

Winter 2-1962

Bulletin No. 13: What's Happening Along Our Roadsides?

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Goodwin, Richard H., "Bulletin No. 13: What's Happening Along Our Roadsides?" (1962). *Bulletins*. Paper 16.
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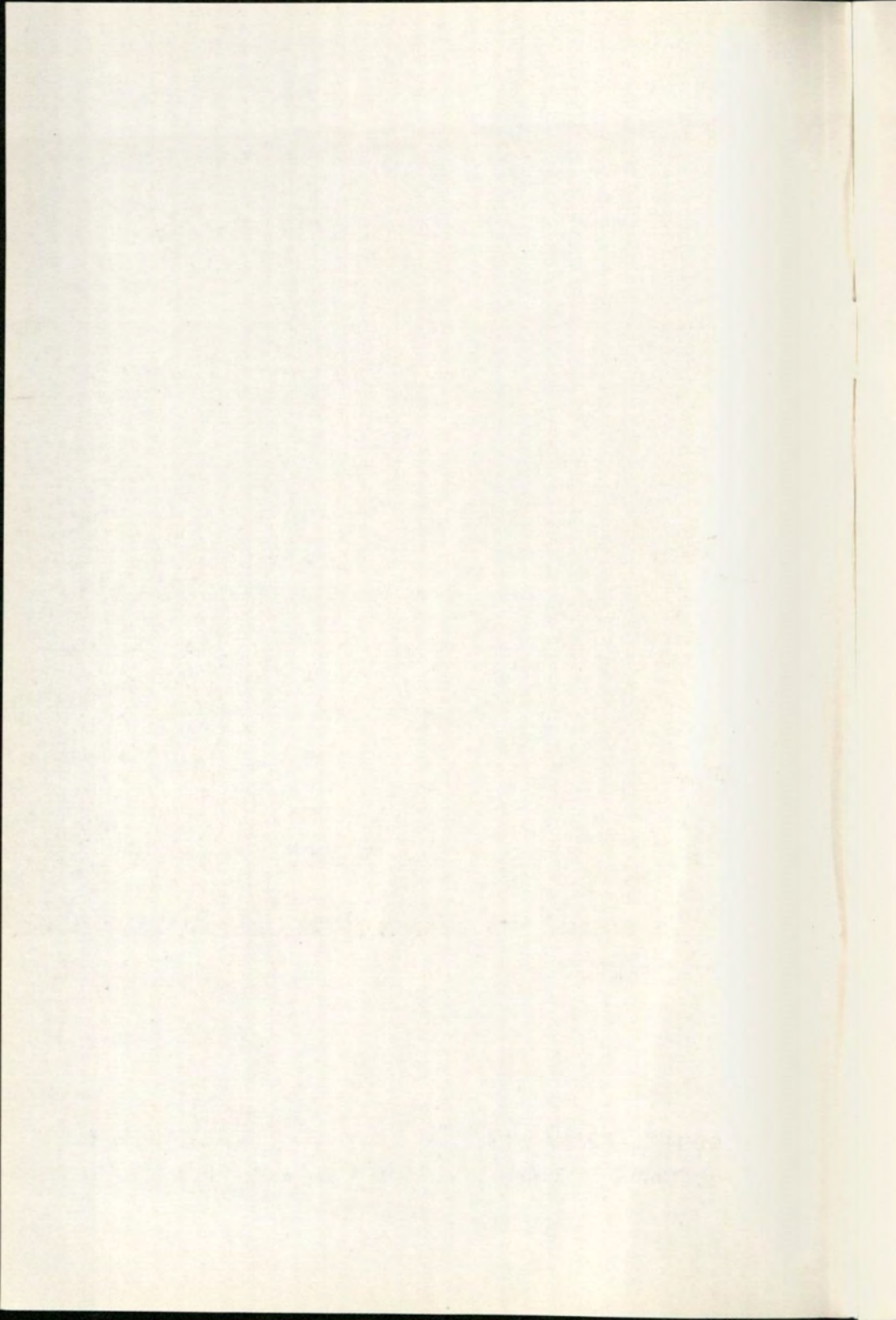
WHAT'S HAPPENING ALONG OUR ROADSIDES?



EFFECTS OF AN UNSELECTIVE STEM-FOLIAGE APPLICATION IN LITCHFIELD, CONNECTICUT

THE CONNECTICUT ARBORETUM
CONNECTICUT COLLEGE

BULLETIN No. 13
NEW LONDON, CONNECTICUT



THE CONNECTICUT ARBORETUM

BULLETIN NO. 13

FEBRUARY 1962

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Foreword

IN RESPONSE TO a growing concern in the State for the defacement of our beautiful roadsides by the indiscriminate use of herbicides, the Shade Tree Committee of the Connecticut Forest and Park Association established a special subcommittee to study this problem and to prepare recommendations for the guidance of the various agencies involved in the maintenance of Connecticut's roadsides. A series of meetings of the subcommittee were held during 1959 and 1960 at which the problem was thoroughly discussed. Recommendations were finally prepared, which received the approval of the Committee, although there may have been reservations as to certain details in the minds of some members of the Committee. These recommendations appear on page 10 of this bulletin.

The preferred methods of herbicide application are the stump and basal treatments. Tall woody growth is cut and the stubs promptly sprayed with herbicides; lower stems, less than four feet in height, are sprayed, preferably in winter, at or near the base with a strong formulation. The stem-foliage technique is the cause of the unsightly brown-outs, a good example of which is shown on the front cover. The technique is not nearly as effective in eliminating the undesirable woody species in most instances. It is interesting to note that the Northeastern Forest Experiment Station of the U. S. Forest Service has, after years of research, reached the same conclusion. Indeed, the Forest Service today relies mainly on the selective basal technique along the forest roads in the national forests of the northeast. An article by McQuilkin and Strickenberg outlining the Forest Service findings has been included here for easy reference.

Eighteen months have now elapsed since the recommendations of the State Shade Tree Committee have been in the hands of all the town selectmen, highway personnel and the public utility companies in Connecticut. It seemed appropriate to us at this time, therefore, to ascertain to what extent the Committee's recommendations were being adopted. To this end a questionnaire was prepared and sent out. The responses to the questionnaires have been prepared in tabular form and are available from my office upon request. We would like to acknowledge with thanks the cooperation of over fifty people who have provided us with information.

In this bulletin we have attempted to summarize what has actually been taking place along Connecticut's roadsides since June 1960. It seems evident that the Shade Tree Committee's recommendations have thus far had little impact upon maintenance practices. An attempt has been made (1) to evaluate the reasons for this failure and (2) to set forth some suggestions for local action.

Richard H. Godwin
Director

Brush Control In Practice On the National Forests¹

WILLIAM E. MCQUILKIN AND L. R. STRICKENBERG

Northeastern Forest Experiment Station, Upper Darby, Pennsylvania

THE SEVEN national forests in Region 7 maintain about 1,700 miles of road. The original plan for conversion from annual mowing to chemical brush control on all national forest roads called for a gradual change-over in 5 years, beginning in 1956. As of 1959 one forest—the George Washington—had completed the change-over, all their roads having been sprayed at least once. The other forests, now in various stages of transition, are expected to have all their roads under chemical control, as scheduled, by July 1961.

One of the crucial tests of a new method for doing any job is its acceptance by the people who actually apply or use it. On the national forests, use of chemicals for controlling roadside brush has passed this test with flying colors. True, some of the men at first have been hesitant to make the change either because of inertia, or fear of adverse public opinion, or because of sentimental admiration for the groomed look that mowing temporarily confers upon a roadside. But after a year or two of experience with spraying, these attitudes have usually changed. Most national forest personnel with whom we have discussed the subject, from supervisors down, are sold on chemical brush control. Particularly impressive has been the unprompted enthusiasm displayed by several of the road-maintenance foremen.

ADVANTAGES OF THE CHEMICAL METHOD

1. *Spraying Is More Economical.*—The average cost of mowing prior to 1956 was about \$16 per year per mile of road. The average initial cost per mile of road for selective oil-basal spraying is about \$45. But one properly done chemical treatment is good for at least 5 years; thus the cost per year is \$9, whereas the \$16 mowing job must be done every year. On this basis, chemicals can be expected to reduce brush control costs by more than 40 per cent. Actually, some of the earlier spray jobs are holding so well that our estimated 5-year treatment interval appears to be very conservative: except where black locust is abundant, we believe, many roads will hold as long as 8 years or more without re-treatment—with proportionately greater savings in maintenance costs.

Moreover, the capital cost of spray equipment is considerably less than

¹ Reprinted by permission from Station Paper No. 148, Northeastern Forest Experiment Station, U. S. Forest Service, Region 7, Upper Darby, Pa. 24 pp. 1961.



Fig. 1. A road on the George Washington National Forest two years after spraying in 1957. Shelf construction along a slope, with bank on one side and drop-off on the other, is typical of many forest roads. With selective oil-basal spraying, the bank remains stabilized under herbaceous cover.

that of mowing equipment, maintenance costs for spray equipment are lower, and less time is lost from breakdowns. Although these items are reflected in the per mile costs cited above, they merit special mention.

2. *Spraying Is Easier Work.*—Driving a power mower is a trying job, as the operator must be ever vigilant in maneuvering his machine along sloping road shoulders, avoiding rocks, ditches, and other hazards. In addition to the machine mowing, it is necessary to do considerable hand cutting with scythes and brush-hooks, and occasionally with axes and saws, in clearing around guard rails and culvert heads, and in 'daylighting' curves in the road.

Spraying is a much more relaxed type of labor. The truck driver moves slowly down the middle of the road, and the physical demands upon the nozzle-men are light compared to scythe and brush-hook work. Spraying

with the backpack outfits of course is more laborious, but ordinarily this is required only intermittently and thus does not become burdensome.

3. *Spraying Permits Greater Flexibility on the Job.*—Mowing usually has been limited to one swath of 5 or 6 feet; to cut back farther requires a second pass and practically a doubling of the costs for the mileage so treated. Spraying, on the other hand, can be varied to fit the situation from spot to spot: 3 or 4 feet may be adequate here; 8 or 10 feet clearance may be desirable there; and on curves treatment with the power outfit can be extended 20 to 30 feet from the road edge— and farther, if necessary, by use of hand sprayers.

4. *Spraying Permits Greater Flexibility in Work Programming.*—Mowing is limited to a period of 2 months or so in mid and late summer. Because of the necessity to get over all the roads in a limited time, the job exerted a relentless pressure on the responsible foremen each year. But oil-basal or stump spraying can be done at almost any time when the ground is free of snow. And if a spray job scheduled for one year has to be postponed until the next year, no significant complications will ensue; the crews simply will have to cover a little more mileage the next year. So, under chemical control, it is much easier for maintenance men on the forests to balance their work programs and to adjust them as conditions may require.

RECOMMENDATIONS²

Methods of Treatment

As a general policy for controlling brush along established roads on eastern forests, selective basal spraying with low-volatile 2,4,5-T ester in oil at a concentration of 12 pounds ahg is recommended. When new roads are built, the same herbicidal solution may be used as a stump spray immediately after the original or capital clearing. If a neglected or abandoned road, bordered by dense, tall brush is to be renovated, such brush should be cut and the stumps treated as on capital clearings.

All oil-basal spraying on either standing stems or stumps should be rigorously selective. Treat only undesirable species; cut off the spray when moving from one stem or stump to the next; save as many herbs and low-growing shrubs as possible, not only for aesthetic reasons, but also because these plants stabilize the soil, furnish food for wildlife, and inhibit the re-establishment of undesirable woody species. In further deference to aesthetic values, scattered specimens of the taller ornamental species, such as dogwood, redbud, laurel, and holly, may be left wherever they will not constitute a nuisance.

²See also: Roadside spraying with chemicals—Manual for Foremen. U. S. Forest Service, Region 7, Upper Darby, Pa. 22 pp. 1959.

Water-foliage spraying is suggested as an alternative method for those occasional situations in which the predominant species are controlled about as well by one method as the other; such species include alder, all birches, sassafras, sumac, black locust, and yellow-poplar. By using the water-foliage method, modest savings in material costs are possible. However, roadsides on which only sensitive species occur will be encountered so seldom, or over such short stretches, that spray crews ordinarily will not find it worth while to change methods.

If a water-foliage spray is to be used, the recommended mix is 4 pounds ahg of low-volatile 2,4,5-T ester in water, or in a 10-per cent oil-in-water emulsion. The addition of oil is suggested particularly for any foliage spraying done toward the latter part of the growing season. Formulations of 2,4,5-T designed especially for use in oil-water emulsions are available; however, with agitation, the regular formulations can be used. For best results in foliage spraying, use pressures of 150 PSI or more, and completely wet all foliage and stems.

Proper Chemicals

Only the low-volatile esters of 2,4,5-T should be used. For use on the national forests, chemicals must meet Federal Specifications 0-H-210a for Type II, which designates the liquid ester form of 2,4,5-T, and Class 2, which designates esters of low volatility. We do not recommend use of mixtures of 2,4-D and 2,4,5-T on the usual run of eastern forest species.

The oil used in our work has been mostly diesel oil, and we have made no comparisons with other oils. However, according to manufacturers' labels, No. 1 and No. 2 fuel oil, and kerosene are equally as good as diesel oil.

Crew Training and Proper Application

Thorough training of spray crews is important. Most instances of poor or mediocre results in our roadside spraying can be charged to inadequate training of crew members. Foremen and nozzlemen must know the common woody species—the ones to treat and the ones to save. Moreover, they must be able to recognize these species both in leaf and in dormant condition, as oil-basal spraying may be done at any season when the ground is bare of snow. Second, the crewmen must appreciate the importance of thorough application, and be conscientious enough to do the job right. Thoroughness means soaking every stump or stem base so copiously that the root collar zone, which may be several inches beneath the surface of the litter, is completely wetted. Particularly on the more resistant species, such as maples and ash, failure to wet this zone leaves dormant buds uninjured and capable of generating new sprouts. Well-trained, careful nozzlemen recognize that certain species are harder to kill than others, and treat resistant ones somewhat more intensively.



Fig. 2. A power sprayer, converted from a standard model fire-control pumper, in use on a road on the Monongabela National Forest. The poles hold surplus hose off the ground and out of the way when spraying close to the truck, as shown here. When the full length of hose is needed, it is readily available.

Re-treatment

It has been stated above that most properly treated roads are expected to stand at least 5 years between treatments, and that some roads might stand several years longer. No doubt there will be much variation from one piece of road to another, depending upon soil characteristics, topographic position, aspect, species composition of the bordering forest, and canopy development over the roadway. Possibly there will be differences between the northern and southern forests of the Region. Obviously 5 years is only a tentative estimate of about how long most roads might stand between treatments. In practice on the forests, maintenance foremen simply will watch their roads and schedule retreatment as it becomes necessary, be it 5 years, 7 years, or any other interval.

Retreatment, when it becomes necessary probably will be a lighter job on most roads than the first treatment. So far, we have only one good comparison of a retreatment job versus the original treatment: On the George Washington National Forest, a 13.6-mile road that was first sprayed early in 1956 was resprayed, after 5 growing seasons, late in 1960. The original brush was a heavier-than-average growth of mixed oaks; 100 gallons of herbicide were used per mile, and the cost per mile was \$58.50. In 1960, the brush density was considerably less, as evidenced by use of only 59 gallons of herbicide per mile. Despite some-

what higher unit costs for both labor and materials, the retreatment was done for \$34.50 per mile.

The retreatment question generally will arise soonest on those roads where considerable black locust is present. There doubtless will be situations where the locust will require attention several years before associated species have made much comeback. For such situations we suggest consideration of a light, touch-up treatment, which mostly would be restricted to the larger locust stems, and could be done fairly quickly and cheaply by a 2- or 3-man crew cruising the roads in a light truck and carrying only back-pack sprayers.

In this connection, some simple administrative tests of other chemicals on black locust are recommended. Aminotriazole, in particular, applied as a foliage spray, has been reported to kill the stems of locust and to suppress sucker regrowth markedly better than 2,4,5-T.³ If the established locust root systems actually could be killed, it probably would be 10 years or so before locusts from seed regeneration again would become a special problem.

SUMMARY

Because of the excessive costs of mowing the 1700 miles of road each year on the seven national forests in Region 7, tests of chemical methods of brush control were started in 1951 and continued on five forests through 1955.

Results of the tests indicated that roadside brush could be satisfactorily controlled by an oil-basal spray of 2,4,5-T, selectively applied, and that the costs would be less than for annual mowing.

In 1956, a 5-year program for converting entirely from mowing to chemical control on all Region 7 forests was started. One forest completed the conversion in 1959; the others are expected to finish on schedule by July 1961.

During the testing period and since, relatively simple modifications of standard-model slip-on fire pumpers have been perfected for converting the pumpers into power sprayers. Since the pumpers can be converted from one use to the other in a few minutes, only a small investment in spray equipment is required. Back-pack sprayers, also somewhat modified from production models, are used to supplement the power outfits.

Experience to date indicates that most properly sprayed roadsides can stand at least 5 years, and often longer, before retreatment will be required. With a 5-year interval, brush control costs with chemicals are averaging about 40 per cent less than costs for mowing.

³ Jeffers, W. A. Late-season foliage applications of amino-triazole and amino-triazole-benzoic combinations on black locust. Northeast. Weed Control Conf. Proc. 14: 383-392. 1960.



Fig. 3. Above: Back-pack sprayer of the type used in Region 7. Manufacturer's hose, wand, and valve assembly have been replaced by higher quality, better designed equipment. Side lever is on opposite side of tank in this view. Below: Back-pack sprayer in position for use. Lever is grasped by man's right hand.

Recommendations for the Use of Herbicides In Controlling Undesirable Vegetation Along Town Roadsides In Connecticut

THE SHADE TREE COMMITTEE OF THE CONNECTICUT FOREST AND
PARK ASSOCIATION¹

General Recommendations

Undesirable vegetation, primarily tree growth, poison-ivy, etc., should be removed along roadsides whenever it creates a safety or health hazard, or whenever removal is necessary for the maintenance of utility lines. Along straight stretches of town roads where there are no utility lines a narrow mowed strip on either side of the road is necessary for the safety of pedestrians and motorists. Beyond this mowed strip, desirable shrubs and low growing trees should be preserved. On curves and where there are utility lines present, removal of trees and tall shrub growth is necessary for a considerably greater distance back from the travelled portion of the road. Low growing shrubs that will not interfere with sight line or utility installation, should be allowed to remain.

Herbicides can assist greatly in the economic control of undesirable vegetation. In many instances they can be used by maintenance crews in conjunction with other work. The type of chemical treatment depends to some extent upon the existing problem. Before starting any program the needs of the roadsides in each town or area should be surveyed. The appropriate treatment should be planned after the survey is made. Recommended techniques are given below.²

A. Stump Treatment

This is a very effective and desirable technique and should be used generally in conjunction with all cutting operations. It involves cutting trees and other undesirable growth and treating with herbicide immediately

¹ The following institutions and agencies participated in the formulation of these recommendations through representatives appointed to a special sub-committee: Connecticut Agricultural Experiment Station, Connecticut Arboretum, Connecticut Forest and Park Association, Connecticut Light and Power Co., Federated Garden Clubs of Connecticut, Hartford Electric Light Co., Southern New England Telephone Co., State Highway Department, University of Connecticut Cooperative Extension Service.

² For a detailed discussion of these methods see Bulletin No. 624, Connecticut Agricultural Experiment Station, New Haven, Conn. pp. 32. 1959.

before or after cutting. This method is effective in preventing resprouting and avoids "brown-out" and unsightly standing dead stems. Since only treated stumps are killed, the ultimate in selective treatment can be achieved. The following formulation is effective:

- a. 2,4,5-T low volatile esters at 8 to 16 pounds of acid equivalent per 100 gallons of spray in fuel oil, diesel oil or kerosene.
- b. 2,4-D plus 2,4,5-T low volatile esters at a combined acid equivalent of 12 to 16 pounds per 100 gallons of spray in fuel oil, diesel oil or kerosene.

The spray is directed at the cut surface of stumps, on all sides and at the root collar or crown, which lies at or just below the ground line, so as to drench the stump and root crown. The spray should be applied immediately after cutting. If this is impractical, it may be delayed up to three days although this is not recommended. In some cases, particularly if small trees are involved or excessive debris makes locating stumps difficult the stump spray may be applied before cutting. Rundown to the root crown is important and stump spray should never be tried if the stumps are covered with water, ice or snow. Stump treatment with 2,4,5-T may be applied during any season of the year. Including an oil soluble dye in the spray mixture would enable one to tell which stumps have been treated. Regrowth from treated stumps can be sprayed the following season, using stem-foliage or basal methods.

B. *Basal Treatment*

Basal treatment involves the application of herbicides to the base of standing woody vegetation. It is recommended for use on smaller growth (4') and on regrowth from previous cutting and stump treatments. Basal sprays are very effective and can be applied just before cutting to avoid missing smaller stems, as is often the case in stump applications. Basal treatments are relatively ineffective for use on trees over 3" to 4" in diameter and are not recommended for use on tall growth which will prove unsightly if left standing. Basal sprays, being oil borne have a tendency to kill grasses and ferns, thus when brush and sprouts are dense, great care must be exercised to confine the spray to the stems and root crown or a "scorched earth" appearance will result the following year.

The same formulations as for stump treatment are used.

The spray is directed at all sides of the stem to a height of 15" to 20" and to the base of the plant. It is important to get rundown at the root collar. Basal treatment can be applied during any season of the year, but should never be used when the stems are covered with water, snow, or ice. For the control of root-suckering species such as sumac and sassafras summer basal sprays are most effective. All danger of damage to sensitive crop plants adjacent to sprayed areas can be avoided by treating before

planting or after harvesting the crops. On the other hand, desirable species are more readily identified when the plants are in full leaf.

C. *Stem-Foliage Treatment*

Stem-foliage sprays should be used for killing poison-ivy as well as for dense stands of undesirable growth where basal treatment is impractical. The misuse of stem-foliage treatments in the past has led to serious consequences. Therefore, great care must be used in applying stem-foliage sprays. They present more of a hazard to susceptible plants by drift and volatility than stump or basal treatments and are more difficult to use selectively.

To permit maximum selectivity, equipment should be adapted to spray only the undesirable growth. Undesirable vegetation exceeding 4 feet in height should be cut and the stumps treated. Undesirable woody growth less than 4 feet tall may be treated by either basal or stem-foliage methods depending upon the density of growth and the nearness of susceptible ornamental or crop plants.

The recommended materials for use in stem-foliage sprays are the low volatile esters or amine salt formulations of 2,4-D plus 2,4,5-T at 6 to 8 lbs. combined acid equivalent or 2,4,5-T alone at 4 to 6 lbs. acid equivalent per 100 gallons of spray in water. These herbicides will not destroy sedges and grasses.

Stem-foliage sprays are most effective when applied during the early summer, but the resulting brown-out is pronounced over a longer period. The preferred practice from the aesthetic standpoint is to apply stem-foliage sprays from August to early September, just before natural autumn coloration begins. At this time, brown-out by foliage sprays will be much less objectionable.

For maximum kill, foliage sprays should wet stems of foliage to run down. Desirable shrubs should not be sprayed. Special precautions should be taken to avoid hazards of volatility and drift.² On roadsides adjacent to susceptible ornamental plants or crops, stem-foliage sprays are recommended only with nonvolatile materials such as ammonium sulfamate or amino triazole. In these areas, however, basal or stump treatments should be considered because ammonium sulfamate or amino triazole compounds are nonselective and kill all vegetation including grasses, causing unsightly brown-out. For a list of desirable plants native to Connecticut and the tolerance of various plants to foliage sprays of 2,4-D and 2,4,5-T, see Bulletin 624.²

D. *Other Methods*

Fenuron pellets are not recommended for use along roadsides because desirable trees and shrubs with roots growing into the treated areas will be killed or injured.

What is Happening Along Connecticut's Roadsides?

RICHARD H. GOODWIN AND WILLIAM A. NIERING, *Connecticut College*

IN RESPONSE to a questionnaire sent out by the Connecticut Arboretum in the fall of 1961 concerning the nature of herbicide practices along Connecticut's roadsides during the past two growing seasons and from other sources, information has been received from 93 towns—over 55 per cent of all those in the state. Eighty-one towns reported using these chemicals. The objectives of the herbicide applications may be roughly classified into four major groups: control of poison ivy in heavily settled areas, 6; roadside maintenance in rural areas, 62; removal of trees under utility lines, 18; cooperative arrangements between the towns and utilities for road maintenance and removal of trees under the lines, 5. This breakdown is a considerable over-simplification of the situation, but will serve to point up some of the complexities of the problem. Twelve towns have not been using herbicides during the past year or two. We surmise that quite a number of the other towns not heard from may also be in this category.

Six municipalities have been employing the stem-foliage technique to control poison ivy. Of the remaining 75 towns, 62 *have apparently been using stem-foliage applications exclusively*; 6, stem-foliage with some stump or basal sprays; 3, stump treatments only; and 4, basal techniques only. It is worthy of note that of the 62 towns in which stem-foliar applications were reported, the data revealed *only two applying them selectively* as stated in the recommendations of the Shade Tree Committee (see page 10).

Non-selective stem-foliage sprays are being widely used, instead of a selective approach, emphasizing the basal and stump techniques. In addition to indiscriminate applications, the undesirable roadside vegetation has been reported sprayed to a height exceeding four feet in 20 towns, contrary to the Shade Tree Committee's recommendations. These specify that growth exceeding four feet in height should be cut and stump-treated.

The Town Aid spraying involved 48 towns in 1961 and several others treated the year before. No reports indicating satisfaction from the herbicide operations were received. Some of the comments on the questionnaires are pertinent: Newington—"inconspicuous . . . was not considered successful in controlling growth of weeds;" Bethlehem—"not satisfied with results;" Essex—"unsightly;" Middletown—"unsightly . . . 1000 feet multiflora rose 6 feet in height . . . now appears 90% destroyed." Six towns responding to the questionnaire expressed dissatisfaction with

the results obtained with the Town Aid stem-foliage program. Four of these towns are discontinuing such treatments, whereas two are apparently planning to continue, despite the poor results. Therefore, it would appear that this program has resulted in inadequate control of unwanted vegetation, has disfigured the roadsides and has destroyed desirable species. Similar reports come from towns which have carried out their own stem-foliage spraying or have had it done by a private contractor.

The data indicate that the utilities are also employing indiscriminate stem-foliage sprays, although four towns report selective basal or stump treatments, and another, a selective stem-foliage approach. In Salisbury the treatment was termed indiscriminate. In Coventry tree growth was sprayed to a height of 8 feet and even up to 12 feet in some places. Encouraging reports from Columbia, Greenwich, Old Lyme and Stafford indicate that the utilities in these towns are using the basal or stump techniques.

It is revealing that the 12 reports concerned with selective basal or stump treatments indicated no damage to desirable vegetation and good control of unwanted species, except in one town where a utility misused the technique in spraying desirable shrub cover. The two towns that adopted a selective cutting and stump treatment reported satisfactory results.

The resumes by counties which follow attempt to document specifically the types of spraying which have been reported. Following these there is a final statement which summarizes the dilemma and outlines a positive course of action.

FAIRFIELD COUNTY

Reports from ten towns indicate that all of them have instituted herbicide programs. In every case pertinent information was provided by persons responsible for the work. At least nine towns were using stem-foliage applications—Darien, Fairfield, and Ridgefield for poison ivy control; Stamford and Stratford for the control of "obnoxious weeds;" Brookfield, Danbury, Trumbull and Wilton for roadside maintenance under the Town Aid Program. In Ridgefield many complaints were made about the unsightly and destructive nature of an indiscriminate 1960 application, and the town was requested to use stump treatments only.

In Greenwich stump treatment was the only method of application reported. The purpose was to clear woody growth underneath utility lines. This work was done by arborists under contract to the Connecticut Light and Power Co. It is perhaps significant that Greenwich has, through the years, been outstanding for its progressive street tree and planting program.

HARTFORD COUNTY

Fifteen out of the eighteen towns reporting have been using herbicides along their roads. All of these employed the stem-foliage technique. West Hartford sprayed for poison ivy control; Canton, Manchester and Glastonbury, to clear woody growth under utility lines; Bloomfield, to control undesirable growth as part of the town's roadside maintenance program. Avon, Bristol, Enfield, Marl-

borough, Newington, Plainville, Rocky Hill, Simsbury, South Windsor, and Southington had their roads sprayed by McMahon Bros. under the Town Aid Program.

In Newington the last treatment (in the Spring of 1960) "was not considered successful in controlling growth of weeds," and present plans "call for repeated treatments in the spring and fall of 1962."

In Glastonbury, where a stem-foliage application was jointly sponsored by the Southern New England Telephone Co. and the Connecticut Light & Power Co., the treatment was described by one of the utility officials as "conspicuous, but not unsightly," and desirable shrubs and wildflowers not sprayed were listed. An independent observer, on the other hand, reported that the vegetation had been sprayed up to a height of seven feet and that woodland shrubs and wildflowers were unnecessarily treated as much as 25 feet away from the wires.

Bloomfield and Canton reported using basal and/or stump treatments in 1961, but have used stem-foliage spraying in the past. Simsbury was the only other town reported as using the basal technique on any of its roadsides.

LITCHFIELD COUNTY

The roadsides of twelve out of the nineteen towns reporting have received herbicide treatments, all but one of these stem-foliage (Bethlehem, Colebrook, Cornwall, Goshen, Harwinton, Litchfield, Morris, New Milford, North Canaan, Norfolk, Salisbury, Torrington). In six cases the treatments were done under contract for the utilities—Connecticut Light & Power Co., Hartford Electric Light Co., and/or Southern New England Telephone Co. (Cornwall, Salisbury, Torrington), or by the towns with materials supplied by the utilities (Goshen, Harwinton, Litchfield). Four towns (Colebrook, New Milford, North Canaan, Torrington) were sprayed by McMahon Bros. under the Town Aid Program. In five localities the vegetation was reported sprayed to a height in excess of four feet. In Salisbury the spray contractor for the utilities (Hartford Electric Light Co. and Southern New England Telephone Co.), was not granted permission to spray by the town authorities, but went ahead anyway.

In general, these stem-foliage treatments were reported unsightly and indiscriminate—a most unfortunate situation in one of Connecticut's most scenic counties. One case of improper herbicide application, contracted by the Southern New England Telephone Co., occurred in one of the State Park picnic grounds on Mohawk Mountain, where azaleas and mountain laurel were sprayed.

The only towns reported as using stump treatments were Litchfield and Norfolk. In the latter town this method was used almost exclusively, but unfortunately, unnecessary damage to the vegetation resulted from an over-enthusiastic clearing program.

An encouraging note comes from the Roxbury-Bridgewater Garden Club. Its president writes, "We have had a meeting with power company representatives and the two towns' first selectmen to advise them of our interest in selective spraying. Their agreement seemed genuine."

MIDDLESEX COUNTY

Out of nine towns, all have reported stem-foliage applications. These treatments were part of the roadside maintenance programs of the towns, except for East Hampton, where control of woody growth under utility lines was the objective.

Chester, Clinton, Deep River, Essex, Haddam, Middlefield and Middletown were sprayed by McMahon Brothers under the Town Aid Program. An indiscriminate application was reported in Middletown, where "1,000 feet of multiflora rose six feet in height, planted seven years ago, and over 8 feet back from the edge of

the pavement appears 90 per cent destroyed." The Deputy Superintendent of Public Works wrote of this incident, "In one instance uncontrollable drift caused slight damage to multiflora rose on private property, for which State and Town are protected as to damages." Payment of insurance for damage seems a rather poor substitute for avoidance of damage by a well conceived program.

In East Hampton the woody vegetation under the lines along Route 16 were sprayed by the utilities. Shrubs up to four feet in height that were causing no problem were sprayed, while taller potential danger trees were left untreated.

In Haddam, where the basal technique was used under the supervision of the Connecticut Agricultural Center, "no destruction of attractive plants" occurred. In Portland, "many people were disturbed by the unsightly condition of the roads during the summer (1959)." It was after the first general spraying that the people of Portland asked for a test spot using stump treatment. There is apparently no evidence of resprouting from this stump treatment after two growing seasons.

NEW HAVEN COUNTY

Out of ten towns, the roads of eight have been reported sprayed with stem-foliage applications, and of these, six (Ansonia, Bethany, Naugatuck, Prospect, Wallingford, Wolcott) have been treated by McMahon Bros. under the Town Aid Program. Branford and Oxford were reported as using no herbicides, although the latter is planning a program for 1962.

The application in Madison was described as "inconspicuous," the one in Hamden, as "temporarily unsightly." In Wallingford, sprayed under Town Aid, the objective of increasing sight-line conditions was not achieved on fifty per cent of the road frontage treated. The results were unsightly in places and damage was done to desirable vegetation such as a hedge of multiflora rose that had been planted along one avenue. Under the same program sight-line conditions were still hazardous in Bethany following an indiscriminate application applied to both woody and herbaceous growth.

NEW LONDON COUNTY

Herbicides have been reported as having been used in thirteen towns. In three (Groton, Old Lyme, Waterford), stump or basal treatments have been used; in all the others (Griswold, Ledyard, Lisbon, Montville, New London, Norwich, Salem, Sprague, Stonington), stem-foliage.

In Waterford the Selectman has approved a cutting and stump treatment approach in the management of the Town roadsides—a method to be recommended for adoption by other towns. A test plot established two years ago showed effective root-kill on black cherry and other species which were up to 6 inches or more in diameter before they were cut and stump treated. One touch-up basal application would put this strip into shape so that no further treatments would be required for 5 to 10 years. Another town road in Waterford which goes through the Connecticut Arboretum has been under stump and basal treatment for over a year. One report on utility brush control in Waterford indicated a cooperative program with the town in use of the basal technique. On the other hand, a specific case has been reported in which a 1960 clearing operation by the utilities was not followed by a stump treatment.

Misuse of the basal technique under utility lines was observed in Groton, where only mountain laurel was saved, while other desirable shrubby cover, including low-bush blueberry and huckleberry, was destroyed. Tall woody growth had been trimmed at the top to a height of four feet before receiving a basal treatment!

In Salem an herbicide application contracted by the utilities was poorly executed,

inasmuch as tree growth was missed that will soon become troublesome, while many desirable shrubs, including dogwood, viburnum, multiflora rose, chokeberry and winterberry, and handsome ferns, which were causing no maintenance or sight-line problems, were sprayed. This highway was blighted with brown-out for two months. A town official reported dissatisfaction with the results of past stem-foliage applications, and these have been discontinued.

Seven towns were sprayed under Town Aid. In Ledyard and North Stonington under this Program, a broadcast spray was applied in a continuous swath up to eight feet in height along the roads. Although dense stands of poison ivy warranted a stem-foliage application on some of this mileage, there was unnecessary destruction of attractive native plants in many places. In New London stem-foliage sprays were used locally to control poison ivy.

TOLLAND COUNTY

Reports from ten towns reveal that nine of them have used stem-foliage sprays under the Town Aid Program (Bolton, Columbia, Coventry, Mansfield, Somers, Stafford, Union, Vernon, and Willington).

Selective stump treatments were observed under utility lines along Route 87, south of Columbia, and along Route 19 in Stafford, although in the latter town poor results were obtained. On another utility line in Andover a selectively applied stem-foliage application was reported. In contrast, an indiscriminate stem-foliage spray occurred in Coventry, where for seven pole spans trees already growing into the lines were turned brown to a height of eight feet and even up to twelve feet in some places. The associated 40 per cent shrub cover was also sprayed. Obviously cutting followed by stump treatment should have been employed. Other nearby roads were also blanket sprayed.

WINDHAM COUNTY

From four towns only the stem-foliage technique has been reported. Town Aid spraying has occurred in three of these towns (Ashford, Eastford, Sterling); three have also been treated by the utilities (Ashford, Eastford, Pomfret). No data concerning the results of the Town Aid applications were received. On roadsides sprayed by the utilities some selectivity was evident, especially where mountain laurel occurred. Where deciduous shrubs were intermixed with the laurel, both were preserved, but where such specimens were by themselves they were frequently sprayed. Mountain laurel, an evergreen and the State flower, is presumably sufficiently conspicuous and known to the spray operators, but this does not appear to be the case with other species. Destruction of former shrub cover by earlier stem-foliage sprays was conspicuous in Eastford. In Pomfret, resurging tree and shrub sprouts as well as herbaceous cover was turned brown in a continuous swath along the roadside. In one situation a well established stand of silky dogwood, causing no sight-line or utility maintenance problem, was stem-foliage treated two years in a row.

RECOMMENDATIONS FOR CITIZEN ACTION

What are the most important reasons for the failure of the various agencies responsible for the use of herbicides to adopt the recommendations of the Shade Tree Committee?

In the case of the town road maintenance programs a serious source of difficulty has been the nature of the Town Aid Program. The State Highway Department has for several years drawn up specifications for

stem-foliage applications which are put out to bid. A letter is sent to the towns announcing the contract. Towns wishing to avail themselves of the service may arrange through the Town Aid Division of the Highway District Office to have their roads sprayed. This work is financed by a State appropriation, an arrangement which may look attractive to the officials of a town that does not own its own spray equipment and that is having problems financing its roadside maintenance work.

Copies of the Highway Department's announcement to the towns and of the spray contract will be found in the appendix on page 21. The contract specifications call for aqueous stem-foliage applications which are basically non-selective and which are causing the very type of damage the members of the Shade Tree Committee had hoped might be avoided. The specifications state that "*Control of weed and brush growth for the development of turf as the final end is the prime requirement.*" Until the towns are discouraged from using the stem-foliage technique, except under very special circumstances, we will continue to have unnecessary brown-outs, poor root kill of undesired woody species, and the elimination of attractive broad-leaved plants along our town roads. A positive approach by the Highway Department would be the circulation of information regarding the merits of the stump and basal techniques and the encouragement of their use through the Town Aid Program. These methods are being effectively used by the Highway Department along the State Highways. They give better root-kill, are more selective, and are cheaper in the long pull.

The utility companies have also evidently not accepted fully the Shade Tree Committee's recommendations. It would be easy enough for them to instruct their contractors as to the kind of job they wish to have done, and then to insist that the performance be up to standard. Such action should be to the interest of these companies from the point of view not only of improved public relations, but also of more efficient management. We cite the experience of the U. S. Forest Service in support of this statement (see page 3).

If the State Highway Department and the utilities should take the leadership in the matter of the use of herbicides along the lines suggested, the problem would be essentially solved. Any citizen action program should be aimed at enlisting their cooperation. To date the work of the Shade Tree Committee has failed to achieve this end, but an informed and concerned public should be helpful in bringing about the necessary reforms.

An action program should involve: (1) consultation with the selectmen to urge strongly the adoption of a *selective* spray program and to provide them with certain basic information in setting up a program such as outlined in the references cited on page 20 of this publication; (2) letters

from private citizens and organizations to the utilities recommending the adoption of improved techniques; (3) letters to newspapers citing improper use of herbicides along the roadsides, in order that a greater segment of the public become aware of the problem; and (4) insistence by landowners upon the use of proper selective techniques on their own property, especially roadside frontages and rights-of-way.

Summary

1. THE RECOMMENDATIONS of the Shade Tree Committee of the Connecticut Forest and Park Association, which were formulated in June, 1960, set forth a sound approach to the use of herbicides in controlling undesirable vegetation along our roadsides.

2. A State-wide survey to determine what has been done by the various towns and utilities in Connecticut during the past two years reveals that, with a few exceptions, the Shade Tree Committee's recommendations have not been adopted. A non-selective stem-foliage approach is the one most widely employed, rather than the preferred more selective and effective techniques set forth in the recommendations.

3. The Northeastern Forest Experiment Station of the U. S. Forest Service, after years of research, has adopted basal and stump techniques as being superior in attaining selectivity and root-kill of undesirable growth and as being cheaper than other methods when calculated on a five-year basis.

4. A basic change in the attitude and approach of the agencies responsible for the use of herbicides is essential to the development of a sound vegetation management program along our roadsides. The State Highway Department should abandon the present procedure of promoting stem-foliage spraying through the Town Aid Program and should encourage the towns to use selective basal and stump treatments which are currently employed along our State highways. The utilities should also adopt selective basal and stump treatments and use stem-foliage sprays only in those exceptional situations where the foregoing techniques are not feasible. Written specifications listing the plant material to be eliminated and to be spared are essential, and the performance of the contractor must be judiciously checked to see that specifications have been met. Within each community citizen action will be helpful in bringing about these needed reforms.

A Selected Bibliography

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- CONNECTICUT SHADE TREE COMMITTEE OF THE CONN. FOREST AND PARK ASSOCIATION. Use of herbicides along Connecticut Town Roadsides. 1960.
A popular leaflet summarizing the recommendations of the State Shade Tree Committee. May be obtained from the office of the Association, 322 North Main St., Wallingford, Conn.
- EGLER, F. E. Herbicides. 60 questions and answers concerning roadside and right-of-way vegetation management. Litchfield Hills Audubon Soc. (Litchfield, Conn.). 23 pp. 1961.
May be obtained from the Society or from the National Audubon Society, 1130 Fifth Ave., N. Y. 58, for 25 cents.
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- GOODWIN, R. H., AND W. A. NIERING. The Management of roadsides by selective herbicide techniques. Proc. Northeastern Weed Control Conference 13:530-532. 1959.
Recommendations for the management of roadside vegetation.
- MCQUILKIN, W. E., AND L. R. STRICKENBERG. Roadside brush control with 2,4,5-T on Eastern National Forests. Northeastern Forest Exp. Sta. (Upper Darby, Pa.), Station Paper 148:1-24. 1961.
A description of the maintenance techniques employed in the northeast by the U. S. Forest Service and of the research that led to adoption of these practices. May be obtained from the Station, Upper Darby, Pa.
- NATURE CONSERVANCY, CONNECTICUT CHAPTER. Policy for roadside and right-of-way vegetation management. 1961.
Policies designed for the Nature Conservancy preserves. May be obtained from the Conn. Arboretum, New London, Conn.
- NIERING, W. A. The Connecticut Arboretum right-of-way demonstration area—its role in commercial application. Proc. Northeastern Weed Control Conf. 15:424-433. 1961.

Research report on the effectiveness of various herbicide techniques and on the application of the selective approach.

PENNSYLVANIA DEPARTMENT OF FORESTS AND WATERS. Policy for maintenance of vegetation on rights-of-way on State Forest lands. Penn. Dept. Forests & Waters (Harrisburg). Circular letter R-24. 1955.

Policy stating adoption of basal techniques on Pennsylvania State Forest lands.

U. S. FOREST SERVICE. Roadside spraying with chemicals—Manual for foremen. U. S. Forest Service, Region 7, Upper Darby, Pa., 22 pp. 1959.

This pamphlet should be placed in the hands of every foreman responsible for roadside maintenance. May be obtained from the Northeastern Forest Expt. Sta., Upper Darby, Pa.

Appendix

Weed and Brush Control Under the State Town Aid Program

Towns throughout the State were notified by the State Highway Department that it had arranged for and awarded a contract for a weed and brush control program through the following letter:

July 3, 1961

Dear Sir:

For your information, bids have been received by this Department and a contract awarded for a weed and brush control program along town-maintained highways for which the use of Town Aid Funds is permissible.

This program will be carried out during the months of August and September.

If your municipality wishes to participate, kindly contact the Town Aid Division of the Highway District Office in your area.

Very truly yours,

Howard S. Ives
State Highway Commissioner

By H. R. O'Loughlin
Highway Town Agent

The 1961 contract governing the spraying of roadside areas for control of growth of weeds and brush reads as follows:

Special Bid Terms and Conditions

LAWS: 1. The contractor at all times shall observe and comply with all Federal and State laws and local by-laws, ordinances and regulations in any manner affecting the conduct of the work and all such orders or decrees as exist at present and those which may be enacted later, of bodies or tribunals having any jurisdiction or authority over the work, and shall indemnify and save harmless the State and all of its officers, agents and servants against any claim or liability arising from or based on the violation of any such law, by-law, ordinance, regulation, order or decree, whether by himself or his employees.

TAXES: 2. The State of Connecticut is exempt from the payment of taxes imposed by the Federal Government and/or the State of Connecticut. Such taxes should not be included in the bid prices.

SCOPE: 3. The work shall consist of furnishing all materials, equipment, transportation, supervision and all other items of services necessary to control the growth of weeds and brush by means of the application of synthetic auxins to the sides of the highway right-of-way from the edge of the paved surface to a maximum width of eight feet on tangent sections and the outside of horizontal curves. On the inside of horizontal curves (to assure adequate sight-line) the width of swath shall be designated by the Engineer. The pattern of the spray area, or swath, on each side of the road will vary in width and location. In no instance, however, shall brush exceeding four (4) feet in height be sprayed. 4. Location of the work has not been determined but will be performed in accordance with these terms and conditions in the various towns of the State of Connecticut. Prior to the work on each road a carefully prepared program map shall be made, designating the sections of each highway where application is to be performed. The program shall designate width of swath, locations of spraying, locations of omission, and all information pertinent for the intelligent and careful execution of the operations to be performed by the Contractor.

MATERIALS: 5. The materials to be used in this weed and brush control work shall be of the synthetic auxin type, shall be low-volatile, water-miscible compounds produced by a responsible and recognized manufacturer and shall be pre-qualified by the U. S. Department of Agriculture or the Connecticut Agricultural Experiment Station. These auxins, properly applied, shall not damage grasses. 6. These materials, as mixed and applied, shall be non-toxic to human and animal life, non-injurious to any of the several species of grasses growing in the roadsides, and not subject to volatility or drift. 7. Selective synthetic auxins contemplated herein are 2,4, Dichlorophenoxyacetic acid and 2,4,5, Trichlorophenoxyacetic acid of low volatile ester formulations. 8. Formulations used shall be as approved or recommended by the U. S. Department of Agriculture. Approval of the Engineer is required in all cases.

RESPONSIBILITIES OF CONTRACTOR: 9. (A) The speed of travel during spray application shall not exceed 10 M.P.H. 10. (B) Contractor shall *not* spray areas containing plantings of vines, shrubs or deciduous or evergreen trees planted or maintained by Town Forces, or any desirable individual trees and plant materials growing along the roadside, unless specifically directed to do so by the Engineer, in writing. 11. (C) The material shall be applied as a foliage spray in an amount sufficient to thoroughly cover all exposed foliage surfaces (not exceeding four (4) feet in height) of brush and weeds being sprayed. A minimum of 100 gallons

solution per roadside (one side of road) mile shall be applied. 12. While spraying, the Contractor shall at all times exercise care to prevent damage to residential plantings, vegetable or flower gardens, or to any susceptible farm crops or other desirable broadleaf plants adjacent to the roadside. In no case shall the roadside adjacent to susceptible crops where direction and velocity of wind might cause damage be sprayed. No spraying shall be performed when the temperature is higher than 85°F. No spraying shall be undertaken during a rain or when the foliage is wet. 13. All workmen engaged in roadside spraying shall have sufficient experience in such work to properly and satisfactorily perform it and operate the equipment involved to the satisfaction of the Engineer. 14. The Contractor shall assume all liability for any damage resulting from the application of weed and brush control auxins and shall hold the State of Connecticut harmless from any such claims for which the State of Conn. becomes legally obligated. 15. If the Contractor has not commenced his work within a reasonable time, or does not carry the same forward with reasonable progress, or is improperly performing his work, or has abandoned, or fails to or refuses to complete the work, the Engineer shall make a finding to that effect and so notify the Contractor in writing. Upon receipt of this notification by the Contractor, the right of the Contractor to control and supervise the work shall immediately cease. 16. The Contractor shall account for each day's work and provide forms which will account for the mileage of work that was performed on that day. This form is to be signed by a representative of the Contractor and the State Inspector and two copies of the form with the proper signatures are to be left with the inspector. One copy to be used by the Town or Using Agency and the second copy for use by the District office.

SPRAYING PROCEDURE: 17. The application of the spray shall be the sole responsibility of the Contractor. The mixture shall contain two (2) pounds 2,4-D acid equivalent and three (3) pounds of 2,4,5-T acid equivalent of low volatile ester formulation per 100 gallons of water. 18. The Contractor shall deliver to the Engineer each day a certified record of the previous day's spraying. The record shall show the speed, roads, miles travelled, and time of starting and stopping. In addition, he shall state general weather conditions and the general direction of the wind on each road at the time the application was made.

RESULTS REQUIRED: 19. Any other provision herein notwithstanding, the following results are required hereunder: 20. (A) As regards to brush, only such growth in the swath 4 ft. or less in height shall be controlled. 21. (B) The pattern of spray shall be uniform and even. 22. (C) Bidders are advised that they must draw upon their knowledge of vegetative species, germination and growth, and upon their experience with successful applications of the selective synthetic auxins for the production of results required. Control of weed and brush growth for the development of turf as the final end is the prime requirement of this proposal, all others being but safeguards set forth to guarantee in so far as possible that these results shall actually be accomplished with maximum safety and convenience of the public and at the maximum economy for the Town.

EQUIPMENT REQUIREMENTS: 23. In order to accomplish the results required, the use of spraying equipment of modern design is necessary and it shall be demonstrated that it should be equal to the following description: 24. It shall conform to the requirements of the Connecticut State Department of Motor Vehicles. 25. It shall be of such design and construction as to permit complete coverage of the varying widths of the roadside as directed by the Engineer. Each piece of equipment shall be equipped with a boom and nozzles which shall be so operated that the mixed auxin solution will be uniformly distributed and spread over the entire swath. The operator of the spray boom shall control this boom from

the side being sprayed where he may have maximum visibility at all times of the area being sprayed. The equipment must always travel in the direction of traffic, while spraying. 26. The equipment shall be self-powered and self-propelled and capable of spreading mixtures as specified. The equipment shall be capable of applying the mixtures safely from the hard surface of the road. Small areas, where the use of mechanical equipment is not feasible, may be treated by hand if so directed by the Engineer. 27. The pump shall produce a maximum of 90-pound pressure at all nozzles, producing droplets not less than the 1000 micron size in accordance with the U. S. Department of Agriculture definition. Constant agitation during filling the spraying operations by jet or mechanical means shall be maintained. 28. Equipment proposed for use on the contract shall be in operational condition and available for inspection by the Engineer. 29. For the protection of traffic each piece of equipment must be equipped with two (2) red flasher lights, visible from the front and rear, and with four (4) red flags, one (1) on each side near the rear end and front end of the trucks. "Saflags R", or approved equal, shall not be less than 12" x 12" in size. The lights must show the full over-all width of the vehicle and each shall be mounted on a hinged or telescoping post, so that the center of the light will not be less than ten (10) feet above the ground when in an operating position. The lens shall not be less than six (6) inches in diameter and shall be of clear red glass. The bulb shall be a minimum of fifty (50) candle power, and the circuit shall have a current interrupter contained within which creates a flashing intermittent beam. This signal system shall be in operation continuously while the vehicle is engaged in the performance of the work on this contract.

EXPERIENCE REQUIREMENTS: 30. The Contractor must be a recognized, experienced and bona fide applicator of herbicides. 31. The bidder shall include in his bid a list of roads he has treated. This list must be certified to by the officials for whom the work was performed. 32. No bid shall be considered which does not satisfy all requirements.

DEFINITION: 33. It is understood that the unit referred to as a mile on which this bid is based shall be the spray application to one side of the road.

INSURANCE: 34. Workmen's Compensation Insurance: 35. With respect to all operations he performs and all those performed for him by subcontractors, the Contractor shall carry Workmen's Compensation Insurance in accordance with the requirements of the laws of the State of Connecticut. 36. Contractor's Public Liability and Property Damage Insurance: 37. With respect to the operations he performs and also those performed for him by subcontractors, and for the duration of the Contract, the Contractor shall carry regular Contractor's Public Liability Insurance providing for a limit of not less than \$100,000.00 dollars for all damages arising out of bodily injuries to or death of one person, and, subject to that limit, for each person, a total limit of \$300,000.00 dollars for all damages arising out of bodily injuries to or death of two or more persons in any one accident, and regular Contractor's Property Damage Liability Insurance providing for a limit of not less than \$50,000.00 dollars for all damages arising out of injury to or destruction of property in any one accident and, subject to that limit per accident, a total (or aggregate) limit of \$100,000.00 dollars for all damages arising out of injury to or destruction of property during said period.

PERFORMANCE BOND: 38. Performance Bond will be required of the successful bidder in the amount of \$5,000.00.

Connecticut Arboretum Bulletins

- No. 3. A Plant Handbook: Lists of Plants for Specific Landscape Uses. Harriet B. Creighton and Priscilla Pasco. 1940. (Out of print)
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- No. 6. Check List of Woody Plants growing in the Connecticut Arboretum and Guide to the Arboretum. Richard H. Goodwin, Katherine H. Heinig and Kaleb P. Jansson. pp. 32. 1950. .35
- No. 7. The Connecticut Arboretum: Its History and the Establishment of the Natural Area. 1952. .15
- No. 8. The Connecticut Arboretum: The Mamacoke Acquisition and Our Research Program. 1955, (Out of print)
- No. 9. Six points of Especial Botanical Interest in Connecticut. pp. 32. 1956. The areas described are the Barn Island Marshes, the Connecticut Arboretum, the North Haven Sand Plains, Catlins Wood, the Cathedral Pines, and the Bigelow Pond Hemlocks. .40
- No. 10. Birds of the Connecticut Arboretum and the Connecticut College Campus, pp. 24. 1958. An annotated list with seasonal records and an account of the breeding bird census program. .40
- No. 11. A Roadside Crisis: the Use and Abuse of Herbicides. 1959. A proposed program for use of herbicides on town roads, to avoid present destructive practices. .10
- No. 12. Connecticut's Coastal Marshes: A Vanishing Resource. pp. 36. 1961. Testimony of various authorities as to the value of our tidal marshes and a suggested action program. .40
- No. 13. What's Happening Along Our Roadsides? 1962. .25

APPROACHES TO THE CONNECTICUT ARBORETUM

