. Such effects have been noted by other workers. Randall (1) obtained significant growth and yield differences with similar insecticides while Nelson (26) obtained marked growth stimulation of onions with Dieldrin soil applications. Phytotoxic effects were noted on cucurbits by Crowell and Morrison (7) when using Aldrin and Dieldrin while Foster (15) reports various effects of Aldrin and Dieldrin on different species of plants.

Although statistically insignificant, applications up to 6.5 lbs. per acre of the four compounds appear to increase yield of potatoes and carrots, while Dieldrin and Endrin resulted in a somewhat greater yield increase than Aldrin and Isodrin when used as soil applications for radish. It appears that very high rates of application give a general depression of yield, irrespective of kind of plant.

Light applications of Endrin and Isodrin appeared to slightly favour top-growth of carrots while Aldrin and Isodrin had a distinctly different effect on top growth of radish to that of Dieldrin and Endrin. While Aldrin and Isodrin significantly depressed top growth, Dieldrin and Endrin had significant stimulatory effects even at rates as high as 40 lbs. actual compound per acre. This is of interest in that initially, it appeared that Aldrin and Isodrin had a stimulatory effect. The leaf diameters of primary leaves were significantly greater as a result of the Aldrin and Isodrin treatments than with the Dieldrin and Endrin treatments. Leaves of plants in the Aldrin and Isodrin treatments were a bright green colour while those of the Dieldrin and Endrin treatment were dull green. The compounds appeared to slightly stimulate growth rates of tomato plants.

Acetone solutions of Endrin and Isodrin significantly depressed growth rates of tomato plants. However, more experimentation using this type of treatment seems necessary to eliminate possible effects of acetone alone. In general, plants so treated developed a purple colour, similar to plants suffering from severe phosphorus deficiency.

The concentrations used in the carrot field experiment appeared to have no effect on the top-root ratios. With radish, definite effects are evident. As might be expected from top growth data, Aldrin and Isodrin decreased the magnitude of the ratio by suppressing top growth while Dieldrin and Endrin increased the magnitude by favouring top growth.

All compounds seemed to stimulate earlier blooming of tomato plants. This must, however, be investigated in greater detail before definite conclusions could be made.

Insecticides, similar to those used in the preceding experiments, have stimulatory effects on germination of sugar cane cuttings while Randall (1) reports increased germination of red clover seed with chlordane, benzene hexachloride and D.D.T. No stimulatory action of Endrin and Isodrin on germination of tomato seeds (soil treatments) was obtained while all four compounds appeared to slightly increase speed and total germination of radish in treated soil. However, marked early stimulation and total germination as well as growth rate of radish seedlings was obtained when seeds were placed on treated bacto-agar in petri dishes. There appeared to be a definite difference in the individual effect of the four insecticides. It is interesting to note that 40, 200 and 600 p.p.m. Aldrin completely prevented germination while the other three compounds stimulated germination at 40 and 200 p.p.m. The stimulatory action of Dieldrin and Endrin was much greater than that of Isodrin. In a later experiment, 10, 20 and 40 p.p.m. Aldrin compared favourably to 40, 200 and 600 p.p.m. Isodrin (see photographs and germination tables).

Under field conditions, no effects of the insecticides could be found on the sugar content of carrots, while in potatoes, a slight reduction of sugar was apparent. In radish, a slight decrease was general in Aldrin and Isodrin treatments while a more marked significant decrease in sugar was found as a result of the Dieldrin and Endrin treatment. It is of interest to note that in all evaluations made, carrots appeared to be least affected by the compounds of any of the plants used in the experiments. Gould (9) also found this to be the case in flavour evaluations--potatoes were most easily affected while carrots were relatively immune.

The effect of Isodrin and Endrin on carotene content of carrots is slight and not statistically significant. A slight depressing trend appears to exist however. Further vitamin analysis showed that a tendency towards an increase of Vitamin C in treated potatoes existed. A very different trend existed in the Vitamin C content of radish in that all compounds depressed Vitamin C at all concentrations and the depression became highly significant at the 5 lb. per acre level.

The compounds appeared to have no effect on moisture and ash content of potatoes and carrots. It has been found that high chlorine content generally reduces dry weights. Although Aldrin and Dieldrin appreciably increased the chlorine content of potatoes, the high chlorine contents apparently were not great enough to affect the dry weights obtained for potatoes.

In the last experiment conducted, using radish as a test plant, it is of interest to note that the two groups of compounds (Aldrin-Isodrin and Dieldrin-Endrin) had in some respects, very different effects.

The Aldrin and Isodrin treatments visibly depressed growth and the foilage exhibited marked visible nitrogen and phosphorus deficiencies. On the other hand check plots and Dieldrin and Endrin treated plots exhibited dark green, lush foilage. In general appearance the Dieldrin and Endrin treated plots appeared superior to the control plots.

Nitrogen and phosphorus determinations substantiated the visual symptoms observed. Aldrin and Isodrin severely depressed the nitrogen level in both foilage and roots while Dieldrin and Endrin caused a highly significant increase of nitrogen in foilage but not a significant one in the roots. Aldrin and Isodrin depressed the phosphorus level in the foilage in a highly significant manner while in the roots the phosphorus level was stimulated at the 1 lb/ac. treatment and significantly depressed at the 80 lb/ac. treatment of Aldrin and the 5-80 lb/ac. treatment of Isodrin. Although Dieldrin and Endrin depressed the phosphorus level at some treatment levels, general trends could not be established and it appeared to have little effect on phosphorus content of the foilage. However, in the roots, some highly significant depressions were encountered at the higher treatment levels. No potassium deficiency was noted and determinations of potassium were not conducted.

The analysis for chlorine in carrots and potatoes showed that the experimental compounds increased the total chlorine content of the crops. The slight increase in chlorine content of carrots was insignificant while with potatoes, total chlorine was increased in all treatments in a highly significant manner. This difference of response to the compounds by different crops is of interest but renders it difficult if not impossible to make a general statement covering their behavior without detailed investigation on a large number of crops.

CONCLUSIONS

(1) At relatively low concentrations, soil applications of Aldrin, Isodrin, Dieldrin and Endrin gave slight yield increases of potatoes and carrots under field conditions.

(2) Aldrin and Isodrin depressed top growth of radish while Dieldrin and Endrin favoured it.

(3) Dieldrin and Endrin stimulated germination of radish seed on treated agar at 40-200 p.p.m., Isodrin at 40 p.p.m. while Aldrin completely depressed germination above 40 and at 200 and 600 p.p.m.

(4) High applications of the compounds depress sugar content and Vitamin C content of radish.

(5) Aldrin and Isodrin depressed nitrogen and phosphorus content of leaves and roots of radish while Dieldrin and Endrin increased the nitrogen content and had little effect on their phosphorus content.

(6) Aldrin and Dieldrin increased total chlorine content of potatoes while Isodrin and Endrin had little effect on chlorine content of carrots.

(7) In general, it may be concluded that Aldrin and Isodrin have similar characteristic effects in one direction while Dieldrin and Endrin have similar characteristic effects in an opposite direction.

(8) Plants are not necessarily affected by the compounds in a like manner, e.g., the high chlorine content of potatoes in contrast to the unchanged chlorine content of carrots.

SUMMARY

The effects of different concentrations of Aldrin, Isodrin, Dieldrin and Endrin as soil applications were studied on a number of horticultural crop plants. Effect on yield as well as their effect on top growth, growth rate and other general growth effects were noted. Germination experiments with radish and tomato seeds planted in treated soil and radish seeds planted on treated bacto-agar were conducted.

Possible effects on chemical constituents of test plants were studied. The effect on sugar content and carotene content were determined on carrots and Vitamin C determinations were made on potatoes and radish. The effects of the compounds on nitrogen, phosphorus and total chlorine content were also evaluated.

Yields appeared to be increased, germination stimulated at certain concentrations, Vitamin C content generally depressed as well as the sugar content. Aldrin and Isodrin suppressed top-growth in general, suppressed nitrogen and phosphorus while Dieldrin and Endrin had the opposite effect. All four compounds increased chlorine content but had no effect on dry weights or per cent ash.

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APPENDIX INDEX

TABLES

* * *

Table I

The effect of Isodrin and Endrin treatments (soil) on carrot yields (oz. per plot)

Treatment Lbs.compd./acre	Replicates 1	2	3	4	5	6	7	8	9	Total
Check	120	124	128	151	124	90	160	160	116	1173
Endrin--0.5	158	190	180	140	144	116	132	155	97	1312
3.5	152	156	184	166	126	134	210	156	134	1418
6.5	206	210	140	164	160	105	117	100	120	1322
9.5	114	198	160	178	150	126	108	103	130	1267
Total	750	878	792	799	704	571	727	674	597	6492
Check	120	124	128	151	124	90	160	160	116	1173
Isodrin-0.5	156	140	106	160	152	152	121	134	153	1264
3.5	120	152	140	144	124	144	166	176	152	1318
6.5	156	136	142	130	161	158	122	196	122	1323
9.5	198	184	100	132	138	132	142	121	141	1288
Total	750	736	616	707	699	676	711	787	684	6366

Although a trend in yield totals is evident, the experiment appears not to be refined enough to show statistical significance. Greater control of variable factors such as soil variation appear to be essential in evaluating yield effects of the compounds at lower treatment levels.

A complete statistical analysis of the above data is found on the following page. The same method of data analysis has been used for all other tables and least significant differences calculated where the F values indicated significance.

$$\text{L.S.D.} = \sqrt{2 \times \text{variance}^{(1)} \times N^{(2)}} \times t^{(3)} \quad \text{Totals}$$

for above table, (1) variance = error variance of variance analysis

(2) N = number of treatments.

(3) t value for above = N = 32 @ .05 = 1.95

for means - L.S.D.

$$= \sqrt{\frac{2 \times \text{var}}{n}} \times t$$

Analysis of data - Table

Endrin

$$C.F. = \frac{(6492)^2}{45} = 936579$$

Total S.S. = 979062 - 936579 = 42483

Block S.S. $= \frac{4759920}{5} - 936579 = 15405$

Treatment S.S. $= \frac{8460970}{9} - 936579 = 3529$

Error S.S. = 42483 - (15405 + 3529) = 23549

Analysis of Variance

Factor	S.S.	D. of F.	Variance	F.c.	F.t.
Total	42483	44			
Block	15405	8	1926	2.61	2.25 (3.12)
Treatment	3529	4	882	1.19	2.67 (3.97)
Error	23549	32	736		

Isodrin

$$C.F. = \frac{(6366)^2}{45} = 900,577$$

Total S.S. = 923170 - 900577 = 22593

Block S.S. $= \frac{4521824}{5} - 900577 = 3788$

Treatment S.S. $= \frac{8120022}{9} - 900577 = 1648$

Error S.S. = 22593 - (3788 + 1648) = 17157

Analysis of Variance

Factor	S.S.	D. of F.	Variance	F.c.	F.t.
Total	22593	44			
Block	3788	8	474	0.88	2.25 (3.12)
Treatment	1648	4	412	0.76	2.67 (3.97)
Error	17157	32	536		

Table II

Effect of Aldrin and Dieldrin on yield of potatoes (Ounces per plot)

Treatment Lbs. Compd/acre	Replicates 1	2	3	4	5	6	7	8	9	Total
Check	32	64	87	124	98	134	68	110	90	807
Aldrin 0.5	72	146	98	75	76	118	151	68	101	905
3.5	172	132	128	103	80	136	108	73	79	1011
6.5	69	196	160	108	57	114	120	88	114	1026
9.5	92	108	84	172	116	124	127	39	78	960
Total	437	646	557	582	427	626	574	378	462	4709
Check	32	64	87	124	98	134	68	110	90	807
Dieldrin 0.5	79	87	126	72	95	60	110	127	95	851
3.5	135	87	103	162	147	83	94	86	66	963
6.5	146	72	180	104	76	108	74	44	100	904
9.5	58	144	116	59	94	103	125	69	96	864
Total	450	454	612	521	510	488	471	436	447	4389

No significant difference (statistical) apparent in total yield figures from complete statistical analysis of data.

Table III

Effect of Aldrin on Yield of Radish

(Weights expressed in grams)

Treatment Lbs.compd./acre	Replicates A	B	C	Total
Check	39	29	42	110
1	35	38	50	123
5	39	37	42	118
10	30	42	49	121
20	38	40	53	131
40	48	35	57	140[x]
80	28	28	30	86[x]
Total	257	249	323	829

L.S.D. @ .05 = 28

Table IV

Effect of Isodrin on Yield of Radish

Treatment Lbs.compd./acre	Replicates A	B	C	Total
Check	39	29	42	110
1	20	34	23	77
5	37	27	41	105
10	28	41	21	90
20	27	45	37	109
40	28	40	47	115
80	17	33	49	99
Total	196	249	260	705

No significant difference exists in yield totals.

Table V

Effect of Dieldrin on Yield of Radish

Treatment Lbs.compd./acre	Replicates A	B	C	Total
Check	39	29	42	110
1	56	59	54	169[x]
5	43	64	40	147
10	35	57	39	131
20	41	49	43	133
40	50	47	34	131
80	65	59	59	183[x]
Total	329	364	311	1004

L.S.D. @ .05 = 41

Table VI

Effect of Endrin on Yield of Radish

Treatment Lbs.compd./acre	Replicates A	B	C	Total
Check	39	29	42	110
1	48	59	62	169
5	58	46	51	155
10	29	34	61	124
20	33	37	53	123
40	36	34	62	132
80	35	32	29	96
Total	278	271	360*	909

No statistical significant difference, probably due to C* replicate total.

Table VII

Effect of Isodrin and Endrin on top growth of carrots - weights in ounces per plot

Treatment	Lbs. compd./acre	Replicates 1	2	3	4	5	6	7	8	9	Total
	Check	33	33	34	36	32	20	40	44	24	296
Endrin	0.5	48	48	40	32	35	30	35	34	20	322
	3.5	48	36	44	42	27	32	48	38	34	349
	6.5	60	64	35	38	36	28	25	28	23	337
	9.5	32	56	40	44	36	28	28	28	24	316
	Total	221	237	193	192	166	138	176	172	125	1620
	Check	33	33	34	36	32	20	40	44	24	296
Isodrin	0.5	50	50	24	38	42	38	28	28	32	330
	3.5	32	40	28	37	28	38	40	41	40	324
	6.5	37	36	36	28	40	36	29	48	30	320
	9.5	60	46	24	42	36	33	28	32	33	334
	Total	212	205	146	181	178	165	165	193	159	1604

No significant difference in treatment totals.

Table VIII

Effect of Aldrin on Top growth of Radish (Weight of Tops in grams)

Treatment Lbs. compd./acre	Replicates A	B	C	Total
Check	60	41	62	163
1	44	56	61	161
5	38	40	51	129[x]
10	46	41	50	137
20	42	46	49	137
40	45	45	48	138
80	33	34	42	109[xx]
Total	308	303	363	974

L.S.D. @ .05 = 28 L.S.D. @ .01 = 40

Table IX

Effect of Isodrin on Top growth of Radish

Treatment Lbs./compd./acre	Replicates A	B-	C	Total
Check	60	41	62	163
1	36	50	45	131
5	53	39	55	147
10	33	51	37	121
20	46	49	33	128
40	47	53	52	152*
80	35	43	49	127
Total	310	326	333	969

* Does not fit otherwise definite trend, nullifies significance.

Table X

Effect of Dieldrin on Top growth of Radish

Treatment Lbs.compd./acre	Replicates A	B	C	Total
Check	60	41	62	163
1	57	70	79	206
5	78	101	75	254[xx]
10	60	71	68	199
20	79	87	76	242[xx]
40	83	83	66	232[x]
80	67	57	62	186
Total	484	510	488	1482

L.S.D. @ .05 = 54 L.S.D. @ .01 = 76

Table XI

Effect of Endrin on Top growth of Radish

Treatment Lbs.Compd./acre	Replicates A	B	C	Total
Check	60	41	62	163
1	63	64	60	187
5	85	79	52	216
10	59	70	73	202
20	62	74	78	214
40	60	64	77	201
80	74	64	53	191
Total	463	456	455	1374

No significant difference in treatment totals but trend similar to that in Table X.

Table XII

Leaf diameters of primary leaves of Radish. An average value of normal plants. Figures in tenths of an inch and measured 13 days after planting

Treatment (Aldrin) Lbs.compd./acre	Replicates A	B	C	Average	Total
Check	9	10	9	9.3	28
1	11	11	11	11.0^{xx}	33
5	11	10	11	10.6^{xx}	32
10	11	11	11	11.0^{xx}	33
20	11	12	11	11.3^{xx}	34
40	11	12	12	11.6^{xx}	35
80	11	11	10	10.6^{xx}	32
Total	75	77	75		227

L.S.D. @ .05 = 0.9 L.S.D. @ .01 = 1.2

Table XIII

Leaf diameters of primary leaves of Radish (Cont'd.)

Treatment (Isodrin) Lbs.compd./acre	Replicates A	B	C	Average	Total
Check	9	10	9	9.3	28
1	11	11	12	11.3^{xx}	34
5	11	10	12	11.0^{xx}	33
10	11	10	10	10.3^{x}	31
20	11	11	12	11.3^{xx}	34
40	12	13	11	12.0^{xx}	36
80	13	11	12	12.0^{xx}	36
Total	78	76	78		232

L.S.D. @ .05 = 1.1 L.S.D. @ .01 = 1.5

Table XIV

Leaf diameters of primary leaves of Radish (Cont'd.)

Treatment Lbs./compd/acre	Dieldrin Replicates A	B	C	Average	Total
Check	9	10	9	9.3	28
1	9	10	9	9.3	28
5	11	10	11	10.6	32
10	10	11	10	10.3	31
20	9	10	10	9.6	29
40	10	11	9	10.0	30
80	9	9	10	9.3	28
Total	67	71	68		206

No significant difference in treatment means

Table XV

Leaf diameters of primary leaves of Radish (Cont'd.)

Treatment Lbs.compd/acre	Endrin Replicates A	B	C	Average	Total
Check	9	10	9	9.3	28
1	9	11	10	10.0	30
5	9	10	9	9.3	28
10	10	9	10	9.6	29
20	9	10	10	9.6	29
40	8	8	10	8.6	26
80	10	8	9	9.0	27
Total	64	66	67		197

No significant difference in treatment means

Table XVI

Effect of Aldrin, Dieldrin, Isodrin and Endrin in growth of tomato plants

Total weight of aerial growth of 10 wks. in oz.

Treatment Lbs.compd./ac.		Replicates 1	2	3	Total
	Check	8.0	7.0	9.0	24.0
Aldrin	10	8.0	12.0	9.0	29.0
	20	6.0	10.0	10.0	26.0
	40	8.5	6.5	12.0	27.0
Dieldrin	10	9.0	9.0	10.0	28.0
	20	9.0	8.0	12.0	29.0
	40	4.0	5.0	4.0	13.0[x]
Isodrin	10	8.0	9.0	6.0	23.0
	20	4.0	8.5	5.0	17.5
	40	5.0	8.0	10.0	23.0
Endrin	10	8.5	9.0	10.0	27.5
	20	8.5	6.5	7.0	22.0
	40	7.5	11.0	8.0	26.5
	Total	94.0	109.5	112.0	315.5

L.S.D. @ .05 = 12.5

Table XVII

Effect of Isodrin and Endrin on top-root ratio of carrots

Treatment Lbs.compd/ acre	Replicates Ratio as R/T 1	2	3	4	5	6	7	8	9	Average	Total
Check	3.63	3.75	3.76	4.19	3.87	4.50	4.00	3.63	4.75	4.00	36.08
Endrin 0.5	3.29	3.95	4.50	4.37	4.11	3.86	3.77	4.55	4.85	4.13	37.25
3.5	3.16	4.33	4.18	3.95	4.66	4.18	4.37	4.10	3.94	4.09	36.87
6.5	3.43	3.28	4.00	4.31	4.44	3.75	4.68	3.57	5.21	4.07	36.67
9.5	3.56	3.53	4.00	4.04	4.16	4.50	3.85	3.67	5.41	4.08	36.72
Total	17.07	18.84	20.44	20.86	21.24	20.79	20.67	19.52	24.16		183.59
Check	3.63	3.75	3.76	4.19	3.87	4.50	4.00	3.63	4.75	4.00	36.08
Isodrin 0.5	3.12	2.80	4.41	3.94	3.61	4.00	4.32	4.78	4.84	3.98	35.82
3.5	3.75	3.80	5.00	3.89	4.42	3.78	4.15	4.29	3.80	4.09	36.88
6.5	4.21	3.77	3.94	4.64	4.02	4.38	4.20	4.08	4.06	4.14	37.30
9.5	3.30	4.00	4.16	3.14	3.83	4.00	5.07	3.78	4.27	3.95	35.55
Total	18.01	18.12	21.27	19.80	19.75	20.66	21.74	20.56	21.72		181.63

No significant difference in means.

Table XVIII

Effect of Aldrin on top/root ratio of radish

Treatment Lbs.Compd./ac.	Replicates A	B	C	Average	Total
Check	1.55	1.42	1.14	1.37	4.11
1	1.27	1.44	1.21	1.31	3.92
5	2.00	1.50	1.21	1.57	4.71
10	1.51	0.98	1.01	1.16	3.50
20	1.10	1.15	0.92	1.06	3.17
40	0.95	1.30	0.84	1.03[x]	3.09
80	1.17	1.21	1.42	1.23	3.80
Total	9.55	9.00	7.75		26.30

L.S.D. @ .05 = 0.35

Table XIX

Effect of Isodrin on top/root ratio of radish

Treatment Lbs.compd./ac	A	B	C	Average	Total
Check	1.55	1.42	1.14	1.37	4.11
1	1.77	1.47	2.00	1.41	5.24
5	1.43	1.44	1.34	1.40	4.21
10	1.83	1.24	1.80	1.62	4.87
20	1.73	1.10	0.92	1.25	3.75
40	1.70	0.90	1.11	1.24	3.71
80	2.02	1.32	1.01	1.45	4.35
Total	12.03	8.89	9.32		30.24

No significant difference in treatment means.

Table XX

Effect of Dieldrin on the top/root ratio of radish

Treatment Lbs.compd/ac	Replicates A	B	C	Average	Total
Check	1.55	1.42	1.14	1.37	4.11
1	1.02	1.18	1.47	1.22	3.67
5	1.81	1.59	1.87	1.76xx	5.27
10	1.70	1.23	1.76	1.56	4.69
20	1.91	1.76	1.80	1.82xx	5.47
40	1.65	1.76	1.95	1.79xx	5.36
80	1.03	0.97	1.05	1.02x	3.05
Total	10.67	9.91	11.04		31.62

L.S.D. @ .05 = 0.26 L.S.D. @ .01 = 0.37

Table XXI

Effect of Endrin on the top/root ratio of radish

Treatment Lbs.compd/ac	Replicates A	B	C	Average	Total
Check	1.55	1.42	1.14	1.37	4.11
1	1.31	1.09	0.97	1.12	3.37
5	1.46	1.71	1.02	1.40	4.19
10	2.07	2.07	1.19	1.78	5.33
20	1.87	2.02	1.47	1.79	5.36
40	1.66	1.91	1.24	1.60	4.81
80	2.14	1.98	1.81	1.98	5.93
Total	12.06	12.20	8.84		33.10

No significant difference in treatment means.

Table XXII

The effects of Aldrin, Dieldrin, Isodrin and Endrin on weekly growth rate of tomato plants (in inches)

Treatment Lbs.compd/ac.		Replicate 1	2	3	Average
	Check	5.20	5.07	5.33	5.20
Aldrin	10	5.58	5.62	5.37	5.52
	20	4.97	6.10	5.86	5.64
	40	4.99	6.07	6.29	5.78
Dieldrin	10	5.76	5.16	5.23	5.38
	20	4.61	5.39	5.77	5.26
	40	4.58	4.59	4.23	4.47
Isodrin	10	5.34	5.22	5.61	5.39
	20	4.66	5.18	4.47	4.77
	40	4.65	4.73	5.17	4.86
Endrin	10	5.68	5.43	5.70	5.60
	20	5.76	5.71	5.04	5.50
	40	5.20	5.52	5.50	5.41
Average		5.15	5.37	5.35	5.29

No significant difference in the treatment means.

Table XXIII

Growth rate (weekly) of Tomato plants grown in soil treated with Acetone solutions of Endrin (#269). Plated 3 days after treatment (In inches)

Treatment Lbs.compd./acre	Replicates A	B	C	D	Average	Total
Check	1.9	1.6	2.1	2.4	2.0	8.0
1	1.7	2.1	1.2	1.4	1.6[x]	6.4
5	1.9	1.3	1.3	1.1	1.4[xx]	5.6
10	0.9	0.8	1.3	1.7	1.2[xx]	4.7
20	0.9	0.6	0.7	0.4	0.6[xx]	2.6
Total	7.3	6.4	6.6	7.0		27.3

L.S.D. - .05 Level = 0.37
" - .01 " = 0.52

Table XXIV

Growth rate (weekly) of Tomato plants grown in soil treated with Acetone solutions of Isodrin (#711). Planted 3 days after treatment (In inches)

Treatment Lbs.compd./acre	Replicates A	B	C	D	Average	Total
Check	1.9	1.6	2.1	2.4	2.0	8.0
1	1.5	1.2	1.4	1.4	1.6[x]	5.5
5	1.4	1.6	1.3	1.2	1.6[x]	5.5
10	1.5	1.1	1.6	1.4	1.6[x]	5.6
20	1.7	2.1	2.1	1.2	1.8[x]	7.1
Total	8.0	7.6	8.5	7.6		31.7

L.S.D. @ .05 = 0.43 L.S.D. @ .01 = 0.61

Table XXV

Weekly growth rate (in inches) of tomato plants grown in soil treated with Endrin (#269). Rates as in Table and planted 18 days after treatment

Treatment Lbs.compd./acre	Replicates A	B	C	D	Average	Total
Check	1.6	1.4	1.1	1.0	1.3	5.1
1	2.4	1.1	1.4	1.1	1.5	6.0
5	1.4	1.3	2.3	1.2	1.6	6.2
10	1.2	1.0	1.2	1.6	1.3	5.0
20	2.6	2.3	2.1	2.0	2.2[x]	9.0
Total	9.2	7.1	8.1	6.9		31.3

L.S.D. @ .05 = 0.58

Table XXVI

Weekly growth rate (in inches) of tomato plants grown in soil treated with Isodrin (#711). Rates as in Table and planted 18 days after treatment

Treatment Lbs.compd./acre	A	B	C	D	Average	Total
Check	1.6	1.4	1.1	1.0	1.3	5.1
1	1.8	1.1	1.3	1.2	1.4	5.4
5	1.2	1.3	1.2	2.4	1.5	6.1
10	1.6	2.0	1.3	2.8	1.9	7.7
20	1.5	1.9	1.5	2.1	1.8	7.0
Total	7.7	7.7	6.4	9.5		31.3

No significant difference in treatment means.

Table XXVII

The effect of Aldrin, Dieldrin, Isodrin and Endrin on blossoming of tomatoes

No. of days till first blossom opens

Treatment Lbs.compd./ac		Replicates 1	2	3	Average
	Check	88	92	90	90
Aldrin	10	85	75	78	79
	20	85	78	85	83
	40	78	85	75	79
Dieldrin	10	75	85	85	82
	20	80	85	75	80
	40	78	85	92	85
Isodrin	10	85	85	78	83
	20	78	85	80	81
	40	85	85	80	83
Endrin	10	78	75	75	76
	20	80	85	85	83
	40	102	78	90	90
Average		83	83	82	83

Compounds appeared to hasten blooming but figures not significant statistically.

Table XXVIII

Effect of Endrin on germination of tomato seed. Number of days first 4 seeds germinate. Total seeds per plot = 10

Treatment Lbs.compd./acre	Replicates A	B	C	D	Average	Total
Check	8	8	12	7	8.7	35
1	8	10	8	8	8.5	34
5	11	12	8	8	9.7	39
10	8	10	8	8	8.5	34
20	8	10	8	8	8.5	34
Total	43	50	44	39		176

No S.D. in treatment means

Table XXIX

Effect of Isodrin on germination of tomato seeds. Number of days first 4 seeds germinate. Total seeds per plot = 10

Treatment Lbs.compd./acre	Replicates A	B	C	D	Average	Total
Check	8	8	12	7	8.7	35
1	10	9	10	8	9.1	37
5	9	9	7	8	8.1	33
10	7	10	10	6	8.1	33
20	10	8	8	8	8.2	34
Total	44	44	47	37		172

No S.D. in treatment means

Table XXX

Total number of tomato seeds germinated in soil treated with Endrin. Seeds per plot=10

Treatment Lbs.compd./acre	Replicates A	B	C	D	Total/40
Check	8	7	7	8	30
1	8	7	9	10	34
5	7	9	10	9	35
10	10	7	9	8	34
20	8	5	10	8	31
Total	41	35	45	43	164

No S.D. in treatment totals

Table XXXI

Total number of tomato seeds germinated in soil treated with Isodrin. Seeds per plot = 10

Treatment Lbs.compd./acre	Replicates A	B	C	D	Total/40
Check	8	7	7	8	30
1	8	10	9	9	36
5	7	7	10	9	33
10	9	8	9	7	33
20	10	7	8	10	35
Total	42	39	43	43	167

No S.D. in treatment totals

Table XXXII

Germination trials with radish in Aldrin treated soil

Treatment Lbs.compd./ac.	Replicates	No. of days 3	4	5	6	Final Count
Check	1	0	11	19	22	24
	2	0	8	11	12	18
	3	0	9	18	21	23
	Total	0	28	48	55	65
1	1	1	12	18	21	23
	2	0	17	22	22	24
	3	0	14	22	23	24
	Total	1	43	62	66	71
5	1	2	17	22	23	25
	2	2	13	18	23	27
	3	2	16	20	21	22
	Total	6	46	60	67	74
10	1	0	15	21	22	25
	2	0	12	20	22	24
	3	0	14	19	22	24
	Total	0	41	60	66	73
20	1	1	13	20	20	24
	2	2	15	19	19	22
	3	2	12	20	21	24
	Total	5	40	59	60	70
40	1	1	9	16	16	23
	2	2	11	19	20	22
	3	1	12	23	23	26
	Total	4	32	58	59	71
80	1	0	12	17	19	21
	2	0	10	17	23	25
	3	0	17	24	25	25
	Total	0	39	58	67	71
	G.T.	16	269	405	440	495

No S. D. in treatment totals.

Table XXXIII

Germination of radish in replicated soil flats, counted at different intervals. 32 seeds per plot

Isodrin

Treatment lbs.compd./ac.	Replicates	No. of days 3	4	5	6	Final Count
Check	1	0	11	19	22	24
	2	0	8	11	12	18
	3	0	9	18	21	23
	Total	0	28	48	55	65
1	1	1	10	18	22	22
	2	1	13	20	22	23
	3	1	12	17	19	20
	Total	3xx	35	55	63	65
5	1	0	19	24	25	26
	2	1	14	17	19	22
	3	1	19	22	24	27
	Total	2xx	52	63	68	75
10	1	1	10	17	22	24
	2	1	21	24	26	27
	3	0	12	15	17	22
	Total	2xx	43	56	65	73
20	1	0	13	20	25	26
	2	1	13	20	20	25
	3	0	17	21	24	25
	Total	1x	43	61	69	76
40	1	12	15	20	24	26
	2	12	16	22	23	25
	3	13	15	21	22	23
	Total	37xx	46	63	69	74
80	1	4	12	16	18	19
	2	4	14	20	22	25
	3	4	15	21	25	27
	Total	12xx	41	57	65	71
	G.T.	57	288	403	454	499

L.S.D. - 3 day column @ .05 = 1.0, @ .01 = 1.3

Table XXXIV

Germination trials with Radish (cont'd).

Dieldrin

Treatment lbs.compd./ac.	Replicates	No. of days 3	4	5	6	Final Count
Check	1	0	11	19	22	24
	2	0	8	11	12	18
	3	0	9	18	21	23
	Total	0	28	48	55	65
1	1	0	3	10	12	23
	2	0	6	11	15	23
	3	0	9	16	22	25
	Total	0	18	37	49	71
5	1	1	9	18	22	26
	2	0	12	23	24	25
	3	0	9	15	20	24
	Total	1	30	56	66	75
10	1	0	11	19	22	24
	2	0	10	17	20	20
	3	0	10	15	19	21
	Total	0	31	51	61	65
20	1	0	6	15	21	26
	2	0	6	21	24	24
	3	0	5	14	17	25
	Total	0	17	50	62	75
40	1	0	5	14	18	23
	2	0	9	17	18	20
	3	0	6	18	20	23
	Total	0	20	49	56	66
80	1	0	7	15	20	22
	2	0	5	14	17	20
	3	0	6	15	17	24
	Total	0	18	44	54	66
	G.T.	1	162	335	403	483

No S.D. exists in totals.

Table XXXV

Germination trials with radish (con't.)

Endrin

Treatment Lbs.compd./ac.	Repli-cates	No. of Days 3	4	5	6	Final Count
check	1	0	11	19	22	24
	2	0	8	11	12	18
	3	0	9	18	21	23
	Total	0	28	48	55	65
1	1	0	1	10	19	24
	2	0	5	12	16	19
	3	0	5	14	20	23
	Total	0	11	36	55	66
5	1	0	8	18	25	28
	2	0	9	20	25	27
	3	0	4	13	18	22
	Total	0	21	51	68	77[x]
10	1	1	8	14	23	27
	2	0	12	17	21	23
	3	1	13	20	22	27
	Total	2	33	51	66	77[x]
20	1	1	10	14	16	20
	2	1	15	22	23	23
	3	1	14	17	19	22
	Total	3	39	53	58	65
40	1	0	7	13	20	22
	2	0	9	13	17	19
	3	0	11	15	19	23
	Total	0	27	41	56	64
80	1	0	12	18	20	20
	2	0	9	14	18	20
	3	0	8	15	17	18
	Total	0	29	47	55	58
	G.T.	5	188	327	413	472

L.S.D. of final count column @ .05 = 12

Table XXXVI

Replicated germination tests with Radish seeds using same concentrations as in preliminary trial--re Table 12

Number of seeds per plate = 20

Isodrin

Treatments p.p.m.compd.	Time	Replicates A	B	C	Total
Check	48 hrs.	2	3	3	8
40		6	5	6	17xx
200		3	5	4	12xx
600		0	0	0	0xx
	Total	11	13	13	37
Check	72 hrs.	8	15	10	33
40		16	16	17	49xx
200		15	16	14	45xx
600		1	3	2	6xx
	Total	40	50	43	133
Check	96 hrs.	8	17	12	37
40		18	17	18	53x
200		18	18	18	54x
600		5	9	6	20x
	Total	49	61	54	164
Check	120 hrs.	13	18	14	45
40		18	17	18	53
200		18	18	18	54x
600		9	13	10	32xx
	Total	58	66	60	184
Check	144 hrs.	14	18	15	47
40		18	17	18	53
200		18	18	18	54
600		10	15	12	37x
	Total	60	68	63	191
Check	168 hrs. (Final)	14	18	15	47
40		18	17	18	53
200		18	18	18	54
600		11	16	13	40
	Total	61	69	64	194

Table XXXVII

Germination results (cont'd.)

Aldrin

Treatments p.p.m.compd.	Time	Replicates A	B	C	Total
Check		2	3	3	8
10	48 hrs.	2	4	4	10
20		1	1	1	3[xx]
40		0	0	0	0[xx]
	Total	5	8	8	21
Check		8	15	10	33
10	72 hrs.	9	13	11	33
20		4	8	5	17[xx]
40		0	4	3	7[xx]
	Total	21	40	29	90
Check		8	17	12	37
10	96 hrs.	16	14	16	46
20		10	9	12	31
40		2	8	5	15[x]
	Total	36	48	45	129
Check		13	18	14	45
10	120 hrs.	16	15	16	47
20		13	14	14	41
40		3	11	7	21[xx]
	Total	45	58	51	154
Check		14	18	15	47
10	144 hrs.	17	16	17	50
20		15	14	15	44
40		4	14	9	27[x]
	Total	50	62	56	168
Check		14	18	15	47
10	168 hrs.	17	16	17	50
20	(Final	16	17	17	50
40	Count)	6	14	10	30[x]
	Total	53	65	59	177

Table XXXVIII

Germination results (cont'd.)

Dieldrin

Treatment p.p.m.compd.	Time	Replicates A	B	C	Total
Check	48 hrs.	2	3	3	8
40		7	7	6	20xx
200		3	5	4	12xx
600		0	0	0	0xx
	Total	12	15	13	40
Check	72 hrs.	8	15	10	33
40		19	18	17	54xx
200		11	15	13	39
600		8	11	9	28
	Total	46	59	49	154
Check	96 hrs.	8	17	12	37
40		20	18	18	56x
200		15	18	16	49
600		10	12	11	33
	Total	53	65	57	175
Check	120 hrs.	13	18	14	45
40		20	19	18	57
200		17	18	16	51
600		10	14	13	37
	Total	60	69	61	190
Check	144 hrs.	14	18	15	47
40		20	19	18	57x
200		18	19	18	55
600		12	15	14	41
	Total	64	71	65	200
Check	168 hrs. (Final Count)	14	18	15	47
40		20	19	18	57x
200		18	19	18	55x
600		14	15	14	43
	Total	66	71	65	202

Table XXXIX

Germination results (cont'd.)

<u>Endrin</u>

Treatments p.p.m.compd.	Time	Replicates A	B	C	Total
Check		2	3	3	8
40	48 hrs.	5	6	5	16[x]
200		5	2	4	11
600		1	1	0	2[x]
	Total	13	12	12	37
Check		8	15	10	33
40	72 hrs.	16	14	15	45
200		14	11	13	38
600		9	9	8	26
	Total	47	49	46	142
Check		8	17	12	37
40	96 hrs.	19	16	18	53
200		15	13	13	41
600		12	12	11	35
	Total	54	58	54	166
Check		13	18	14	45
40	120 hrs.	19	16	19	54
200		17	15	15	47
600		13	15	13	41
	Total	62	64	61	187
Check		14	18	15	47
40	144 hrs.	19	16	19	54
200		17	17	16	50
600		15	15	14	44
	Total	65	66	64	195
Check		14	18	15	47
40	168 hrs.	19	16	19	54
200	(Final	17	17	16	50
	count)	15	15	14	44
	Total	65	66	64	195

Statistical analysis of Table XXXVI

48	hrs. -	L.S.D.	@	.05	= 1.22,	@	.01	= 1.85
72	"	"	"	"	= 3.41,	"	"	= 5.18
96	"	"	"	"	=13.4 ,	"	"	=20.7
120	"	"	"	"	= 9.0 ,	"	"	=13.7
144	"	"	"	"	= 9.0,	"	"	=13.7

Statistical analysis of Table XXXVII

48	hrs. -	L.S.D.	@	.05	= 3.3,	@	.01	= 5.0
72	"	"	"	"	= 6.0,	@	"	= 9.1
96	"	"	"	"	= 16.7,	"	"	= 25.3
120	"	"	"	"	= 12.4,	"	"	= 18.8
144	"	"	"	"	= 15.9,	"	"	= 24.1
168	"	"	"	"	= 12.0,	"	"	= 18.1

Statistical analysis of Table XXXVII

48	hrs. -	L.S.D.	@	.05	= 2.6,	@	.01	= 3.9
72	"	"	"	"	= 10.0,	"	"	= 15.5
96	"	"	"	"	= 14.0,	"	"	= --
120	"	"	"	"	= 13.4,	"	"	= 20.4
144	"	"	"	"	= 7.3,	"	"	= 11.1
168	"	"	"	"	= 6.0,	"	"	= 9.1

Statistical analysis of Table XXXIX

48 hrs. - L.S.D. @ .05 = 6.6

All other intervals not significant.

Table XL

Effect of Isodrin and Endrin on the sugar content of carrots as measured by refractometer

Treatment Lbs.compd/ acre	Replicates 1	2	3	4	5	6	7	8	9	Average	Total
Check	15.5	14.0	11.2	11.5	12.5	10.0	11.3	14.3	12.0	12.4	112.3
Endrin 0.5	11.5	13.5	13.7	12.2	13.7	11.5	12.5	12.2	13.5	12.7	114.3
3.5	13.5	13.0	10.0	12.0	11.2	10.3	11.0	11.2	14.2	11.8	106.4
6.5	13.0	12.7	13.0	12.2	10.7	11.7	13.5	12.5	11.2	12.2	110.5
9.5	12.2	11.5	11.5	12.7	12.7	10.7	9.7	12.7	12.2	11.7	105.9
Total	65.7	64.7	59.4	60.6	60.8	54.2	58.0	63.9	63.1		549.4
Check	15.5	14.0	11.2	11.5	12.5	10.0	11.3	14.3	12.0	12.4	112.3
Isodrin 0.5	13.0	11.7	11.2	10.0	9.0	12.0	11.2	12.5	11.0	11.3	101.6
3.5	13.0	10.0	10.5	12.5	12.7	10.2	11.5	13.5	14.2	12.0	108.1
6.5	13.0	10.5	12.7	10.7	11.2	10.2	11.2	13.2	11.2	11.5	103.9
9.5	13.0	11.0	11.0	11.2	10.2	11.5	12.0	11.5	12.2	11.5	103.6
Total	67.5	57.2	56.6	55.9	55.6	53.9	57.2	65.0	60.6		529.5

No S. D. in treatment means.

Table XLI

Effect of Aldrin and Dieldrin on the sugar content of potatoes as measured by a refractometer

Treatment Lbs.compd/acre		Replicates 1	2	3	4	5	6	7	8	9	Average	Total
Check		5.5	6.2	5.7	6.2	6.7	6.5	5.5	5.0	4.5	5.75	51.8
Aldrin	0.5	5.7	5.2	5.7	6.5	7.2	5.7	5.5	5.5	5.0	5.77	52.0
	3.5	4.0	4.7	5.0	4.2	5.7	5.2	4.5	5.2	5.2	4.85	43.7
	6.5	5.7	5.0	6.0	5.7	6.0	5.0	6.2	5.0	5.2	5.53	49.8
	9.5	5.7	5.7	5.2	5.2	6.0	6.7	6.2	3.5	5.5	5.52	49.7
Total		26.6	26.8	27.6	27.8	31.6	29.1	27.9	24.2	25.4		
Check		5.5	6.2	5.7	6.2	6.7	6.5	5.5	5.0	4.5	5.75	51.8
Dieldrin	0.5	5.2	5.2	5.7	4.7	6.0	5.0	5.2	5.0	3.7	5.07	45.7
	3.5	5.0	4.7	6.0	6.2	6.0	6.0	5.2	5.0	3.5	5.28	47.6
	6.5	5.2	5.2	5.5	6.7	6.2	5.2	4.2	6.2	4.5	5.43	48.9
	9.5	5.2	5.7	6.0	6.0	5.5	5.7	5.2	6.0	4.7	5.55	50.0
Total		26.1	27.0	28.9	29.8	30.4	28.4	24.3	27.2	20.9		

No S. D. in treatment means

Table XLII

Effect of Aldrin on the sugar content of radish as measured by a refractometer

Treatment Lbs.compd./acre	Replicate A	B	C	Average	Total
Check	3.5	3.5	4.0	3.66	11.0
1	3.0	3.0	3.5	3.16	9.5
5	5.0	4.0	4.0	4.33[x]	13.0
10	3.5	3.5	3.0	3.83	10.0
20	3.5	3.5	3.5	3.50	10.5
40	3.5	3.5	3.5	3.50	10.5
80	3.0	3.0	3.0	3.00[x]	9.0
Total	25.0	24.0	24.5		73.5

L.S.D. @ .05 = 0.52 L.S.D. @ .01 = 0.73

Table XLIII

Effect of Isodrin on the sugar content of radish

Treatment Lbs.compd/acre	Replicate A	B	C	Average	Total
Check	3.5	3.5	4.0	3.66	11.0
1	2.5	2.0	3.0	2.50[xx]	7.5
5	3.5	3.0	3.0	3.16[x]	9.5
10	3.0	3.0	3.5	3.16[x]	9.5
20	3.0	3.5	3.0	3.16[x]	9.5
40	3.0	3.5	3.5	3.33	10.0
80	3.5	3.5	4.0	3.66	11.0
Total	22.0	22.0	24.0		68.0

L.S.D. @ .05 = 0.50 L.S.D. @ .01 = 0.70

Table XLIV

Effect of Dieldrin on the sugar content of radish as measured by a refractometer

Treatment Lbs.compd./acre	Replicate A	B	C	Average	Total
Check	3.5	3.5	4.0	3.66	11.0
1	3.0	3.0	3.0	3.00xx	9.0
5	2.5	2.5	2.5	2.50xx	7.5
10	3.0	3.0	3.0	3.00xx	9.0
20	2.5	2.5	3.0	2.66xx	8.0
40	2.0	2.0	2.0	2.00xx	6.0
80	2.5	2.0	2.5	2.33xx	7.0
Total	19.0	18.5	20.0		57.5

L.S.D. @ .05 = 0.26 L.S.D. @ .01 = 0.37

Table XLV

Effect of Endrin on the sugar content of radish

Treatment Lbs.compd./acre	Replicate A	B	C	Average	Total
Check	3.5	3.5	4.0	3.66	11.0
1	2.5	3.0	3.0	2.83xx	8.5
5	3.0	3.5	3.5	3.33	10.0
10	3.5	3.5	3.0	3.33	10.0
20	3.0	3.5	3.5	3.33	10.0
40	3.0	3.0	3.0	3.00xx	9.0
80	4.0	4.0	3.5	3.83	11.5
Total	22.5	24.0	23.5		70.00

L.S.D. @ .05 = 0.45 L.S.D. @ .01 = 0.64

Table XLVI

Effect of Isodrin and Endrin on ~~Vitamin A~~ Carotene content of carrots - Mgs./100 gms

Treatment Lbs.compd/ acre		Replicates 1	2	3	4	5	6	7	8	9	Aver-age	Total
Check		3.48	3.02	3.78	5.59	5.30	5.20	2.85	3.23	2.32	3.86	34.77
Endrin	0.5	3.27	3.60	2.50	3.48	6.06	3.60	2.52	2.60	3.90	3.50	31.53
	3.5	3.01	2.66	2.28	3.69	4.80	3.79	2.66	2.30	3.38	3.17	28.57
	6.5	3.65	4.50	1.20	4.02	4.06	4.20	2.65	1.70	4.20	3.35	30.18
	9.5	4.20	4.86	2.21	5.64	5.46	4.17	2.48	3.15	3.48	3.96	35.65
Total		17.61	18.64	11.97	22.42	25.68	20.96	13.16	12.98	17.28		160.70
Check		3.48	3.02	3.78	5.59	5.30	5.20	2.85	3.23	2.32	3.86	34.77
Isodrin	0.5	1.80	3.40	3.60	5.04	4.92	4.92	2.64	2.85	2.96	3.57	32.13
	3.5	2.47	2.73	2.56	5.14	4.88	2.97	3.65	3.64	3.10	3.46	31.14
	6.5	5.40	3.36	2.76	3.40	5.24	4.88	3.24	3.04	1.65	3.66	32.97
	9.5	4.95	3.69	2.97	4.88	4.44	4.88	2.08	2.73	3.00	3.64	33.62
Total		18.10	16.20	15.67	24.05	24.78	22.85	14.46	15.49	13.03		164.63

No S. D. in treatment means

Table XLVII

Effect of Aldrin and Dieldrin on Vitamin C content of potatoes (in milligrams/100 gms F.W.)

Treatment lbs.compd./acre	Replicates 1	2	3	4	5	6	7	8	9	Average	Total
Check	13.5	12.5	15.5	9.0	14.0	17.0	18.5	15.0	8.5	13.7	123.5
Aldrin 0.5	16.5	14.5	16.5	17.5	15.0	13.0	14.0	14.0	15.0	15.1	136.0
3.5	12.0	15.0	21.0	13.5	13.0	12.0	18.5	20.0	18.5	15.9	143.5
6.5	17.5	16.5	12.5	13.0	21.0	16.0	13.5	16.5	12.0	15.4	138.5
9.5	12.5	9.5	20.0	12.5	11.5	15.5	20.0	12.0	11.5	13.8	125.0
	71.0	68.0	85.5	65.5	74.5	73.5	84.5	77.5	65.5		666.5
Check	13.5	12.5	15.5	9.0	14.0	17.0	18.5	15.0	8.5	13.7	123.5
Dieldrin 0.5	15.0	16.5	19.5	10.5	17.0	16.0	20.5	18.0	10.0	15.8	143.0
3.5	13.5	16.0	14.0	15.0	15.5	18.5	15.5	12.0	13.0	14.7	133.0
6.5	13.0	17.0	16.5	11.0	13.5	12.5	11.5	9.5	9.0	12.6	113.5
9.5	17.5	10.0	17.0	14.0	16.0	16.5	16.0	9.5	10.5	14.1	127.0
	72.5	72.0	82.5	59.5	76.0	80.5	82.0	64.0	51.0		640.00

No S. D. in treatment means.

Table XLVIII

Effect of Aldrin on the Vitamin C content of radish (milligrams/100 gms.F.W.)

Treatment Lbs.compd./ac.	Replicate A	B	C	Average	Total
Check	15.0	15.0	16.3	15.4	46.3
1	16.3	15.0	15.0	15.4	46.3
5	13.8	13.8	13.8	13.8^{x}	41.4
10	12.5	12.5	12.5	12.5^{xx}	37.5
20	12.0	11.8	12.0	11.9^{xx}	35.8
40	11.3	10.0	11.3	10.9^{xx}	32.6
80	10.0	12.5	12.5	11.6^{xx}	35.0
Total	90.9	90.6	93.4		274.9

L.S.D. @ .05 = 1.34 L.S.D. @ .01 = 1.89

Table XLIX

Effect of Isodrin on the Vitamin C content of radish (mg./100 gms. F.W.)

Treatment Lbs.compd./ac.	Replicate A	B	C	Average	Total
Check	15.0	15.0	16.3	15.4	46.3
1	13.8	13.8	13.8	13.8	41.4
5	12.5	12.5	12.5	12.5^{xx}	37.5
10	12.5	12.5	12.5	12.5^{xx}	37.5
20	12.5	12.5	12.5	12.5^{xx}	37.5
40	7.5	8.8	8.8	8.3^{xx}	25.1
80	6.3	6.3	6.3	6.3^{xx}	18.9
Total	80.1	81.4	82.7		244.2

L.S.D. @ .05 = 2.17 L.S.D. @ .01 = 3.05

Table L

Effect of Dieldrin on the Vitamin C content of radish (Mg./100 gms. F.W.)

Treatment Lbs.compd./ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	15.0	15.0	16.3	15.4	46.3
1	11.3	11.3	11.3	11.3xx	33.9
5	13.8	13.8	13.8	13.8xx	41.4
10	12.5	11.3	11.3	11.7xx	35.1
20	10.0	10.0	8.8	9.6xx	28.8
40	8.8	8.8	8.8	8.8xx	26.4
80	7.5	7.5	7.5	7.5xx	22.5
Total	78.9	77.7	77.8		234.4

L.S.D. @ .05 = 0.85 L.S.D. @ .01 = 1.19

Table LI

Effect of Endrin on the Vitamin C content of radish (mg./100 gms. F.W.)

Treatment Lbs.compd./ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	15.0	15.0	16.3	15.4	46.3
1	12.5	12.5	12.5	12.5xx	37.5
5	8.8	8.8	8.8	8.8xx	26.4
10	7.5	7.5	7.5	7.5xx	22.5
20	7.5	8.8	8.8	8.4xx	25.1
40	8.8	7.5	8.8	8.4xx	25.1
80	8.8	8.8	8.8	8.8xx	26.4
Total	68.9	68.9	71.5		209.3

L.S.D. @ .05 = 0.85 L.S.D. @ .01 = 1.19

Table LII

Effect of Isodrin and Endrin on moisture content of carrots - % water

Treatment Lbs.compd/ acre	Replicate 1	2	3	4	5	6	7	8	9	Average	Total
Check	82.05	85.10	85.35	84.40	83.40	84.90	86.45	82.35	84.80	84.31	758.8
Endrin 0.5	84.50	84.50	84.60	85.20	82.70	85.60	83.90	84.50	83.90	84.38	759.4
3.5	82.50	83.75	85.70	82.50	82.95	85.55	84.90	85.90	84.05	84.20	757.8
6.5	83.00	84.75	83.90	84.20	83.60	84.20	83.50	84.15	85.40	84.08	756.7
9.5	84.00	85.45	83.80	83.55	83.10	85.25	85.40	83.95	84.80	84.37	759.3
Total	416.05	423.55	423.35	419.85	415.75	425.40	424.15	420.35	422.95		3792.0
Check	82.05	85.10	85.35	84.40	83.40	84.90	86.45	82.35	84.80	84.31	758.8
Isodrin 0.5	83.70	86.20	84.90	81.60	86.40	81.15	83.70	83.05	83.75	83.83	754.4
3.5	83.75	85.80	86.30	82.65	84.45	82.90	85.35	84.15	82.65	84.22	758.0
6.5	83.45	85.40	80.80	85.10	82.95	83.20	85.65	83.95	85.90	84.04	756.4
9.5	84.25	85.55	84.95	85.65	85.45	83.75	84.45	86.50	84.50	85.01	765.0
Total	417.20	428.05	422.30	419.40	422.65	415.90	425.60	420.00	421.60		3792.6

No S. D. in treatment means.

Table LIII

Effect of Aldrin and Dieldrin on per cent dry matter (dry weight) of potatoes

Treatment Lbs. compd/ acre	Replicate 1	2	3	4	5	6	7	8	9	Aver-age	Total
Check	21.5	25.3	23.8	25.2	25.5	22.8	25.5	25.2	25.5	24.5	220.3
Aldrin 0.5	22.6	22.9	22.1	22.6	25.6	26.9	23.8	28.1	25.9	24.5	220.5
3.5	20.4	24.6	23.5	22.1	24.8	25.3	25.9	24.8	24.9	24.1	216.3
6.5	24.8	24.4	23.1	22.6	26.9	24.2	25.2	27.1	29.1	25.3	227.4
9.5	22.7	24.0	24.4	23.0	23.9	22.9	22.3	27.9	26.6	24.2	217.7
Total	112.0	121.2	116.9	115.5	126.7	122.1	122.7	133.1	132.0		1102.2
Check	21.5	25.3	23.8	25.2	25.5	22.8	25.5	25.2	25.5	24.5	220.3
Dieldrin 0.5	23.3	23.3	22.7	22.9	27.0	24.1	22.3	26.8	28.3	24.5	220.7
3.5	23.2	27.0	22.1	23.8	25.5	26.0	23.6	24.7	26.3	24.7	222.2
6.5	20.7	24.7	24.0	26.3	25.0	23.3	24.4	25.6	26.5	24.5	220.5
9.5	28.4	22.9	23.8	24.8	23.4	29.0	23.4	27.5	27.5	25.6	230.7
Total	117.1	123.2	116.4	123.0	126.4	125.2	119.2	129.8	134.1		1114.4

No S.D. in treatment means.

Table LIV

Effect of Isodrin and Endrin on ash content of carrots. Expressed in per cent

Treatment Lbs.compd/ acre		Replicates 1	2	3	4	5	6	7	8	9	Average
	Check	0.7580	0.7780	0.7280	0.8830	0.6115	0.7915	0.8125	0.8730	0.7120	0.7719
Endrin	0.5	0.8800	0.8670	1.1260	0.7115	0.8840	0.7625	0.7770	0.7120	0.7100	0.8256
	3.5	0.7835	0.7690	0.6015	0.7625	0.7715	0.7355	0.7435	0.6550	0.8225	0.7383
	6.5	0.8335	0.8485	0.9115	0.9310	0.8335	0.7845	0.7540	0.7735	0.7895	0.8288
	9.5	0.7130	0.7755	0.8300	0.8385	0.9985	0.7155	0.7115	0.8760	0.6635	0.7913
	Check	0.7580	0.7780	0.7280	0.8830	0.6115	0.7915	0.8125	0.8730	0.7120	0.7719
Isodrin	0.5	0.8555	0.8630	0.7540	1.0390	0.7680	0.9160	0.7880	0.7610	0.6730	0.8253
	3.5	0.9875	0.6420	0.8650	0.8410	0.8600	0.9495	0.6835	0.7625	0.8650	0.8284
	6.5	0.6855	0.6405	0.8030	0.7625	0.8300	0.8995	0.7215	0.7985	0.7450	0.7651
	9.5	0.8005	0.7240	0.7425	0.9225	0.7980	0.8615	0.7110	0.6765	0.7610	0.7775

No S. D. in treatment means.

Table LV

Effect of Aldrin and Dieldrin on ash content of potatoes. (expressed in per cent)

Treatment Lbs.compd/ acre	Replicates 1	2	3	4	5	6	7	8	9	Average	Total
Check	1.361	1.183	1.337	1.387	1.160	0.979	1.041	0.936	1.150	1.170	10.534
Aldrin 0.5	0.993	1.253	1.124	1.051	1.360	1.028	1.065	1.388	1.120	1.154	10.382
3.5	1.436	1.034	1.178	1.375	1.251	1.211	1.103	1.060	0.931	1.175	10.579
6.5	1.093	0.997	1.170	1.037	1.234	1.222	1.011	0.962	1.047	1.086	9.773
9.5	1.047	1.338	0.898	0.994	1.234	1.091	1.016	1.004	1.071	1.077	9.693
Check	1.361	1.183	1.337	1.387	1.160	0.979	1.041	0.936	1.150	1.170	10.534
Dieldrin 0.5	0.864	1.268	1.337	1.198	1.160	1.214	0.913	1.075	1.031	1.118	10.060
3.5	1.124	1.037	0.849	1.012	1.181	1.286	0.946	1.027	0.909	1.041	9.371
6.5	1.126	1.337	0.998	1.431	1.220	1.213	1.118	1.445	1.042	1.214	10.930
9.5	1.085	1.309	1.225	1.304	0.989	0.930	0.995	1.830	1.280	1.216	10.947

No S.D. in treatment means

Table LVI

Effect of Aldrin on Nitrogen content of radish (Test of leaf petiole - in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	164	148	164	492
1	60	84	72	72xx	216
5	48	64	60	57xx	172
10	60	52	64	59xx	176
20	56	50	48	51xx	154
40	48	48	36	44xx	132
80	28	44	32	35xx	104
Total	480	506	460		1446

L.S.D. @ .05 = 17.19 L.S.D. @ .01 = 24.16

Table LVII

Effect of Isodrin on Nitrogen content of radish (Test of leaf petiole - in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	164	148	164	492
1	112	60	92	88xx	264
5	82	80	56	73xx	218
10	60	64	40	55xx	164
20	36	64	36	45xx	136
40	28	40	32	33xx	100
80	8	8	8	8xx	24
Total	506	480	412		1398

L.S.D. @ .05 = 25.90 L.S.D. @ .01 = 36.42

Table LVIII

Effect of Dieldrin on Nitrogen content of radish (Test of leaf petiole -- in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	164	148	164	492
1	380	320	260	320xx	960
5	340	400	300	346xx	1040
10	420	360	460	413xx	1240
20	500	420	460	460xx	1380
40	360	500	340	400xx	1200
80	140	124	116	126	380
Total	2320	2288	2084		6692

L.S.D. @ .05 = 91.36   L.S.D. @ .01 = 128.41

Table LIX

Effect of Endrin on Nitrogen content of radish (Test of leaf petiole - in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	164	148	164	492
1	152	180	180	171	512
5	160	168	140	156	468
10	156	164	200	173	520
20	172	198	160	176	530
40	400	480	440	473xx	1320
80	320	220	340	293xx	880
Total	1540	1574	1608		4722

L.S.D. @ .05 = 61.43   L.S.D. @ .01 = 86.35

Table LX

Effect of Aldrin on Nitrogen content of radish roots

(in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	200	200	160	186	560
1	60	68	68	65xx	196
5	64	68	80	71xx	212
10	72	64	60	65xx	196
20	70	72	64	69xx	206
40	72	80	88	80xx	240
80	64	88	80	77xx	232
Total	602	640	600		1842

L.S.D. @ .05 = 20.72   L.S.D. @ .01 = 29.13

Table LXI

Effect of Isodrin on nitrogen content of radish roots

(in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	200	200	160	186	560
1	220	220	240	226xx	680
5	100	88	80	86xx	268
10	120	108	104	111xx	332
20	80	60	68	69xx	208
40	88	80	60	76xx	228
80	100	88	88	92xx	276
Total	908	844	800		2552

L.S.D. @ .05 = 20   L.S.D. @ .01 = 29

LXII

Effect of Dieldrin on Nitrogen content of radish roots

(in p.p.m.)

Treatment Lbs.compd./ac	Replicate A	B	C	Average	Total
Check	200	200	160	186	560
1	240	180	200	206	620
5	220	228	220	229	668
10	260	200	260	240	720
20	200	220	220	213	640
40	180	220	160	186	560
80	200	220	260	226	680
Total	1500	1468	1480		4448

No.S.D. in treatment mean - a general trend is evident, however.

LXIII

Effect of Endrin on Nitrogen content of radish roots

(in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	200	200	160	186	560
1	180	160	180	173	520
5	180	140	140	153[x]	460
10	112	88	92	97[xx]	292
20	120	120	132	124[xx]	372
40	140	180	180	166	500
80	160	160	160	160	480
Total	1092	1048	1044		3184

L.S.D. @ .05 = 31 L.S.D. @ .01 = 44

Table LXIV

Effect of Aldrin on phosphorus content of radish leaf petiole (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	198	168	182	546
1	151	182	157	163^{x}	490
5	119	107	110	112^{xx}	336
10	72	103	66	80^{xx}	241
20	86	110	80	92^{xx}	276
40	94	119	94	102^{xx}	307
80	106	100	84	96^{xx}	290
Total	808	919	759		2486

L.S.D. @ .05 = 17 L.S.D. @ .01 = 23

Table LXV

Effect of Isodrin on phosphorus content of radish leaf petiole (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	198	168	182	546
1	176	186	164	175	526
5	157	157	122	145^{xx}	436
10	116	113	114	114^{xx}	343
20	103	97	138	113^{xx}	338
40	103	113	110	109^{xx}	326
80	94	100	100	98^{xx}	294
Total	929	964	916		2809

L.S.D. @ .05 = 26 L.S.D. @ .01 = 36

Table LXVI

Effect of Dieldrin on phosphorus content of radish leaf petiole (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	198	168	182	546
1	239	252	252	247xx	743
5	189	189	141	173	519
10	163	116	119	133x	398
20	97	81	91	89xx	269
40	157	189	151	166	497
80	204	132	182	173	518
Total	1229	1157	1104		3490

L.S.D. @ .05 = 38 L.S.D. @ .01 = 53

Table LXVII

Effect of Endrin on phosphorus content of radish leaf petiole (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	B	C	Average	Total
Check	180	198	168	182	546
1	170	189	163	174	522
5	176	157	151	161	484
10	144	170	144	153	458
20	119	97	107	108xx	323
40	144	182	163	163	489
80	220	170	236	209	626
Total	1153	1163	1132		3448

L.S.D. @ .05 = 36 L.S.D. @ .01 = 50

Table LXVIII

Effect of Aldrin on phosphorus content of radish roots (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	50	44	47	47	141
1	72	56	63	64xx	191
5	37	56	44	46	137
10	34	40	44	39	118
20	38	42	40	40	120
40	47	50	40	46	137
80	28	28	34	30xx	90
Total	306	316	312		934

L.S.D. @ .05 = 11 L.S.D. @ .01 = 15

Table LXIX

Effect of Isodrin on phosphorus content of radish roots (in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	50	44	47	47	141
1	59	63	63	62xx	185
5	40	37	37	38xx	114
10	47	47	47	47	141
20	31	31	28	30xx	90
40	37	31	31	33xx	99
80	37	30	30	32xx	97
Total	301	283	283		867

L.S.D. @ .05 = 4 L.S.D. @ .01 = 6

Table LXX

Effect of Dieldrin on phosphorus content of radish roots (Tissue tests - in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	50	44	47	47	141
1	34	59	59	51	152
5	47	47	50	48	144
10	63	47	53	54	163
20	47	53	44	48	144
40	37	31	31	33[x]	99
80	31	28	25	28[xx]	84
Total	309	309	309		927

L.S.D. @ .05 = 13 L.S.D. @ .01 = 18

Table LXXI

Effect of Endrin on phosphorus content of radish roots (Tissue tests - in p.p.m.)

Treatment Lbs.compd/ac	Replicate A	Replicate B	Replicate C	Average	Total
Check	50	44	47	47	141
1	50	47	53	50	150
5	37	34	37	36[xx]	108
10	37	37	44	39[x]	118
20	37	44	44	42	125
40	37	40	34	37[xx]	111
80	34	40	34	36[xx]	108
Total	282	286	293		861

L.S.D. @ .05 = 6.0 L.S.D. @ .01 = 9

Table LXXII

Effect of Isodrin and Endrin on chlorine content of carrots
mg/100 gms. fresh weight

Treatment Lbs.compd/ acre		Replicates 1	2	3	4	5	6	7	8	9	Average	Total
	Check	52.1	78.6	94.6	90.6	90.6	90.6	63.9	78.1	68.6	78.6	707.7
Endrin	0.5	108.8	71.0	89.9	80.7	92.5	93.5	71.0	73.3	66.2	83.0	746.9
	3.5	92.3	101.7	78.1	90.6	74.8	91.0	61.5	79.7	89.9	84.4	759.6
	6.5	94.6	99.4	120.7	89.4	91.6	85.6	79.7	71.0	73.3	89.5	805.3
	9.5	89.4	120.7	99.4	78.8	91.6	91.6	78.1	89.9	68.6	89.8	808.1
	Total	437.2	471.4	482.7	430.1	441.1	452.3	354.2	392.0	366.6		3827.3
	Check	52.1	78.6	94.6	90.6	90.6	90.6	63.9	78.1	68.6	78.6	707.7
Isodrin	0.5	59.5	80.4	92.3	88.6	86.6	92.5	63.9	56.8	101.7	80.3	722.3
	3.5	63.9	82.1	63.9	92.5	89.6	86.6	97.0	78.1	85.2	82.1	738.9
	6.5	89.7	75.7	104.1	92.5	74.8	94.5	94.6	75.7	82.0	87.1	783.6
	9.5	82.8	99.4	87.5	90.6	93.5	83.7	82.8	97.0	82.8	88.9	800.1
	Total	348.0	416.2	442.4	454.8	435.1	447.9	402.2	385.7	420.3		3752.6

No S.D. evident in treatment means.

Table LXXIII

Effect of Aldrin and Dieldrin on chlorine content of potatoes (in milligrams/100 gms.F.W.)

Treatment Lbs.compd/ acre		Replicates 1	2	3	4	5	6	7	8	9	Average	Total
	Check	21.3	14.2	33.1	23.7	21.3	28.3	16.6	26.0	18.9	21.5	193.4
Aldrin	0.5	21.3	52.1	45.0	28.4	49.7	56.8	35.5	45.0	16.6	38.9xx	350.4
	3.5	42.6	26.0	71.0	42.6	30.8	45.0	33.1	35.5	45.0	41.3xx	371.6
	6.5	35.5	30.8	63.1	28.4	40.2	44.2	28.4	26.0	45.0	38.0xx	341.6
	9.5	23.7	49.7	54.4	61.5	47.3	52.1	49.7	56.2	45.0	48.8xx	439.6
	Total	144.4	172.8	266.6	184.6	189.3	226.4	163.3	188.7	170.5		1706.6
	Check	21.3	14.2	33.1	23.7	21.3	28.3	16.6	26.0	18.9	21.5	193.4
Dieldrin	0.5	52.1	21.3	61.5	45.0	54.4	14.2	37.9	45.0	18.9	38.9xx	350.3
	3.5	35.5	37.9	45.0	40.2	52.1	47.3	42.6	16.6	56.8	41.5xx	374.0
	6.5	35.5	36.6	30.8	37.9	47.3	47.3	73.3	45.0	49.7	44.8xx	403.4
	9.5	42.6	35.5	49.7	43.7	35.5	30.8	87.5	49.7	33.1	45.3xx	408.1
	Total	187.0	145.5	220.1	190.5	208.6	167.9	257.9	182.3	177.4		1729.2

Aldrin L.S.D. = 9.67 at .05 level
12.74 at .01 "

Dieldrin L.S.D. = 11.93 at .05 "
15.7 at .01 "