OUR modern highways are a far cry from the dirt tracks and gravel lanes of the early nineteen-hundreds. Highway improvements, however, have meant disruption of the landscape and destruction of trees and woody shrubs. A concrete or asphalt strip fringed with grass is the usual result of this disruption.

To develop a desirable highway corridor, the roadside must be re-vegetated to blend into its surroundings. Nursery stock (trees 2 to 3 inches in diameter) is usually used to re-establish the missing woody vegetation.

However, nursery stock is considerably smaller than the surrounding, undisturbed, woody vegetation, and takes many years to grow to a size that has a noticeable, visual impact. The development of mechanical tree transplanting equipment in 1964 and 1966 provided an economical means of hastening the visual impact derived from landscaping materials. Now, an immediate effect can be gained by using larger tree stock, usually 4 to 8 inches in diameter.

The Minnesota Department of Highways initiated a large tree moving program in the fall of 1968. At that time, 179 Green Ash and Silver Maple were relocated (for safety reasons) from an expressway median to two interchanges, one at each end of the highway section involved.

Since this first project was completed, an additional 1,591 large trees and shrubs have been transplanted to 19 different locations.

Today, the Department is moving roughly 400 trees per year. Some of these trees are salvaged from new construction and regrading projects. Others are moved because they create problems or traffic hazards (reduced sight distances, too close to travel lanes, etc.). Most are moved for landscaping purposes, and come from such varied sources as old windbreaks, large tree nurseries, forest tree farms, and wooded portions of the highway right-of-way.

Forty-one different tree and shrub species have been moved to date (Table 1). Included in this total are early plant successional species such as Aspen and Willow, and large, tap-rooted trees such as the Oaks and Pines. More Green Ash and Spruce (both Black Hills and Colorado Green varieties) have been transplanted than any other species.

Statistical evaluations regarding plant survival are difficult to make because of the variable sample size involved. However, trend patterns can be pointed out. Of the 1,770 trees and shrubs moved to date, 1,646 individuals, or 93 percent, have survived. This survival rate is very good considering the size of these plants and their general lack of previous care.

This clam-type digger (72 inch) was developed in 1964 for large tree moving. Authors used clam- and spade-diggers in moving trees.

The high or low success with some of the species may be due to the relatively short time period during which we have been moving trees, and/or the small numbers moved. A longer evaluation period and larger sample size are needed to determine the long range effects of the transplanting technique on these species. As more specimens of satisfactory size and quality are located, they will be included in the program.

All survival evaluations were made in the fall of 1972. The evaluation included classifying the transplants according to the amount of

*continued on page 20)*

**TABLE 1. Plant Survival By Species Moved**

| Species | Number Moved | Number Living | Percent Survival |
|---|---|---|---|
| Spruce (Picea glauca and P. pungens) | 666 | 619 | 93 |
| Green Ash (Fraxinus pennsylvanica) | 358 | 351 | 98 |
| Red Pine (Pinus resinosa) | 209 | 197 | 94 |
| Burr Oak (Quercus macrocarpa) | 95 | 83 | 87 |
| Aspen (Populus tremuloides and P. grandidenta) | 82 | 69 | 84 |
| Jack Pine (Pinus banksiana) | 39 | 36 | 92 |
| Sugar Maple (Acer saccharum) | 32 | 30 | 94 |
| White Birch (Betula papyrifera) | 28 | 19 | 68 |
| Eastern Larch (Larix laricina) | 25 | 23 | 92 |
| Red Maple (Acer rubrum) | 21 | 18 | 86 |
| Red Oak (Quercus rubra) | 21 | 19 | 90 |
| Honeylocust (Gleditsia triacanthos) | 19 | 19 | 100 |
| Silver Maple (Acer saccharinum) | 18 | 18 | 100 |
| Eastern Redcedar (Juniperous virginiana) | 18 | 18 | 100 |
| American Linden (Tilia americana) | 16 | 16 | 100 |
| American Elm (Ulmus americana | 13 | 12 | 92 |
| Pin Cherry (Prunus pennsylvanica) | 12 | 7 | 58 |
| Ironwood (Ostrya virginiana) | 11 | 10 | 91 |
| Apple (Malus spp.) | 10 | 10 | 100 |
| Willow (Salix spp.) | 10 | 9 | 90 |
| Crabapple (Malus spp.) | 9 | 9 | 100 |
| Wild Plum (Prunus americana) | 9 | 9 | 100 |
| Norway Maple (Acer platanoides) | 7 | 6 | 86 |
| Speckled Alder (Alnus rugosa) | 6 | 6 | 100 |
| Black Walnut (Juglans nigra) | 6 | 5 | 83 |
| Common Lilac (Syringa vulgaris) | 5 | 5 | 100 |
| Service Berry (Amelanchier alnifolia) | 3 | 3 | 100 |
| Honeysuckle (Lonicera spp.) | 3 | 3 | 100 |
| Austrian Pine (Pinus nigra) | 3 | 3 | 100 |
| Mountain Ash (Sorbus americana) | 3 | 3 | 100 |
| Hackberry (Celtis occidentalis) | 2 | 2 | 100 |
| Russian Olive (Elaeagnus angustifolia) | 2 | 2 | 100 |
| Pin Oak (Quercus palustris) | 2 | 2 | 100 |
| American Arborvitae (Thuja occidentalis) | 2 | 1 | 50 |
| Balsam Fir (Abies balsamea) | 1 | 1 | 100 |
| Ohio Buckeye (Aesculus glabra) | 1 | 1 | 100 |
| Hawthorn (Crataegus spp.) | 1 | 1 | 100 |
| Eastern White Pine (Pinus strobus) | 1 | 1 | 100 |
| Choke Cherry (Prunus virginiana) | 1 | 0 | 0 |
| Totals | 1770 | 1646 | 93 |

[1] Fifty-one plants died and were removed before accurate size records were compiled.

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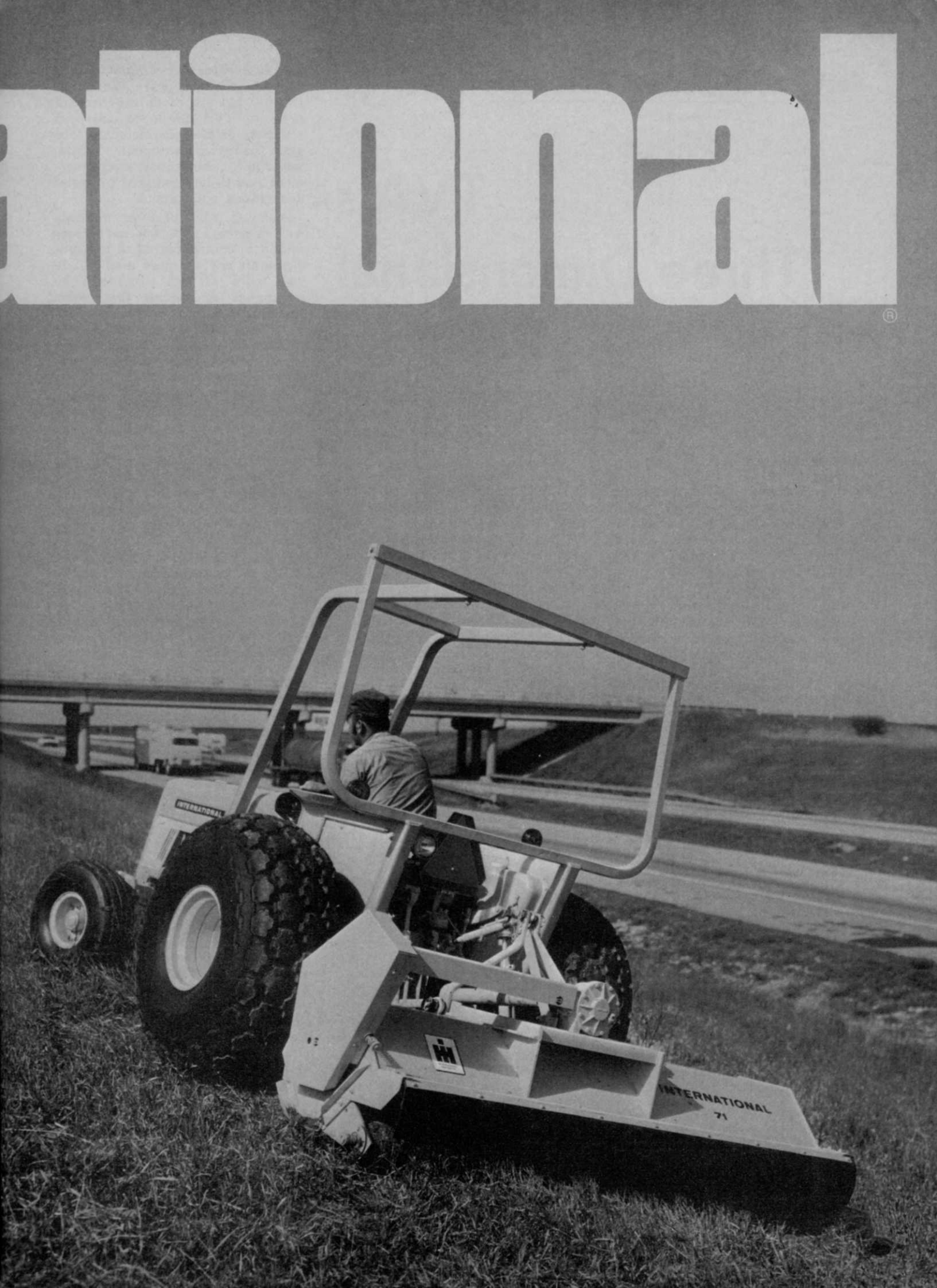
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71

# TVA's Three Dimensional Program

By DORMAN C. FRANCISCO
Tennessee Valley Authority
Chattanooga, Tennessee

THE Tennessee Valley Authority has approximately 17,000 miles of transmission lines that are routed through parts of seven states. About 60 percent of the transmission line right of ways are in areas that are visible to the public.

Brush control is a major and expensive recurring problem connected with the transmission of electric energy in the Tennessee Valley region because of the numerous species of brush and terrain, which varies from swamps and rolling uplands to high plateaus and rugged mountains.

The average annual rainfall is more than 50 inches, and the average annual temperature is above 60° F. These factors contribute to luxuriant growth of vegetation. The right of way width varies depending on the voltage and the number of circuits; however, the vast majority of right of ways are cleared 100 feet wide.

Chemical maintenance on TVA's right of ways began in 1949, and for the next six years hand clearing and power saws were gradually replaced by chemical methods. For two decades herbicides were used almost exclusively to control undesirable brush species on TVA's right of ways.

In addition to the scheduled maintenance program, extensive field testing and screening programs of new herbicides and combinations of proven herbicides were conducted. During this era of an all-chemical program, TVA developed and used a variety of methods including foliage handgun, automatic nozzle, helicopter, basal, initial stump treatment, and pellet treatment by aerial and ground applications.

Although each of these methods was effective, TVA was never successful in controlling all of the species with any of these methods. It was more or less a process of eliminaton of species that were susceptible to the herbicides that were used, and fortunately the resistant species that remained on the right of ways were primarily the slow-growing types.

By 1968 these resistant species had reached a height where they were beginning to be a hazard to the line; therefore, we turned our attention to mechanical methods. Another factor which influenced our change was the increasing general anxiety toward the use of herbicides, especially in highly residential areas, croplands, etc.

In 1968 TVA began to change from almost exclusively chemical methods to other methods which would not only be more desirable from an environmental standpoint but would also remove the resistant species that had remained on the right of ways in spite of repeated chemical applications.

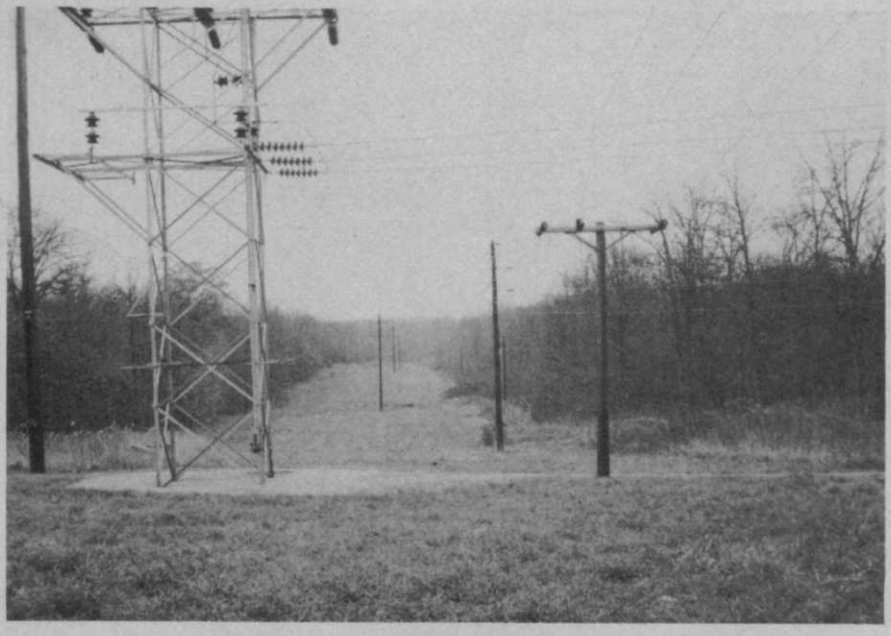
For the past two years 70 percent of our scheduled maintenance has been by mechanical methods with the greater part of the right of ways being mowed with large rotary-type machines and the remainder shear-cleared. Mechanical methods have been fully accepted by property owners and the general public. The other 30 percent of our scheduled maintenance is by various chemical methods.

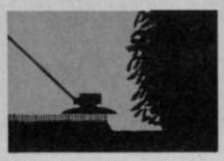
Our chemical maintenance is carefully planned, and its use is only in the more remote areas. Herbicides are not used near water sources, crops, or areas exposed to public view. Chemical maintenance is avoided also in areas where "brown-out" would be visible from interstate or U.S. highways or heavily traveled state or county roads. TVA strictly regulates the use of herbicides and complies in all respects with the Department of Health, Education, and Welfare restrictions. Also each year TVA's chemical program is submitted to the President's Working Group on Pesticides for review and approval.

The major portion of ground

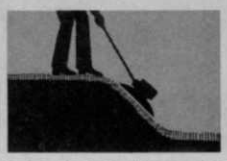
(continued on page 46)

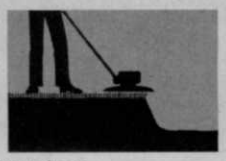
A tractor-powered rotary cutter keeps this TVA power line right-of-way looking like a park.

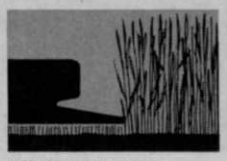




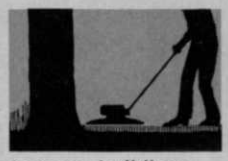
*Overhanging edges, steep slopes, traps, and bunkers*







*High, wet grass*



*Under benches, close to trees, buildings*

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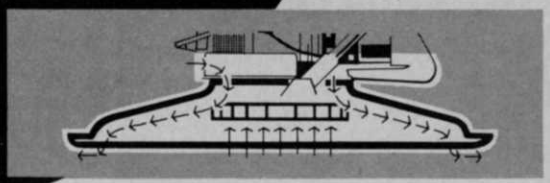

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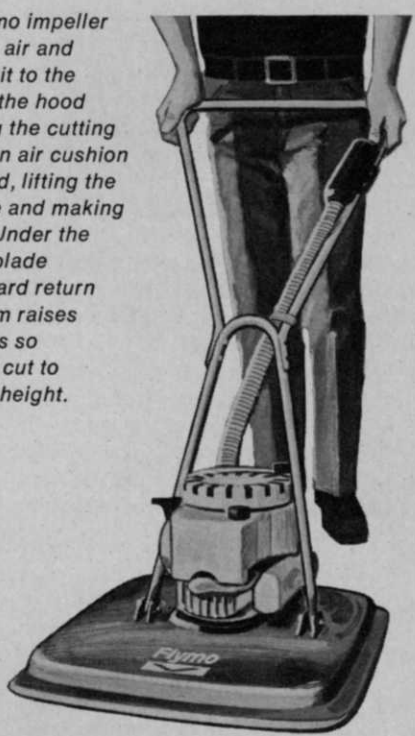


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WTT SPECIAL REPORT

# Residual Control Of Annual Bluegrass With Preemergence Herbicides

By F. V. JUSKA and J. J. MURRAY*

ANNUAL BLUEGRASS *Poa annua* L., is a very serious weed which infests putting greens and other turfgrass areas *Poa annua* is a prolific seed producer during both fall and spring. Seed is produced under low cutting heights such as those required for bent- and bermudagrass putting greens and in low density turf. A good stand of *Poa annua*, obtained in the field and seeded in the greenhouse on the same day, showed that seed does not require the after-ripening process that is necessary for the germination of many other grasses.[5]

A study was initiated in 1965 to determine the phytotoxicity to bentgrass *Agrostis palustris* varieties from preemergence herbicides. The herbicide plots were 2½ feet by 55 feet and variety subplots within herbicide treatments were 2½ feet by 5 feet. Herbicides and rates used during a five-year period are given in Table 1.

This study was continued for three years after the last application of herbicides in 1969 to determine the residual control of *Poa annua* plants following the application of herbicides.

Except for Betasan bensulide herbicide (Table 2), some injury from all preemergence herbicides was noted in August of 1965-67[2]. Little or no injury was noted in 1968 through 1969. The greater injury from calcium arsenate was due to severe injury to C-52 (Old Orchard), and high rates applied at one time.

Griffin[1] reported that research results from Virginia Polytechnic Institute and State University showed a reduction of roots with an application of DCPA at five pounds (active ingredient) per acre and a greater reduction with Betasan at 15 pounds (active ingredient) per acre.

**TABLE 1. Average percent of Poa annua present after treatment with preemergence herbicides on eleven bentgrass varieties*.**

| Herbicides** and rates | Aug. 1965 | July 1966 | Aug. 1967 | Aug. 1968 | April 1972 |
|---|---|---|---|---|---|
| Betasan bensulide 15 lb. ai/A | 10.0 | 14.1 | 21.0 | 13.4 | 15.0 |
| Zytron DMPA 15 lb. ai/A | 12.7 | 17.1 | 31.5 | 21.6 | 30.0 |
| Calcium arsenate 69% ai 5 lb./1,000 ft.² | 2.3 | 7.3 | 1.5 | 2.7 | 2.0 |
| Control plot | 13.2 | 10.9 | 22.5 | 27.0 | 30.0 |
| Tupersan siduron 12 lb. ai/A | 19.5 | 13.5 | 24.5 | 20.7 | 35.0 |
| Lead arsenate 96% ai 5 lb./1,000 ft.² | 6.8 | 7.0 | 2.0 | 8.6 | 5.0 |
| Dacthal DCPA 10 lb. ai/A | 9.5 | 12.3 | 19.0 | 16.6 | 20.0 |
| Control plot | 9.1 | 8.8 | 15.0 | 19.3 | 15.0 |

*The bentgrass plots were aerified and topdressed with sterilized soil in the spring and fall of each year.

**Herbicides were applied in May of each year (1965 through 1969).

The percentage of *Poa annua* present for each preemergence herbicide treatment was averaged for 11 bentgrass varieties (Table 1) for 1965 through 1968 and 1972. Percentage of annual bluegrass was not recorded in 1969. Poor control was obtained (Table 1) for each treatment except for calcium arsenate and lead arsenate. Sprague and Burton[5] reported that lead arsenate applied to turf to control grubs greatly reduced, but did not eliminate annual bluegrass in bentgrass turf.

Two applications of two pounds of calcium arsenate per thousand square feet, two to three weeks apart in the spring and two to three applications at the same rate in the fall, will gradually remove annual bluegrass. It was the observation of Holman Griffin, mid-Atlantic director, USGA Green Section, Charlottesville, Va., that two or three years of this treatment in the Mid-Atlantic regions does not injure

*(continued on page 48)*

**TABLE 2. Injury of preemergence herbicides on bentgrass selections: average for 1965-1967.**

| | HERBICIDES AND RATES (a.i.) | | | | | |
|---|---|---|---|---|---|---|
| Varieties | Betasan Bensulide 15 lb./A | Zytron DMPA 15 lb./A | Tupersan Siduron 12 lb./A | Dacthal DCPA 10 lb./A | Calcium arsenate 5 lb./1,000 sq. ft. | Lead arsenate 5 lb./1,000 sq. ft. |
| Arlington | 0 | .8 | .7 | 1.0 | 1.0 | .17 |
| Arlington Congressional | 0 | .3 | .8 | 1.2 | .3 | 0 |
| C-52 (Old Orchard) | 0 | .8 | .17 | 1.0 | 2.2 | 0 |
| Cohansey | 0 | .7 | .17 | 1.8 | .7 | .3 |
| Collins | 0 | .8 | 1.3 | 1.2 | .17 | 0 |
| Congressional | 0 | .3 | .3 | .8 | .7 | 0 |
| Metropolitan | 0 | 1.0 | .8 | 1.0 | 1.7 | 0 |
| Pennlu | 0 | 1.3 | .7 | 1.2 | 1.0 | .17 |
| Penncross | 0 | 1.2 | 0 | 1.2 | .8 | .3 |
| Seaside | 0 | 1.3 | 1.7 | 1.5 | 1.2 | .3 |
| Washington | 0 | 1.3 | 3.3 | 1.7 | .3 | 0 |

Scores: 0 = (no apparent injury) to 10 = (severe injury).

*Research Agronomists
Turfgrass Laboratory
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# Surge In Construction Marks West Central Golf Course Outlook


**By GEORGE KERR**
West Central Facility
Development Consultant
National Golf Foundation


George Kerr

THE PAST year was very slow by comparison with respect to official golf course openings in the West Central Region. Weather played a big part and usually at the wrong time. It was either too hot after planting with no moisture to assist irrigation systems, or it was too wet for the construction crews to move dirt with their machinery. As a result, our figures reflect the fact that only 24 courses opened in the NGF fiscal year, for this region.

It must be pointed out though that 1973 will be a banner year with respect to official golf course openings. At this time, there are 99 courses in some phase of construction between moving dirt and maturing turf prior to opening.

Of the 24 courses that opened, 20 were regulation length, one was of executive length and three were considered Par-3 facilities.

Texas is the leader on number of courses open during the past year with seven, while there are 35 facilities under construction. All but two of those under construction are considered in east or south Texas.

Colorado interests continue to build new golf layouts and it appears that several will be built in the mountains as soon as the weather permits. Mountain courses generally take longer to build because of the short season, but the vistas and panoramas available on a mountain course are truly worth waiting for.

One of the courses recently opened in the foothills of the Rockies at Larkspur, Colorado is Perry Park designed by Richard Phelps of Phelps-Brauer & Associates, Denver. Recently, superintendent John Ford hosted a most successful monthly meeting of the Rocky Mountain GCSA. John is now actively engaged in "bringing in" another nine holes, which should be ready for play next summer.

Another foothills course closer to Denver is Roxborough Park, designed by Robert Trent Jones, Jr. Superintendent Gordon Brinkworth was kept busy bringing in 18 holes of new turf until the snow arrived. The course winds through natural formations of rock and trees, and should be ready for play next summer.

The Pinery at Parker, Colorado is presently building 27 holes with Purr-Wick greens. David Bingaman designed the golf facility and is building it with Jack Maurer, superintendent. Both men have had prior experience with the Purr-Wick system. The Pinery is now owned by the Club Corporation of America.

All the aforementioned golf facilities have been designed to compliment the sale of real estate surrounding the golf course and adjacent environs.

Of the 35 courses under construction in Texas, almost 75 percent of these are because of real estate developments.

The Houston area is a fine exponent of real estate golf projects. Diamondhead Corporation is building "Newport," a 6000-acre resort type community on the east shore of Lake Houston. The master plan provides for three 18 hole courses, two marinas, riding stables, swim and tennis club, plus numerous other amenities.

The Kingwood Country Club will be built on the opposite or west

shore of Lake Houston. The Friendswood Development Company and the Club Corporation of America are cooperating in this venture. Joseph S. Finger, golf course architect from Houston, designed three 18 hole layouts for Kingwood. The club and its golf courses will be patterned after the highly successful Brookhaven Country Club in Dallas. The courses will be designed to play from 5500 yards to 7100 yards, all with pars of 72. The most difficult course will be reserved for men only. The middle course will be open to all players with handicaps of 20 or better. The third course will be open to all players with no handicap requirement. Several holes will front on Lake Houston.

The Folsom Investment Company of Dallas, Texas has taken on a new project which will be adjacent to the Preston Trails Country Club. This new multi-million dollar golf-real estate venture will be known as Bent Tree Country Club. Designer Desmond Muirhead is working with builder Keith Dewar in this development.

Last, but not least, several municipal projects are going strong. Jay Riviere of Houston, designed and built a second 18 holes for Dick Forester et al at Bear Creek on the west side of Houston. This course will be ready to play this spring, weather permitting.

The Richardson, Texas municipal golf course, which was five years in planning, should be ready to open this year. Leon Howard of Austin, Texas did the design work while the Gunderson's of Rapid City, South Dakota did the final two finishing phases of construction. "Buster" Creagh will be the head professional and Mike Lasoya is the Supt. in charge. R. B. Sherrill, City Manager, did a lot of legwork before this project got off the ground. He visited many of the more successful municipal golf operations as far away as Fairfax County, Virginia.

Because of the prior planning and incorporation of successful ideas, the Richardson Muni-facility is truly first class and will rate among the finest. The site is an old horse pasture with many established trees as high as 40 feet. Present clubhouse plans feature cart storage in the basement or lower level. All indicators point to a highly successful operation, as there is a definite need for more municipal golf facilities in the suburbs of a large metroplex such as Dallas — Fort Worth.

Dallas has recognized the need for additional municipal golf facilities and has incorporated needs and desires into a comprehensive Green Belt Program. Grover Keeton, supt. of special activities for the Parks and Recreation Dept. reflected that several golf courses are in the long range plans for the Green Belt and other areas.

Oklahoma City broke ground on a new 36 hole facility early this year. The Earlywine Park project will be a total recreational complex encompassing all forms of outdoor activities. Floyd Farley designed the golf courses for this new municipal park.

The South Suburban Recreational District will open a new 27 hole muni golf course early next summer. The SSRD is located in Littleton, Colorado a suburb of Denver. The facility, designed by Phelps-Brauer of Denver, will include 18 holes of regulation length play, plus a Par-3 nine. The course should be ready to open early this summer.

1973 promises to be an exciting year with many course openings and ground breaking ceremonies. Hopefully, this surge in construction will begin to accommodate golfers who flock to the links each year in ever increasing numbers □

**TABLE 2. Plant Survival By Size -- Class Moved**

| Size Class (inches) | Number Moved | Number Living | Percent Survival | Root Ball Size Used |
|---|---|---|---|---|
| Shrubs | 41 | 34 | 83 | 42 & 66 |
| 2 | 32 | 32 | 100 | 42 |
| 2½ | 55 | 55 | 100 | 42 |
| 3 | 371 | 363 | 98 | 42 |
| 3½ | 230 | 223 | 97 | 42 |
| 4 | 231 | 219 | 95 | 42 & 66 |
| 4½ | 137 | 136 | 99 | 66 |
| 5 | 145 | 136 | 94 | 66 |
| 5½ | 90 | 88 | 98 | 66 |
| 6 | 86 | 84 | 98 | 66 |
| 6½ | 81 | 79 | 98 | 66 & 72 |
| 7 | 66 | 58 | 88 | 66 & 72 |
| 7½ | 64 | 62 | 97 | 72 |
| 8 | 41 | 38 | 93 | 72 |
| 8½ | 22 | 20 | 91 | 72 |
| 9 | 15 | 10 | 67 | 72 |
| 9½ | 4 | 4 | 100 | 72 |
| 10 | 7 | 4 | 57 | 72 |
| 11 | 1 | 1 | 100 | 72 |
| Unknown[1] | 51 | 0 | 0 | Unknown |
| TOTALS | 1770 | 1646 | 93 | ..... |

## LARGE TREE MOVING

*(from page 11)*

crown dieback sustained by each plant. The results of this condition evaluation are:

| Crown Condition | Plants Effected |
|---|---|
| 0 to 25% dieback | 82% of all transplants |
| 25 to 75% dieback | 11% of all transplants |
| Dead plants | 7% of all transplants |

Trees with crown dieback in excess of 75 percent were considered dead. The small amount of life remaining in these trees is insufficient for healthy growth and survival.

The middle classification (25 to 75% dieback) is especially important because of the temporary, adverse appearance of the trees. These trees do produce new crowns by sprouting along their main branches and trunk, but this crown redevelopment takes many years and requires constant thinning and shaping.

In spite of dieback, a 5-inch diameter transplant still has three to four times the crown volume and visual impact of comparably priced nursery trees 2 to 3 inches in diameter.

The trees which we have moved range in size from 2 to 11 inches in caliper (Table 2). The minimum root ball diameter for the various sizes of trees moved is based on standards set by the American Association of Nurserymen. We have, however, adjusted these A.A.N. standards to cover the mechanical transplanting of wild or semi-wild grown materials. These adjusted standards are:

| Tree Trunk Caliper | Minimum Root Ball Diameter |
|---|---|
| 2 to 3½ inches inclusive | 42 inches |
| 4 to 6 inches inclusive | 66 inches |
| 6½ to 8 inches inclusive | 72 inches |
| all multi-stemmed plants | 66 inches |

Our best success has been achieved with trees in the 2 to 7½ size range. Trees above 7½ inches in diameter almost invariably develop considerable crown dieback. This is probably due to the disproportionate root system to crown volume ratio which results from the mechanical transplanting of this large a tree. Where optimum results are being sought, only trees under 8 inches in diameter should be transplanted.

We are constantly improving our specifications and special contract provisions to provide for better control of the general quality of our transplanting work. These specifications and special provisions are available to anyone upon request. The installation work we require includes: machine transplanting, staking and guying, removal of competing vegetation, a wood-chip mulch, and trimming to improve tree shape and compensate for root loss.

Post-installation work includes: weekly waterings, pest control work, and maintenance of the guying system and weed-free mulch areas. Both experience and experimentation have shown that of all of these requirements, the pruning and watering are the most critical steps in successful transplanting.

All transplants must have their live crowns reduced in direct proportion to the amount of roots that they lose during the digging operation. Improper or insufficient pruning results in massive crown dieback. Our experience has shown that 40 to 60 percent of a tree's crown must be removed in order to avoid this massive dieback.

Even with proper pruning, transplanting will still place most trees in a state of shock. When the trees are in shock, inadequate watering during the hot, dry, growing season will result in additional crown dieback. However, good growth can be maintained if water is applied in sufficient quantities on a regular schedule. Experimentation has shown that, in Minnesota, this watering involves supplying 100 gallons per tree per week during the two growing seasons following transplanting. One season of watering will reduce shock-induced dieback by 50 to 60 percent, but two seasons are needed to completely eliminate the problem.

Many factors must be considered when planning a tree transplanting project. These factors include soil type, rooting habit of the trees, slope of the ground, and susceptibility of tree species to destructive agents.

Mechanically, tree transplanting equipment operates best in sandy soils. However, sandy soil tends to fall away from the root system during transit to the planting site. Consequently, damage occurs to the root hairs, and this damage can kill the tree.

Trees are more difficult to dig out of heavier soils, but damage to the root system does not occur as readily. If trees must be dug from sandy soils, water should be applied to the root ball during the digging operation to plasticize the soil and keep it in the ball.

Soils at the tree source and the new planting site should be similar in texture. Complications can result if there is a significant difference between the soils at the two sites. When a tree is moved from a heavy soil to a sandy soil, water tends to

Massive crown dieback (50 to 75 percent) on 8-inch Burr Oak due to insufficient watering.