ROADSIDE VEGETATION CONTROL

Operations Manual

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Alberta
AGRICULTURE

ROADSIDE VEGETATION CONTROL OPERATIONS MANUAL

This manual is designed to aid anyone with the responsibility of controlling undesirable roadside vegetation. The reasons for control and means of control are discussed. An attempt has been made to stress the advantages of long term planning and integrated mechanical and chemical control to ensure desired results with a minimum cost.

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Why Vegetation is Controlled on Roadsides.

1. To reduce the infestation of weeds growing on roadsides and to prevent those weeds from infesting farmland by seed or creeping roots.
2. Removal of woody species will aid drainage of water from the road, ditches and adjacent farmland. Ditches are kept clear so the water flow is not impeded.
3. Removal of woody species improves travel safety by improving visibility at corners and railway crossings.
4. Winter snow removal is easier if there is no roadside woody growth.
5. Woody growth is killed to reduce shading and nutrient loss from adjacent farmland.
6. Woody growth removal will increase visibility and reduce hazards from wildlife - vehicle collisions.

How Vegetation May Be Controlled on Roadsides.

A. Weed growth.

(i) The most effective, most economical and most widely used means of controlling weeds growing on roadsides is to treat with the proper chemical applied at the most susceptible stage.

(ii) If for some reason chemical treatment cannot be carried out at the proper time, mowing of the weed growth, prior to seed set, will aid in control.

NOTE - In every municipality there will be a certain percentage of roadside which cannot be sprayed. This may be due to:

(i) Adjacent very sensitive crops,

(ii) Close proximity to water, or

(iii) Personal request from the landowner.

ACTION

Figure 3 gives suggested wording for a sign which could be erected prior to spraying. These signs will aid your spray operators to reduce mistakes.

Weed control in these areas should not be ignored.

(i) Roadsides adjacent to sensitive crops such as canola, sugar beets, fababeans should never be ignored. Weeds which spread into these

crops wreak havoc with yields and provide a source of infestation for next year. Mowing is a practical alternative to chemical treatment provided it is carried out often enough that no seed is allowed to set.

(ii) Weeds growing along water, drop seeds into the water and the weeds spread very rapidly along the water course. Mowing is a practical alternative in some of these situations, although in areas near sloughs, grades may be too steep to mow, or if the ground is swampy, it may be too soft for the equipment.

(iii) Some landowners may not wish to have any chemical treatment carried out along their property. It should be the right of any property owner to make such a request. However, along with such requests should go certain responsibilities. If a property owner does not wish to have his weeds controlled by the municipality, then he should be prepared to carry out an acceptable type of control himself, prior to the set of seeds.

It would appear reasonable that when the landowner requests the "DO NOT SPRAY" signs that he be asked to sign an agreement to control weeds and to present a satisfactory plan for control of weeds along his property. Such a plan must include a completion date which is satisfactory to municipal weed control officials. If work is not completed by the agreed date, it should be made clear that a Weed Notice will be issued.

B. Brush Growth

Handling of brush growth differs substantially from the handling of weed growth. Brush on a roadside may grow to a height of 10m or more and may be very thick. This brush must not only be killed, it must also be removed.

Roadsides provide a frame for rural scenery, as viewed by the travelling public, and a mass of dead brown foliage or dead stems is completely unacceptable. A public outcry generated by this unattractive appearance manifests itself, not against the unwise use of a chemical, but against the chemical itself, or against all chemicals. Public outcry has been responsible for the banning of some very useful agricultural chemicals.

(i) Mechanical Brush Control.

All brush taller than 2m should be routinely cut and the debris disposed of.

Brush which is 10cm or more at the butt should be cut, as low as possible to the ground and the debris chipped, hauled away for disposal or piled and burned after drying out.

Always ensure that debris does not accumulate in the ditch as this will prevent the ditch from carrying out its function of draining water.

If the brush is less than 10cm through at the butt, it may be handled very well with a rotary brushcutter. A good operator will never rush the job; he will cut off the stems close to the ground and, working slowly, will shred the debris very finely. If this is not done, ditches and culverts will soon be plugged.

The use of a bulldozer should be only as a last resort or if a complete job of back sloping is being done. A bulldozer creates a major disturbance and could lead to serious erosion problems plus the necessity of reseeding.

NOTE - Following any form of mechanical brush control regrowth will begin immediately from the stumps or from root segments left in the ground. Follow-up treatment must be initiated no more than two years following the initial brush control operation.

(i) One alternative follow-up treatment would be to run the brush cutter over the entire area. The advantage of such a treatment is that it can be carried out at whatever season the roadside is accessible and not snow covered. The main disadvantage of this option is that it will need to be repeated a number of times to attain satisfactory root kill.

Another advantage, of course, is that there is no prohibition necessary because of adjacent water or susceptible crops.

(ii) A second, and preferred alternative is to chemically treat the regrowing brush with a registered chemical at the proper time. The total cost, including chemical and application, is much lower with this method. The time of application is restricted to the susceptible period of growth of the brush and application is limited to those areas where herbicide application is permitted.

Chemical Treatment of Brush

The chemical treatment of brush requires a great deal of skill and training if good brush control is to be obtained with no negative environmental impact. All applicators should be licensed although an unlicensed person may operate under the direct supervision of a licensed applicator.

General Directions re Brush Spray

A. Spray no brush taller than 2m because:

(i) If an excellent job of spraying tall brush is done, the brown out will be very objectionable to the travelling public using the roads and the municipal officials will be subject to criticism.

(ii) To produce a barely acceptable spray job will require large volumes of spray solution, often more than 1000 L/ac, and many litres of expensive spray concentrate.

(iii) Coverage of tall brush, sufficient to get even mediocre final kill, requires the spray be directed upward at relatively high pressures to penetrate dense stands of brush. Such action almost guarantees injury to a clover field or a canola field or shelterbelt anywhere within one kilometer of the area being sprayed.

B. Spray brush shorter than 2m because:

(i) The spray will be directed downward and applied at normal pressure. This will eliminate the risk to susceptible vegetation normally associated with roadside spraying of brush.

(ii) Since there is considerably less brush foliage to spray there will be a substantial reduction in the volume of spray mixture applied.

C. Mixed Wood Growth and Weeds.

Generally speaking when brush and weeds are growing together a spray application will provide adequate control of both. However, in the case of a solid stand of brush, it may be advantageous to ensure all weed spray is completed before they drop seed and leave the brush spray until later in the season.

Planning a Control Program

Planning is absolutely essential for a control program for roadside weeds and brush to succeed. The first step is to assess the present condition. This information will have several uses.

(a) Will enable an informed decision re the type of control program to be initiated.

(b) Will aid in priorizing areas of control.

(c) Will provide a record against which long term control may be assessed.

The best method of documenting the condition is to have one person survey all the roadsides in late summer, when all the problems are clearly visible. If one person does the survey, then personal variations will be reduced to a minimum (or alternatively, a clear set of guidelines would reduce variations).

When the survey is complete, the information should be transferred to a permanent record sheet (Fig. 1 and Fig. 2) as an example. A program can then be planned.

Guidelines Suggested:

(i) All areas where noxious weeds are a problem should be treated.

ii) No brush taller than 2m should be sprayed. It should be cut.

(iii) All brush under 2m in height may be scheduled for spraying before it becomes too tall, or cut if desired.

Points to Consider in Planning a Program

(a) Mechanical clearance.

In the short term, mechanical clearance is more costly than spraying; however to handle tall brush there is no alternative. Areas to be mechanically cleared should be confined to as compact an area as possible; unproductive travel is costly.

(b) Areas which have been mechanically cleared must be scheduled to have regrowth chemically sprayed no later than the second growing season after clearance. Failure to complete this follow-up action can only lead to failure in the control program and the need to repeat the mechanical control.

(c) Areas of noxious weed growth must not be forgotten. No matter what action is undertaken to control roadside brush, the prime reason for spraying a roadside is to prevent roadside weeds from developing and infesting adjacent farm land.

(d) Every councillor should ensure that work is done in areas of greatest need and in areas where the adjacent landowner is making an effort to control weeds on his land.

Sprayer Operator

Planning covering all phases of vegetation control on roadsides may be of the very best, but, if the man in charge of the spray operation, the man who physically carries out the plans, is not properly supervised, properly trained and motivated all your planning will be lost.

All operators must operate under the direct supervision of a licensed applicator who visits the job site on a daily basis, however, every municipality should seriously consider having each one of their sprayer operators study for and obtain the appropriate Applicator's License.

Characteristics of a Good Sprayer Operator

(a) He must be knowledgeable in the operation of his equipment, both the truck and the sprayer.

(b) He must be knowledgeable about the chemicals he is using. He must know how to apply them for maximum effectiveness and how to prevent injury to non-target areas.

(c) He must know any restrictions and possible hazards to human health. He must know and be seen to use any protective gear suggested for use with the material he is applying.

(d) He must be aware of and be seen to abide by all environmental restrictions which apply to work he is doing - e.g. do not apply within 30m of water.

Chemical Controls

Successful chemical control depends upon two factors.

(a) Selection of the correct chemical.

(b) The proper application of the chemical mixture. In most cases this will involve adequate coverage of above ground foliage with a rate as indicated on the label.

Chemicals Used on Roadsides

Roadsides are considered to be industrial areas, and all chemicals used on roadsides must be registered for use in industrial situations.

1. 2,4-D - Usually the ester formulation is used, applied when weeds or brush are actively growing and before maturity, usually mid June to mid July. It is essential that all foliage be covered to the point of run-off if adequate control is to be achieved. 2,4-D is often used as a registered tank mix with another material or as a component of a commercial mix to extend the range of control.
2. 2,4-DP (dichlorprop) - Used in combination with 2,4-D. The commercial mixtures are sold as Desormone 7, Diphenoprop 700 or Silvaprop 700.

   Timing and application of this material is very similar to 2,4-D; ensure that all foliage is covered to the point of run off.
3. Dicamba (DyCleer) - This material is usually sold as a formulated mix with 2,4-D (DyCleer 2:4). Timing of the spray and methods of application are very similar to 2,4-D. This mixture usually results in somewhat better control of brush and thistle than will be obtained with 2,4-D. A granular form is also available for use in special circumstances.
4. Picloram (Tordon 10K Pellets, Tordon 101) - Tordon 101 is a formulated mixture of picloram and 2,4-D registered for use to control weeds and brush growing on roadsides. Spray should be applied to actively growing vegetation, usually mid June to mid July, spraying to cover all foliage. If application at this time is not possible, reasonable results may be obtained when spraying is completed a couple of weeks before freeze up.

   Tordon 10K Pellets are a pelletted formulation of Tordon which may be applied to the soil surface in or near patches of weeds or brush. Application may be made at any season when the ground is not snow covered.

   Caution

   (a) Tordon, and to a somewhat lesser degree, dicamba, are highly active and soil persistent. Depending upon the rate applied, Tordon may persist in the soil or in grass growing on the treated soil for several years. Extreme care should be exercised to prevent contamination of any soil where susceptible crops are to be grown.

(b) Haying of treated areas should be permitted only if the farmer is made aware that Tordon has been used on the area and that manure from any animals fed on this forage should only be applied to cereal crops, not underseeded to legumes.
Tordon, and to a somewhat lesser degree, dicamba, are soil persistent and may be picked up by the roots of trees feeding in the treated area. Such trees may be very seriously injured or killed. Treatment should be no closer than one and one half times the height of the desirable tree.

(c) Generally, results from foliar spraying are dependant upon adequate coverage of all foliage from all sides.

5. Tebuthiuron (Spike) - Experimental applications of this material have been made for woody plant control. The material is applied as a narrow band. Some problems may develop related to the total vegetation control capability of this material. This material should be used only on a very limited basis until additional information is available.

Total Vegetation Control - Road Verges - (Shoulders)

Some municipalities treat a small area, usually about 1.5m beyond the edge of the travelled road surface, with a long term total vegetation control mix. This treatment is useful where some of the shallow rooted annual weeds begin to grow here and spread into adjacent fields. In addition it appears that the grader operators are able to maintain to the outside edge of the road without pushing the gravel into the ditch. It also appears that water drains off the road readily, thus eliminating soft and soggy shoulders. Finally, the grader operator does not uproot grass growing along the edge of the road and pull it back into the centre of the road, making for a ridge and rough and rather unsafe driving conditions.

Those municipalities who have used this program for a couple of years find that road conditions are some 30% improved. Indications are, although this theory has not been confirmed, that one gravel program in 20 to 25 years would be saved.

The chemicals used for this purpose are those usually considered to be "soil sterilants" such as bromacil (Hyvar X), atrazine, (Primatol), Simazine (Simadex, Simmaprim), or tebuthiuron (Spike).

Not many municipalities do this type of spraying, but those which do plan to continue, feeling that the not inconsiderable cost is justified by the advantages.

Caution

Before undertaking a major program a municipality would be well advised to experiment with rates of chemical and application equipment. If applied too wide all growth may be killed on the ditch bank and erosion will occur. Do not spray over the edge of the slope into the ditch.

Making up Chemical Mixes

A. Roadside Spray - It is extremely difficult, because of the varying density of growth, to determine the exact chemical application rate on a per acre basis. For this reason, mixes are usually prepared on 1000L basis. On an average, each 1000L of spray solution will treat about 5 acres.

Using estimated 1984 retail prices it is possible to prepare a very rough cost comparison.

Commercial Product(s)	Rate per 1000 L	Cost per Litre	Cost per 1000L Sol'n	Cost per Acre
2,4-D Ester 600	15 L	$4.35	65.25	13.05
2,4-D Ester 700	12.5 L	$4.75	59.40	11.90
2,4-D Ester 800	11 L	$4.75	52.25	10.50
Tordon 101	10 L	$8.50	84.00	16.80
Desormone 7				
Diphenoprop 700	11.0 L	$6.50 L	71.50	14.30
Silvaprop				
DyCleer LH	5 L	$14.90		
Plus	Plus		98.50	19.70
2,4-D Amine 500	8 L	$ 3.00		
DyCleer 2:4	10 L	$11.65	116.50	23.30

Specialized application of Tordon 10K Pellets may be carried out to control undesirable growth in areas where more conventional applications are not practical, such as sightlines at road or rail crossings or patches of noxious weeds or for application after susceptible crops are harvested.

Tordon 10K Pellets - 10 kg/ac. @ 8.60/kg or 86.00/ac.

Conversion Factors

1000L approximately 220 gallons

500 L/ha approximately 45 gal/ac

1 mile - 8 feet wide approximately 1 ac.

1 km - 2.5m wide approximately 0.6 ac.

B. Mixing "Soil Sterilant" Chemicals to Treat Road Verges (Shoulders)

Many of these materials are wettable powders and heavy mechanical or jet agitation is required to maintain them in suspension. If mechanical agitation is not available use the liquid formulations. Screens should be no smaller that 50 mesh. Width of treatment will be in the range of 1.5m. Thus 1 km treated 1.5m wide equals approximately 0.37 ac.

Commercial Product	Rate per acre	Rate per 0.37 ac	Unit Cost	Cost to Treat 1 km x 1.5m
Hyvar X	5 kg	2 kg		
Hyvar XL	15 L	5.5 L	9.50/L	52.25
Spike	4 kg	1.5 kg	35.00/kg	52.50
Simmaprim	10 kg	4.0 kg		
Primatol 80W	7.5 kg	3.0 kg		
Primatol L	15 L	6.0 L		

Public Relations

Good public relations will tend to temper any criticism your operations may provoke. Spraying is a very visible operation and many ratepayers have read reports which detail hazards associated with the use of chemicals. An ad in the local newspaper or a letter sent to the landowners detailing which roads will be sprayed and explaining that the weeds are being controlled to ensure that they do not spread into the

farmers fields will aid your program. If you are controlling brush explain that your actions are designed to aid in road maintenance and to ensure safety for the travelling public.

SURVEY FORM

Road Number: Total Length:

Date Surveyed: Surveyed By:

Location	Weed Condition	Brush Condition
Each municipality may use a different method e.g. mileage in tenths from a starting point or the adjacent land location. List - eastside or westside of the road. Note - any hazards to spraying which may exist e.g. water, shelterbelts, gardens or susceptible crops.	List in particular those weeds of major concern in your municipality and indicate how serious the infestation is.	List species, height and density.

This form should be completed each time a survey is carried out - ideally every year.

FIGURE 1

Suggested Design for Survey Form

RECORD OF ACTIVITY

Road Number: Total Length:

Date of Activity: Supervised By:

Location	1984	1985	1986	1987	1988

FIGURE 2

Suggested Form - Record of Activity

This form should be completed annually on every municipal road. A continuing record of what has been done, and where, is thus available.

PLEASE

DO NOT SPRAY

BETWEEN SIGNS!

- Sensitive vegetation nearby.

- The person erecting these signs has accepted responsibility for vegetation management in this area.

Agricultural Service Board

Landowner Erecting Sign

FIGURE 3

Suggested Wording of "Do Not Spray" Sign

Roadside Spray Equipment

The spray equipment used in Alberta varies widely. A good operator can perform a fair job of vegetation control with a somewhat less than adequate piece of equipment and likewise a poor operator using the very best equipment will often provide poor results.

If a municipality has a good, knowledgeable applicator it would seem logical that he be given the proper equipment to do his work.

For complete details on component parts of a sprayer and detailed hook-up directions refer:

Guide to Weed Control in Alberta
Part III - Herbicide Application Equipment
Agdex 744-5.

Available from:
Alberta Agriculture's district offices or from
Print Media Branch
Alberta Agriculture
7000 - 113 Street
Edmonton, Alberta
T6H 5T6.

Sprayer Components

Sprayers and other application equipment have three basic functions to perform.:

1. Storing chemicals during application.
2. Metering the quantity of material being applied.
3. Distributing the material accurately in the desired pattern.

To perform these functions sprayers have numerous components which can be arranged in many ways. For a particular situation, the best combination depends on:

- the chemical being applied
- the area being treated
- the application rate
- the required accuracy.

A. Tanks

Sprayer tanks are available in a variety of shapes, sizes and materials. Square tanks and tanks with flat bottoms should be avoided as proper agitation and cleaning are difficult. The most popular shapes are the oval tank and the cylindrical tank. They both have good agitation and cleaning characteristics.

Tank sizes will vary depending upon the main use to which the sprayer is put. If the sprayer is designed as a slip-in unit for a farmer's pickup truck for use in treating fence rows or patches of noxious weeds, probably the best size would be 450-700L (100 - 150 gal.). If, on the other hand, the unit is to be mounted on a larger truck and used exclusively for roadside spraying, then the largest tank size consistent with the rated capacity of the truck would be most effective. Time used in driving to refill the tank will reduce the spraying time. If spraying conditions are suitable for spraying, those valuable hours should not be wasted in refilling the tank.

The tank must have a conveniently located, large opening for filling, cleaning and inspecting. An opening of 45 centimetres (18 inches) is usually sufficient. The opening should be splash-proof and fitted with a large 80 or 100 mesh screen. The lid should be vented and leak proof. This will help to keep the outside of the tank clean and free from corrosion.

The drain hole must be located in the tank bottom to facilitate thorough draining. A liquid level gauge complete with capacity markings is a must.

Tanks are available in galvanized steel, stainless steel, aluminum, fibreglass and polyethylene. Mild steel is not recommended as it corrodes readily, requiring considerable maintenance.

The above mentioned materials are resistant to most chemical corrosion, however, the operator must check the chemical label for instructions and precautions.

1. Galvanized Steel Tanks

These tanks are inexpensive and are made in a variety of shapes and sizes. They are easily repaired and modified. The biggest drawback is corrosion. Even with protective coatings,

chemicals cause rapid rusting. Rust flakes off, plugs nozzles, clogs strainers and damages pumps.

2. Stainless Steel Tanks

Stainless steel is the highest quality material for pesticide applicator tanks. It is strong and resistant to corrosion by crop chemicals. Since it is the most expensive material used for sprayer tanks, only equipment with high yearly use is equipped with it.

3. Aluminum Tanks

Aluminum tanks are medium in cost, resistant to corrosion and are suitable for many chemicals. Lab tests have shown that the herbicide TCA has some chemical reaction with aluminum, however, if the tanks is cleaned immediately after use no problems should arise.

4. Fibreglass Tanks

Fibreglass tanks are widely used on all types of sprayers and as nurse tanks. Fibreglass is strong and durable, however, it will crack or break under sharp impact. "On farm" repair kits are available for minor problems. The cost of fibreglass is about equal to aluminum. Some types of solvents may affect fibreglass tanks.

5. Polyethylene Tanks

Polyethylene tanks are relatively inexpensive and can be made in many sizes and shapes. They are resistant to corrosion and can be used with all pesticides. Polyethylene tanks are tough and durable, however, if one is cracked or broken it must be replaced as there is no effective way to repair it. Since polyethylene breaks down under ultra-violet light, tanks should be stored inside when not in use.

Polyethylene and fibreglass tanks must be properly mounted on a "saddle" which supports the tanks over a large area. Without it, the weight of the liquid in the tank may damage the tank as the sprayer bounces over rough terrain.

B. Undercarriage

If the sprayer is mounted in a truck, then there will be no concern regarding the undercarriage. If, however, the sprayer is trailed then it is essential that the undercarriage be heavy enough to support the weight even when travelling over rough terrain.

C. Agitation

Intense agitation is required to keep some chemicals in suspension. The return flow from the pressure regulator does not normally provide enough agitation, especially when the pump output drops off.

Using only the return liquid to provide agitation is usually inadequate even with full pump output, and as the output decreases the amount of return liquid decreases, thus providing less agitation. No indication of low pump output is given with this system until the return liquid drops to zero. To ensure adequate agitation for all chemicals, a mechanical, or jet agitator should be used in the tank. A jet agitator is probably easier to install in most existing sprayers, although mechanical agitators provide the most positive mixing. Sparge tube agitators may also be used.

1. Mechanical Agitation

Mechanical agitation can be provided by paddle wheels or propellors driven by electric motors or power shafts from the tractor. Mechanical agitation provides the most positive and thorough mixing possible but the systems are expensive and require a high degree of maintenance. The added expense and complications make them impractical for most farm-type sprayers but they are common on commercial, high pressure, utility sprayers, and roadside type units.

2. Sparge Tube Agitation

Sparge tubes consist of a perforated pipe or pipes running the length of the tank. The pipe is connected to a pressure line and liquid pumped through it sweeps the bottom of the tank. These devices must not be connected to the bypass since excessive pressure would build up when the booms are turned off. Although sparge tubes do not increase the quantity of liquid in circulation, they do provide uniform agitation throughout the tank.

3. Jet Agitation

Jet agitators with venturi caps have an output of two or three times their input. Various sizes are available for different sizes and shapes of tanks. A per minute input of about one to two percent of the tank capacity is recommended.

In order to get adequate mixing of wettable powders, several nozzles are required to get a complete sweep of the tank bottom. Large flat bottom tanks need more nozzles than do round tanks.

Jet agitators must NEVER be connected to the return line from the pressure regulator as excessive pressure will occur when spray lines are shut off.

Jet agitators must be securely fastened inside the tank to prevent whipping. A throttling valve should be provided in the agitator line to reduce the flow if excess foaming occurs.

To adjust for spraying, first close the agitator control valve and open the boom valve. Adjust the relief valve until the pressure gauge reads 75 to 100 kPa above the desired spraying pressure. Slowly open the agitator control valve until spraying pressure is reached. If the pressure won't come down even with the control valve wide open, use a larger orifice in the agitator.

D. Pumps

A variety of pumps can be used on sprayers. Each kind has certain capabilities and limitations that determine when it should be used. The kinds of pumps are:

- Gear
- Diaphragm
- Flexible Impeller
- Roller
- Centrifugal
- Piston
- Metering

The most widely used pumps on agricultural spray equipment are the roller pump, piston pump and the centrifugal pump.

1. Gear Pumps

Many early weed sprayers used gear pumps. However, they are seldom used today because of the high wear rate incurred when pumping abrasive materials. A worn pump cannot be reconditioned and must be discarded.

2. Diaphragm Pumps

The pumping action in a diaphragm pump is produced by the movement of a flexible diaphragm. Liquid is drawn into one chamber

on the downstroke and forced out of another on the upstroke. The diaphragm is resistant to wear by abrasives but may be attacked by certain chemicals.

Recently high volume, high pressure, diaphragm pumps are being used on industrial sprayers with success.

3. Flexible-Impeller Pumps

Flexible-impeller pumps have a series of rubber "paddles" attached to a rotating hub. The pump housing squeezes the paddles, as the rotor turns causing the pumping action. This pump has an automatic pressure relief. The paddles will not return to the radial position if the pressure is too high. These pumps are not commonly used any longer because they wear quickly.

4. Roller Pump

Roller pumps are commonly used due to low cost and compact size. They operate at 540 and 1,000 rpm, they are easily repaired and have adequate capacity for field sprayers, but not usually for roadside or industrial sprayers. Roller pumps can be used to pump plain water and other pesticide solutions including wettable powders. The roller material should be compatible with the solution being pumped. Always check manufacturers information on pump use.

The "rollers" of a roller pump fit into slots of a rotating hub. The slots allow the rollers to follow the eccentric shape of the housing. As the rollers pass the inlet port, the space between rollers and the housing becomes larger and draws fluid into the pump. The fluid remains between two rollers as it moves to the outlet port. As the rollers near the outlet port, the spaces become smaller and the fluid is expelled from the pump.

The output from a roller pump decreases substantially as the operating pressure increases because the rollers tend to let more fluid "leak back" between rollers.

5. Piston Pump

These pumps are primarily designed for high-pressure spraying applications. Piston pumps are positive displacement pumps, which means that output is proportional to speed and virtually independent of pressure. They are a good pump for wettable powder

suspensions and other abrasive liquids. Piston pumps operate efficiently at tractor PTO speeds. These pumps are suitable for use on field sprayers but are not commonly used due to their high purchase price. However, they are one of the best types of pumps for custom operators or on any utility sprayers.

6. Centrifugal Pump

Centrifugal pumps have become increasingly popular as they handle abrasive materials well, and have a high capacity to provide adequate hydraulic agitation. Centrifugal pumps must be driven at high speed to develop pressure by belt, gear, or hydraulic drives. Pump output falls off rapidly after 300 kPa pressure. The centrifugal pump's main disadvantage is that pump output decreases rapidly with small reductions in pump speed. Turbine pumps have similar characteristics to the centrifugal pumps but run at a lower speed.

7. Metering Pumps

Metering pumps are driven by a ground wheel. When speed changes, the rate of pumping increases or decreases proportionately. Thus, the application rate is held constant. Variable-stroke, piston pumps are designed to change the length of the piston stroke to adjust the application rate. Increasing the piston stroke increases flow; reducing the stroke, cuts the flow. Some pumps have a dial setting to indicate the output required. Other models require changing the sprocket size according to the desired volume. These types of pumps are mainly used in liquid fertilizer applicators, however some manufacturers of herbicide sprayers also offer metering pumps. Evaluation of metering pump systems for herbicide application is not complete and it is suggested that at this time these pumps not be considered for roadside sprayers.

8. Determining Pump Capacity

As a general rule no roadside sprayer will operate successfully with a pump capacity of less than 90 L/min. (20 gal/min.)

Such a capacity pump will usually allow for variation in rate of application, some normal wear, and will include an allowance for agitation.

E. Sprayer Circuits

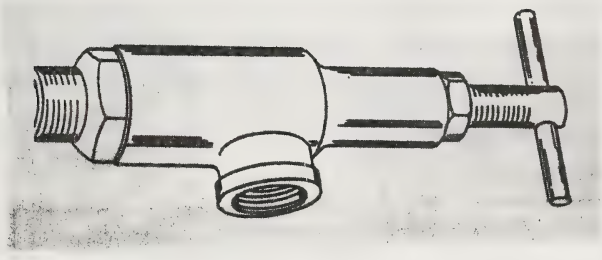
A sprayer circuit is the path followed by the liquid as it pumps through the sprayer and out the nozzles. All circuits are similar and involve the same basic components. However, a few important differences exist.

Circuit variations depend primarily on the kind of pump. Each new sprayer has a specific hydraulic circuit. If the type of pump is changed, always change the hydraulic circuit to match the new pump.

For details of the suggested circuit for each type of pump refer to "Herbicide Application Equipment" publication - pages 10 and 11.

F. Sprayer Circuits

1. Relief Valve



A relief valve is a safety device that releases liquid when the pressure exceeds a safe level. Relief valves can be used to regulate sprayer pressure by adjusting them to open at the desired setting. When used this way, the valve is always partly open while the sprayer is operating. The excess flow is bypassed back to the tank.

2. Unloader Valve

Spraying systems operated at pressures over 1400 kPa should use an unloader valve in place of a relief valve to unload the pump when the distribution system is turned off. An unloader valve opens and enables the pump output to flow back to the tank at low pressure. This reduces pump wear as well as relieving the pressure on the entire system.

G. Pressure Gauges

The importance of this item is often overlooked. Its reading is an indication of the rate of application being applied. A spare, accurate gauge should be kept on hand in case of failure and for checking boom pressure.

Pressure gauges should have a total range of twice the maximum reading expected. Gauges reading 0-450 kPa or 0-700 kPa are satisfactory. Gauges should be checked yearly for accuracy. If in doubt, replace the gauge as it is not an expensive item. The gauge should also be equipped with a pulsation damper to prevent damage and to keep the needle from fluctuating.

Pressure gauge accuracy may be checked as follows:

1. Attach a hose equipped with a tire chuck to the sprayer gauge;
2. Inflate a tire of 250 kPa being sure to check pressure with a good tire pressure gauge;
3. Compare reading with sprayer pressure gauge;
4. Inflate the tire to 275 kPa and compare readings.

H. Screens and Filters

An 80 or 100 mesh screen should be used in the tank filler opening. This will effectively pre-screen the material before it enters the tank.

Additional filtration is required to help prevent nozzle plugging and to prevent foreign material from entering the pump. This filter is located between the tank and the pump when using roller, piston and turbine pumps and located between the pump and booms when using a centrifugal pump. The reason for this is that the centrifugal pump can handle foreign material without damage. By having the filter between the pump and booms, a much smaller volume of tank solution is filtered.

A 50 or 60 mesh filter is satisfactory for most solutions. Wettable powders require a 40 or 50 mesh filter.

Felt filters have been replaced by metal screen filters as they provide more filter area, are easier to clean and handle wettable powders.

Note: Mesh size refers to the number of holes per 25 mm.

I. Plumbing

1. Hoses

Hoses convey the liquid through the sprayer. Liquid pressure varies at different points on the sprayer. Hoses and pipes must be strong enough to prevent bursting. The rated working pressure of a hose decreases as the diameter increases. Be sure hoses are rated for higher capacity than the expected operating pressure to provide a margin of safety and avoid bursting from pressure surges.

Suction hoses are not pressurized and will not burst, but they can collapse, if the inlet becomes plugged. Suction-hose diameter should be at least as large as the pump inlet port. The hose must be chosen carefully and should be of the noncollapsing, wire-reinforced type. A collapsed suction hose can restrict flow of liquid and "starve" a pump, causing decreased outflow and greatly accelerated wear.

The inner and outer layers of all hoses should be resistant to the chemicals to be used. Check with both the chemical supplier and the hose supplier if there is any doubt. A hose weakened by chemical attack can leak or burst unexpectedly.

Hose size is important because pressure losses affect flow rates. Pressure loss depends on hose diameter, length and flow rate. Although pressure losses may not seem significant in hoses shorter than 2 meters it's wise to always use hose of the recommended size to minimize pressure and power losses.

2. Control

(a) Boom Control - Control valves used to regulate the flow of liquid are those valves other than the pressure regulator. The type of control valves used on a particular sprayer will depend on operating requirements and personal preferences. Electric solenoid valves are available in materials resistant to all common herbicides. These valves may be mounted on the sprayer and controlled remotely from the driver's seat. Advantages include easier, faster control, a shorter and less complex plumbing system, and increased operator safety.

(b) Other Valves - Valves are required at several points throughout the plumbing system of the sprayer. Depending on the application, gate valves or ¼-turn ball valves are recommended. Valves are required to control the agitation system and the hand gun. A ball valve is normally installed on the suction line up-stream from the main filter. This enables cleaning of the filter while there is liquid in the tank. A valve on the tank drain is very handy and can be installed to replace the drain plug. This makes cleaning the tank much more convenient and reduces the chances of the operator coming in contact with the chemical mixture while draining the tank.

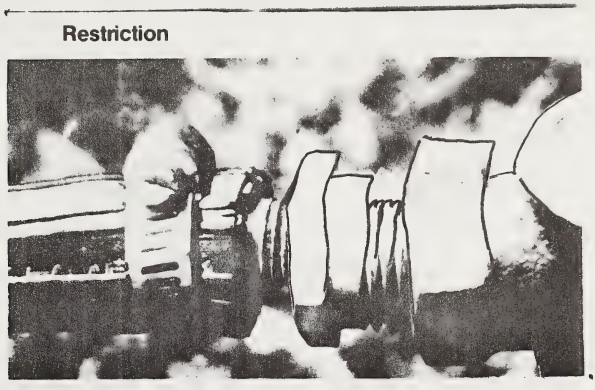
Gate or ball valves should be used throughout due to their low flow restriction. Globe valves may only be used in lines or circuits which require throttling, such as the agitation line.

4. Pressure Loss

In any system where flow of liquid is involved there are pressure drops between the pump outlet and the discharge point.

The amount of pressure loss depends upon:

1. Size of hose,
2. length of hose,
3. flow rate, and
4. other fittings in the lines (restrictions).



Pressure drop can also occur on the inlet or suction side of the pump. The allowable restriction at this point is critical, since the pump output and life can be affected. A total pressure drop of less than 30 kPa is desirable. This includes the total drop through fittings, filter and inlet hose. Since most filters, when clean, cause a pressure drop of 15 to 25 kPa (depending on the flow rate), it is necessary that the remainder of the suction line not cause a pressure drop of more than 15 kPa at maximum flow. Hose and fitting sizes must be correctly chosen. A large pressure drop will shorten the pump life and drastically reduce output.

Pressure drops can be reduced by selecting the correct line sizes, minimizing the number of fittings, elbows or sharp bends and reducing the length of hoses as much as possible.

O.C. Nozzles (Large Size) Output Chart

3/4" NPT Off-Center Single Swivel Nozzle No.	Pressure kPa	Nozzle Capacity in L/min	"W" m	SPRAYING HEIGHT "H" = 90 cm LITRES PER HECTARE 8 km/h	16 km/h	24 km/h	"H" = 35 in. LITRES PER ACRE 8 km/h	16 km/h	24 km/h
	200	3.22	5.4	45	22	14.9	18	9	6
4629-3/4T-0C10	300	3.95	5.6	53	26	17.6	21.5	10.5	7
	400	4.56	5.6	61	31	20	25	12.5	8
	200	6.45	7.1	68	34	23	27.5	13.8	9.3
4629-3/4T-0C20	300	7.90	7.4	80	40	27	32	16.2	11
	400	9.12	7.4	92	46	31	37	18.6	12.5
	200	12.89	7.9	122	61	41	49	25	16.6
4629-3/4T-0C40	300	15.79	8.2	144	72	48	58	29	19.4
	400	18.23	8.2	167	83	56	67.6	33.6	22.7
	200	25.80	8.8	220	110	73	89	44.5	32
4629-3/4T-0C80	300	31.60	9.1	260	130	87	105.3	52.7	35
	400	36.50	9.1	300	150	100	121.5	60.8	40.5
	200	48.30	9.3	390	194	130	157.9	78.6	52.7
4629-3/4T-0C150	300	59.20	9.6	460	230	154	186.3	93	62.4
	400	68.40	9.6	530	270	178	214.7	109.4	72.1
	200	96.70	9.7	750	370	250	303.8	150	101.3
4629-3/4T-0C300	300	118	10.0	900	440	300	364.5	178	121.5
	400	137	10.2	1010	500	340	409	202.5	137.7

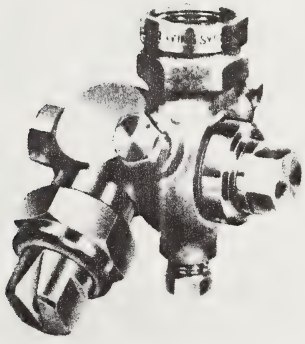
3. Nozzles

(a) Large Capacity O.C Nozzles

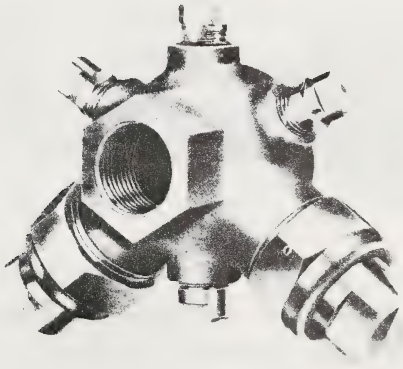
Large capacity off-centre (O.C.) nozzles come either as a single swivel or double swivel and are tractor mounted for boomless broadcast spray in rough areas.

The single swivel is often mounted on trucks for roadside spraying.

Single Swivel



Double Swivel



(b) Raindrop Nozzles

Raindrop nozzles produce large droplets which can significantly reduce spray drift. In order to get good patterns from a raindrop nozzle, they must be mounted at 90

degrees to the horizontal, rather than straight down, as with other nozzle types. The very large droplets produced may not provide adequate coverage with foliar-applied herbicides. They are useful for industrial and specialized areas and are probably ideal for roadside spraying and aerial application.

(c) Accutrol Nozzles

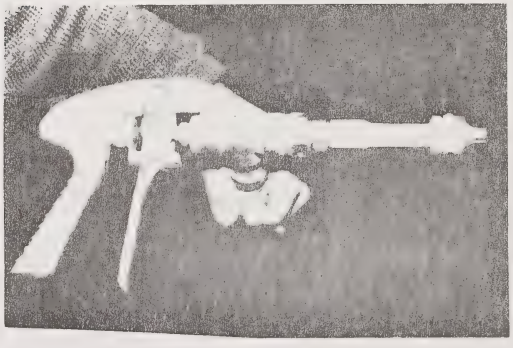
These nozzles are designed for industrial uses such as spraying roadsides or other rights-of-way. Accutrol nozzles produce large droplets to reduce drift control and are designed to be used in combination with a spray adjuvant. The nozzle draws in air and mixes it with the spray to form a milky mixture resembling foam that is visible to the operator.

Large V-nozzles are used on a boom and produce a fan shaped spray pattern.

Other types of accutrol nozzles are designed for use as a boomless spray system. These can also be adapted to handguns.

F Nozzle (Fan Stream)

Accutrol Fan Nozzle On Handgun

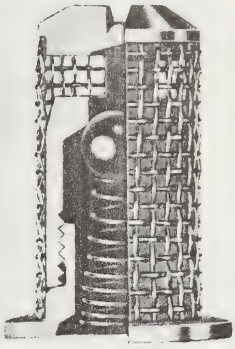


LF Nozzle (Long Fan Stream)

Nozzle Tip Strainers

Diaphragm Check Valve

Ball Check Valve



Nozzle Strainers and Screens

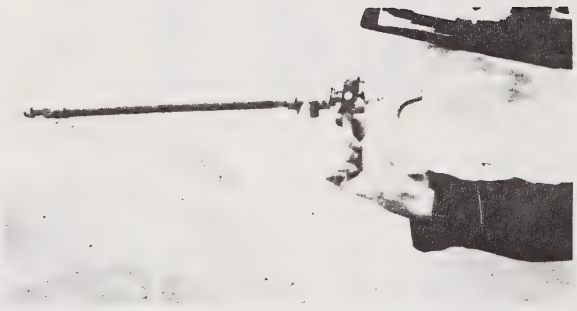
In order to help prevent nozzle tip plugging, nozzle tip strainers stop dirt and other particles before they can plug the orifice.

The size of strainer depends on the tip size and the type of solution. A 50 mesh screen or equivalent slotted strainer is normally sufficient for larger tips and for wettable powders. An 80 or 100 mesh screen is normally used with smaller tips.

Nozzle Check Valves

Nozzle check valves can be used to effectively eliminate nozzle dripping when pressure has stopped. The valves also provide spray without hesitation, when flow is reapplied. This is accomplished by means of a diaphragm check valve or a spring-loaded check ball which stops flow through the nozzle when the pressure drops to a certain level. When using a nozzle check valve, the spraying pressure must be increased by the amount it takes to open the valve. This is usually 35 kPa, although 70 kPa springs are available.

Hand Guns



For jobs that are too big for self-contained hand sprayers, or where large amounts of solution are required to wet the foliage, the handgun is a convenient accessory to the field or truck mounted sprayer.

The handgun consists of the gun itself and a length of hose used to treat patches of weeds in locations inaccessible to the sprayer.

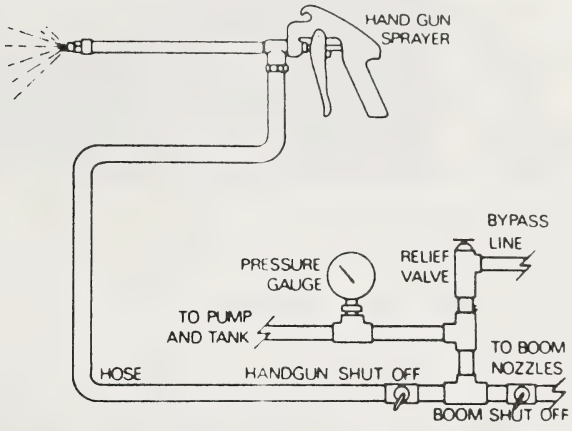
1. Hooking up a Handgun

   A minimum amount of plumbing is required to hook up a handgun. Once the connection to the outlet line is made, it may be permanently left in place.

1. Installation should be made in a line between the pump and the boom. If a selector valve is present, the installation can be made right at the valve.

   If other types of valves are used the connection should be between the valve and one boom section.
2. A tee is installed at some convenient point between the pump and boom.
3. A nipple is installed in the tee leading to a shut-off valve.
4. A nipple is installed on the other side of the shut-off valve, leading to a hose connector.
5. A hose, at least 8 m in length and leading to the handgun, is hooked into the system at the hose connector.
6. To complete the hook up, a shut-off valve should be installed between the tee and the boom.

HOW TO HOOK UP A HANDGUN



2. How To Use A Handgun

Controlling weeds with a handgun requires a relatively high volume of spray solution per acre. It is essential that weed foliage be thoroughly covered to the point of run-off.

Output from a handgun depends upon:

(a) Size of orifice disc in handgun.

(b) The pressure at the gun.

(c) The spraying habits of the gun operator. The whole operation is completely manual so the laydown depends upon how long the operator dwells on a weed patch.

3. Handgun Orifice Disc Output Capacity

	Capacity L/min at kPa Pressure			
Disc Orifice Size	500 kPa	1000	1500	2500
4	2.74	3.87	4.74	6.12
5	4.10	5.80	7.10	9.17
6	5.70	8.06	9.87	12.70
7	7.52	10.60	13.0	16.80
8	9.80	13.90	17.0	21.90

Two precautions are suggested when using a handgun:

(i) Thoroughly clean the gun between jobs since the hose can contain a substantial amount of pesticide mixture.

(ii) Precise calibration is very difficult, so hand guns should be used for applications where very accurate rates are not required. For example, herbicides are generally applied with a hand gun by mixing a very dilute solution and applying to the point of runoff.

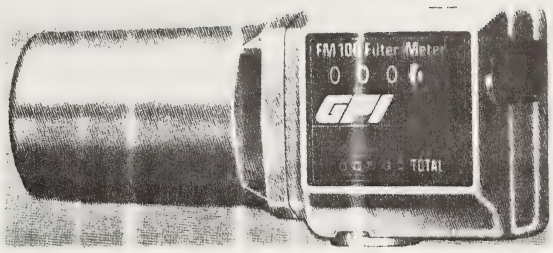
Sprayer Calibration

Accurate calibration of spraying equipment is an important aspect of chemical usage. An application of more than the recommended rate is wasteful and may cause damage. Applications of less than the recommended rate may be ineffective; again wasteful.

1. Electronic Calibration

Electronic calibration is now available from several companies. This is one of the most significant advances in spraying technology. With the use of electronic circuitry, it is possible to correlate liquid flow out of the booms with the forward speed of travel to display the result in litres per hectare as a continual digital readout. These devices enable selection of the proper application rate and the operator simply adjusts the forward speed until correct application is achieved as indicated on the dial. Liquid flow is continuously measured, so any significant change in the spraying system, such as excessive plugging, pump or regulator malfunction, or excessive leakage will show up instantly on the monitor.

Electronic Monitor



2. Flow meters can be used to measure liquid flow. The flow is a digital readout in litres which can be correlated with speed and distance travelled to determine the application rate. Flow meters should be mounted on the line to measure only the liquid flow to the spray or handgun. The bypass flow must not go through the flow meter.

Cleaning And Storage

Proper maintenance of a sprayer will result in longer life and more hours of trouble-free operation. Consult your operator's manual for proper maintenance procedures.

The sprayer should be cleaned at the end of each day of use by flushing the tank, pump, hoses and nozzles with clean water. Remove and clean out filters, screens and nozzle tips.

Plugged tips should be cleaned with a soft brush. Never use your mouth to blow a tip clean. Nozzle tips should be removed and stored in light oil at season's end.

Cleaning For Storage Or When Changing Chemicals

1. Drain sprayer thoroughly.
2. Circulate clean water through entire spray system and drain.

*3. When cleaning out "esters" add diesel fuel to the tank and circulate, then drain, then

*4. Add detergent with water; circulate and drain. Grease pump after using detergent for cleaning.

5. Add ammonia with water, circulate and leave overnight.
6. Recirculate and drain.

Rinse with clean water.

*Note: If ester formulations are not used, steps 3 and 4 are not necessary.

Follow pump manufacturer's maintenance and storage procedures to ensure longer pump life.

Note: If Glean is used - mix a chlorine solution for clean-out. DO NOT use ammonia.

Trouble-Shooting Check List

Sprayers fail to operate correctly because of breakage, corrosion, abrasion or pumps that run dry. Avoid breakage by selecting good equipment, operating carefully, and maintaining properly.

Here are some of the more common problems that can occur with sprayers. Possible causes and remedies are included.

Problem	Possible Cause	Remedy
Loss of Pressure	1.Pressure regulator improperly adjusted or stuck open.	1.Clean and adjust pressure regulator.
	2.Suction screen plugged.	2.Thoroughly clean screen.
	3.Cracked or porous suction hose.	3.Replace hose.
	4.Worn pump.	4.Replace or recondition pump according to the manufacturer's instructions.
	5.Faulty gauge.	5.Replace gauge.
	6.Pump starving.	6.Check for collapsed suction hose, plugged filter, main control valve too small or wrong type.
Excessive Pressure	1.Pressure regulator improperly set.	1.Adjust pressure regulator.
	2.Bypass hose plugged or too small.	1.Unplug the hose or replace it with a larger one.
	3.Faulty gauge.	2.Replace gauge.
Pressure gauge needle jumps excessively.	1.Gauge too sensitive.	1.Replace gauge and mount a damper between the gauge and the pump.
	2.Pump starving.	2.Check for restriction or air leak on inlet side of pump.
Nozzles plugging.	1.Too fine a nozzle screen or the screen is corroded.	1.Replace with the proper mesh screen or clean the screen thoroughly.
	2.Dirty water or foreign material in the tank.	2.Drain tank and clean thoroughly; check suction screen for holes.
	3.Chemical (wettable powder) not properly mixed.	3.Increase agitation.
	4.Nozzles too small.	4.Replace with the proper nozzles for the chemical being used.
	5.Boom or hose filled with foreign material.	5.Clean the boom or hose.
Poor spray	1.Pressure too low.	1.Check pressure on boom end with a gauge. Pressure should be within 10 to 15 kPa of main gauge.If not,check sizes of fittings and hoses for restrictions.
	2.Discs or nozzles worn or damaged.	2.Replace nozzles or discs.