27. Application of Herbicides, Spraying Equipment, Safety Problems and Laws

Farm sprayers are of many kinds. Various types are commercially available. In addition, numerous kinds of homemade units, put together through separate purchase and assembly of components, fill the spraying needs of many farmers.

Any technical consideration of sprayers is outside the scope of this treatment. The following is concerned primarily with the identification of the various parts and some considerations relating to their utilization.

Sprayers may be tractor, truck, or trailer mounted. In general, tractor mounting is the cheapest, but time is required to mount and dismount. The result is that the tractor is tied up for a couple of weeks or weeds do not get sprayed at the right time. Contrariwise, a trailer-mounted rig, although more expensive, is more adaptable to the exigencies of farm work.

Most weed spraying is done at low pressures, less than 50 pounds per square inch. Hydraulic sprayers in which the liquid herbicide is placed under pressure by a pump are employed. The spray material is forced through nozzles which disperse it into a mist and direct it in a given pattern to the subject to be sprayed.

The following are the essential components of any spray unit:

Power plant — A self-contained gasoline engine or power take-off.

Supply tank — Often an ordinary 55 gallon drum. These rapidly corrode and rust may clog nozzles. Specially treated or aluminum tanks are much less susceptible to corrosion but are more expensive. Some people use a cheap tank and replace it every year. Large units may possess tanks capable of holding one to four hundred gallons.

Agitator — Often desirable for wettable powders or unstable emulsions. Agitators are of several types depending on the nature of the pump. Most operators provide agitation by running the mixture through the bypass.

Intake filter screen — A strainer will prevent debris from the tank clogging up the pump distribution system and nozzles.

Pump — Several kinds are employed. These are basically of two types, reciprocating (piston and plunger), and those whose action is rotary (gear and roller impeller). General purpose sprayers capable of use at high or low pressures usually have plunger or piston pumps.

Since most weed spraying is done at low pressures the less complex rotary types are well adapted to low-volume, low-pressure units.

Cut-off valves — To control release of spray solution to nozzles.

Pressure regulator and gauge — To allow control of spray pressure.

Bypass valve and line — Controls pressure going to the boom.

Boom and "guns" — To distribute spray to the crop. The hand gun is manually operated. A hose connects the nozzle-containing unit to the pump line. Booms of various lengths are available but a 6-row, 21-foot type is common. The nozzles are distributed along the boom. Drop extensions are sometimes used; if these possess two nozzles at the extremity, they can then handle two rows. The boom should be adjustable in height for different jobs. It should be high enough so that the spray from adjacent nozzles will meet at the top of the weeds.

Nozzles — To distribute the spray. Nozzles are widely variable to meet the specifications of different application jobs. They differ as to angle of release of the spray, the type of pattern, and the rate of discharge. A frequently employed type possesses a 65^{0} spray fan. Broad jet nozzles are for roadside spraying or brush control and eliminate the need for a boom but give poor distribution patterns.

In addition to powered farm sprayers, knapsack applicators are desirable for spot application on small patches of weeds, and are employed by the homeowner. These units, usually of about 5 gallons capacity, operate through compression of air. After the herbicide solution is placed in the tank, the sprayer is manually pumped up. Attached straps allow the tank to be slung over the back or one shoulder. A short hose and extension tube allow gun-type spraying.

Airplane application of herbicides is practiced in some crops, particularly wheat and rice. Spraying is done on a custom basis by established companies specializing in this type of work. Gallonages as low as 1-1/2 per acre may be employed. Spray drift, if susceptible crops are adjacent, is a hazard. Injury to cotton as a consequence of rice spraying has resulted in major controversies in the southern states.

KEEP SPRAYERS CLEAN

Many of the chemicals used as herbicides (and likewise insecticides and fungicides) are corrosive. Wettable powders are frequently abrasive, shorten the life of all parts, especially gear pumps, and may stop up valves, booms, and nozzles. Thorough cleaning and rinsing is a necessity.

After each sprayer use, several rinses of water should be run through all parts. It is usually well (essential if wettable powders have been employed) to pull nozzles and strainer apart and wash them in kerosene.

Multi-purpose sprayers must be subjected to even more rigid sanitation measures. If an insecticide is placed in an uncleaned sprayer which has just been used for 2,4-D and then applied to a sensitive crop,

disastrous results may ensue. Ammonia solution, a quart per 10 to 15 gallons of water can be employed for removing 2,4-D from spray equipment. After rinsing, a fresh batch should be subsequently prepared and allowed to remain in the sprayer over night. Several final rinses with water should complete the job.

At the end of the use season, subsequent to the usual cleaning, it is desirable to refill the tank and add a few gallons of used crankcase oil. A protective coat of oil will remain on all internal parts after the mixture is pumped out, and will reduce the danger of over-winter corrosion. (Be sure no water is left in any of the parts.)

APPLICATION OF THE CORRECT AMOUNT OF CHEMICAL

To achieve correct field dosage, it is necessary to determine the amount of water to which it must be added in order to achieve the desired dosage. Sprayer operation must then be calibrated to ensure that the correct amount of chemical is applied.

Dosages are usually given in terms of number of pounds per acre of the pure chemical or the acid equivalent as in the case of 2,4-D. Commercial preparations are often in the form of a liquid formulation in which the active ingredients may constitute only a part of the whole;

Amount of 2,4-D To Apply Per Acre[1]

If you wish to apply this many pounds per acre	Your chemical contains this much 2,4-D acid equivalent or MCP acid equivalent or 2,4,5-T acid equivalent per gallon					
	2.00	2.64 or 2.68	3.00	3.34 or 3.40	4.00	6.00	6.40
	Apply this amount on each acre						
1/8	1/2 pt.	3/8 pt.	1/3 pt.	3/10 pt.	1/4 pt.	1/6 pt.	3/20 pt.
1/4	1 pt.	3/4 pt.	2/3 pt.	3/5 pt.	1/2 pt.	1/3 pt.	3/10 pt.
1/3	1 1/3 pt.	1 pt.	8/9 pt.	7/9 pt.	2/3 pt.	4/9 pt.	4/10 pt.
1/2	1 qt.	3/4 qt.	2/3 qt.	1 1/5 pt.	1 pt.	2/3 pt.	3/5 pt.
3/4	1 1/2 qt.	1 1/7 qt.	1 qt.	9/10 qt.	1 1/2 pt.	1 pt.	9/10 pt.
1	2 qt.	1 1/2 qt.	1 1/3 qt.	1 1/5 qt.	1 qt.	2/3 qt.	3/5 qt.
2	1 gal.	3 qt.	2 2/3 qt.	2 2/5 qt.	2 qt.	1 1/3 qt.	1 1/4 qt.

Amount of Chemical Needed on 1 Square Rod When Treating Patches

Pounds of acid equivalent used per acre	Chemical required on a square rod[2]	
	2,4-D, MCP or 2,4,5-T	
	Contains 4 lb. per gal.	Contains 3 lb. per gal.
1/2	2/3 teaspoonful	7/8 teaspoonful
3/4	1 teaspoonful	1 1/3 teaspoonsful
1	1 1/6 teaspoonsful	1 3/4 teaspoonsful
1 1/2	2 teaspoonsful	2 2/3 teaspoonsful
2	2 1/5 teaspoonsful	3 1/2 teaspoonsful

[1] Adapted from South Dakota Circular 122.
[2] A square rod is 16 1/2 x 16 1/2 feet.

if sold as a dry powder, they may contain additives. For example, 2,4-D merchandized as a liquid concentrate is usually available by the gallon; this amount of volume measure may contain from 2 to 6.4 pounds (4 pound formulations are most frequently employed) acid equivalent of 2,4-D depending upon the product. It is then necessary to translate liquid measures to the desired rate of application in pounds of 2,4-D per acre. For example, if 1 pound of 2,4-D acid equivalent per acre is to be applied and a 2.0 pound per gallon formulation is at hand, it is obvious that 2 quarts would be required. Similar calculations can be made for any other dosage or formulation. For convenience, those for 2,4-D and related chemicals are summarized in the tables.

In order to assure correct rate of application, it is necessary to know the sprayer output per rod or per acre. For knapsack sprayer operation, this is often estimated, and one primarily attempts to wet down the plants to be treated. For greater precision, it is possible to stake out a square rod. Starting with a full tank of water, the operator should then spray the area with the degree of thoroughness — trying for complete coverage of the weeds in the area — that he will employ when putting on the herbicide. After completion, the amount of water used can then be determined by the amount required to refill the tank. From this, the amount of chemical to be added can be calculated. For example, if a pound of commercial preparation per square rod is to be applied and a gallon of water has been used in spraying this area, the formulation should be one pound per gallon. If the tank holds five gallons, then five pounds of chemical should go into it.

For large scale field applications, the above factors are again involved, but somewhat more precise calibration may be desirable. There are several ways this can be done, and anyone by doing a little figuring can devise what suits him best. The following procedure is merely one which appeals to the writer as a relatively simple way of accomplishing this objective: Measure off a linear eighth mile (220 yards or 660 feet). Fill the tank and make a trial run for this distance, using speed and pressure intended for operation. Measure the amount of water required to refill the tank. Multiply this figure in gallons by 66 and divide by the width of the spray swath in feet. This gives the number of gallons applied per acre.

The above calculations are based on the fact that an acre is an area 66 x 660 feet (1 x 10 surveyor's chains). If a sprayer puts down a swath 22 feet wide, the operator has actually sprayed 1/3 of an acre in traveling 660 feet. If he used 2 gallons of water, the sprayer obviously is operating at the rate of 6 gallons per acre (2 x 3: equivalent to 2 x 66/22). The chemical can then be added to the water on the basis of the number of acres to be sprayed.

The above procedure should probably be repeated several times during the season as the performance of the machinery may change with use; output of nozzles can be altered. Obviously, if nozzles are removed and new ones put on, or any other changes made in the equipment, recalibration will be necessary.

Calibrating jars are commercially available. Attached to the spray unit, the output of one of the nozzles is discharged into the bottle while the operating sprayer is driven a specific distance, usually 330 feet. Scorings on the jar make it possible, with due allowance for distance between nozzles, to read off rate of application per acre.

There may be added considerations. Changes in tractor speed will obviously affect spray coverage. A uniform pace is usually not difficult to achieve on level ground, but less so if the field has ups and downs. Band application requires determination of the proportion that the band width is of the whole. Or contrariwise, band application can be made in the trial run and the figures used directly. The same applies to late herbicidal treatment of corn in which two rates, in and between the rows are employed. Rate of application can be determined either by a working trial duplicating field procedure, or nozzle output at given speeds can be determined separately, and the contribution of each to the total job summed.

Possible overlapping of spray swaths should not be overlooked. Undesirable double spraying is all too easy to do, particularly when changing course or reversing direction. If spraying is in crop plants, double dosages may wreak damage. Contrary to the above, a very slight overlapping is desirable since nozzle patterns tend to thin out at the edge.

PERSONAL SAFETY RECOMMENDATIONS

The following are summarized from previously published safety recommendations and apply to fungicides and insecticides as well.

Storage

Store in original labeled containers (don't give a portion to someone else in an unlabeled container) in an area never used for food or medicine or animal feeds. Keep out of the reach of children.

Use

Read and follow precautions concerning safe use on the label. Herbicides should not be used in manners not recommended on the label. See if there are instructions telling what to do in case of an accident. In mixing do not allow material to slop or blow on operator. Mix only what is needed for immediate use; don't leave any excess for next application in an unmarked container. Avoid breathing dust or spray; especially watch direction of wind and stay out of mist from the sprayer. Use a mask, goggles, or rubber gloves when recommended. This especially is desirable if Randox, Dowpon, TCA, or certain of the

dinitros are used. If material gets on hands or clothing it is usually best to wash and change clothes immediately. Wash clothing each day after use. Do not smoke while using chlorates or until clothing is changed afterwards.

HERBICIDE RESIDUES ON FORAGE AND FOODS

Herbicides which may be applied to the foliage of forage plants are in general non-poisonous or have a very low toxicity level (the dinitros would constitute an exception). Nevertheless it is usually unwise to spray plant materials cut for hay or silage with contact herbicides. This does not eliminate the use of selective herbicides in seedings or on mature plants in seed fields. Animals should not be allowed to graze in pastures for a week or two following spraying with 2,4-D.

The possible dangers of herbicide residues on human food were somewhat dramatically brought to public attention in 1959 by the Food and Drug Administration in connection with seizures of cranberries believed to carry traces of amino triazole. This action was taken in compliance with a Federal law (see following section) which renders food products moving in interstate commerce liable to seizure if herbicide, insecticide, or fungicide residues are in excess of certain tolerances, or if no tolerance has yet been established.

A recent Minnesota weed bulletin specifically warns that the problems relating to residues on agricultural commodities have not been investigated at this experiment station. Likewise, the subject has apparently been little studied at other experiment stations.

Plant parts intended for human consumption should never be exposed to weed sprays. This precaution does not eliminate the possibility that translocated herbicide residues from earlier soil or foliage treatments may move to subsequently developed plant tissues or parts, and therein exceed allowable government tolerances.

LAWS RELATING TO HERBICIDES

Earlier in this book, seed laws and weed laws as they relate to weed distribution and control were briefly reviewed. The Federal government and various states also have enactments pertaining to herbicides. Reference has been made to legislation in southern states which places certain restraints upon the use of 2,4-D.

The Federal laws relate primarily to human safety from injurious chemicals as noted in the above section and to proper labeling of herbicides. Two Federal agencies have such enactments. The U.S. Department of Health, Education, and Welfare is responsible for the Food, Drug, and Cosmetic Act which, in the event residues on foods or feeds are involved, sets allowable tolerances. A very considerable amount of research information concerning possible toxicity to mammals is

necessary before tolerance determinations can be made. A recent amendment to this act concerning possible long range carcinogenetic effects of pesticide chemicals further renders development research lengthy and expensive.

The second law concerned is the Insecticide, Fungicide, and Rodenticide Act which is administered by the Plant Pest Control Division of the U.S. Department of Agriculture. Herbicides (and other pesticides) which are distributed in interstate commerce must be registered with this division. Registration requires adequate information on safety and performance, i.e. prior clearance by the Food, Drug, and Cosmetic Act. The law also requires specific label information on herbicide containers exposed for sale.

These laws are desirable from the standpoint of public information and safety. Unfortunately, they complicate the development of pesticide chemicals. Many substances possessing potential herbicidal properties may likewise be harmful to human beings and must be dropped from consideration.

SOME GENERALIZATIONS

With the employment of proper judgement, herbicides can increase the efficiency of farming operations and broaden profit margins. On the other hand, improper or ill-timed application of chemical weed killers may net only loss of money or time.

The individual lacking equipment or experience can frequently hire custom operators to do the work for him. If he desires to undertake it himself, he may desire to obtain suggestions as to the best material and methods to use for his particular situation. He can usually obtain advice from his dealer, or he can contact his county extension director, or the weed specialist at the agricultural college in his state. Bulletins or pamphlets, if available, are useful for reference. Directions and precautions on the containers should be read carefully.

It is often recommended that a beginning operator experiment with herbicides on relatively limited areas before he attempts a large scale operation. In this way he can judge for himself the effect of the chemical under his conditions of application and can gain some familiarity with his equipment.