KILLING WOODY PLANTS WITH CHEMICALS

FOR the past seven years, a considerable number of experiments have been conducted at the Arnold Arboretum with chemical weed killers, much of the work being done at the Arboretum's Case Estates in Weston. In 1944, the first reference was made to what is now popularly termed "2,4-D," and since that time many products have appeared on the market. Some kill "lawn weeds," some "thin carrots," some are supposed to kill poison ivy, and several kill "brush." During this period we have tried several dozen different materials, noted their results, and tried to repeat the experiments with as good or better success. Each year recently, some new and better material has been offered, and been tried here. It may be of interest to ARNOLDIA subscribers to learn a little about these experiments, and especially to learn what the results have been up to the present time.

In the first place, since many "selective" weed killers are available, it is well to understand exactly what our problem is here. Primarily it is one of maintenance, in which we are interested in eliminating poison ivy and the many woody weeds that are continuously appearing in our collections and doing it as thoroughly and economically as possible. Secondly, the hand labor around plants (chiefly in the form of hoeing) which eats so deeply into our maintenance budget, must be reduced in order to keep within budgetary limits. Witch grass is a constant problem, for it grows around specimen shrubs, is difficult to cut except with hand labor, and takes a great deal of nourishment from young plants. Such weeds must be controlled as economically as possible, without injury to any of the specimen plants in the collections. At the present time, most of these things are being done quickly, efficiently and economically, thanks to some of the newer weed killers.

The above objectives should be kept in mind when going through this progress report. So many materials are available today, each one of which may well have
its own specific use, that the following notes should not be used to condemn any individual material for all purposes. A very few materials have proved themselves to be meritorious for our specific purposes, but in order to have the complete picture of what has been done over a seven-year period, this progress report is offered.

**Flame Thrower**

Experiments were first started in 1943 to eradicate poison ivy with the flame thrower, a kerosene burning torch in which the kerosene vapor (under pressure) is ignited, giving a flame several feet long with a killing temperature of 2000°F. The above-ground parts of this poison ivy were old and woody and it took considerable time on the part of the operator to "burn them off." The operator is frequently in the smoke of the poison ivy, and if he is susceptible, he is often poisoned from the fumes. As a result of this burning, the poison ivy frequently re-sprouted, either the same season or in succeeding seasons, due to the inability of the torch to completely kill the plant below the ground.

In later years, much was claimed for controlling weeds in field crops by "sizz" burners, in which a flame of high heat intensity was quickly passed over annual weeds. If they were tall, it was recommended to go over them in the morning and a second time in the afternoon. This was tried for killing the grass and weeds around the large lilacs in our lilac collection. On May 9, 1947, above-ground parts of the grasses and weeds were killed, but were reappearing from the roots on May 29. They were green again by June 13 and were almost normal grass by July 19. Another time this method was tried around the lilacs, searing the grass foliage twice the same day, but the grass eventually came up from the roots again the same season.

**Results:** Killing poison ivy and witch grass by use of a flame gun was not satisfactory, nor did it give a complete kill. It was costly in that it took a considerable amount of the operator's time, and dangerous in the case of an operator susceptible to poison ivy poisoning. This type of vigorously growing material is quite different from the small annual weeds in field crops which can be killed by recommended "sizz" burners.

**Sodium Arsenite and Sodium Chlorate**

Both chemicals were used in 1943 and succeeding years at rates recommended by the manufacturers for the specific weed killers. (Sodium chlorate at the rate of $\frac{3}{4}$ to $1\frac{1}{4}$ lbs. per gallon of water, and sodium arsenite, in a form then commercially available, at 4 gallons to 50 gallons of water.) It was the sodium arsenite that brought home to us the importance of killing annual weeds with sprays, for we found that the materials, plus the labor of applying them to our shrub collection, cost about $75.00, whereas the labor cost for one hoeing alone (in 1941) was $85.50. However, sodium arsenite is highly poisonous to the operator and to animal life.
Results: In 1945, these materials were compared with the then-new "2-4-D" for the purpose of killing broad-leaved, herbaceous weeds in grass plots, and "2-4-D" was apparently just as effective. In addition, and as mentioned before, sodium arsenite is poisonous to human beings and animals. Sodium chlorite dries after application, and a serious fire hazard results in areas where it has been used.

Borax

This material has been recommended for killing poison ivy and was used in 1949, being applied at the rate of \( \frac{1}{2} \) lb. per square yard. It can be used either in powder form or in solution. It is easier to merely broadcast it in powder form, but it must be washed in by a rain. We applied it on June 2, 1949, and it did not start to kill the poison ivy until July 8, 1949 (due to lack of rain), but by July 28, 1949, after good rains, the poison ivy was completely killed and remained so the succeeding year as well. Incidentally, this was in continuous shade in the woods, one of the most difficult places to eradicate poison ivy. Nevertheless, the use of this material in this fashion would unquestionably be a serious hazard to any tree roots in the area.

Results: A complete kill of poison ivy was obtained. For small areas in home gardens this might prove satisfactory, for it is easy to apply and does not take extra equipment. However, nothing else grew in the soil so treated for a year afterwards. It would be rather difficult and expensive to apply it this way on a large scale—the cost would be nearly five times that of "Ammate."

Kerosene

This cheap oil has been used as a grass killer, especially in edging flower beds. It is effective, kills the lawn grasses completely (the grass is apparently dead an hour after application), is not a fire hazard after drying since it is volatile, but it is inflammable while in use. It costs less than "Ammate" (which kills grass), but considerably more than Dow’s "Brush Killer" (which does not kill grass). Soil used after four light applications of kerosene, germinated beets, carrots, lettuce and radishes at once, with no injury whatsoever.

"Ammate"

Sodium sulfamate (popularly termed "Ammate") was in use several years prior to 1945, when we first used "2-4-D." It was at first recommended only for poison ivy eradication. Many experiments have been conducted with this material at the Arnold Arboretum, but we will mention just those during 1949 and 1950, when "Ammate" was being compared with Dow’s "Brush Killer." Applied on June 2, 1949 (at the rate of 1 lb. per gallon of water), to poison ivy growing in continual shade, the plants were apparently dead by June 16, 1949, and no shoots came up from this spot in 1950. During some of our experiments with grasses, it was found that "Ammate" did not always kill grass completely, but
in one experiment with witch grass 18" tall, it completely killed the grass in four days, and none sprouted the rest of the season. Mr. R. G. Williams, Superintendent of the Arboretum, noticing that the material does not adhere well to waxy-leaved weeds, has been using O. E. Link's "W.A." as a wetting agent, with apparently much better results.

Blueberries and young peaches have easily been killed merely by the application of this "Ammate" spray to the soil about their roots, and not to their foliage. The time of application to plants in general seems to make little difference, since witch grass has been completely killed (at Rhode Island State College) when applications have been made from July 1 to October 1.

Applied on June 9, 1950, to the young suckers around lilacs (and also in 1947), the suckers hit by the spray were killed, but the untouched parts of the plant were not affected in any way, either then or later. Sprayed against the trunk of a large lilac, no injury was observed to any portions of the plant above the point of application.

**Results:** Sodium sulfamate has proved to be an efficient killer of woody weeds. There is no fire or explosion hazard in its use. Most important, we have found no "drift" injury to other plants. So often, with "2-4-D" and similar materials, regardless of how careful the operators are, there is a drift to nearby plants that results in severe injury. "Ammate" does not kill members of the genus *Rubus* in the shade more than about 75%, and *Fraxinus* only about 50 to 75%. We have used it to kill standing trees, by notching around the trunk and thoroughly soaking the cut surfaces with a solution of 4 lbs. of "Ammate" in 1 gallon of water. Smaller tree stumps (6") have been notched with a "V" cut in the stump after the tree was cut down, and a tablespoon of "Ammate" crystals put in to prevent the stump from re-sprouting. However, "Ammate" is corrosive to pump parts, causing abnormal rusting of iron or steel and the electrolytic reaction on brass which makes it break easily.

Some of the plants (none over 8' in height) we have killed with one application of "Ammate" spray prior to July 15 are:

- *Aronia arbutifolia*
- *Berberis vulgaris*
- *Castanea dentata*
- *Pinus strobus*
- *Prunus serotina*
- *Prunus virginiana*
- *Quercus alba*
- *Quercus rubra*
- *Rhus glabra* "typhina"
- *Sambucus canadensis*
- *Vaccinium angustifolium* "corymbosum"
- *Vitis labrusca*

In a woodland of cut white and red oaks with 3 to 12" stumps, most of which had 3' suckers by June 5, 1950, we sprayed once with "Ammate" to thoroughly cover these suckers, almost completely killing them. **Caution:** See note page 70.
Also known as "Stoddard's Solvent #5," "Mineral Spirits," and "Sun Spirits," "Sovasol" is a naphtha-type petroleum product used in industry as a paint thinner, a solvent, and for dry cleaning clothes. It is inflammable but not explosive, and has been sprayed for several years on carrot seedlings to thin them as well as to kill the weeds among the seedlings. It evaporates rapidly, is relatively non-toxic to human beings, and will not plug or corrode spraying equipment, although rubber and leather washers as well as pump fixtures will disintegrate after a period of use with this material.

As a selective weed killer for carrots it has been used considerably, and is recommended widely for killing herbaceous weed seedlings. It has been shown that plants like Juniperus virginiana, spruce and hemlock are highly resistant to injury from it (if small amounts reach the foliage), but that Taxus is very susceptible to injury from this material.

It has been used at the Arnold Arboretum regularly for three years now, to kill small herbaceous weed plants in the shrub collection. As a brush killer, it was tried on June 9, 1950, on poison ivy in sun and shade, Rubus, Sambucus canadensis, Acer rubrum and Prunus virginiana.

Results: When applied at full strength on the above plants, foliage was killed within an hour, but most of the plants were growing remarkably well again by July 1, 1950. Even ragweed and morning-glory started growth after treatment. The spray did not kill poison ivy, some of which still grew well two weeks after being treated. Since "Sovasol" is highly volatile, the soil hit by the spray was not affected, and seeds of lettuce, beets, and radishes germinated and grew in the upper half inch of loam a few days after application. Applied to witch grass 18" tall on June 9, 1950, the tops were killed within an hour, but the grass was growing vigorously again from the roots by July 9, 1950. Applied to lilac suckers around a huge plant, it killed the suckers to which it was applied and was not absorbed in sufficient quantity by the larger stems to cause injury to them. Sprayed on the trunk of a lilac, it did not injure the foliage above the spot of application.

Considering that it is as costly as sodium sulfamate (on a sprayed area basis), it is not nearly as good a killer of woody plant weeds or witch grass. The perennial grasses and woody weeds are killed to the ground only. Small herbaceous weeds are killed quickly, and for this purpose it has merit.

"2-4-D"
(2-4-dichlorophenoxyacetic acid)

We have been experimenting with this material since the spring of 1945, only a few months after its plant-killing properties became known. Erratic results have been obtained from the first, especially when the material was used in the shade. When sprayed on suckers (about 3' tall) of a large lilac bush, the suckers
in full sunlight were killed—those in the shade were not. Sometimes it proved effective on poison ivy, yet frequently, when applied in the shade, it was not thoroughly effective.

It has been produced in several forms, and widely advertised under various trade names. We have used Dow Chemical Company's "Esteron 44" (which is the isopropyl ester of "2-4-D") with some success.

**Results:** Because of superior results with Dow's "Brush Killer," "Ammate," and "T.C.A.," no detailed experiments with "2-4-D" will be discussed. Both the salts and esters have been tried. As a killer of broad-leaved, herbaceous weeds in the lawn, "2-4-D" in one or more of its several forms may have its place, but in view of many experiments which we have carried out, it is not (alone) a dependable killer of miscellaneous woody plants. Among poison ivy plots receiving five different treatments in 1949, only those treated with "2-4-D" produced new growth eight weeks after application. "2-4-D" was applied at the direction of the manufacturer. Time and again it has produced very poor kills on *Fraxinus americana*, *Acer rubrum*, *Rubus* species and poison ivy, especially in the shade.

In one experiment it was applied to weeds along plant rows in our Weston nurseries. Broad-leaved weeds were killed (they were only a few inches tall), but of course the witch grass and the crab grass were not. At the end of the summer, plots treated with kerosene were devoid of all weeds and grass, while those sprayed at the same time with "2-4-D" had no broad-leaved weeds, but were thickly covered with crab grass 2' tall.

**Dow's "Brush Killer"**

*(Being a mixture, half and half, of the isopropyl ester of "2-4-D" and the isopropyl ester of 2-4-5 trichlorophenoxyacetic acid)*

In the spring of 1947, chemists of the Dow Chemical Company were experimenting with "2-4-5-T," and found it gave a better kill for certain specific weeds like blackberry, raspberry and dewberry, than did "2-4-D." Shortly after, it was found that a mixture of the two were even more effective, and in 1949 we were experimenting with this combination. The esters of these acids seem to be more soluble in the wax of the leaf epidermis than are the salts, possibly one of the reasons why Dow's "Brush Killer" is more effective, especially in rainy weather.

As a dormant spray, 2 pints of "Brush Killer" were mixed in 10 gallons of kerosene and sprayed on brush March 25, 1949. The brush was not over 4' tall, but it included poison ivy, ash, red and sugar maple, blackberry, raspberry, dewberry and gray birch. All this brush failed to grow in the spring of 1949, and it was apparently completely killed. Brush in ground immediately adjacent, and not sprayed, grew vigorously.

In extensive spraying operations with "Brush Killer" during 1950 at our Case
Estates in Weston, many plants were killed, most of them apparently within two days after spraying. Poison ivy was entirely killed where it grew in the shade, with one spray applied June 2, 1949, and in another plot, on June 2, 1950. Even *Polygonum cuspidatum*, a vicious weed once it is established, was killed when sprayed June 9, 1950. Other woody plants killed in the 1950 experiments were American ash, red and white oak, red maple, American linden, gray and paper birch, black cherry, willow, smooth and staghorn sumac, elderberry, meadowsweet, Virginia rose and brambles. Of these, the only plant in our experiments which showed much resistance was the American ash.

**Results:** Dow’s “Brush Killer,” applied at recommended strengths, is an effective woody plant killer. It has killed most of the actively-growing brush on which we have sprayed it—brush seldom over 6-8’ tall, and usually much smaller. When applied on a sunny day, the usual effect is a drooping of the leaves a few hours after application. It must be particularly noted that all applications were made on suckers that were growing vigorously. The one serious danger in using “Brush Killer” results from “drift,” for, if applied on a windy day, the spray can be easily blown some distance and can severely injure plants. In fact, the odor of “Brush Killer” is noticeable in the vicinity days or even weeks after application, and I am inclined to believe that the very small amount in the atmosphere (as evidenced by that odor), can injure overly susceptible plants.

Because of this feature, care must be taken when using it near valuable plants, especially if it is known in advance that they are susceptible.

A list of plants (not over 6-8’ tall) that were killed with Dow’s “Brush Killer” follows:

- Acer negundo
- "rubrum
- "saccharum
- Amelanchier canadensis
- Aronia arbutifolia
- Berberis vulgaris
- Betula papyrifera
- "populifolia
- Bocconia cordata
- Carya ovata
- Castanea dentata
- Cornus florida
- "racemosa
- Crataegus – many species
- Fagus grandifolia
- Fraxinus americana (but some resistant)
- Hicoria ovata
- Malus sdig. of many species
- Parthenocissus quinquefolia
- Polygonum cuspidatum
- Populus tremuloides
- Prunus serotina
- "virginiana
- Quercus alba
- "rubra
- Rhus – several species
- Robinia hispida
- "pseudoacacia
- Rosa virginiana
- Rubus species
- Salix species
- Sambucus canadensis
- Sassafras albidum

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The sodium salt of trichloroacetic acid (popularly termed "T. C. A." in the trade) is much easier and safer to use than the acid itself. It was first suggested a few years ago as a weed killer, and has been available for this purpose since 1949. First experiments in the Arnold Arboretum were undertaken in 1949 when 60% "T. C. A." was used at the rate of 1 lb. per gallon of water and sprinkled on weeds and witch grass in several places at the Case Estates in Weston, as well as between the vines along the Arborway wall in the Arboretum. Applications were made in some areas July 1, 1949, and in others September 1, 1949. In all instances the grass (witch grass, Kentucky Blue, Red top, Orchard grass and Timothy) was brown and dead the next day, and no perennial grasses have come up in these treated plots for a year. A few annual weeds have grown, but they undoubtedly have seeded-in since the original spraying was done.

Unlike the chlorates or arsenites, there is no long-term soil sterilization, since soil can be taken sixty to ninety days after "T. C. A." is applied, and seeds of vegetables can be quickly and normally germinated.

On May 5, 1950, 10% "T. C. A." was applied (1 lb. dissolved in 1 gallon of water) to witch grass growing beneath overhanging branches of Prunus maritima plants about 3' tall. The grass was completely killed in three days. No damage to the plants was noted until June 13, when some of the leaves began to turn color, dry up and fall off. One or two bushes were apparently killed. Several sent out a new set of leaves by July 7, 1950. Absolutely no "drift" hit the branches. The same treatment was given witch grass under Malus sikkimensis plants about 6' tall. Here again the grass was killed at once and although the trees showed no apparent injury they failed to grow any more for the rest of the season.

"T. C. A." (70%, 1 lb. per gallon of water) sprayed on lilac suckers 3' tall, quickly killed the suckers. Within two weeks the tops of the original 12' plants were dying. No "drift" reached them. Apparently the material was translocated from the injured suckers to the tops of the plants. The material also was sprayed on lilac trunks, wetting the bark, but no injury to the tops occurred within three months' time.

Rubus was not entirely killed in the shade (only about 95% kill was obtained), but in the sun nearly perfect kill was obtained.

**Results:** Nearly complete kill on everything in the shade, and excellent kill on all woody weeds in the sun was obtained by using "T. C. A." in this strength. Others have stated that the sterilizing effects in the soil last only sixty to ninety
days, depending upon the type of soil and the amount of moisture in it. Because of its action on *Prunus maritima*, when the material did not touch the plant foliage, and on lilacs, when it was apparently sprayed only on the foliage of suckers and then translocated to the tops of 1½ stalks at least 6' away from the point of application, it would seem that this is a dangerous material to use in the vicinity of valuable woody plants. It is the most expensive of the materials here discussed (figured on an area-of-application basis). It is caustic to the skin if left on for a period, but is not seriously poisonous.

**Hop Mulch As A Weed Preventative**

Spent hops have been used in the Arnold Arboretum since 1946. This is the best material we have found for suppressing weeds around plants, while at the same time it acts as a mulch that is resistant to fire. Many mulches burn readily and are impractical in a public place such as the Arboretum where the danger of fire among valuable plants is a very real one. Applied as a 4 to 6" mulch around plants, hops are merely stirred every month or so with a fork, if weeds grow through them. There have been examples in the Arboretum where this was not necessary until the second year after application. They are very acid, and probably should not be applied to lime-loving plants. We apply them to plants directly as they come from the brewery. The only precaution taken is to keep them 6" away from the trunks or bark of plant shoots, for, on hot days, the temperature of these wet hops can easily be raised to such a high point that they may kill any living plant tissue with which they come in contact.

**SUMMARY**

DuPont's "Ammate" has proved successful (used at the rate of one pound per gallon of water) for killing brush, broad-leaved herbaceous weeds, grass and poison ivy.

Dow's "Brush Killer" (half "2-4-D" and half "2,4-5-T") has proved effective in killing brush under 6 to 8' in height in one treatment, when applied while the plants are still in active growth at the rate of three quarts per one hundred gallons of water.

Dow's "T. C. A." has proved effective in killing brush, poison ivy and grass in one application.

"Ammate" does kill grass as does "T. C. A." "Brush Killer" does not. The latter is only one half as expensive (estimated on area-covered basis) as "Ammate," which in turn is only one half as expensive as "T. C. A.," can be slightly dangerous and can cause some skin irritation to the operator if it gets on the hands, face, or in the eyes. The mist or drift of "Brush Killer" can cause injury to other plants some distance away, unless properly applied on a quiet day.

Poison ivy in sun or shade can be killed by all three materials if applied during the active growing season. Sometimes a second application is necessary late
in the summer. We have completely eradicated large areas in this way, but from an economic point of view, "Brush Killer" is cheapest.

"Sovasol" (costing about the same as "Ammate") is excellent for spraying on grass and young herbaceous weeds (a few inches high), quickly killing them to the ground within a few hours. Small weeds are entirely killed — grass is killed only to the ground. Brush is slightly injured and very poor killing results have been obtained on poison ivy. Because of "Sovasol's" rapid action, the work of the operator can be quickly checked. This material is highly volatile, and the drift is not seriously troublesome to plants in most cases.

"T. C. A." can be highly destructive to plants, especially when merely sprayed on the grass under spreading branches. It is apparently quickly absorbed by the roots of plants and may damage tall lilacs, for instance, when it has only been sprayed on a few surrounding suckers. "Brush Killer" and "Sovasol" are not as destructive when used in this manner, although there is always the danger of injuring valuable plants when such spraying is done near them.

Present indications are that the transportation of "2-4-D" (and also "2-4-5-T") in plants is similar to that of the translocation of carbohydrates. When plants are more difficult to kill in the shade than in the sun it would seem that in the sun there is greater photosynthetic activity, hence a greater translocation of carbohydrates. In the shade, there is less photosynthetic activity and less translocation of carbohydrates, hence less movement of "2-4-D," resulting in less effective killing. In hot, dry spells during the summer months, the translocation of carbohydrates toward the storage organs may be at a minimum in certain plants, hence killing plants with "2-4-D" at this time has not been as complete as it has been earlier, when the translocation of carbohydrates from the leaves to the roots was more pronounced.

To summarize, Dow's "Brush Killer" is the cheapest material for eradicating most types of brush (under 6 to 8' tall) when applied before the end of the growing season, or about mid-June. However, there is always the danger of drift injury to other plants. "Brush Killer" will not kill grass.

DuPont's "Ammate" will also kill brush and poison ivy as well as witch grass. There is little drift injury, action is often quicker than with "Brush Killer," but the cost is twice as much.*

Dow's "T. C. A." is also an effective killer of brush, poison ivy and witch grass, is slightly dangerous to the operator and costs (at present) four times as much as "Brush Killer." It should be kept away from the roots of valuable specimens.

Other materials which we have used for eradicating brush and poison ivy (including sodium arsenite, sodium chlorate, "2-4-D" used alone, borax, kerosene, burning, etc.) are not as practical nor as effective as the above materials.

*Note: One serious effect of "Ammate" has just become evident in our 1950 experiments. The foliage of poison ivy was sprayed under pine trees 6' in diam-
eter, during early summer. The soil was not soaked — merely enough spray was applied to moisten the foliage. Within three weeks all of the foliage on several 33' pine trees was dead. As soon as this was noted, the experiment was repeated, with the same result. The destructive effect on white pines, at least, during a drought period, is serious. Hence, "Animate" should never be used under pine trees.

DONALD WYMAN

Note: At the national convention of the American Association of Nurserymen, held this summer in Washington, D.C., Dr. Donald Wyman was presented with the first Norman Jay Colman Award. This commemorates the name of a former prominent nurseryman who was also Secretary of Agriculture (1889) and is to be given annually to stimulate "horticultural progress through research." The committee selecting the winner was composed of five Experiment Station Directors and was awarded for the research work in ornamental horticulture which went into the preparation of the book SHRUBS AND VINES FOR AMERICAN GARDENS, published in 1949.