A look at the future of herbicide application

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Today agricultural chemical usage is an integral part of the farming system because of financial losses caused by insect pests, fungal diseases and weeds. World expenditure on these chemicals is about $2,600 million.

Western Australia’s farmers now spend about $15 million a year on herbicides alone... a big proportion of their farm costs. This is good justification for many machinery manufacturers and farmers to look for ways to reduce costs and increase the efficiency of herbicide application.

Weed Agronomy Research Officer J. R. Peirce details some of the modifications to existing methods of ground application of herbicides, and new techniques now being applied in Western Australia and other parts of the world.

Misters

Ever since the introduction of 2,4-D for broadleaved weed control in cereals in the early 1950s, misters have been used in Western Australia. They work on the principle of an air blast at an angle of about 45° above the crop, into which the chemical, either concentrated or diluted, is metered. Because of spray drift problems, the variation in swathe width with changing wind conditions, and the rising cost of chemicals, farmers are tending to concentrate on more-accurate methods to apply herbicides.

Boom sprayers

These have been used for some thirty years in Western Australia. In recent years they have undergone radical improvements in design, function and construction materials. The spray tanks on the older booms were built either of wood or galvanised iron, and the boom arms were of galvanised water pipe. These machines were very heavy, relative to similar capacity units constructed today. Modern units have tanks of either fibre glass or stainless steel and the hoses or pipes along the boom arms are usually of plastic or stainless steel.

The pumps on the units have been improved, although the basic piston-type pump is still used widely. Roller pumps, diaphragm, centrifugal and turbine pumps also are in common use. This article does not review the merits and operations of these various pumps.

Two developments to boom sprayers in Western Australia have simplified crop spraying operations: The first of these is the metering of the herbicide so that the output per unit area is constant over a given range of speeds. The ‘computer’ spray consists of a conventional piston pump which is chain-driven from one of the ground wheels. Any change in ground speed is accompanied by a change in pump pressure and hence the output is regulated. With such sprayers the herbicide is added to the main water tank, thus the whole spray mixture is regulated.

In the second and more recent metering system, the concentrated chemical is injected into the spray lines. The amount of chemical injected is regulated from a ground wheel-driven pump. This means that only water is held in the main tank, so it is never contaminated with chemicals. Two independent pump systems are required, one operating at a constant output, from a motor or PTO-driven pump, to deliver water from the main tank to the boom, and a ground-driven pump which meters concentrated chemical into the main line at a rate dependent on groundspeed.

New techniques

Many advances in spray application technology have been directed...
towards reducing the volume applied, thus reducing the cost of spraying operation. Less water applied means fewer tank refills.

Spraying speeds also are being increased. This principle has been applied to boom spray modification. As a result, volumes have been reduced substantially below 100 L/ha, and in some instances as low as 15 L/ha. This has been achieved through lighter and stronger boom units, along with more-accurately designed nozzles. Some of today's plastic and ceramic nozzles are longer-wearing, and because of their moulded construction, are initially more accurate. The moulded nozzles tend to vary less in spray output than the drilled type, and the nozzle aperture is better finished, thus giving a more consistent fan pattern.

In other countries considerable research is being directed at improving the hydraulic nozzle (conventional boom spray nozzle) or developing other methods to produce droplets that will permit reduced application volume. Many reviews on this subject are available, but a more-recent one by Cox (1980) outlines the principles and history of the development of machinery for reducing spray volumes.

**Controlled droplet application**

One of the requirements in the early work to reduce application volumes was for drops to move by gravity, with as little drift as possible, to the target weed or soil surface. This required larger spray droplets of uniform size. From this the term CDA (controlled drop application) was derived to describe the process of producing sprays with a liquid drop size regulated to a much greater extent than is possible with the conventional hydraulic nozzles. For example, CDA should produce droplets of 150-350 microns diameter in spray volumes of 5-45 L/ha, while conventional nozzles will produce a wide range of droplets between 30-300 microns at volumes greater than 200 L/ha. With the CDA equipment now available it is possible even to produce droplets within 10 per cent of a selected size.

Today, many small commercial CDA units can produce uniform droplets at low volumes. The principle involves metering a solution of chemical and carrier onto a toothed spinning disc. The disc in the small hand-held units is driven by a torch battery-powered electric motor. Centrifugal force spins the liquid to the toothed edge of the disc where the teeth break it into drops. These units have been used in Victoria to apply 2,4,5-T to blackberries growing in areas inaccessible to machinery. Some are used in Western Australia to apply pesticides to vegetable crops.

Tests during the early development of the CDA gave mixed results. On average the CDA technique was about 20 per cent less effective with herbicides than conventional spraying methods. However, this was predictable. Obviously, not all the various herbicides used in selective weed control would give optimum performance when applied at a fixed droplet-size. Research was needed to reformulate many of the herbicides and also to determine the optimum droplet size that was most effective against the target weeds.

This is now being carried out to some extent. For example, Lake (1977) showed that small droplets (110 micron) were more effective than larger droplets in retarding wild oats growth. This was because leaves retained smaller droplets while larger ones bounced off. When applying the chemical paraquat to wild radish, he found no response to droplet size.

Development of tractor-mounted CDA equipment is progressing, but there are several major problems to be solved. Firstly, the present CDA designs require low operating speeds, which conflicts with current conventional boom trends. Secondly, discs produce a circular spray pattern which will not give an even linear swathe. However, this can be rectified partly by using shields that permit only a small fraction of the circular pattern to be released, and by increasing the number of spinning discs across the boom. This unit is cumbersome and extremely expensive. It would not be practical for cereal spraying in...
Western Australia where most booms are wider than 12 m. A further modification to the boom spray has been developed in South Australia. It uses the Micronair machine which was developed originally for aerial pesticide application. The Micronair unit produces a spray by feeding a chemical through a flow meter into a rotating wire gauze cage which atomises the liquid into droplets of uniform size. The speed of the rotating cage and the rate of flow of the chemical determines the size of the droplets.

These Micronair units, which are used instead of nozzles, have certain advantages in that they have no jets to block, so powdered herbicides can be applied easily. Also they can be regulated to form droplets of various uniform sizes. The formation of uniform droplets is of particular importance. Research is continuing to determine the size of droplets at which a particular herbicide performs best, or alternatively, what droplet size is required for a specific weed.

Although relatively new, these Micronair booms have been tested successfully in vineyards, orchards, market gardens and in some broad area situations. Further testing with herbicides will continue during 1981.

More recently a spinning cup (Micron Battleship) has been developed. It can produce uniform droplets over a swath width of 1.5-2 metres (Bals 1978).

Despite the fact that the CDA units supply uniform drops of spray solution which do not drift and are suited to the type of crop and weed, much of the lethal dose is wasted still because it misses the target plants. This wastage may be eliminated if the novel technique of forming electrically-charged droplets is developed commercially. Each droplet carries an electric charge which is attracted to plants because they act as 'earths'. Electrically-charged droplets cover both sides of the leaves of target plants. In addition to reducing wastage this technique cuts drift to a minimum, giving the operator greater safety and widening the range of weather conditions for spraying.

**Rope wicks and re-circulating sprayers**

Applicators of this type have been in existence for many years, but have had only limited success until the introduction of the herbicide glyphosate. So great was the impact of the combination of the new herbicide and the rope wick that within two years of their introduction farmers in the U.S.A. used the technique to treat more than four million hectares of cropland (McWhorter 1980). In 1979 some 26 manufacturers marketed over 15,000 rope wick applicators.

The basic rope wick unit consists of a P.V.C. reservoir from which the chemical solution flows down to a series of ropes. Each rope functions similarly to a lamp wick. The chemical solution moves readily along it. The wet ropes are brought into contact with the target plants, which they 'brush' with chemical.

There are many designs of these applicators and their rope configuration. A smaller unit is illustrated in this article.

This technique can be made plant-selective using the differences in height between the target weed and the crop or pasture. In the U.S.A. this method is very useful for removing tall grass weeds from crops such as cotton and soybeans. In Western Australia the rope wicks may not be so useful in the cereal districts, but they will find an application in many higher rainfall districts. Early results suggest that they remove Cape tulip, rushes, docks and Guildford grass from pastures, and perhaps grass weeds from certified clover pastures.

Re-circulating sprayers also rely on the differential height of the crop and weeds. The herbicide is sprayed horizontally from nozzles set above the crop onto the taller weeds. Any spray not captured on the weeds is collected on a shield and recycles to the main tank. Although basically doing the same job as the rope wick applicators, it is not as popular for several reasons. The machines are much more cumbersome and expensive.