Recent Developments in the Control of Weeds

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The period from 1940 to 1948 has brought more revolutionary changes and improvements in weed-control methods than in all previous agricultural history. Reference is made here particularly to chemical methods as contrasted to non-chemical methods. The shortage and high cost of labor, the high price of most farm crops, and the rather rapid spread of certain primary noxious weeds—all of which occurred during the war period—created an urgent demand for such changes and improvements.

The three great enemies of agricultural production are insect pests, fungous diseases, and weeds. For many years we have spent huge sums for research to find means of combatting insects and fungi which infest crop plants; annually, we have expended millions of dollars for insecticides and fungicides. All through history, weeds have been taking their toll, and, comparatively, we have done little or nothing about it. We have taken weeds for granted; that, like bad colds, they have always been with us, and there is nothing we can do but live with them and tolerate them.

Within recent years our viewpoint has changed; weed control is receiving greater emphasis; there is more research and increased educational effort; and there is more serious consideration of the problems involved on the part of both growers and of manufacturers of herbicides and equipment.

There is a growing realization that the production of almost all crops is largely a battle with weeds; that weeds are often the main factor responsible for decreased yields, for increased cost of labor, for impairment of the quality of farm products, for depreciation of land values; and that weeds too frequently harbor the very insects and fungi which attack crop plants.

Another change of viewpoint is evident. I refer to planned methods of weed control which extend over several years and have as their objective the almost complete eradication of weeds from certain areas. Instead of temporizing with weeds, using half-way measures year after year with no perceptible lessening of the infestation, we see in operation programs which gradually reduce the annual costs of weed control. These call for the use of pure seed, for cleaning up the sources of infestation, such as fence lines, roadsides, ditchbanks, and waste places, for the use of chemicals, now available, which are more than top-killers of perennials, for the use of soil sterilants, and the judicious timing of seasonal cultural and other operations which eliminate the maturing of weed seeds.

These are not idle dreams. The objectives just mentioned are being realized in many places. Fields once weed-infested are now weed-free. We are well on our way toward solving, in a practical way, the age-old problem of weeds. New materials and new methods, developed during the last few years, have made this possible.

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Let us summarize the recent progress in weed-control methods:

I. Selective Herbicides

The use of selective weed-killers has become standard practice. We now have selective herbicides for the control of weeds in all the small cereals, including rice; in corn and milo; in lawns and pasture lands; in carrots, celery and related crops; in peas, flax, onions, and garlic; and in alfalfa, both old stands and seedling stands. The principal selective herbicides now in use commercially are (1) certain dinitro compounds (salts of dinitro-orthocresylate and ammonium salt of dinitro-ortho-secondary-butyl-phenol); (2) certain oils (stove oil or special fractions having a gravity rating in A.P.I. units of 37° or above (Shell Weedkiller No. 10 and Standard Weedkiller No. 1); and (3) both inorganic and organic salts of 2, 4-D (2,4-dichlorophenoxyacetic acid). In addition to the three principal groups of selective weed-killers just mentioned, others show some promise, particularly isopropylphenyl carbamate (IPC), phenylmercuric acetate, and ammonium trichloro-acetate.

The selective dinitro compounds find their greatest use in the control of weeds in small cereal crops (excluding rice), in peas, flax, onions, and seedling stands of alfalfa; the oils in carrots, celery and related crops, and in established stands of alfalfa; the 2,4-D compounds in all cereal crops, in corn, milo, lawns, and pasture lands, and in the control of many different shrubby species. IPC has shown promise for use in destroying certain grasses without serious injury to broad-leaved crop plants associated with them; phenylmercuric acetate has been used in a limited way to control crab-grass in bluegrass lawns; and ammonium trichloro-acetate is destructive to certain grasses but not to some broad-leaved crops.

With the exception of the three last-mentioned chemicals, the others listed above are now being sold in hundreds of thousands of pounds and/or gallons annually; and it is safe to say that in 1948 several million acres of crops were treated with selective herbicides. Within the last 2 or 3 years a whole new industry has been created. Nearly all of the major chemical manufacturers are in heavy production; and most of these weed-killers may be purchased in all cities and towns of the country. Who knows but that the volume of herbicide business may equal in a few years that of either insecticides or fungicides?

The selective or differential action of many of the new herbicides is not necessarily due to differences in the structure and in the nature of the surfaces of plants. We now recognize that species tolerance or susceptibility to a given chemical may be due to the effect of the substance on the plant's metabolism. For example, the foliage of carrots absorbs oil but the cells tolerate it; and representatives of the grass family are relatively insensitive to quantities of 2,4-D which are lethal to members of many other plant families. Even among the grasses, some are more sensitive than others to 2,4-D. In these cases, it is known that 2,4-D penetrates the surface cuticle and enters living cells. And, among broad-leaved plants

belonging to the same family, some species may be sensitive to 2,4-D while others are not. In our search for selective herbicides, especially among the plant growth-regulating substances, we may discover a great many chemical compounds which will answer specific agricultural needs in destroying this or that weed without injury to this or that crop plant.

II. General-Contact Herbicides

These weed-killers are designed to destroy all kinds of vegetation—both weeds and crop plants. They are used to control undesirable plant growth along highways, rights-of-way, and fence lines, and around farm and industrial buildings. There are three types of general-contact herbicides: (1) water-soluble materials, (2) oils, and (3) emulsions of oil and water. The principal water-soluble general contact weed-killers are sodium arsenite and sodium chlorate; the principal oils are diesel fuel, smudge-pot oil, stove oil, kerosene distillates, and various low-grade oils.

The significant progress in the development of general-contact herbicides has been the introduction of several new chemicals—certain phenol compounds such as pentachlorophenol, dinitro-cresol, dinitro secondary butyl phenol, dinitro secondary amyl phenol, and their salts. Examples of these products are "Sinox General" and "Dow General" weed-killers. These phenols are now used extensively to fortify oils; they increase the killing power of the mixture where an oil is being used in emulsion, or in low-volume applications by airplane. These fortified oils destroy certain oil-resistant weeds, such as sweet fennel, yellow star thistle, mayweed, and pineapple-weed.

III. Pre-emergence Sprays for Weed Control

Considerable attention and emphasis have been given recently to the control of weeds in row crops by pre-emergence chemical treatments. Two methods of attack have been employed: (1) application of a selective herbicide to the soil at the time of seeding. The chemical in the soil kills weed seedlings, but those of crop plants are uninjured. In England, 2,4-D and related growth-regulating substances have been so employed to control broad-leaved weeds in cereal crops. (2) Application of a general contact herbicide to a population of weed seedlings prior to the emergence of crop seedlings, or prior to the seeding of the crop. Under certain soil and weather conditions, slowly emerging seedlings, like those of onions, may be preceded by a dense stand of weed seedlings. It may be advantageous and economical to destroy this weed population by using a chemical which is lethal to all types of weeds, including grasses. The crop seedlings later emerge and make their early growth free of weed competition. Moreover, the cost of hand weeding may be substantially reduced. Under other conditions it may be desirable to allow a crop of weeds to develop, drill the seed right into the young weeds, and then destroy the weed population before crop seedlings emerge.

Pre-emergence weed control recognizes the fact that, as a rule, only those weed seeds that are within the upper one-fourth to one-half inch of soil germinate; and that if the initial population of weed seedlings is destroyed, without further tilling the soil, and thus bringing more weed seeds near the surface, very few weeds will later be present to interfere with the early growth of the seedlings of crop plants. Pre-emergence weed control also recognizes the fact that the early competition of weeds with crop seedlings is a factor of great significance; that the competition underground is quite likely more severe than that above ground; and that vigorous, healthy development of crop seedlings is enhanced by the absence of this root competition.

If pre-emergence chemical weed control is to be of maximum benefit, and yet economical, application of the materials must be made when the weeds are very small from one-fourth inch to one inch tall. At these stages the weeds are easily killed, the volume of materials required is low, and competition is eliminated early.

IV. Low-volume Application of Herbicides

It is difficult to overrate the value of low-volume application of weed-killers. This has been a most significant recent development in weed control. Such low-volume applications have been made possible by the development of suitable equipment and nozzles, and by the discovery of the growth-regulating types of herbicides. Formerly, chemicals available and suitable for control of weeds in cereals, for example, called for rather complete coverage of the foliage, and consequently for a large volume of material, usually from 100 to 150 gallons per acre. Hence, hauling and refilling added greatly to the cost of application, and also precluded the use of the airplane. In contrast, effectiveness of 2,4-D does not require full coverage of the foliage surface, and low-volume applications are made possible. In those cereal sections of the country where sources of water are few and far between, low-volume application of weed-killers is imperative if costs are to be kept within reason.

The fortifying of oils has also enabled the use of low-volume applications of general contact herbicides. With ground rigs, equipped with small-aperture nozzles, running at low pressures (20 to 60 pounds), and at high ground speed, it is now possible to reduce the effective volume of contact herbicide applied per acre to as low as 10 gallons. Fortified oils also lend themselves to airplane application. It must be emphasized that if low-volumes are to be effective, they must be applied to very small weeds—a practice which usually is advisable under all circumstances.

V. Non-cultivation of Orchards and Vineyards

Some 50,000 acres of citrus groves in southern California are operating under a system of non-cultivation; weeds are kept under control by general

contact herbicides. A few of these groves have not been cultivated for 18 to 20 years, and many for 10 to 12 years. The costs the first few years were high but they rapidly decreased during succeeding years. The soils in these orchards have improved as to structure, water-penetration has increased, repeated applications of the herbicides (chiefly oils) have left no injurious residues in the soil, and the general vigor of the trees and quality of fruit have been entirely satisfactory. Moreover, repeated applications of contact herbicides have eliminated such perennials as Johnson grass, morning-glory, and Bermuda grass. Olive and vine growers are also showing great interest in non-cultivation, substituting chemicals to control the weeds. Fortified oils are indicated as suitable materials for weed control in orchards: with these we may reduce costs per acre.

Summary

Emphasis has been placed in this discussion on recent developments in chemical methods of weed control. Without detracting from the importance of such methods, it needs be said that cultural operations, suitable implements, and proper timing in their use, and crop rotation—in short, GOOD FARMING—will always be approved and highly recommended as a method of practical weed control.

As regards weeds and their control, and as compared with a few years ago, there is greater interest on the part of growers and of manufacturers of herbicides and equipment; there is more research and education; a keener realization of the importance of weeds from the standpoint of food production: more effective regulatory measures; and, above all, a degree of progress in the whole field of weed control which has changed the attitude of growers: today they are realizing that weeds need not be tolerated, that weedy fields can be changed to weed-free fields, and economically so.

Recent progress in weed-control methods involve: (1) selective herbicides, (2) general contact herbicides, (3) pre-emergence sprays and dusts, (4) low-volume applications of herbicides, and (5) non-cultivation of orchards.

The principal selective herbicides are: dinitro-compounds to control weeds in small cereals (excluding rice), in flax, peas, onions, and seedling stands of alfalfa; certain oils to control weeds in carrots, celery and related crops, and in established stands of alfalfa; and 2,4-D compounds to control weeds in all cereal crops, in corn, milo, lawns and pasture lands, and in the control of certain woody species. In addition, several other selective herbicides are showing promise, namely, isopropyl phenyl carbamate, ammonium trichloro-acetate, and phenyl mercuric acetate.

Certain toxic phenol compounds are of great importance as fortifiers of oils. Fortified oils make oil-water emulsions feasible and the use of less oil per acre.

Pre-emergence sprays and dusts are finding use in the control of weeds in row crops.

The development of certain herbicides and the improvements in equipment for their application are making possible low-volume applications.

Every year sees an increase in the acreage of orchards and vineyards in which chemical methods rather than cultural ones are used to control weeds.