APPLICATION OF CHEMICALS WITH AIR SPRAYERS

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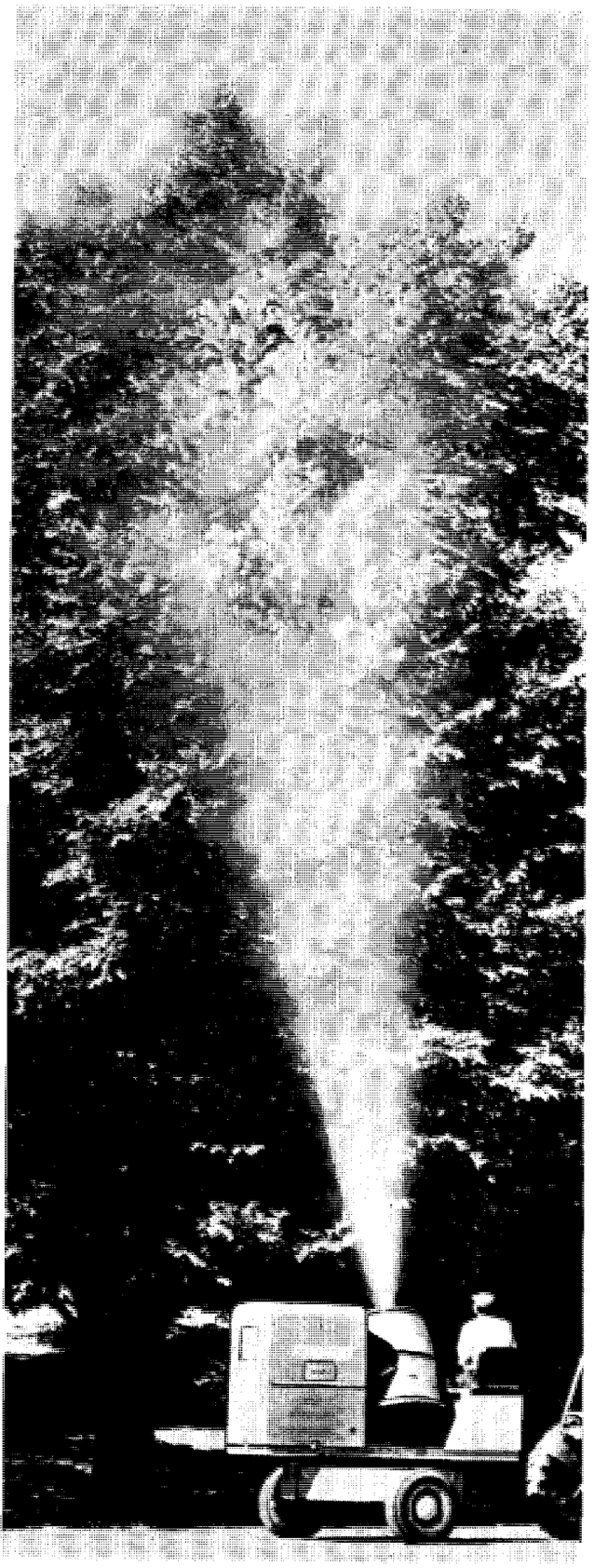

Savings in labor and chemicals are two advantages of air sprayers responsible for their rapid growth

THE NAME "AIR SPRAYERS" designates the class of machines which employ a stream of air to carry liquid chemicals to trees and plants. These machines may be contrasted with "hydraulic sprayers" which utilize the power of liquid pressure to project the chemicals into the areas where they are desired.

The well-known hydraulic sprayers were introduced in the year 1883 with the invention of portable hand-operated pressure pumps. These were soon replaced by powered pumps and many improvements, such as booms equipped with nozzles and masts with oscillating spray guns, have been made to ease the labor of hand-gun spraying. Hydraulic sprayers are still widely used and, no doubt, will continue to have their place, especially for smaller operations. However, the use of air sprayers is growing rapidly and they are now internationally accepted by orchardists, farmers, and shade tree experts as a forward stride in the spraying field.

The air sprayer had its beginning in the citrus industry about 12 years ago. A means was sought to cover large groves more quickly and less expensively than was possible with hydraulic equipment. After conducting successful experiments with cumbersome machines, in which the carrying air stream was created by airplane propellers operating in long tunnels, limited production was begun and followed by rapid development of better equipment. As the natural outgrowth of this improved method of spraying groves and orchards, the machines were adapted for shade tree and sanitation spraying. About six years ago manufacture of air sprayers specially designed for this work was begun. In more recent years the use of air equipment for row-crop spraying has also developed from tests of modified orchard machines. Experiments on test plots and actual field use during the past three years have proved the value of this method of row-crop spraying. Equipment designed specifically for this use is now in production.

The objectives sought in the development of air sprayers are: (1) thorough coverage and uniform deposit of chemicals; (2) reduction in spraying costs; (3) ability to handle all desirable chemicals with the minimum of operating difficulties and equipment maintenance.

Early in the development of air-type sprayers, it was determined that best results were obtained by the use of a large volume of air with velocity not exceeding 100 miles per hour. This type of air stream is less effected by wind conditions than relatively low volume having high velocity and is especially advantageous in orchard and row-crop spraying where high velocity air may cause serious damage to plants, trees, or fruit. Design of the sprayer to permit proper control of direction of the air stream was found to be of utmost importance. Since the problem of obtaining optimun chemical deposit includes so many uncontrollable variables, it was found impractical to operate satisfactorily a sprayer having a fixed air discharge pattern under all conditions encountered by even one user. Of course the number of variables increases greatly when the conditions encountered by all potential users are considered. In orchard spraying, for example, such factors as tree height and spacing, pruning practices, condition of foliage, and changing wind conditions make it imperative that sprayers be versatile. Therefore, modern sprayers are equipped

with adjustable air directing vanes to permit the user to "tailor" the air discharge from his sprayer to meet his inindividually changing requirements. Equally important for versatility is the ability to vary the chemical spray discharge volume and pattern, thus filling the air stream with the correct amount and size of droplets to cause thorough deposit without waste or danger of chemical damage. To allow the operator to make quick changes in the amount of liquid discharge, sprayers are equipped with nozzles having easily changeable orifices. Also, in many sprayers, valves are located in certain nozzle feeding pipes permitting them to be quickly cut off if desired.

Importance of Droplet Size

Another factor in the problem of most effective chemical deposit is the size of the spray droplets carried by the air stream. The importance of droplet size, means of obtaining desired sizes and methods of droplet measurement have been given much study and are still subjects of important research. No doubt we will continue to learn fine points and refinements in this field but we now know that we have bracketed the size into a range where the spray is effective and practical to obtain.

Undoubtedly, the primary reason for acceptance and rapid growth of air sprayers has been the definite and sizable savings in spraying costs compared to hydraulic equipment. By designing equipment with remote controls, orchard and row-crop air sprayers may be operated by one man and, since operation is not difficult, the man may be trained to do satisfactory work in a relatively short time. The sprayers are equipped with tanks of the largest practical capacity to reduce the time required for transporting them to and from the water supply. All components of the equipment are engineered to ensure a minimum of operational difficulties and those mechanisms which require periodic service are readily accessible. These and other mechanical design features contribute to low cost operation of air sprayers.

However, the outstanding factor in cost savings is the ability of air sprayers to utilize much more concentrated chemicals than is possible with hydraulic equipment. The basic principle of operation of hydraulic sprayers requires that a sufficient volume of liquid be projected from the nozzles or gun to carry by its own force into the areas where it is desired. With air equipment, however, the liquid volume may be greatly reduced, since all that is necessary is that the material be introduced into the air stream in the form of a spray at the point of discharge from the machine. This ability of the air sprayer to operate with more highly concentrated chemical solutions, emulsions, or suspensions permits savings not only by reducing the time required for refilling but also by eliminating the substantial waste of chemicals resulting from the drip or "run-off" of dilute chemicals. Many users have found by actual experience that satisfactory control of insects and disease can be obtained by applying considerably less toxicant per tree, with air sprayers, than the conventional amount applied with hydraulic sprayers. A factor which makes this reduced toxicant possible is the lack of "run-off" associated with dilute spraying, but it is also generally true that more effective use is made of the chemicals which are deposited because of the thorough and more uniform coverage possible with air sprayers.

Many orchardists have kept accurate records of actual spraying costs which invariably show substantial savings in both chemicals and time when using air sprayers. As a general statement it may be safely said that chemical costs have been reduced by as much as 15% while labor savings have been in the range of 40 to 60%. While it is true that air sprayer equipment cost is somewhat greater than hydraulic, this difference is small compared to the operating savings realized over a few years.

In shade tree and sanitation spraying, also, actual cost records reveal impressive savings. As a concrete example of such records, the following was published by the Board of Park Commissioners of the city of Lansing, Mich. In 1951, the cost of spraying one round for mosquito control in nine city parks with hydraulic equipment was $197.20. In 1952, the same areas, plus three additional parks, were sprayed with an air sprayer for a total cost of $91.75 per round. The time required for hydraulic spraying was 20 hours while the air sprayer work was completed in nine hours. The report concludes with a statement that even though the cost was less than half, the control obtained with the air sprayer was at least equal to that obtained with the hydraulic sprayer.

Better Timing Possible

The fact that air spraying permits more rapid coverage results in another important advantage—better timing of applications and quicker applications during the critical periods when they are most needed. This is important because many applications of the right chemicals with the right equipment lose much or sometimes all of their value because of improper timing. Of course, the time a user sprays certain chemicals is beyond the control of the manufacturers but manufacturers can aid him in proper timing by supplying chemicals and equipment that can be effectively and quickly used, even under adverse conditions.

The problems and goals of the chemical and equipment manufacturers in advancing the science of insect and disease control are generally very closely allied and actually overlap in many cases. The necessity for chemical and equipment manufacturers to recognize the effective use requirements and limitations of each other's products has existed since the practice of spraying began 70 years ago and has increased in importance to the point where such consideration is a basic factor in the degree of success of their products. Increasing use of more highly concentrated chemicals has greatly amplified the equipment manufacturers' problems. Also, the increasing variety of chemicals adds to the difficulty of designing sprayers which will satisfactorily handle all of them. Each of the problems involved might well be subjects of individual papers; however, a few can be mentioned as being of outstanding importance.

Corrosion Difficulties

Probably the greatest difficulties are caused by the corrosive effects of the chemicals. Designing equipment with components which are reasonable in cost, are resistant to the chemical action of all materials they will contact, and have the other required structural characteristics frequently necessitates compromises. Materials satisfactory for tanks, pump parts, pipes, hoses, and nozzles must be given careful consideration. Since steel tanks are commonly used because of cost and strength qualities, an internal coating of resistant material must be applied. Several types of coatings are now being used by various manufacturers and many more are being tested. The coating we have found to be the most satisfactory is zinc bonded to the steel by the Metalizing process. Since this is a difficult and costly operation, it must be limited to expensive deluxe equipment.

The abrasive characteristic of many chemicals is troublesome, especially in pumps and nozzles. Many pump and nozzle parts could be designed to have excellent operating qualities much less expensively if they did not have to withstand the severe abrasion caused by many chemical formulations. Even though they are made of the finest abrasion resistant materials available, they are frequently the first parts requiring replacement because of wear.

Continuous Agitation

The necessity for thorough mixing and continuous agitation of certain chemicals causes a number of difficulties. In the more highly concentrated formulations, agitation must be vigorous to ensure uniformity of the material throughout large tanks. This necessi-

tates a costly mechanical agitation mechanism and use of a substantial amount of power. The action of the agitator sometimes causes a problem of excessive foaming of the material. This has been attributed to the effect of the wetting agents which are compounded with the chemicals in amounts satisfactory for normal dilute usage. When these compounds are mixed for concentrate use of four, six or even 10 times the dilute strength, the amount of wetting agent present is reported to cause the mixture to foam when agitated and during refilling operations.

Clogging of filling screens, line filters, and nozzles is another problem which has been amplified by the change to higher chemical concentrations used in air sprayers. Since discharge volume is reduced when using concentrates, the nozzle orifice sizes must be reduced to ensure proper break-up and spray patterns. To prevent excessive clogging of these smaller orifices, finer mesh filters and screen must be employed which, consequently, have greater tendency to clog, especially with materials difficult to keep in suspension in the quantities used in concentrate spraying.

While these examples of difficulties in handling chemical concentrates have been referred to as equipment manufacturers' problems, they are, of course, also limitations which the chemical manufacturers must recognize in practical use of their products. However effective the chemicals may be as toxicants, their value to the user is determined by his ability to place them at the proper location, in the proper quantity, and at the proper time to take advantage of their toxic effect.

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PROBLEMS AND MATERIALS OF SPRAYER CONSTRUCTION

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New types of pesticides and fertilizers have intensified the problems of the designer and manufacturer of sprayers. Chemical accumulation, corrosion, and abrasion are the trouble areas

SPRAY APPLICATION OF AGRICULTURAL pesticides has become a widely diversified practice involving several types of equipment. Some types of sprayers are produced for a specific purpose while others are used for numerous pest control requirements and many of the recent or present problems in sprayer design are a result of the diversified requirements and the complex situations occurring in spraying practices.

The versatility required in the modern sprayer can be best illustrated by a brief review of the history of agricultural pest control practices.

Prior to 1946 we had a long period of stabilization in the types of chemicals and equipment used. Inorganic chemicals, such as the arsenicals, coppers, and sulfur, were very generally used and the high pressure plunger pump was the accepted standard for a power sprayer. The basic sprayer unit was supplied with hand operated spray guns for orchard or grove spraying and with booms for field spraying. The operating pressure was generally 600 pounds per square inch to apply what is now termed a "dilute" spray.

Construction materials to withstand corrosion and abrasion have been under continuous study since pesticides were first applied by mechanical means. During this period of stabilization the high pressure sprayer was refined to handle effectively the dilute sprays commonly used. This was accomplished by the selective use of corrosion and abrasion resistant materials for the critical components. In addition, these components were designed for easy replacement at nominal cost.

Recent Changes in Pesticide Application

Four significant developments have occurred in agricultural sprayer use since 1946. These are: new chemical groups for insecticidal and fungicidal use; new chemicals for new purposes, such as herbicides, defoliants, soil conditioners, and liquid or water-soluble fertilizers; new spraying methods, such as the air blast sprayer and the tractor-mounted sprayer; and use of concentrated spray mixtures.

A demand for greater versatility in spraying equipment has resulted from these developments. The types and characteristics of the pesticides available have broadened. Many pesticides can be applied very effectively at low pressure while others may require high pressure and the quantity required per unit of area is quite variable. The same type of sprayer may be required to apply a dilute spray in addition to mixtures concentrated 5 to 10 times the dilute ratio.

The introduction of the air blast spraying method was a transition from manually operated spray guns or booms to an automatic operation in distributing the pesticide on the plants. Air is used as a carrier to replace some of the water formerly used, thus providing a means of safely applying concentrated spray mixtures.

In recent sprayer development the objective has been to obtain the required versatility at the lowest possible cost. However, the use of new pesticides and new application practices have brought forth some new problems and intensified the old ones. For purpose of discussion, the numerous factors which influence the serviceability, life, and usefulness of a sprayer can be broadly classified as: the effects of chemical accumulation, the effects of solvents, abrasion, and corrosion.

Each factor enumerated can be troublesome alone or in combination with one or more of the other factors. To avoid the details required to present the innumerable variations possible, only the typical problems are discussed.

Effect of Chemical Accumulation

The air blast spraying method furnishes several excellent examples of the effects of chemical accumulation on spraying equipment. The air blast and