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UNITED STATES DEPARTMENT OF AGRICULTURE
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BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

A REVIEW OF THE INSECTICIDAL USES OF ROTENONE AND ROTENOLIDS FROM DERRIS,
LONCHOCARPUS (CUBE AND TIMBO), TEPHROSIA, AND RELATED PLANTS.

Part XI: ACARINA

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INTRODUCTION

This is the eleventh in a series of papers designed to review all available information on the insecticidal uses of rotenone and the rotenoids. Parts I-X have reviewed tests with derris, cube, timbo, Tephrosia, Mundulea, and their constituents on members of the Collembola, Orthoptera, Dermaptera, Odonata, Isoptera, Corrodentia, Mallophaga, Thysanoptera, Homoptera, Hemiptera, Anoplura, Coleoptera, Lepidoptera, Hymenoptera, Diptera, and Siphonaptera. Apparently no tests with the rotenone plants upon Thysanura, Ephemeroptera, or Plecoptera have been recorded. Part XI, the present paper, reviews the tests and recommendations for use on Acarina (Class, Arachnida).

ACARINA

Argasidae

Argas miniatus Koch, the fowl tick

Little (93) in 1931 reported that laboratory tests on adults of the fowl tick showed both devil's-shoestrings and derris to be ineffective.

Ornithodoros moubata Murray

O. tartakovskyi Olenov

Mironoff et al. (106) in 1940 reported tests with rotenone against ticks. The nymphs of these two species were resistant to derris powder.

Dermanyssidae

Ophionyssus serpentium Hirst

Schroeder (135) in 1934 reported that a solution of derris (acetone extract of derris added to water) is effective as an acaricide for dipping snakes. Such a dip does not interfere with the physiological function of shedding, is not toxic to the snake, yet is entirely efficient in the destruction of snake mites.

Eriophyidae

Epitrimerus vitis Nal.

Stellwaag (141) in 1938 recommended a pyrethrum-derris spray as a spring

treatment for the control of the mites, including this species, which cause curly-leaf disease of grapes in Germany.

Eriophyes sheldoni Ewing

Boyce and Maxwell (13) in 1938 reported that oil sprays, either alone or with rotenone-bearing materials, gave promising results for the control of the citrus bud mite in California.

Phyllocoptes oleivorus (Ashm.), the citrus rust mite

Winston (170) in 1926 reviewed information on Derrisol for the benefit of Florida citrus growers. If a grower who is spraying with lime-sulfur solution for rust mites should find any aphids present, an addition of Derrisol 1:800 will enable him to control this pest with one spraying.

Lenfest (91) in 1926 wrote that lime-sulfur mixed with Derrisol will kill the rust mites, as well as the aphids, on citrus.

Phyllocoptes viticulus Pent.

P. vitis Nal.

Stellweeg (141) in 1938 recommended a pyrethrum derris spray as a spring treatment for the control of these two species.

Gamasidae

Dermanyssus gallinae (Deg.), the chicken mite

McIndoo, Sievers, and Abbott (94) in 1919 reported that when derris powder was freely dusted over chicken mites confined in jars all were killed within 24 hours, but when used under practical conditions in a badly infested chicken house not all the mites were killed.

Davidson (50) in 1924 reported the results of tests with derris powder and derris extract against the chicken mite. The composition of these materials was not known. Four infested chicken houses inhabited by the common chicken red mite were dusted with the finely ground powder of derris roots. Undiluted dust was efficient in one house and temporarily so in another. In a third house a 75-percent dust was only moderately efficient; in a fourth test a 50-percent dust was inefficient. Flour was used as a diluent. Davidson concluded that derris powder is a remedy of value, but apparently two or more applications are necessary and it loses its efficiency if diluted more than 25 percent. It acts on larvae and adult mites by stupefying them, the individuals dropping to the ground and dying after 2 or 3 days. The material is rather unpleasant to apply. A commercial extract of derris, 16 percent, diluted 1:1,000 and 1:500, with the addition of whale-oil soap, applied at the rate of 4 pounds per 100 gallons, was inefficient.

Schmitt (134) in 1930 reported that dusting with dry powder of the finely pulverized root of Derris elliptica was effective against chicken mites.

Boophilus annulatus (Say); the cattle tick

Kraneveld (89) in 1936 conducted two types of experiments to study the toxicity of aqueous derris-powder suspensions to ticks of this species.

1. Ticks were immersed in suspensions containing various quantities of derris powder for 5 to 10 seconds and also for 15 to 20 seconds. They were then removed, dried, and placed in tubes containing blood-saturated cotton wads, to offer them an opportunity to eat. The ticks were observed twice each day to determine how long they lived after this treatment. Controls were run on ticks dipped in water, and on untreated ticks. The results . . . indicate that the derris-powder suspension must contain more than 0.076 percent of rotenone to be effective.

2. A steer infested with ticks was sprayed with a derris suspension containing 0.1 percent of rotenone. Several dead ticks were found on the animal 2 days after this treatment, but living ticks could be found even 3 weeks after the treatment. A second steer was washed with a suspension containing 0.2 percent of rotenone. Most of the ticks were dead on the following day, and all were dead 3 weeks after the treatment. Neither animal suffered any ill effects from this treatment. Kraneveld concluded that, since the other treatments now used to free animals of ticks are effective and cheap, the price of derris would have to be very low to be practical and suggested that derris powder containing small quantities of rotenone that could not be used for other purposes could be used to kill ticks on cattle.

Kraneveld's work was reported by D. W. Smith (138), American Trade Commissioner at Batavia, Java, in 1938.

Dermacentor andersoni Stiles (syn., D. venustus Banks)

According to a release by the Interdepartmental Safety Council published in the United States Department of Agriculture, Agriculture Exchange (147), if there is an animal pet in the family, it should be searched for ticks and should be dusted with derris powder.

Dermacentor nigrolineatus (Pack.), the brown winter tick

Babcock (6) reported in 1936 that, in some preliminary tests with Tenhrosia virginiana, examination on the third day after the animal had been treated once showed that all D. nigrolineatus infesting a horse had been killed. All but one of a number of ticks of this species placed in a box containing the powdered material were killed in 31 hours.

Parish (118) in 1940 reported that spraying cattle infested with the brown winter tick at Menard, Tex., with the following mixture resulted in

little or no kill: Wettable sulfur, 100 pounds; derris powder (5 percent rotenone), 10 pounds; water, 1,000 gallons. This is the formula found effective as a dip for controlling the short-nosed cattle louse.

Dermacentor variabilis (Say), the American dog tick

C. N. Smith, in a typewritten quarterly report to the Division of Insects Affecting Men and Animals, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, for the period July-September, 1937, gave the results of tests made at Vineyard Haven, Mass., on the control of the American dog tick. Tests were made with derris as a wash to kill and repel adult ticks on dogs and horses. In general, it appears that a dip made of 2 to 4 ounces of derris (rotenone 4 percent) to the gallon will kill all flat ticks and most of those partially engorged. Treatment of animals every 5 or 6 days should be sufficient to prevent engorgement of ticks, as the animals are protected for 3 or 4 days, and ticks attached 1 to 3 days are easily killed. No animals were made sick by the dip, as animals occasionally are by breathing derris dust. Although the dip leaves the dog's hair feeling somewhat greasy, no objections were made by the owners.

The United States Department of Agriculture in a Press Release dated May 18, 1938, issued information on how to avoid dangerous tick bites. Keeping ticks from engorging themselves on the blood of dogs is a protective measure. A pair of forceps is all that is needed to remove ticks from dogs if only a few have attached themselves thereto. Dusting every 5 days with derris powder is necessary for dogs supporting a large number of ticks.

Bishopp and Smith (10) in 1938 recommended application of a derris dip to dogs to control the American dog tick, or common wood tick, which is the principal vector of the Rocky Mountain spotted fever in the Central and Eastern States and is also capable of carrying rabbit fever (tularemia). Derris dip is made by mixing 2 ounces of fine derris powder (containing at least 3 percent rotenone), 1 ounce of neutral soap, and 1 gallon of tepid water. The dip may be applied by putting the dog in a tub containing it, or it may be brushed in thoroughly. The dip should be allowed to dry on the dog or, if necessary, the surplus liquid may be removed with a towel. The dip can be kept for at least a week without deteriorating. If the dip cannot be used conveniently, derris powder may be applied next to the skin on all infested parts. To prevent ticks from engorging, the powder must be applied every other day. The persistence of either the dip or the dust depends on the type of dog, and the interval between treatments can be determined best by experience. Do not permit the powder or dip to get into the eyes.

These authors (11) again in 1938 recommended derris for the control of the American dog tick. The thorough application of derris as a powder or wash is effective in destroying the ticks already attached and in preventing the reinfestation of dogs for short periods. Application is easier when the powder is used, and ticks that actually come in contact with the derris will be killed, but the animals are less thoroughly covered than when the material is used as a wash or dip. In addition to giving a more complete treatment at

ticks then against the fully engorged

the time of application, the derris wash is retained on the hair and skin longer than the powder and has a more extended repellent action. When used by either method, derris is more effective against flat or slightly engorged females; therefore, in order to prevent all reproduction, treatments should be given before females become well engorged. The powder should be applied at intervals of 2 or 3 days and the wash or dip at intervals of 5 or 6 days. The derris powder should have a rotenone content of at least 2 percent. (See Bishop and Smith (10), p. 5.)

C. N. Smith (137) in 1939 reported tests with derris against the American dog tick. Laboratory tests with derris powder dips (see Bishop and Smith (10) p. 5) indicated that none of the mixtures will kill the inactive stages of the adult ticks; 16 percent of the females and 33 percent of the males active but unfed in nature were killed; 92 percent of fed males and slightly engorged and fully engorged females were killed, as were 44 percent of the females that were from one-eighth to one-third engorged, and 50 percent of the females that were half engorged.

Ixodes holocyclus Newm.

Ross (130) in 1935 reported tests with both rotenone and derris against ticks, Ixodes holocyclus. Both derris powder and derris infusion were highly lethal. Infusions were made by soaking 1 percent of derris powder by weight in cold water overnight, and the following morning adding sufficient soap or soap powder to make a good lather. By one application of such solutions, or or the dry powder rubbed well into the coat, newly attached ticks were found to be dead or dying in 4 to 8 hours, but semigorged specimens may remain alive for 24 hours, though in almost every case they are obviously sick in this time, then they gradually dry up and finally fall out.

An anonymous writer (3) in 1939 wrote that dogs in Queensland, Australia, may be protected against the scrub or bottle tick if given every 6 or 7 days either a dusting with derris powder or a wash in a derris infusion.

Ixodes ricinus (L.), the castor-bean tick

Little (93) in 1931 reported that powdered root of Tephrosia virginiana proved to be effective in the control of the castor-bean tick.

MacLeod (95) in 1933 described tests made with derris against the sheep tick in Scotland. Tests were made with dip solutions containing 0.2 percent of arsenic trioxide, 0.35 percent of phenol, and 0.21 percent of toxic extract of derris, respectively, on sheep infested with the sheep tick. His conclusions were as follows:

"Derris at a bath-strength of 0.21 percent of toxic extract, when mixed with a soap solution, forms a highly satisfactory tick dip. A solution prepared from a mixture of derris and soap powder forms an equally satisfactory dip. Derris-dip solution retains to a great extent its properties in the bath for a period of at least 4 days. The 4-day-old dip is not so efficacious as fresh dip, but appears to be practically as destructive to ticks as are fresh solutions of arsenic or carbolic dips."

MacLeod also referred to the introduction of powdered derris root to veterinary practice as an acaricide by J. Russell Greig in 1924.

In 1938 MacLeod (96) discussed the sheep tick and its control in Great Britain. He suggested that in cases where ordinary sheep-farming methods are not practised and the primary consideration is the removal of the ticks, the sheep should be dipped at short intervals throughout the tick season (mid-March to the end of May) in a derris wash, or in some other preparation that may be used repeatedly without harming them. On sheep farms, where it is desirable to increase the farm profits without interfering too greatly with the normal sequence of farming activities, especially during the busy lambing season, which coincides with the tick season, it is suggested that the sheep be dipped in one of the special preparations now available that will protect them from reinfestation for 2 to 3 weeks after its application. The two main dippings (one of which is carried out immediately before lambing begins and the other about 3 weeks later) may be augmented by one or two supplementary dippings. For farms where profitable farming is impossible unless ticks are eradicated, a scheme combining starvation of the ticks with serial dipping of the sheep is recommended.

The North East of Scotland Sheep Tick Committee (114) in 1939 published a report of work by Walter Moore, of the North of Scotland College of Agriculture, in 1938 to control the sheep tick. Various standard sheep dips prescribed for sheep scab were tried but none proved to be completely effective. Most of the dips killed the active feeding stages of the tick, but all failed to kill the ticks that had completed feeding, and also failed to protect the sheep from reinfestation for more than 1 or 2 days. Laboratory tests with various insecticides showed that the contact insecticides were very efficient, and of the materials tested derris and pyrethrum gave the most promising results. In conjunction with the Cooper Technical Bureau, a large-scale field experiment was carried out with a derris dip and proved very successful, giving a 100-percent kill at all stages. A 1:500 solution of Derris elliptica root containing 5 percent of rotenone in water was found to be most efficient and economical. The time of immersing the sheep in the dip bath was found to have an important effect on the protective period. In dipping it is not sufficient to kill only the ticks on the sheep, as this would necessitate repeated application every 10 days. Enough of the insecticide must be retained on the skin or wool to kill all ticks that attack the animal for several days after dipping. If sheep are immersed in the dipping solution for at least 30 seconds there is a protective period of from 9 to 10 days during which the animal remains tick-free. Immersion for 1 minute is recommended.

Cameron (39) in 1939 wrote that in Scotland dipping is used to control the sheep tick. In recent years derris has assumed prominence as an acaricide because of its rapid lethal action and is included in certain proprietary dips, along with either arsenic or carbolic, or both. The percentage of derris in the bath is about 0.014 of the total extract. Although arsenic alone as an ingredient of dipping fluids is effective as an acaricide, its efficacy is increased when it is combined with carbolic acid, which by itself has only very slight toxicity to ticks. Derris alone is quick in its action, but it is

not so satisfactory as is combined arsenic-carbolic, which has greater lasting properties.

Recent experiments made by Stewart (142) in Northumberland, England, suggest that derris powder applied as a dry dust to the fleeces of young lambs is an effective tick deterrent, with obvious advantages over dips in that it is less troublesome to apply and less likely to cause mis-mothering. Stewart (143) in 1939 reported on the control of the British sheep tick in Scotland. Dips and dusts were tested. The following dips were used: A plain derris dip; derris-carbolic dip; derris-carbolic-woolfat dip; arsenic-carbolic dip; and arsenic-derris dip. Two methods of rendering lambs tick-free have been tried, and the method of choice appeared to be the use of a powdered preparation of derris root. The dusting is quickly and easily carried out, produces no ill effects, and dusted lambs remain remarkably tick-free for more than 2 weeks. An oily smear also proved useful. It checked tick infestation, and smeared lambs were more thrifty and on the average 10 pounds heavier than the corresponding unsmeared lambs. As a result of the failure of the derris dips to protect sheep under field conditions, the derris-carbolic and the derris-carbolic-woolfat dips were discarded at the second dipping on May 5 and the plain derris and the arsenic-derris dips were substituted. The arsenic-carbolic dip showed only moderate protection. The most satisfactory dip proved to be arsenic-derris, which showed a marked deterrent effect 2 weeks after use.

Mironoff et al. (106) in 1940 reported that larvae of Ixodes ricinus were killed in 1/2 to 1 hour by derris powder. The nymphs were killed in 1/2 hour, but the mature ticks were more resistant.

Rhipicephalus sanguineus (Latr.), the brown dog tick

Little (93) in 1931 reported that the powdered root of both Tephrosia virginiana and derris were unsatisfactory in the control of the brown dog tick.

In 1931 Bishopp (8) recommended powdered derris root, either dry or as a wash, for combating the brown dog tick on dogs.

Marney (98) in 1932 wrote that a powder containing 1 percent of rotenone, when dusted on a dog infested with the brown dog tick, killed the parasites within 24 hours and prevented reinfestation for 10 days or more.

The United States Department of Agriculture, Bureau of Entomology (149), in 1933 reported that for combating the brown dog tick, a severe pest of dogs in Texas and Florida, the use of derris and derris derivatives on the dogs and in their sleeping places, together with the application of insecticidal sprays on the walls of the infested rooms, had given satisfactory control.

Ross (130) in 1935 reported that, from dog owners' reports, derris preparations appeared to be effective against Rhipicephalus sanguineus, the dog tick of central Queensland, and that weekly application, either of derris powder in dry form or of a 1-percent soapy cold-water infusion, should confer a high measure of protection against tick infestation. Derris must be applied

cautiously to Persian cats and long-haired toy breeds of dogs. Because of the excessive quantities sometimes applied to such animals, and the likelihood of some of it being swallowed, symptoms of gastric irritation have been observed. At times, also, the eyes may become inflamed, and care should be exercised in preventing the wash or the powder from entering them. Persons applying the powder should also guard against inhaling it. Infusions were also found, in practically every instance, to kill all ticks that attached themselves during the first 72 hours after the dog was bathed, and in most cases killed all of those attaching within 96 hours, or sometimes longer. The rotenone used was extracted from samples of Derris species from New Guinea, which were found to contain 5 percent of rotenone.

In 1939 Bishopp (9) again recommended derris wash containing at least 3 percent of rotenone as the most satisfactory insecticide for combating the brown dog tick on dogs. (See Bishopp and Smith (10, 11) p. 5.) Derris powder scattered behind baseboards and other hiding places is advised when residences become infested.

Parasitidae

Lasioseius pomi (Parrot)

Garman and Townsend (64) in 1938 reported that the effect of rotenone extracts alone on (Scutius) ^{pomi} Lasioseius (Parrot) or related species was not so great as might have been expected, as many ticks were seen alive after an application.

Pediculoididae

Pigmaeophorus sp.

The Pennsylvania Agricultural Experiment Station (120) in 1938 reported that these mites were not controlled by pyrethrum and derris dusts and sprays.

Penthaleidae

Halotydeus destructor (Tucker)

Swan (144) in 1934 reported that pyrethrum dusts had been tested and that they killed quickly. The dust used had been diluted 1:5 with sulfur. Derris dust also killed well, but did not seem quite so effective as pyrethrum, although its killing power probably lasts longer.

Sarcoptidae

Chorioptes bovis (Gerl.)

Götze (68) in 1933 reported that Derrilavol, India-Rotenon-Lösung and India-Gesamtextrakt-Lösung, both at the rate of 20 cc. to 1 liter of cold 2.5-percent-soap solution, and the India-sine-Rotenone-Lösung containing the

extracted substances from derris root, with the exception of rotenone, and used at the rate of 20 cc. and 60 cc. per liter of soap solution, proved to be very successful in curing mange of cattle caused by this mite.

Scheiner (133) in 1934 found that Derrisol (3 percent rotenone) made by Bengen & Co., Hannover, Germany, was more effective than Panderran (5 percent rotenone) made by E. Merck, Darmstadt, Germany, used in water solutions in simple washes to control chorioptic mange of cattle caused by this mite. Two washes were sufficient for 100-percent control of chorioptic mange, if used in sufficiently strong solution (up to 10 percent in water).

Demodex folliculorum bovis Stiles

The United States Department of Agriculture, Bureau of Animal Industry (148), in 1940 reported tests to control demodectic mange. External applications used on cattle infected with demodectic mange, in the form of dips or sprays, included arsenical dip, fused-bentonite-sulfur dip, and a saturated solution of borax. The treatments as applied failed to prevent the development of, or to eradicate, demodectic mange caused by this mite. The same statement applies to rotenone in oil and acetone, and to proprietary preparations that had been reported to control the disease, when these materials were applied direct to the lesions.

Demodex canis Leydig, the dog follicle mite

Crane (46) in 1933 reported on tests with rotenone against follicular mange, caused by D. folliculorum canis, on dogs at the Small Animal Clinic of the New York State Veterinary College at Cornell University. In 11 of the 13 cases in which it was used, an unusually rapid recovery followed the application of rotenone. The remaining two cases recovered in the time usually necessary for the standard remedies. These cases included several that had not responded to the citrine-ointment dressing, which is the standard treatment in the Small Animal Clinic. Rotenone has the additional advantages of being entirely nontoxic and is not greasy or dirty to apply.

Eastman (56) in 1935 and Morris (109) in 1936 reported control of follicular mange on dogs by the use of a special oil solution containing rotenone. The preparation, called Solution 34 AR 348, is manufactured by Merck and Company, Rahway, N. J. It is thoroughly applied by hand, either into and around the infested areas or over the entire body. Thorough and almost rough massage appears to hasten improvement. The preparation should not be permitted to reach the conjunctival membrane or the cornea. Eighty-six cases in 12 States were treated by 24 veterinarians who reported 84 cases as complete recoveries.

The United States Department of Agriculture, Food and Drug Administration (151), in 1936 reported that during 1935 many preparations containing derris extracts and rotenone appeared on the market labeled as a specific treatment for demodectic mange of dogs and other animals. Preliminary tests of such preparations have not confirmed the claims made for their efficacy.

Psoroptes sp.

Sarcoptes sp.

Wille et al. (167), of the Agricultural Experiment Station at Lima, Peru, in 1937 published an account of the use of cube in dips against Sarcoptes sp. on sheep and against a species of Psoroptes on alpaca in Peru. The effective concentrations of ground root (85 percent passed a sieve of 0.074 mm. mesh) containing 6.8 percent of rotenone, and of extract containing 5.5 percent of rotenone, were 1:1,000 and 1:5,000, respectively, for Sarcoptes sp. and Psoroptes sp. The ground root and the extract were equally effective and were in no way inferior to other dips.

Sarcoptes scabiei (Deg.), the itch mite

Götze (68) in 1933 reported that Derrilavol, India-Rotenon-Lösung and Indie-Gesamtextrakt-Lösung, both at the rate of 20 cc. to 1 liter of cold 2.5-percent-soap solution, and Indie-sine-Rotenone-Lösung containing the extracted substances from derris root, with the exception of rotenone, and used at 20 cc. and 60 cc. per liter of soap solution, proved very successful in curing mange of cattle caused by the mite (Acarus bubalus) Sarcoptes scabiei (Deg.).

Scheiner (133) in 1934 found that Derrisol (3 percent rotenone) was more effective than Panderran (5 percent rotenone), when used in water solutions in simple washes to control sarcoptic mange of cattle caused by "Acarus bubalus." Both were 100 percent effective if used in sufficiently strong solution (up to 10 percent in water), although as many as eight washes were required for stubborn cases of sarcoptic mange.

DeBussy et al. (18) in 1936 reported that this mite was effectively controlled by derris preparations.

Thomas and Miller (145) in 1940 reported that rotenone in the form of 1- or 2-percent lotions with a base similar to that of many hand lotions (quince seed, Irish moss) produced prompt cure of scabies in 24 unselected cases encountered in clinic and institutional practice. At the time treatments were begun, 6 of these patients presented most severe secondary pustular and dermatitic complications. The preparation is nonobjectionable from the standpoint of odor, is nonirritating, even to sensitive skins, does not stain bed-clothes or underwear, and the patient is not conscious of its presence on the body. The lotion was made as follows: Rotenone dissolved in chloroform (1 gm. to 3 cc.) was added with vigorous shaking to the quince seed and Irish moss mucilage in the proportion desired to make either a 1- or a 2-percent lotion. The mucilage contains 0.1 percent of sodium benzoate as a preservative. Perfume may be added.

Sarcoptes spp.

See Wille et al. (167) under Psoroptes sp. on page 11.

Weinrich (166) in 1933 reported that derris preparations made by the

Chemische Fabrik Marienfelde are effective against mange mites on cattle. The rotenone contained in the derris root is very effective against mites, although the other ingredients of the root also have a certain but considerably inferior effect; therefore, the manufacture of the preparations should be standardized to guarantee a certain percentage of rotenone. In the control of insects on animals covered with a more or less dense coat of hair, the application of aqueous solutions with an addition of 2.5 percent of green soap is preferred, whereas in human medicine oily solutions appear to be more favorable. In slight infestations a single application is sufficient. On the other hand, in severe infestations several applications, made at 8-day intervals, will be required, according to the severity of the case.

Lesser (92) in 1940 wrote that in Japan a 2.5-percent emulsion of bromo-rotenone was prepared, using gum arabic, and was applied to the entire body, except the head and neck, of 20 patients with scabies. After 3 or 4 applications 10 patients were completely cured, although some of them had been unrelieved by various sulfur treatments. Of the others, 9 were relieved and 1 failed to complete the treatments. One patented dermal parasiticide contains rotenone as the active agent.

Tarsonemidae

Hemitarsonemus latus (Banks), the broad mite

Gonggrijn (66) in 1929 reported comparative tests with sulfur, akar toebea extract prepared by the Deli Proefstation te Medan, Sumatra, and Neoton against mites, (Tarsonemus translucens) Hemitarsonemus latus (Banks), on young rubber trees in a nursery. The Neoton was used at the rate of 22.5 gm., added to a solution of 45 gm. of soft soap dissolved in 700 cc. of water at 60° C. This was stirred to a homogeneous emulsion and then diluted to 18 liters for spraying upon the trees. The derris preparations appeared to kill mites only by actual contact, but the effect of sulfur is attributed to the formation of volatile sulfur compounds. Sulfur gave the best and quickest results at one-third to one-fourth of the cost of the other materials.

Tarsonemus pallidus Banks, the cyclamen mite

The Ohio Agricultural Experiment Station (116) in 1934 reported that Rotecide used at the rate of 1:400 on begonia plants gave good results in the control of the cyclamen mite. Flower production was increased more than 100 percent on the treated plots, as compared with the checks.

Tarsonemus sp.

The Pennsylvania Agricultural Experiment Station (120) in 1938 reported that these mites were not controlled by pyrethrum and derris dusts and sprays.

Tetranychidae

Bryobia praetiosa Koch, the clover mite

Andries (5) in 1932 recommended Derrisol at 1:800 as a summer spray against

the "briobia mite."

Hamilton (69) in 1934, after describing the damage done by the clover mite, (Bryobia pratensis Garman) B. praetiosa Koch, stated that sprays containing the active principle of derris root are effective. The diluted spray should contain 0.0025 percent of rotenone plus the other constituents of derris root. If the spray contains little or no wetting agent it may be advisable to add sufficient soap to make about 0.5 percent of soap in the diluted spray. Ordinarily 1 ounce of powdered soap or 2.5 ounces of a 40-percent liquid soap, to 2 gallons of the diluted spray will give good results.

Neotetranychus buxi Garman

Ries (127) in 1935 reported that Black Arrow Dust, Red Arrow, Cubor, and Cubor Dust had no effect on boxwood plants and that these dusts killed this mite as follows:

Material	Mortality	
	Adults (24 hours)	Eggs (10 days)
	Percent	Percent
Black Arrow	98.4	28
Red Arrow (1:100)	93.3	19
Cubor	96.0	27
Cubor Dust	97	25

Paratetranychus simplex Banks, the date mite

Dowson (54) in 1935 reported the results of trials of sulfur, lime-sulfur, petroleum, derris, derris + sulfur, pyrethrum, nicotine, and other materials against date mites (apparently (Oligonychus) Paratetranychus simplex Banks). From 5 to 10 8-year-old palms of the Hallawi variety were either dusted (1/2 to 8 oz. per palm) or sprayed (1 gal. per palm). Only dusting sulfur killed all mites with one application. Derris does not control the mite.

Paratetranychus bicolor Banks

See Hamilton (69) under Bryobia praetiosa on page 13.

Paratetranychus citri (McG.), the citrus red mite

See Boyce and Prendergast (14) under Tetranychus bimaculatus Harv. on page

Boyce (12) in 1935 reported the results of tests of various insecticides

against the citrus red mite in California. Various concentrations and combinations of rotenone, finely powdered derris, finely powdered cube root, pyrethrum extract, finely powdered pyrethrum flowers, free nicotine, and nicotine sulfate were tested under field conditions. None of these products as used, even at concentrations that are commercially prohibitive, showed sufficient toxicity to the citrus red mite or its eggs to be considered promising in control.

Paratetranychus ilicis McG., the southern red mite

The Michigan Agricultural Experiment Station (103) in 1931 reported that Derrisol at 1:800 plus 2 pounds of Ivory soap per 100 gallons killed the active raspberry mites that were fairly hit by the spray. In 1932 this station (104) reported that for the control of raspberry mites many sprays were tried, among them glue, oils, nicotine, pyrethrum, derris soap, and as many combinations as time permitted. It was finally demonstrated that summer oils used at the rate of 1 percent, either alone or in combination with bordeaux, controlled this pest.

Paratetranychus pilosus C. & F., (syn. Oligonychus ulmi Koch), the European red mite

See Moore et al. (107) under Tetranychus pacificus McG. on page 33.

See Hamilton (69) under Bryobia praetiosa on page 13.

Turner (146) in 1932 reported that cube extract 1:25,000, emulsified in 2 percent of oil with a sulfonate emulsifier, killed 86.9 percent of European red mite eggs, whereas the check oil killed 89.6 percent.

Heal (73) in 1936 reported field tests made in New Jersey for the control of the European red mite on apples. Derris was supplied in three forms, a dust containing 1 percent of rotenone, a dust containing 0.75 percent, and a finely ground root containing 4 percent. Aresket, Areskap, Aresklene, skim milk, and soap were used as wetting agents. The most satisfactory combination consisted of 1.25 to 2 pounds of derris root (4 percent rotenone) and 10 ounces of Aresket or Areskap to 100 gallons of spray. The outstanding feature of this spray, beyond its toxicity to the pest, was its compatibility with sulfur and lead arsenate deposits on the foliage, the presence of the former precluding the use of any oil spray, and the presence of the latter estopping the use of any spray containing soap. Two applications spaced from 1 to 2 weeks apart were necessary to effect control. A dust made from derris and containing 1 percent of rotenone was valueless. Clay residues on apples at picking time were objectionable. When used so as to give equal rotenone content per unit of spray, derris root of 4 percent rotenone content gave better kill than did the 1 percent derris dust. As wetting agents, Aresket at 10 ounces per 100 gallons and soap at 0.2 percent were equal, and both were superior to skim milk at 2 pounds per 100 gallons..

In 1937 Heal's work was referred to by C. L. Smith (136), who stated that the control obtained by Mr. Heal in these tests after two applications amounted to 99 percent.

Petherbridge and Thomas (121) in 1937 recommended the following spray for ^{the} control of the fruit-tree red spider (Paratetranychus pilosus):

Mineral oil emulsion	3-1/5 pints (85 percent oil by weight)
Derris	13 ounces
Water	40 imperial gallons

Garman and Townsend (64) in 1938 reported that derris or cube sprays gave fair kills of the European red mite. These sprays do not affect the eggs and within a week are probably lost as killing agents for young, recently hatched mites. Some growers have reported successful control with derris or cube extracts combined with the regular sprays. Partial success was observed at Lebanon in 1936 with powdered root, and somewhat better results were obtained at Cheshire a year or two previous, on prunos. When combined with the usual spray ingredients, rotenone extracts were not especially successful in the experiments of 1938. The 1938 experience indicated that thorough applications of summer oil alone give good clean-up without additional materials.

Rotenone extract 1:800, applied on July 25 to a single apple tree, permitted an increase in the number of adult females per 100 leaves from 143 before spraying (July 19) to 180 on July 28 and 230 on August 3. Rotenone extract 1:800 applied at the same time to another apple tree caused the number of adult females per 100 leaves to range from 114 on July 19 to 50 on July 28 and 130 on August 3. A test was also made with rotenone extract 1.5:800 + dry lime-sulfur 3 pounds per 100 gallons + manganese sulfate 1/4 pound per 100 gallons + lead arsenate 2 pounds per 100 gallons. Results were as follows:

Time of examination	Mites per 100 leaves	
	Eggs	Adults
	Number	Number
July 28, before spray----	3,320	980
August 2, after spray----	4,390	190
August 12, after spray----	2,490	680

Derris powder (4 percent rotenone) at 4 pounds per 100 gallons killed 90 percent of the European red mites present.

Jary and Austin (81) in 1938 reported that during 1937 derris-petroleum-oil sprays gave a high degree of control of the fruit-tree red spider, which was otherwise very severe on plums.

Kearns and Martin (86) in 1939 discussed the use of postdormant combined sprays on fruit crops in England. "Rotenone-containing sprays, excluding those containing high-boiling petroleum oil, give somewhat erratic results in red spider control at the petal-fall stage. Eggs are not killed. If most of the spiders are active at the time of the application, control is satisfactory; but should a large number of them be molting, the control is frequently unsatisfactory. The following spray is recommended for the control of the plum sawfly and fruit-tree red spider: 1 gallon of petroleum-oil emulsion (67 percent oil) enough rotenone-containing material to give 0.004 percent of crystalline rotenone in the wash, and enough water to make 100 gallons of spray.

Robertson (129) in 1939 reported that Rotox with Stantex oil at 1:100 was tried against the European red mite on Yellow Newtown apple trees, but was less effective than "Cosmic sulfur" at 1:200, and equally as effective as 10-percent commercial summer oil.

Paratetranychus yothersii McG., the avocado red mite

See Hamilton (69) under Bryobia praetiosa, on page 13.

Paratetranychus sp.

Pettit and Hutson (122) in 1931 reported that the red spider mite (belonging to the same group as the Paratetranychus that was feeding on the Michigan holly, but distinct from it) infesting raspberry plants was finally controlled through the use of a Derrisol-soap solution (Derrisol about 1:800 with Ivory soap 4 pounds to 100 gallons of water). As earlier tests in controlling this mite had apparently failed because of inadequate pressure, this application was made at a pressure of 200 pounds.

Tetranychus bimaculatus Harv.

See Hamilton (69) under Bryobia praetiosa, on page 13.

McIndoo, Sievers and Abbott (94) in 1919 reported that derris applied as a dust was of no value against red spiders.

The California Agricultural Experiment Station (20) in 1923 stated that Derrisine (an extract of derris) was found to be inefficient against the red spider.

De Ong and White (53) in 1924 reported the results of tests with derris in which a commercial derris extract of 16-percent concentration, diluted 1:300, gave a maximum control of 25 percent of the red spider.

Lenfest (91) in 1926 reported that lime-sulfur mixed with Derrisol will kill red spiders on citrus.

The Florida Agricultural Experiment Station (61) in 1929 reported that on Asparagus plumosus Derrisol spray gave better control of red spiders than did ordinary flowers of sulfur.

Garlick (63) in 1929 reported experiments made in Ontario for the control of the red spider on raspberries and black currants. Derrisol was tried at 1:800 plus 1 pound of fish-oil soap per 40 imperial gallons. This had practically no effect on the red spider. Finely powdered derris at the rate of 2 pounds per 40 gallons of water plus 1 pound of soap gave some results, but the mites very soon came back. The derris left on the leaves apparently had no toxic effect on the mites. Often the mites actually preferred parts of the leaf where particles of derris were thickest. Eggs laid under such conditions hatched normally, and the immature forms were able to develop. This was true even when the dry derris particles were so thick as almost to obscure the leaf tissue. The fish-oil soap was used as a spreader. In order to find out whether it had any effect on the spiders, a spray composed of 5 pounds of the soap in 40 gallons of water was tried. It had little or no effect on the mites.

According to an anonymous writer (1) in 1930, the milky colloidal solution of resins and other compounds obtained by extracting the roots and stems of Derris elliptica with water has been found effective against red spiders. The powdered material may be applied as a dust with equal effect.

Compton (43) in 1930 recommended Derrisol for the control of the red spider on acacia, achyranthes, ageratum, alternanthera, cineraria, gerbera, hydrangea, lace flower, lantana, larkspur, lupine, petunia, primrose, rose, salvia, and schizanthus in greenhouses. Compton stated that Derrisol may be used with safety on all greenhouse plants at the dilutions recommended by the manufacturers.

Davidson (51) in 1930 reported the results of spraying and dusting tests with rotenone on a variety of insects. Pure rotenone, recrystallized from alcohol, was tested in the form of (1) suspensions produced by adding an acetone solution of rotenone to water, and (2) diatomaceous-earth powders containing 1 or 2 percent of very finely divided rotenone. Aqueous suspensions were not effective against red spiders on beans. This inefficiency against the red spider appeared to be due more to lack of penetrating power in the suspensions used than to absence of intrinsic toxicity, and would probably be remedied by incorporating rotenone in a penetrating carrier, such as an oil.

The contact insecticidal action^{of rotenone} on active red spiders on beans growing in a greenhouse, applied as a suspension in water, was as follows:

<u>Concentration (gm./cc.)</u>	<u>Net mortality (percent)</u>
1:90	78.6
1:1,000	64.5
1:2,000	60.7
1:20,000	18.5

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A dust containing 2 percent of rotenone killed none of the active red spiders on beans growing in a greenhouse.

Davidson (52) in 1930 compared the value of aqueous suspensions of rotenone, deguelin, tephrosin, and toxicarol when used against insects living on potted plants in a greenhouse. Their relative contact insecticidal value was in the order given, rotenone being the most potent. An aqueous suspension of rotenone (1:2000) killed 60.7 percent of the red spiders on beans. Deguelin and toxicarol at the same concentration killed 10 and 18 percent, respectively, and Tephrosin at 1:5,000 killed 10 percent.

The Florida Agricultural Experiment Station (62) in 1931 reported that Derrisol has been found to be an effective spray for the green mite on Asparagus plumosus.

Yothers and Keck (172) in 1930 reported that sprays containing 5 percent of derris extract were more effective than those containing nicotine sulfate, kerosene emulsion, lubricating-oil emulsion, or pyrethrum extract in controlling the red spider on Asparagus plumosus in Florida ferneries. Derris spray kills very slowly and very little mortality is obtained in 4 or 5 hours. In some cases it is greater in 48 hours than in 24.

Compton (44) in 1931 recorded tests with Derrisol and rotenone against the red spider in greenhouses. Derrisol in a concentration of 1:400 killed from 72 to 81 percent of red spiders on greenhouse plants. When Penetrol in a concentration of 1:200 was added to this solution from 98 to 100 percent of the red spiders were killed. Penetrol containing 0.1 gm. of rotenone per 100 cubic centimeters at a dilution of 1:100 (equivalent to 1:100,000 of rotenone killed from 58 to 64 percent. Derrisol at 1:400 combined with Penetrol at 1:200 killed from 87 to 93 percent of the eggs of the red spider. Mixtures of Derrisol and Penetrol in other proportions were less effective. The mortality figures are based on the number that were dead at the end of 24 hours, as no appreciable increase in percentage of kill was observed after this period. Commercial tests with this mixture were made in eight greenhouses in Cook County, Ill., and excellent control of red spiders was obtained with two applications made 8 days apart.

Darley (49) in 1931 reported comparative tests with rotenone, nicotine, and pyrethrum on the common red spider. Rotenone was used in the form of a solution consisting of 0.2 gm. of rotenone, 5 cubic centimeters of benzol, and 95 cubic centimeters of Penetrol. Rotenone at 1:50,000 killed 89.8 percent of the common red spider. The check mortality was 6.4 percent.

Jones and Davidson (82) in 1931 reported that rotenone and derris extracts prepared with fish oil have a high toxicity to red spiders.

Little (93) in 1931 gave a detailed account of the insecticidal properties of devil's-shoestrings. Dried and powdered (100-mesh) roots were suspended

in water and tested against many kinds of insects in the laboratory. Observations showed that, with the dosages used, the red spider suffered only a light mortality.

Wilson (169) in 1931 reported tests with sulfur dusts, nicotine, pyrethrum extract, derris extract, soap-and-white-oil emulsions, and miscible oils against the two-spotted mite on Asparagus plumosus in Florida. White-oil emulsion (1:100), thoroughly applied at 7-day intervals, was the safest and cheapest insecticide. The sulfonated-oil derivative [Penetrol?] was used as a spreader with a compound of derris, but after a few days the plants showed severe burning. Sprays in which the derris compound (1:400) was used gave good controls and no burning effects. When the derris compound was used at a dilution of 1:600, 85 percent of the mites were killed.

Brooks, Watson, and Mowry (17) in 1932 stated that in Florida dusting strawberry plants with flowers of sulfur is the quickest and most economical way of combating red spiders. Nicotine sulfate, pyrethrum, and derris compounds are also good insecticides for red spiders.

Campbell (40) in 1932 reviewed work by H. H. Richardson, of the Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, and others, with rotenone as an acaricide. Richardson proved that wetting and spreading agents greatly increased the effectiveness of rotenone suspensions against the common red spider on a kudzu vine in a greenhouse. The experiments were carefully controlled and mortality counts were made after 24 hours. Rotenone at 1:5,000 killed 12 percent of the adult mites; at 1:5,000 + potassium oleate (1:400), from 54 to 78 percent. The soap solution alone killed from 9 to 11 percent, a mortality not much greater than that in the untreated checks. The increased effectiveness of the rotenone-soap mixtures was therefore due to rotenone, aided in some chemical or physical way by potassium oleate. Rotenone at 1:1,000 with potassium oleate (1:400) killed only 67 and 83 percent of the mites, a fivefold increase in concentration producing very little increase in mortality. W. M. Davidson, of the Food and Drug Administration, United States Department of Agriculture, killed 64.5 percent of the mites with rotenone at 1:1,000 without a wetting and spreading agent but, since his methods are not described, his result does not necessarily contradict those of Richardson. By adding Penetrol to rotenone suspensions, Darley killed 75 percent of the mites in 24 hours with rotenone at 1:100,000 and 90 percent at 1:50,000--much greater dilutions than those used by Richardson. Whether Penetrol increases the effectiveness of rotenone suspensions more than does potassium oleate can be determined only by paired experiments. Richardson also tested sulfonated castor oil as a wetting and spreading agent for rotenone suspensions, and found it less effective than potassium oleate. Both Richardson and M. M. Darley, of the Division of Cereal and Forage Insect Investigations, found that rotenone with wetting and spreading agents was more effective against the common red spider than were the pyrethrins or nicotine with the same agents.

Richardson (124) in 1932 compared the insecticidal value of rotenone, the pyrethrins, and nicotine against the greenhouse red spider mite. Without the addition of some wetting agent, the pyrethrins, rotenone, and nicotine, even at high concentrations, have little toxicity to the greenhouse red spider mite. With the addition of 0.25 percent of potassium oleate soap, rotenone at 0.02 percent is slightly more toxic than the pyrethrins (0.02 percent); nicotine is much less toxic than either of these two, approximately 0.66 percent being necessary to produce a mortality equivalent to that produced by the above-mentioned concentrations of the other two poisons. With sulfonated castor oil as the wetting agent, the pyrethrins and rotenone at 0.02 percent are about equivalent in toxicity; nicotine again is much less toxic, about 0.2 percent being necessary to equal the insecticidal efficiency of the other two at the concentrations given above. Potassium oleate soap at 0.25 percent and 0.5 percent is approximately equivalent in toxicity to sulfonated castor oil at 0.5 percent and 1.0 percent, respectively. Soap is more efficient than sulfonated castor oil as a wetting agent for rotenone and the pyrethrins. With nicotine, however, the reverse appears to be true. Nicotine (1:500) makes distinctly alkaline the almost neutral 0.5 percent of sulfonated castor oil, but has a relatively slight effect on the already alkaline soap solution. Alcoholic extracts of the pyrethrins have an acidic effect when added to either sulfonated castor oil or soap solution. Acetone solutions of rotenone have very little effect on the pH of either of these wetting agents.

Hutson (76) in 1932 reported that summer oils used at 1-percent strength, alone or in combination with bordeaux, applied 2 or 3 times at intervals of 5 days, controlled the greenhouse red spider in southwestern Michigan. Nicotine and Penetral, Derrisol and soap, and glue were three other successful sprays.

Webster (158) in 1932 reported that freedom from red spider injury was conspicuous during the 1931 season on blocks of trees in the Wenatchee, Wash., experimental orchard, which had been sprayed with rotenone, oil-nicotine, or the oil-pyrethrum combination.

Turner (146) in 1932 reported that cube extract 1:12,500, emulsified in 1 percent of oil with powdered milk, killed 70 percent of the red spiders in greenhouses, whereas the check oil killed 14 percent.

Gnadinger (65) in the first edition of his "Pyrethrum Flowers," published in 1933, cited unpublished work by Ginsburg which indicates that rotenone is more toxic to red spiders than are the pyrethrins.

According to a statement made by its manufacturers, Penick and Company (119) in 1936, Foliafume is a balanced pyrethrum-derris plant spray with spreader. The use of Foliafume at 1:400 is recommended for insects of intermediate resistance, such as the red spider. At this concentration the average mortality was 87 percent after 48 hours.

Richardson (125) in 1934 reported tests with an acetone extract of derris containing 5.7 gm. of rotenone and 18.1 gm. of total extractives per 100 cc. In greenhouse and small field tests derris extract with sulfonated castor oil

showed promise in control of red spider mites on roses and other plants.

Richardson (126) in 1935 reported on the control of the red spider on greenhouse plants. Sprays made from commercial acetone extracts of derris (see Jour. Econ. Ent. 26: 995. 1933) and sulfonated castor oil (turkey-red oil) have been found to be toxic to the common red spider in small-scale tests on infested tomato plants in the greenhouse. Dilutions giving rotenone contents, respectively, of 1:15,000, 1:25,000, 1:50,000 by weight and total extractives of approximately 1:4,000, 1:6,250, and 1:12,500 in water containing 0.25 percent (1:400) by volume of sulfonated castor oil, 75-percent product, gave 100.0-, 98.3-, and 93.7-percent mortality. Considerable trouble has been experienced with commercial acetone extracts that have deteriorated during storage. They are not only much less effective in insecticidal and acaricidal action, when added to the spray, but they produce large quantities of resinous precipitates, even though first diluted with an equal volume of acetone. These precipitates tend to clog the sprayer and pump valves, making such extracts unsuitable for practical use. Undeteriorated derris extracts are much more toxic to the red spider than are equivalent quantities of pure rotenone. A dust containing derris extract in diatomaceous earth, prepared to give 0.5 percent of rotenone or 1.8 percent of total derris extractives, had little effect against the red spider on hollyhocks in the greenhouse (2 percent kill of 321 mites).

Suspensions of finely ground derris root (2.9 percent of rotenone and 16.7 percent of total carbon tetrachloride extractives) at a concentration of 0.25 percent by weight (rotenone approximately 1:14,000) in combination with 0.25 percent by volume of sulfonated castor oil (1:400) were found to give very high kills of the red spider on cucumber plants. Two series of small-scale tests, 5 replications each, killed averages of 92.4 and 99.2 percent of the adults and 86.2 and 97.6 percent of the nymphs. More sulfonated castor oil (0.5 percent) was used in the second series. These sprays also killed the onion thrips on cucumber. Suspensions of powdered cube root (5.3 percent of rotenone and 17.3 percent of total carbon tetrachloride extractives) at the rate of 0.25 percent (rotenone approximately 1:8,000), in combination with 0.25 percent by volume of sulfonated castor oil, also gave high mortality.

Cube killed 97.2 percent of the adults and 96.6 percent of the nymphs, as compared with 99.2 and 99.5 percent kill, respectively, for adults and nymphs by the same concentration of derris with 0.5 percent of sulfonated castor oil. The derris-root powder suspensions (0.5 percent by weight) with sulfonated castor oil (0.25 percent) seemed to be stable, as they were just as toxic to the mites 6 days after preparation as when freshly prepared. There appeared to be no advantage in soaking the powder in cold water before spraying, or in boiling the suspension (in 1/8 the final volume of spray) for a few minutes and then diluting it in the spray. The suspension was much less effective when used without a wetting agent. In a heavily infested cucumber greenhouse, the same derris at a concentration of 0.12 percent (rotenone = 0.0034 percent) plus sulfonated castor oil at 1:300 killed 98.4 percent of the adults and 96.4 percent of the nymphs. This work by Richardson was reviewed by Roark (128) in 1938.

The Ohio Agricultural Experiment Station (116) in 1934 reported that Rotecide at 1:400 in water gave a 92-percent kill of red spider with no observable injury to the soybean plants in a greenhouse.

Howard, Mason, and Davidson (74) at the meeting of the Ohio Vegetable Growers Association held January 31, 1935, at Columbus, Ohio, reported that tests with derris dust had been made against the red spider, but in every instance the infestation was too light to draw conclusions.

The Rubber Service Laboratories Company, Inc. (131) in 1934 and again (132) in 1935, issued suggestions for the use of Areskap and Aresket in insecticidal sprays. A mixture of 7 parts by weight of derris resin, 33 parts by weight of Dry Areskap, and 60 parts by weight of either pine oil or oleic acid has been found to be effective at 1:400 for control of the red spider.

The Polytechnic Institute of the Alabama Agricultural Experiment Station (4) in 1935 stated that derris mixed with sulfur is effective against red spiders. Derris dust should contain at least 0.5 percent of rotenone.

Weigel and Richardson (165) in 1935 reported that the proportion of sulfonated castor oil is an important factor in the effectiveness of derris sprays against the red spider. Tests conducted against red spider mites at Barberton, Ohio, indicated that a spray composed of derris-root powder in water (rotenone approximately 0.0034 percent), which had not proved entirely effective, showed a marked increase in effectiveness when the proportion of sulfonated castor oil was increased from 1:400 to 1:200. With this proportion, kills of 98.4 percent of the adults and 96.4 percent of the nymphs were obtained. It was observed that increasing the rotenone content to 0.0052 percent without increasing the proportion of sulfonated castor oil did not appreciably increase the effectiveness. Similar results were obtained when cube-root powder in water, containing approximately 0.0095 percent of rotenone, was used with the sulfonated castor oil.

Murphy (111) in 1936 reported that beta-butoxy-beta'-thiocyano-diethyl-ether (the active constituent of Lethane 420 and Lethane 440) was more effective against the greenhouse red spider than pyrethrum or derris sprays. One commercial derris spray killed 61 percent of the spiders at 1:200 and another killed 74 percent at 1:500; whereas the thiocyanate killed 76 percent at 1:1,000 and 95 percent at 1:800, when used with a spreader at 1:200.

The Ohio Agricultural Experiment Station (117) in 1936 reported that for the control of the red spider the rotenone sprays were the most satisfactory of the materials used, when effectiveness, freedom from plant injury, and costs are all considered. A new sulfated alcohol spreader and sticker, when used at 1:500 with various commercial rotenone sprays, served to increase the kill over that produced by the same rotenones when used with various soap spreaders, at 1:250, by approximately 11 percent in a number of tests.

Van Gundia (152) in 1936 reported excellent control of the red spider with a rotenone formula that carried approximately 30 percent of sulfur in the form of fused bentonite sulfur, which aids as a sticker for the rotenone and also acts as an activator. It should not be applied to conifers until the new growth for the season has ceased. If the tips are young, tender, and growing, some conifers, particularly hemlock, will be scorched.

Consumer's Research, Inc. (45), in 1937 recommended rotenone products for use against red spiders.

Derrisol controls red spiders, according to advertising literature issued by the manufacturers, William Cooper and Nephews, and enclosed in a letter dated November 16, 1937, to R. C. Roark.

C. L. Smith (136) in 1937 reported tests of derris sprays against several species of insects. Small-plot tests were made and the derris powder (90 to 95 percent passing a 200-mesh sieve; rotenone 4 percent) plus a 40-percent coconut-oil soap was applied with a knapsack sprayer. Against red spiders on delphinium plants in the field, results were as follows:

<u>Application</u>	<u>Reduction in 48 hours</u> <u>Percent</u>
Derris 3 lb., soap 40 oz. (anhydrous basis), per 100 gal.	81
Derris, 1.5 lb., soap 30 oz. (anhydrous basis), wettable sulfur 1.5 lb.	90
Dust, rotenone 0.75 percent	62

Against red spiders on hydrangea, derris 2 pounds and soap 30 ounces (anhydrous basis) per 100 gallons caused 96-percent reduction, as revealed in a count made every 24 hours. C. L. Smith's work was reviewed by Manschke (97) in 1937.

Weigel and Nelson (163) in 1937 reported that experiments performed against the red spider on greenhouse-grown tomato and cucumber plants, in which four sprays were applied at 4-day intervals, gave the following results: A derris spray having a rotenone content of 0.0056 percent was as effective as one with 0.0112-percent-rotenone content; the derris sprays used were superior to cube sprays of the same rotenone content, the difference being explainable on the basis of the total-extractives content, which was 18.6 percent for the derris and 12.3 percent for the cube; the addition of pyrethrum extract did not improve the effectiveness of the sprays against the red spider; with sprays of the same rotenone content, containing sulfonated castor oil as a spreader, the result was a better kill than when either alkylphenylbenzenesulfonic acid or rosin residue was used. In a second series of experiments the same insecticides that were used in the first series, but applied four times at weekly intervals, gave approximately the same results, except that on tomatoes the spray containing derris, pyrethrum, and alkylphenylbenzenesulfonic acid appeared to be as

effective as the sulfonated castor-oil sprays. None of the sprays except lauryl thiocyanate caused any permanent injury to either tomato or cucumber.

Boyce and Prendergast (14) in 1938 reported that, aside from the regular oil spray, there are several materials or combinations of materials including oil at low dosage plus rotenone-bearing materials, that may be used in the control of the citrus red mite. Combinations of rotenone-bearing materials, such as derris, cube, timbo, and others with a low dosage of oil (0.5 to 0.7 percent), have been in use for several years. Such combinations have generally afforded satisfactory control of the black scale but have been definitely inferior to a regular dosage of oil in red spider control. Experimental work with these combinations, together with extensive field observations of commercial treatments, indicates that when from 1/2 to 2/3 of 1 percent of light-medium oil is used with any of the more commonly used rotenone-bearing materials the average length of time that red spider control may be expected is about 3 months. With thorough application, the kill of all stages, except the egg, is usually as good with these materials as with the full dosage of oil. The amount of egg kill, however, appears to be directly related to the amount of oil deposited and the nature of the deposit. Therefore, the period over which these materials effect satisfactory control is largely determined by climatic conditions and other factors affecting the development of the spider after treatment. The oil-rotenone mixtures are relatively expensive when considered in the control of the red spider alone; however, when considered in the combined control of aphids, the red spider, and the "off-hatch" black scale during the spring, they are very practical. Of the available materials (Selcide excepted) that may be used at this season for red spider control, the 0.5 percent light-medium oil plus rotenone-bearing materials is perhaps the safest and is generally most effective.

Hamilton (70) in 1938 reported the results of tests of cube and derris powders (4 percent rotenone and 16 to 18 percent total extractives), applied as a spray at the rate of 4 pounds per 100 gallons, with the addition of 4 pounds of rosin-residue emulsion. Cube powder appeared to be as effective as derris powder in the rosin-emulsion spray, both as a contact poison and as a repellent. These tests were made by members of the National Shade Tree Conference under a cooperative project with the Hercules Powder Company, manufacturers of rosin residue, and 5 of the principal suppliers of derris and cube powders. Sufficient spray material to make from 500 to 1,000 gallons of diluted spray was sent to each of 38 cooperators in 14 States, together with instructions for using the spray and a report blank to be used in giving the results of the tests. In 4 out of 6 tests, the sprays were satisfactory against spider mites on spruce, juniper, and privet, but probably were not effective against the eggs.

The Massachusetts Agricultural Experiment Station (99) in 1937 reported that further studies of pyrethrum and derris extracts as used in commercial sprays showed that the red spider mite is not satisfactorily controlled by pyrethrum extracts, but that extracts of derris, either as rotenone or as other extracted resins, principally deguelin, terhrosin, and toxicarol, gave satisfactory control when used in the proper concentration. The emulsified extracts containing 10 percent of sulfated alcohol as a wetting and spreading agent were diluted 1:200 for application. A spray containing 1.5 percent of pyrethrins ha

practically no effect on the red spider, and when the pyrethrins were increased to 2 percent, a relatively high concentration, the mortality was only 9.52 percent. The addition of 0.5 percent of rotenone to the 1.5 percent of pyrethrins killed 37 percent of the red spiders which is poor control but indicates an increased toxicity of 35 percent due to the rotenone. One percent of pyrethrins and 1 percent of rotenone combined caused an average mortality of 79.65 percent; and 2 percent of rotenone without pyrethrins killed 87.16 percent of the red spiders and was the most effective formula used in this series. Spray mixtures containing "other extracted resins" of derris were approximately one-half as toxic to the red spider as was rotenone, and when used at twice the concentration produced an equal or slightly greater mortality of this pest. A summary of results is as follows:

Pyrethrins	Rotenone	Other derris resins	Average mortality
:	:	:	:
:	:	:	of the red spider
<u>Percent</u>	<u>Percent</u>	<u>Percent</u>	<u>Percent</u>
1.5	0.	1.0	62.24
1.0	0	2.0	84.25
0	0.	4.0	86.77
1.5.	0.	0.	1.81
2.0	0.	0.	9.52
1.5	0.5	0	37.09
1.0	1.0	0	79.65
0	2.0	0	87.16

In 1938 the same station (100) reported that in studies of insecticides used for the control of the red spider on carnations and greenhouse plants, materials containing rotenone continued to show a high toxicity against this pest and generally became more effective as the temperature increased. The addition of wettable sulfur as a fungicide to one of the rotenone sprays caused no material change in the number of red spiders killed. In comparable tests most of the newer commercial insecticides containing rotenone were inferior to the older standard mixtures or to laboratory preparations. Suspensions of derris, cube, or pyrethrum powder in water were less effective than the extracts of these materials, and the addition of a wetting agent did not increase their effectiveness in the laboratory. This station (101) in 1939 reported that experiments with sprays containing extractives from derris and cube indicated that effective sprays of this nature for combating the common red spider, and capable of consistently giving better than 90 percent control, should contain 0.03 percent of total extractives (0.0075 percent rotenone). This is equivalent to a stock mixture containing 1.5 percent of rotenone and 4.5 percent of other resins, diluted 1:200. Sprays containing these active ingredients are slightly more consistent in effectiveness if combined with brown camphor oil, rather than with soluble pine oil or sulfonated castor oil. The addition of 0.2 percent of Karaya gum increased the effectiveness about 5 percent, apparently by building up the deposit on the leaves; but when both gum and spreader were added the run-off was increased and no benefit from the gum resulted. When the temperature was 80° F. the effectiveness against the red spider was from 25 to 40 percent greater than at 60°. An alcoholic extract of derris containing 0.0075 percent of rotenone and 0.0225 percent of other extractives was 10 percent more effective than a similar extract containing 0.005 percent of rotenone. The addition of 0.005 percent of pyrethrins not only failed to increase the mortality of the red spider but actually gave an average decrease of 6 percent in three experiments.

The New Jersey State Agricultural Experiment Station (112) in 1938 reported that during the last few years the greenhouse red spider has done much damage to roses. In 1937 studies of the effect of derris-oil emulsions on this arthropod indicated that these are very satisfactory and cheap materials for red spider control. By the use of derris, the amount of oil necessary to effect control has been greatly reduced and the danger of damage to the rose plants correspondingly decreased. This material destroys all stages, including the eggs.

Weigel and Nelson (164) in 1938 tested derris and cube with various wetting agents (including alkylphenylbenzenesulfonic acid, sulfonated castor oil, and ammonium caseinate+rosin-residue emulsion) for control of the common red spider on greenhouse tomatoes and cucumbers. The authors concluded that a derris spray having a rotenone content of 0.0056 percent is as effective as one with a 0.0112-percent-rotenone content when sulfonated castor oil is used as a spreader; that the derris sprays used in these tests are superior to cube sprays of the same rotenone content, the difference being explainable on the basis of the total extractives; that the addition of pyrethrum extract does not improved the effectiveness of the spray against

the red spider; that with sprays of the same rotenone content with sulfonated castor oil as a spreader the kill is better than with either alkylphenylbenzenesulfonic acid or ammonium caseinate with rosin residue; and that proprietary thiocyanate spray is as effective as the derris spray plus sulfonated castor oil. None of the derris or cube sprays plus the spreader or the proprietary thiocyanate caused any permanent injury to either tomatoes or cucumbers. The lauryl thiocyanate spray with a sodium oleyl sulfate, plus synthetic resin as a spreader, caused severe injury to both the foliage and the fruit of tomatoes. This work was referred to by the United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (150) in 1933.

Weigel and Johnson (159) in 1939 reported the results of tests made at Beltsville, Md., on the control of red spider on cucumbers. The results of mortality counts of red spiders on greenhouse-grown cucumber plants after six sprays were applied, the first two of which were applied 4 days apart and the remainder at weekly intervals, indicated that in sprays containing 0.0056 percent of rotenone and 0.01 percent of total pyrethrins with sulfonated castor oil (1:300) a greater kill resulted than when an alkylphenylbenzenesulfonic acid was used as a spreader. The addition of pyrethrum to a derris and sulfonated castor-oil spray did not increase its effect against red spiders. Sulfonated castor oil diluted 1:300 when used alone did not possess much toxicity to the spider mites. A proprietary thiocyanate gave a good kill of red spiders. Three applications of tartar emetic and brown sugar gave a kill of 100 percent of the spiders, but caused serious injury to the cucumber plants and reduced the yield of fruit. When peanut oil was used with derris and pyrethrum at the strength indicated above, 98.5 percent of the spiders were killed after four applications, but the treatment caused a yellowing of the cucumber foliage. No positive correlation was found between the yield of cucumbers and the control of red spiders obtained with the various sprays.

In August 1939 Weigel and Johnson (160) reported that a proprietary compound containing derris, an organic thiocyanate compound, pine oil, petroleum, and an emulsifier was less effective than was tartar emetic with either brown sugar or glycerin when used against the red spider on chrysanthemum cuttings in the laboratory. In November 1939 these authors (161) reported that tests made at Beltsville, Md., indicate that, on the basis of examinations made of all living red spiders found on representative samples of cucumber foliage from greenhouse-grown plants, which were given a total of nine applications of a derris-pyrethrum-sulfonated castor-oil spray, this combination proved superior to an equal number of applications of sprays composed of a commercially prepared thiocyanate. This confirmed the results obtained during the preceding three seasons. Under the conditions of this experiment no differences were revealed in the numerical production of cucumbers from plants treated with these two sprays, but the per-plant production was considerably reduced in the check plots. It should be emphasized, however, that the plants in the check plots produced a higher percentage of Grade No. 1 cucumbers than the plants subjected to either of the spray treatments, indicating the possibility of mechanical injury to the flowers or young cucumbers by the spray. The derris-pyrethrum-sulfonated castor-oil spray did

not cause detectable injury to the cucumber plants, but those to which the thiocyanate spray was applied suffered some injury directly attributed to the treatment.

Weigel and Johnson (162) in 1940 reported that white-oil emulsion is more effective than sulfonated castor oil as a spreader for derris-pyrethrum spray against red spider. Small-scale toxicity tests against Tetranychus bimaculatus were made on potted cucumber seedlings, and were designed to determine whether certain spreaders could be substituted for sulfonated castor oil in the derris-pyrethrum-sulfonated castor-oil spray without reducing the effectiveness of the spray combination against this pest. The test plants were uniformly treated by spraying both sides of all leaves with a small atomizing electric sprayer held at a distance of 15 feet from the leaves during application. In all derris-pyrethrum spray mixtures tested the concentration was 0.0056 percent of rotenone and 0.01 percent of pyrethrins, while the derris spray alone contained 0.0056 percent of rotenone. All mortality counts of red spiders were made 2 days after treatment. The mortality of red spiders ranged from 71.9 to 100 percent for the 11 spray combinations used in the tests. Both the derris spray and the derris-py-rethrum spray, to which had been added white-oil emulsion, 1:100 by weight, gave 100-percent mortality of the spiders, as compared with 82.2 and 83 percent from derris-pyrethrum sprays to which had been added sulfonated castor oil at the rates of 1:300 and 1:400 by volume, respectively. Water sprays containing only the white-oil emulsion at concentrations of 1:100 and 1:200 by weight resulted in mortalities of 97.3 and 92.1 percent, respectively. A derris-pyrethrum spray containing sodium oleyl sulfate 1:1,000 by volume gave a mortality of 72.7 percent, whereas one containing the sodium oleyl sulfate plus synthetic resins, 1:1,000 by volume, gave 87.6 percent mortality. Another derris-pyrethrum spray containing sodium lauryl sulfate, 1:3,000 by weight, resulted in a mortality of 71.9 percent; for the same period of observation there was an average mortality of 5.3 percent of the red spiders on untreated cucumber seedlings and 23.3 percent on plants sprayed with plain water. Apparently the white-oil emulsion 1:100 by weight was considerably more effective than sulfonated castor oil 1:300 or 1:400 in the derris-pyrethrum spray. The white-oil emulsion alone, 1:100 or 1:200 by weight, was very effective against the spiders. There was probably little, if any, real difference between the effectiveness of sodium oleyl sulfate 1:1,000 by volume, sodium oleyl sulfate plus synthetic resins 1:1,000 by volume, sodium lauryl sulfate 1:3,000 by weight, and sulfonated castor oil 1:300 or 1:400 by volume, in the rotenone-pyrethrum spray.

Crosby, Chupp, and Leiby (47) in February 1939 discussed the control of diseases and insects affecting vegetable crops on Long Island. Experimental results indicated that the red spider mite on lima beans can be controlled by dusting with a sulfur-rotenone dust containing 0.75 percent of rotenone. The rotenone is included in the formula under the assumption that the vines would be dusted for the control of the Mexican bean beetle at the same time that efforts to control the red spider mite are being made. If a spray is desired, 4 pounds of rotenone-bearing powder (4 percent rotenone) in 100 gallons of water probably will control this pest satisfactorily. The dust

or spray must hit the mites on the under side of the leaves, where ^{most of} they do/ their feeding. If it is desired to control downy mildew, along with the bean beetle and the red spider, the rotenone spray should be combined with a copper spray. The 4 pounds of a 4-percent-rotenone powder should be added to each 100 gallons of a bordeaux mixture or other copper spray, as advised for mildew control. A copper-rotenone spray should be applied soon after it is mixed.

Hamilton (71) in 1939 recommended derris- or cube-extract sprays as contact poisons for the control of the red spider on house plants.

According to W. J. Haude, in advertising literature published by John Powell & Co., New York, N. Y., in 1939, derris-oil sprays have been successfully used for red spider control in the coastal areas; however, this use has not been extensive, except in areas where the black scale is also a factor. Sprays containing rotenone are effective for the control of the red spider on ornamentals. A contact spray containing the equivalent of 1 percent of rotenone may be diluted at the rate of 1 part to 400 parts of water. It is advisable that such a spray when diluted contain at least 0.5 percent of a nonalkaline wetting agent. Dusts are apparently not so effective as sprays. The addition of derris or cube to sulfur dusts will increase their efficiency against the red spider on cotton.

O'Brien (115) in 1940 wrote that, according to McDaniel of Michigan State College, red spiders dislike any preparation that contains derris or its derivative, rotenone. He recommends dusting with a copper-derris compound, which can be bought in commercial mixture, or spraying with a mixture of sulfonated castor oil and derris powder. To 1 gallon of water, use a little less than a tablespoonful of the oil and a teaspoonful of the derris.

Brennon (15) in 1940 reported that a derris-pyrethrum-sulfur dust mixture is promising as an all-purpose dust mixture for the combined control of several species of insects commonly attacking beans, including the Mexican bean beetle, the bean leaf beetle, the potato leafhopper, and the common red spider, and for the prevention of powdery mildew.

Coleman and Lyle (42) in 1940 reported the results of tests with a large number of materials to determine the most effective and economical control for red spiders, thrips, mealybugs, and aphids in greenhouses. The three most effective were Loro, Lethane, and derris extract. Derris extract diluted 1:200 killed 98 percent of the red spiders, but it cost nearly 2.4 times as much as the same amount of Loro, which at 1:800 killed 97.8 percent of this insect.

Morrison and Mote (110) in 1940 reported that a dust containing 0.75 percent of rotenone plus 2 percent of sodium lauryl sulfate killed 35 percent of red spiders on hops in Oregon; whereas a dust containing 1 percent of dinitro-ortho-cyclohexylphenol killed 99 percent. Rotenone was compatible with the proprietary DN dust (1 percent DN on walnut-shell flour) but did not contribute added toxicity.

stated
The California Fruit Growers Exchange, Bureau of Pest Control, (21)/in the November 1935 issue of their Pest Control Circular that Ortho Derris and Tox-X are less effective than oil spray against the red spider. In the August 1936 issue of this circular (22) it is stated that Ortho Derris and Tox-X are composed of a powdered insecticide containing derris added to a low dosage of light-medium oil, usually from 1/2 to 2/3 of 1 percent. At slightly higher oil dosages, up to 1.0 or 1.25 percent, they kill red spiders and eggs, but have not given control for such long periods as have the oil sprays normally recommended; however, they will check spiders for at least a few months. The article says further:

However, in orchards where red scale is a problem and red spider is important, in the light of present knowledge it would appear that these sprays, even with the higher dosages of oil, should not be substituted for the regular oil spray and fumigation program.

If a grower in this area [Rivera-Downey-Whittier area] must treat over-mature fruit for spider, and so much of his crop remains that he does not desire to treat over it with light-medium oil, the other possible treatment in this area is one of the so-called derris sprays with 0.5 percent of light-medium oil. To date, derris sprays with 0.5 percent of light-medium oil have shown little oil deposit, no interference with color, will control the black scale satisfactorily, and handle the spider for several months; but, unless conditions are very favorable, additional spider control will have to be made within the year. While light-medium oil applied at this time will give a longer spider control than derris sprays, it is not recommended over mature fruit.

The Exchange (23) in the September 1936 issue of its Pest Control Circular, stated that it is uncertain whether derris-oil sprays at 0.5 to 1.0 percent of light-medium oil will hold the red spider [in check] for more than a few months. The Exchange (24) wrote as follows in July 1937:

Oil sprays, while the most effective of any materials against red spider, are not advisable, even at the low dosage of 1 percent light-medium oil, owing to the danger of causing excessive drop of the young crop should the weather become hot. Even the so-called derris-oil sprays, made up of 0.5 percent of a light-medium oil and derris powder, although applied on a large acreage of oranges during the last few months without apparent damage, cannot be recommended, for the same reason. A sudden hot spell following application of this material might hasten the drop of small fruit. However, where growers feel justified in using oil, at present it appears to be the safest oil type.

In November 1937 the Exchange (25) stated that the most dependable material for control of red spiders on Valencia oranges at that time of the year is light-medium oil, preferably 1-1/2 to 1-2/3 percent emulsion. Where

growers prefer less oil, even with the possibility of shorter control, the better known oil-rotenone combinations, such as Botano-R or Tox-X, may be used. For growers who refuse to accept the risk attendant on the use of miscible oil and lime-sulfur on navel oranges, an alternative is low-dosage oil-rotenone. With this material, however, there is the possibility of retarded fruit coloration, which may necessitate late shipment. In December 1937 the Exchange (26) recommended rotenone-oil sprays for the control of the red spider on lemons and oranges. These sprays are usable in all districts, whereas the use of miscible oil and lime-sulfur is limited to interior areas.

Rotenone-oil products were recommended by the California Fruit Growers Exchange (27) in January 1938, for the control of red spider on lemons in the coastal areas and on oranges in the interior. In February 1938, the Exchange (28) recommended oil-rotenone combinations for combating the red spider, the citrus aphid, and the immature black scale. A suitable spray is made from 0.5 to 0.75 gallons of light-medium oil, 1 to 4 pounds (depending on the brand) of rotenone powder, and water to make 100 gallons. In March 1938, the Exchange (29) reported that the beginning stages of water rot became evident the last week in December in some oil-sprayed Thompson Navel Orchards in eastern Los Angeles County, but the rot was arrested by drying weather. There appeared to be no outstanding difference between orchards sprayed with emulsion and those sprayed with emulsible oils. Oil-rotenone combinations containing less oil showed less damage than the regular oil sprays; in fact, the extent of water-rot development was largely in proportion to the percentage of oil used. Sprays carrying less than 1 percent of oil showed much less rot than sprays carrying 1.5 percent or more. For the control of red spiders on oranges in the coastal area of California it was stated that, since aphids are almost always present at this time of year along with the red spider, one of the rotenone-oil sprays with 0.5 percent of light-medium oil should be the preferred treatment and will control both pests. The most widely used rotenone-oil sprays of known value are Botano-R, Tox-X, and Retox.

In May 1938 the California Fruit Growers' Exchange (30) discussed the red spider situation. For lemons, in groves where there is a considerable amount of maturing fruit or where spring fumigation has been practiced, light-medium oil (1.5 to 1.67 percent), or one of the rotenone-oil sprays at 0.5 to 0.67 percent of light-medium oil, might be given preference. In July 1938, the Exchange (31) advised growers of oranges in Ventura County as follows: "If spray is used on oranges for black scale, low-dosage dorrin-oil will handle the black scale, and in most cases the red spider, and is easier on the trees and fruit."

The Exchange (32) in January 1939 recommended rotenone-oil for use against red spiders on lemons in coastal areas. In April 1939 it (33) recommended one of the rotenone-oil sprays with $1/2$ of 1 percent of light-medium oil as the preferred treatment to handle both aphids and the red spider on oranges in the coastal areas. In July 1939 the Exchange (34) recommended rotenone-oil sprays using $1/2$ to $2/3$ of 1 percent of light-medium oil for the control of the black scale and the red spider in Ventura County, where treatment must be made over ripe fruit. In August 1939 it (35) discussed the control of the red spider in coastal citrus orchards. In areas where a spray is also necessary for black

scale control, straight oil spray will also control the red spider. Where rotenone is used with a light dosage of oil, the control will be only temporary unless aided greatly by weather unfavorable to the red spider.

In April 1940 the Exchange (36) reported on control of red spiders on oranges. In coastal areas, if aphids become a pest along with the red spider, one of the rotenone-oil sprays with 0.5 percent of light-medium oil should be the preferred treatment to handle both pests. The formula given: Light-medium oil 1/2 to 3/4 gallon, rotenone powder 3/4 pound to 3 pounds (depending on the brand), and water to make 100 gallons.

The Exchange (37) in January 1941 reported on the control of red spiders on citrus fruits. If scales are also present in immediate coastal areas, light-medium oil or oil-rotenone might be used. In March 1941 the Exchange (38) recommended one of the DN dusts as the preferred treatment at that time of year. If rain falls sooner ⁱⁿ than 3 or 4 days after the application, its effectiveness is greatly reduced. Valencia areas along the coast, where aphids may be a pest along with red spiders, one of the rotenone-oil sprays at 0.5 to 0.75 percent of light-medium oil is the preferred treatment to control both insects. Where oil is used for scales on lemons, it will also control the red spider.

Tetranychus althaeae v. Hanst.

DeBussy et al. (18) in 1936 reported that (Epitetranychus) Tetranychus althaeae was not controlled by dorriss dust and was imperfectly controlled by dorriss spray, which was more effective than pure rotenone (both on a basis of rotenone 1:3,000). In each spray material 0.05 percent of lethalate was added as a spreader.

Tetranychus medanioli McG.

The Michigan Agricultural Experiment Station (103) in 1931 reported that Dorrisol at 1:800 plus 2 pounds of Ivory soap per 100 gallons killed active raspberry mites that were fairly hit by the spray; and in 1932 this station (104) reported that many sprays were tried for the control of this species, among them glue, oils, nicotine, pyrethrum, dorriss, soap, and as many combinations as time permitted. It was finally demonstrated that summer oils used at the rate of 1 percent, either alone or in combination with bordeaux, controlled this pest.

Hutson (77) in 1933 reported that in tests of single applications of insecticides, Dorrisol 1:800 plus 2 pounds of Ivory soap in 100 gallons was sprayed on raspberries with an orchard sprayer developing 250 pounds pressure. After this treatment 247 live mites of this species were found per 100 leaves, as compared with 822 on the check. The best control, 114 live mites per 100 leaves, was obtained with glue at the rate of 15 pounds in 100 gallons of water.

Tetranychus pacificus McG., the Pacific mite

The Washington State College Extension Service (156) in 1940 stated that rotenone material (powdered dorriss, cube, and Timbo) containing not less

than 3.6 percent of rotenone, when used at the rate of 1 pound per 100 gallons with 3 quarts of kerosene, is effective in reducing infestations of the Pacific mite.

Moore et al. (107) in 1941 reported on control of the Pacific mite and the European red mite on apples. Although mites have been a serious pest on apples in Washington for many years, no satisfactory method of control has hertofore been found. Infestations present early in the spring are generally kept down by the regular codling moth spray program; the sprays, applied under high pressure, wash some of the mites off the trees. In July, when the codling-moth spray program tapers off, the mite infestations build up. At this time it is dangerous to use more than 0.75 percent of oil on the trees and this is not sufficient to kill both mites and eggs, for which about 1.5 percent of oil is necessary. The use of derris, with 0.5 to 0.75 percent of oil, increases the kill of mites somewhat, but does not kill the eggs; hence the infestation soon builds up again. Because of climatic conditions and the use of oil in codling moth sprays it is dangerous to use sulfur compounds for mite control in Washington.

Tetranychus telarius L.

The Experimental and Research Station of the Nursery and Market Garden Industries' Development Society Ltd., of Cheshunt, Herts, England (57), in 1934 reported tests with spray fluids, purporting to contain rotenone, for the control of the red spider mite on potted plants of Arum and tomato. A dosage of 1/2 fluid ounce of concentrate to 1 gallon of water was applied. On the Arum foliage about 1 percent of the adults remained alive 24 hours after spraying. On the tomatoes several adults and deutonymph resting stages were alive 12 days after spraying. Infested plants in a greenhouse were thoroughly sprayed with 7 fluid ounces of concentrate to 12 gallons of water. Ten days later a considerable number of mites were alive on the sprayed foliage. Tomato shoots infested with mites were sprayed with an emulsion consisting of 0.12 percent of rotenone, 5 percent of acetone, and 1 percent of saponin. After 24 hours all the mites appeared to be dead except one larva, which probably hatched after spraying had been finished. After 48 hours the following mites were collected: Dead, 5 females, many young stages; moribund, 3 females; alive, 1 female and 12 larvae. Five days after spraying many mites were alive and had migrated to the upper surface of the foliage. The conclusion reached was as follows:

"A reasonably good control on commercial nurseries is certainly not to be expected from sprays containing this substance [rotenone]."

The same station (58), in 1936 reported that many commercial derris sprays and dusts had been tried for the control of the red spider mite on young tomato plants. Dusts containing derris were without appreciable action on the mite, but several sprays containing emulsified derris extracts, or finely ground derris, together with a wetting agent, showed considerable toxicity to the mite in small-scale trials conducted early in the season. Control of the pest was obtained in February by two applications of these sprays to badly infested cucumber and tomato plants. Extended trials throughout the season, however, showed that a

satisfactory control of the pest was unobtainable during the summer, even if the same insecticides were applied at two or more times the strength found effective in the first instance. Consequently sprays containing derris as the active principle appear unlikely to replace petroleum-oil emulsions for general use, and further work is necessary before they can be recommended for use early in the season when risk of edema is greatest. This station (60), in 1938 reported that derris extract added to a petroleum-oil emulsion was more effective against red spider mites than derris only.

Miles and Miles (105) in 1935 reported that recent work had indicated that sprays containing derris or extract of pyrethrum may prove of value in controlling red spiders. Derris sprays were used extensively against red spiders on hops. With derris sprays there is no risk of injury to delicate plants. In this publication Polvosol was advertised by Cooper, McDougall, and Robertson, Ltd., Yalding, Kent, for the control of red spiders. Polvosol is a highly concentrated liquid preparation of derris, which kills at 1:400 and is particularly suitable for plants susceptible to edema.

Jary (79) in 1935 reported tests of insecticides against the red spider on hops. Indications were that the toxicity of a derris spray to the mite may be greater some hours after its preparation than when freshly prepared. A derris spray of 0.0056 percent of rotenone content and containing 0.036 percent of sulfonated Lorol appeared to give a complete control at the second application, whereas it failed to do so at the first. Jary (80) in 1936 again reported the results of spraying potted hop plants for control of this mite. Two derris extracts diluted to 0.005 percent and 0.002 percent of rotenone, respectively, were without appreciable effect when two applications were made with a knapsack sprayer. Pyrethrum extract also proved ineffective. Lime-sulfur 1:79 gave the best results in pot experiments, and proved successful in the field when a wetter was added.

Tetranychidae (unidentified species)

Carlos (41) in 1926 reported that red spiders are among the chief pests that can be easily exterminated by the application of insecticides containing derris or its products.

The Institute of Physical and Chemical Research (78) Tokyo, Japan, in 1927 reported that Neeton, at the rate of 1 pound per 80 imperial gallons of water, killed 100 percent of the red spiders.

Schmitt (134) in 1930 reported that dusting with dry powder of the finely pulverized root of Derris elliptica was not effective against red spiders.

Andries (5) in 1932 recommended Derrisol and Katakilla for use against red spiders in South Africa.

Kearns, Marsh, and Pearce (84) in 1933 reported that derris spray gives a good measure of control of the red spider. Commercial experience with derris as a means of controlling apple pests in England is limited and the results have been variable. The indifferent results are probably due to the use of too low a concentration of the toxic principle (rotenone). Derris is used mainly in two forms for the preparation of washes: Finely ground derris root added to a weak soap solution, and an oil emulsion consisting of a derris extract in a mineral or vegetable oil. The duration of effective toxicity after the application of some preparations may be several days, but critical data on this point are not available for apple pests. Derris dusts have not been used to any extent on apples.

Kearns, Marsh, and Martin (83) in 1935 reported trials carried out the previous year at Long Ashton, England, with combined sprays for the simultaneous control of the red spider, caterpillars, and the plum sawfly on plums. At Finvin trials were carried out on trees of the variety Czar. Double spraying was employed, and two types of spray were tested in the second application. For the first application, on May 11, 7 days after petal fall, the following mixed spray was used: Colloidal lead arsenate 2 pints, nicotine 8 ounces, lethalate wetting preparation 8 ounces, and water 100 gallons. The second application was made on May 29, when half the trees previously sprayed on May 11 received the following spray: Refined petroleum-oil emulsion 1.5 gallons, lead arsenate powder 4 pounds, and water 100 gallons. The remaining half of these trees was sprayed on May 29 with a derris-arsenate spray of the following composition: Ground derris root (2 percent crystalline rotenone) 2 pounds, lead arsenate powder 4 pounds, lethalate wetting preparation 8 ounces, and water 100 gallons. The control of the red spider was satisfactory in both types of treatment employed, and no foliage damage was recorded.

Van der Lean (90) in 1936 reported that Tetranychidae are sensitive to derris.

The East Malling Research Station, England (55) in 1936 reported that a proprietary derris powder was used in the routine spraying program in 1935 for the red spider on apples (1-1/4 pounds + 5 pounds of soft soap per 100 imperial gallons of water).

Steer (140) in 1936 published a summary of the use of derris as an insecticide in England. On damsons in 1934 derris and soap, applied on May 18, was substantially as effective as lime-sulfur for the control of red spiders. The reduction caused by these sprays in the amount of red spider injury, and the reduction in numbers of summer eggs subsequently laid on the leaves, was 92 and 97 percent, respectively. Derris showed great promise and is worthy of trial for the control of red spiders where lime-sulfur cannot be used with safety.

The University of Bristol, Agricultural and Horticultural Research Station at Long Ashton, England (16), in 1936 reported that derris was the most satisfactory spray for the control of the red spider.

writer

According to an anonymous/ (2) for the Long Ashton Research Station, the annual open day of the University of Bristol Research Station at Long Ashton was held on May 6, 1937, the control of the plum sawfly and the red spider was demonstrated by the use of combined sprays containing white-oil emulsion and rotenone-containing substances.

Kearns and Martin (85) in 1938 recommended a spray containing 0.67 gallon of actual oil and 1 pound of derris or Lonchocarpus ground root (rotenone 4 percent) to 100 gallons of water for the control of the plum sawfly. One drenching application made just before the hatching of most of the eggs controls not only the plum sawfly but also red spiders. An extract of Lonchocarpus nicou gave a more potent combined spray than did the powdered root.

The New Jersey Agricultural Experiment Station (112) in 1938 reported^{added} that derris or cube powder in water to which rosin-residue emulsion had been added killed the adults and young of several species of spider mites, but there did not seem to be much kill of the eggs.

The New Zealand Department of Scientific and Industrial Research (113) in 1940 reported that derris sprays, consisting of ground derris root in various concentrations, gave only partial control of red mites on apples. Derris products of this type cannot be regarded as suitable substitutes for summer oil.

Tyroglyphidae

Caloglyphus kramerii Berl.

Mills and Miles (105) in 1935 reported that dusting mushroom beds with derris and pyrethrum dusts may give some relief when an attack of mushroom mites (Caloglyphus kramerii Berl. is the most common) is severe.

Tyroglyphus longior Gerv.

The Experimental and Research Station (59) of Cheshunt, Herts, England, in 1938 reported that several dusts containing pyrethrum, derris, and nicotine were tried and found unsatisfactory for the control of Tyroglyphus longior in mushroom beds.

Unidentified species of Acarina

See Preston (123) under ticks, on page 41.

The Wageningen Plantenziektenkundige Dienst (153) in 1928 recommended Erysit [derris preparation?] and Phytophiline for the control of mites.

Schmitt (134) in 1930 reported that after being dusted with dry powder of the finely pulverized root of Derris elliptica, cats, dogs, rabbits, and chickens were freed from mites within 3 to 5 hours.

Bernales, Bambaren, and Maldonado (7) in 1932 reported on the therapeutic uses of cube in Peru. The first case of mange treated was one of generalized scabiosis, with an edema more or less diffuse, dyspneal, and oliguretic. Rubbings were given with a rotenone solution ("Sernol") as the only treatment, changing the underclothes of the patient as frequently as is customary in these cases. The sick person stated that from the first day of treatment the itching had diminished and by the third day the edema began to decrease and the diuresis to increase. By the sixth day there were no traces of dropsical phenomena and the skin affection had disappeared. In view of this result, the remedy was used on 20 more patients, including each sex and various ages and conditions, and it invariably effected a cure after 4 or 5 daily rubbings. In a case in which mange was complicated with skin lice the curative success in the two diseases was shown. "Piojol" (a proprietary rotenone preparation) not only kills the body louse (Pediculus humanus corporis Deg.) with certainty, but also destroys the eggs, or nits.

Hanson (72) in 1932 reported that a mixture of 1 part of fresh, finely ground derris root and 2 parts of flour, tac, or some other carrier, applied as a dust, is a good remedy for the control of the usual species of flea found on foxes. In discussing this paper C. W. Bower stated that good results against ear mites in foxes and cats had been obtained by swabbing the ears and bathing the head and neck in an 8- to 10-percent active solution of derris root. Generally one application was sufficient. Dr. Hanson replied:

As regards derris root for ear mites, Dr. W. L. Chandler, of Michigan State College, apparently was the first to introduce this drug as a remedy for ear mites. He proposed its use in a soap solution. This, like the aqueous solution, fails, however, to possess ability to cut and dissolve earwax, an ability which is a desirable, if not essential, property of an ear-mange remedy in order that it prove effective and practicable.

Götze (67) in 1933 compared derris suspension with oil of birch and another proprietary "Oil aa" for control of "Grabmilbenraude" [sarcoptic mange?] on 1-1/2-year-old bulls. This derris was applied as for warble fly larvae, and produced excellent results, with no disturbance to the health of the animals; whereas the oils, while giving equal control, produced reddening and swelling of the skin, as well as other general disturbances. The derris can be applied without sheering the animals.

Spoon (139) in 1933 concluded that rotenone can be of service in horticulture for the control of spider mites on various plants.

The Wageningen Plantenziektenkundige Dienst (154) in 1933 reported the results of tests on spider mites in the Netherlands. The derris powder used in the experiments contained 2 percent of rotenone, and was added to 50 parts of 1-percent soap solution (1 part rotenone to 2,500 parts of water). Pure rotenone was dissolved in 25 parts of acetone, and the acetone solution was added to 200 parts of water (1 part of rotenone to 5,000 parts of water).

The following results were obtained in 1932:

Rotenone concentration	Insect	Host	Result	Locality
1:5,000	Spider	Rose	No result	Aalsmeer
1:2,500	do.	do	do	Do.
1:5,000	do	Grape and pear	do.	Naaldwijk
1:2,500	do.	do.	do.	Do.
1:5,000	do.	do.	Unsatisfactory	Goes
1:2,500	do.	do.	do.	Do.
2 percent + 1 percent soap	do	Stringbean	Satisfactory	Amsterdam
Do.	do.	Cucumber	do.	Do.
1 percent + 1 percent of soap	do.	do	Not satisfactory	Do.

In 1934 the Wageningen Plantenziektenkundige Dienst (155) reported tests with rotenone and derris. Rotenone, with the addition of 0.1 percent of Agral I, was sprayed with the following results: At Amsterdam this material at the rate of 1:5,000 was satisfactory against mites on pears and mites on grapes; 1:5,000 was satisfactory against mites on pears and mites on grapes; 1:5,000 kills the mites but not the eggs, therefore repeated spraying is necessary. Rotenone, without the addition of Agral I, gave results as follows: At Pancras 1:10,000 against mites on grapes killed about 70 percent of the mites; at Naaldwijk 1:2,500 on nonbearing pears was satisfactory for control of mites; at Boskoop 1:5,000 did not give satisfactory control of mites in cucumbers, when sprayed during the day on May 27; and 1:5,000 0.1 percent of Agral I, sprayed during the day on June 6, was also unsatisfactory. When used at a concentration of 1:10,000 with 0.1 percent of Agral I, however, and sprayed in the evening on July 19, no living mites could be found on July 20. The same plot was sprayed in the evening regularly each week with rotenone 1:10,000 0.1 percent of Agral I. Cucumbers were harvested from this plot for 3 weeks longer than from the untreated plot, and commanded a higher price because they were practically free from insect injury. Alvesco derris dust did not give satisfactory results in the control of the "spint" (a mite) on grapes at Naaldwijk.

DeBussy, Van der Leen, and Jacobi (19) in 1935 reported the results of tests with derris powder and rotenone on a number of insects in the Netherlands. Thirty-two species were found to be sensitive to dusting with derris

powder containing 2 percent of rotenone, and 15 species were found to be not sensitive. Derris or rotenone suspensions at a concentration of 1:5,000 or 1:6,250 were effective in the control of "spintmijt" (a spider mite). At Utrecht Klarenbeek and others investigated the effect of derris on parasites of dogs, cats, and foxes and found that the prospects of using it successfully against mange mites appeared good. They advised that a watery extract be made by boiling the derris powder (2 percent rotenone) in 300 parts of water for half an hour, then adding a little soap to promote contact with the skin. The derris powder, mixed with 40 parts of French chalk, may be rubbed in and gives satisfactory results.

The United States Department of Agriculture, Bureau of Entomology and Plant Quarantine (150) in 1938 gave the results of much work with rotenone products. Tests made against mites and other pests in the mushroom houses at Beltsville, Md., with a number of drenches, including free nicotine (40 percent), nicotine sulfate (40 percent), alcoholic extract of pyrethrum (2 percent total pyrethrins), hellebore powder, and derris-root powder, demonstrated that the drenches containing free nicotine or the alcoholic extract of pyrethrum gave the best results, as judged by yield.

Moore et al. (108) in 1939 reported on the control of mites infesting apple trees in the State of Washington. Derris powder (3.6 percent rotenone) was extracted for 15 minutes with kerosene (1 lb. to 3 qt.) and this extract was added to the regular cryolite spray used to control the codling moth. The reduction of mites was 95.6 percent.

Ticks in General

Daniels (48) in 1905 reported that in British Malaya derris was known to be useful in destroying ticks on dogs.

Probably the earliest published account of the use of cube as an insecticide occurs in an article by Klinge (87) published 1910 at Lima, Peru. A translation from the Spanish is as follows:

At present I am studying and testing out a liquid for the control of ticks on llamas, of which I spoke in one of my recent letters. There is a plant here called "Cubé" in the Quechuan dialect, which is used for catching fish in dammed-up streams by poisoning the water with the root. From tests that I made * * * maceration produces an effective insecticide, which destroys the tick; but I do not know whether it will be toxic to the llamas, if these animals should take it internally, as would be the case in a dipping process. I am making solutions by crushing and maceration in various proportions, in order to find one, if possible, which kills the tick and is not poisonous to the llamas [when used] in quantities larger than 1 liter, which is the maximum that can be taken during a dipping bath.

Wood (171) in 1912 reported that a preparation made by soaking 2 pounds of crushed fresh derris root in 2 imperial gallons of boiling water for a few hours, adding 1 quart of this to 2 gallons of water, readily killed ticks on dogs bathed in it. Dogs suffering from mange should not be treated with derris solution.

On June 15, 1921, W. R. Allen wrote N. E. McIndoo, of the Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, that cube was used in Peru as a wash for killing parasites. He enclosed a snapshot which showed the washing of a cow to kill ticks.

The Institute of Physical and Chemical Research (78), Tokyo, Japan, in 1927 reported results obtained with Neoton at seven agricultural experiment stations in Japan. The following tests were made at the Animal Husbandry Experimental Station, Chiba, Japan: A solution of 1/2 pound of Neoton and 1 pound of soap in 20 imperial gallons of water was painted on the skin of nine calves of Holstein-Ayrshire strain. All ticks were killed within 28 hours. No injurious action on the calves was noted during and after the experiment. A solution of 1/2 pound of Neoton and 1 pound of soap in 24 or 28 imperial gallons of water killed all ticks on one mature and three young Yorkshire pigs 1 hour after application. This pamphlet on Neoton also records tests by Ito, of Bolivar, Argentina, who reported in 1926 that three or four applications of Neoton will exterminate skin diseases (sarna or kräze) of cattle, and that Neoton has been found to be the most effective of all the medicaments now being used in that country.

Howes (75) in 1930 wrote that an infusion of the roots of Tephrosia macropoda with water was commonly used by early settlers in Natal as a wash for freeing dogs from fleas and ticks.

The Kolonizal Instituut (88) of Amsterdam in 1930 stated that there is a good ground for believing that derris root contains active materials other than rotenone. For instance, some Sumatra root from which no rotenone could be obtained was active. Experiments were made at the Handelsmuseum of this Instituut to test the conclusions arrived at in other countries concerning the effectiveness of derris. When dipped in the emulsion, all ticks were killed.

Schmitt (134) in 1930 reported that cats, dogs, rabbits, and chickens were freed from ticks within 3 to 5 hours after being dusted with dry powder of the finely pulverized root of Derris elliptica.

Watt and Breyer-Brandwijk (157) in 1932 stated that the Zulus use Tephrosia macropoda as a vermin killer. The leaves of T. vogelii are said to be an efficient parasiticide against fleas, lice, and ticks, and are commonly used for this purpose by Europeans in Rhodesia. The Thongas use a decoction of the root of a species of Tephrosia (probably T. grandiflora) as a parasiticide. The preparation is said to have been used for the same purpose by transport riders in the early days of Natal.

Preston (123) in 1935 reported as follows on the use of cube:

In experiments in Peru a suspension of the ground dried roots of cubé [Lonchocarpus] in a solution of sodium carbonate proved a successful dip in control of ticks and mange mites on sheep. The treatment protected sheep from reinfestation with ticks for at least a week. Ticks survived for several days on a piece of fleece wetted with the liquid and kept moist, but died in a day on another piece of fleece similarly wetted but allowed to dry. It is, therefore, concluded that the drying of the wool and the body warmth assist the action of the poison. The amount of sodium carbonate must be varied according to the hardness of the water. Two applications, with a week's interval, of a mixture of 1 part of cube powder and 100 parts of oil cured mange on llamas.

Williams (168) in 1934 reported that the latex from the roots of Lonchocarpus nicou is used in the Andean highlands as a wash to kill ticks on cattle.

Meyer (102) in 1938 described the treatment of animals afflicted with scab by the use of timbo. A severe outbreak of scab among rabbits led to a trial of the toxic principle of timbo. The favorable results obtained led subsequently to the application of this substance in the treatment of various types of the disease in dogs, cats, swine, and other animals. A great improvement of the condition, and in many cases a complete cure, was obtained. The preparation used in the treatment of rabbits was an ointment made of 200 gm. of powdered timbo roots, extracted in 2 liters of ether for 2 days. Two hundred cc. of this solution was mixed with 1 kg. of vaseline, which produced an ointment slightly yellow in color. The application of this ointment was found to be preferable to washing, because it left the fur in better condition. On the other hand, dogs, cats, and swine were treated with a liquid solution of 400 gm. of the powdered roots dissolved in 1 liter of 95-percent alcohol, or 200 cc. of ethereal extract diluted in 800 cc. of 95-percent alcohol. Incidentally, with the treatment of the scab infection, a large proportion of the insect pests and ticks affecting these animals at the same time were destroyed.

Literature Cited

1. ANONYMOUS

1930. Powdered derris root. Pharm. Jour. and Pharm. [London] 124: 568.

2. -----

1937. Long Ashton Research Station. Nature [London] 139:874-875.
Noted in the Daily Digest, U.S. Dept. Agr., 65 (53): 2.

3. -----

1939. The scrub tick. Queensland Agr. Jour. 51 (1): 97.

4. ALABAMA POLYTECHNIC INSTITUTE

1935. The use of derris in controlling garden insects. Ala. Polytech. Inst. Cir. May 20, 1935, 2 pp. [Processed.]

5. ANDRIES, H. E.

1932. Controlling Plant Pests in Southern Africa. 199 pp., illus. Johannesburg.

6. BABCOCK, O. G.

1936. Ground devil's-shoestrings gives promise as a tickicide. U. S. Dept. Agr., Bur. Ent. and Plant Quar. News Let. 3 (4): 14. [Processed.]

7. BERNALES, J. V., BAMBAREN, C. A., and MALDONADO, A.

1932. Aplicaciones terapéuticas del cube o barbasco. Crón. Méd. Lima 49: 309-311.

8. BISHOPP, F. C.

1931. The brown dog tick, with suggestions for its control. U. S. Dept. Agr., Bur. Ent. E-292, 2 pp. [Processed.]

9. -----

1939. The brown dog tick, with suggestions for its control. U. S. Dept. Agr., Bur. Ent. and Plant Quarantine E-292, revised 3 pp., illus. [Processed.]

10. ----- and Smith

1938. Combating the American dog tick, carrier of Rocky Mountain spotted fever in the Central and Eastern States. U. S. Dept. Agr., Bur. Ent. and Plant Quar. E-454, 5 pp., illus. [Processed.]

11. ----- and SMITH, C. N.

1938. The American dog tick, eastern carrier of Rocky Mountain spotted fever. U. S. Dept. Agr., Cir. 478, 25 pp., illus.

12. BOYCE, A. M.

1936. The citrus red mite Paratetranychus citri McG. in California, and its control. Jour. Econ. Ent. 29: 125-130.

13. ----- and MAXWELL, K. E.

1938. The new citrus bud mite. Calif. Citrogr. 23 (3): 109, 152.

14. ----- and PRENDERGAST, D. T.

1938. Control of citrus red mite (spider). Calif. Citrogr. 23 (9): 370, 398-400.

15. BRANNON, L. W.

1940. Derris-pyrethrum-sulfur dust mixture effective against bean leaf beetle and associated insects on beans. U.S. Dept. Agr., Bur. Ent. and Plant Quar. News Let. 7 (7): 22. [Processed.]

16. BRISTOL [ENGLAND] UNIVERSITY

1936. Report on advisory work 1934-35. Bristol Univ., Agr. and Hort. Res. Sta. Ann. Rpt. 1935: 220-247.

17. BROOKS, A. N., WATSON, J.R., and MOWRY, H.

1932. Strawberry production. Fla. Univ. Agr. Ext. Bul. 63, 51 pp., illus.

18. BUSSY, L. P. de, LAAN, P. A. van der, and DIAKONOFF, A.

1936. Bestrijding van nederlandse insecten met derris. Tijdschr. over Plantenziekten. 42: 77-100, illus.

19. ----- LAAN, P. A. van der, and JACOBI, E. F.

1935. Resultaten van proeven met derrispoeder en rotenone op nederlandse insecten. Tijdschr. over Plantenziekten. 41: 33-50, illus. Also in Amsterdam Kolon. Inst., Afd. Handelsmuseum Ber. 91, 25 pp.; illus.; and Indische Mercur 58: 103-104, 119-121.

20. CALIFORNIA AGRICULTURAL EXPERIMENT STATION

1923. Insecticidal value of derris. Calif. Agr. Expt. Sta. Bien. Rpt. 1922-23: 132.

21. CALIFORNIA FRUIT GROWERS EXCHANGE

1935. Preliminary results of new citrus sprays against black scale. Calif. Fruit Growers Exch. Pest Control Cir. 11: 1-3.

22. -----

1936. So-called "non-oil" sprays. The use of Selocide in the Rivera-Downey-Whittier area. Calif. Fruit Growers Exch. Pest Control Cir. 20: 2-3.

23. -----

1936. Red spider. Calif. Fruit Growers Exch. Pest Control Cir.
21: 2.

24. -----

1937. Red spider persists in some areas. Calif. Fruit Growers
Exch. Pest Control Cir. 31: 2.

25. -----

1937. Red spider. Calif. Fruit Growers Exch. Pest Control Cir.
35: 2.

26. -----

1937. The red spider situation. Calif. Fruit Growers Exch. Pest
Control Cir. 36, 4 pp.

27. -----

1938. Red spider. Calif. Fruit Growers Exch. Pest Control Cir.
37: 4.

28. -----

1938. Importance of winter red scale treatment. Calif. Fruit
Growers Exch. Pest Control Cir. 38: 2-3.

29. -----

1938. Water rot again appears in oil-sprayed navel orchards. Red
spider. Calif. Fruit Growers Exch. Pest Control Cir. 39: 5

30. -----

1938. Present spider condition. Calif. Fruit Growers Exch. Pest
Control Cir. 41, 4 pp.

31. -----

1938. [Derris-oil.] Calif. Fruit Growers Exch. Pest Control Cir.
43: 4.

32. -----

1939. [Red spider.] Calif. Fruit Growers Exch. Pest Control Cir.
49, 4 pp.

33. -----

1939. Red spider.. Calif. Fruit Growers Exch. Pest Control Cir.
52: 3..

34. -----
1939. The summer pest control program. Calif. Fruit Growers Exch. Pest Control Cir. 55, 6 pp.
35. -----
1939. Red spider. Calif. Fruit Growers Exch. Pest Control Cir. 56: 2.
36. -----
1940. The citrus aphid. Calif. Fruit Growers Exch. Pest Control Cir. 64, 4 pp.
37. -----
1941. Red spider. Calif. Fruit Growers Exch. Pest Control Cir. 73, 4 pp.
38. -----
1941. Red spider. Calif. Fruit Growers Exch. Pest Control Cir. 75: 1
39. CAMERON, A. E.
1939. Insect and other pests of 1938. Highland and Agr. Soc. Scot. Trans. (5) 51: 136-174.
40. CAMPBELL, F. L.
1932. Review of information on the insecticidal value of rotenone. U.S. Dept. Agr., Bur. Ent. E-298, 28 pp. [Processed.]
41. CARLOS, A. S.
1926. Derris and its uses as an insecticide. Fert., Feed. Stuffs, and Farm Supplies Jour. 11: 161.
42. COLEMAN, S. H., and LYLE, C.
1940. Insecticides for greenhouse pests. Assoc. South. Agr. Workers Proc. 41: 116-117.
43. COMPTON, C. C.
1930. Greenhouse pests, a manual of practice in the control of insects and other pests attacking ornamental plants and flowers grown under glass in Illinois. Ill. Nat. Hist. Survey Cir. 12, 112 pp., illus.
44. -----
1931. Red spider control in greenhouses. Jour. Econ. Ent. 24: 1094-1097.

45. CONSUMERS' RESEARCH, Inc.

1937. Gardening. VI. Insecticides and fungicides. Consumers' Res., Inc., Gen. Bul. 3 (9): 13-20.

46. CRANE, D. B.

1933. Rotenone - A new parasiticide. Cornell Vet. 23 (1): 15-31.

47. CROSBY, C. R., CHUPP, C., and LEIBY, R. W.

1939. The control of diseases and insects affecting vegetable crops on Long Island. N. Y. Agr. Col. (Cornell) Ext. Bul. 278, revised, 87 pp., illus.

48. DANIELS, C. W.

1905. A plea for the scientific study of native drugs and poisons. Malaya Branch Brit. Med. Assoc. Jour. [Singapore] (n.s.) 2: 3-5. [Reviewed in Brit. Med. Jour. 2373: 1475.]

49. DARLEY, M. M.

1931. Some comparative tests with rotenone, nicotine, and pyrethrum. Jour. Econ. Ent. 24: 111-115.

50. DAVIDSON, W. M.

1924. Results of experiments with miscellaneous substances against the chicken mite. U. S. Dept. Agr. Bul. 1228: 5,7.

51. -----

1930. Rotenone as a contact insecticide. Jour. Econ. Ent. 23: 868-874.

52. -----

1930. The relative value as contact insecticides of some constituents of derris. Jour. Econ. Ent. 23: 877-879.

53. De ONG, E. R., and WHITE, L. T.W.

1924. Further studies of derris as an insecticide. Jour. Econ. Ent. 17: 499-501.

54. DOWSON, V. H. W.

1935. Notes on insecticide trials with date palms, Kut As-sayvid Estate, 1934. Hedar 8 (6): 174-175.

55. EAST MALLING RESEARCH STATION

1936. Routine spraying programme. East Malling [Kent] Res. Sta.
Ann. Rpt. (1935) 23: 22-25.

56. EASTMAN, D. A.:

1935. Follicular mange in dogs. North Amer. Vet. 16 (8): 44-47.

57. EXPERIMENTAL AND RESEARCH STATION, CHESHUNT, HERTS.

1934. [Rotenone.] Cheshunt Expt. and Res. Sta. Ann. Rpt. (1933)
19: 70.

58. -----

1936. Red spider mite. [Cheshunt] Expt. and Res. Sta. Ann. Rpt.
(1935) 21: 73

59. -----

1938. Derris. [Cheshunt] Expt. and Res. Sta. Ann. Rpt. (1937)
23: 61-65.

60. -----

1939. Derris. [Cheshunt] Expt. and Res. Sta. Ann. Rpt. (1938) 24,
108 pp.

61. FLORIDA AGRICULTURAL EXPERIMENT STATION

1929. Derrisol. Fla. Agr. Expt. Sta. Ann. Rpt. 1928: 5R-123R.

62. -----

1931. Derrisol. Fla. Agr. Expt. Sta. Ann. Rpt. 1930: 72.

63. GARLICK, W. G.

1929. Notes on the red spider on bush fruits, Tetranychus telarius
L. Ent. Soc. Ontario, Ann. Rpt. 59: 86-93.

64. GARMAN, P., and TOWNSEND, J. F.

1938. The European red mite and its control. Conn. (State) Agr.
Expt. Sta. Bul. 418, 34 pp., illus.

65. GNADINGER, C. B.

1933. Pyrethrum Flowers. 269 pp., illus. Minneapolis.

66. GONGGRIJP, I. H.

1929. Mijtenbestrijding op hevea kweekbedden. Arch. v. Rubbercult. Nederland.-Indië 13 (2): 79-97. Also in Alz. Proefsta. der A. V. R. O. S. Rubber Ser. 67: 19. Abstract in Expt. Sta. Rec. 62: 457.

67. GÖTZE, R.

1933. Über die Derriswurzel und ihre Anwendung zur Bekämpfung von Ektoparasiten bei Rindern. Deut. Tierärztl. Wchnschr. 41: 129-131.

68. -----

1933. Die Behandlung der Rinderräude mit Derris-Waschmitteln. Berlin. Tierärztl. Wchnschr. 49: 789-792.

69. HAMILTON, C. C.

1934. Control of spider mites on ornamental plants. N. J. Agr. Expt. Sta. Cir. 334, 4 pp.

70. -----

1938. Tests with derris powder or cube powder in rosin residue emulsion sprays for the control of shade tree insects. Natl. Shade Tree Conf. Proc. 13: 140-147.

71. -----

1939. Controlling house plant pests. N. J. Agr. Expt. Sta. Cir. 388, 4 pp.

72. HANSON, K. B.

1932. Parasites of ranch foxes and their treatment. Amer. Vet. Med. Assoc. Jour. 80: 202-212.

73. HEAL, R. E.

1936. Derris insecticides. VI. Summer control of European red mite on apple with derris and neutral wetting agents. Jour. Econ. Ent. 29: 550-556.

74. HOWARD, N. F., MASON, H. C., and DAVIDSON, R. H.

1935. Derris for the control of certain vegetable insects. Ohio Veg. Growers' Assoc. Proc. 20: 21-25.

75. HOWES, F. N.

1930. Fish poison plants. Kew Roy. Bot. Gard. Bul. Misc. Inform.
4: 129-153.

76. HUTSON, R.

1932. Tests show way to control raspberry mites. Mich. Agr. Expt.
Sta. Quart. Bul. 14 (3): 191-193.

77. -----

1933. Experiments on the control of mites infesting raspberries.
Jour. Econ. Ent. 26: 425-430.

78. INSTITUTE OF PHYSICAL AND CHEMICAL RESEARCH

1927. "Neoton" what it means to agriculturists. [Tokyo] Inst.
Phys. and Chem. Res. Bul. 12 pp.

79. JARY, S. G.

1935. Some observations upon the "Red spider", Tetranychus telarius
L., on hops and its control, with notes on some predatory
insects. Ann. Appl. Biol. 22: 538-543.

80. -----

1936. Further experiments on the control of the hop red spider
mite, Tetranychus telarius L. Ann. Appl. Biol. 23: 606-611

81. ----- and AUSTIN, M. D.

1938. Department of Entomology. Southeast. Agr. Col. Jour. 41:
9-14.

82. JONES, H. A., and DAVIDSON, W. M.

1931. Preparations containing rotenone for use as insecticides. I.
Aqueous suspensions. Jour. Econ. Ent. 24: 244-257.

83. KEARNS, H. G. H., MARSH, R. W., and MARTIN, H.

1935. Combined washes. Progress Report. Bristol Univ., Agr. and
Hort. Res. Sta. Ann. Rpt. 1934: 109-125.

84. ----- MARSH, R. W., and PEARCE, T. J. P.

1933. Experiments with combined insecticide-fungicide sprays for
apples. Progress Report Bristol Univ., Agr. and Hort.
Res. Sta. Ann. Rpt. 1932: 66-85.

85. ----- and MARTIN, H.

1938. The control of plum sawfly (Hoplocampa flava L.) Bristol Univ., Agr. and Hort. Res. Sta. Ann. Rpt. 1937: 78-84.

86. ----- and MARTIN, H.

1939. The position of combined washes in the post-dormant spray program. II. The use of post-dormant combined washes in fruit crops. Sci. Hort. [Wye, Kent] 7: 105-118.

87. KLINGE, G.

1910. Ligeros apuntes sobre el valle de Huancayo. [Peru] Min. de Fomento, Dir. Agr. y Ganad. 8 (2): 43-45.

88. KOLONIAAL INSTITUUT TE AMSTERDAM

1930. Toebea-wortel. Inlichtingen en onderzoekingen van de afdeeling handelsmuseum in 1929. Amsterdam Kolon. Inst. Afd. Handelsmuseum Meded. 26 (8): 91-99, illus.

89. KRANEVELD, F. C.

1936. Overzicht over proeven inzake de tekendoodende werking van derrisnoeder-extracten. Nederland. Indische El. v. Diergeneesk. 43: 97-102.

90. LAAN, P. A. van der

1936. Verslag ven de Negen-en-Zestigste Wintervergadering der Nederlandsche Entomologische Vereeniging, Amsterdam, February 23, 1936. Tijdschr. v. Ent. 79: 52-58.

91. LENFEST, R.E.

1926. Citrus comments. Citrus Indus. 7 (4): 20.

92. LESSER, M. A.

1940. Dermal parasitocides. Drug and Cosmetic Indus. 47 (1): 33-35, 37, 47.

93. LITTLE, V. A.

1931. A preliminary report on the insecticidal properties of devil's shoestring, Cracca virginiana Linn. Jour. Econ. Ent. 24: 713-754.

94. McINDOO, N. E., SIEVERS, A. F., and ABBOTT, W. S.

1919. Derris as an insecticide. Jour. Agr. Res. 17: 177-200.

95. Mac LEOD, J.

1933. The use of derris against the sheep tick. Scot. Jour. Agr.
16: 84-86.

96. Mac LEOD, J.

1938. The sheep tick (*Ixodes ricinus*) and its control in Great
Britain. Cooper Tech. Bur. Bul. 2, 27 pp., illus.
[Abstract in Rev. Appl. Ent. (B) 26: 108.]

97. MANSCHKE, R.

1937. Schädlingbekämpfung mit wässerigen Derrispulver-Lösungen.
Obst u. Gemüsebau 83 (4): 54.

98. MARNEY, U. E.

1932. Controlling the brown dog tick. North Amer. Vet, 13 (8):
22-24.

99. MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

1937. : [Derris.] Mass. Agr. Expt. Sta. Ann. Rpt. (1936) 339: 36-40
46-61.

100. -----

1938. [Derris.] Mass. Agr. Expt. Sta. Ann. Rpt. 1937
(Bul. 347), 99 pp.

101. -----

1939. [Derris.] Mass. Agr. Expt. Sta. Bul. 355: 40, 60, 63.

102. MEYER, J. R.

1938. Tratamento das sarnas dos animais pelo timbo. Biologico
4 (8): 257-261.

103. MICHIGAN AGRICULTURAL EXPERIMENT STATION

1931. [Derrisol.] Mich. Agr. Expt. Sta. Ann. Rpt. 1931: 11.

104. -----

1932. [Derris.] Mich. Agr. Expt. Sta. Bien. Rpt. Dir. 1932: 31.

105. MILES, H. W., and MILES, M.

1935. Insect pests of glasshouse crops. 174 pp., illus. Surbiton Surrey, England.

106. MIRONOFF, W., NABOKOFF, W., and KATCHALOVA, E.

1940. Derris and its insecticidal properties. Med. Parasitol. and Parasitic Dis. 9 (1-2): 106-108.

107. MOORE, J. B., GNADINGER, C. B., COULTER, R.W., and FOX, C.C.

1941. Control of Pacific mite and European red mite on apples. Jour. Econ. Ent. 34: 111-116.

108. ----- WEBSTER, R. L., GROVES, K., and FALLSCHEER, H.

1939. [Rotenone.] Investigations on codling moth and mite control Wash. State Hort. Assoc. Proc. 35: 95-105.

109. MORRIS, M. L.

1936. Demodex folliculorum (canis), its diagnosis and treatment. Amer. Vet. Med. Assoc. Jour, 28 (4): 460-474.

110. MORRISON, H. E., and MOTE, D. C.

1940. DN dusts on hops for control of the red spider. Jour. Econ. Ent. 33: 614-619.

111. MURPHY, D. F.

1936. Insecticidal activity of aliphatic thiocyanates. III. Red spiders and mites. Jour. Econ. Ent. 29: 606-611.

112. NEW JERSEY AGRICULTURAL EXPERIMENT STATION

1938. [Rotenone.] N. J. Agr. Expt. Sta. Ann. Rpt. (1938) 59: 46-47.

113. NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

1940. [Derris.]. New Zeal. Dept. Sci. and Indus. Res. Bul. 14: 65.

114. NORTH EAST OF SCOTLAND SHEEP TICK COMMITTEE

1939. North East of Scotland Sheep Tick Committee Report, 1938. 55 pp. Aberdeen.

115. O'BRIEN, H. R.

1940. Diary of a plain dirt gardener. Better Homes & Gardens. 19 (1): 10, 63.

116. OHIO AGRICULTURAL EXPERIMENT STATION

1934. [Rotecide.] Ohio Agr. Expt. Sta. Ann. Rpt. (1933)
532: 43.

117. -----

1936. Entomology. Ohio Agr. Expt. Sta. Ann. Rpt. (1935) 561:
43- 51.

118. PARISH, H. E.

1940. Sulfur-cube ineffective against brown winter tick. U. S.
Dept. Agr., Bur. Ent. and Plant Quar. Ext. Ent. 4(2): 14.

119. PENICK, S.C., and COMPANY

1936. Derris, the New Safe Insecticide. Ed. 4, 14 pp., illus.
New York.

120. PENNSYLVANIA AGRICULTURAL EXPERIMENT STATION

1938. [Derris.] Pa. Agr. Expt. Sta. Ann. Rpt. 1938 51: 59.

121. PETHERBRIDGE, F. R., and THOMAS, I.

1937. Spraying for plum sawfly. [Gt. Brit.] Min. Agr. and
Fisheries Jour. 44 (9): 858-865.

122. PETTIT, R. H., and HUTSON, R.

1931. The insect situation in Michigan. Ent. Soc. Ontario Ann.
Rpt. 61: 33-35.

123. PRESTON, H.

1935. El cube como parasitocida. [Peru] Dir. de Agr., Ganad.,
y Colon. Bol. 4 (13-16): 95-97. [Abstract in Rev. Appl.
Ent. (B) 23: 174.]

124. RICHARDSON, H. H.

1932. A preliminary study of the insecticidal efficiency of the
pyrethrins, nicotine, and rotenone against the greenhouse
red spider mite. Jour. Econ. Ent. 25: 592-599.

125. -----

1934. Studies of derris, nicotine, paris green, and other poisons
in combination with molasses in the control of the
gladiolus thrips. Jour. Agr. Res. 49: 359-373.

126. -----

1935. The effectiveness of various derris and cube products for control of the red spider on greenhouse plants. Jour. Econ. Ent. 28: 1076-1078.

127. RIES, D. T.

1935. A new mite (Neotetranychus buxi, n. s. Garman) on boxwood. Jour. Econ. Ent. 28: 55-62.

128. ROARK, R. C.

1938. Derris versus cube - Is cube equal to derris as an insecticide? Soap 14 (1): 111-113, 120.

129. ROBERTSON, W. H.

1939. Report of Horticultural Branch. Brit. Columbia Dept. Agr., Ann. Rpt. (1938) 33: 27-42.

130. ROSS, I. C.

1935. Tick paralysis: A fatal disease of dogs and other animals in eastern Australia. Austral. Council Sci. and Indus. Res. Jour. 8 (1): 8-13.

131. RUBBER SERVICE LABORATORIES COMPANY, Inc.

1934. The use of Aresco and Aresket in insecticidal sprays. GLH 634, 5 pp. [Processed.]

132. -----

1935. The use of Areskap and Aresket in insecticidal sprays. Rubber Service Laboratories Co., Inc., GLH 634, 5 pp. [Processed.]

133. SCHEINER, A.

1934. Versuche zur Bekämpfung der Rinderräude. II. Beitrag. Derris-präparate (Panderran und Derrisol), Aulin. 39 pp. Hannover. (Inaug.-Diss.)

134. SCHMITT, N.

1930. Derris elliptica Benth., ein vegetabilischer und ungiftiger Insecticidlieferant. Angew. Bot. 12: 453-463.

135. SCHROEDER, C. R.

1934. The snake mite (Ophionyssus serpentium Hirst). Jour.
Econ. Ent. 27: 1004-1014.

136. SMITH, C. L.

1937. Studies on the use of derris powder in the form of an
aqueous suspension. Canner 84 (5): 36, 38, 40.

137. -----

1939. Resistance of American dog tick to derris dips. U. S.
Dept. Agr., Bur. Ent. and Plant Quar. News Let. 6 (8):
20. [Processed.]

138. SMITH, D. W.

1938. Insecticidal effect of derris powder extracts. Econ. and
Trade Note No. 390, 2 pp. Batavia, Java.

139. SPOON, W.

1933. Het insecticide rotenon in de nederlandse praktijk,
eerste proefjaar. Amsterdam Kolon, Inst. Afd. Handels-
museum Ber. 83, 17 pp., illus. Also Indische Mercur 56
(51): 805-807.

140. STEER, W.

1936. Insecticides and fungicides. The use of derris root as an
insecticide. East Malling Kent Res. Sta. Ann. Rpt.
(1935) 23: 225-227.

141. STELLWAAG, F.

1938. Die Milbenkrauselkrankheit der Rebe und ihre Bekämpfung.
Piol. Reichsanst. f. Land u. Forstw. Flubgl. 102, ed. 2,
8 pp., illus.

142. STEWART, W. L.

1939. [Derris.] The tick problem. Vet. Rec. 51 (4): 33-38.

143. -----

1939. The economic importance of Ixodes ricinus L. (British sheep
tick). Vet. Jour. 95 (9): 341-349.

144. SWAN, D. C.

1934. The red-legged earth mite, Halotydeus destructor (Tucker) in South Australia: With remarks upon Penthaleus major (Dugés). So. Austral. Dept. Agr. Jour. 38 (3): 353-367.

145. THOMAS, C. C., and MILLER, E. E.

1940. Rotenone in the treatment of scabies. Amer. Jour. Med. Sci. 199 (5): 670-674.

146. TURNER, N.

1932. Notes on rotenone as an insecticide. Jour. Econ. Ent. 25: 1228-1237.

147. UNITED STATES DEPARTMENT OF AGRICULTURE

1940. Ticks and spotted fever. U. S. Dept. Agr. Employee Activ., Agr. Exch. 11 (17): 1-2. [Processed.]

148. ----- BUREAU OF ANIMAL INDUSTRY

1940. [Derris.] U. S. Dept. Agr., Bur. Animal Indus. Ann. Rpt. 1940: 81-82.

149. ----- BUREAU OF ENTOMOLOGY

1933. [Derris.] U. S. Dept. Agr., Bur. Ent. Ann. Rpt. 1933, 47 pp.

150. ----- BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

1938. [Derris.] U. S. Dept. Agr., Bur. Ent. and Plant Quar. Ann. Rpt. 1938, 84 pp.

151. ----- FOOD AND DRUG ADMINISTRATION

1936. [Derris.] U. S. Dept. Agr., Food and Drug. Admin., Ann. Rpt. 1936: 20-21.

152. VAN GUNDIA, G. K.

1936. Possibilities of dusting shade trees for pest control. Natl. Shade Tree Conf. Proc. 12: 161-167.

153. WAGENINGEN PLANTENZIEKTENKUNDIGE DIENST

1928. Het spint (roode spin). Wageningen plantenziektenkundige vlugschr. 36, 4 pp.

154. -----

1933. Rotenon en aftreksel van Derris elliptica (Akar toeba).
Wageningen Plantenziektenkund. Dienst Verslag. en Meded.
72: 96-99.

155. -----

1934. [Rotenone.] Wageningen Plantenziektenkund. Dienst Verslag.
en Meded. 76, 116 pp., illus.

156. WASHINGTON STATE COLLEGE

1940. Rotenone. Recommendations for codling moth and orchard
mite control in Washington for 1940. Wash. State Col.,
Ext. Serv. Bul. 252: 10.

157. WATT, J. M., and BREYER-BRANDWIJK, M. G.

1932. The Medicinal and Poisonous Plants of Southern Africa.
314 pp., illus. Edinburgh.

158. WEBSTER, R. L.

1932. Red spider control. Wash. State Hort. Assoc. Proc. (1931)
27: 17-21; Northwest Fruit Grower 3 (12): 8, 12, 15; and
Better Fruit 26 (8): 10-11.

159. WEIGEL, C. A., and JOHNSON, G. V.

1939. Control of red spiders on cucumbers. U. S. Dept. Agr.,
Bur. Ent. and Plant Quar. News Let. 6 (1): 20.
[Processed.]

160. ----- and JOHNSON, G. V.

1939. Glycerine and tartar emetic effective against red spider.
U. S. Dept. Agr., Bur. Ent. and Plant Quar. News Let.
6 (8): 20. [Processed.]

161. ----- and JOHNSON, G. V.

1939. Control of red spider on greenhouse cucumbers. U. S.
Dept. Agr., Bur. Ent. and Plant Quar. News Let. 6 (11):
24. [Processed.]

162. ----- and JOHNSON, G. V.

1940. White-oil emulsion more effective than sulfonated castor
oil as spreader for derris-pyrethrum spray against red
spider. U. S. Dept. Agr., Bur. Ent. and Plant Quar.
News Let. 7 (10): 17-18. [Processed.]

163. ----- and NELSON, R. E.

1937. Control for red spiders and thrips on tomatoes and cucumbers. U. S. Dept. Agr., Bur. Ent. and Plant Quar. News Let. 4 (12): 21. [Processed.]

164. ----- and NELSON, R. E.

1938. Insecticidal tests against red spiders and thrips on greenhouse tomatoes and cucumbers. Jour. Econ. Ent. 31: 211-216.

165. ----- and RICHARDSON, E. E.

1935. Proportion of sulfonated castor oil is important factor in effectiveness of derris sprays against red spider. U. S. Dept. Agr., Bur. Ent. and Plant Quar. News Let. 2(11): 21 [Processed.]

166. WEINRICH, F.

1933. Versuche zur Bekämpfung der Raude bei Rindern mit Derrispräparaten. 40 pp. Hannover. (Inaug.-Diss.) [Abstract in Milchw. Literaturber. 112: 411.]

167. WILLE, J., ORAMPO, J. A., WEBERBAUER, A., and SCHOFIELD, D.

1937. El cubé (*Lanchocarnus nicou*) y otros barbascoos en el Peru. Lima, Peru, Estac. Expt. Agr. de La Molina. Bol. 11, 117 pp., illus. [Abstract in Rev. Appl. Ent. (A) 25: 760-761.]

168. WILLIAMS, L.

1934. A Peruvian fish poison. Field Museum News 5 (6): 4.

169. WILSON, J. W.

1931. The two-spotted mite (*Tetranychus telarius* L.) on *Asparagus plumosus*. Fla. Agr. Expt. Sta. Bul. 234, 20 pp.

170. WINSTON, J. R.

1926. Derrisol, a new aphid spray. Citrus Indus. 7 (3): 32.

171. WOOD, W. L.

1912. Tuta root. Fed. Malay States Dept. Agr. Bul. 1: 164-166.

172. YOTTERS, W. T., and KECK, C. B.

1930. Red spider in Florida plumosus ferneries. South. Florist & Nurseryman 29 (25): 7-8, 24.

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