MR COLIN WARD
DEPT OF C.A.L.M.

MANJIMUP RESEARCH

DEPT OF CONSERVATION
AND LAND MANAGEMENT
50 HAYMAN ROAD
COMO 6152

Ref 26/86 THW/ES

June 19, 1986

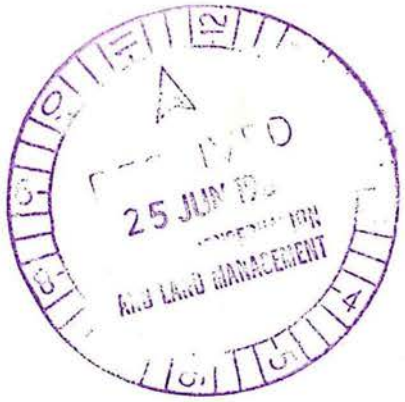
TRAINING IN THE USE OF CHEMICALS

Arrangements have been made for a training school for District Chemical Officers and other staff involved with the use of chemicals. The course will be conducted by the Agricultural Protection Board and other specialist officers.

It will take place at the Noalimba Centre, Venus St, Bateman, from 11.30 hours on Monday the 28th of July till 1200 hours on Thursday the 31st of July, 1986. Accommodation (twin share) and meals are provided at Noalimba and these costs will be paid directly by the Department. Officers using this accommodation will be able to claim $4 per day for incidental expenses.

The following personnel have been nominated to attend.

1.	Barry Jordan	Harvey
2.	Malcolm Graham	Katanning
3.	John Dorlandt	Como Research
4.	Wayne Aggiss	Walpole
5.	Wolf Tiedemann	Nannup
6.	Steve Davis	Collie
7.	Brad Commins	Busselton
8.	Colin Ward	Manjimup Research
9.	John Rooney	Kalgoorlie
10.	Gary Hartnett	Jarrahdale
11.	Grant Pearson	Woodvale
12.	Rod O'Donnel	Broome
13.	Don Greenwood	Yanchep N.P.
14.	Richard McAlinden	Dwellingup
15.	Clayton Sanders	Wanneroo Research
16.	Greg Durell	Narrogin
17.	Rory Butcher	Busselton Research
18.	Wally Edgecombe	Karratha
19.	Craig Gardiner	Kirup
20.	Jamie Ridley	Mundaring
21.	Gordon Graham	Murdoch House, Metropolitan Region
22.	Lindsay Bunn	Manjimup
23.	Paul Marsh	Wanneroo



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Regional Leaders are to make travel arrangements for participants in their respective Regions. Participants are asked to arrive at Noalimba Centre not later than 11.30 am on the opening day for checking in and lunch. Please bring personal effects for overnight stay as well as notepaper and pens and wet weather gear for outdoor use.

For any queries please contact Mr Tom Wood at SHQ Como.

REGIONAL FORESTER (SAFETY)

Distribution:

All participants
District Managers of all participants
Regional Managers of all participants
Manager Research Como, Manjimup, Wanneroo & Busselton
R/F Pridham, Dwellingup
Manager Wildlife Research, Woodvale
Mr Fremlin, Busselton
Mr Scott, Bunbury

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

Training Course on the use of chemicals at Noalimba Training Centre, 28 to 31 July, 1986

Monday 28th July

11.30	Arrival and Registration	
12.00 - 13.00	Lunch	
13.00 - 13.30	Opening. Course Objectives	Mr G Bradshaw, CALM
13.30 - 15.00	Pesticides - Government Legislation	Mr P A Rutherford Dept of Agriculture
15.00 - 15.15	P.M. Tea	
15.15 - 17.00	Terminology, Groups, Mode of Action, Characteristics	Mr B Uren, APB

Tuesday 29th July

08.30 - 10.00	Calibration methods. Theoretical	Mr C Newman, APB
10.00 - 10.15	A.M. Tea	
10.15 - 12.00	Calibration methods. Theoretical	--- " ---
12.00 - 13.00	Lunch	
13.00 - 15.00	Application methods & techniques. Practical	Mr D Chantler, APB Mr C Newman, APB Mr I Scott, CALM
15.00 - 15.15	P.M. Tea	
15.15 - 17.00	do do	do

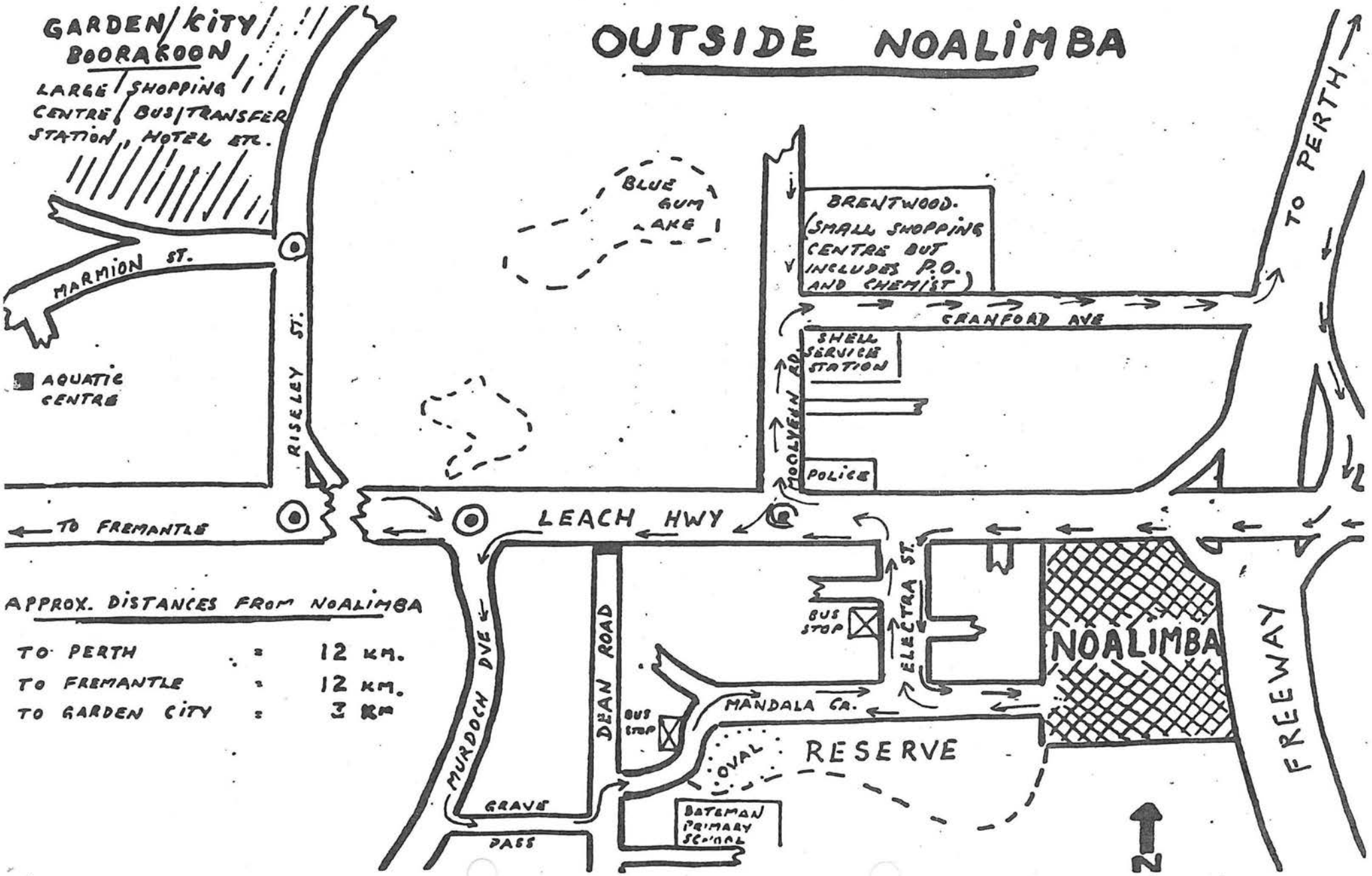
Wednesday 30th July

08.30 - 10.00	Operator and Environmental Safety	Mr D Chantler, APB
10.00 - 10.15	A.M. Tea	
10.15 - 11.00	Operator and Environmental Safety (continued)	Mr D Chantler, APB
11.00 - 12.00	Equipment used by C.A.L.M.	Mr I Scott, CALM
12.00 - 13.00	Lunch	
13.00 - 14.00	Health Legislation	Mr N Bolton Health Dept
14.00 - 15.00	Bulk Transport. Declared plants & animals	Mr D Chantler, APB
15.00 - 15.15	P.M. Tea	
15.15 - 17.00	Use of Herbicides in CALM Softwood Operations	Mr R Fremlin, CALM

Thursday 31st July

08.30 - 10.00	Use of Herbicides in CALM Hardwood Operations	Mr T Birmingham, CALM
10.00 - 10.15	A.M. Tea	
10.15 - 11.30	Use of Herbicides in National Parks. Target Species	Mr R Madin Dept of Agriculture
11.30 - 12.00	Course Review & Close	Mr Chantler, APB/CALM
12.00	Lunch	

OUTSIDE NOALIMBA



APPROX. DISTANCES FROM NOALIMBA

TO PERTH	=	12 KM.
TO FREMANTLE	=	12 KM.
TO GARDEN CITY	=	3 KM

CHEMICAL USERS MANUAL.

Notes for Chemical Training 28-31st July, 1986.

INTRODUCTION.

The Chemical Users Manual as used by the Department of Conservation and Land Management contains instructions for safe use, handling methods, correct first aid and health hazards of chemicals being used in the field. Many of these instructions are brought about by Government Regulations.

The Manual also provides the basis for training courses in chemicals.

THE MANUAL.

A chemical instruction sheet (FD 729) is included in the manual for every chemical being used in the field. Before inclusion in the Manual, Health Department approval is necessary. Chemicals which have had their use restricted by the Department of Health have their information printed on a green sheet. These chemicals are to be used only as instructed on the label.

Only chemicals registered with the Department of Health and included in the Manual will be used.

Chemical users must sight and understand the relevant sheet and be aware of the personal precautions and hazards to health.

Each District has a nominated chemicals officer to ensure that requirements of the Users Manual is being followed as well as the A.W.U. Forestry Award.

Manual reviews and chemical business is dealth with by the Departmental Chemicals Committee.

Chemical sheets (FD 729) incorporate all relevant information from the main text of the Manual, State Regulations, manufacturers data, C.A.L.M. prescriptions and Health Department instructions.

SHEET NUMBER.

The Manual has been divided up alphabetically into Sections.

"A" = Herbicides
"B" = Fungicides, and so on.

The number indicates the sheet number in each section eg.
A30 = Herbicide sheet number 30.

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TRADE NAME.

Trade names of products will differ depending on the manufacturing company. Identical products (with the same active ingredient) are sold under different trade names.

ACTIVE INGREDIENT.

Expressed a number of ways.

Eg. A. grams of A/1 - litre of product
B. grams of A/1 - kg of product

The active ingredient is that part of a chemical which does the job required.

Eg. Herbicide - Vorox A/1 320 g/l Atrazine
320 g/l Amitrole

Amitrole performs the knockdown grass control while atrazine is the residual to effect pre-emergent grass control.

CLASSIFICATION.

The Chemical Users Manual is divided into sections Eg. Herbicides, Fungicides, Insecticides etc.

FORMULATIONS.

Many formulations exist. Powder, liquid, granulated etc.

USE.

Strictly speaking chemicals may only be used for the purpose and rate stated on the FD 729.

MIXING.

Mixing of concentrates should only be carried out by directly supervised personnel using no-touch methods and preferably in a well ventilated area. Only mix approved chemicals because some mixtures may be incompatible causing a breakdown of required results or even a lethal combination.

Actual product is the figure stated when referring to application rates. Eg. 5 litres of chemical/ha not 5 litres of A/I.

PROTECTIVE CLOTHING.

For mixing and application operations each individual FD 729 states what protective clothing is needed for handling the

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chemical. This is compulsory and any variations from this must be approved by the Health Department via Safety Branch. Protective clothing is supplied by C.A.L.M. and must comply with Australian Standards.

PERSONAL PRECAUTIONS.

Safety precautions that are the sole responsibility of the chemical user. Eg. Clean any protective clothing used and thoroughly wash exposed parts of the body as soon as possible after the job is completed and before drinking, eating or smoking.

HAZARD TO HEALTH.

This refers to the measure of an adverse effect on the health of people involved or inadvertently involved in a particular chemical exposure. It can be assessed as high, medium or low intensity.

FIRST AID.

For each type of chemical, standard procedures apply to swallowing, splashing in the yes and spillage over persons. These are stated on the FD 729 Chemicals Sheet.

When a person becomes ill apparently as a result of working with chemicals, first aid should be given, the local medical officer notified and the person transported as quickly as possible to a medical centre.

The relevant FD 729 should also be given to the Doctor.

A record of exposure is to be kept on workers exposed to pesticides or materials treated with pesticides.

ENVIRONMENTAL LIMITATIONS.

Some areas have State restriction governing the use of certain chemicals. Permission is necessary to use them. Eg. Herbicides and vineyards.

Application, storage, spillage and disposal of empty containers require special precautions so as not to contaminate people or the environment. Users should comply with manufacturers label, C.A.L.M. prescriptions and State laws.

STORAGE.

Government Regulations control the storage and tranport of chemicals.

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There is standard specifications for chemical store design.

Records of storage and usage are necessary.

SPILLAGE.

Procedures for cleaning up spillages vary considerably from chemical to chemical. Details of these are described on each chemicals sheet. If there is any doubt as to what action is needed enquiries should be directed to the Safety Officer S.O.H.Q.

DISPOSAL OF EMPTY CHEMICALS CONTAINERS.

Various methods of disposal are necessary according to container type being disposed. Chemical sheets state the recommended method.

If the method of disposal could cause problems, consult the local Health Surveyor.

MANUFACTURER - DISTRIBUTOR.

These vary from year to year according to who has won the Government tenders to supply each chemical.

To find alternate Company trade names with equivalent active ingredients it is necessary to consult the Pesticide Register of W.A. which is published annually by the Department of Agriculture.

For further detailed information refer to the Chemical Users Manual.

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I.D. SCOTT
CHEMICALS OFFICER

IDS:CGC

16th July, 1986.

TRAINING COURSE ON THE USE OF CHEMICALS

28 - 31 JULY, 1986

THE USE OF HERBICIDES IN SOFTWOOD PLANTATIONS

THE USE OF HERBICIDES IN SOFTWOOD PLANTATIONS

INTRODUCTION:

It has long been recognised that competition from unproductive vegetation in pine plantations has a substantial effect on the survival and productivity of trees. Failure to adequately control grass and annual broad leaved weeds during the establishment phase will at best reduce growth and more probably result in inadequate survival. In many instances total mortality has occured.

Where native forest is converted to plantations there is usually a need for post establishment weed control. Species most likely compete with pine include Eucalyptus spp, Acacia pulchella, Acacia europhylla, Acacia myrtifolia, Pultenea reticulata, Bossaea aquifolium, Trimalium spathulatum and Pteridium esculentum. In extrmeme circumstances these species, if allowed to remain uncontrolled, have the potential to reduce volume production by up to 80%. In Western Australia trials have shown that the equivalent of eight years growth may be lost due to scrub competition.

In many circumstances where there is a potential for competiting species to exist, control by herbicides is the only practical option.

This section of the course aims to explain the factors that are involved in preparing a prescription for controlling potentially competitive vegetation.

ESTABLISHMENT OF PINES ON PASTURED SITES

i) ANNUAL GRASSES AND HERBACEOUS WEEDS

Traditionally the control of annual weed has been achieved by two methods. Firstly by pre-plant sprays of proprietory mixture of atrazine and amitrole (ie. Vorox AA). This is usual where hand planting is envisaged and spraying is in strips, two or three weeks prior to planting. Trees are planted in the middle of the sprayed strips. Where machine planting is possible spray nozzles are attached to the rear of the planter and the herbicide is applied over the top of the seedlings. It has been usual to apply "Vorox AA"

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in both these circumstances at 4 lha^{-1} although different rates have been used occasionally. Reports of poor efficacy, especially relating to the control of late germinating species and on wet sites prompted studies of alternative ratios of atrazine adn amitrole than was available in proprietory mixes. Some Districts increased the rate of "Vorox AA" to as high as 7 lha^{-1} to improve the residual capacity of the treatment. However on dry or sandy soil this often resulted in amitrole toxicity.

Studies over a number of seasons on different soil types, in different climatic regions, have enabled us to prescribe herbicide treatments that will be appropriate for different conditions.

The factors that influence the efficacy of atrazine/amitrole mixtures include:

a) Soil Type : phytotoxicity is more likely to occur on sandy soils than on laoms or clay soils.

b) Weed Composition : late germinating species, Rye Grass (Lollium rigidum), Lotus (Lotus minor) etc., will require higher rates of atrazine if control is to be assured.

c) Weed Development : it is advisable to spray weeds when they are as small as possible. This will enable you to reduce the rate of amitrole.

d) Soil Moisture Relationship : there is usually a requirement to increase the rate of atrazine on moist sites because of accelerated leeching. It is essential to mound sites that may become waterlogged for periods of the year. Spraying on the mound will give adequate control.

e) Strip Spraying : studies have demonstrated that the optium swath width for sprayed strips when establishing pines is 1.5m. However, in circumstances where tall weeds (eg. Wild Radish, Raphanus raphanistrum) occur it is advisable to increase this to two metres. Tall weeds

fall over and smother young trees.

f) Sprayer Output : in order to correctly prescribe a herbicide treatment to suit your circumstances it is necessary to mix atrazine and amitrole in the appropriate ratio. This can be achieved in two ways;

i) - mix Gesaprim 500 FW (500 gml^{-1} atrazine) with Weedazol TL plus (250 gml^{-1} amitrole + 220 gml^{-1} Ammonium thyocyanate).

ii) - calculate the appropriate rate of amitrole using Vorox AA or equivalent and add Gesaprim 500 FW in order to apply the correct rate of atrazine.

The minimum rate of atrazine to ensure weed free conditions throughout winter and spring is 2.5 $kgha^{-1}$ (5 lha^{-1} Gesaprim 500 FW). This should be increased to 3.5 $kgha^{-1}$ (7 lha^{-1} Gesaprim 500 FW) on moist sites, where late germinating species occur or where weeds are predominantly broadleaved species.

Where weeds are small (< 50mm) amitrole applied at 0.5 $kgha^{-1}$ (2 lha^{-1} Weedazol TL plus) is adequate. This rate should be increased up to 1.0 $kgha^{-1}$ (4 lha^{-1} Weedazol TL plus) for weeds up to 150mm in height. In situations where weeds exceed this height the rate can be increased to 2 $kgha^{-1}$ (8 lha^{-1} Weedazol TL plus). However, at rates above this amitrole may be toxic to pines. All spraying involving atrazine/amitrole mixtures should include a wetting agent at the rate of 1 lha^{-1}.

ii) PERENNIAL GRASSES AND HERBACEOUS WEEDS

Amitrole is not effective against perennial weeds. Glyphosate is substituted at rates between 1.08 $kgha^{-1}$ and 2.16 $kgha^{-1}$ (Roundup at 3 to 6 lha^{-1}). The lower rate is effective on actively growing plants while the higher rate is recommended where plants are dormant or heavily matted (eg Kikuyu Grass, Pennisetum clandestinum. The efficacy of Glyphosate is improved by the addition of 2% (w/v) of Ammonium Sulphate to the mixture. Glyphosate cannot be

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sprayed over pines.

iii) WOODY WEEDS

Woody weeds is a term describing plants that grow into shrubs or trees. Acacia spp., Eucalyptus spp., Pultenea spp., etc. come under this description. Measures to control woody weeds should be implemented before the effects of competition are expressed. Except for Eucalypts, it is usual to control this type of competition by interrow cultivation. However, logistics often prevent cultivation, besides weeds are only killed in the interrow, not in the rows. Hexazinone (Velpar L) is an effective herbicide against this type of weed and can be safely sprayed over pines. Plantations should be inspected regularly and the herbicide applied when weeds are small. Recently germinated plants can be controlled by spraying at 1.25 $kgha^{-1}$ (5 lha^{-1} Velpar L). Although pines may tolerate up to 3.75 $kgha^{-1}$ (15 lha^{-1} Velpar L) it is important for economic reasons to spray plantations when weeds are small. Boomspray application of Velpar L is not recommended for controlling Eucalypt regrowth in plantations. This is because most regrowth originates from an established root system and requires a different method of control.

iv) BRACKEN (Pteridium esculentum)

Bracken is a highly successful competitor for resources in young pine plantations. It is also difficult to control. The most successful method available at this time is to slash the plant in late spring (November) and apply herbicide to fully mature, even aged, fronds in autumn (April). Glyphosate (Roundup) is recommended and can be applied by either a rope-wick applicator or boom spray. For rope wick application the recommended concentration is 1 part "Roundup" to 2 parts water. Where boom sprayers are to be used apply a mixture of Roundup at 6 lha^{-1} and Ulvapron at 10 lha^{-1} in water. It is essential when spraying bracken that boom sprayers are calibrated to apply as low a quantity of liquid per hectare as possible. The efficacy of Roundup

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is increased if applied as small even droplets in a concentrated solution.

CONTROL OF EUCALYPT REGROWTH IN PINE PLANTATIONS

Three methods for controlling eucalypt regrowth in plantations have been developed. As with other forms of competition eucalypt regrowth should be controlled before the effects of competition are expressed. The foliar spray technique offers this advantage; in addition to being the most economical method. However, there remains a backlog of plantations where regrowth is advanced for which other methods of control are more appropriate. The most effect of these is the cut-stump technique. This has proved to be superior to stem injection because it is easier to supervise and more positive in nature. It is also applicable to a wider range of size classes.

FOLIAR SPRAY TECHNIQUE:

Spraying is best carried out between October and February to regrowth of less than 800mm in height. The type of equipment used is optional. However, most Districts use pneumatic sprayers fitted with either fan or cone nozzles. A mixture of 1 part Roundup to 15 parts of water is used and it is important to completely cover all the foliage. However, to spray to the point where runoff occurs is wasteful as Roundup is not active in the soil. Many people prefer to add a herbicide dye in order to see what has been treated. Only Ciba Geigy red herbicide dye is recommended for this purpose.

CUT-STUMP TECHNIQUE:

Treatment may be commenced in September and continued until the end of April. Regrowth about 1 metre in height can be treated provided all stems in a stool are treated. A mixture of 1 part Roundup in 10 parts water is applied to the freshly cut stumps through a vaccinator at a rate of 2ml to every 25mm of stump diameter. It is important to cut the stem horizontally as close to the ground as possible and apply the herbicide within 15 seconds. It is recommended that Ciba Geigy red herbicide dye be added to the water.

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STEM INJECTION TECHNIQUE:

This method is not recommended for controlling eucalypt regrowth in pine plantations. For it to be successful it requires a high level of supervision and a commitment on the part of the operators to apply the method conscientiously.

Treatment can be continued throughout the year provided its not raining.

When notching trees it is important to use an axe with an approximate blade width of 25mm to ensure that the herbicide is contained in the cambium zone. The point of injection must be below any live branch and as close to the ground as possible.

A mixture of 1 part Roundup to $1\frac{1}{2}$ parts water should be applied at the rate of 2ml to each notch. Notch frequency is one to every 25mm of stem diameter and should be placed evenly round the stem.

R. Fremlin
July 1986

NOTES FOR CHEMICALS TRAINING - 28-31ST JULY, 1986.

Chemicals Officer - I.D. Scott

PESTICIDES - APPLICATION EQUIPMENT.

The selection of correct equipment is vital for the safe and efficient use of pesticides. Equipment must be well maintained and carefully calibrated for accurate application.

Nozzle sizes, delivery pressures and speed of travel influence the rate of application, when using spraying equipment.

When spraying weeds in forests, equipment which operates at low pressures, producing droplets which range in size from 200-400 microns is best, as this reduces the risk of drift. The Department of Conservation and Land Management are currently applying pesticides with the following equipment:

1. **NURSERIES.**

   (A) **Boomspray** - Application of fungicides, insecticides and herbicides.

   (B) **Pressurized Packspray** - For small applications of insecticides and fungicides.

   (C) **Pressurized packspray or tractor mounted tank with power take-off driven pump and hand held wand** - for applying herbicides around buildings, fences etc.

   (D) **Dribble Bar** - Post emergent treatment of weeds between rows of plants, used only on a small scale to apply herbicides.

2. **SOFTWOOD PLANTATIONS.**

   (A) **Boomspray** - Pre-plant weed control for control of grasses prior to planting and annual firebreak maintenance.

   (B) **Side Delivery Nozzles** - Powered by a motorized pump and coupled to a tanker unit.

   (C) **Axe and Drench Gun** - For carrying out "stem injection" to control unwanted Eucalypt.

   (D) **Chainsaw, Drench Gun or Pressurized Packspray** - used for cut stump operations to control unwanted Eucalypt. This operation is more expensive but results are far better than "stem injection".

   (E) **Pressurized Packspray or Drench Gun** - For pre-plant Eucalypt control by "foliar spray".

   (F) **Rope Wick Applicator** - At the moment this method is only used on a small scale, for specific jobs eg. Bracken control on powerlines and planting areas.

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3. **HARDWOOD FOREST.**

(A) **Axe and Drench Gun** - For control of unwanted Eucalypt Banksia in jarrah silvic. work by the "stem injection" technique.

(B) **Chainsaw, Drench Gun or Pressurized Packspray** - For control of Eucalypt and Banksia in jarrah silvic. work by the "cut stump" technique.

4. **DECLARED PLANT CONTROL.**

Both softwood and hardwood.

(A) **Tractor mounted tank units with power take-off pumps** attached to hand held wands or **vehicle mounted tanks with motorized pumps** are used for most declared plant control carried out by C.A.L.M. employees.

(B) **C.D.A. Units** - Used only on a limited basis.

It is most important that the correct equipment be is used for your particular type of chemical application. This is essential in order to maintain correct application rates. Faulty or incorrectly calibrated equipment can result in a complete job failure. In the past many failures have occurred due to this.

To ensure that the recommended rates of application are applied precise calibration of equipment is necessary.

For further details of this equipment along with the names and addresses of State distributors refer Appendix 1 of the Chemical Users Manual.

CHEMICAL APPLICATION EQUIPMENT

Contents

EQUIPMENT - MAINTENANCE AND CALIBRATION

INTRODUCTION

Decisions about pest management are usually determined by economics. Chemicals are frequently the cheapest on a cost per unit area basis, give the best control, lowest cost of application and, most importantly, are easiest to apply at the optimum time.

Too often the decision which was based on logic is scuttled by lack of care in actual application.

The chemical or the recommendations are often blamed, but in most cases the failure is due to operator error and, more commonly, in the calibration or maintenance of the chemical distribution equipment.

A survey carried out in the United States showed 60% of the farmers investigated were more than 10% inaccurate in their application of the pesticide. One in three under-applied by 30% and one in four over-applied by 30%.

As pest control advisors we must be fully conversant with the various component parts of accurate application and be able to convey this information in a practical way.

The cost of registering new herbicides is rapidly escalating. This cost will be passed on to the user, therefore, it is becoming increasingly important that we place the right amount of active ingredient in the right place at the right time.

The key to success of the spraying operation is the operator, who will have considerable control over many associated variables.

These include:

1. Selecting the right equipment for the job.

2. Ensuring the equipment is correctly set up and adjusted for the operation in hand.

3. Calibrating the equipment accurately to ensure that the required rate of chemical and volume of spray is applied.

4. Thorough mixing and agitation of the pesticide in the spray tank.

5. Operating and monitoring the equipment accurately to maintain uniform distribution.

6. Monitoring both the weather conditions and the growth stage of the pest to ensure the chemical is applied at the optimum time.

7. Maintaining the equipment in a safe and operational condition.

SELECTING EQUIPMENT FOR THE SPRAYING OPERATION

The decision on which type of chemical application to use is based on several

factors:-

a) Accessibility of the target species.

b) Stage of growth of target species.

c) Ambient weather conditions.

d) Type of chemical to be used.

For example:

a) Accessibility - is the target living in a wide flat arable paddock where it can be controlled with a boomspray or on a steep rocky slope necessitating the use of a 4-wheel drive and side delivery nozzles, or even a power-driven knapsack mister ?

b) Stage of growth - is the weed dominating desirable species which could be controlled by a rope-wick applicator ? Has the insect reached plague proportions, requiring urgent control with an aircraft ?

c) Ambient weather conditions - is the wind too strong for high pressure small droplet-producing mist blowers but not excessive for using high volume large droplet boomsprays or Terra(R) nozzles ?

d) Type of chemical to be used - some chemicals must not be used in certain types of equipment, for example Roundup(R) and Sprayseed(R) cannot be used in mist blowers, due to danger to non-target organisms and the operator. Some chemicals, such as soil borne root absorbed herbicides, require high volumes of water; there are other such as Roundup(R) and Garlon(R) that can be applied through Controlled Droplet Applicators with a minimum of carrier fluid.

TYPES OF EQUIPMENT AVAILABLE

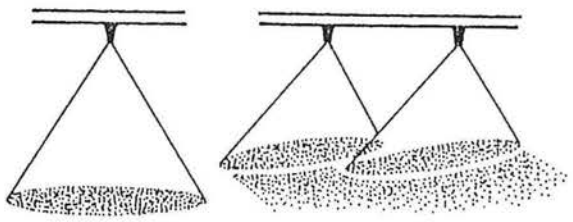
Briefly, the types of equipment available and their important features are:

Boomsprays consisting of three major components:

1. Tank for mixing chemicals and carrier fluids.

2. Pump for pressurising the liquid.

3. Hydraulic nozzles located on boom arms that control the flow, atomise the liquid and distribute the liquid.



(a)

Tapered fan nozzle most commonly used on boomsprays.

(b)

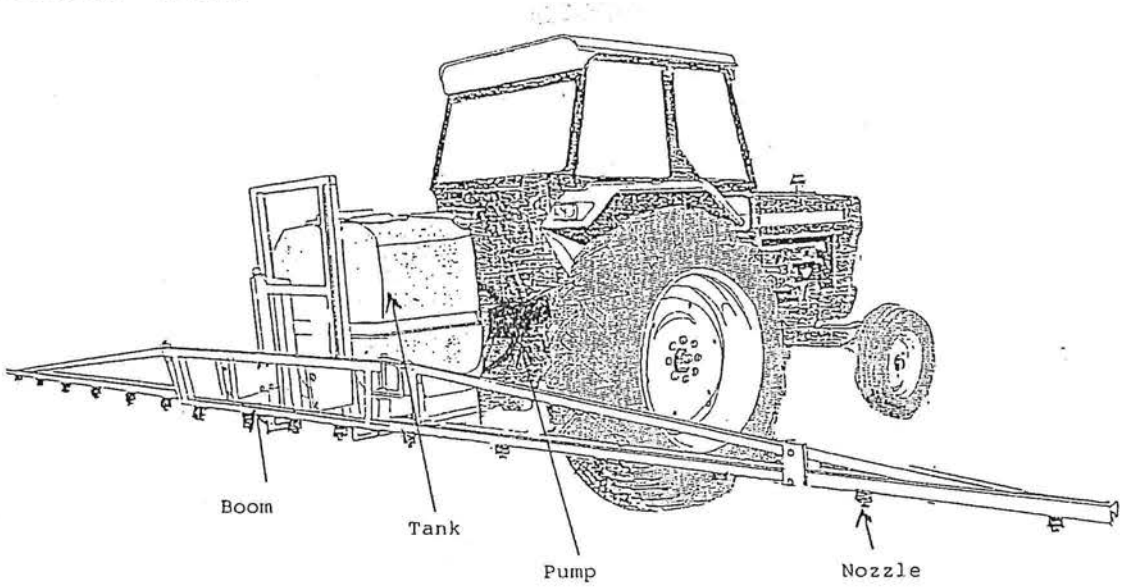
Overlap is necessary for even distribution.

30% Single coverage

The various components can be mounted on a 3 point linkage, on a trailer or on the back of a vehicle.

Power to drive the pump can be derived from the power take-off, from a ground wheel, or from a stationary engine.

Depending on the speed of the equipment, length of the boom, nozzles chosen, and the capacity of the pump, the output can vary between 5 and 5000 litres per hectare. Boomsprays present the opportunity for great versatility in application rates.



Controlled Droplet Applicators (CDA)

As their name implies, this type of chemical application equipment produces droplets of a uniform size. It is reasoned that this type of droplet will adhere to the target whereas the larger droplets tend to bounce or roll off and the smaller droplets slide around the boundary layer or drift off.

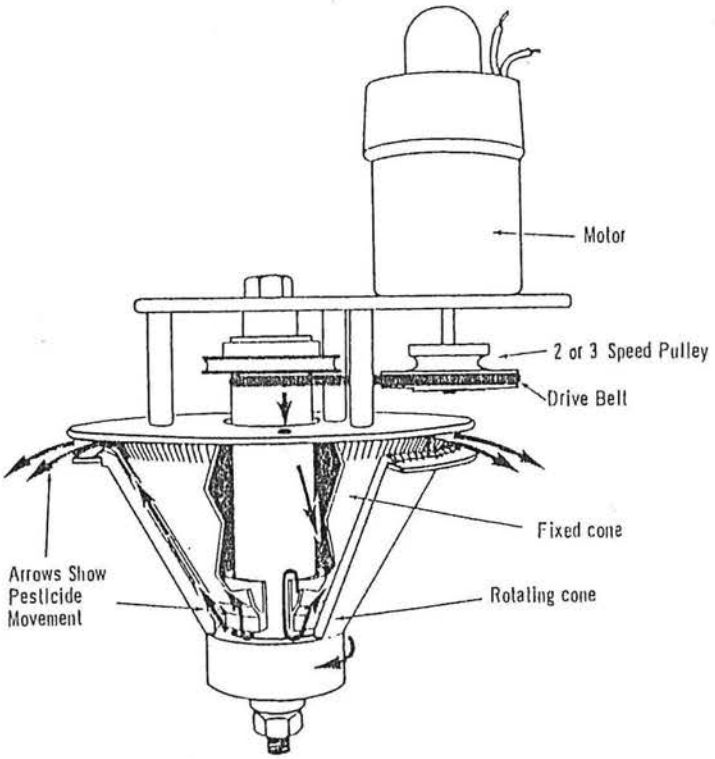
This enables the active ingredient to be dispensed in a much lower volume of carrier liquid.

Controlled droplet applicators come in two types:

1. Rotary atomisers

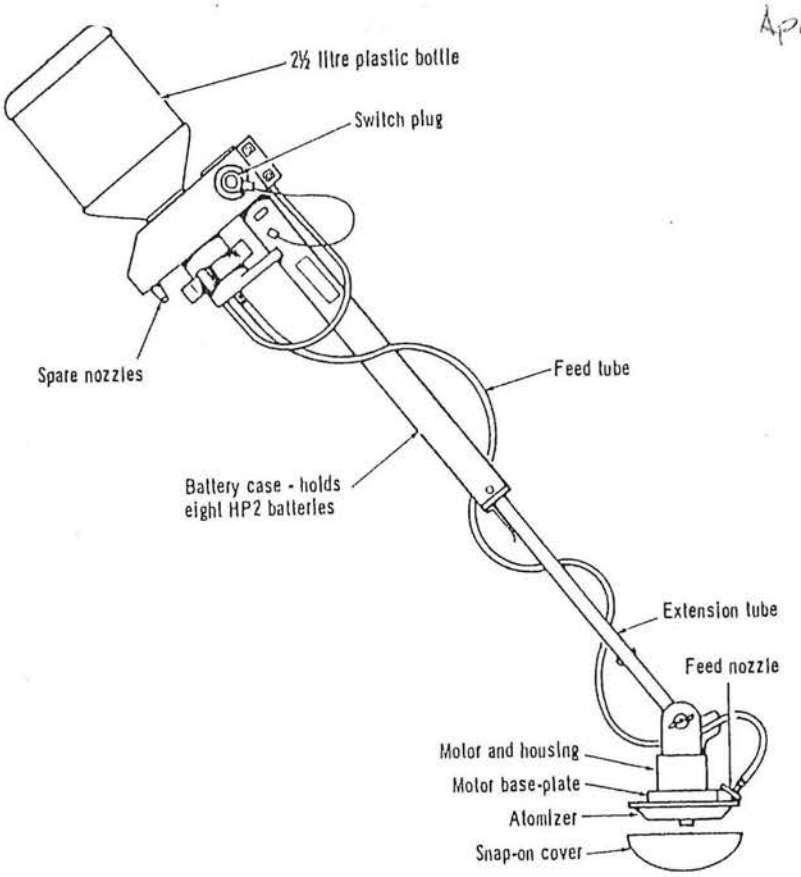
2. Electrostatic sprayers (it is not proposed to cover this type as they are still largely experimental).

Rotary atomisers were first used on aircraft and are generally a spinning cage orslotted drum through which chemical is propelled as uniform droplets. A power driven fan in front of the unit produces a strong turbulent air current collecting the droplets giving an improved deposition on the target.



CONSTRUCTION AND OPERATION OF A MICRON 'MICROMAX' ROTARY ATOMISER

Aprox $150.



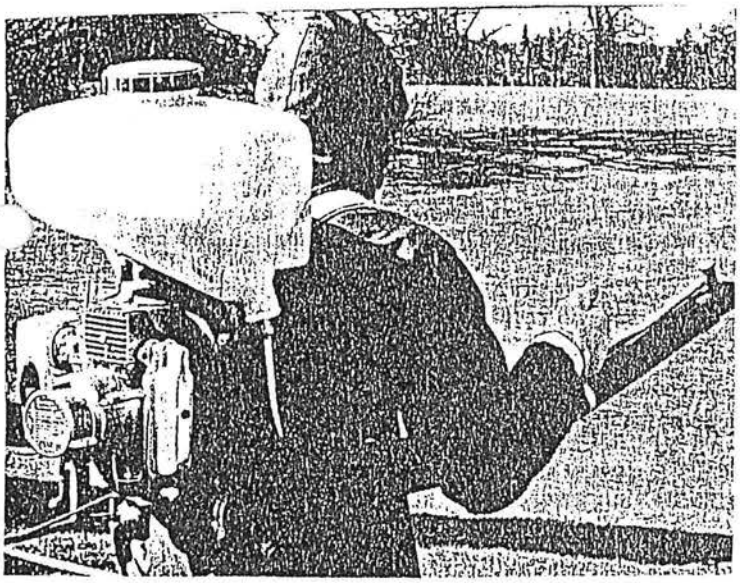
DESIGN FEATURES OF A MICRON 'HERBI' HAND HELD CDA SPRAYER

Mist Blowers (or Air-Carrier Sprayers)

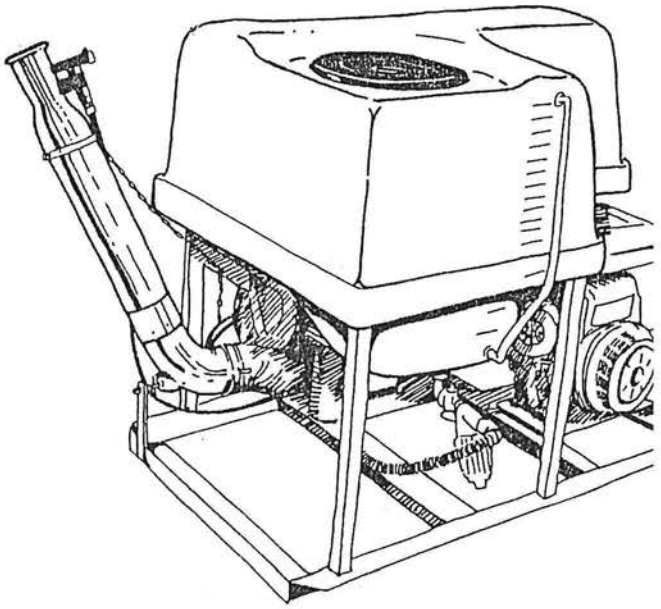
The term MISTERS is commonly used for spray systems that utilise the shear forces of an airstream to break up the spray liquid into droplets.

A high capacity fan produces an airstream that is ducted past one or several orifices discharging the mixed liquid. As the air flow increases or the liquid flow decreases the droplet size decreases.

Misters can be mounted on a vehicle. A smaller version may be carried on an operator's back.



Knapsack mist blower

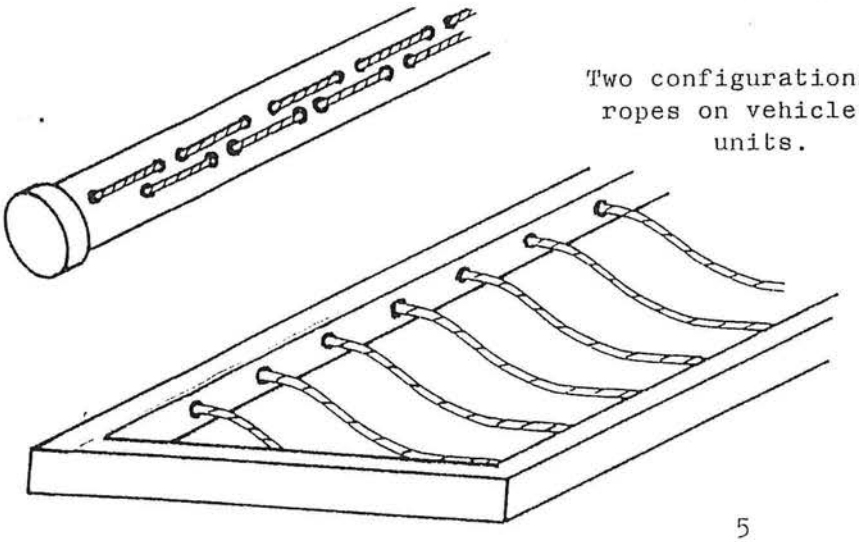


Tractor-mounted mist blower

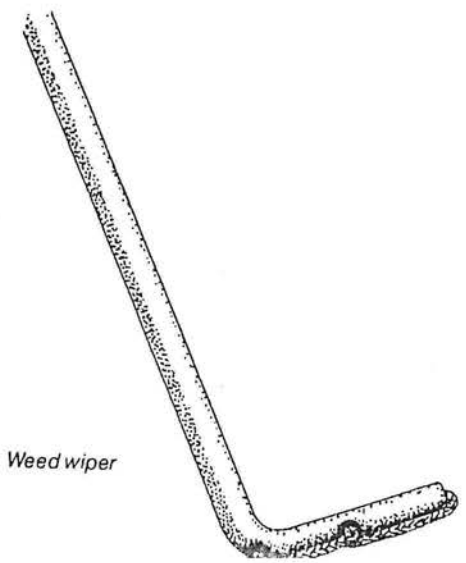
Misters can be very useful for applying chemical to targets in inaccessible arezs, using the breeze to carry the cloud of droplets.

Rope Wick Applicators

These devices use a length of rope (called wicks) to deposit herbicide on weeds by direct contact. The rope is a solid braided type with an inner core to carry the herbicide evenly along its length. The herbicide is usually supplied to the wicks from a gravity feed reservoir.



Two configurations of ropes on vehicle-mounted units.



Weed wiper

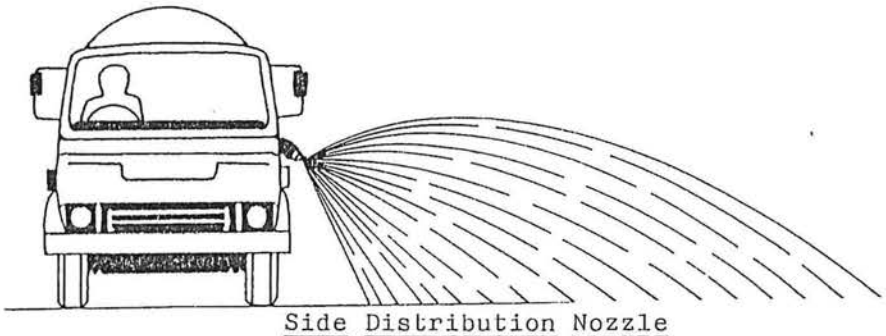
The applicators can be mounted on a vehicle or used in a hand-held device such as a Chemi-Hoe(R).

Wick applicators are a useful tool in situations where the target species is taller than the desirable species. Examples of this could be Cape tulip or dock. The hand-held device is useful for precisely locating herbicide onto the target species in a spot treatment situation. Wick applicators are particularly useful for applying a total herbicide such as Roundup(R) but can also be used for some of the phenoxy chemicals.

Miscellaneous Hydraulic Nozzles

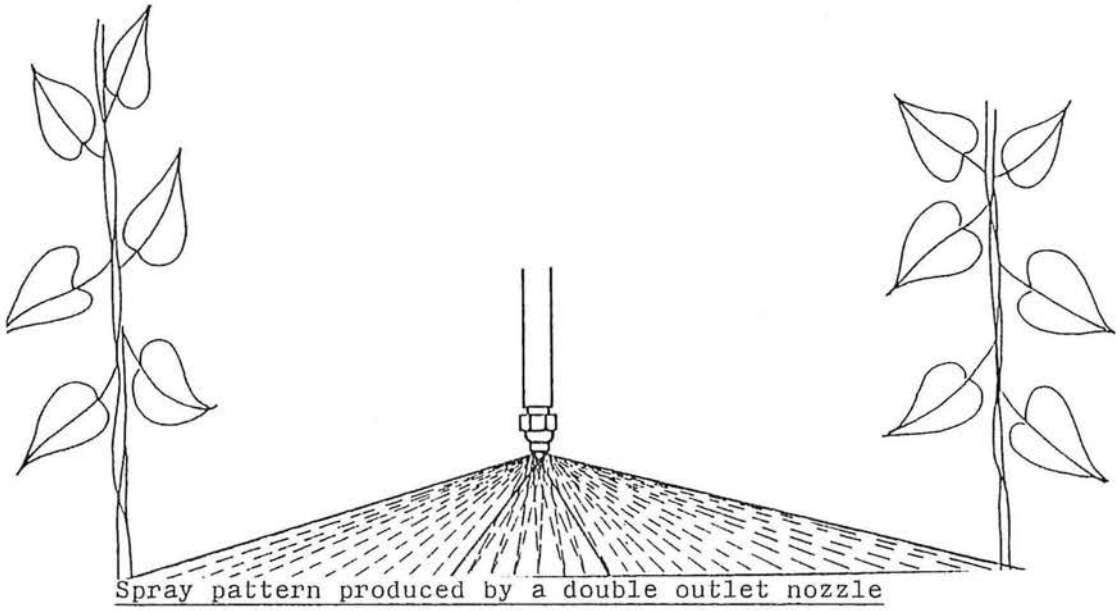
There are many hudraulic nozzles available designed for specific purposes. Some of these are:-

1. Side distribution nozzles (high and low volume)



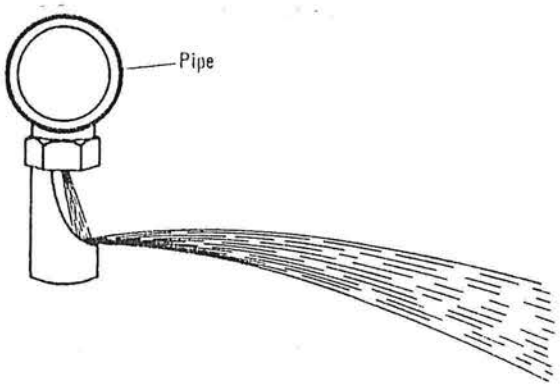
Side Distribution Nozzle

2. High volume, wide-angle fan jets such as Terra jets and double outlet jets.



Spray pattern produced by a double outlet nozzle

3. Flooding or Anvil nozzles.



Flooding nozzle for application of large droplets

4. Raindrop nozzles (see text)

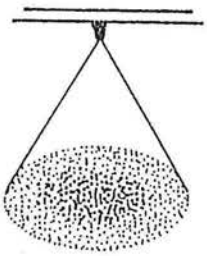
5. Hollow cone nozzles

6. Full cone nozzles

7. Even face or band spray nozzles

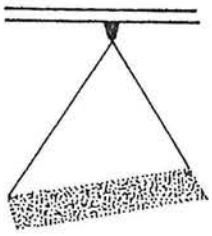
Hollow Cone
Spray Pattern

5.



Full Cone
Spray Pattern

6.



Even Fan
Spray Pattern

7.

8. Adjustable nozzles (Aperture Adjustable : see text).

1. Side distribution nozzles are useful for applying chemicals to targets in inaccessible areas such as tree lines, roadsides, railway lines. The 'throwing' action is achieved by utilising high volumes of carrier fluid. Droplet size produced by this type of nozzle is highly variable.

2. High volume, wide angle fan jets have a more positive deposition pattern and are generally used in line with the vehicle on which they are mounted or on short arms extending from the side.

3. Flooding nozzles are similar to the above but mounted closer to the ground and generally have a smaller swath width.

4. Raindrop nozzles as their name suggests, produce very large droplets and are particularly useful where off-target drift reduction is a top priority.

5, 6, 7. These nozzles are the types most commonly found on knapsack and pneumatic hand sprayers. Even fan nozzles are also useful for band application of chemicals or fertilizers using a boom spray.

8. Adjustable nozzles are also found on hand-held equipment. They vary from wide angle hollow cone to a solid stream. These nozzles should be calibrated with the adjustment fixed in the desired spray mode.

SETTING UP THE EQUIPMENT

Refer to manufacturers' specifications regarding speed, pressures, angle of nozzles, etc. for the correct way to operate the equipment.

1. Ensure the tank is clean, the filters and nozzles have been checked for damage, the pump is serviceable and the equipment generally is in good repair.

2. Check for correct operating height and angle of nozzles.

3. Operate pump at correct pressure and check for evenness of distribution or suitable mist cloud. Replace faulty nozzles.

CALIBRATION OF EQUIPMENT

Calibration is the term used to describe the collection of data from spraying equipment and its use to calculate the amount of active ingredient that will be applied to a known area.

The data to collect is:

a) speed over the ground;

b) rate of discharge from nozzles;

c) width of swath.

Although there are several formulae for calculating the amount of liquid applied to an area, the one we use is:

$$\frac{600}{\text{swath width}} \times \frac{\text{output in litres/min.}}{\text{speed}}$$

Example:

$$\frac{600}{5 \text{ metres}} \times \frac{4 \text{ litres}}{8 \text{ Kph}} = 60 \text{ litres/ha.}$$

The constant figure 600 is derived from the fact that a one metre wide sprayer travelling at one km/hr will cover one six hundredth of a hectare in one minute or 600 sq. metres.

Mechanically powered boomsprays, mist blowers and boomless nozzles are calibrated using this formula. Ground drive boomsprays with positive displacement pumps, controlled droplet equipment, hand powered knapsacks or pneumatic sprayers and hand lines are calibrated over a known area.

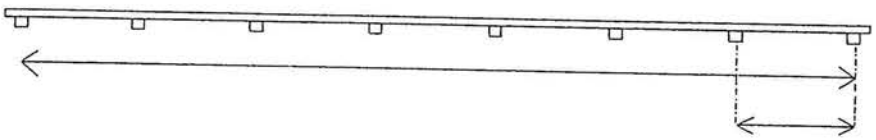
Methods of collecting data

1. Boomsprays with power driven pumps :

Output Collect the output from each nozzle for one minute. Find the average and replace any nozzles that are ± 5% of this figure. Re-check aand add all nozzles delivery for total output.

Swath Swath measurement equals the distance between the two end nozzles of the boom plus the distance between any two nozzles.

MEASUREMENT OF BOOM



Swath width equals addition of the two measurements

Speed Check tractor or vehicle speed. (See formula at end of this section.)

Concentrate addition Calculate amount of active ingredient to add to tank using the formula at the end of this section.

2. Boomsprays with ground wheel driven pumps :

Collect or record on a flowmeter the output while travelling over a known area of ground. The formula then becomes -

$$\frac{\text{output over known area}}{\text{hectares in that area}}$$

Example: Spray for 400 metres with 12 metre boom
Area covered = 400 x 12 = 4800 square metres
Hectares covered = $\frac{4800}{10000}$ = 0.48 ha.

Measured output over that area = 22 litres

Formula is then $\frac{22}{0.48}$ = 45 litres/ha.

It is recommended that the machine be operated in the middle of the manufacturers' stated speed range as there is no control on pressure. Fluctuation in pressure effectively alters the droplet size and can increase or decrease output appreciably toward the upper and lower limits of the speed range.

3. Controlled Droplet Applicators (hand held) :

Output In gravity fed equipment collect the output that runs through the nozzle for one minute. Where the unit is fed by pump to the spinning distributor collect and measure the output from all outlets in one minute. For Micromax(R) units refer to manufacturers' instructions.

Speed and Swath For hand held single head units (Herbi(R) type) measure the width of the swath distributed by the spinning disc. Walk at normal speed in a straight line for exactly one minute. Area covered equals distance walked multiplied by swath width.

Amount delivered/ha :

$$\frac{\text{output in litres for 1 minute}}{\text{area covered in fractions of a hectare}}$$

Example: Walking at normal speed for 1 minute in straight line
Distance covered = 50 metres
Swath width = 1.2 metres
Area covered = 50 x 1.2 = 60 square metres
Hectares covered = $\frac{60}{10000}$ = 0.006 ha.

Output collected for 1 minute = 60 ml = 0.06 litres

Formula is then $\frac{0.06}{0.006}$ = 10 litres/ha.

4. Controlled Droplet Applicators (boom type) :

Speed and Swath For boom type equipment measure the effective swath width in metres. Drive the vehicle over the terrain to be sprayed for exactly one minute. Measure the distance covered. Multiplication of these two factors together gives the area covered.

Output Collect and measure the output from all the nozzles for one minute. Use the formula as above to calculate the amount of liquid delivered per ha,

5. Misters or air carrier sprayers :

Output Collect the output with the machine running at operating speed. Either fill the tank to overflowing, run for one minute and refill to the original level, or attach a hose to the outlet nozzle in the air stream

and record the discharged liquid over the same period of time.

Swath width In theory the swath is checked using Kromekote boards laid at right angles and downwind to the direction of travel. There is a tendency to stretch the swath to impractical limits using this system. Problems of bout marking are created and they do not take into account vagaries of the wind at different times of the day and various locations in the paddock.

It is more convenient to assume, say, a 15 metre swath for vehicle-mounted or 5 metres for a backpack and calibrate the machine accordingly. This will enable the previous run wheel marks to be seen more readily.

Speed Calculate the speed of a vehicle mounted or backpack unit by the method shown at the end of this section.

6. Rope Wick Applicators :

Output The output from these is altered by adjusting the gland nuts holding the ropes into the distribution chamber. Adjust until the ropes begin to drip.

Speed is determined by the density of the target species.

Chemical is usually added to the reservoir at a fixed ratio to the carrier fluid. Such as Roundup(R) at 3:1 in water, i.e. 1 litre of Roundup added to 3 litres of water. (Refer to chemical company specifications for correct ratio.)

7. Miscellaneous Hydraulic Nozzles:

Side throwing nozzles and wide angle fan jets are calibrated by measuring the output, swath and ground speed as in a powered pump boom spray. Wind shear effect must be taken into account when measuring swath of side delivery nozzle - deduct 0.5 metres to compensate.

Flooding or anvil nozzles, raindrop, hollow cone, full cone or even fan nozzles, whether attached to a knapsack pneumatic or hand lance type sprayer are calibrated on an area basis. Mark out an area 10 metres x 5 metres = $\frac{1}{200 \text{ th}}$ ha.

Spray at operating pressure. Spray to run off point on the plants at a constant ground speed. Refill the tank to a known level and multiply the amount replaced by 200 to achieve the application per hectare.

Example Output of hand lance over $\frac{1}{200 \text{ th}}$ ha.

(or 0.02 ha or 50 square metres)

= 15 litres.

15 x 200 = 3000 litres/ha.

Alternatively, record the time taken to cover the plot, then discharge the liquid into a container for the same period of time. Again, multiply that amount of liquid by 200.

CALIBRATION FORMULAE

Calculation of Ground Speed

Record the time taken either by vehicle or on foot to cover 100 metres.

$$\text{Speed} = \frac{360}{\text{time taken to traverse 100 m (secs)}}$$

Example Time taken to traverse 100 metres = 30 secs.

$$\text{Speed} = \frac{360}{30} = 12 \text{ Kph.}$$

Calculation of the amount of pesticide to add to tank

$$\frac{\text{Tank capacity (litres)}}{\text{Volume applied/ha}} \times \text{Recommended rate (litres)}$$

Example Tank capacity = 450 litres
Volume of carrier liquid applied/ha. = 75 litres
Recommended rate of chemical/ha. = 4 litres

$$\text{Formula} = \frac{450}{75} \times 4 = 24 \text{ litres of chemical to be added to tank}$$

Calculation of tank capacity

Square tanks $L \times B \times H = m^3$

$M^3 \times 1000 =$ litres

Examples of calculation of tank capacity

1. Square Tanks : Length = 2 m; Breadth = 1.2 m; Height = 1 m.
$2 \times 1.2 \times 1 = 2.4 \text{ m}^3$

$= 2400$ litres

Cylindrical tanks : $\text{Pi} \times r^2 \times H = m^3$

$M^3 \times 1000 =$ litres

2. Cylindrical Tanks : Pi = 3.14, Radius = 1.25, $R^2 = 1.5$
Height = 1.5
$3.14 \times 1.56 \times 1.5 = 7.3 \text{ m}^3$

$= 7300$ litres

Spherical tanks $1.3 \times \text{Pi} \times r^3 = M^3$

$m^3 \times 1000 =$ litres

3. Spherical tanks $1.3 \times \text{Pi}$ (3.14) x Radius 1.25 $R^3 = 1.95$
$1.3 \times 3.14 \times 1.95 = 7.95 \text{ m}^3$

$= 7950$ litres

MIXING AND AGITATION OF THE PESTICIDE IN THE SPRAY TANK

. Commence filling the tank with clean water. Start the pump and activate the agitator. Ensure the agitator is working adequately.

- Always filter water entering the tank.

- When filling from dams first make sure the water is clean. Suspended solids will reduce the efficiency of contact pesticides. Always remove the suction hose from the dam or the pressure hose from the tank immediately the pump is turned off to prevent the water siphoning back and contaminating the water source.

- Remain with sprayer while filling to prevent overflow and possible contamination of waterways.

- Fill to required level; do not make more spray mix than required.

- When handling concentrated chemical always wear protective clothing, as discussed in the chapter on safety, and related to the chemical to be used.

- Always read and follow the instructions on the label of the chemical container.

- Do not use chemical from an unlabelled container.

- Do not put surplus chemical into containers other than the original packaging.

- When using wettable powders, emulsifiable concentrates or dry flowables follow manufacturers instructions for any pre-mixing. Weigh or measure specified amount into clean mixing vessel. Use a stirring stick that is retained for chemical mixing only. Mix chemical with water until a smooth cream is formed. Pour this through the lid filter of the spray vat.

- Most liquids and flowables will readily mix with the carrier fluid but they should also be poured through the lid filter in case of precipitation or crystalization of the concentrate in the container.

- If using ground-driven equipment, agitate with a stick or paddle to ensure dispersion of the chemical before driving off. Drive a good distance with the agitator operating before spraying to ensure even dispersion of the chemical through the carrier fluid.

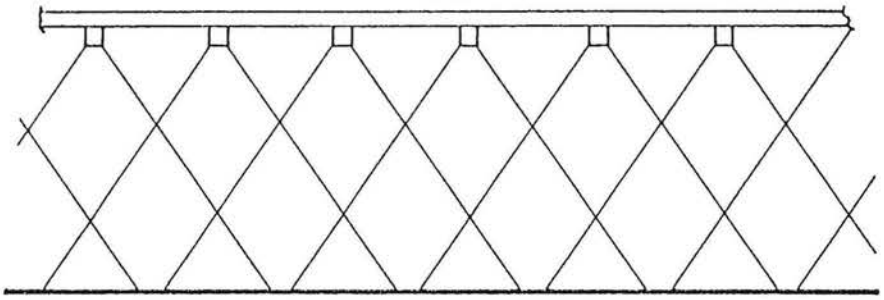
- If the spraying operation ceases for any length of time agitate adequately before recommencing.

- Store empty containers in asecure place until they can be disposed of safely.

OPERATING AND MONITORING THE EQUIPMENT

Boomsprays

- Before spraying, check that the spray boom or nozzle is set at the correct height above the target to achieve double overlap.



Double overlap spray pattern to minimise effects of boom height variation.

- Check all nozzles are operating before driving off.

- The most accurate and effective method of spraying a paddock is to spray two boom widths around the edge of the paddock and then travel up and down the longest run switching off at the headland. However, Western Australian farm practice is to plough and seed 'on the square'. This makes for very uncomfortable operating conditions and is rough on the equipment if spraying is done across the 'working' of the paddock. Most boom spraying is also done on the square. This results in overdosing on the corners when spraying out the 'new moon' shaped pieces caused on the turn.

- It is useful to have some sort of bout marking device fitted for more accurate spraying.

- Blocked nozzles should be attended to immediately to avoid stripping and consequent loss of production. Carry rubber gloves for the cleaning job and always clean with a soft brush. Never use wire or any metal objects as this will affect the fan pattern and so alter the deposition of the chemical.

- Maintain a constant speed as per the calibration exercise. This is more difficult than it sounds and can only be achieved accurately using an electronic measuring device connected to a towed wheel. In lieu of this type of equipment, calibrate the vehicle tachometer to the required speed on the surface to be sprayed. Ground drive boomsprays overcome this problem by the increase or decrease in speed of the pump. Accuracy is achieved only within one or two Kph of the speed at calibration.

- Constantly monitor the pressure gauge. On a powered boomspray this will give a good guide to the spraying efficiency of the unit. Always maintain the pressure used at calibration. Fit a pressure gauge to a ground drive boomspray and drive within the range 250-350 Kpa.

- Check the main filter between each tank fill. If this is a difficult process, fit a ball valve and a 'spin off' bowl type filter for ease of operation.

Controlled Droplet Applicators

- Hand-held, controlled droplet applicator units. Always maintain a steady forward speed. t is useful to add a marking dye to the chemical mix in the reservoir. This will ensure the correct overlap when spraying large areas and identify areas covered when spot spraying.

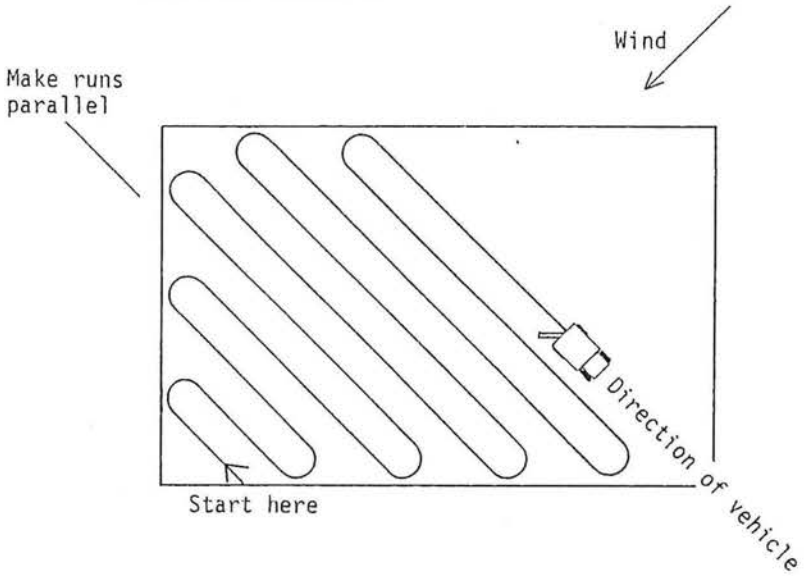
- It is essential to wear rubber boots when using this type of equipment.

Mist Blowers

Vehicle-mounted units. A cross wind is essential to the success of the operation. Do not spray in wind speeds in excess of 13 Kph to prevent drifting off target, droplets under 50 microns.

Always spray from downwind to upwind with the wind approximately 90 degrees to direction of travel.

MISTING OPERATION



- Operate with airstream orifice pointing upwards at 45 degrees and downwind. A tachometer is essential as the noise from the stationary motor drowns the noise of the vehicle engine.

- Backpack mounted units. Follow instructions as above except for maintaining a constant walking speed. Do not be tempted to 'spot spray' ; always hold the outlet arm at a constant trjectory. Ear protection is essential when operating any misting machines.

Rope Wick Applicators

- As the density of the target species increases, decrease the forward speed to allow the wick more time to regain saturation. It may be necessary to make two passes from opposite directions or at least 90 degrees in a very dense weed situation.

- Height adjustment to be made in relation to the weed to be controlled. Wicks should be located at least 15 cm above the desired species.

Miscellaneous Hydraulic Nozzles

- Side delivery nozzles and high volume fan jets. Care should be taken to avoid drift onto adjacent crops. Because of their height of operation, fine droplets are more susceptible to drift

off target. Otherwise maintain forward speed and pressure as for a power boomspray.

. Hand operated equipment. Maintain the same height of nozzle above the target as during calibration.

MONITORING AMBIENT WEATHER CONDITIONS AND GROWTH STAGE OF PEST

Weather Spray in light wind conditions if possible. Cease spraying in all areas if wind speed exceeds 24 Kph. Do not spray if a temperature inversion is present. Do not spray dew wet plants. Cease spraying at dew fall. Avoid spraying while rain is falling or imminent. An exception is when applying soil absorbed chemicals onto bare ground.

Growth stage

Observe all recommendations related to application timing to target and crop. Crops may be susceptible to chemical damage at a certain stage of growth.

Carefully check the plants to be sprayed for growth stage and stress. Apply the chemical at the optimum growth stage. It may be necessary to increase the dose rate once this period has passed. Weeds should be sprayed under ideal growing conditions when not stressed, to ensure maximum uptake of the chemicals.

Monitor the growth stage of insects to be sprayed to be sure of optimum timing and chemical rate.

General Do not use more carrier volume than necessary. Refer to manufacturers' specifications for correct volume.

Refer to manufacturers' specifications for use of surfactant. Some applications do not require surfactant. Some applications require increased surfactant.

Avoid high pressures; spray in the range 200-350 Kpa except for low pressure nozzles.

MAINTAINING THE EQUIPMENT IN A SAFE AND OPERATIONAL CONDITION

Chemicals other than Glean(R)

After the spraying operation has been completed, dispose of unused spray mix in a suitable area as discussed in Pesticides and the Environment section.

. Remove all nozzles and filters and drop into bucket of water containing a cleaning solution (see below).

. Refill tank with water and discharge into a sump or soakaway.

. Wash the outside of the spray unit and vehicle to remove chemical. Ensure that run-off discharges into the sump or soakaway.

. Refill tank again; add a cleaning agent -

: for oil-based chemicals use 50 ml of liquid detergent per 100 litres of water.

: for other sprays use 100-150 g of washing soda per 100 litres of water. Alternatively, household ammonia at 1 litre to 100 litres water.

- Agitate the solution in the tank and discharge through the spray lines into the sump or soakaway.
- Flush the tank with clean water.
- Clean nozzles and filters with toothbrush

Cleaning up after Glean(R)

Follow the procedure as above but substitute chlorine for household ammonia. If the next operation involves spraying vegetation that is susceptible to Glean, leave the chlorine solution in the equipment overnight before pumping out. Repeat the procedure and pump out immediately. Clean up the nozzles and filters in the chlorine solution before refitting.

General Maintenance

- Repair all damage or faults at end of season.
- Order spares needs immediately.
- Check pump and stand down according to manufacturer's instructions.
- Lubricate all moving parts.
- Stand down stationary motors on full compression to prevent valves sticking.
- Store spraying equipment under cover.

***** *****

terra - hortie

Pre-emergence control of weeds

Chemical	Weeds Controlled	
Kerb (Propyzamide)	Wintergrass	Poa annua
	Rye grass	Lolium spp.
	Crab grass	Digitaria sang nalis
	Portulaca	Portulaca oleracea
	Black night shade	Solanum nigrum
	Chick weed	Stellaria media
	Barley grass	Hordium leporinum
	Brome grasses	Bromus spp.
	Silver grass	Aristida contorta
	Wild oats	Avena spp.
Dacthal (Chlorthal)	Capeweed	Arctotheca calendula
	Burr grasses	Cenchrus spp.
	Chickweed	Stellaria media
	Amaranths	Amaranthus spp.
	Paddy melons	Cucumis myriocarpus
	Doublegees	Emex australis
	Heliotropes	Heliotropum
	Portulaca	Portulace oleracea
	Docks	Rumex spp.
	Caltrop	Tribulus terrestris
	Love grasses	Eragrostis spp.
	Rye grass	Lolium spp.
	Wintergrass	Poa annua
	Wire weed	Polygonum arviculare
	Thistles	Sonchus spp.

Pre & Post-emergence

Glean	Annual ryegrass	Lolium rigidum
Chlorsulfuron	Fumitory	Fumaria spp.
	Wireweed	Polygonum aviculare
	Wild turnip	Brassica tournefortii
	Chickweed	Stellaria media
	Paterson's Curse	Echium plantagineum
	Indian Hedge mustard	Sisymbrium spp.
	Soursob	Oxalis pes-caprae
	Yellow burr weed	Amsinoia sp.
	Guildford grass	Romulea rosea
	Doublegee	Emex australis +
	Docks	Rumex spp.
	Capeweed	Arctotheca calendula +
	Saffron Thistle	Carthamus lanatus +
	Cape Tulip	Homeria spp.
	Wild Radish	Raphanus raphanistrium*
	Arum Lily	Zantedeschia aethiopica

\+ Pre-emergence only
* Post-emergence only

Aquatics	
Parrot feather	Myrriophyllum acquaticum
Water Hyacinth	Eichhornia crassipes
Salvinia	Salvinia molesta
Water lettuce	Pistica stratiotes

SAFETY IN USE

Before a pesticide is used it must be remembered that this is only one of the tools of pest control and it should not be considered in isolation. Effective control of virtually all pests is by an integrated management programme which includes the strategies of mechanical, ecological, biological and chemical control methods. All these options should be investigated and their possible incorporation into the integrated management program reviewed. If it is found desirable to use a pesticide within your integrated management program, then the following points should be observed.

Again, remember all the information concerning the necessary precautions is printed on the product labels. READ THE LABEL - HEED THE LABEL.

GENERAL POINTS

- Wear clean and proper clothing and other protective devices when called for.
- Change respirator filters as frequently as called for by the manufacturer or whenever chemical is smelt.
- Never work alone when handling hazardous pesticides.
- Do not allow children or other unauthorised persons in the vicinity of mixing, loading or application.
- Never eat, drink or smoke when handling pesticides.
- Always wash thoroughly, especially after handling pesticides, before eating, drinking or smoking.
- Read the label again. Check the contents. Follow the precautions on the label.
- Follow the label directions for mixing and applying chemicals. Do not deviate from these directions.
- If it is absolutely necessary to handle toxic pesticides at night, make sure there is adequate light.
- Mix chemicals outside or where there is adequate ventilation.
- Use only recommended amounts and double check your measurements.
- Do not combine pesticides unless the combination is called for on the label or you have consulted with an authority.
- Handle concentrated chemicals with extreme care.

- Pour liquids, powders and dusts slowly to avoid splash, spill or drift.
- Open sacks with a knife rather than tearing.
- Always stand upwind when mixing or loading pesticides.
- Avoid inhalation of chemical dust and fumes.
- Avoid skin contact with concentrated chemicals.
- If the concentrate is spilled or splashed onto your skin or your eyes, wash immediately. Wash affected clothing.
- If concentrate is spilled or splashed on the clothing, take it off and wash it immediately.
- Do not wipe your hands on your clothing if chemical has been spilled on your gloves. This will contaminate your clothing and the chemical may be absorbed by your skin.
- If a concentrate is spilled on the floor or ground, clean it up or dilute it with soil, sand or other absorbent material (do not use sawdust) to reduce the possible hazard of contact. Some chemicals in the concentrated form will remain in toxic quantities in the soil for many months.
- Check your application equipment frequently to ensure proper function and dosage rate.
- Do not blow out clogged hoses, nozzles or lines with your mouth.
- Do not work in drift or run-off.
- Provide proper supervision of employees, especially if they are new on the job.
- In the event of a serious exposure to insecticides, especially of the organo-phosphorus or carbamate type, do not attempt to drive a vehicle.
- Do not leave pesticides unattended in the field or at the site of operation.
- Do not leave application equipment partially filled with unused chemicals at the end of the operation. Pesticides should be used as soon as possible after mixing to avoid the possibility of chemical change occurring in the tank, and access by unauthorised persons.
- Plan your application carefully so you will not have to dispose of large quantities of left-over chemicals.
- Shower and change your clothing at the end of each day.
- Wash your clothing at the end of each day's use.

Protection against over-exposure to toxic materials depends on four main factors:

- the prevention of accidents;
- the use of protective clothing;
- thorough understanding of the material being used in the spraying operation;
- adequate medical resources.

PESTICIDE SAFETY

BEFORE APPLYING PESTICIDES

- Know the pest and how much damage is really being done.
- Use pesticides only when really needed.
- Seek advice on the proper method of control.
- Use only recommended and registered pesticides for the problem. If several pesticides are recommended, then try to use the one least toxic to mammals and, if possible, the least persistent.
- Read the label, including the small print. Be certain to read the label of every pesticide used. The labels are carefully prepared and carry the necessary information on rates, uses, cautions and hazards. If a label is damaged or illegible do not use that material. Be sure you know the chemical being used.
- Make sure that the appropriate protective clothing is available and is used and that everyone concerned with the application of the pesticide understands all the application recommendations.
- Check the application equipment for leaks, calibrate it with water and ensure it is in proper working order.
- Check that plenty of water and soap and a towel are available and that a change of clean clothing is on hand.
- Check that the pesticides are in a dry, locked store. Avoid inhaling pesticide mists or dust, especially in confined spaces such as a pesticide store.
- Advise neighbours of your spray programme, especially if they keep bees, and find out what susceptible crops are in the area.
- Take only sufficient pesticide for the day's application from the store to the site of application. Do NOT transfer pesticides into other containers, especially beer and soft drink bottles.

PESTICIDE SAFETY

PRECAUTIONS WHILST MIXING PESTICIDES

- Wear appropriate protective clothing. If it becomes contaminated, remove it and replace it with clean clothing.
- Never work alone when handling the most toxic pesticides.
- Never allow children or other unauthorised persons near the mixing.
- Re-check the instructions on the label.
- Avoid contamination of the skin, especially your eyes and mouth. Liquid formulations should be poured carefully to avoid splashing. Avoid powder formulations puffing up into your face. If contaminated with the concentrate, wash immediately.
- Never eat, drink or smoke when handling pesticides.
- Always have plenty of water available for washing.
- Make sure pesticides are mixed in the correct quantities.
- Open all pesticide containers carefully and on a stable surface where they will not tip or spill readily.
- Open, pour and mix pesticides in a specific area where no person can be contaminated and where any spills can be cleaned up properly.
- Use the proper tools to open containers. Use a knife to open paper and plastic bags and to cut out tops. Do not use a screwdriver, pickaxe, etc. because of the risk of material spurting out into the face and eyes. Ripping open a bag usually causes an uneven tear, thus making spills more likely.
- Stand upwind of all opening, pouring and mixing operations.
- Open, pour, weigh and mix in a well-ventilated area and outside if possible.
- Learn how to pour properly from a container. Splashing and spurting can be avoided if the can is held so that the opening is at the top. If an air vent is provided on the can, use it.
- Wear clean, well-fitting goggles and respirator, impervious gloves, overalls, rubber boots and an apron for protection in the event of a splash or spill, especially when handling concentrated or highly toxic materials. Be sure you know where to easily and quickly obtain a good supply of lime, soil or sand, or other absorbent material to soak up a spilled pesticide.
- After adding the pesticide to the tank, rinse the containers thoroughly so that they are free of pesticide residue. This should be done as follows:

  After emptying the contents into the tank, allow the container to drain for 30 seconds, then refill it with clean water to about $^1/_4$ full. Replace the cap, agitate the container, then pour the contents into the tank and allow it to drain thoroughly. Repeat this rinsing and draining twice (a total of 3 times), and retain the empty containers for correct disposal.
- Learn to recognise the typical signs and symptoms of pesticide poisoning.

PESTICIDE SAFETY

PRECAUTIONS WHILST USING PESTICIDES

- Never use your mouth to syphon liquid materials.
- Keep all unprotected people away from any equipment that may be contaminated. Consider all such equipment dangerous, until properly decontaminated.
- Remember that equipment used for the application of herbicides should be reserved exclusively for that purpose. All equipment should be calibrated correctly.
- Avoid inhalation of chemical, dust or fumes.
- Start spraying near the downward edge of the field and proceed upwind so that you move into unsprayed areas.
- Never blow out clogged materials or hoses with your mouth.
- Never leave pesticides unattended in the field.
- Provide proper supervision of those assisting with pesticide application and always have adequate rest periods.
- If you feel ill during pesticide application or shortly after, stop work and seek medical attention at once.

PESTICIDE SAFETY

PRECAUTIONS AFTER APPLYING PESTICIDES

- Return all unused pesticides to the store. .
- Safely dispose of all empty containers. It may be difficult to bury containers after each day's spraying operations; they should be kept in the pesticide store until a convenient number are ready for disposal.
- Never leave pesticide in application equipment. Clean the equipment and return it to the store. Make sure that all personnel who maintain or clean equipment are aware of the hazards and follow safety procedures similar to those for handling the toxic products themselves. Do not permit anyone unfamiliar with chemical safety practices to carry out cleaning procedures.
- Remove and clean protective clothing.
- Check all protective clothing and equipment for faults. Never fail to discard leaky gloves or contaminated footwear.
- Wash well and put on clean clothing. Operators should take a shower afterwards with special attention to hair and finger nails before going home.
- Change your clothes daily and more often if contamination occurs.
- Ensure that smoking, drinking and eating are absolutely prohibited in every chemical handling operation.
- Keep a record of the use of your pesticides.
- Do not allow other people to enter the treated area if restrictions apply for the pesticide used.
- Remember that a very serious risk is taken if a possible victim of pesticide poisoning is allowed to drive home unattended. Once poisoning is suspected, someone should stay with the patient until he reaches medical treatment and he should certainly not operate a vehicle.

SELECTION AND CARE OF PERSONAL SAFETY EQUIPMENT

Exposure to pesticides can occur in transporting, storing, mixing and loading pesticides, applying pesticides, working in treated crops, cleaning applicators after use, disposing of used pesticides and empty containers and cleaning up pesticide spills and used protective clothing and equipment.

No safety recommendations can cover all situations. Again, it must be stressed that the label on the pesticide container must be read thoroughly and obeyed to the letter. These labels generally contain all the safety information you will be required to know when applying that pesticide.

When using any pesticide, wear at least a hat, long-sleeved shirt and long-legged trousers or a cover-all garment. When handling pesticide concentrates during mixing and loading or when using highly or moderately toxic materials you should also wear rubber gloves, a rubber or PVC apron and goggles and face shield and a respirator. Trousers should be worn outside of boots to prevent pesticides being channelled inside. If you have been working in a mist or your clothes would become wet for any reason, wear a waterproof suit.

1. *Overalls*. These should be of cotton/polyester material as this is lighter for wear in hot weather and operators would be more likely to keep them on; however, cotton overalls give equal protection. These overalls should be of the long-sleeved, combination type and these would provide adequate protection for most situations. Overalls should be washed regularly, every day when spraying for long periods and washed separately from other clothing to avoid contamination.

2. *Waterproof clothing*. Disposable or short life wet weather gear such as Tyvek or Protector Safeguard should be worn whenever particularly toxic preparations are used or there is an increased risk of contamination from spray drift or the concentrate. One advantage of this wet weather-type gear is that it can be hosed down after use.

3. *Gloves*. These should be of PVC or nitrile rubber and should be of the gauntlet type. They should be unlined as the lining can accumulate the pesticide and unlined gloves are easier to clean. Never use leather or cotton gloves as these simply absorb the chemical and hold it closer to the skin and, in fact, cause more problems than if no gloves at all were worn. If the gloves smell of chemical inside, then they must be discarded immediately. Check regularly for holes by filling the gloves with water and squeezing. Again, if holes are found, discard the gloves. After use, gloves should regularly be washed in warm soapy water and allowed to dry naturally in a well ventilated area away from pesticide contamination.

   A problem here is that when it is necessary to perform a fairly delicate operation, e.g. remove a nozzle for cleaning, it may be that the normal agricultural type gauntlet gloves give insufficient 'feel', although some of the new nitrile butyle rubber types are much improved. It may be necessary to use a pair of disposable latex examination gloves.

4. *Boots*. PVC or rubber boots are best for agricultural situations. Always wear overalls over your boots. If unlined boots are available, these are the most suitable as, again, lining can accumulate pesticide. Boots should be regularly washed both inside and out to remove any contamination and then stood and allowed to dry naturally.

5. *Goggles or face shield*. These must be worn whenever handling concentrate material. The face shield provides better protection but in many cases it is difficult to wear when using a respirator.

PVC apron. When mixing or handling concentrates, a PVC apron should be worn. This can be hosed down after use to remove contamination.

6. *Hat*. As we have seen, the scalp has a high rating for the dermal absorption of chemical, therefore one should always wear a hat of non-absorbent material, waterproof if possible, with a broad brim. The hat, again, should be washed regularly. Keep separate from clothing which is not used for spraying.

7. *Respirator*. The respirator is one of the most important parts of your personal safety equipment. It must be worn, maintained and stored correctly. A respirator should be worn when handling concentrates and spraying some pesticides, especially insecticides. Only those respirators meeting Australian Standard AS1337/1974 and AS1716/1975 should be used for agricultural purposes. It is essential that the correct cartridge for agricultural chemicals must be fitted - simple dust filters are of no use at all. Correct cartridges usually contain an absorbing material such as activated charcoal as most modern pesticides are organic chemicals and are readily absorbed by this material. They also contain a particle filter that removes dust and spray particles. This filter is usually made of wool and this prolonges the life of the absorbing material. The twin cartridge type is preferred.

The correct fitting of this respirator is essential. The headband should be adjusted tightly enough to get a good seal. It is almost impossible to get a correct fit if you have a beard or a moustache. All persons frequently engaged in spraying operations should carefully weigh their personal preference for facial hair against a possible health risk. Filters must be changed on a regular basis. This can be as often as twice a day if working in heavily contaminated conditions, but after 8 hours of regular use is a reasonable guide. During use do not expose the inside of the respirator to spray or drift by wearing it hanging around the neck or exposed on a spray machine. If it should become contaminated on the inside, then it should be removed and washed immediately. When you have finished using the respirator, remove the filter and cartridges and was the face piece in warm soapy water. Rinse it thoroughly and dry with a clean, uncontaminated cloth and place it in a well ventilated place to dry. When dry, store the respirator well away from any source of contamination, preferably in a re-sealable plastic container or bag. Remember that the cartridges will keep on working, absorbing the chemical even if not actually worn by the operator. Routine maintenance of your respirator, other than changes of cartridge, include checking that the one-way diaphragm valves are not stuck or damaged and that the rubber material of the respirator is not perished.

8. *Gas masks*. This equipment is used mainly for especially hazardous, high volatile chemicals and fumigants and users must be properly trained in their fitting, use and maintenance. This represents a specialist area in agricultural pest control. Gas masks usually cover the entire face and the canister containing the absorbent material is often connected by means of a flexible hose. These canisters are usually much larger and more absorbent and with a longer life than the standard agricultural respirator.

9. *Air blown hoods or supplied air respirators*. These should be used when handling or mixing highly toxic and/or volatile substances in enclosed or inadequately ventilated spaces or when dealing with fumigants. The supplied air respirator has a blower filter with a breathing hose leading to a hood worn by the operator and including a safety helmet and face shield. Again, it is vital that this equipment is kept in peak condition and regularly checked and maintained.

Pesticides

Dermal absorbtion

forearm	1
Palm hand	1·3
Ball of foot	1·6
Abdomen	2·1
Scalp	3·7
Forehead	4·2
Ear Canal	5·4
Scrotal area	11.

HERBICIDES AND THE PUBLIC

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Summary. Observations of the public's attitude to the use of herbicides in New Zealand are described. The importance of the type of questions posed by various sections of the public on health and environmental effects of herbicide use with suggestions on the alternative means of communicating scientific facts are discussed.

INTRODUCTION

The papers presented at this conference and other similar ones around the world provide data which either directly or indirectly lead to an improved understanding and the more efficient control of unwanted plant life. This may relate to food production or amenity services. The information presented in this proceedings is the result of years of effort however, if the scientist, extension worker and marketer of herbicides does not place more emphasis on explaining the value of herbicides to the public much of this effort will be wasted as products are banned on political grounds. Hardly a week goes by without herbicides being mentioned in the popular press and practically all relate to alleged health or environmental problems. It is not surprising that John Citizen in his urban dwelling believes his environment is awash with highly toxic chemicals ready to destroy himself and his family. The aim of all people using herbicides is to have no spillages or accidents but in the real world some will occur and it is important that the potential hazards of such events are put in perspective.

This paper presents some personal views of one who has been involved in public issues with herbicides in New Zealand which undoubtedly have relevance to the situation in Australia. There is no need to demonstrate that a major problem exists but I believe it is necessary to cover the scope of the problem and identify the major contributors.

Scope of the problem.

A general description of the major groups involved in herbicide (pesticide) issues can be summarized as follows:

(1) The User Group.

In New Zealand approximately 20 percent of the population is employed in the rural sector where most herbicides are used. These people are comparatively well informed on the herbicides which they use due to experience in working with them and much of the extension work of both Government and Industry has been directed towards the user. If they require some further information they normally know who to contact. In general they will not become involved in an issue unless they are specifically named or they can see a valuable product which they use being removed for a non scientific political reason.

(2) The Urban Group.

This forms the majority of the population which has comparatively little or no direct exposure to the use of herbicides except around the home garden. These people obtain their information and form their personal views from what they read or see on radio, television or the newspapers. Their access or interest in technical literature on herbicides is for practical purposes non existent. If they do require technical information they are often not sure whom to approach. No politician can ignore the feelings of the majority and survive so one can understand the pressure of putting emotion before fact on an issue in order to politically survive. Regretfully political decisions based on emotions are occurring around the world with greater frequency.

(3) Anti Chemical Minority.

This is a very vociferous minority group who regularily promote their cause through the media. Often the statements are emotional and based primarily on information obtained from the popular press. Whatever the personal reason for these people taking this stance, they are dedicated and persistent and will not cease on an issue until they lose credibility or are unable to claim a victory. Regrettably there have been instances of irresponsible actions by marketers and users of herbicides and this minority group serves a useful purpose in monitoring operations to prevent further mishaps.

(4) The communicators and opinion formers.

Although very small in numbers this group is the key to communication. The media gather and interpret facts and opinions before supplying information to the public at large. With notable exceptions these people have none or little technical background regarding herbicides and work under severe restrictions of time and space. Apart from staff of rural publications most have little general understanding of how herbicides are used in the rural sector and little interest unless it is related to a specific story which is usually a negative one as far as industry is concerned. In New Zealand, particularily in the rural towns, there is almost continual movement between jobs at the junior and reporter level so one can expect little continuous contact.

(5) Industry, scientists and extension workers.

Relatively few in numbers and in many instances a very introspective group. To the public this group is perceived as secretive, having little idea of the realities of life and not interested in explaining matters to the ignorant public. Some believe the scientist looks on the public as guinea pigs or test species while industry only views it as a source of profit and thus has a vested interest. The favourite quotation when approached is "no comment".

Facts to communicate.

This discussion only deals with the urban and communicator groups as the user group is comparatively well informed.

What information on herbicides do the people in the urban group require to satisfy them that they are not threatened? The following list is not exhaustive but does cover some of the main concerns which do exist.

(a) All want an assurance that the herbicide is safe and expect a black and white answer with no qualifications and in simple language that can be understood. This may sound unreasonable to us who are prevented by law from claiming a product is safe and from a scientist that knows complete assurances on biological matters stretching into the future are not possible but it is a fact of life.

(b) Most people are unaware of the testing procedures and registration requirements before the sale of a herbicide and are much more suspicious of herbicides than other chemicals used in their daily lives which have much less stringent health requirements.

(c) It is a commonly accepted view that naturally occurring chemicals are safe and synthetic chemicals are not and this view is promoted by the anti-chemical lobby.

(d) The difference between the terms toxicity and hazard are not understood. Great concern is generated by the presence of relatively toxic compounds whatever the quantities or the negligible risk of exposure. Little effort is made to put the degree of hazard in perspective.

(e) All people employed by companies manufacturing and marketing herbicides are suspected of having a "vested" interest and will only present the facts that will suit their objective of selling maximum volumes of product.

(f) The urban group shows little concern with the withdrawal of a product from the rural scene unless it can be proven that it will markedly increase the price of food he purchases. Because they seldom have direct contact with herbicides and the most memorable material they read about them is sensational and negative they have a genuine fear. Most of us fear what we do not understand.

(g) Cancer creates a real fear with most people. When the word is connected with herbicides it generates widespread concern and emotional judgement in the lay person.

Communication.

The question posed is how does one present sound scientific facts in simple language that the media can readily interpret and present to the public and the politicians? The main aim of the exercise is to present a credible and truthful alternative to the anti-chemical lobby's message to the urban group. It is unlikely that most of the anti-chemical lobby will change their views when presented with facts however they may if these facts are presented correctly.

The most effective way of getting the message across to the public is by using the media which is set up for this purpose. This is the most economic and cost effective way. Contact the local reporters and point out you are readily available for comment on issues concerned with herbicides. You may be able to supply background information or purely direct a particular enquiry to the

person who is in the best position to reply. You will be providing an alternative view which any sound professional reporter should welcome. It will take regular contact to establish ones credibility as a useful source of information and comment. If a reporter is disinterested or prejudiced against you express your disatisfaction to his editor but be sure you have your facts right and a justifiable case.

Writing letters to the newspapers and magazines is one way of stating a point of view. One advantage to this approach is that one's statements are normally unedited however the readership of such columns is lower than the general news section and some of the public prefer to believe an independant spokesperson. Where possible it is preferable to come to an arrangement with the editor to publish letters on the issue side by side on the same day to give readers a better perspective of the position.

Radio, and in particular "talk back" sessions are useful in answering queries from people on what questions worry them rather than what you believe are the important issues. The drawback to this type of programme is that it only reaches a limited audience depending on the time of the day it is broadcast. An interview of both parties is likely to give the listening public a reasonable understanding of the various positions on an issue.

Undoubtedly television is a prime media for influencing public opinion and unless one is in a live interview situation the severe restrictions on time and editing provide many opportunities for the message to become confused.

This association with the media requires considerable time involvement and also the need to respond immediately which may cause scheduling problems in remainder of one's job. It is essential to obtain full committment of senior personnel in the various organisations that this job requires top priority. Very few scientists or advisors have been trained in the art of communication, particularly television and thus training is essential. Likewise it is essential to obtain professional help in identifying media contacts and having someone on which to test out ideas. To be most effective, contact with the media should include written material which can be left for study and background.

Other means of communicating the use and value of herbicides are at meetings, workshops, posters, publication and schools. Organising a public meeting at a central place for a local issue where all parties are able to air their views is useful and preferably arrangements should be made for at least one "independant" person to speak in addition to the two opposing parties.

These comments have been largely confined to the response to the media concerning issues and will not cover the educational role of putting the use of herbicides in perspective through groups such as schools and service organisations. Similarly I do not intend to provide detailed answers of the questions asked by the urban public as I believe these are best handled in an individualistic manner.

One must accept that although the issues are based on science, emotion often takes over from logic, misreporting will occur and not every battle will be worn but providing one sticks to scientific facts and not speculative opinion in the end the majority of your views will have a good chance of being accepted. In conclusion to be successful in getting across your point of view on herbicides one must be as persistent as the opposition and patient realizing that sound scientific facts wear well. In general terms the public relations of those concerned in the area of weed science has been found wanting in the past and a major effort will be required to restore the balance.