D. INSECT CONTROL AND INSECTICIDES

A Coordinated Research Effort Toward Insect Control

L. A. Carruth

Experiment station

Insect pests annually destroy an estimated 20 percent of the Arizona cotton crop, equal to two-thirds of a bale per acre, in that one-third of the acreage where no control applications are made. This loss, plus the expense of control in the remaining acreage, averages about 16 million dollars per year in Arizona, or about 14 percent of the value of the crop actually harvested.

Nineteen species or species groups of insects and mites are listed as pests in the latest Arizona insect control recommendations although numerous additional species are of occasional or minor importance. The most serious pests are lygus bugs and bollworms. Other major pests include the beet armyworm, cotton leaf perforator, salt marsh caterpillar, and thrips. The pink bollworm and western boll weevil have recently become more abundant and may become increasingly important as pests in Arizona. Significant problems have arisen which involve the effects on the surrounding environment following the application of pesticides for the control of cotton insects.

Research at least partly involving cotton insects is conducted in 11 of the 18 projects of the University of Arizona Agricultural Experiment Station, Department of Entomology and approximately 4 professional staff man years (M.Y.) are now devoted to this cotton-oriented research. In addition a large and expanding cotton insect research program is maintained in Arizona by the U.S. Department of Agriculture. There is close cooperation by the research staff at the University of Arizona with members of the USDA research staff and with the Extension Service entomologists in the state.

The following Experiment Station projects in Entomology have a major or supporting relation to cotton:

Project 383 Biology and control of insects affecting cotton in Arizona.
575 Ecological factors affecting the abundance and cultural control of the pink bollworm.
404 Insect parasites and predators of insect pests of Arizona crops.
594 Evaluation and augmentation of biological control agents to augment or supplement pesticides.
416 Total fate of insecticides in plants.
542 Pesticide residues: their nature and persistence on Arizona crops.

-56-
596 Pesticide application equipment in relation to drift of pesticides.
602 Effects of ambient pesticides on the marketability of animal feeds, animals and animal products.
466 Taxonomy of Arizona economic insects.
607 Plant feeding mites of Arizona.

The more important Experiment Station works relating to cotton insects during 1965 are summarized in this report.

U.S.D.A.

An increasing amount of cotton insect research in Arizona is being conducted by the Cotton Insects Research Branch, Entomology Research Division, A.R.S., U.S.D.A. Much of this work involves basic and technical studies of regional and national importance. A portion of this work involves the active cooperation of the Department of Entomology, University of Arizona Agricultural Experiment Station.

This federally supported research has been centered at Tucson at laboratories located adjacent to the Allen Road Farm of the Experiment Station, with an additional worker (L. U. Sheets) stationed at the Experiment Station Cotton Research Center, Phoenix, for field control studies in cooperation with Dr. George P. Uene. Mr. G. T. Bottger was in charge of the program until his retirement at the end of 1965. Dr. R. E. Fye is now in charge of the program at Tucson. Since October 1965 Mr. John C. Keller has been in charge of the program at Phoenix, with headquarters at the Cotton Research Center, where plans for a recently approved U.S.D.A. cotton insect research laboratory are being developed. The 1965 research program in Arizona included projects under the following major areas of interest: development of more effective insecticides and formulations and development of non-chemical control methods.

* * * * *

Biology and Control of Insects Affecting Cotton in Arizona

George P. Uene, with L. W. Sheets, U.S.D.A., A.R.S.

Objectives

A. To study the field ecology of important cotton pests.
B. To make field tests of insecticides and to develop practical and effective cotton insect control programs.
Soil applications of systemic insecticides

A granular formulation of Union Carbide 21149 (Temik), applied at one pound per acre in the seed bed, gave better thrips control than either phorate or Di-Syston granules applied at the same rate.

Soil applications of Union Carbide 21149 (Temik), side-dressed during the first week of June at the rate of 2.4 pounds per acre, gave excellent control of lygus bugs and black fleahoppers. Predatory insect populations were also reduced. Di-Syston, phorate and Niagara NIA-10242, when similarly applied, failed to control lygus bugs or black fleahoppers.

Phorate granules applied with cotton seed by a spacer-planter gave effective thrips control with one-fourth the commonly recommended dosage of 10 pounds of the 10 percent granules. The cotton seed was spaced nine inches apart in the row and the granules were applied only in the seeded areas.

Light traps

Light traps again failed to control lygus bugs.

Low volume sprays

Technical malathion applied at 1 pint (1.25 pounds) per acre gave excellent control of lygus bugs and thrips, but accentuated bollworm infestations. Salt marsh caterpillar infestations increased in a field which received repeated applications of malathion.

TDE (Rothane) applied at the rate of 3 pounds per acre as a low volume spray gave excellent control of bollworms but created a mite problem. Applying TDE at this rate from a height of 6 feet above the cotton plants (instead of the usual 20 feet) resulted in a severe leaf drop caused by insecticide injury. A low volume mixture of 1 pound of malathion plus 1 pound of TDE per acre gave excellent lygus bug control but failed to control bollworms. Good bollworm control was obtained by doubling the application rate of the mixture. The low volume mixture of malathion-TDE also created a spider mite problem.

A low volume concentration of trichlorfon (Dylox) at one pound per acre gave excellent lygus bug control.

Naled (Dibrom) gave excellent control of lygus bugs when applied at the rate of 0.5 pounds per acre. Repeated applications resulted in severe leaf injury. Naled failed to control bollworms when applied as a low volume spray.

A low volume ground sprayer developed by the Chapman Chemical Company was effective in controlling lygus bugs and bollworms with a total spray volume of 1.5 or 2 gallons per acre.
Conventional aerial spray experiments

In three experiments a bollworm virus applied at the rate of 100 larvae per acre failed to control bollworms.

Methyl parathion at one pound per acre, applied on a 4-day schedule, gave excellent control of bollworms. The addition of commercial molasses to the spray mixture at the rate of 1 gallon per acre did not increase to the effectiveness of methyl parathion against bollworms.

Good control of lygus bugs was obtained with Azodrin applied at 0.5 pounds per acre on a 8-day schedule. Azodrin at one pound per acre, as a dust (2.5 percent) or as a spray, gave excellent control of bollworms when applied on a 4-day schedule. Extending the intervals to 8 days between applications created a bollworm problem which was very difficult to control. Azodrin at one pound per acre gave excellent control of salt-marsh caterpillars.

As in past years, toxaphene or Strobane at the rate of 6 pounds per acre gave commercial control when applied on an 8-day schedule.

A 10 percent Banol dust gave commercial control of bollworms when applied on an 8-day schedule although a mixture of 4 pounds Strobane with 2 pounds of DDT gave more effective control. A severe spider mite infestation developed after 4 applications of the Banol dust.

* * * * *

Precision Placement of Systemic Insecticides

M. D. Cannon and George Hene

Previous pilot tests have indicated that it is possible, when hill-drop planting, to meter systemics into the hills and leave the intervening area untreated. If practicable, this would enable the grower to do one of two things, (1) cut down on the amount of material, or (2) apply the same amount more effectively by using it in the immediate area of the seeds. The latter choice might not be the better with phytoxic materials.

This test was designed to determine the effects of dropping Thimet into the hills at varying rates and ascertain, (1) any phytoxic effects on the cotton plants, and (2) the effectiveness of insect control. Four granular applicators were mounted on a four-row planter so that granular Thimet could be fed into the rotary hill-drop mechanism.

A ten percent formulation was used at four rates per acre, 2.5, 5.0, 10.0 and 20.0. The recommended application rate is 10.0 pounds per acre.
Thrip counts were made on May 12, May 19 and May 26. Stand counts were made on May 4. Additional measurements were made of plant height, number of squares and width of largest true leaf.

Table I shows the results of the stand and thrip counts. No differences were found in the other attributes.

Table I. The Effects of Applying Thimet in the Hills with the Seeds when Planting to a Stand

<table>
<thead>
<tr>
<th>Pounds of Thimet per Acre Planted</th>
<th>A. Thrip Counts/100 plants</th>
<th>B. Stand Counts 1.000/Acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>May 12</td>
<td>1.25</td>
<td>3.50</td>
</tr>
<tr>
<td>May 19</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
<td>3.75</td>
</tr>
<tr>
<td>May 26</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>51.25</td>
<td>66.25</td>
</tr>
</tbody>
</table>

The results of this test indicate that the lower rates of .25 and .5 pounds technical Thimet per acre are as effective in controlling thrip as the higher rates. Stand counts however, show that any of the rates in excess of .25 pounds reduced the stand slightly. It would seem then, that this system of application would allow the grower to cut his application to 1/4 the recommended rate and still have thrip control. It might also be concluded that this technique would require that he reduce his application rate to about 1/4-normal to avoid damage to the stand.

***

Thimet and Disyston Give Good Systemic Control of Insects on Seedling Cotton

Sam Stedman

A demonstration using systemic granules applied at planting resulted in vigorous growing plants, which gave young seedling cotton a good vigorous start. The 1965 cotton season had a cold spring and even low populations of thrips and other early insects affected the growth of seedling cotton plants.
Two fields, one using granular disyston and the other using no systemic granules, were compared:

May 18

<table>
<thead>
<tr>
<th>Field A Disyston Treated</th>
<th>Field B Untreated</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Insects</td>
<td>No. of Insects</td>
</tr>
<tr>
<td>_________________________</td>
<td>__________________</td>
</tr>
<tr>
<td>Thrip....................</td>
<td>4 ..................</td>
</tr>
<tr>
<td>Spider....................</td>
<td>0 ..................</td>
</tr>
<tr>
<td>Lady Beetle..............</td>
<td>0 ..................</td>
</tr>
<tr>
<td>Pirate Bug..............</td>
<td>0 ..................</td>
</tr>
<tr>
<td>Black Fleahopper.........</td>
<td>0 ..................</td>
</tr>
<tr>
<td>Big Eyed Bug.............</td>
<td>0 ..................</td>
</tr>
<tr>
<td>Total Insects on 10 Plants</td>
<td>4 ..................</td>
</tr>
</tbody>
</table>

Conclusions:

The application of disyston gave seedling plants a better start as shown by the fewer number of distorted leaves and terminals. The untreated field B showed heavy terminal distortion. Black fleahoppers, adults and nymphs, were probably responsible for as much of this terminal distortion as thrips. Disyston also did a good job of controlling black fleahoppers as shown by the absence of fleahoppers on disyston treated Field A.

Some growers feel that a second irrigation activates the granules and causes a lengthening of control by the granules. Observation showed that this is not true. It is also questionable if systemic granules give five or six week control of insects. Because untreated Field B was controlled with a chemical spray, it is difficult to come to any valid conclusions on that point at this time.

* * * * *

Ecological Factors Affecting the Abundance and Cultural Control of the Pink Bollworm

George P. Wene

Objectives

A. Study environmental factors influencing behavior and abundance of the pink bollworm.

B. Investigate physical, mechanical, cultural, chemical and biological agents as possible control measures under Arizona conditions.
Highlights of 1965 investigations

Spring moth emergence was significantly reduced by burial of pink bollworm infested bolls to a depth of 12 inches, or by burying infested bolls 4 inches and planting burley with suitable irrigations.

Cage tests in a heavily infested field of growing cotton showed that an average of 5400 moths emerged from the soil between September 15 and October 15. Cage tests showed that pink bollworm adults emerged in numbers until November 1 at Safford and until November 27 at Phoenix.

First instar larvae were observed on Nov. 15 near Phoenix, indicating that pink bollworms were still in an active stage of growth. A majority of the larvae did not enter diapause until the end of September and not until November were 90 percent of the larvae in diapause. The percentage of pink bollworm larvae in diapause was about the same for both the lower and higher elevations.

Six insecticide applications applied to a heavily infested field between September 15 and October 15 significantly reduced the number of larvae per boll in the top crop.

In Maricopa County heavy infestations were observed as early as July 5 in a number of stub cotton fields. Damaging infestations were observed in "stub" fields by October 1. As practically all farmers were trying to produce a late top crop of cotton, the plants still had a good set of half grown bolls as late as November 15. In the Mesa-Queen Creek area from one to three larvae were found in most of the developing bolls on November 15. This indicated the possibility of a large winter carry-over of pink bollworms. If the winter months are dry, one may expect a large spring moth emergence capable of producing increased numbers of pink bollworms to threaten the 1966 cotton crop, especially the bolls maturing after September 15. Because of population increases in the stub cotton fields during 1965 one can expect earlier and more severe damage in stub fields during 1966. Therefore it will be to the growers' advantage to eliminate stub cotton fields.

* * * * *

Insect Parasites and Predators of Insect Pests of Arizona Crops

George D. Butler, Jr. and Floyd G. Werner

Objectives

A. To determine the identity, distribution, relative abundance, host relationships, and life histories of representative common and significant species of insect parasites and predators in various taxonomic groups.
To evaluate by field and laboratory studies the relative effectiveness of the more common species of insect parasites and predators in controlling insect pests of important Arizona crops. To study the life histories of the more effective species and the various factors that influence their abundance.

**Highlights of 1965 work**

The effectiveness of 19 species of predatory insects as destroyers of bollworm eggs was studied under controlled laboratory conditions. The most effective predators of bollworm eggs belonged to the genera Geocoris, Nabis, Collops, and Chrysopa (larva). Other potential predators included Spenognoncus, Orius, Hippodamia, and Notoxus.

The life cycle of the lacewing Chrysopa carnea was studied in detail. Fourteen larvae of this species ate an average of 280 bollworms each during their larval development.

The most effective predators against larvae of the beet armyworm and bollworm in laboratory tests were Geocoris punctipes (1st instar), Collops (adult), Zelus (2 species), Hippodamia, and Geocoris pallens.

**Evaluation and Augmentation of Biological Control Agents to Replace or Supplement the Use of Pesticides**

George D. Butler, Jr.

**Objectives**

A. To determine the role of parasites, predators and pathogens of phytophagous arthropod pests in agricultural environments.

B. Assess the influence of environmental factors, both natural and artificial, on the effectiveness of parasites, predators, and pathogens in suppressing pests.

This was the first year on this new project. Techniques for collecting and rearing parasites of lepidopterous larvae were developed. A field trap for collecting parasites in crop areas was designed and used effectively.

The development of the bollworm and beet armyworm in relation to temperature were determined in the laboratory. Similar studies were made of the rates of development of two species of Cheionus (hymenopterous parasites of caterpillars).

Rearing methods were developed for several species of tachinid (dipterous) parasites attacking the bollworm and beet armyworm.

**-63-**
Boll Weevil Investigations

R. E. Fye and Adair Stoner

During the cotton seedling stage covering the period from April 9 to May 31, 1965, 11 fields in Yuma County, 12 in Pinal County, 5 in Maricopa County, 10 in Pima County, and 6 in Santa Cruz County were examined to detect overwintering adult boll weevil populations. No weevils were detected in the seedling cotton during two or more inspections of each field.

During the same period a number of adult weevils were found in a field of stubbed cotton in Yuma County. For the remainder of the growing season 7 fields in Yuma County, 7 in Pinal County, 5 in Maricopa County, 5 in Pima County, and 6 in Santa Cruz County were examined at about weekly intervals to determine the infestations present. From the data we may conclude that Anthonomus sp. is present in most cotton growing areas of Arizona and may under proper conditions, as yet undetermined, reach damaging levels.

Heavy boll infestations developed in a stub study field in Yuma County, in all of the study fields in Pinal County, and in 2 of the study fields in Pima County and caused heavy losses. Generally speaking Anthonomus sp. was prevalent in varying numbers throughout the cotton growing areas of Arizona, with the exception of Western Yuma County at the time of frost.

Of particular interest is a major infestation which occurred on one ranch in Yuma County during the entire season. This infestation was generally restricted to 600 acres of stub cotton on the ranch but late in the season a light infestation developed in nearby planted cotton. Early applications of insecticide in the stub field were effective but a lapse in the applications during early July enabled highly damaging infestations to develop. These heavy infestations, complicated by infestations of other cotton damaging insects, necessitated ten additional applications of insecticide on a total of 900 acres of cotton. These applications reduced the infestation in the stubbed cotton considerably and apparently prevented a major migration to the planted cotton.

Also of concern was the development of a damaging infestation in planted cotton near Stanfield in Pinal County in the latter part of July. Several applications of insecticide brought this incipient infestation under control but the experience indicates that the boll weevil may appear sufficiently early in the season to cause appreciable damage in planted cotton. Effect of neglect of late season populations was also emphasized in the fields of a grower in the Stanfield area.

Due to the later defoliation of these fields the foliage remained green after many of the adjacent fields had been defoliated or desiccated. Apparently a major migration from these nearby fields occurred and the invasion into the green fields caused a loss of about 40% of the top crop of bolls and resulted in a population of from 80-100 thousand immature weevils per acre in the bolls at the time of frost. It is suspected that this form of
weevil may successfully overwinter in the cells in these bolls, thus empha-
sizing the need for early stalk destruction and plow up.

Other major infestations occurred in fields not included in the survey. The most severe infestation brought to our attention was near Agua Caliente in Maricopa County. The infestation in this field of stubbed long staple cotton reached damaging levels in July and six applications of insecticide were made. A small crop was made but the developing bolls in late season were infested with from 3 to 10 immature weevils with uninfested bolls a rarity. The remainder of the heavy infestations occurred in late season and were damaging to late developing bolls. This survey indicates that:

(1) The most damaging infestations occur in stubbed cotton.

(2) Damaging infestations can develop early enough to cause losses in planted cotton.

(3) Severe losses of bolls can occur in late season due to late developing infestations.

* * * * *

Laboratory Insecticide Tests

Raymond F. Patana and G. T. Bottger

The insecticidal properties of sixty-one candidate insecticides were tested as sprays on potted cotton plants with third-instar beet armyworm larvae. Four materials showed promise. The insecticidal properties of fifty-one candidate insecticides were tested as sprays on potted cotton plants with adult lygus bugs. Fifteen of these materials showed promise. The insecticidal properties of fifty-eight candidate insecticides were tested as sprays on potted cotton plants with third-instar salt-marsh caterpillar larvae. Ten of the materials showed promise. Promising materials will be considered for further testing as appropriate.

* * * * *

Systemic Insecticide Tests Against Lygus Bugs

R. A. Champlain and L. L. Sholdt

Bioassay tests were conducted in small plots and greenhouse tests to determine the effectiveness of stem and soil systemic treatments against lygus bugs on cotton. The materials which were tested were Union Carbide UC-21149 and Shell Chemical Company's Azodrin. Both of the materials tested gave lygus bug control, the main differences being speed of uptake and persistence. The Azodrin stem application gave the highest control from 2 to 9 days and the granular side dress applications were most effective between about 9 and 20 days, with the 2 pound rate still giving 84
percent kill after 27 days. Irrigation increased the effectiveness of the granules at both application rates.

In greenhouse tests lanolin formulations of Azodrin and UC-21149 were applied to squaring cotton plant stems and tested against adult lygus bugs. Azodrin gel formulations, and a UC-21149 10 percent granular formulation were also tested. These tests show a similarity to the field test results.

Azodrin treatments gave somewhat higher mortalities in greenhouse tests than in small plot tests but highest mortalities were also recorded between 2 and 9 days after treatment for both the lanolin and gel formulation. In the greenhouse tests there was a more gradual drop-off of insecticidal activity. In greenhouse tests with the UC-21149 lanolin and granular formulations all gave quite comparable results at 2 and 9 days after treatment, but there was a greater drop-off of activity at 16 days with the 2.5 mg lanolin and 1 pound granules. The UC-21149 granules used at 2 pounds still gave 90 percent mortality at 26 days.

* * * * *

The Effect of Gossypol on Larval Development

G. T. Bottger and R. F. Patana

Different concentrations of gossypol acetic acid were incorporated into a diet and fed to larvae of 4 species of cotton pests. The larvae were reared individually and records were kept of mortality, 10-day weights, length of larval periods, and length of pupal periods. Check larvae were reared on plain diet. Likewise several concentrations of acetic acid were incorporated into the diet to determine any effects on larval development. The acetic acid did not have any noticeable effects on the 4 species of larvae at the concentrations tested. The results from these tests are given below.

**Bollworm**

There was complete larval mortality at the 0.35% gossypol level and the average 10-day weights were noticeably smaller for all the gossypol levels than for the check. The average number of days to pupation ranged from 15.4 in the check to 41.6 days for the 0.3% gossypol level. The average number of days to moth emergence ranged from 26.7 at the 0.025% gossypol level to 50.0 days for the 0.3% level as compared to 27.1 for the check.

**Beet armyworm**

At the 0.3% gossypol level there was a 100% larval mortality and there was a noticeable effect on mortality down to the 0.15% level. With the
10-day larval weights there seems to be a direct relationship between the weight of the larvae and the amount of gossypol added to the diet, going from an average of 1.6 mg for the 0.3% gossypol larvae up to an average of 179.9 mg for the check larvae. As with the larval weights, there seems to be a direct relationship between the length of pupation and emergence time to the gossypol concentration. The average length of pupation time at the 0.2% level is 2.5 times greater than that of the check, and for the average emergence time about two times greater than that of the check.

Salt-march caterpillar

At the 0.5% gossypol level there was an 88% larval mortality and the average 10-day weight was almost 10 times smaller than for the check larvae. The pupation time of larvae reared at the 0.5% gossypol diet was more than two times as long as for the check larvae. This added time carried through to moth emergence where the average time was 77.4 days as compared to 37.5 days for the check.

Cabbage looper

The 0.2% level was the highest gossypol concentration at which any larvae survived to pupation. The average 10-day weight at the 0.2% concentration was only 3.6 mg as compared to 196.7 mg for the check larvae. Above the 0.2% level no larvae pupated and at this level the average time for pupation was 33.5 days as compared to 13.9 days for the check and average moth emergence time was 41.9 days as compared to 20.5 days for the check.

* * * * *

The Effect of Temperature on Development of the Immature Stages of *Lygus hesperus* Knight

R. A. Champlain and L. L. Sholdt

A temperature of 40°C. is lethal to the egg stage of *Lygus hesperus*. Constant temperatures of 10°C. prevent hatching of eggs, but that hatching will occur if the temperature rises above the 10°C. mark for half the time. In general, between the limits 15° to 35°C., the mean hatching time decreases as the temperature increases. The nymphal data agree quite well with the egg data, in that the time required for nymphal development decreases as the temperature increases, within the limits of 10°-35°C.

Field population studies on lygus bugs and predators in Arizona.

*Lygus hesperus* is the major pest species in Arizona. *L. elisus* is evenly distributed over the state (9% western vs. 12% eastern). *L. hesperus* is more prevalent in the west (87% western vs. 69% eastern) while *L. lineolaris* is more prevalent in the east (4% western vs. 20% eastern).
This is consistent with the fact that *L. hesperus* is displaced as the major pest species by *L. lineolaris* in states lying east of Arizona.

The superb plant bug, *Adelphocoris superbus* occurred in eastern samples but none were taken in western samples.

*Orius* spp. and *Geocoris* spp. were the predators found in greatest numbers.

* * * * *

**Pesticide Research Projects**

L. A. Carruth

Pesticides are used in greater amounts on cotton than on any other crop grown in Arizona. The following four pesticide projects summarized below are therefore directly or indirectly related to cotton. The author is temporarily in charge of these projects pending the arrival of a new project leader.

* * * * *

**The Total Fate of Some Polychloro Alicyclic Insecticides in Plants Under Controlled Conditions**

L. A. Carruth

**Objectives**

To determine precisely the routes of dissipation of an insecticide from a plant. The amounts and nature of the products disappearing by volatility, metabolic changes, translocation, and growth dilution will be precisely determined in a way which will account for the total amount applied. This fundamental project is particularly relevant to this review because by far the greatest use of pesticides in Arizona is related to the control of insects affecting cotton.

**Summary of progress**

An air sampling system suitable for measuring insecticide vapor in air from controlled laboratory experiments and field environment applications was devised. Vapor losses of representative pesticides have been determined from artificial and natural surfaces and at different temperatures. This work is continuing. Rates of loss from artificial systems differed from rates from actual plant surfaces. Relevant explanations are being sought.
The capability of plant tissue to metabolize DDT to DDE has been indicated, but has not been unquestionably established.

* * * * *

Pesticide Residues on Arizona Crops

L. A. Carruth

Objectives

This state supported project included fundamental and practical investigations related to Arizona pesticide problems not covered in other projects. The project has the cooperation of the Department of Dairy Science, United Dairymen of Arizona, Arizona Farm Bureau Federation, Arizona Agricultural Chemicals Association and Arizona State Department of Health. As an exploratory project it includes preliminary work which may later lead to new projects. The main objectives are:

A. Determination of the nature and persistence of residues of pesticides used on Arizona crops to insure that control recommendations are in conformity with prevailing legal restrictions.

B. To study effects of pesticide applications, including pesticide drift and resultant effects on forage, milk, animal products, vegetables and other factors in the environment. (A portion of this work has recently been transferred to a new project, No. 596.) (Another portion has recently been transferred to new project 602.)

C. To conduct needed pesticide investigations not covered under other projects.

Summary of progress

Recent work has included studies of the dissipation of DDT, endrin, and parathion from lettuce, and DDT, Carbaryl (Sevin), and diuron from cotton. Pesticide drift studies have included comparisons of drift of aerial applications of sprays versus dusts, conventional sprays versus thickened sprays, and morning spray applications (high inversion) versus afternoon applications (normal lapse rate).

The level of DDT and its metabolites was determined in the milk of cows which had been treated with DDT at the same dosage both for one day and for six days in the following manner: (1) intra-tracheal infusion, (2) alimentary exposure with a corn oil solution, (3) with an aged residue on alfalfa hay, and (4) intravenous infusion. It was found that the respiratory exposure produced the lowest level of DDT (and its metabolites) in the milk and that the alimentary administration of the aged residues produced higher levels of residue than alimentary administration of the
corn oil solution of DDT. The intra-venous tests were conducted to produce a theoretically maximum response to DDT administration. The routes of exposure which by-pass the rumen resulted in a lower level of the metabolites of DDT in the milk than the alimentary exposures; however sufficient increases of DDE and DDD occurred so that it is clear that the cow does have the capability of making this metabolic alteration although it cannot carry out the transformation as rapidly as we do the rumen microorganisms. The rates of loss of the stored DDT from the cow were established.

* * * * *

**Pesticide Application Equipment in Relation to Drift of Pesticides and Pest Control**

L. A. Carruth

**Objectives**

1. To evaluate existing ground and air application machinery to pesticide drift.
2. To modify equipment and practices to reduce drift of pesticides.
3. To develop new equipment and management practices which will reduce drift and give effective pest control.
4. When equipment for drift safe application has been developed, it will be evaluated for effectiveness of insect control.

The work on this project was done with the cooperation of the Department of Agricultural Engineering.

**Summary of progress**

The attempt to reduce drift by modifying existing practices was continued by comparing the drift during aerial application from a conventional emulsion spray with a thickened emulsion spray under the strong inversion conditions (-9°F to -5°F) existing in the winter months. Under these conditions, there was no reduction in the drift of the pesticide from the use of the thickened emulsion. The effect of a normal lapse rate (±0.5°F to 1.0) versus an inversion condition (-4°F to -10°F) was studied by comparing the drift from a conventional emulsion spray during aerial application during early morning and mid-afternoon conditions. The data are not yet complete but the extent of the drift appears to be greater with the normal lapse rate. However, the normal lapse rate (afternoon) conditions were accompanied by a slightly higher wind velocity which would increase the drift rate.

* * * * *

-70-
Pesticide Residues -- Their Nature, Distribution, and Persistence in Plants, Animals, and Soils

L. A. Carruth

Objectives

1. To determine the nature and extent of pesticide contamination of animal feeds (particularly baled forage), animals, and animal products which are in marketing channels.

2. To investigate practical and accurate methods, suitable for use during the marketing period, for measuring and evaluating chlorinated hydrocarbon pesticide residues in the above commodities.

Summary of progress

This new project was begun in 1965.

Sampling methods for pesticide residues on growing alfalfa, windrowed alfalfa, and baled alfalfa hay were compared. The analytical results are now complete only for the baled hay. A three-fold range around a mean of 0.07 ppm and a ten-fold range around a mean of 0.004 ppm was determined for a method involving a high intensity of sampling by coring. The levels detected were in a range where the analytical method is marginal and analytical errors contribute to the apparent sampling error, and studies need to be made at moderate and higher levels. Sampling of milk from a single cow in relation to day-to-day and morning-evening variation was studied. The data do not reveal any inherent variation in pesticide levels. Results from these studies are important for providing sampling procedures which will give uniform results without a gross oversampling effort so that producers and processors may conduct adequate surveillance of their products.

* * * * *

E. DISEASE CONTROL

Diseases Cause Cotton Losses

A. D. Davison

Cotton diseases caused an estimated 10.28% loss to cotton farmers in Arizona during 1965. A breakdown of the estimate is as follows: