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emical Weed Control

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e recommendations and discussions in this mphlet are based on the "Recommendations the Research Committee of the North Central eed Control Conference for 1953." This committee represents state universities throughout the ea. Since the effectiveness of herbicides deends on factors that vary from region to region, e recommendations have been modified where cessary to make them fit Minnesota conditions.

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Chemical Weed Control in Minnesota—1953

PERENNIAL WEEDS

Quack Grass

Cultivation is the cheapest method of eradicating quack grass on large areas if soil erosion is not a problem. Begin cultivating during the late summer or fall and do it frequently enough to keep the soil black. You may begin after a hay crop is cut from an old stand, but be sure to harvest the hay before seed is formed. Heavy pasturing preceding cultivation is also helpful. In dry years cultivation will largely eradicate the weed, but in wet years little control is possible.

Two methods of cultivation are practiced: (1) the use of a one-way disk or disk harrow to shred the rootstocks and starve the plants, and (2) the use of a spring-tooth harrow to bring the rootstocks to the surface where they will dry out and die. In either case the operation must be intensive and continued over a long enough period to free the soil of all living quack material. If the quack is in scattered patches, it is better to use a disk, for it will not drag rootstocks to clean parts of the field.

Patches of quack can also be eradicated with chemicals. Sodium chlorate may be applied at any time, though possibly the best time is in the fall. Use 2-3 pounds per square rod.

TCA is best applied in late summer or fall. Amounts required on undisturbed sod are much larger than on land that is plowed first. Sixty-six pounds or more of TCA per acre are needed if applied without plowing. Good kills have resulted from two applications—one of 44 pounds in one year and one of 22 pounds the next. If the land is plowed a few days before treatment, 22 pounds per acre give good control.

If the land is subsequently cropped, a follow-up application of 18 pounds of TCA per acre or cultivation after harvest is recommended to eradicate the quack. Flax has been a better crop than corn under these conditions. TCA on land that has been cropped does not give as good a kill as on old sod.

Tolerance of crops is in the following descending order: flax, potatoes, red pine, oats, corn, barley, wheat, and soybeans, with the biggest break occurring between corn and barley. Normal growth of crops sown or planted in the spring following application of 22 pounds of TCA in the fall can be expected from flax, potatoes, oats, corn, strawberries, red pine, green ash, jack pine, white spruce, Russian olive, Bolleana poplar, Ural willow, and ponderosa pine.

CMU may be used for eradicating quack on nonagricultural land. Early-spring or late-fall applications have been superior to those in June, and applications on undisturbed sod have been much superior to those on plowed sod. A satisfactory kill of quack usually occurs with 20 pounds of CMU per acre, but 30-40 pounds are required for eradication. It has not been determined how long the soil remains toxic.

Field Bindweed

Field bindweed can be controlled by intensive cultivation followed by the sowing of a late-sown crop. Cultivation to cut off all plants about 4 inches below the surface should be done eight to ten days after each emergence. About July 1, after the plants have been weakened by this treatment, you may stop cultivating and plant soybeans, sorgo, or sudan grass to reduce erosion and yield some returns from the land. Alternate cultivation and cropping should be repeated until the weed is eliminated. Two to four years are required for eradication.

Applications of ½ to 1 pound of 2,4-D per acre in bud to bloom stage or in late fall are effective, but the treatment must be repeated to get a kill and to control seedlings. In small areas apply 4 to 6 pounds per square rod of dry sodium chlorate and follow a year later with spot treatment of any remaining plants.

Borax materials are also suitable if the effect on the soil is not objectionable. Use 30 pounds of Borascu, 15 pounds of concentrated Borascu, 10-15 pounds of Polybor, or 8-10 pounds of Polybor chlorate per square rod.

Leafy Spurge

Intensive cultivation and the sowing of winter wheat or rye have proved to be effective methods of controlling leafy spurge in areas where these crops are adapted. The land should be plowed early in the spring as soon as spurge plants have emerged and then duckfoot-cultivated at two-week intervals until fall when the crop is sown. After the crop is harvested, the process is repeated.

At least two and probably three years are required to eliminate this weed. In areas where soil erosion is not a problem, two years of intensive cultivation alone will often give almost complete eradication.

In many cases 2,4-D is the most practical chemical available for the control of large infestations of leafy spurge, and the ester forms are more effective than the amines. Top growth is easily retarded and seed production is usually prevented in leafy spurge in small grain by applications of one-half pound of 2,4-D per acre. In the case of large infestations, seed an adapted perennial grass where possible, as its competitive effect adds to the effect of 2,4-D.

Applications of 1 pound of 2,4-D twice a year to leafy spurge growing in a brome grass sod will often eliminate this weed in two or three years. You can control it more quickly by duckfoot-cultivating at two-week intervals for one season before the grass is seeded.

Several repeat applications of 1 to 2 pounds made at a prebud stage will greatly weaken stands of leafy spurge not in a growing crop, but two or three years are required to control it. Spring and summer applications are more effective than fall treatments.

Soil sterilants can be used to eliminate small patches of leafy spurge and should be applied between July 1 and October 1. The borax compounds are the most effective chemicals of this group and will generally eliminate the weed completely

when applied at the rate of 5 to 6 pounds of boron trioxide per square rod (15-18 pounds of Borascu, 8-9 pounds of concentrated Borascu, 5-8 pounds of Polybor).

Four to five pounds of sodium chlorate or Polybor chlorate per square rod are also effective. Seedlings that appear on patches that have been killed with soil sterilants can be eliminated with 2,4-D.

Large areas of leafy spurge can be controlled by pasturing without harmful effects on sheep. The degree of control is dependent on the intensity of grazing. Turn the sheep into the pasture when spurge plants are 6 to 8 inches tall, and follow good pasture management practices.

Canada Thistle and Perennial Sow Thistle

At least two applications of 2,4-D each year over a period of two or more years are generally necessary to eradicate Canada thistle and perennial sow thistle. Apply the 2,4-D first at the bud stage, and make the later treatments in the early fall when the resprouting thistles are in the rosette stage.

Apply from ½ to 2 pounds of 2,4-D per acre, using the lower rate in growing crops. Applications of ⅛ to ¼ pound per acre repeated two to six days apart to give a total application of ½ to 1 pound have been very promising in recent experiments. Good control has been obtained by treating infested areas with 2,4-D and subjecting the area to intensive cultivation as soon as new growth appears. Cultural practices that have proved effective are (1) spring duckfooting followed by sowing of sorgo, sudan grass, or proso millet about July 1, (2) using alfalfa or alfalfa-grass mixture and cutting for hay over several years, (3) fallowing where erosion is no problem.

For small areas use Borascu at 20 pounds, concentrated Borascu at 10 pounds, or sodium chlorate at 3 to 5 pounds per square rod.

Perennial Peppergrass or Hoary Cresses

Summer fallowing every second year keeps this weed in check sufficiently to permit growing a crop in the intervening year. Seeding of infested areas to grass reduces vigor, especially when applications of 2,4-D have been made.

These species respond somewhat to 2,4-D at 1 pound or more per acre applied in the bud or fall rosette stages. Repeated applications are required for eradication. Applications of one-half pound in crops reduce top growth of the weed. Sodium chlorate at 5 to 6 pounds per square rod can be used successfully in eradicating small patches.

Butter and Eggs or Toadflax

Intensive tillage (at least eight operations) during the summer fallow year has permitted the growing of one crop. When applied to infestations in grass, 2,4-D, ester, at 2 pounds or more per acre reduces vigor of the weed.

Sodium chlorate at 5 to 6 pounds per square rod eradicates patches of the weed when the application is repeated at least once.

Russian Knapweed

One year of fallow reduces the vigor of the weed only slightly. Use 2,4-D, ester, at 1 pound or more per acre to reduce vigor, especially if the infestation is in grass. Sodium chlorate at 5-6 pounds per square rod is satisfactory, but more than one application is usually necessary.

Cattails

Permits are required for applications of herbicides to public waters. Cattails that are in areas that are not a part of the public domain can be sprayed with 2,4-D at 5 pounds per acre just before flowering. Repeat applications for two or more seasons are necessary for eradication. When found in locations where the rootstocks are not covered by water, CMU at 40 pounds per acre will kill the plants.

WEEDS IN FIELD CROPS

Spring-Sown Grain

Barley and wheat should be sprayed only from the fifth leaf to just before early boot stage—oats during the latter part of this period. Because of the narrow margin of safety in oats, lighter dosages should be used on this crop than on wheat or barley. The rate of application for any of these crops should not exceed ½ pound of amine or ¼ pound of ester per acre.

The growing period of small grains can be divided into at least five developmental subperiods of response to 2,4-D. In barley these are (1) a highly susceptible seedling period extending from emergence through the one-leaf stage when the grain reacts to 2,4-D by forming tubular or onionlike leaves, (2) another susceptible period extending from the two-leaf to the five-leaf stage, (3) a relatively tolerant period between the five-leaf and early boot stages, (4) a highly susceptible period between the early boot and fully headed stages, (5) a highly resistant period between the milk stage and full maturity.

Wheat follows the same general pattern. But these developmental periods are not so well defined in oats, since this crop appears to be more susceptible at all stages.

At rates adequate for susceptible weeds like mustard, the stage of application is not so important as it is when ½ pound and over of 2,4-D, amine, is used. Mindo and to a lesser degree Clinton and Andrew oats have been more susceptible to 2,4-D than Bonda, Ajax, Zephyr, Shelby, James, Gopher, and Branch.

Varietal differences in barley have been small but Feebar, Plains, and Moore showed somewhat more susceptibility than Barbless, Mars, Kindred, Montcalm, and Vantage.

One pound of 2,4-D may be applied after the early-milk stage for preharvest treatment without appreciable crop injury.

Fall-Sown Wheat

Winter wheat may be treated with 2,4-D to control most annual broad-leaved weeds without injury to the crop if ap-

plied in the spring from the fully tillered to the early-boot stage. Suggested dosages are 4 to 5 ounces of the ester per acre or 8 to 10 ounces of the amine. Similar applications made in the fall usually result in damage to the crop and are not recommended.

Preharvest treatment when the wheat is in the milk to hard-dough stage should be looked upon as an emergency measure to be used only when weeds threaten to interfere seriously with harvesting. A dosage of 1 pound to the acre is required at this stage and may result in damage to the crop. Weed control at this stage is often not satisfactory.

Flax

Cultural practices—Weeds are generally more of a problem in flax than in small grain; therefore, growers should attempt to sow flax on relatively clean land. Early after-harvest tillage of small grain stubble is a recommended method of preparing land for flax the following year except where after-harvest tillage results in serious wind erosion. This practice will control perennial weeds, prevent weed seed production, and stimulate annual weed seed germination in late summer and fall.

A field where weed seed production has been prevented in corn, soybeans, and other cultivated crops and where the seedbed has been prepared by surface cultivation is a good one for flax. Delayed sowing of flax to permit spring tillage for wild-oat control has been successful in some areas although it is sometimes detrimental to flax. For delayed sowing, early-maturing Redwing, Sheyenne, or Marine are recommended.

Herbicides—Flax should be sprayed with MCP or 2,4-D as soon as enough susceptible weeds have emerged to make spraying practical. Spraying may reduce yields of seed and straw unless weed competition is reduced sufficiently to offset injury from spraying. Flax tolerates MCP better than 2,4-D.

Use 2 to 3 ounces per acre of MCP or 2,4-D in amine formulations for susceptible weeds like wild mustard. Use 4 ounces for lambsquarters, pigweed, stinkweed, cocklebur, marsh elder, and ragweed. For moderately resistant weeds, spot spraying at heavier rates may be necessary.

TCA at 5 pounds per acre will kill green foxtail, yellow foxtail, and barnyard grass in young flax. The flax should be at least 2 inches tall and the weeds less than 2 inches tall for best results. TCA can be applied in mixture with 2,4-D or MCP to kill susceptible grass weeds and susceptible nongrass weeds with one application.

Corn

Post-emergence treatment—Some injury to corn may be expected from spraying with 2,4-D. Until the corn is tasseled, stalk brittleness commonly follows over-all spraying. A storm or cultivation shortly after treatment may result in severe loss from breakage. Hybrids vary in their susceptibility to 2,4-D, but differences are not important at rates below ½ pound per acre. Do not spray seed fields unless the tolerance of the parents is known.

Corn is most susceptible for about a week after leaves appear and most resistant after ear formation. Susceptibility is associated with rapid growth. Injury is not important at ¼ pound of 2,4-D, amine, per acre—an amount sufficient to kill susceptible weeds such as cocklebur and wild mustard. Rates necessary to control more resistant weeds such as Canada thistle usually reduce yields.

Five pounds of TCA applied to the soil following the last cultivation have controlled foxtail without reduction of corn yields. The chemical should be applied with drop nozzles in order to wet not more than the lower 6 inches of stalk. When 2,4-D is combined with TCA, broad-leaved annual weeds can also be killed.

Pre-emergence treatment is not recommended.

Soybeans

Weed control in soybeans by either pre-emergence or post-emergence applications of herbicides has not been dependable. Early seedbed preparation and frequent cultivation to kill weeds until planting time is recommended. Post-emergence cultivation with the rotary hoe or weeder is effective if done when the weeds are very small.

Sugar Beets

Where annual grasses, except wild oats, are known to be a problem, 5 to 7 pounds per acre of TCA just before the emergence of the beets is recommended.

If weather makes it impossible to apply the spray before emergence of the crop, it is best to wait 10 days. TCA at the same rate may then be used to control annual grasses, but this should be considered an *emergency treatment only.*

Forage Legumes

Seedling stands of Ladino clover, alsike clover, red clover, and alfalfa growing in flax or small grain may be sprayed for the control of many broad-leaved annual weeds. Use sodium or amine salts of 2,4-D or MCP at rates of ¼ pound per acre.

Alfalfa is generally less tolerant of 2,4-D and MCP than Ladino, alsike, and red clovers and some loss of stand can be expected. Sweet clover will not tolerate either 2,4-D or MCP. Applications made when the small grain is 8 to 10 inches high usually injure legumes less than earlier applications.

The dinitro sprays also may be used on these legumes—including sweet clover—for the control of small broad-leaved annual weeds, but more water is required than for 2,4-D or MCP and results are more dependent on the weather. The ammonium salt of DNBP at rates of ¾ to 1 pound in 60 to 80 gallons of water per acre is suggested. With high temperatures or wet plants, use lower amounts of DNBP.

TCA at 5 to 7 pounds per acre may be used to control pigeon grass, barnyard grass, and witch grass in seedling stands of alfalfa and sweet clover. However, this chemical cannot be

used when wheat, oats, or barley are used as a companion crop.

Established stands of alsike, Ladino, and red clovers may be sprayed with 2,4-D, MCP, or the ammonium salt of DNBP when the top growth of the legume is nearly dormant or immediately following harvest. MCP and 2,4-D will usually reduce vigor of the legume temporarily. Established stands of alfalfa and sweet clover may be sprayed at the same dates with 5 to 7 pounds of TCA for control of foxtails, barnyard grass, and witch grass. Red clover and alsike clover are too susceptible to TCA to be sprayed.

Seed production of annual broad-leaved weeds in seedling alfalfa, red clover, alsike clover, and Ladino clover may be controlled by mowing, but it is not effective for annual grass weeds. Sweet clover will not tolerate close mowing. The use of a weedy first-crop legume as ensilage is an effective means of removing many weed seeds from the fields.

WEEDS IN PASTURE AND RANGE GRASSES

Good management and controlled grazing are most important in any attempt at weed control in pasture land.

In very weedy pastures where good perennial grasses are thin, frequent cultivation in late summer or early fall to kill the old sod and reseeding are probably the most important improvement practices. In order that the reseeding be successful, a good firm seedbed should be prepared. Protect new seedlings from grazing until established, and graze moderately thereafter. Plowing and seeding to adapted grass where practicable will almost eliminate many of the perennial pasture species. Spot spraying with 2,4-D is effective for susceptible perennial weeds.

Mowing is the recommended practice for controlling many kinds of weeds if done at the right time for two, three, or four years. In general, mow such herbaceous weeds as thistles when in the bud to bloom stage.

Spraying with 2,4-D or 2,4,5-T gives better control of more kinds of weeds by a single application than does a single mowing. Spraying while the weeds are actively growing gives best results. Repeated treatments for two or more years are usually necessary, and these materials may be used at rates necessary for weed or brush control without much injury to the grasses.

Seedlings of perennial grasses may be treated with 2,4-D to good advantage if the broad-leaved weeds are a problem and if the land is not heavily infested with seeds of the weedy annual grasses. Rates up to ¾ pound ester per acre may be used after the grass seedlings have reached the two- to four-leaf stage.

WOODY PLANTS

Both 2,4-D and 2,4,5-T have a definite place in woody plant control. Foliage sprays of 2,4-D will kill some plants not killed

by 2,4,5-T, and vice versa. Therefore, for general foliage spraying of mixed brush populations, use mixtures of 2,4-D and 2,4,5-T. The use of 2,4,5-T is especially effective in killing blackberry, wild rose, chokecherry, black cherry, and other species not as readily killed by 2,4-D. For most species and methods of treatment repeated applications are necessary.

Foliage sprays—Treat woody plants that are sensitive to either 2,4-D or 2,4,5-T with wetting foliage sprays containing at least 2 pounds of acid per 100 gallons of diluent. For more tolerant species use higher concentrations. Under most conditions water is preferable to oil as a diluent.

Use ester formulations for most situations, but near sensitive crops use low-volatile ester formulations. Ammonium sulfamate applied at concentrations of ¾ to 1 pound per gallon of water is also effective but requires special care to prevent corrosion of equipment.

Cut-surface treatments—Woody plants may also be killed by applying chemicals to freshly cut surfaces of stumps or to "frill girdles" chopped around the ground line of standing trees. This type of treatment is possible at any time of the year. Some shrubs and trees tolerant of foliage sprays or too large to spray conveniently may be killed by this method.

Esters of 2,4,5-T or 2,4-D in oil solutions at concentrations of 8 to 16 pounds of acid per 100 gallons of oil applied liberally are effective. Also recommended is ammonium sulfamate applied as a dry powder or as a concentrated water solution (6 to 9 pounds per gallon of water). The addition of some sticker or spreader to water solutions may be necessary.

Basal bark sprays—Basal stem and ground line treatments of woody plants offer promise as good control measures. Use esters of 2,4,5-T at concentrations ranging from 8 to 16 pounds per hundred gallons of oil for most species. In species like buckbrush, esters of 2,4-D are preferred.

The entire basal area at the ground line completely encircling the plant should be wetted until the liquid runs off. For shrubs this might involve the entire stem and in some species with rhizomes, this will involve the ground area surrounding the plant.

Soil treatment—Sodium chlorate, sodium chloride, CMU, and borax formulations are recommended as soil treatments for control of woody plants under certain conditions. These chemicals are especially useful for spot treatment if spraying with growth regulators will not work.

It should be recognized that most of these materials tend to make the soil unfit for plant growth for one or more years. In addition, sodium chlorate creates a fire hazard during and after application.

WEEDS IN HORTICULTURAL CROPS

The rates of application of chemicals recommended below for use in garden crops are based on over-all coverage. If only a narrow strip over the row is sprayed, the amount of chemical

should be reduced accordingly. Rates of application listed for 2,4-D and TCA refer to pounds of acid equivalent (active ingredient).

Vegetable Crops

Asparagus—After the early spring disking and before spears have emerged, the application of 2 pounds of 2,4-D or 4 to 6 pounds of SES per acre will control most annual broad-leaved weeds in established asparagus plantings. If annual grasses are a problem, 5 to 10 pounds of TCA may be added to the spray mixture.

During the cutting season, weeds can be kept under control by using a wire weeder or by applying granular calcium cyanamid at the rate of 300 to 400 pounds per acre immediately after a cutting and when the weeds are small. The dust form of calcium cyanamid applied at 75 to 100 pounds per acre is also effective if weeds are small and if there is enough dew to stick the dust on the foliage.

Following the post-harvest disking of an established asparagus bed, weeds can be controlled by applying 2 pounds of 2,4-D or 6 pounds of DNBP before any spears appear.

To control weeds in asparagus seedbeds, use 80 to 100 gallons of Stoddard solvent, 1 pound of DNBP, or 1 pound of 2,4-D per acre.

To kill quack grass in small areas of an asparagus planting, spot treatment using 40 to 50 pounds of TCA per acre just after disking is recommended. Such treatment will result in some injury to the crop but may be worth while to prevent spread of the weed.

Beans—The use of pre-emergence sprays to control weeds in the row, together with cultivation between rows, has proven quite successful. The application of 6 to 9 pounds of DNBP or 15 to 25 pounds of sodium PCP per acre of actual sprayed area will control annual weeds for a considerable period. The higher rates should be used when sprays are applied immediately after planting.

When spraying is delayed until shortly before bean emergence—at a time when many weeds have emerged—the lower rates may be used with equal effectiveness.

Beets—For the control of annual grasses apply TCA at 8 to 10 pounds per acre at least two days before beet emergence. If weather makes it impossible to spray before emergence of the crop, wait 10 days after emergence and apply 10 pounds of TCA. Since some beets will be stunted by the latter treatment, this treatment should be used as an emergency measure only.

Cabbage, cauliflower, rutabaga, turnips, brussels sprouts, broccoli—When any of these crops is direct-seeded, a pre-emergence spray of 5 to 10 pounds of TCA per acre applied 2 to 3 days before crop plant emergence may be used to control annual grasses.

Carrots, celery, dill, parsnips, parsley—Small annual weeds can be controlled by the application of 80 to 100 gallons of Stoddard solvent per acre if the entire area is sprayed. The

spray should be applied when most of the first crop of weeds has emerged but before any of them is more than two inches tall. The oil is most effective, and often at lower rates, when it is applied at night when there is little air movement and humidity is high. Early-evening applications are best in areas where exceptionally heavy dews may cause run-off of the chemical if it is applied later at night.

Carrots and parsnips should not be sprayed after the tap root is more than one-fourth inch in diameter or after five or more leaves are present. Stoddard solvent should be applied to celery only in the seedbed.

Onions—For the control of weeds that have emerged before the onions, use 40 to 80 gallons of Stoddard solvent, 16 to 20 pounds of potassium cyanate, 75 to 100 pounds of calcium cyanamid dust, or 3 to 5 per cent sulphuric acid at 100 gallons per acre as pre-emergence applications. This should be done eight to ten days after seeding.

For control of weeds in onions in the loop stage or after the first true leaf is at least 2 to 3 inches long, post-emergence sprays of 2 to 3 per cent sulfuric acid at the rate of 100 gallons per acre or 12 to 16 pounds of potassium cyanate in 50 to 100 gallons of water per acre are recommended. Purslane is controlled only in the seed-leaf stage, and lambsquarters and grasses are usually not killed.

In older onions which are bulbing and which have been "laid by," the use of basal sprays of herbicides to control late-germinating weeds such as purslane is recommended. Potassium cyanate at 16 to 24 pounds per acre, 3 to 5 per cent sulphuric acid at 100 gallons per acre, and 1 to 1¾ pounds of DNBP in 50 to 100 gallons of water are effective if applied when weeds are small. Such sprays should be applied so as to avoid hitting the tops of the onion plants. You can do this by using shields over the spray nozzles or over the onion row, or by using drop nozzles.

Potatoes—While blind cultivation is generally preferred to control weeds, in wet weather chemical pre-emergence treatments may be valuable. Good results have been obtained by using 2,4-D at 1½ to 2 pounds, DNBP at 4 to 6 pounds, and sodium PCP at 10 to 20 pounds. These should be applied two to six days before emergence. Where annual grasses are a problem, TCA at 8 to 10 pounds per acre may be used as a pre-emergence spray.

During wet weather if broad-leaved weeds threaten to take over a potato field after emergence of the potato plants, 2,4-D, amine, at 1 pound per acre can be used to control the weeds. If this application is made when the tubers are setting, it may reduce crop yields as much as 25 per cent. Thus it should be used only as an emergency measure during that period.

Sweet corn—2,4-D can be used to control weeds in sweet corn by following the same recommendations as given for field corn.

Vine crops—Weeds in cucumbers, muskmelons, and watermelons have been successfully controlled with N-1 naphthyl phthalamic acid. It should be applied pre-emergence immedi-

ately after planting these crops at 2 to 4 pounds per acre on sandy soils or 4 to 8 pounds on heavier soils. As a post-emergence treatment when these crops are grown from transplants the chemical should be applied at not more than 4 pounds per acre.

Fruits and Ornamentals

Apples—Poison ivy in apple orchards can be controlled with ammonium sulfamate applied as a wetting spray at 1 pound per gallon. Also recommended are 2,4-D (amine, sodium salt, or low volatile ester) or 2,4,5-T (low volatile ester) at 1½ to 2 pounds per 100 gallons of water. Application of the latter two chemicals when fruit buds are forming (late June and July) should be avoided. Herbicidal sprays should be kept off the trunk and leaves of the trees.

The same materials can be used to control brambles and perennial weeds but these may be more difficult to eradicate than poison ivy. Perennial weeds and woody plants are more susceptible when the topmost leaves on the new growth are reaching full size. Some regrowth may occur and it is usually necessary to make a second application later in the same season using ammonium sulfamate. This second application may be replaced with a treatment of either 2,4-D or ammonium sulfamate in the following season.

Grapes—Where weeds beneath the trellis cannot be controlled effectively with the hoe, use an oil emulsion containing 10 to 20 gallons of aromatic or fuel oil plus 2 pounds DNBP or 4 pounds PCP per 100 gallons of spray. Use a suitable emulsifying agent and make certain the oil remains emulsified.

Apply 40 to 50 gallons per acre in a strip 18 inches wide beneath the trellis, using a low-pressure sprayer. Keep the spray off foliage and do not spray young vines which do not have a protective coating of loose bark.

Raspberries—Young weeds can be successfully controlled by basal sprays of ½ pound of 2,4-D (amine or sodium salt) or 2 to 4 pounds of DNBP. The first application should be made early in spring before new shoots have emerged. The second application should be delayed until the young canes are tall enough so that the basal spray will not hit the growing tips. DNBP should be used at 2 pounds per acre for the second application.

SES at 3 to 6 pounds per acre can be used at any season without injury to raspberry plants. However, to be effective SES must be applied before the weeds emerge.

Strawberries—The use of 1 to 2 pounds of 2,4-D, amine, or 3 to 6 pounds of SES per acre is recommended. In a new planting 1 pound of 2,4-D can be applied during the period from 3 to 4 weeks after setting to September when fruit buds begin to form. Treatment at the time when runners are beginning to form may inhibit their production.

During the fruiting year 2,4-D can be used at 1½ to 2 pounds per acre but should not be applied to strawberries in bloom. SES can be applied without injury at any time after

plants are set out, and repeat applications may be made as needed. SES, however, must be applied before weed emergence and thus is not effective when applied to a weedy strawberry planting.

Gladiolus—Two pounds of 2,4-D, 8 pounds of DNBP, or 3 to 6 pounds of SES will control most annual broad-leaved weeds when applied before the emergence of the gladioli. Where annual grasses are a problem, a pre-emergence spray containing 10 pounds of TCA is effective. Post-emergence treatment using 1 pound of 2,4-D, sodium salt, when the gladioli are six inches tall or before the leaf blades open will control most of the weeds in the row. Injury may result if plants are treated with higher concentrations or at later stages of growth.

SES at 3 to 6 pounds per acre can be used either as a pre- or post-emergence spray without injury. To be effective, SES must be applied prior to weed emergence.

Cormels grown for size increase are more subject to injury from herbicides than flowering-size corms.

Turf—Annual broad-leaved weeds in new turf can be controlled by ordinary mowing and management practices which favor the development of turf grasses. Herbicidal sprays should not be applied until the turf is one year old.

In established turf, perennial broad-leaved weeds can be controlled by 2,4-D applications when the weeds are in active growth. A concentration of 0.1 to 0.2 per cent of 2,4-D, amine, applied at a volume of 1 gallon per 1,000 square feet will control most weed species. For resistant weed species, better control is obtained when 2,4-D esters are used, but nearby ornamentals may be damaged more from drift.

Crabgrass can be controlled by applications of phenyl mercuric acetate (PMA) at 0.3 ounce or potassium cyanate at 3 ounces per 1,000 square feet. These should be applied as soon as crabgrass seedlings are observed. Additional applications at 7- to 10-day intervals may be required.

WEEDS IN WASTE PLACES

Weeds in places where it is difficult to plow or mow or where complete vegetation control is desired can be controlled with herbicides, but the cost on an acre basis may be rather high. Larger dosages than those recommended will give better and more lasting control. Larger dosages are generally more necessary on low ground than on high, dry locations.

Lower dosages and less water or other carrier are needed if applications are made before vegetative growth becomes large and dense.

For a temporary kill, 3 pints of DNAP or DNBP (phenol) in 3 or more gallons of Diesel oil diluted with water to 40 gallons per acre gives a quick kill, but grass and perennial weeds quickly recover. The addition of 10 to 25 pounds of TCA to the above mixture may also give fairly good control of annual grasses from early June until winter.

Polybor-chlorate at about 1,600 pounds per acre (10 pounds per square rod) in 1,000 or more gallons of water gives a quick

kill of all herbaceous vegetation and should last for at least one season.

CMU at 40 or more pounds per acre applied in either fall or spring gives nearly complete vegetation control for at least one or two years. CMU is very slow acting and if applied in April it might take until July for all vegetation to be killed. Some deep-rooted weeds such as morning glory and Canada thistle may require a follow-up application with 2,4-D in order to keep the ground bare of vegetation.

FARM SPRAYER CALIBRATION AND ADJUSTMENT

Uniform application of spray chemicals is essential to control weeds. A small variation in the rate of application may fail to kill the weeds or may injure the crop, thereby causing a loss of time, effort, and money.

To calibrate the sprayer accurately it is first necessary to determine whether or not each nozzle is discharging at a uniform rate. Clean each nozzle thoroughly and then with the sprayer in a stationary position, run clear water through at normal spraying pressure. Catch the discharge from each nozzle in a quart fruit jar, watching to see whether the level of the liquid in the jars rises uniformly. Nozzles which vary from the rest should be replaced.

If there is a gradual decrease toward the ends of the boom in the amount of liquid from each nozzle, the boom is too small. Boom capacity can be checked by catching the discharge from a nozzle at the end of the boom and from one near the inlet hose feeding the boom. Fruit jars should be placed under the nozzles simultaneously.

Compare the discharge from the two nozzles. If there is variation the nozzles should be interchanged and another test made. If the variation remains relatively the same the boom is too small or restricted. The variation should not be over 10 to 15 per cent. When it is more than that, a new boom should be provided as its cost will be a small fraction of the crop to be saved or the chemical which is wasted.

A simple method for determining the amount of liquid a sprayer applies per acre is as follows:

1. Start with a full tank of clean water and have the pressure adjusted as you will use it in the field (usually 30 to 40 pounds).
2. Drive exactly ⅛ of a mile (40 rods) in a field at the speed you will use when spraying—usually 4 to 5 miles per hour. Mark the notch the throttle is in and keep it in this notch when spraying.
3. Refill the tank, carefully measuring the amount of liquid required.
4. Calculate the application rate as follows:

$$\frac{\text{Number of gallons used} \times 66}{\text{Boom coverage in feet}} = \text{Gallons per acre}$$

Example: If 2½ gallons were used in ⅛ mile and the width covered by the boom is 24 feet, multiply 2½ by 66 and divide by 24. The result is 6.9 gallons per acre.

$$\frac{2.5 \times 66}{24} = \frac{165}{24} = 6.9 \text{ gallons per acre}$$

Here is the way to determine the amount of 2,4-D to be put in the tank.

1. Divide the number of gallons the tank will hold by the number of gallons your sprayer applies per acre. This will give you the number of acres one filling will spray.
2. Multiply the number of acres the tank will spray by the amount of 2,4-D to be used per acre. This will give the amount of 2,4-D to be used per tank.

Example: If the tank holds 55 gallons and the sprayer applies 6.9 gallons per acre, one tank will spray 8.0 acres (55 divided by 6.9 equals 8.0). If 1 pint of spray material is required per acre, 8.0 pints would be required for each tankful. That is, 1 pint per acre × 8.0 acres = 8.0 pints per tankful.

When refilling a partially filled tank, first determine the number of gallons you will need. Then divide this by the number of gallons the sprayer applies per acre to get the number of acres you will spray with what you are adding. Multiply this by the number of pints of 2,4-D required per acre to get the amount of 2,4-D to be added to the tank. Add the 2,4-D and then fill the tank with water.

The case may arise where you want to spray a small area and you will not need a full tank of solution. The problem then is to determine how much water and 2,4-D to put in the tank. Multiply the number of gallons per acre that the sprayer applies by the number of acres to be sprayed. This is the total amount of solution required.

Then multiply the amount of 2,4-D supplied per acre by the number of acres to be sprayed to get the total amount of 2,4-D to be added to the tank. Add the 2,4-D to the tank before the water.

Example: If 5 acres are to be sprayed and the sprayer applies 6.9 gallons per acre, 5 × 6.9 = 34.5 gallons of solution to be applied to five acres. If 1½ pints of 2,4-D are to be applied per acre, 5 × 1½ = 7½ pints of 2,4-D. Add the 2,4-D to the tank and then enough water to bring the liquid level in the tank up to the 34.5 gallon mark.

Vibration, wear on pump, corrosion, partial clogging of nozzles and strainers, and changes in field conditions are factors which affect the discharge rate of the sprayer. For these reasons keep close watch on the spraying operation and check the calibration often.

Remember that calibration of a sprayer is accurate only for the set of conditions under which it is made. Changes in speed, pressure, or field conditions are factors which will make a new calibration necessary.

Description of Herbicides

All rates of 2,4-D, 2,4,5-T, MCP, and TCA are the basis of acid equivalent. Avoid direct contact w skin and eyes—especially repeated or prolong contact with all chemicals.

Ammonium sulfamate—Ammate

Borascu—agricultural borax, contains 34 per c B_2O_3

Calcium cyanamid—Aero Cyanamid, spec grade or granular

CMU—3-(p-chlorophenyl)-1, 1-dimethylurea, c tains 80 per cent active ingredient

Concentrated Borascu—contains 61.5 per c B_2O_3

DNAP — 4,6-dinitro-o-sec-amyl phenol, Sin General

DNBP—4,6-dinitro-o-sec-butyl phenol, Dow G eral, contains 5 lbs. of active ingredient gal.

DNBP, ammonium salt—Sinox W and Dow Sel tive, contains 1 lb. of active ingredient per g

MCP—amine salt of 2-methyl-4-chlorophenox cetic acid

Methyl-bromide—bromomethane, soil fumigant

PCP—sodium salt of pentachlorophenol, wa soluble

PMA—phenyl mercuric acetate, 10 per cent tive ingredient

Polybor—contains 66.6 per cent B_2O_3

Polybor-chlorate—contains 50 per cent B_2O_3 a 25 per cent sodium chlorate

Potassium cyanate—contains 91 per cent act ingredient

SES—2,4-dichlorophenoxyethyl sulfate

Sodium chloride—common salt

Sodium chlorate—highly flammable when mi with organic materials

Stoddard solvent—petroleum distillate, conte 15 to 18 per cent aromatics

TCA—sodium salt of trichloroacetic acid

2,4-D — 2,4-dichlorophenoxyacetic acid, for lated as sodium and amine salts and esters

2,4,5-T—2,4,5-trichlorophenoxyacetic acid, for lated as sodium and amine salts and esters

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