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Chemical Control of Weeds in South Dakota

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THE EIGHT NOXIOUS WEEDS

CHEMICAL CONTROL OF *Weeds* IN SOUTH DAKOTA

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CHEMICAL CONTROL OF WEEDS
IN SOUTH DAKOTA[1]

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There are now many chemicals on the market that have possibilities for use in a weed control program. Many of these chemicals are being tested and several can be used in controlling weeds. This bulletin explains the use and value of the more important chemicals.

Recommendations are based on experimental results from cooperative tests in South Dakota and the results reported at the North Central Weed Control Conference. The tests in South Dakota include plots established throughout the state in 1945 and 1947, and at the Weed Research Farm at Scotland, which was begun in 1946.

The Use of 2, 4-D as an Herbicide

The most important chemical to be considered is 2,4-D. At present it appears that 2,4D will be used extensively during the coming year; therefore, a discussion of various formulations, rates of application, various uses, and equipment for applying it will be included in this circular.

Formulations of 2,4-D

Classification. Since 2,4-D itself is insoluble in water, it is made soluble by treating it with other chemicals. This results in the manufacture of many formulations, all of which can be classified as ester, amine or sodium salt sprays. Ester, amine and sodium salt dusts are also manufactured. The ester and the amine sprays are produced in liquid form, the sodium salt spray as a powder, and the others as dusts.

Comparison of formulations. The name, methyl ester, ethyl ester, isopropyl ester, or butyl ester will appear on the container label. These esters are about equally valuable for weed control. The term "alkyl ester" means that any one or more than one of these esters may be in the compound.

Likewise, the triethyl amines, di-ethanol amines, triethanol amines, and the morpholine amines are considered equal. The term "alkanol amine" means that any one or more than one of the above mentioned "ethanol" amines may be in the compound. Of the sodium salts, the monohydrate forms are more effective than the anyhdrous, because they are more readily soluble in water, especially hard water.

The ester formulations are injurious to more species of plants than the other formulations. It is, therefore, somewhat hazardous to use the ester formulations when spraying in crops. It is advisable, however, to use an ester formulation for weed control along roadsides, railroad rights-of-way and other areas that have many different kinds of weeds not growing among crops. The esters are more ef-

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fective than the amines or sodium salts on tolerant weedy plants and on any plant that is treated before or after the optimum stage of growth. The amines and the monohydrate sodium salts are about equally effective.

The ester dusts have proven to be superior to the sodium salt dusts. Very little is known about the effectiveness of the amine dusts. A pound of 2,4-D acid in the form of an ester dust compares quite favorably with a like amount of 2,4-D acid in spray. The dusts are harder to control than the sprays, as wind will carry the drift from 2,4-D dusts for several miles. For this reason, the dusts should be used only when drift will not contact susceptible crops or trees. It is best to limit the use of dusts to areas that have a limited supply of water.

Rates of Application

Amount of 2,4-D required. Many of the most troublesome annual weeds may be controlled by the application of ¼ to ¾ pound of 2,4-D acid per acre; ¾ pound or more must be used to control noxious weeds. With the list of weeds given under the section "Reaction of Weeds," is given the amount of 2,4-D needed to control or eliminate most of the weeds species that are troublesome in South Dakota. The required amount may be applied as a spray or as a dust.

Amount of water required. The 2,4-D acid may be applied with any quantity of from 5 to 80 gallons of water per acre. Water serves as a carrier for the 2,4-D, and the amount used does not influence the results if applications are made properly. The correct use of suitable equipment is essential. Equipment specifications are enumerated under the section, "Equipment for Application of 2,4-D."

If the equipment is designed right and if the operator knows exactly how much spray solution he is applying per acre, volumes of 5 to 10 gallons per acre are recommended. If the equipment and the operator are not exacting, however, it is advisable to use more water.

When low volumes of water, (5-10 gallons per acre) are used, the slightest error may be disastrous. It is therefore advisable to carefully calibrate the sprayer before using it and to recheck it often to be certain that an exact amount of material is being applied. The entire sprayer system must be kept free of sediment to insure a constant flow from low-volume nozzles.

Use of 2,4-D on Weeds

Field Bindweed (Creeping Jenny). This weed can be controlled satisfactorily with ¾ pound of 2,4-D acid per acre. The chemical should be applied when there is plenty of soil moisture and the weed is growing fast. The best results have been obtained when the bindweed is beginning to bloom. The use of 2,4-D is recommended where bindweed is growing in perennial grasses, small grains, or in areas that are not cropped. It may be used as a substitute for or in combination with cultivation. Retreatments, if needed, should not be made until the remaining weeds have recovered from the first application.

Canada thistle and perennial sow thistle. Two or more treatments are necessary to kill these weeds. When ¾ to one pound of 2,4-D per acre is applied to thistles starting to bud and again in the fall, good control can be obtained in many cases. However, retreatments the following year are quite often necessary. The tops of the plants can be killed in grass lands, small grains, or in areas that are not cropped. 2,4-D may be used as a substitute for or in combination with cultivation.

Perennial peppergrass (hoary cress or white top). This weed is quite resistant to 2,4-D. One pound of 2,4-D acid per acre in the ester form should be applied in the fall or early spring before the plants start to bloom. Top growth will be killed down and no seed will be produced, but retreatments are necessary to kill this weed. For fall treatments, plow the land in midsummer so that the weed will emerge completely and develop to the rosette stage before treatment.

Leafy spurge. This weed is seldom eliminated with 2,4-D. The roots remain alive, even though the top growth can be almost completely destroyed by the application of 2 pounds of 2,4-D acid per acre in the ester form. Several repeat applications made at the time the plant is in bud or early flower will greatly weaken or "thin out" the stands.

Russian Knapweed. This weed reacts much like leafy spurge to 2,4-D treatment. It is seldom eliminated by 2,4-D. Two pounds of 2,4-D in ester form per acre will destroy the top growth but the roots will remain alive. Several repeat applications made before buds are formed will reduce the stand.

Horse Nettle and quackgrass. The use of 2,4-D has not controlled these weeds effectively. Neither the roots nor the top growth has been seriously damaged. Consequently, it is inadvisable to use the chemical on them.

Annual weeds. Sunflower, cocklebur, Kochia, Frenchweed, mustard, ragweed, pigweed and others can generally be killed with ¼ pound of 2,4-D acid per acre. Treatments should be made when the weeds are in the seedling stage of growth (2 to 8 inches tall).

Reaction of Weeds to 2,4-D

The following classification of the most common annual, biennial, perennial and woody weeds is based on their reaction to 2,4-D. These are the weeds most common to South Dakota. They usually react as listed, but most species react differently to 2,4-D at different stages of growth.

Annual and Winter Annual Weeds

Annual weeds in this list are marked by the letter "a," and winter annuals by the letter "w." Some act as annuals under certain conditions and as winter annuals under others. These are marked "aw."

1. Generally susceptible. Most of these weeds can be killed with from ¼ to ½ pound of 2,4-D acid per acre if treated when quite young. More 2,4-D is needed when treatments are made at the blossom and seed setting stages.

Annual sow thistle—aw
Buttercup—aw
Cinquefoil and other five fingers—a
Cocklebur—a
False flax—aw
Frenchweed (pennycress)—aw
Henbit—a
Hoaryalyssum—aw
Mallow—a
Morning glory—a
Most mustards—aw
Peppergrass—aw
Pigweeds—a
Puncture vine—a
Ragweeds—a
Shepherds purse—aw
Sunflowers—a
Speedwells—aw
Wild radish—aw
Yellow trefoil—a

2. Moderately resistant. These weeds will be killed or their growth stunted if treated with ½ to ¾ pound of 2,4-D per acre. The 2,4-D should be applied when the weeds are young, as they become quite tolerant after they start to flower.

Chickweed—a	Prickly lettuce—aw
Hare's ear mustard—aw	Smartweeds—a
Kochia—a	Russian thistle—a
Lamb's quarters—a	Wild buckwheat—a
Mare's tail—a	Wild lettuce—aw

3. Highly resistant. These weeds are not killed and are usually only slightly injured by 2,4-D.

Black nightshade—a	Sandbur—a
Buffalo bur—a	Spurge—a
Corn cockle—a	Purslane—a
Cow cockle—a	
Grassy weeds—aw	
Knotweed—a	
Night flowering catchfly—aw	

Herbaceous Perennial and Biennial Weeds

Perennial weeds are followed by the letter "p" and biennials are marked by the letter "b." Some grow as a biennial under some conditions and as a perennial under others. These are marked "pb."

1. Generally susceptible. One application of ½ to ¾ pounds of 2,4D per acre may eradicate these weeds. Two or more treatments are sometimes necessary.

Austrian field cress—p	Ground ivy—p
Bitter wintercress—pb	Hedge bindweed—p
Buckhorn—p	Heal-all—p
Bull thistle—b	Lawn-Pennywort—p
Burdock—b	Nettles—p
Chicory—p	Sweet clovers—b
Curled dock—p	Western ragweed—p
Dandelion—p	Wild carrot—b

2. Moderately tolerant: Top growth is usually killed and the stand reduced by a single application of ½ to one pound of 2,4-D acid per acre. Retreatments are generally necessary to kill them.

Blue lettuce—p	Gumweed—pb
Burr ragweed—p	Perennial peppergrass—p
Canada thistle—p	Perennial sow thistle—p
Dogbane—p	Poverty weed—p
Field Bindweed—p	Red sorrel—p
Goatsbeard—b	Silverleaf poverty weed—p

3. Highly resistant. 2,4-D will seldom control these weeds satisfactorily, but the stands of some may be reduced by repeated applications.

Alkali mallow—p	Oxeye daisy—p
Cactus—p	Russian knapweed—b
Climing milkweed—p	Swamp smartweed—p
Goldenrod—p	Toadflax—p
Grassy weeds—pb	White cockle—pb
Hoary vervain—p	Wild garlic—p
Horse nettle—p	Wild gourd—p
Ironweed—p	Wild onion—p
Leafy spurge—p	Wood sorrel—p
Milkweed—p	Yarrow—p
Mullein—b	

Woody Weeds and Other Woody Plants

1. Generally susceptible. These plants can be defoliated with 2,4-D, but retreatments are generally needed for two or more seasons. Two pounds of 2,4-D acid per acre or spray solutions of 1000 to 2000 parts per million of 2,4-D are recommended. The esters are generally more effective than other formulations.

Birch	Lilac	Sumacs
Box elder	Matrimony vine	Wild licorice
Buffalo berry	Poison Ivy	Wild plum
Choke cherry	Sagebrush	Willow
Currant		

2. Generally tolerant. These plants are seldom defoliated or damaged in any other way with standard solutions of 2,4-D.

Buckbrush	Gooseberry	Oak
Cedar	Hackberry	Pines
Cottonwood	Locust	Rasberry
Dogwood	Maple	Spruce
Elms	Mulberry	Wild Rose

Use of 2,4-D in Crops

Wheat, oats and barley. Common annual weeds such as mustard, Frenchweed, sunflower, cocklebur, ragweed, marshelder, pigweed and perennials such as hedge bindweed (wild morning glory) and artichoke can be eliminated in spring grain crops with 2,4-D without appreciable injury to the crops. Use ¼ to ½ pound of 2,4-D acid per acre.

Use ½ to ¾ pound of 2,4-D acid per acre for control of perennial weeds such as field bindweed, Canada thistle, sow thistle, and semi-tolerant annuals such as wild lettuce or wild buckwheat. If the 2,4-D is to be applied in ester form, use the lower rate of application. Treatments should be made after the grain is well tillered and before heads emerge from the boot.

Winter wheat and winter rye. The recommendations as outlined for spring grains may be followed, but the application must be made during the late spring. Treatments should be made after the crops are well tillered and before they begin to shoot heads. If the esters of 2,4-D are to be applied, use the lower rates of application.

Flax. Annual weeds such as mustard, Frenchweed, sunflower, cocklebur, ragweed, marshelder and pigweed, may be safely controlled in certain varieties of flax.

Koto, Dakota, Redwing and Sheyenne are much more tolerant of 2,4-D than Crystal, B-5128 and Minerva. The use of 2,4-D to control the above weeds is recommended only in the more tolerant flax varieties. Not more than ¼ pound of 2,4-D acid per acre in the form of a sodium salt or an amine should be used. Treatments should be made when the flax is 3 to 6 inches tall and when the weeds are in the seedling to rosette stage of growth. The use of esters in flax is hazardous and injury may result from rates of application as low as ¼ pound per acre.

To control more tolerant annual weeds, such as wild buckwheat, or perennial weeds, such as blue lettuce, field bindweed, Canada thistle or perennial sow thistle, rates of application must be over ¼ pound of 2,4-D acid per acre. At this rate, one can expect damage to the flax. The advantage in controlling the perennial weeds in flax may offset any reduction in yield that results from the higher rate of application of 2,4-D.

Corn and Sorghum. Weeds such as cocklebur, sunflower, annual smartweeds and mallow are controlled or eliminated by applications of 2,4-D of from ¼ to ½ pounds acid per acre. In general, no appreciable damage to the crop will result from these low rates. Application should be made after the crop is 12 inches high and before it is "laid by."

Corn and sorghums are affected by recommended rates of 2,4-D applications. Brittleness of stalks commonly results from treatment with 2,4-D, and cultivation or high winds shortly after treatment may break off many stalks.

Grass crops. Grasses such as bluegrass, bromegrass, and the wheat grasses, are in general very tolerant of 2,4-D. Rates of application necessary for the control and elimination of the weeds infesting these crops can be used without reduction in yield of forage or seed. Applications of 2,4-D in grass crops should be made when the weeds are in the best stage of growth for treating. Grasses to be harvested for seed should be treated before the heads appear.

Other crops. Sugar beets, soybeans, peas, buckwheat, potatoes, alfalfa and other legume crops and most garden vegetables are very sensitive to 2,4-D. Weed control in these crops with 2,4D cannot be recommended. Extreme care should be taken to prevent drift when treating fields near these crops.

Fungicides and insecticides should not be applied to these crops with a 2,4-D sprayer until the sprayer has been thoroughly cleaned and tested. Trisodium phosphate dissolved at the rate of 1½ ounces to the gallon of water has proved satisfactory for removing 2,4-D from metal sprayers. It is best to check for residual 2,4-D, however, by making tests on the crop to be sprayed at least 24 hours before the spraying is to be done.

2,4-D as a Pre-emergence Treatment

Application of 2,4-D to the soil between the time of planting and the time crops emerge cannot be recommended for weed control. Research results have been very inconsistant. Some experiments have resulted in excellent control of weeds without injury to the crop; others have not affected weeds or crop, and still others have damaged both.

Soil applications of 2,4D before planting a crop have in general proven unsatisfactory. The seeding operation disturbs the soil and appears to render the 2,4-D ineffective.

Equipment for Applying 2,4-D

Knapsack sprayers and hand dusters. For spot treatments of small patches of weeds, these two pieces of equipment are quite useful. A three-gallon knapsack sprayer can be made more efficient by equipping it with two nozzles spaced about 16 inches apart on a light T-boom.

Power driven ground sprayer. A good sprayer must have a supply tank that will hold 50-200 gallons of water, a good pump, a by-pass valve to regulate pressure, a pressure gauge to indicate pressure, a spray boom that may be 20 to 40 feet long, nozzles and the necessary hoses and valves to connect the pump to the tank and boom. Filters should also be included in the system between the supply tank and nozzles to filter out any sediment that would stop up the nozzles.

The pump may be driven by power take-off or belt pulley of the tractor, or may be driven by an auxillary motor. The pump must be mounted where it can be shut off while the tractor is moving. Pumps should create a pressure of 20 to 60 pounds when in operation.

Booms may be 20-40 feet long, depending upon the capacity of the pump and acreage to be covered. Booms should be adjustable so that changes in elevation can be made when spraying roadsides and hilly fields.

Nozzles that produce a fan shaped discharge give the best coverage of weeds. These nozzles should be so spaced that they will give complete coverage at a height of 18 to 24 inches from the ground. The spacing will usually be 16 to 24 inches apart.

Trailer-mounted sprayers are best adapted for use where large acreages are to be sprayed or where only a small amount of spraying is to be done at any given time. Pumps may be driven by power take-off or by an auxillary motor.

Tractor-mounted sprayers are best adapted to individual farm use since they cost less than the trailer-mounted type. They may be purchased with or without a supply tank. The supply tank may be mounted on the drawbar or on a trailer. The pump may be driven by power take-off or by the belt pulley. They have the disadvantage of extra time required for mounting and dismounting.

Power driven ground dusters. The application of 2,4-D in the form of dusts is more hazardous than ground spraying applications because of the danger of wind drift. Dusters should be used only in areas where crops susceptible to 2,4-D are not grown in nearby fields. Suitable equipment for applying 2,4-D dust is in short supply as well as being expensive. Row crop dusters are not too well adapted to general field dusting. The general use of dusters should be limited to areas that already have suitable boom-type dusters on hand and to areas where there is not enough water for low volume spraying.

Airplane spraying. The application of 2,4-D dusts by airplane is extremely dangerous, but airplane spraying may be practical in some sections. This method of applying 2,4-D spray solutions has been highly developed and is practical only in areas of large sized fields where crops sensitive to 2,4-D are not grown in adjacent fields. The advantage of airplane application of 2,4-D is the ability to cover large areas rapidly, to spray when fields are too wet to permit the use of ground equipment, and to use much less water per acre. These factors tend to decrease the cost of application per acre.

Drift of spray from airplane application is greater than from ground equipment. There is also a danger of dripping 2,4-D on susceptible crops at each end of the treated field and on the way to and from the landing strip. Consequently, planes should be equipped with a boom that has nozzles which automatically close as soon as the operator closes the cut-off valve.

Table 1. Determination of tractor speed in miles per hour.

Speed in miles per hour	Time required to travel ½ mile	¼ mile	100 yards
2	15 minutes	7 min. 30 sec.	1 min. 42 sec.
2½	12 minutes	6 minutes	1 min. 22 sec.
3	10 minutes	5 minutes	1 min. 8 sec.
3½	8 min. 45 sec.	4 min. 22 sec.	1 minute
4	7 min. 30 sec.	3 min. 45 sec.	51 sec.
4½	6 min. 45 sec.	3 min. 22 sec.	46 sec.
5	6 minutes	3 minutes	41 sec.

Calculating for Field Application of 2,4-D

Many sprayer operators have difficulty in determining how much water they use per acre. They also have difficulty in determining how much chemical should be added to a sprayer load of water. It is absolutely essential that the operator know how much spray is being applied per acre and that they be able to apply the recommended amounts of 2,4-D. Therefore, operators must calibrate their sprayers and calculate the amount of 2,4-D chemical needed to give the desired amounts of 2,4-D acid.

Adjusting Equipment for Spraying

The volume of spray solution applied per acre is regulated by the speed of the tractor, pressure, and size and number of nozzles. All of these factors must be considered in order to calculate the amount of material to be applied. The adjustment of tractor and sprayer is divided into the following steps.

Step 1. Set the tractor speed. Drive the tractor and sprayer in the field (not on hard ground) and time it. Any speed between two and five miles will do, but a speed of four miles per hour will be best in most cases. After the desired speed has been established, mark the gas setting so that the same gear and gas setting can be used when actually spraying. Table 1 will help in setting the tractor speed.

Step 2. Determine the amount of solution sprayed per hour. Put the machine in operation with a pressure that will be used for spraying. This pressure should be between 20 and 60 pounds per square inch. Hold a container under one nozzle for four minutes to collect the discharge, and then measure it.

Example: Suppose that a sprayer has 16 nozzles on the boom, and one nozzle discharges two quarts in four minutes. Using Table 2, locate the number 16 in the column reading "number of nozzles on boom." Then, by looking directly across the table on this line to the column headed "2 quarts," we find the number 120. This means that the sprayer will discharge 120 gallons per hour.

Step 3. Determine the number of acres sprayed in one hour. Using Table 3, locate the length of the boom in the left hand column. Follow this line across the table to the column under the speed at which the tractor has been set. The figure at that point will be the number of acres that can be sprayed in one hour.

Example: Suppose that a tractor and sprayer have been set to operate at a speed of four miles per hour and the sprayer boom is 24 feet long. Looking across the table from the figure 24 in the left hand column, we find that figure 11.6 under the column headed "4 m.p.h." Thus, 11.6 acres will be sprayed in one hour.

Step 4. Determine the gallons per acre. This is done by dividing the gallons per hour (step 2) by the acres per hour, (step

3) as follows.

Gallons per hour ÷ acres per hour = gallons per acre.

Example: In step 2, the gallons per hour are 120, and in step 3, the acres per hour are 11.6. The gallons per acre are determined as follows:

120 ÷ 11.6 = 10.34 (gallons per acre)

A small change in gallons per acre can be obtained by a change in pressure. If one wants to increase or decrease this amount a great deal, it is best to change nozzles.

Table 2 Determination of the total output of a sprayer in gallons per hour

Number of Nozzles on boom	Gallons per hour when one nozzle discharges a specific number of pints or quarts in four minutes							
	1 pt.	1 qt.	3 pts.	2 qts.	5 pts.	3 qts.	7 pts.	1 gal.
10	18¾	37½	56¼	75	93¾	112½	131¼	150
14	26¼	52½	78¾	105	131¼	157½	183¾	210
16	30	60	90	120	150	180	210	240
18	33¾	67½	101¼	135	168¾	202½	236¼	270
20	37½	75	112½	150	187½	225	262½	300
22	41¼	82½	123¾	165	206¼	247½	288¾	330
24	45	90	135	180	225	270	315	360
26	48¾	97½	146¼	195	243¾	292½	341¼	390
28	52½	105	157½	210	262½	315	367½	420
30	56¼	112	168¾	225	281¼	337½	393¾	450
32	60	120	180	240	300	360	420	480
34	63¾	127½	191¼	255	318¾	382½	456¼	510
36	67½	135	202½	270	337½	405	472½	540

Table 3. Determination of the number of acres that can be sprayed in one hour with various speeds and boom lengths.

Length of boom in feet	Acres per hour at various speeds in miles per hour								
	2 mph	2½ mph	3 mph	3½ mph	4 mph	4½ mph	5 mph	5½ mph	6 mph
1*	.242	.302	.363	.423	.484	.544	.604	.665	.726
14	3.4	4.3	5.1	5.9	6.8	7.6	8.5	9.3	10.2
15	3.6	4.5	5.4	6.3	7.3	8.2	9.1	10.0	10.9
16	3.9	4.8	5.8	6.8	7.7	8.7	9.7	10.7	11.6
18	4.4	5.4	6.5	7.6	8.7	9.8	10.9	12.0	13.1
20	4.9	6.0	7.3	8.5	9.7	10.9	12.1	13.3	14.5
24	5.8	7.2	8.7	10.2	11.6	13.1	14.5	16.0	17.4
26	6.3	7.9	9.4	11.0	12.6	14.1	15.7	17.3	18.8
30	7.3	9.1	10.9	12.7	14.5	16.3	18.1	20.0	21.8
32	7.8	9.7	11.6	13.5	15.5	17.4	19.4	21.3	23.2
40	9.7	12.1	14.5	17.0	19.4	21.8	24.2	26.7	29.0

*The acres per hour for any boom length not listed can be determined by multiplying the length of the boom in feet by the acres per hour for one foot.

Calculating Correct Amount of 2,4-D

It is difficult to determine the amount of a commercial product that is needed to get the desired amount of 2,4-D acid. The calculation involved would be much simpler if the weight of the 2,4-D acid in a pint, quart or gallon of liquid chemical and number of ounces of 2,4-D acid in a pound of powdered chemical were listed on the label.

Since many container labels do not carry such a listing, some of the following calculations will be necessary. Most products carry on the label the percent of 2,4-D acid and either the specific gravity (sp. gr.), the net weight, or the weight of the 2,4-D acid. This information is used in the calculations. Let us consider liquid, powders and dusts separately.

Liquid Chemicals

Four steps are involved in determining the amount of 2,4-D to be used in liquid form. If the net weight is given on the label, omit Step 1. Steps 1 and 2 are omitted if the weight of 2,4-D acid per pint, quart or gallon is given.

Step 1. Net Weight. If the net weight is not given on the label and the specific gravity (sp. gr.) is given, the net weight can be determined with the following formula. sp. gr. x 8.6 (Wt. of 1 gal of water) x No. of Gal. in container = net weight.

Example: Suppose that the label on a one gallon container of chemical states that the specific gravity is 1.25. The net weight is calculated as follows:

1.25 x 8.6 x 1 = 10.75 lbs.

Step 2. Determine the number of pounds of 2,4-D acid in one pint of chemical. This is done by using the net weight, the percent of 2,4-D acid and number of pints in the container with the following formula.

Percent of 2,4-D acid x net wt. ÷ No. of pints in container = lbs. of 2,4-D acid in one pint.

Example: The label on a one gallon container states that it contains 40% 2,4-D acid and that the net weight is 10.75 lbs. Since one gallon contains eight pints, the number of pounds of 2,4-D acid is calculated as follows:

40% x 10.75 = 4.30 (lbs. of acid in 1 gal. container).

4.30 ÷ 8 = .5375 lbs. (slightly over ½ lb.) in 1 pt.

Step 3. Determine the number of pints to be used per acre. The above mentioned chemical contains slightly over one-half pound of 2,4-D acid in each pint of chemical. If ¼ pound of 2,4-D acid is to be applied per acre, ½ pint would be enough. Approximately 1½ pints would be needed to apply ¾ pound of 2,4-D acid per acre.

Step 4. Determine the amount of chemical needed for each sprayer load. Use the following formula.

Gals. in sprayer ÷ gal. per acre x No. of pts. per acre = Pts. per sprayer load.

Example: Suppose the sprayer holds 100 gallons and has been set to apply 10 gallons per acre. Suppose ¼ pound 2,4-D acid is to be applied per acre. In step 3 this was calculated as ½ pint of the chemical. The calculation is as follows:

100 ÷ 10 = 10 (acres sprayed with one load)

10 x ½ pt. = 5 (pints per sprayer load to apply ½ pint per acre)

Powdered Chemicals

The amount of a powdered chemical needed for each sprayer load of water can be calculated as follows:

Step 1. Using the following formula, determine the number of pounds of chemical needed per acre.

Lbs. 2,4-D acid per acre ÷ % of 2,4-D acid = lbs. of powder per acre.

Example: Suppose that a powdered chemical containing 75% 2,4-D acid is to be applied at the rate of ¾ pound of 2,4-D acid per acre. The calculation is as follows:

¾ ÷ 75% = 1 (pound of powdered chemical per acre)

For ease in calculation, the fraction and percent may both be changed to decimals as follows:

.75 ÷ .75 = 1 (pound of powdered chemical per acre)

Step 2. Using the following formula, determine the number of acres that one sprayer load will cover.

Gals. in sprayer ÷ Gals. per acre = acres per sprayer load

Example: Suppose that the sprayer holds 100 gallons and has been set to apply 10 gallons per acre. The calculation is as follows.

100 ÷ 10 = 10 (acres per sprayer load)

Step 3. Determine the amount of chemical needed for each sprayer load. Multiply the pounds of powder per acre (step 1) by the acres per sprayer load (step 2) in the following formula.

Lbs. powder per acre x acres per sprayer load = lbs. of chemical per load.

Example: In step 1, one pound of chemical is needed per acre, and in step 2, 10 acres can be sprayed with one sprayer load. Therefore,

1 x 10 = 10 (lbs. of powdered chemical per sprayer load).

After the amount of powdered chemical needed for each sprayer load has been determined, it is advisable to select a container that will hold the exact amount needed (10 pounds in the example just given) and use one container full for each sprayer load.

Calculating Dust Amounts

The amount of 2,4-D dust required to apply a certain amount of 2,4-D acid per acre may be determined as in step 1 of the calculation for powdered chemical.

Example: Suppose that a dust containing 5 percent 2,4-D acid is to be applied at the rate of ¼ pound of 2,4-D acid per acre. The pounds of dust needed per acre would be figured as follows:

¼ ÷ 5% = 5 (Lbs. of dust per acre)

When changed to decimals, the calculation would be:

.25 ÷ .05 = 5 (Lbs. of dust per acre)

Sample Problem

A sprayer operator has a tractor that will go one-fourth mile in three minutes and 45 seconds. He has a sprayer with 26 nozzles on a 32-foot boom. The tank holds 125 gallons of water. He finds that one nozzle puts out two quarts of spray in four minutes.

The label on the 2,4-D container states that the chemical is an ethyl ester that contains 39 percent 2,4-D acid and that it contains three pounds of 2,4D per gallon of chemical. The farmer wants to spray sunflowers in his oats field. He must make the following calculations.

By using Table 1, he finds that when his tractor goes ¼ mile in three minutes and 45 seconds it is traveling at the rate of four miles per hour. By using Table 2, he sees that when one nozzle discharges two quarts in four minutes, 26 nozzles will discharge 195 gallons per hour.

By using Table 3, he sees that he can cover 15.5 acres per hour with a 32-foot boom traveling at the rate of four miles per hour. As in step 4 under "Adjusting Equipment for Spraying," he divides 195 gallons per hour by 15.5 acres per hour, and finds that he uses 12.58 gallons per acre.

Since the chemical contains three pounds of 2,4-D acid per gallon and there are eight pints in one gallon, the amount of 2,4-D acid per pint is determined by dividing three pounds by eight pints. This equals .375 pounds of 2,4-D per pint. Under "Reactions of Weeds" it is stated that ¼ to ½ pound of 2,4-D acid are needed per acre to kill sunflowers. As in step 3 under "Liquid Chemicals," the operator must determine the number of pints needed per acre. He has calculated that one pint of chemical contains .375 pound of 2,4-D acid. This is equal to ⅜ pound, which is more than ¼ and less than ½, so one pint of chemical per acre would be satisfactory.

In order to determine the number of pints of chemical to be added to a sprayer load, Step 4 under "Liquid Chemicals" states that the gallons in the sprayer should be divided by the gallons per acre and this answer multiplied by the pints of chemical needed per acre. Thus 125 divided by 12.58 equals 9.94, or approximately 10 acres that can be sprayed with one load. It was decided that one pint per acre was needed. Therefore, 10 x 1 equals 10 pints, the amount needed for one sprayer load.

Borax as an Herbicide

Borax is recommended for use on small areas of leafy spurge. It should always be used dry. It may be applied by hand or with mechanical spreaders at the rate of 15 pounds to the square rod. Even coverage must be attained in order to get the best results. Borax may also be used at the rate of 20 pounds to the square rod for spot treating other perennials such as Canada thistle, perennial sow thistle, perennial peppergrass, and bindweed. Borax will leave the soil unproductive for one or more years. It may be applied anytime during the growing season.

Sodium Chlorate as an Herbicide

Sodium chlorate is recommended for spot treating such perennials as bindweed, Russian knapweed, Canada thistle, perennial sow thistle, and perennial peppergrass. Applications may be made by hand or with a chlorate spreader. Complete coverage is essential. It should be applied dry or as a spray at the rate of four to five pounds per square rod. Leafy spurge may also be treated at the same rate, but Borax usually gives better results.

Atlacide, a commercial preparation containing sodium chlorate, used at the rate of six pounds per square rod is as effective as sodium chlorate and may be applied either dry or in a spray solution. Both chemicals will leave the soil unproductive for a period of one or more years, but not as long as Borax under the same conditions. Salt-hungry cattle will eat these chemicals and become poisoned. Caution must be observed. Both these chemicals are highly inflammable. Since the chlorate chemicals are inflammable, it is not advisable to store them on wooden floors. The crystals work into the wood and are easily ignited. After clothing has been wet with spray solution and then dried, it is very inflammable. Although it is difficult to apply atlacide dry with a mechanical spreader, the dry application of either chemical reduces the fire hazard. Treatments should be made between July 1 and October 15.

The Dinitros as Herbicides

The selective dinitro compounds (Sinox W and Dow Selective) are recommended for annual weed control in flax varieties that are susceptible to 2,4-D and in legumes. A boom type low-pressure field sprayer is essential to efficient use of these herbicides. Directions on containers should be followed closely in order to obtain the proper concentration and rate of application.

The contact dinitro sprays (Sinox General, Dow Contact and Dynitro) are very useful in burning off all vegetation around bulk stations and similar places.

IPC as an Herbicide

Ortho, iso-propyl N-phenyl carbamate (IPC) was highly publicized as a "quack grass killer," but field trials have been disappointing. Consequently, this chemical is not recommended for the control of quack grass or any other weed.

ATA as an Herbicide

Ammonium trichloracetate (ATA), a relatively new chemical, promises to be valuable for the control of grassy weeds. At present the supply of the chemical is limited and the cost is relatively high. Too little research has been conducted to warrant a recommendation for its use.