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Recommended Citation
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INJURIES TO COTTON BY 2,4-D

MAR 27 1947

By

CLAIR A. BROWN, Q. L. HOLDEMAN, AND E. S. HAGOOG

Warning

It has been estimated that about 2 million acres of crop lands were sprayed or dusted with 2,4-D and other herbicides in the United States and Canada during 1947. There is little doubt that these compounds will be used in greater quantities in the years to come. There is a definite place for these compounds in Louisiana.

This bulletin is written, not to discourage the use of 2,4-D, but rather to point out that if not properly applied, this and similar compounds may cause serious injuries to certain crops, and to recommend that all users obtain information on how, when, and where they can be used safely.

Information on these herbicides can be obtained by writing to, or calling at the office of, the Department of Botany, Bacteriology, and Plant Pathology, Louisiana State University.
INJURIES TO COTTON BY 2,4-D

By

CLAIR A. BROWN, Q. L. HOLDEMAN, AND E. S. HAGOOD

The new chemical 2, 4-dichlorophenoxyacetic acid, more commonly known as 2,4-D, is classed as a "selective" herbicide when used in extremely low dilutions. Either as a spray or as a dust, it will kill or injure many broadleaved plants without seriously injuring most members of the grass family. During the past couple of years it has been used extensively in various parts of the country in fields of cereals to destroy various weeds, in sugarcane fields to destroy the alligator weed, and in fields of rice to destroy such rapidly growing weeds as indigo and Mexican weed. It has also been used to clear the weeds from canals and drainage ditches and to eradicate water hyacinths in ponds, lakes, and bayous. In recent years, probably nothing has had a greater impact on agriculture than has the introduction of and use of 2,4-D and similar herbicides. In the future when more is known about these compounds and how and when they should be applied, they will be very widely used.

During the growing seasons of 1945 and 1946, tests with 2,4-D were made in South Louisiana in fields of sugarcane and rice and to a limited extent on other plants and crops. The results obtained were very promising. Similar results were also obtained in other parts of the country. Information regarding the preliminary tests became generally known and by the spring of 1947, in spite of warnings that there might be trouble on some plants, the stage was set for the wide use of 2,4-D. Warnings were issued in the following publications:


That 2,4-D might cause injuries on such crops as cotton was indicated by the preliminary observations made in 1946. As an example, a cotton field near Baton Rouge was dusted with an insecticide that had been mixed in a machine in which 2,4-D had previously been mixed. Although the machine was cleaned as well as was thought
necessary before mixing, enough 2,4-D was carried over to the insecticide to injure cotton rather severely. In this field, the yield of cotton was reduced about 60 per cent.

In 1947, 2,4-D was applied to bayous and lakes to kill water hyacinths, to sugarcane fields to kill alligator weed, and to rice fields to eradicate various weeds. It was applied in both spray and dust forms. It was applied by ground machines and by airplanes. The operators did not in all cases appreciate the dangers to adjoining fields and the result was that many fields of cotton and other crops received light applications of 2,4-D. The dust and even the spray, especially when there was a light breeze, drifted for considerable distances. Sometimes, airplanes made turns out over adjoining fields and even when the dust or spray was cut off, the air currents from the machines were sufficient to disperse the chemical. In some cases, the 2,4-D escaped from leaking hoppers.

Areas Studied

It was not long after the season opened in 1947 before reports of damage began to come in, especially from cotton growers. Injury to cotton in Louisiana by 2,4-D was reported from several parishes. Due to requests from the growers, a survey was made in certain areas and tests were made to answer certain questions regarding 2,4-D. The information obtained from the survey and the tests is given in this bulletin. The areas receiving the most attention are listed below.

Ouachita-Morehouse Area—During the early spring, 2,4-D dust was applied by airplane in Bayou Bartholomew and Black Lake Bayou near Monroe to eradicate water hyacinths.

Reports of damage to cotton and other crops began coming to the Experiment Station in early May. In this area, the airplanes were forced to fly rather high to miss the stumps and trees, and the dust drifted out over neighboring fields. It also appeared that airplanes in some places in making turns circled over the margins of cotton fields.

In this area, cotton plants were mostly small when the 2,4-D was applied. The reports as to damage were so numerous that two meetings were held for a discussion of the problems. A committee was appointed to determine the possible extent of the damage and to make recommendations to the farmers. This committee consisted of Mr. I. W. Carson, Extension Agronomist, Louisiana State University, Chairman; Dr. Clair A. Brown, Professor of Botany, Louisiana State University; and Dr. W. T. Penfound, Professor of Botany, Tulane University. This committee remained active during the season, and a study was made of this and other areas in the State.

Rice Area—In Southwestern Louisiana at different times during the growing season, rice fields were sprayed or dusted with 2,4-D.
Both ground machines and airplanes were used. In this area, cotton plants were in various stages of development. Some were blooming and producing squares and bolls when the rice was being treated.

**Pine Prairie Area, Evangeline Parish**—In Evangeline Parish, Miller's Lake, near Pine Prairie, was dusted with 2,4-D by airplane on June 18, 19, and 25 to eradicate the water hyacinths. As this area is well isolated from other areas in which 2,4-D was used, it was possible to obtain definite information on the distance of the drift of the dust. On the first day (June 18), the wind was blowing from SSE at a velocity of 10 miles per hour at take-off time, and the next day the wind shifted to ESE with a velocity of 7 miles per hour. There was little or no wind on June 25. The western and northern margins of the lake have a fringe of trees about two miles wide. Outside of this, the region is broken into small individual farm units which are a mixture of pasture, woodland, and fields of corn, cotton, and sweet potatoes.

**Ferriday Area**—Near Ferriday, cotton injury occurred in an area as much as 1,200 feet from a storage depot. Drums and sacks of 2,4-D were unloaded and reloaded at this depot as needed. Some of the packages were broken and the dust was apparently dispersed by the wind. Home gardens and sensitive ornamentals were injured.

**Shreveport Area**—Some injury to cotton was reported in the vicinity of Shreveport. From reports, apparently some 2,4-D had accidently become mixed with an insecticide which was used in dusting cotton. This case emphasized the necessity for careful handling of such toxic compounds.

**Symptoms of 2,4-D Injuries**

Cotton plants were injured by 2,4-D at practically any time during the growing season, from the seedling stage up until the bolls were well developed. All parts, including leaves and stems, flowers and young bolls, were injured. Injuries, however, mainly showed on the young developing parts. As the leaves and bolls approached maturity they seemed to be less sensitive. Young plants in the seedling or the pre-flower stage also recovered more rapidly than did those injured after flowering began. The following symptoms are based on observations made in the field during 1947.

**Injuries to Leaves (Fig. 1)**—Injuries mostly showed on the young developing leaves. Leaves fully formed at the time 2,4-D was applied rarely showed any characteristic or clear-cut symptoms though the normal green color often faded to a pale, yellowish-green. Leaves 2/3 to 3/4 normal size showed a general pallor and a slight clearing along the veins. The leaves developing from the unexpanded leaf buds were the ones which exhibited the conspicuous symptoms and it usually took from 10 to 14 days after dusting for the full development of
Fig. 1.—Characteristic leaf modifications caused by 2,4-D based on the categories used. First two leaves on the left are typical for heavy injury; middle pair, for moderate injury; and leaf on right, for light injury.
symptoms on these. The production of malformed leaves was usually confined to this period. Progressive changes in the degree of injury did not occur after this period except where the plants received a second or third application of 2,4-D.

**Injuries to Flower Parts (Figs. 2 and 3)** — The bracts surrounding the flower bud became veiny-mottled, with extra long tips to the fringing teeth. At times, the bracts were partially fused to each other. The greatest modification was the formation of cylindrical, fused bracts with attenuate lobes. The modification to the flower parts depended upon the time the plants received the 2,4-D and the quantity. Plants injured in the pre-square stage formed squares which showed only a mottled, veiny appearance, with longer lobes and a partial fusion of
the bracts but without other changes in the general shape of the square. When the injury was somewhat later, the greatest modification to the square was the change to a cylindrical shape and a complete fusion of the bracts (Fig. 2B). The injured squares were also smaller than the normal ones.

![Fig. 3.—Modifications of the flower bud by 2,4-D.](image)

When 2,4-D was applied in the pre-bloom stage or later, large quantities of the squares turned yellow and dropped off. Prior to falling, the flower buds started to grow. The growth of the perianth was retarded and the stamens and pistils pushed out of the apex of the bud (Fig. 3). The flowers were also modified, but most of the modifications observed were on plants which had partially recovered from an earlier application of 2,4-D. The petals were dwarfed, sometimes strap-shaped to filiform, and in many cases were fused to form a united corolla. Flowers which developed after the plants recovered were mostly normal.

Bolls which developed from the cylindrical-shaped squares were frequently abnormal. Usually they were elongated with a slightly hooked apex. At times, one or more locks did not develop seeds.

**Injuries to Stems (Fig. 4)**—In some instances the lower part of the stem of the cotton plant at the ground level was distinctly swollen. This type of injury was observed in a field adjacent to a dusted rice field. It is possible that these plants received more 2,4-D than other plants exhibiting similar leaf symptoms but lacking the swollen stems.
Classifying Injuries On Cotton

In the survey, it became necessary to group the fields in several categories, representing degrees of injury to the plants. The survey was started during the early part of the season when the plants were young, and consequently most attention was paid to injuries to seedlings and to young leaves. For the most part, the degree of injury was determined merely by the symptoms actually observed in the field. In the survey, it was not possible to judge the amount of 2,4-D which the plants received by the injuries which were observed. The categories as used in the survey are listed below (Fig. 1).

Dead and Dying—The terminal bud became black, shriveled, and was easily detached. The cotyledons drooped and became pale, gray-green in color. The hypocotyls were either swollen excessively and
cracked, or shrunken. Such plants sometimes died. Diagnosis of injury was very difficult on seedlings of this size, being complicated by a heavy infestation of aphids and thrips and by an infection of sore shin on the roots, a disease caused by *Rhizoctonia* sp., which seemed to have been intensified by planting of cotton on a recently buried legume crop.

**Heavy**—The leaves were dwarfed, frequently curved, elongated, usually less than 3/4 of an inch wide. The main veins were distinctly parallel, close together, conspicuous, with white to yellow areas around them; the margins were narrow and wavy. The lateral lobes pointed forward with long attenuate apices. Usually the leaves were thickened and crisp.

**Moderate**—The leaves were elongated, with a trend toward expansion near the tips. The veins were conspicuous, with cleared areas around them, frequently divergent, but connected with a conspicuous network. The margins were more ruffled than in the above category, and the sides usually drooped. The apices of the lobes were long attenuate.

**Light**—The leaves showed a reduction in size and were frequently irregular in shape, but lacked most of the symptoms of the above classes. The margins were slightly wavy. The lobes were longer and sharper pointed than normal, but not as long as the more severely injured leaves. The network of small veins was conspicuous. The surfaces were glabrous in contrast to the normal leaves with fine pubescence.

**Trace**—This category was used for leaves which were nearly normal, with a slight pebbling of the surface, as well as for the condition in which a field showed only an occasional plant with marked symptoms while the rest of the plants were normal in appearance.

**Extent of Injuries**

In Ouachita and Morehouse parishes some 10,500 pounds of 15 per cent dust were applied by plane. Injury was found on 1748 acres of cotton, classified as follows: dead and dying, 287 acres; heavy, 471 acres; moderate, 404 acres; light, 256 acres; trace, 320 acres; and no injury on an additional 1,806 acres surveyed. A survey in the Pine Prairie area of Evangeline Parish showed injury on 86 farms and the degree of injury was classified as follows: heavy, 192 acres; moderate, 62 acres; light, 74 acres; and trace, 117 acres.
Drift

That fine dust particles can be carried for long distances by air currents is recognized. In this country in recent years, dust has been carried in dust storms originating in the semi-arid plains region for a thousand miles or more. Dust from volcanoes is known to have encircled the earth.

It is not surprising then that insecticidal, fungicidal, or herbicidal dusts when applied by airplane or even by ground machines will be dispersed to a certain extent to adjoining areas by air currents before settling to the ground. This is usually spoken of as drift. Drift has caused some concern in the past with certain insecticidal dusts containing arsenic. Drift did not, however, receive serious consideration until 2,4-D herbicides began to be widely used. With these, serious losses have resulted from the drift of the dust.

In Louisiana, the drift of 2,4-D dust was early recognized as a very important factor in the weed control work and in 1947 considerable attention was paid to it.

Drift in the Bayou Bartholomew and Black Lake Bayou areas was mostly confined to 1¼ miles from the zone of application. That the injury was confined to this distance is remarkable in view of the height the pilot had to fly to keep clear of the snags in the bayou. Some injuries occurred along the flyway from the loading depot to the bayous, which was possibly due either to leaking hoppers or to the blowing off of spilled dust on the outside of the plane or the possible cleaning of the hopper by the pilot. Pilots have been observed to clean out their hoppers while in flight. Injuries to cotton were greater in the areas where the airplanes turned around or changed their courses than in those affected by the general drift. Bayou Bartholomew is so serpentine that the pilot could not fly the area treated in one continuous trip. Instead, he flew short segments, which necessitated turning around over adjoining fields. The suction of the plane apparently pulled considerable quantities of 2,4-D along after the pilot had shut off the hopper.

At Miller’s Lake, symptoms of heavy injury were found for about 2 to 3½ miles from the lake, light symptoms at 5 miles, and trace injuries at 8 miles. These distances were ascertained from measurements on aerial photographs and maps.

Drift may occur with ground machines and even hand dusters as well as with airplanes, though the distance is usually much less. In one area, slight damage was noticed at a distance of nearly a mile following the application of 2,4-D with a hand duster.

Drift also occurred with sprays, although the distance was usually much less when compared with dusts. In one instance, a liquid spray was applied in diesel oil at the rate of 2 gallons per acre by airplane with a 10-12 mile wind. A trace of injury was noticed at a distance
of 1,800 feet in an area of non-sensitive crops. In another instance, weeds showed 2,4-D symptoms about 1,200 feet from a rice field which was sprayed with a water-ester emulsion at 2 gallons per acre. In Tennessee, TVA research workers found that a finely atomized spray injured cotton at a distance of 2½ miles.

This emphasizes the care with which 2,4-D compounds must be handled. Until some way is found to reduce the drift, either by larger particle size of the dust or by a heavier diluent, it is unwise to use 2,4-D dusts in areas of mixed agriculture. Liquid sprays will be found much safer. However, it must be remembered that the liquid sprays will also drift to some extent and unless the proper precautions are taken, losses with these may occur.

Recovery

One of the interesting observations made in 1947 was that cotton plants may recover after receiving an application of 2,4-D. It took from 3 to 6 weeks for plants showing heavy injuries to recover. Seedlings made a quicker recovery than older plants, and plants showing moderate injury likewise made a quicker recovery than those showing more severe injury. In instances where the growth of the main stalk was permanently arrested, axillary buds produced branches which grew to about normal height (Fig. 5). These side shoots showed no 2,4-D symptoms and produced normal flowers and fruits. If the normal branches were started at the time of dusting, then 2,4-D injury appeared on the new growth, but as the branches elongated, normal foliage was again produced. The temporary cessation of growth, however, is an important factor which must not be overlooked. Usually the boll weevil infestation builds up by the middle of July so that there is very little chance of producing cotton from the late-set bolls. The delay of 3 to 6 weeks put some of the cotton fields into the period of maximum injury by the boll weevil. Fields which, on the basis of estimates, had the capacity to produce 260 to 360 pounds of lint per acre did not produce this quantity because many of the top bolls had weevils in them. Under such conditions additional poisonings were necessary for best production.

Effect on Yields

Information on the effect of 2,4-D on yield of cotton is very important. Such information, however, has been difficult to obtain. All that it has been possible to do has been to estimate the apparent injury in the field, watch the recovery, and then check the actual yield against yields of other years and other fields and against estimates of expected yields. It is important to consider the effect of time of application of 2,4-D, whether in the seedling stage or in the flowering stage, and also to have some idea of the effect of different amounts of 2,4-D.
Yields are affected not only by the actual injury to the plants but also by the length of the recovery period. If the growth is checked for 2 to 3 weeks, boll formation may be delayed and consequently there may be more loss due to the boll weevil.

In estimating losses in yield, it is necessary also to consider other factors which may have affected yield, such as aphid and thrips infestations, root rot and sore shin troubles, rainfall, fertilization, cultivation, and numerous other factors that may influence the growth and production of the bolls. Also, the past season was very favorable for the production of cotton and this may have helped to minimize the actual losses.
In estimating the losses it has been possible to compare yields in the different fields with those of previous years. Records on yields of previous years are on file in the Louisiana State Office of the Production and Marketing Administration, Louisiana State University, Baton Rouge, Louisiana. Of course, yields in some years are better than those of other years and this has to be taken into consideration.

In general, yield losses have been greater on cotton injured late in the season when the plants were in bloom than on young cotton.

The following information on the conditions in different parishes is presented merely to give some general idea of the effect of 2,4-D. No attempt is being made to evaluate losses in any particular field.

**Ouachita and Morehouse Parishes**—About the middle of September certain fields in the area which had been surveyed in the spring were examined and the yields estimated by counting the number of bolls per 100 feet of row and computing the yield per acre. Estimates made in this way were slightly lower than the actual yields obtained at time of picking and ginning.

When the committee recommended plowing up the injured cotton in certain fields, the farmers were requested to leave a few rows so the development of the plants could be followed. Estimated yields on some of these check rows are as follows: 370, 370, 363, 239, 142 pounds of lint per acre respectively. The first three are within the range of the normal yields for these farms but under the yields of uninjured cotton in nearby fields. The last two were not representative yields as these checks were on poor sites and did not receive normal cultivation.

Cotton which was plowed up and replanted to cotton by May 24 produced good yields. The production of one specific field was estimated at 568 pounds of lint per acre and the owner reported 625 pounds.

Estimates made in September of three fields which in the spring showed heavy injury were 478, 414, 393 pounds of lint to the acre. These figures are within the ranges of yields according to the past histories of the respective farms. The actual yield reported by the farmer for the first field was 630 pounds of lint. No attempts were made to estimate losses in these fields.

Fields showing moderate, light and trace injuries made such good recovery that no estimates were made in these categories.

Fields which were dusted before the cotton plants emerged from the soil showed no reduction in yield. The estimate for one field indicated a yield of 631 pounds of lint. The owner reported better than a bale to the acre and was well satisfied that he sustained no injury.

**St. Landry Parish**—Several communities in this parish suffered injury to cotton and other crops from drift of 2,4-D dust. One of these fields was dusted the last of May or during the first week of June when the plants were just starting to bloom. The plants exhibited heavy in-
jury symptoms and shed many unopened squares. This field produced 198 pounds of lint to the acre, whereas it has a maximum crop history of 649 pounds of lint to the acre. Another farm which had cotton in a field adjoining a rice field produced 74 pounds of lint to the acre. This field had always produced a poor crop, as its maximum recorded yield was 162 pounds of lint. It would seem that losses as high as 50 to 60 per cent occurred in fields which received a heavy application of 2,4-D when the plants were in bloom.

**Vermilion Parish**—One field in this parish was examined June 20. At that time it showed moderate to heavy injury. The plants were about 30 inches tall and had many blossoms and squares which showed injury. It was dusted about May 5-7. The farmer picked an average of 435 pounds of lint per acre from 10.7 acres and the normal yield on the farm is 375 pounds.

**Evangeline Parish**—The Pine Prairie community near Miller's Lake received 2,4-D dust on June 18, 19, and 25, when the lake was dusted for control of water hyacinths. The cotton was 24 to 30 inches tall with squares, blossoms, and bolls present. From 1 to 3 bolls per plant were set at the time of the dusting. Fields which received sufficient quantity of the dust to produce heavy injury to the foliage shed all of the unopened squares in a short time. This region was visited again on August 4. At that time the plants were starting to recover, as judged by the production of normal flowers and a few normal leaves. Yield figures are not available for these fields. However, the lateness of injury and the length of time necessary for recovery indicate prospects of a decreased yield in the fields which showed severe injury.

**Experimental Studies**

Many questions in regard to the action of 2,4-D need answering. Some of the most urgent ones have received some attention.

**Minimum Quantities of 2,4-D Producing Injury**—Field observations showed that 2,4-D dust drifted for a distance of 8 miles and produced slight abnormalities. It seemed important to know the minimum quantity of 2,4-D that would produce injuries. Staten¹ has reported injuries with 0.1 cc of a 1000 parts per million (ppm) solution and no injuries at concentrations between 0.0001 and 0.1 ppm. At Baton Rouge, 0.1 cc of 0.01, 0.1, 0.5, 1, 10, 25, 50 ppm solutions of 2,4-D acid were applied to the cotyledons of cotton seedlings while the first two leaves were in bud (Fig. 6B). The first symptom was a drooping of the cotyledons in about 24 hours, from which there was a recovery in

the next 2 to 3 days. At concentrations of 50, 25, and 10 ppm the first two leaves became dwarfed, curled, and malformed. The succeeding 6 to 8 leaves were similar and the plants did not recover in a period of 8 weeks. At 1 ppm the first 4 to 5 leaves were injured, and recovery started at the end of 5 weeks. The quantity of 2,4-D used at the 1 ppm level was 0.0001 milligram of acid per plant. Light but unmistakable injury showed at the 0.5 ppm level, or 0.00005 milligram. At this concentration only 2 to 3 leaves showed injury before the normal leaves were produced in about 4 weeks after treatment. These minimum amounts indicate the sensitivity of cotton seedlings and emphasize the
value of sensitive plants in the detection of 2,4-D by a bio-assay.

The application of 1 cc of a 50 ppm solution to the soil around the cotton seedlings resulted in less injury than the application of 0.1 cc of a 1 ppm solution to the cotyledons.

2,4-D was applied to the soil in a set of flats at the rate of 1, 0.1, 0.01 pounds of free acid per acre. In the 1-pound treatment, only 2 seedlings emerged, one of which subsequently died. At the lower levels a good germination was obtained, although the emergence of the seedlings was slower than in the controls.

Cotton seeds were germinated in petri dishes containing 5 cc of 0.01, 0.1, 0.5, 1, 5, 10, 25, 50 ppm solutions (Fig. 6A). The lowest concentration producing a reaction was at the 0.1 ppm level. At this concentration, there was a slight stunting of the root tip. At the 0.5 ppm level, the growth of the root tip was arrested and there was a noticeable swelling in the transition zone between the hypocotyl and the root tip. At 1 ppm, the swelling was very evident and the hypocotyl was definitely shortened in length. Seeds of other plants exhibiting this degree of injury never recovered when transferred to soil. Cotton seeds barely germinated at the 5, 10, 25, 50 ppm levels and the hypocotyls and root tips were markedly dwarfed.

Ten pounds of 15 per cent dust per acre was the quantity used to kill water hyacinths, this being equal to 1.5 pounds of the free acid per acre. This quantity was also toxic to cotton seedlings. This is the equivalent of 0.0156 grams of acid per square foot. One pound of the 15 per cent dust per acre (or 0.15 lb. of acid) did not kill cotton seedlings, but produced severe leaf injury. Thus the amount necessary to kill cotton seedlings is between 1 and 0.15 pounds of acid per acre. The exact minimum killing quantity has not been determined but it will vary with the size of the plants, rapidity of growth, and method of application. Three grams of a 15 per cent dust, about a teaspoonful, when liberated in a slight wind, produced injury on about one-half acre of cotton.

**Leaching of 2,4-D from Soil**—A 2,4-D dust was applied to a series of flats at the rate of 1, 0.1, 0.01 pounds of acid per acre. One set of flats received water at the rate of 1 inch of rain per acre and another set at the rate of 2 inches of rain. These flats were planted to cotton. When one inch of rain was used, malformed leaves developed on the cotton in the flats which were treated at the 1 pound of 2,4-D acid per acre level, whereas at the lower levels the cotton produced normal leaves. After the equivalent of 2 inches of rain the cotton grew normally. This indicated that 2,4-D will either leach from the soil or become inactive in a wet soil. Several investigators have reported that spray strength solutions of 2,4-D in moist soil have become non-toxic in a period of 4 to 7 weeks.

**Seed Transmission**—The question has been asked whether cotton
seed from 2,4-D injured plants can be stored and then used for planting purposes. Pridham\textsuperscript{1} reported that young bean plants from seed harvested from plants sprayed while the pods were green showed malformations characteristic of those produced by 2,4-D. In view of the sensitivity of cotton and the fear by farmers that they should not save their seed, the possibility of seed transmission of 2,4-D was studied. Cotton seeds were collected from plants in two fields which were dusted early in May and which later showed heavy injury. Collections of seeds were also made from two fields which were dusted in June just after the plants started to bloom. There was a 60 per cent reduction in yield of lint cotton from the latter two fields. These seed lots and also seed from non-injured plants were planted in sterilized soil in the greenhouse. The first three true leaves of all seedlings were normal in appearance. This seems to indicate that 2,4-D was not stored in these seeds in sufficient quantity to produce abnormal seedlings.

These preliminary tests, however, are not sufficient to answer the question, especially since 2,4-D symptoms have recently been reported from Texas on seedlings from seed harvested from 2,4-D injured fields.

**Discussion**

The various 2,4-D compounds have proved to be very effective weed killers and therefore their use has become a standard agricultural practice for the production of certain crops. Their widespread use and popularity arose through their relatively low cost per acre in comparison with standard herbicides. The intensive investigations for the past three years have been centered on their ability to kill undesirable or unwanted plants. At first, very little attention was paid to their stimulatory possibilities or to their disadvantages. As investigations with 2,4-D progressed certain disadvantages were found and recorded in the literature. Certain crop plants were found to be very sensitive to 2,4-D.

Unfortunately, until very recently very few have realized the potency of the 2,4-D compounds. At times, these products have been handled carelessly and have been applied in a haphazard manner without due consideration of the possible effects upon adjoining crops. Also, these products have come into general usages rapidly and before the necessary information concerning them has been obtained by research. In other words, the commercial use has out-distanced the research. In some cases, the information has come the hard way, by experience. In the future these herbicides will be used in much greater quantities than at present, and ways to eliminate the dangers will be found. Users of 2,4-D, however, should recognize the dangers involved, and should use all precautions to minimize injuries on sensitive crops.

\textsuperscript{1} Pridham, A. M. S. "Effect of 2,4-D on bean progeny seedlings." Science 105: 412. 1947.
During 1947 the various 2,4-D compounds were used as herbicides in Louisiana. They were used principally in rice and sugarcane fields to control various broadleaved weeds and in ponds, canals, and bayous to eradicate the water hyacinth. They were used both as dusts and sprays and were applied by airplanes, ground machines and by hand dusters and sprayers.

In some cases the 2,4-D drifted out over adjoining fields and settled on sensitive crops. Drift occurred with both dusts and sprays but was more pronounced with the dusts.

While a number of cultivated plants were injured by the 2,4-D, most of the reports of damage were in fields of cotton.

The extent of injury to cotton was associated with the age of the plants. Losses were less on plants which received the 2,4-D while in a young stage than on plants in the flowering stage.

Cotton seedlings between 4 and 6 inches tall produced abnormal foliage in the period immediately following the application of 2,4-D. Even those plants which showed severe leaf symptoms eventually recovered and later produced bolls in a normal manner.

Seedlings which showed only moderate to light leaf symptoms developed into normal plants.

Plants injured severely during the flowering period in most cases showed decreases in yield.

In limited tests, seedlings raised from seed from injured plants developed normally.

2,4-D falling on the soil is leached out or rendered inactive by water. Normal cotton was raised on soil which had received a small amount of 2,4-D.

One serious aspect of the 2,4-D problem is that the herbicide checks the growth of the cotton plants for 3 to 6 weeks during the period of recovery. This may place the plants in the period of maximum boll weevil injury and be responsible for reduced yields.