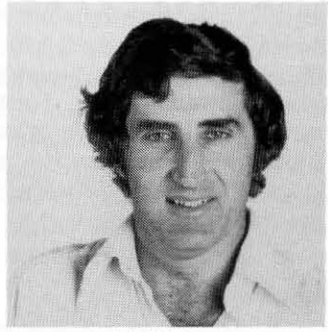
GENERAL ARTICLES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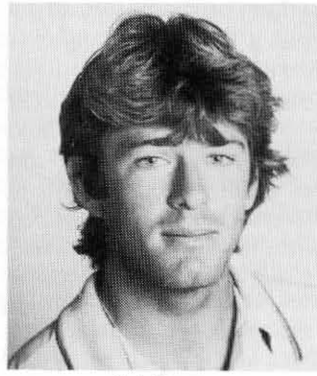
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Small plot sprayer for testing rates of herbicides applied singly or in mixtures

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Summary

A motorized experimental plot sprayer has been constructed which can apply a single herbicide at a fixed concentration, dilute successive applications of a herbicide by a fixed amount, dilute one herbicide in a mixture whilst increasing the concentration of the other, and function as a normal logarithmic sprayer. The sprayer's construction allows the rapid testing of a number of herbicides at different concentrations over areas large enough to be machine harvested.

Introduction

Testing herbicides for the control of weeds or for crop and pasture tolerance can be very time consuming, particularly if combinations of herbicides are being evaluated. Commercial and experimental plot spraying units are available that operate on a continuous dilution system to give a logarithmically reducing range of treatments; they have taken many forms (e.g. Fryer and Elliott, 1954; Pfeiffer *et al.*, 1955; Brunskill, 1957; Day, 1958; Yates and Ashton, 1960). Modifications of various commercial hand held sprayers to make logarithmic sprayers have also been made (Kasasian, 1964 and 1969).

While logarithmic or variable dosage rate sprayers are useful for initial screening of some herbicides, neither the hand nor the currently available motorized units permit a large enough area of crop to be treated with a constant dose if mechanical harvesting for yields is essential, as in the case of cereal herbicide tolerance studies. A variation to the standard logarithmic sprayer provides a step-wise dilution of the concentrate rather than a continuous dilution (Leasure, 1966) and overcomes the problem of taking yield measurements across areas that vary in dosage. With step-wise dilution it is possible to select the ratio of dilution and apply a fixed rate over a large enough area for assessment.

The acceptance of tank mixes of various herbicides for broad-leaved and grass weed control in Western Australia (Peirce, 1979) and increased demand for cereal tolerance data have brought about a need for a more versatile experimental sprayer that permits rapid testing of many rates of herbicides either singly or in combinations. The machine has to be light enough to drive over cereal crops without causing wheel track damage, and small enough to be easily manoeuvrable between plots. It also has to have the capacity to treat plots which are wide and long enough to harvest with existing mechanical harvesters. Such a machine has been designed and constructed at the experimental machinery workshop of the Department of Agriculture in Western Australia and is described below.

Construction

The unit is self-propelled by a 170 cc four-stroke motor through a three-speed Albion gear box, and can achieve speeds of 1 to 10 km h^{-1}. Vehicle tyres (5.25×15) are used to minimize crop damage and prevent the unit from sinking into cultivated soil, and the operator follows the machine and adjusts direction and spraying from the controls at the rear (Figure 1).

The wheels are spaced 1.6 m apart and the machine and boom are quite stable. The adjustable height guiding wheel is attached to one of the hand shafts to give the operator control over nozzle height. The boom has six nozzles spaced 40 cm apart giving an effective swath width of 2 m.

Three stainless steel tanks of 7-, 10- and 22-litre capacity are used. The two smaller tanks (A and B in Figure 2) hold the herbicides and the larger tank (C) the water used for dilution and washing out the system. Compressed air is fed into the tanks via inlets (i) to force the liquids to the boom.

Liquid is forced down tube g of tank A, and by changing the level of the top of this tube the concentration or dilution rate can be altered. Once the liquid has been discharged down to the level of the top of tube g the tank is refilled with water from tank C, thus giving another dilution. Experiments conducted so far with this unit have used a step-wise dilution factor of 0.2, that is, every treatment used only 20% of the volume of chemical in tank A. In this manner, if the initial concentration is 1 kg ha^{-1}, then the second treatment would be 0.8 kg ha^{-1}, the third 0.64 kg ha^{-1} and so on for as many dilutions as may be required.

Thorough mixing takes place in tank A because new liquids enter through small holes along the length of tube h, setting up a swirling motion to aid mixing. Agitation of the contents of tanks A and B is aided by having the air tube outlets (i) at the bottom of the tank angled to cause swirling in the liquid.

Operation

Normal or constant dosage plot spraying is performed by filling tank A or

Figure 1 The small plot sprayer in use in the field

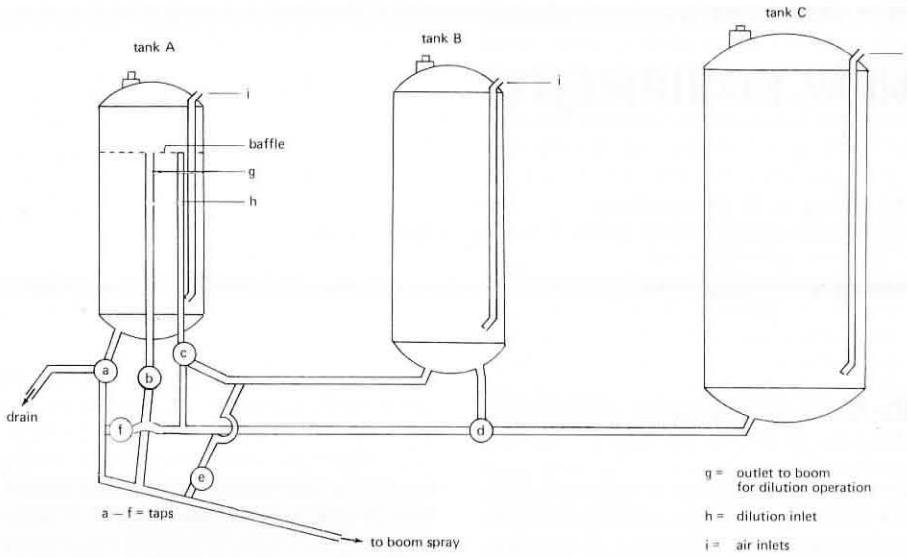

Figure 2 Schematic layout of the tanks and connections of the small plot sprayer

B with the herbicide and opening the appropriate taps between the tank and the boom.

Stepwise dilution spraying is achieved by filling tank A with the herbicide to be diluted and spraying out the first dilution. The boom is then washed out with water from tank C and the new dilution obtained by adding water to tank A from tank C. As tank A fills air is bled off from a valve at the top. Once the tank is full the spraying process is repeated. The dilution factor is regularly checked by using a salt solution of known initial concentration which is diluted in the same manner as the herbicides and the dilutions collected from the nozzles. The salt concentrations are determined by using a conductivity meter. Sample results are given in Table 1.

Diluting one herbicide while increasing the concentration of another is achieved by placing the herbicide to be reduced in concentration in tank A and that which is to be increased in tank B. After the first treatment is applied and the boom washed out, herbicide from tank B is injected into tank A so that the herbicide originally in tank A becomes less concentrated, whilst that being mixed with it from tank B becomes more concentrated.

Logarithmic spraying can be carried out if a suitable manifold is placed after tap (a) and hoses of equal length connected to the spray nozzles.

Costs and materials

The three stainless steel tanks cost \$57, \$77 and \$107 respectively for the 7-, 10- and 22-litre tanks. The three two-way brass taps cost \$136 altogether and the three three-way taps cost \$180. The air gauges cost \$39 and other fittings and adapters \$17. The motor and gearbox are not included in the price as they were already part of a spray vehicle. Labour and welding costs are also not included. The taps and fittings were supplied by Swagelok Pty Ltd of Sydney, but since construction of the original sprayer other fittings and two- and three-way taps have become available.

Discussion

Although operation of the sprayer looks complicated due to the number of taps, it is quickly mastered. Once this occurs it is very efficient and one person can, for example, apply an experiment containing four herbicides at five dilutions having three replications and a plot size of 3 m × 10 m within two hours. The testing of mixtures of two herbicides can be done just as rapidly.

The only minor problem has been foaming of some herbicides through the air bleeds at the tops of the tanks during refilling. The unit is not suitable for spraying tall crops as boom height adjustment is limited to about 70 cm above the ground.

A more detailed account of the unit's construction, capabilities and operation can be obtained by contacting the authors.

Table 1 Conductivity tests of concentration of dilutions when the sprayer is used for step-wise logarithmic dilution

Dilution order	Chloride (Cl mg L^{-1})	Actual dilution[1]	Theoretical dilution
1	1150	0	0
2	932	0.810	0.800
3	729	0.634	0.640
4	590	0.513	0.512
5	483	0.420	0.410

[1] mean of four replicates

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