DEVELOPMENTS IN GRANULAR HERBICIDE APPLICATION EQUIPMENT ON RAIL TRACKS

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Summary. The application of granular herbicides on rail track had, as early as 1979, demonstrated an ability to provide greater cost efficiency, increased safety to non-target species and improved weed control efficacy due to greater flexibility of application. Subsequent operations involving early commercial granular application equipment[3], highlighted four major functional deficiencies which restricted the maximisation of these benefits. Though the basic principle of the airblast equipment remains the same, more recent machines[3] have been gradually modified to improve these four critical areas of uniformity of air flow, uniformity of granule flow, uniformity of granule placement and operator reaction time.

INTRODUCTION

Early development work demonstrated that hexazinone based granules[4] provided efficacious weed control while concurrently evaluating various types of application equipment (McLennan and McFadzean 1979). It was confirmed that the most practical method was the "fluidising" of the herbicide granules into an air stream using air blast equipment.

By 1980 the first commercial air blast unit was in operation. This was the forerunner of the Macspred[3] range of granular application equipment. The basic principle is the gravity drop of granules through a metering device into an air stream which is directed through distributor arms so as to accurately and uniformly place granules over a target area.

The early Macspred units did demonstrate the projected benefits of granular herbicide application, namely: -

1. ease of use,
2. well defined weed control,
3. operator controlled variability of application across the swath width,

[3]Trade name MACSPRED® (various models)

[4]Trade names VELPAR® 20G (200 g kg^{-1} hexazinone) and DYBAR® 10/10G (100 g kg^{-1} hexazinone + 50 g kg^{-1} bromacil + 50 g kg^{-1} diuron)

4. flexibility of application rates in relation to weed pressures and weed spectrums,
5. speed of operation

It did become evident that there were design faults which limited the projected degree of performance efficiency and safety to non-target species. Constant monitoring of commercial field applications showed that operational efficiency was related to four major functional requirements. Consistency of calibrated rates through predetermined meter settings was interdependent on:

1. uniformity of air flow, and
2. uniformity of granule flow,

and economy of application, efficacy against weeds and safety to non-target species depended on:

3. uniformity of granule placement, and
4. operator reaction time.

DESIGN MODIFICATIONS TO IMPROVE PERFORMANCE

Following recognition of the equipment limitations, the problems and necessary solutions that were actioned are detailed below:

Design functional requirement	Problem	Solution
1. Uniformity of air flow		
• Even flow discharge per distributor arm is fundamental to "fluidise" granules for uniform swath distribution.	• Variability of air flow - granule output found to vary by up to 20% from left to right hoppers.	• Install individual fans for each meter feeding each distributor arm.
• Constant air flow (fan revolutions) is mandatory for uniform granule application.	• Fluctuating application rates ha^{-1} on similar meter settings.	• Mechanism to quickly readjust belt drive tension installed.
2. Uniformity of granule flow		
• Uniformity of granule size and bulk density are critical to metering and flow characteristics, particularly at low application rates ha^{-1}.	• Blockages and flow reductions of up to 10% were experienced between manufactured batches of the same granular product.	• Manufacturing quality control achieved consistent granule size and bulk density; also, the equipment modifications below improved granule flow: (a) all contact surfaces (hoppers, tubes and meters) were changed from mild to stainless steel, and

Design functional requirement	Problem	Solution
2. Uniformity of granule flow (cont.)		
		(b) mesh screens were incorporated into the hoppers, and (c) as an operational function, all granules are removed at the completion of each day's activity - necessary as granule products are hygroscopic.
3. Uniformity of granule placement		
• Maximisation of herbicide efficacy requires uniform granule placement across the swath, and the ability to vary herbicide rate within the swath in relation to weed pressure.	• Swath pattern varied according to the airflow and the angle of the fish-tail distributor nozzles.	• Overall swath width variation is readily achieved by simple height adjustment. The introduction of adjustable vanes in the fish-tail distributor nozzle achieved the necessary variation in direction and concentration within the swath.
• Accurate and fast acting controls are imperative for environmental protection (i.e. non-target areas like channels, streams, embankments).	• Original metering was so constructed that orifice selection ranged from 0 to 12.	• The "on-off" controls were made positive but selective by installing "off" positions between each "on" meter setting.

Design functional requirement	Problem	Solution
4. Operator reaction time		
• Operator concentration is critical. Functions include avoiding: (a) damage to non-target species (eg. trees), and (b) movement down embankments, and (c) application into channels and streams, and (d) obstructions in the cess, whilst: (a) assessing weed pressures, and (b) assessing weed spectrums.	• Operator is required to simultaneously perform multiple operations.	• Collectively system requirements were met by: (a) installation of immediate total cut-off switch, and individual hopper immediate cut-off switches, and (b) electronic operation of meters to achieve required setting (c) remote control of side (cess) distributor arms allowing a swinging movement.

MACSPRED TRACKPACK 3000A

The Trackpack 3000A is the latest addition to the Macspred range of granule application equipment. It has been designed and constructed to incorporate those features that will maximise granule flow, performance and overall efficiency of the total operation.

General Description (see Figure 1.)

The stainless steel hoppers are divided into two banks, each containing four compartments. The forward or maintenance hoppers are designed for normal application whilst the rear "spot-out" hoppers allow additional product or an alternate product to be applied across the total swath width, or portion thereof.

A diesel motor provides the operational power of 240 volts AC and drives the four blower fans. Electric motors control the operation of:

1. lateral movement of each side (cess) distributor arm,
2. cut-off plates for each of the eight hopper outlets,
3. each of the eight feed screws - these motors are variable speed and are individually operated allowing positive rate variations.

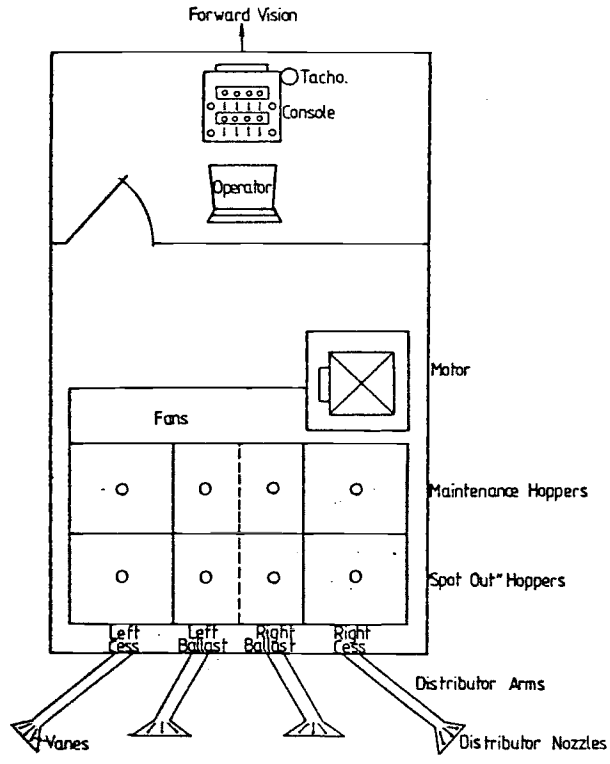

Figure 1. General layout of Macspred Trackpack 3000A mounted in specially designed vegetation management vehicle.

The operator sits in a cabin at the front of the unit. He has complete forward vision and controls all operations from a console. Provided is:

1. one switch immediate cut-off of all fans and screws and therefore the total flow of granules,
2. individual cut-off plates for each hopper,
3. variable screw feed from each hopper which enables rapid application rate variation,
4. monitoring of speed, plus an easily read chart showing settings relative to the required rate of application.
5. controls for the variable lateral positioning of the cess arms.

Summary of the Innovative Features

1. Uniformity and Placement (see Figure 2.)

The innovative features incorporated into the Trackpack 3000A that improve uniformity and placement are:

1. positive screw feeding of the granules ensuring application rate accuracy,
2. screw speed variability ensures rapid application rate variation to meet variations in weed pressure and weed species,

Summary of the Innovative Features (cont.)

1. Uniformity and Placement (see Figure 2.) (cont.)

3. four hopper feeding enables a more economical overall application to control variable weed pressures both along and across the swath,
4. the additional four "spot-out" hoppers provide a dual service in as much as they can function as either a supplement to the maintenance hopper application by increasing rates of the same herbicide on difficult-to-kill species and dense biomasses, or as an alternative to the maintenance hoppers by providing another herbicide capable of meeting the demands of changes in weed spectrum, or movement into an environmentally sensitive area.

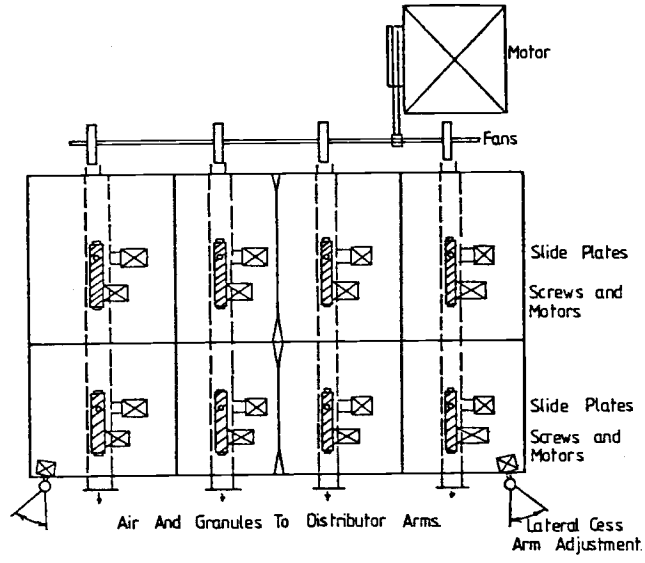

Figure 2. Detailed layout of Macspred Trackpack 3000A showing granule metering mechanism and lateral cess arm adjustment.

2. Operator Reaction Time (see Figure 3.)

All operations are electronically controlled by direct "make-or break" or rheostat switches. This rapid action allows even small areas of problem weed species to be accurately treated as well as allowing potential hazard areas to be more readily avoided.

One operator can responsibly maintain an efficient and environmentally safe application at speeds up to 40 km hr^{-1}. Whilst the Trackpack 3000A can operate and accurately place granules onto a target area at speeds of 60 km hr^{-1}, it has been determined, based on field experience and the volume of granules usually being applied, that in the interests of overall efficiency and safety to non-target species, optimum operating speeds should be in the region of 30 to 40 km hr^{-1}.

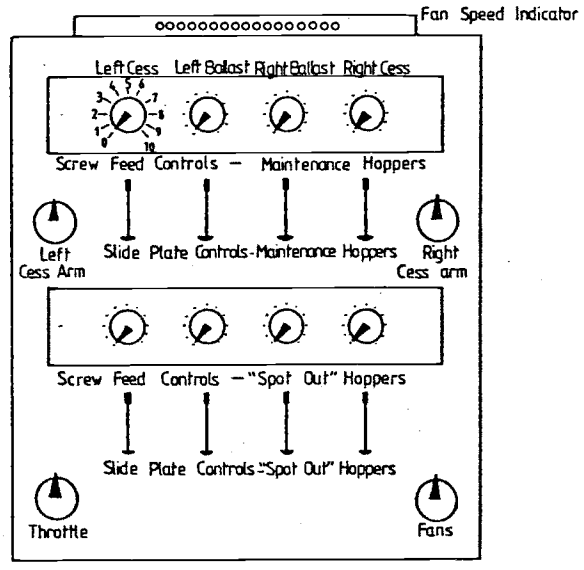

Figure 3. Layout of operators console of Macspred Trackpack 3000A.

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