Sprayer Equipment

Aerial Pesticide Applications

Many pesticides may be applied by either fixed-wing aircraft or by helicopters. The main advantage of aerial spraying is that it can be carried out quickly and at times when ground equipment cannot operate. The main disadvantage is the increased possibility of pesticide drift onto neighbouring areas and decreased spray coverage. Even when properly calibrated and operated, aircraft sprayers are often not as thorough in applying material as ground rigs, especially to the lower surfaces of the leaves and to the lower portions of the plants when the foliage is dense.

Aerial applications should not be used for small acreages or in residential areas, and should be done only by properly trained individuals who hold a valid BC pesticide applicator's certificate. Information on aerial applicator courses and pesticide applicator certificates can be obtained from the Pesticide Management Program, BC Ministry of Water, Land and Air Protection. Aerial application of pesticides in berry crops in the Lower Mainland of BC is very limited.

Ground-based Pesticide Applications

Most farms use ground-based equipment to apply pesticides. Hand-operated or backpack sprayers are common on all farms for spot treatments and areas difficult to reach with tractors. Motorized sprayers are used on most farms.

Boom-sprayers

The most common motorized sprayer is a boom sprayer with a pump that provides enough liquid pressure to spray the target from nozzles located on the boom. High pressure sprays (700 - 2000 kPa or 100 - 300 psi) are typically required for spraying insecticides and fungicides on berry crops. The same sprayers can be used at lower pressures when spraying herbicides.

Airblast Sprayers

Airblast sprayers for spraying insecticides and fungicides have become more common on blueberry farms. These use a combination of air and liquid to deliver the pesticide to the plant. The pesticide is pumped through nozzles into a blast of air from a high-speed fan. Airblast sprayers may use lower water volumes than boom sprayers. However, drift can be more of a problem due to the fine droplets required for thorough coverage when spraying at low volumes. The components of airblast and high pressure boom sprayers are very similar except for the added fan and air manifold on the air-blast sprayer. A separate boom on the airblast sprayer is required for spraying herbicides if a separate sprayer is not used.

Hand Operated Sprayers

The most common spraying equipment on small operations is the hand-operated sprayer. It is suitable for spraying herbicides. Basic, low cost backpack sprayers will generate only low pressures and lack features such as diaphragm pumps, agitators, pressure adjustment controls (regulator), and pressure gauges found on commercial grade units. These low pressure sprayers without pressure regulators and gauges should not be used for applying insecticides and fungicides where uniform coverage is important. This is especially true with some of the new plant growth regulators where uniform coverage is a crucial part of their effectiveness. These sprayers with their limited control options are better suited for the home gardener situation.

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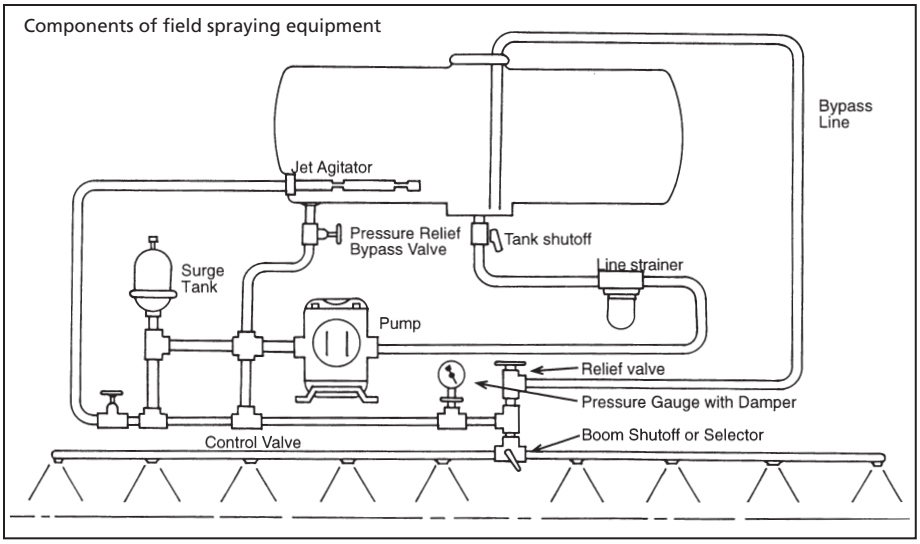
Components of field spraying equipment



Diaphragm pumps and agitators will allow sprayers to be used with wettable powder sprays more effectively. Pressures should be above 80 psi to achieve the finer sprays suitable for applying insecticides and fungicides. Pressure gauges and pressure regulators enable the sprayer to operate at higher pressures (80 to 200 psi) and the operator to achieve a more uniform output from the sprayer. **Note** that a smooth uniform walking speed and spray wand motion is also required to achieve uniform coverage. Nozzles must be selected for the operating pressure of the sprayer and spraying conditions. Backpack sprayers should have a positive shut-off spray control valve to eliminate pesticide drips form the wand and nozzle. Drip-proof nozzle assemblies are also available as an alternative. Ball check valves in the nozzle body require 5 to 10 psi of liquid pressure to start spraying and close when the pressure drops below this level to prevent drips. Full protective equipment should be worn to reduce the operator's exposure to pesticides especially when spraying at high pressures and with small droplets.

Operation of Sprayers

Essential components of any chemical spraying equipment are the power source, pump, tank and nozzles. Others which must be considered are agitators, screens, filters, valves, pressure regulators, booms, hoses, gauges and hand-guns (see following figure).

Power Source

The power-sprayer is normally driven by the PTO (power take-off) of the tractor or by an auxiliary engine. The power rating of these should be double the theoretical power required by the pump.

Pumps

A pump creates the pressure required for atomization and penetration of the spray on almost all types of sprayers.

Choose a pump having the characteristics required for the job. Common pumps include:

- roller pump—excessive wear can occur with wettable powders
- piston pump
- diaphragm pump

For spraying insecticides or fungicides, sprayers require either diaphragm or piston pumps to develop the higher pressures needed (700 kPa or 100 psi) to get thorough plant coverage. Determine the capacity of the pump by the highest rate of application the sprayer is expected to deliver, an adequate volume for agitation and an additional 25% volume to account for the pump's wear. During operation there should always be flow in the bypass line indicating the pump has sufficient capacity to send some excess to the tank. **Note** the maximum rpm allowed for the pump and always operate the tractor throttle so that the maximum is not exceeded. Be aware that increasing the pump's rpm will also increase its output, therefore, the tractor's throttle setting must be fixed during calibration and sprayer operation. Operating at too low an rpm may decrease the pump's output below that required for the sprayer.

Tanks

The size of the spray tank depends on the intended application rate and the mounting space available. The tank should be equipped with a large screened opening

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for easy filling and cleaning. Tanks may be constructed of steel, stainless steel, epoxy-coated steel, fiberglass, polyethylene or aluminum. Fibreglass, stainless steel and polyethylene tanks are preferred because of their rust and corrosion resistance.

The herbicide "Roundup" and liquid nitrogen fertilizers must not be put in galvanized steel tanks, as a hazardous chemical reaction can result.

The rusting of steel tanks can be reduced by proper draining, cleaning and airing of the tank after use and by the use of rustproofing compounds. Either hydraulic bypass or mechanical agitation must be provided. If hydraulic agitation is used in the spray tank, additional pump capacity is required. Mechanical agitation is preferred if wettable powders are to be used.

Mechanical agitation with paddles gives the best mixing for wettable powder formulations. If hydraulic agitation is used, 1/10 to 1/20 of the tank capacity should be recirculated per minute. This flow should be supplied from a separate pressure line, not from the relief valve bypass.

Tanks should be equipped with drains in the lowest part of the tank to allow complete emptying of the tank. Drains should be easy to operate to encourage operators to drain the tank at the end of each day.

For proper mixing of pesticide dilutions it is important to know the volume capacity of the spray tank.

Hoses

Suction hoses (from the tank) should be reinforced so they will not collapse, be resistant to chemicals and oils, and be of the same diameter as the pump inlet hole. The same type of hose can be used for the bypass line.

Hoses on the pressure side of the pump must be able to handle pressures higher than the intended use and preferably as high as the maximum pressure the pump can develop. To avoid excessive pressures on the hose the relief or unloading valve should be released before flow to the boom is shut off.

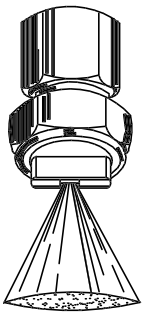
Nozzles

The size of droplet produced by various nozzles depends upon operating pressures and nozzle design. The droplet size decreases with a higher pressure and with a smaller nozzle tip opening. Droplets that are too big give poor coverage and droplets that are too small drift easily.

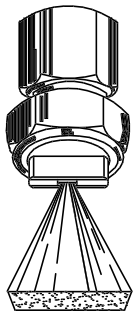
Types of nozzles

The main nozzle types used for chemical application are:

- **Flat spray nozzles.** (Also called fan type or TeeJets) These are used for low-pressure spraying such as the application of herbicides and insecticide drenches. They produce a fan-type pattern with less material applied along the edges of the spray pattern (see figure below). By properly overlapping the spray, a uniform application is produced across the spray boom. Offset flat spray nozzles at an angle of 10 degrees to the boom to prevent interference of the overlapping spray patterns. Nozzle spacing on the boom and the height of the boom above the target are critical to obtain a uniform application. Sprayer equipment suppliers and nozzle manufacturers' catalogues can advise growers as to the correct height of the boom at different nozzle spacings and for different nozzle spray angles. Do not operate these nozzles above 400 kPa (60 psi) to prevent excessive wear and fine spray droplets. Refer to manufacturer's specifications for recommended nozzle pressures.


Flat spray nozzle

- **Even spray nozzle tips.** These produce an even spray pattern across the entire fan width (see figure below). These nozzles are used in band spraying of herbicides where there is no overlap from other nozzles. Align even spray nozzles with the spray boom. These nozzles are designed to operate at low pressures (less than 400 kPa or 60 psi). Refer to manufacturer's specifications for recommended nozzle pressures.


Even spray nozzle

- **Cone nozzle tips.** These are used for medium to high-pressure spraying (mostly fungicides and insecticides). These nozzles produce a good swirling mist so the spray material can reach the undersides of leaves. Nozzle spacing should allow the adjacent spray patterns to cover the entire target otherwise skips may occur. An example of skips would be when the nozzles (and boom) are too close to raspberry plants,

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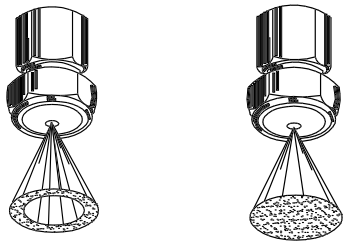
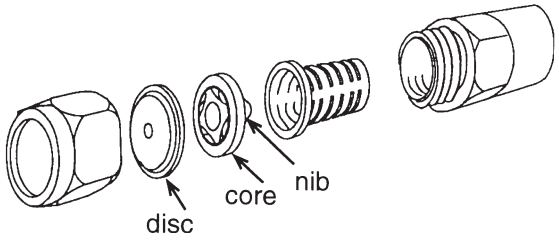


Hollow cone nozzle Solid cone nozzle

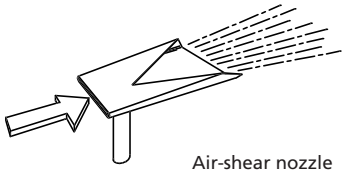
the plants close to the boom and between the nozzles will be missed. Cone nozzles are available as either hollow cone or solid cone types – both produce the same swirling mist but the solid cone nozzles are used when larger volumes are required (see figure below). The cone nozzles most commonly used in the berry industry are two-piece disc-core nozzles which must be installed correctly with the rear nibs facing the nozzle body (see figure below). Cone nozzles are used in both boom and most air-blast sprayers.



Assembly of disc-core cone nozzles

- **Air-shear nozzles.** These use a high-speed air stream to break up the liquid into droplets, so this nozzle is limited to air-blast sprayers with a high-velocity air discharge (at least 250 km/h or 150 mph). Air shear nozzles operate at low pressures and have large openings which minimizes plugging (see figure below). Air-blast sprayers using regular cone nozzles normally operate at air-velocities of 160 km/h (100 mph) and air-velocity is not critical for droplet formation.

Nozzle sizes



Air-shear nozzle

Various sizes of flat, even and cone nozzle tips may be used to obtain the volume of water desired. Consult with your sprayer equipment supplier as he has information on nozzle outputs for the various nozzle sizes. Ask for a catalogue with nozzle outputs in litres per minute. For your convenience nozzle outputs for Spraying Systems flat spray tips and disc-core type hollow cone spray tips in Table 36 and Table 37 respectively.

Nozzle tip materials

Nozzle tips are made from a variety of materials. Choice of material depends upon the abrasiveness of the spray mixture. Wettable powders are more abrasive than emulsions. Brass tips are cheap but the metal is softer and the tips wear faster. In increasing order of durability the following materials are used: plastic, brass, stainless steel, hardened stainless steel, ceramic and tungsten carbide. By making flat and even spray tips out of colored plastic with a small amount of stainless steel or ceramic in the center with the spray orifice, the more durable tips can be made at a very reasonable cost. These nozzles are more cost-effective than nozzles made entirely of brass.

As nozzle tips wear out, the rate of application increases. Tests have shown that some wettable powders wear nozzle tips sufficiently to increase the rate as much as 12% after spraying only 20 ha. For this reason, frequent calibration of equipment is necessary. Also, very worn nozzles should be replaced because their spray pattern is distorted and uneven application will result.

Screens

Screens prevent foreign material from entering the system, clogging the nozzles and wearing out the sprayer.

Suction strainers, line strainers and nozzles should all be equipped with 50 mesh or coarser screens when wettable powders are to be used. Some pesticides may require coarser suction strainers. It may be necessary to have more than one suction strainer for the sprayer.

Screens finer than 50 mesh (100 mesh, for example) may plug with some wettable powders.

Screens are generally used in fine nozzles, but slotted strainers can be used in those that have a larger opening. Consult the nozzle manufacturer's catalogue for recommendations on specific screen mesh sizes for specific nozzles. Generally for flat spray nozzles with small holes (TeeJet 80015 or smaller) a 100 mesh nozzle is recommended. Generally larger nozzles

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Table 36. Flat spray nozzle outputs (Litres per minute)

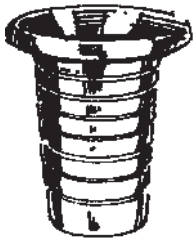
Nozzle	PSI	LPM	Nozzle	PSI	LPM	Nozzle	PSI	LPM
8002	15	0.45	8005	15	1.17	8010	15	2.31
	20	0.53		20	1.32		20	2.69
	25	0.59		25	1.48		25	2.99
	30	0.64		30	1.63		30	3.29
	35	0.70		35	1.76		35	3.54
	40	0.76		40	1.89		40	3.79
	45	0.79		45	2.01		45	3.97
	50	0.83		50	2.12		50	4.16
	55	0.87		55	2.21		55	4.35
	60	0.91		60	2.31		60	4.54
8003	15	0.68	8006	15	1.40	8015	15	3.48
	20	0.79		20	1.59		20	4.01
	25	0.89		25	1.78		25	4.47
	30	0.98		30	1.97		30	4.92
	35	1.06		35	2.12		35	5.30
	40	1.14		40	2.27		40	5.68
	45	1.21		45	2.40		45	6.06
	50	1.29		50	2.54		50	6.43
	55	1.34		55	2.65		55	6.62
	60	1.40		60	2.76		60	6.81
8004	15	0.91	8008	15	1.85	8020	30	6.43
	20	1.06		20	2.16		35	7.00
	25	1.19		25	2.38		40	7.57
	30	1.32		30	2.61		45	7.95
	35	1.42		35	2.82		50	8.33
	40	1.51		40	3.03		55	8.89
	45	1.61		45	3.20		60	9.46
	50	1.70		50	3.37			
	55	1.78		55	3.54			
	60	1.85		60	3.71			

Table 37. Hollow cone nozzle outputs (Litres per minute)

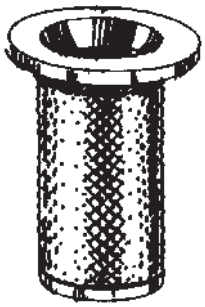
		Pressure (psi)							
Disc	Core	80	100	125	150	175	200	250	300
2	25	0.83	0.95	1.02	1.10	1.19	1.29	1.42	1.55
3	25	0.98	1.10	1.21	1.32	1.42	1.51	1.67	1.82
2	45	1.06	1.21	1.32	1.44	1.55	1.67	1.84	2.01
3	45	1.25	1.36	1.51	1.67	1.80	1.93	2.14	2.35
4	25	1.51	1.70	1.87	2.04	2.20	2.35	2.59	2.84
5	25	1.82	2.04	2.25	2.46	2.65	2.84	3.12	3.41
4	45	1.89	2.12	2.35	2.57	2.76	2.95	3.27	3.60
5	45	2.42	2.69	2.97	3.26	3.50	3.75	4.18	4.62
6	45	3.14	3.52	3.94	4.35	4.69	5.03	5.62	6.21
7	45	3.67	4.20	4.66	5.11	5.53	5.94	6.64	7.34
8	45	4.58	5.11	5.73	6.36	6.85	7.34	8.21	9.08
10	45	5.94	6.70	7.48	8.25	8.86	9.46	10.60	11.73

(TeeJet 8002 to 8008) should use a 50 mesh screen. Disc-core cone nozzles should normally be used with a slotted strainer equivalent to a 16 mesh screen (any Spraying Systems D3 or larger disc and No. 25 and larger core). A slotted strainer equivalent to a 25 mesh screen should be used with D2 discs.

Clean screens and strainers are essential to the efficient operation of the spray system. They should be cleaned often and checked for breaks in the screen. If the nozzle screens are plugging too often, check to make certain the chemicals are properly mixed, the spray tank and plumbing system are properly rinsed and cleaned between sprays, and that the suction and tank screens are in place when filling and using the sprayer. If the plugging problem persists, consider changing to an alternative pesticide formulation. Also check to see if a larger nozzle that has a larger recommended screen size can be used. **Do not operate the sprayer without the recommended nozzle screens**.



Slotted Strainer



Screen Strainer

Mixing Chemicals

When mixing the chemical in the sprayer tank, NEVER put the chemical in first and then top with water. Always fill the tank 1/3 to 1/2 with clean water, start the agitator and then add the required quantity of chemical. Continue agitating while filling the tank.

For tank-mixes of two or more chemicals, first check the product label for compatibility information. Add the first chemical at the 1/3 to 1/2 full stage and the second chemical at the 2/3 to 3/4 full stage. Mixing by this method will ensure that the chemical is completely mixed in the water. To keep the chemical completely mixed keep the agitator on until you are finished spraying. Never turn off the hydraulic agitation to get enough pump pressure to spray – the chemical will not stay mixed in the water.

For best results, wettable powders should be premixed before being added to the spray tank. Make a slurry of wettable powder and water and then pour it into the spray tank.

Always follow manufacturers' directions when mixing. Always keep the agitator running once the spray materials have been added to the tank.

Excess Pesticide Spray Tank Mixtures

Avoid mixing surplus spray by carefully calculating rates, calibrating the sprayer and carefully measuring the area of the fields. If too much is mixed, use that material according to label directions on another crop or site listed on the label. If no such area can be found, spray the mixture over an area on the property where it will cause no damage. Never re-spray the treated field with extra tank mix. Spraying an area twice will double the rate and may cause high residues in the crop or soil.

Sprayer Cleaning

Immediately after use, drain and collect any excess spray mixture. This excess material can be very difficult to dispose of properly, therefore sprayers should be properly calibrated to avoid any excess. Then flush the sprayer out with soapy water and rinse with clean water. Talk to the equipment dealer to have a new drain installed if the current drain is hard to use. Select a cleaning area where water will not contaminate wells, streams or crops.

Separate equipment is recommended for applying 2,4-D, MCPA or similar hormone-type herbicides. If this is not possible, use separate sprayer hoses when using these chemicals as they cannot be properly washed out of the hose lines. To thoroughly clean equipment after applying 2,4-D, MCPA, etc., follow these steps:

1. Drain and collect any excess spray mixture from the tank.
2. Rinse tank, lines, screens, pumps and nozzles thoroughly with warm water.
3. Remove pressure chamber and line strainer and drain.
4. Fill tank with 100L of warm water and then add one of the following:
   - 1 L household ammonia or Agri-Kleen; **or**
   - 500 g washing soda, lye or Nutrasol.
5. Spray out a small amount of solution and leave remainder in tank overnight.
6. Drain and rinse the equipment several times with warm soapy water. Rinse out the soapy water with clean water.

   Even stainless steel nozzles will rust if left in the sprayer. Nozzles and nozzle screens should be removed and cleaned each fall and stored in a can of light oil or diesel fuel for the winter. After a spray application the nozzles should be cleaned and coated with a light coat of oil to prevent corrosion. Ceramic nozzles are not subject to corrosion.

   Before winter storage, remember to drain the pump, boom and all lines to prevent frost damage. Add light oil or antifreeze during the last rinsing to leave a protective coating on all parts.

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