the wheat and the DDT shows good results on the sweet clover weevil. Farmers report that the mixture seems to have better physical application qualities than either material used separately. The weevil has become such a big problem in sweet clover that Indiana farmers cite it as one reason for turning away from sweet clover as a green manure crop. Trials are also starting with this method for oats. Further west, BHC and aldrin are being used with nitrogen solutions against the corn root worm. Research is also being done on aldrin with ammonium nitrate and free ammonia solutions.

Herbicide Development Rapidly Picking Up Speed

Organic herbicides as we now know them have an active history of only about 10 years. A great deal has been accomplished during that time. 2,4-D has been by far the best known and most widely used of the herbicides, but during the past two years several new and promising compounds have appeared. Today some of these are in active and effective use, others are only beginning to find use on the farm, and some are still in the research stage. Rapid development is under way, many of the problems are being overcome, and it seems that we can look forward to the availability of tailor-made herbicides which will more effectively control specific weeds while not harming other plants.

With the development of new tailor-made chemicals for killing weeds, it is evident that much more precision will be required in proper use. This will mean that farmers must be kept informed on the latest and best knowledge of the action of these chemicals and the techniques for applying them.

Phenoxy-Type Compounds

Of the herbicidal chemicals, the best known group is the phenoxy-type compound. This includes 2,4-D (2,4-dichlorophenoxyacetic acid), 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) and MCP (2-methyl-4-chlorophenoxyacetic acid). Use of these compounds for the control of broadleaf weeds and certain other plant species has been extensive. They have been used both as post-emergence and pre-emergence sprays. As pre-emergence agents they are effective for both broadleaf weeds and grasses.

As might be expected in the early use of such compounds, there have been some difficulties. For example, some highly volatile esters of 2,4-D have been used to control weeds, but their volatility allowed them to affect the crops and cause considerable damage. New low-vapor-activity esters have been found which do not harm the crops but are as effective in their capacity to kill weeds as are the earlier agents. Also in some areas where 2,4-D was used to spray rice, there was a drift over onto cotton fields causing severe damage to the cotton. New products now are on the market which may overcome this difficulty.

Silvex (2,4,5-trichlorophenoxypropionic acid) has been made available in limited quantities only during the past year. It is a product being watched with special interest. Tests have indicated that it is equal to 2,4,5-T for the control of certain specific woody plants, especially for oak species. One of its most promising characteristics is its relatively low toxicity to cotton as compared with 2,4-D or 2,4,5-T. This may provide some relief for the disturbing problem of damage to cotton in the spraying of brush or other crops with weed killers.

Among other new compounds in the phenoxy group which show promise are 4-chlorophenoxyacetic acid, 2,5-dichlorophenoxyacetic acid, and 3,4-dichlorophenoxyacetic acid. These compounds are highly specific and as a result are expected to have special usefulness for controlling weeds in cereal crops, where legumes such as alfalfa and clover may be underseeded for later harvest. In experimental trials, 3,4-D has caused little or no injury to either Ladino clover or alfalfa. 4-Chlorophenoxyacetic acid has shown some damage to alfalfa stems but caused little or no injury to Ladino clover. It has also reduced yields of small grains under some conditions. Under identical conditions, 3,4-D caused no injury to small grains.

A new compound closely related to TCA (trichloroacetic acid) now has appeared on the scene. It is given the name dalapon. Its chemical name is 2,2-dichloropropionic acid. Recently put on the market, this new compound is more effective than TCA on many grasses and shows promise for the control of grasses and grass-type weeds in sugar beets and other row crops. Dalapon shows particular promise for use in pasture renovation. It will make possible the killing of weeds, to be followed by reseeding with a minimum of seed bed preparation, plowing, and cultivation.

Another group of compounds with the phenoxy group includes chlorinated phenoxyethyl esters. 2,4-Dichlorophenoxyethyl benzoate has been used in pre-emergence applications on soil and 2,4-dichlorophenoxyethyl sulfate has been established and its derivatives are being developed. One of these derivatives which will be in the demonstration stage this year is sodium 2,4,5-trichlorophenoxyethyl sulfate. This is an example of a tailor-made herbicide, as it will be especially suited in weed control for tomatoes. Tomatoes are particularly sensitive to most herbicides but this one can be used with relative safety.

Dinitro Compounds

Dinitro alkyl phenols and also certain chlorine substituted phenols have found extensive use as contact selective and nonselective post-emergence herbicides. Two of the more important dinitro compounds are dinitro-*o*-(sec-butyl)phenol and dinitro-*o*-cresol. They also have been used as pre-emergence sprays on weeds in a number of crops, including cotton, peanuts, and soybeans. One of the problems with the dinitro compounds has been their volatility and relatively high vapor activity. This has been particularly troublesome in their use with cotton when temperatures exceed 88° F. and the cotton is in the seedling stage. It has not been a serious handicap in other crops outside the South. A new development designed to overcome this difficulty is the use of as little as 50 pounds of lime per acre with these compounds. This reduces the volatility and, therefore, makes them safer to use. It has proved particularly valuable in their use with cotton. The lime is either applied in the spray mixture or applied separately to the soil surface immediately after the spray has been put on.

Considerable research is under way with the dinitro compounds to improve selectivity and specificity of action and to find compounds with lower vapor activity.

Carbamates

Certain carbamate compounds have found extensive use in the past few years. The best known among these are IPC (isopropyl-N-phenylcarbamate), and CIPC (isopropyl-N-(3-chlorophenyl)carbamate). Specific action and high selectivity has led to the wide use of carbamates. They have been particularly useful as post-emergence sprays for the control of germinating annual grasses in legumes and more recently have come into use as preemergence sprays for weed control in cotton, soybeans, and certain other crops.

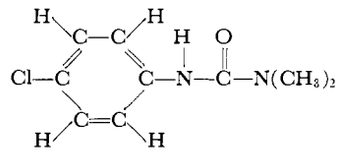
Two new carbamates are now making their appearance as experimental herbicides. They are 2-(1-chloropropyl)-*N*-(3-chlorophenyl) carbamate, and 2-chloroethyl - *N* - (3 - chlorophenyl)carbamate. These compounds are so new as to be little known outside the research field at

present but are likely to make prominent showings in the next year or two.

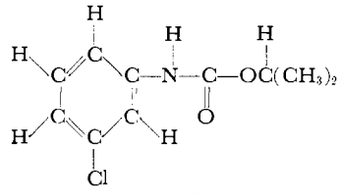
Substituted Ureas

Some of the substituted ureas have made an effective impression as herbicides. They are the first organic chemicals to show sufficient stability as soil sterilants to be satisfactory. The two best known of this group are CMU (3-[*p*-chlorophenyl]-1-dimethylurea) and PDU (3 - [phenyl] - 1,1 - dimethylurea). They not only are good soil sterilants on nonagricultural lands but also appear effective as pre-emergence treatments for weed control in cotton, soybeans, and other large deep-seeded crops. They have the ability to persist in the soil for long periods of time.

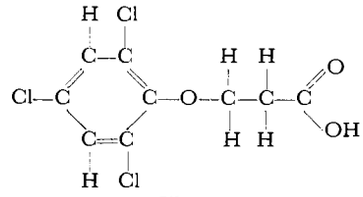
Two new compounds of this group are showing promise as soil sterilants on lands where it is desirable to control all plant growth. They are 3-(3,4-dichlorophenyl)-1,1-dimethylurea and 1-(3,4 - dichlorophenyl) - 3 - methylurea. These products may also be useful as pre-emergence treatment for the control of weeds.



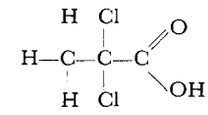
CMU



CIPC



Silvex



Dalapon

Aminotriazole

Aminotriazole looks promising as a pre-emergence herbicide and also as a fortifying agent for other herbicides. It is yielding good results as a defoliant, especially for the inhibition of second growth cotton. It also appears to have value as a post-emergence herbicide. Aminotriazole inhibits chlorophyll formation in green plants. Salts of the phenoxy compounds of aminotriazole also are being developed.

Certainly there has been a great deal of progress in weed control agents during the past decade. However, there are problems yet to be overcome. Certain annual grasses have become a serious problem, as in rice production, for example, and new techniques or new products are needed to compliment the present successful control of broadleaf weeds. Some of the new agents are certainly showing promise here. The margin of safety for use of chemical agents in controlling weeds in soybeans, peanuts, lima beans, and other large-seeded legumes is still narrow. Here again, a new agent is showing promise. Efficient control for perennial weeds is a problem. For example, the control of such weeds as Canada thistle, Johnson grass, and nut grass. Wild oats are a serious menace. An area of about 29 million acres in northern U. S. and Canada is estimated to be seriously infested by wild oats.

There is an increasing realization of the value of pasture lands and of their fertilization and management. This emphasizes importance of the use of better weed control agents in pasture renovation. Already one agent is showing particular promise in this area and more work is under way. It is important to get something that the farmer can use without too much expert consultation. The giant foxtail is a serious annual weed in the cornbelt and the northcentral region generally.

Brush control has been active for quite some time, but there is still much room for progress. The same is true in control of weeds in drainage canals, irrigation ditches, and ponds.

A first-class nonselective soil sterilant that is translocated in plants so as to give control in the absence of rainfall would be of great value. Selective weed killers are needed that show more physiological selectivity between weeds and crops. The margin of safety between weeds and crops is too small now.

One very important area which is getting attention but needs more and could profit with more knowledge of improved techniques is that of application. This refers particularly to crop damage and liability suits. In Texas, California, Washington, and elsewhere, a number of hearings have been held recently and more may be coming. Unofficial reports from the Texas Commissioner of Agriculture's office indicate that new regulations may go into effect by the end of March. There has been a report that there is some doubt concerning the Commissioner's authority to regulate the application of 2,4-D in the state of Texas. For those who have read House Bill No. 402, effective Sept. 1, 1953, and those who have talked with the Commissioner, doubt no longer exists concerning his authority.

Despite the obvious value in using herbicides, there still seems to be a great lack of awareness on the part of potential users. For example, although 2,4-D has been used with outstanding success in controlling certain weeds in cereal crops, the fact that less than 20 million acres are being sprayed annually indicates that practices and techniques so far developed have not been fitted into farm operations.

The cost picture speaks favorably for the use of herbicides. In the case of 2,4-D for post-emergence application for control of broadleaf weeds in corn, the cost of materials is 25 to 50 cents an acre. The only effective means now available for controlling weeds in some crops such as wheat, oats, barley, rice, and flax is the use of chemical agents.

The cost of using the best cultural and mechanical methods for controlling weeds in cotton is around $18 an acre. With chemicals, this cost can be reduced to about $8.00 an acre. Chemical control for sage brush and mesquite on range lands costs about $2.50 an acre and may increase forage production by 30 to 60%.

Potential Market for $8 Million Worth of Fungicides; Yearly Fungi Loss at $1.5 Billion

The potential market for fungicides is estimated to be worth about $8 million per year. Despite the progress in recent years in the development of organic fungicides an estimated $1.5 billion is lost each year to fungi.

The development of organic fungicides is now in about the same position of expansion that insecticides had gained five or six years ago. Rapid development started about 1950 with the aggressive merchandizing of the phenyl mercuric fungicides and the quinones. Derivatives of the quinones were among the first of the modern organic fungicidal compounds; tetrachloro-*p*-benzoquinone occupies a position in this development analagous with DDT in the history of insecticides. Tetrachlorobenzoquinone was first marketed in 1940.

Present research and development in the field of fungicides seems to be following 4 general classes of organic compounds: the quinones, dithiocarbamates, heterocyclic nitrogen compounds, and mercuric salts of organic compounds.

The dithiocarbamates are among the