in early February, was ideal for large aphid populations. The secondary spread of the disease was impossible to control.

One example is cited. Easter Lilies and cucumbers were planted in adjacent fields separated by a roadway. The commercial bulbs of the previous season showed 1/2 of one percent infection after forcing so the planting stock was fairly clean. The fall crop of cucumbers matured about the time the lilies were nicely above ground. Good roguing failed to keep pace with new infections. Cold injury to the foliage masked the fleck-symptoms so completely that roguing was impossible until new growth made its appearance. To complete the picture was the spring crop of cucumbers. At digging time the visual infection was 80-85 percent.

It is difficult to convince all growers of the importance of necrotic fleck because the disease does not materially affect bulb or flower production in the field. Also, there has been little or no price distinction between clean and infected bulbs.

Necrotic fleck seriously impairs the forcing performance of bulbs under greenhouse conditions. The foliage is unsightly, the flowers are often spotted and many plants come blind.

Repercussions from this past season's bad lot of bulbs will materialize before another crop is marketed.

One can be sure that binder payments of $500 to $1000 per acre are things of the past. Likewise there will be a big price distinction between clean and infected bulbs.

The present status of the Florida Easter Lily bulb industry will not improve until the growers realize they must produce a good quality bulb. Bulb buyers are largely responsible for the present condition of the industry. If purchases, in the past, had been limited to clean fields the individual grower would have had an incentive to continue careful roguing.

There are a few isolated plantings of clean bulbs in the State although many plantings, which appeared to be isolated, were "flecked" out this past season. This illustrates the difficulty of growing clean bulbs regardless of the distance to the nearest infected field.

The possible solution is for the growers to organize and request legislation prohibiting the movement of diseased bulbs.

HORTICULTURAL TRADING CO.,
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NEW DEVELOPMENTS IN INSECTICIDES AND APPLICATION EQUIPMENT

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In 1945 the author presented before the members of The Florida Horticultural Society a paper entitled, "Present Status of DDT As An Insecticide." In this paper an effort was made to present the most pertinent facts pertaining to this compound. Since 1945 research work relative to the use of this compound has broadened greatly, and the possible uses of this chemical, as an insecticide, have been extended. In 1947 we find a general tendency toward widespread recommendations for the use of various formulations of DDT in the control of pests of garden and truck crops, deciduous fruits, citrus, cereal and forage crops, cotton, forest and shade trees, stored seed, grain, and pests affecting the health and comfort of man and domestic animals.

The advent of DDT upon the world ento-

mological scene stimulated terrific scientific interest in the development of new chemicals; and the uncontested right of this compound for the spotlight in world publicity was soon challenged by other notable chemicals, which have proven to be equally valuable as DDT in some respects and superior in others. This treatise deals with the most promising of these compounds.

Velsicol 1068 (*Clordane*).—Vesicol 1068 has many characteristics that will encourage its general use in the control of pests. It is a chlorinated hydrocarbon, which has residual action which is not as extended as that of DDT. This compound is insoluble in water, but is readily soluble in the usual organic solvents such as aliphatic, aromatic and chlorinated hydro-carbons; also in ketones, ethers, and esters. The proper formulation of Chlordane will enhance its insecticidal value. Compositions may consist of solutions emulsions, wettable powders, dusts, and aerosols.

The determination of the degree of compatibility between Velsicol 1068 and other spray materials is still elementary and in a state of flux. It is quite evident that it should not be combined with hydrated lime or other alkaline materials in dust or spray formulations as alkaline diluents reduce the toxic affects of this compound.

Velsicol 1068 may be used sucessfully with DDT, pyrethrum, thanite, and lethanes. Compatibility range of this chemical will be broadened as studies continue.

Velsicol 1068 in sufficient quantities is poisonous to vertebrate animals, including man. The effects of 1068 upon warm blooded animals is comparable to DDT if the comparison is made strictly on a weight basis. Data thus far indicates that Velsicol 1068 may be successfully employed at weaker strength, thereby increasing the safety factor.

Numerous tests relative to the physiological effects of Velsicol 1068 upon plants are being made. Research workers under the author's supervision have conducted numerous tests on the phytocidal action of this chemical. These have included vegetable and field crops, citrus, and ornamentals. Burn records on the plants tested were insignificant. It may be said that plant tolerance for this chemical is exceptionally good.

Velsicol 1068 (Chlordane) is demonstrating a wide range of insect control qualities that is quite comparable to DDT. Thus, this is another chlorinated hydrocarbon which bids well to have a strong impact upon all types of pest control. It has proven to be highly efficacious in the control of disease vectoring and pest mosquitoes, houseflies, fleas, ticks, lice, roaches, bedbugs, and spiders. Sprays containing this chemical may be used as space sprays or residuals. Formulations of Chlordane have been successfully used in the control of grain beetles and moths, carpet beetles, ants, silverfish, fruit flies, and book lice. Wettable powders and emulsions containing Velsicol 1068 may be used in protecting domestic animals from such pests as sucking lice, houseflies, hornflies, mosquitoes, and ticks. Many of the most prominent of the agricultural pests have also submitted to the insect toxic effects of this chlorinated hydrocarbon. Results of an extensive character have not been reported on ornamental shrubs and shade trees. Indications are that successful control of aphids, whiteflies, armored scales, mealybugs, leaf feeders, and others will be possible.

Dichloro-Diphenyl-Dichloroethane.— One of the most promising closely related compounds to DDT is dichloro-diphenyl-dichloroethane, which is commonly called DDD, and is sold under the trade name Rhothane D3. This chemical reveals sufficient stability to permit storage under varied conditions but should not be stored in alkaline mixtures.

Toxicological data assimilated thus far indicates that DDD is somewhat less toxic than DDT from an acute and chronic poisoning standpoint. The insecticidal activity

of this compound is superior to DDT in some instances while in others it is reported as inferior.

It has proven to be a rather effective ingredient in cattle sprays. Its reduced toxicological effect might constitute an encouraging factor. It may also be used in powders for application to animals for the control of lice, fleas, and other ecto parasites. It is also proving to be of value in agricultural sprays.

Hexachlorocyclohexane.—The chlorinated hydro carbon 1, 2, 3, 4, 5, 6, hexachlorocyclohexane is commonly known as benzene hexachloride or 666. The crude material contains the Alpha, Beta, Gamma and Delta isomers. The Gamma is the most important from an insect toxicity angle and comprises 10-12 per cent of the crude. This isomer was termed Gammexane by one of the early workers. The pure Gamma isomer is a colorless crystal, practically insoluble in water but soluble in organic solvents.

Some of the solvents which may be used in the formulation of benzene hexachloride sprays are as follows: acetone, benzene, carbon techrachloride, cyclohexanone, diesel oil, ether, ethyl alcohol, xylene. Insecticidal preparations of this material may be as dusts, solutions, emulsions, wettable powders, smokes, or aerosols.

This chemical has revealed a wide range of toxicity to insects. Phytocidal action is rare, and toxicological studies have revealed that it is a safe insecticide for use in the control of insect pests when used with normal safeguards. Research investigations under the author's supervision have revealed that it will effectively control many of the pests of vegetable crops.

Toxaphene. — Toxaphene is described chemically as a chlorinated camphene. It is prepared in technical grade and purified forms. This newly developed compound is readily soluble in organic solvents, thereby making the formulation of liquid insecticides and insecticide concentrates easy. It is soluble in water.

Toxaphene may be formulated into oil soluble concentrates, water miscible concentrates, wettable powders, and dusts. Formulation ingredients should not be alkaline in character as this reduces the toxicity of the chemical. It is compatible in chemical formulations containing thanite, pyrethrum, rotenone, DDT, lead arsenate, calcium arsenate, nicotine sulfate, fixed copper fungicides, sulfur, and neutral emulsifying and wetting agents.

Laboratory and field experimentation have revealed its effectiveness in the control of household and storage insects, pests of livestock, pests affecting the health and comfort of man, pests of field crops such as cotton, and pests of ornamental shrubs

Ortho Ortho-Diethyl Ortho-Para-Nitrophenyl Thiophosphate.—This insecticide is very slightly soluble in water. However, it is completely miscible in the majority of organic solvents. It is only slightly soluble to insoluble in petroleum ether, kerosene, and refined spray oils. It is commonly known as Parathion or 3422.

Parathion may be formulated into emulsions, dusts, wettable powders, and aerosols. It demonstrated good insect toxic qualities in laboratory tests. Field tests are now being conducted in all regions. In Florida the first field test with this compound was made under the author's supervision in the shade grown tobacco belt. 3422 revealed the highest toxic efficiency of all insecticides tested for the control of the green peach aphid.

This chemical has approximately the same toxic range to warmblooded animals as nicotine sulfate. Phytocidally it seems to have a safe range on a number of plants; but may cause injury to some when improperly used.

Hexaethyl Tetraphosphate. — Hexaethyl terraphosphate has revealed rather excellent toxic qualities upon aphids and some other species of insects. It seems to have exceptional initial toxicity to aphid species. This compound is very dangerous to warmblooded animals and therefore necessitates

the use of extreme care in manufacture, formulation, and field use.

Synergism

Synergistic action of materials added to insecticidal chemicals is a field that interested workers during the war and has been carried over into the post war period. The initial compound produced commercially for this purpose was isobutylundecyleneamide. Subsequently there was reported piperine compounds, sesame oil, piperonyl cyclophexenone, and piperonyl butoxide.

Sesame oil, which contains sesamin, was extensively used during the war period as an ingredient in aerosol bombs for the activation of the pyrethrins.

D and O 312, which is piperonyl cyclohexenone has some insecticidal value and also serves as an activator for pyrethrins. It is commonly called PCH by the trade, or Pyrenone. Its snyergistic behavior is marked, affecting degree and speed of toxicity of the pyrethrins. Cyclohexenone seems to be activated also by pyrethrin thereby increasing its basic insect toxic quality.

Piperonyl butoxide is another synergist for pyrethrins that has demonstrated basic insect toxic qualities. It is readily soluble in mineral oils used as solvents, and in propellents used in aerosol preparation. It may be used in preparing dusts, wettable powders, or emulsions.

Piperonyl butoxide has a basic insecticidal value and activates and is activated by pyrethrins. Its presence with the pyrethrins seems to result in an extended residual effect. The safety of such combinations increase the usage in domestic areas, and on consumable products.

Soil Fumigants

Advancements have been made in the soil fumigant field that are exceedingly promising. Two of the chemicals that seem destined to play an important part in the control of soil infesting pests are ethylen dibromide, and 1-2 dichloropropane and 1-3 dichloropropylene mixture. DD is the abbreviated name used in referring to a dark liquid soil fumigant consisting of a mixture of 1-2 dichloropropane and 1-3 dichloropylene. This mixture eflectively controls wireworms and nematodes. There is some evidence of carry-over for two years. It may be retained in soil for extended periods, and thereby injure or kill certain seeds and young plants. Some root crops may take up "DD" odor if planted soon after treatment. There is some evidence of accrued value when DD is combined with ethylene dibromide. Dosages range from 200-700 pounds (20-40 gallons) per acre. Spacing should be 16 inches, and a seal is not required.

Etheylene dibromide is another effective fumigant for the control of nematodes and wireworms. This fumigant is less phytocidal than "DD," and may at times be applied to living plants. A dosage of 2 gallons of EDB per acre used in a naptha base is effective. A range of 1-4 gallons may be employed. Spacing should be 12 inches as diffusion range is narrower. Water seal is not required, and soil should not be too dry or too wet. Dowfume W10 contains 10 per cent ethylene dibromide, while Dowfume W 40 contains 40 per cent.

DD and Dowfume W-10 are most effective when a special applicator is used in making soil treatments. Dowfume W-10 is for small garden plots and does not require a special applicator.

Development and Improvement of Application Equipment

The chemicals discussed have only been a few of the many thousands of organic and inorganic insecticides that have been tested in the field and laboratory during the last eight to ten years. Thus it is revealed that only a comparatively few have proven feasible in the control of our pests. Unquestionably many additional chemicals will be added in future years. Problems per-

taining to the most effective use of these insecticides will arise and require patient investigations by many scientists.

If a full realization of the effectiveness of newly developed chemicals is to be attained it is essential that application equipment keep pace in this period of progress. This is true in order that applications may be made with the least labor and costs. Three important factors involved in the application of insecticides are dosage control, uniformity of application, and proper placement or coverage. These are functional requirements of equipment.

Improvements in existing equipment include hydraulic lifts for tower units which permit them to be pivoted and laid down to facilitate travel along roads. The development of the vertical multiple-nozzle boom increases the speed and effectiveness of spray applications by facilitating the coverage of the sides and crowns of trees.

In the field of newly developed application equipment there are many interesting trends. Some of the most important follow:

Sprayer-Duster. — The sprayer - duster combination permits the application of dust or liquid spray alone or in combination. When the two are applied simultaneously the liquid acts as a sticker for the dust. These are one man machines which permit the coverage of 4-15 acres per day. These outfits utilize a high air velocity resulting from a 12-inch fan operating at 4000 rpm, driven by a 4-6 horsepower air cooled engine. This insures an equalization of air currents. The dust is usually directed into the blower or fan of the machine, while the liquid is applied in small quantities at outlets of air stream.

Speed Sprayer.—The speed sprayer is another addition to modern application equipment which utilizes an airplane-propeller blast which moves large volumes of air at low velocities. The usual dilute spray material is used and the air blast creates a heavy mist which is driven through the foliage.

Aerosols.—The use of Aerosols were popularized during the war period. This type of aerosol utilizes such chemicals as dichloro-difluro-methane (Freon 12) as a propellent, and pyrethrins and other materials as toxicants. Their usage is well established. The use of this application method is being extended into the greenhouse and on field grown plants. The utilization of methyl chloride as a propellent has facilitated the broadened use of this method as larger particle size is required.

Fog Generators.—Following the development of the aerosol method came the steam aerosol or fog applicators. These use concentrated sprays which are atomized into steam or hot air which create a vapor. This vapor condenses under atmospheric conditions and is aided in its movement as a fog by air currents. These machines have attracted widespread attention but remain somewhat in an early experimental stage.

Mist Blowers.—Another piece of insecticide application equipment which was advanced during the war period is the Mist Blower. The mist blower utilizes an engine-driven turbine (blower) which develops air currents of high velocity. The current of air is "straightened" and channeled through a series of baffle-plates into the barrel or dispersal gun. Concentrated sprays are used and these are finely atomized by the air currents, and propelled considerable distances. Coverage is excellent.

Aircraft.—The dispersal of insecticides by airplane, autogiros, and other machines is progressing along stable lines. This method will receive greater play in the future as methods and materials are perfected. This is true especially in large areas devoted to specialized crop production and inaccessible areas which prohibit the use of ground equipment. Aircraft applications remain in an experimental stage.

Looking Forward

In reviewing the literature it is emphatically revealed that newly developed chemicals possess a wide range of toxicity and effectiveness. This fact justifies in part the enthusiasm with which some scientific people have endorsed and recommended general usage. However, complexities resulting from general usage are beginning to appear and may in time reflect badly upon those who have been too hasty in their appraisals. Requirements for the wide-spread use of newly developed chemicals are: safety to soils; safety to public health; safety to plants; safety to farm animals; safety to beneficial insects; and safety to wildlife. Such complete information has not been obtained thus far for the newly developed insecticides.

Indications of troubles arising from ill advised use of chemicals are classically illustrated by the possible effects upon the soils. DDT may tend to retard plant development when used at certain rates. The retardation effect may depend upon the degree of acidity or alkalinity of the soil, or the amount of organic material or colloidal clay that is present.

Data is rapidly being recorded that indicates the tremendous toxic effect that newly developed chemicals have upon the parasitic and predaceous enemies of economic insect species. Thus has been demonstrated the abnormal increase of scale insects on citrus, aphids on deciduous fruits, and pests of vegetables due to the heavy destruction of beneficial species. This upsets the biotic complex to such a point as to endanger crop production. Time must be taken in the detailed investigation of all problems involved in the use of such chemicals.

It is quite evident that we are well advanced into a new insect control era. We are well equipped, for this period in human affairs, with great Industrial Agencies staffed and equipped for the synthesis and manufacture of new chemicals, and with thousands of well trained entomologists who ask mainly for the opportunity to serve. If provision is made for the proper appraisal of these new developments it will result in a worldwide advancement of civilization.

FLOWERING TROPICAL TREES—A PLANTING PROGRAM FOR FLORIDA

By Edwin A. Menninger
"The Flowering Tree Man"
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Florida needs a well-rounded program of ornamental tree-planting. There are three distinct zones in this state: north Florida with its usually acid soil and temperatures as low as 18 degrees; central Florida with its neutral, or sometimes acid soil, with temperatures as low as 25 degrees; and south Florida, with its predominantly limestone soil and a minimum temperature of 32 degrees.

For each of these areas it is necessary to work out a schedule of the trees best suited for special purpose planting, particularly highways, parkways, yards, parks, cemeteries, community forests, special locations on the waterfront which are exposed to high winds, salt spray, or occasional inundation, and lastly, trees which best resist hurricane winds.

In working out such a schedule, we should consider trees that provide a combination of shade and flowers, those that are particularly useful in providing shade, those that are distinguished mostly for their showy flowers, and those which, like mahogany, the tung oil, and many similar trees, can be planted with the thought of timber or nut crops.