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Science serves your farm and home.

A. H. VanLandingham

Science

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COVER: Some 250 people from throughout West Virginia attended the Second Annual Animal Industry Field Day. The young man on our cover, Greg Arnott of Fairmont, is intent on his part of the program—junior livestock judging. (Photo by Dave Creel)

Science Serves Your Farm and Home will be sent free to any resident of West Virginia in response to a written request to the Director, Agricultural Experiment Station, West Virginia University, Morgantown, West Virginia 26506.

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Strawberry Production: High Net, But Some Problems

A. H. VonLandingham
Director

STRAWBERRY PRODUCTION in West Virginia has increased considerably since 1962, promising to become a new commercial enterprise that is well adapted to the State. Only relatively small areas of land are required but the soil must be fertile and productive.

Requirements for producing strawberries for home use or the local market are one thing, but for the commercial market they are something else. In order to meet the demands of the commercial market it is necessary to produce in sufficient quantities berries of high quality, good appearance and attractiveness which are able to withstand the necessary storage and handling. This will require cooperation among growers and markets.

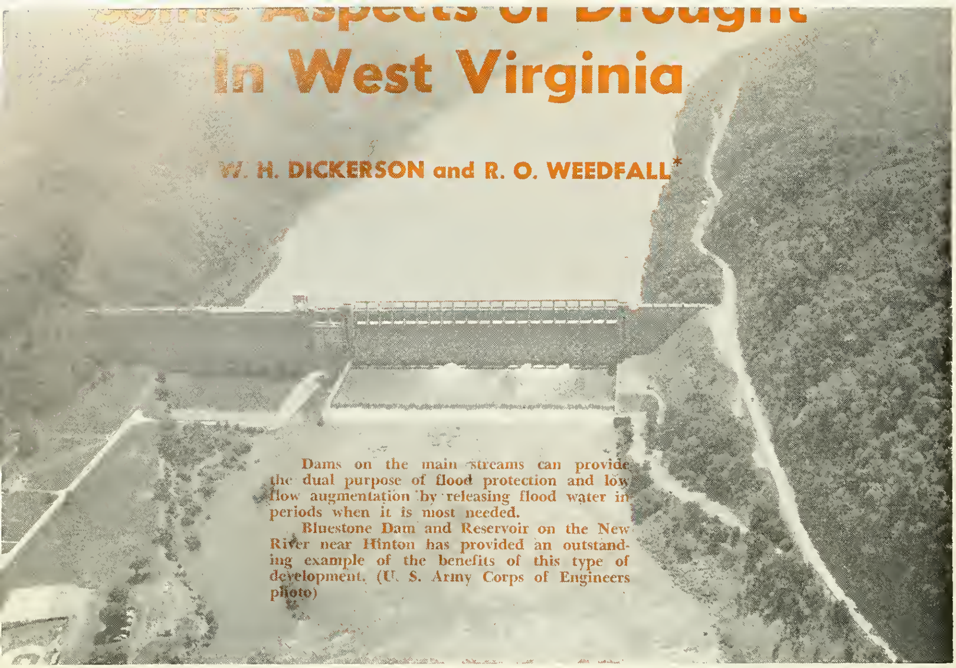
Strawberries can return about the highest net per acre of any crop in this area but there are many problems that must be solved. One or two varieties of high quality and good appearance is a must. Inasmuch as there is considerable difference in growth habits among varieties, such things as planting distances, space between rows, fertilizer needs, etc. must be considered. Late spring freezes frequently cause large reductions in yields. Many fruit and vegetable growers are using sprinkler irrigation for frost protection as well as for additional moisture in dry seasons very effectively. Thus, irrigation seems a must.

Mechanization, disease control, and insect control are also important factors in the development of this new enterprise. Our Agricultural Engineering Department has developed a new personnel carrier which looks promising for both cultivation and harvesting of the berries (p. 8, SSYF & H, April 1966).

During the past year we have activated a new research project on the production and mechanization of strawberries in which Horticulturists, Soil Specialists, Agricultural Engineers, Plant Pathologists, and Entomologists are all cooperating. This new project, in combination with research on post-harvest physiology and marketing already underway, should be of much value to this new industry.

Some Aspects of Drought In West Virginia

W. H. DICKERSON and R. O. WEEDFALL*



Dams on the main streams can provide the dual purpose of flood protection and low flow augmentation by releasing flood water in periods when it is most needed.

Bluestone Dam and Reservoir on the New River near Hinton has provided an outstanding example of the benefits of this type of development. (U. S. Army Corps of Engineers photo)

NUMEROUS DEFINITIONS of drought have been proposed but none has received general acceptance simply because it is not possible to define in terms that have the same meaning for all concerned. However, a definition that appeals to us was given by Professor A. Vaughn Havens (Weatherwise, Volume 7, 1954): "Lack of rainfall so great and long continued as to affect injuriously the plant and animal life of a place and to deplete water supplies both for domestic purposes and the operation of power plants, especially in those regions where rainfall is normally sufficient for such purposes."

As the definition by Havens implies, drought is harmful and costly to many segments of the economy but the most directly affected are agriculture and municipal and industrial users of water.

Drought is one of the most perplexing, troublesome, and costly features of the climate of West Virginia. With the development of several ski slopes in the State we have become aware of another aspect of drought—"snow drought" and how it affects the recreational industry.

Classification of Droughts

The understanding of drought may be improved, perhaps, by considering a classification

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suggested by John T. Carr in a study for the Texas Water Development Board (Texas Droughts, Report 30, 1966). Carr's categories were: (1) agricultural drought, (2) meteorological drought, and (3) hydrologic drought.

Agricultural drought in humid regions is experienced when rainfall is inadequate to maintain soil moisture at desired levels. Crop production is related to the plant species, soil, and other environmental factors in addition to soil moisture. This being the case, a decision as to when an agricultural drought starts or ends is a very subjective determination.

Nevertheless, agricultural drought is a real as well as a common occurrence, as any farmer can attest. Agriculture is especially vulnerable in that farmers are usually the first to be adversely affected. Indeed, a period of only ten to fourteen days without rain can drastically curtail the germination of seeds or the growth and maturation of some crops on some soils. The more shallow-rooted the crop and the smaller the available water holding capacity of the soil the greater is the vulnerability to drought. Thus a drought may exist for the farmer before it is even thought about in the meteorological or hydrologic sense, as explained later. Conversely, an agricultural drought may be ended, at least temporarily, by rainfall that replenishes the available soil moisture supply but does not add to ground water or stream flow.

Left: Land treatment which influences the intake of water by the soil or changes the evapotranspiration opportunity offers a limited means of reducing surface runoff or recharging ground water. In an experiment near Moorefield, subsoiling was accomplished by ripping the thinly bedded shale to a depth of 1½ to 2 feet, making the chisel marks on the contour. Observation of surface runoff and soil moisture changes are being made.

Bottom: Irrigation affords a means of maintaining soil moisture at desired levels. An adequate water supply must be available and careful attention must be given to selection of crops and management. Research by the University and practical experience by farmers are gradually establishing the information needed for using irrigation successfully in the State.

A meteorological drought may be described as a significant decrease from the expected or seasonally normal precipitation over a wide area and for a prolonged time. The situation is more severe and widespread than the local or short time variations in rainfall that can cause an agricultural drought. As defined above, an agricultural drought may exist because of poor distribution of rainfall when the total for the growing season or for the year is normal or above and no meteorological drought would be indicated. Hydrologic drought is still more widespread and severe, usually lasting for one or more years. It is reflected in the drying up of springs and small streams, the shrinking of rivers, and the depletion of water stored in lakes and reservoirs with an accompanying decline in ground water levels.

A definitive classification of drought was used by D. J. Fieldhouse and W. C. Palmer in a study covering the Northeastern United States (The Climate of the Northeast—Meteorological and Agricultural Drought, University of Delaware, Bull. 353, 1965). These investigators treated drought as a function of accumulated, weighted differences between rainfall and the rainfall requirement. The requirement was dependent on the carry-over of previous rainfall as well as on evapotranspiration, moisture recharge, and runoff. Thus, the average requirement is for average rainfall, but individual periods may require much above or below the expected value depending on the character of the prevailing weather. This concept was the basis for calculating drought index values that seem to correlate well with general crop conditions, forest fire danger, and water supplies in streams, lakes, and reservoirs.

Several communities in the State have availed themselves of the opportunity for providing a water supply in conjunction with the flood control activities on small watersheds by the Soil Conservation Districts and the Soil Conservation Service, U. S. Department of Agriculture. Water can be stored in periods of low evapotranspiration and high runoff to be released as needed in periods of low flow common to late summer and fall.

Causes of Drought

What happens when the usual course of events resulting in rainfall is aborted and widespread drought sets in for weeks, months, or years? Many theories have been advanced. Some of the current ideas that receive the most credence suggest that changes in the rainfall regime may be due to colder than usual temperatures in the oceans around North America, diminished changes in the large scale circulation of the air or a shift in the prevailing wind patterns, low sunspot activity, or changes in the climate caused by dust thrown into the air by volcanic eruptions.

Lunar influences also have been suspected of having an effect on rainfall, but no satisfactory physical explanation for this has been offered. Air pollution may be a factor tending to bring about climatic changes, including a shift in rainfall patterns, but here again the present understanding of the forces involved does not provide the basis for a satisfactory explanation of changes to be expected.

A common thread running through most theories is that variations in the energy from the sun are directly or indirectly responsible for changes in the climate.

The immediate synoptic patterns accompaning drought in West Virginia can be observed as a slowdown or failure in the flow of moisture-laden air from the Gulf of Mexico or the Atlantic Ocean, a change in the movement of frontal systems across the State, or the failure of coastal storms to follow a tract that will bring moisture into that portion of the State east of the Allegheny Front.

In recent years there seems to have been a greater frequency of anticyclones moving across the northeastern United States during the warm months. The more frequent invasion of cool dry air could be expected to interfere with the summertime rainfall associated with the flow of moist, tropical air from the Gulf of Mexico as it moves across the State.

Weather Cycles

So much has been written and said about weather cycles that any discussion of drought is not complete without some reference to this complex subject. A British meteorologist is reported to have sorted out over 130 different cycles which various investigators have discovered in the weather records. One of the best known of these is the 35-year cycle advanced by Edward Bruckner, a Viennese climatologist. Another that has received much attention is the sunspot cycle which averages approximately 11 years but has been as short as 7 and as long as 17 years.

In pointing out how current weather sometimes seems to duplicate previous weather development Ivan R. Tannehill (Yearbook of Agriculture, 1955), explains how the surface weather map for November 8, 1913, was used as an analog to make a correct prediction of the storm and heavy snow that struck the northeastern United States on November 25, 1950.

Protection in the Future

The low average rainfall over the period 1953-66 is one of the most striking departures from normal to be found in the records. In some respects, however, the higher than average

McIntosh Appointed Chairman Agricultural Economics

Dr. Kenneth D. McIntosh has assumed the duties of Chairman of the Department of Agricultural Economics.

McIntosh, a native of North Carolina, holds a B. S. degree in Agricultural Economics from the University of Tennessee (1956) and M.S. (1957) and Ph.D. (1966) degrees in Agricultural Economics from the University of Wisconsin. Prior to taking a two-year leave of absence in 1961 to work on his doctorate, he worked in livestock marketing research, and he has authored or co-authored five major reports on his research in this area.

After returning to WVU in 1963, he began studies in land and water resource economics. From his findings here, he has authored three reports dealing with the use, quality, and access arrangements of privately owned hunting lands in West Virginia. (Two bulletins which have resulted are Bulletin 539, Hunting Quality of Privately Owned Land in West Virginia; and Bulletin 542, Posting of Land in West Virginia and Landowner Attitudes Regarding Posting, Hunting Fees, and the Hunter.)

McIntosh is associated with several educational and professional groups and is a member of Alpha Zeta, honorary agricultural fraternity, Gamma Sigma Delta, honor society of agriculture, and Phi Kappa Phi, national scholastic honorary. While studying at Wisconsin, he was the recipient of two fellowships: the Kemper Knapp Fellowship, and the Department of Agricultural Economics Fellowship. He is a veteran of six years service in the U.S. Air Force.

precipitation over the long period 1901-29 is equally unusual (although the period was interspersed with a few dry years). There seems little reason to believe that a drastic or permanent change in the weather is taking place.

The work by Fieldhouse and Palmer previously mentioned, as well as studies in progress by the writers, suggests that the State has always been subjected to wet and dry spells.

If the future weather is to have about the same "ups and downs" as the past, what prospect is there of forecasting these periods in advance? It must be admitted that if variations in solar energy seem to be the ultimate cause of variations in rainfall, it is not now possible to use this knowledge in a practical way to forecast the beginning, severity, or end of a drought period. And, in spite of all the interest, no clear-cut cycles or rhythms have been identified in the weather that can be used to foretell the future. Really good analogs which have been identified are not numerous, and the work involved in typing and classifying the weather has tended to discourage this approach.

Based on ideas advanced by Drs. Langmuir, Schaefer, Vonnegut, and others, developments in the late 1940's raised some hope that weather modification by cloud seeding could bring widespread relief from drought, increase precipitation over arid areas, eliminate lightning and hail as destructive manifestations of local weather and hopefully modify or steer tropical hurricanes.

In the past two decades, the interest in "rainmaking" has spread throughout the United States and indeed all over the world. This is not to say that there has not always been a lively and imaginative approach to rain-

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If Used Properly—

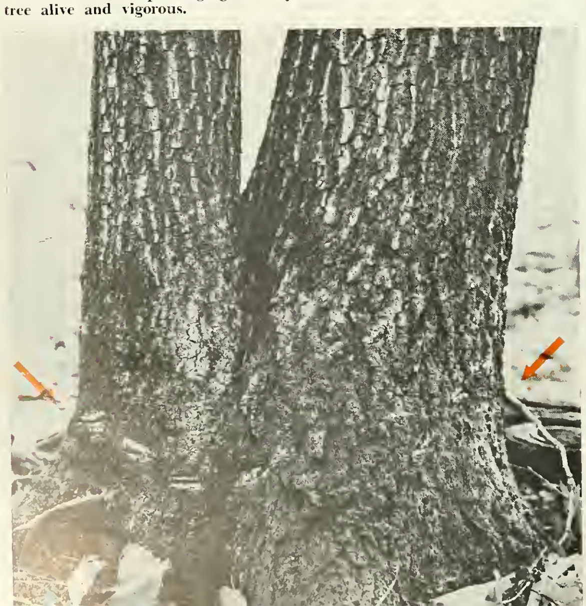
Tree Injectors Are Effective!

Kenneth L. Carvell and Franklin C. Cech

Silviculturist Assoc. Silviculturist

Figure 1. (Below) The interval between incisions (arrows) must not exceed the width of the injector blade. This tree should have been injected above the fork, and the spaced incisions should encircle each stem.

Figure 2. (Right) When the interval between incisions was increased to more than 1¼ inches, the intervening strip of wood and bark remained alive. One live strip bridging the injection band is sufficient to keep the tree alive and vigorous.



making throughout recorded history. A large number of carefully planned studies are now in progress on various aspects of weather modification. The results to date suggest that relief from the vagaries of the weather through this means is not imminent, although there may be some hope of success in the future.

The conclusion seems plain, then, that protection from drought and augmentation for water supplies in West Virginia will have to be dependent on conventional methods for the foreseeable future. Alternatives, such as irrigation for agriculture and the storage of surface water in reserviors or the drilling of more and deeper wells, are well-known which can alleviate or eliminate the shortage of water caused by a drought in West Virginia's humid climate. For those concerned with the skier, artificial snow can be produced by introducing compressed air into a stream of water as it emerges from a nozzle when air temperatures are well below freezing.

All of the methods of combating drought are expensive, so costly in some cases it may be out of the question to apply the remedy. The one exception, perhaps, is that users are generally willing to pay the cost of water for strictly domestic purposes, that is for drinking, cooking, and bathing. Agricultural and industrial interests develop in, or move to, locations affording favorable supplies. For this reason, it is essential that more attention be directed to evaluating and developing water supplies.

As the demand for water increases, the problems involved in the selection and development of adequate supplies will necessarily become more complex. It is in this context that research in climatology-hydrology can hopefully provide knowledge that will make possible an improved utilization of the water resources of the State.

Figure 3. After striking the tree with the injector (left), the unit must be lowered before the handle for releasing the herbicide is depressed (right). If the handle is not lowered, much of the chemical is deposited on the bark above the incision, not on the exposed wood.

INJECTOR TOOLS for applying herbicide to unwanted trees have been available commercially since the mid-thirties, but they have gained wide acceptance only during the past five years. The most recently-designed injectors are lighter, easier to operate and clean, and give more effective, economical control of woody vegetation than do the earlier models.

Because of conflicting reports about the effectiveness of injectors for eliminating unwanted hardwoods, and the amount of sprouting from stumps and roots following the death of the bole and crown, systematic experiments have been conducted at the West Virginia University Forest in Preston County to determine the value of injectors for stand improvement work in hardwood types. These tests were designed to discover which hardwood species are most resistant, and a suitable interval to leave between adjacent incisions.

Description of Research Area

The forest area selected for these tests occupies a north-facing slope. The even-aged hardwood stand was 30 years old, and consisted of single sprouts, twins, and scattered multiple-stemmed sprout clumps. Test plots were established on lower-third, middle-third, and upper-third slope positions. In this way a larger number of species could be included in the study and the effect of moisture conditions could be observed.

The lower slope position consisted primarily of yellow-poplar (**Liriodendron tulipifera** L.), northern red oak (**Quercus rubra** L.), white oak (**Quercus alba** L.), and red maple (**Acer rubrum** L.) with occasional cucumbertree (**Magnolia acuminata** L.), chestnut oak (**Quercus prinus** L.), and black cherry (**Prunus serotina** Ehrh.). On the middle-third plots, northern red oak, white oak, chestnut oak, and red maple predominated with sassafras (**Sassafras albidum** (Nutt.) Nees), blackgum (**Nyssa sylvatica** Marsh.), black birch (**Betula lenta** L.), and black locust (**Robinia pseudoacacia** L.) associates. Sassafras and black locust formed the major species on the upper-third slope, but there was a strong component of oaks and red maple on these sites.

The small understory trees on this slope included flowering dogwood (**Cornus florida** L.), witch-hazel (**Hamamelis virginiana** L.), serviceberry (**Amelanchier arborea** (Michx. f.), and hawthorn (**Crataegus** spp.).

The stand was heavily-stocked, and the vigor and condition of most trees were excellent. Ordinarily trees of this condition would not have been eliminated; however, methods of introducing superior hardwood planting stock were being investigated. Immediately following the injector treatment, black walnut (**Juglans nigra** L.), black cherry, yellow-poplar, and northern red oak seed or seedlings were planted.

Procedure

Three one-quarter-acre plots were established on each slope position. During April 1965 all of the woody vegetation one inch and larger in diameter at the root collar was treated, a total of 1,763 treated stems.

A standard "micro" tree injector was employed. Micro tree injectors are designed to release a minute amount of undiluted concentrate in the incision. The blade of this tool is 1¼ inches wide. Between successive incisions an interval equal to the width of the injector blade was left untreated.

Trees one inch in diameter and smaller received only one injection; trees larger than one inch in diameter received more.

Undiluted 2,4-D, triethyl amine formulation, was used for this work. This formulation has proven as effective as the ester of the hormone-like herbicides for concentrate injection,

Figure 4. Where trees occurred in pairs or multiple-stemmed clumps, it was difficult to inject the inner faces, but these faces must be treated to assure success.

and the cost of 2,4-D amine is considerably lower than that of other hormone-like herbicide formulations. The herbicide discharge valve of the injector was adjusted to release one milliliter of undiluted herbicide into each incision.

April was selected for these tests, since there seems to be general agreement that the highest per cent kills are obtained in the early spring, presumably because physiological activity is greatest at this time. If the same treatment had been applied during the dormant season, it is anticipated that the per cent kill would have been slightly reduced.

Every effort was made to place the incisions as close to the root collar as possible. This allows greater penetration of chemical into the root system, and thus greater root kill and less sprouting occurs. Where twins and multiple-stemmed clumps occurred, it was often difficult to make injections on the face between adjacent stems, but every effort was made to follow the specified spacing between incisions around every stem in these clumps (Figures 1 and 2).

Results and Discussion

PER CENT KILL. In the fall of 1966, eighteen months after treatment, the number of dead, dying, and live stems was tallied. When stems failed to respond to treatment, the depth and spacing of the incisions was investigated to see whether improper treatment was the cause. The degree of sprouting from the root collar and roots was also recorded. Table 1 gives a summary of this evaluation.

These investigations indicated that where the interval between incisions was increased to more than the width of the injector blade, live strips of wood and bark persisted and kept the tree thrifty and vigorous. Often trees with only one live strip of wood bridging the band of injections appeared healthy, and showed no evidence of future decline and death (Figure 3).

Another common cause of low per cent kill was failure to insert the injector deeply enough to penetrate into the wood. In species with hard bark, such as chestnut oak, and species with thick layers of bark, such as white oak, it is essential to hit the root collar a particularly

Figure 5. In rocky country, boulders, and ledges often make it difficult to treat each stem properly.

TABLE 1

Evaluation of Injected Trees, 18 Months After Herbicide Application

Species	Total Number Treated	Number Dead	Alive (Poorly Treated)	Alive (Properly Treated)	Per Cent Kill (Poorly Treated Trees Omitted)
Scarlet oak	39	38	1	0	100.0
Aspen	30	28	2	0	100.0
Black cherry	76	75	1	0	100.0
Fire cherry	4	4	0	0	100.0
Hawthorn	5	5	0	0	100.0
Serviceberry	19	19	0	0	100.0
Black locust	8	7	1	0	100.0
Black birch	156	142	12	2	98.6
Northern red oak	183	164	16	3	98.2
White oak	114	109	3	2	98.2
Sassafras	376	351	21	4	97.8
Chestnut oak	277	226	45	6	97.4
Blackgum	99	90	1	8	91.8
Hickory	7	6	0	1	85.7
Witch-hazel	57	47	2	8	85.5
Dogwood	62	49	2	11	81.7
Yellow-poplar	43	27	5	11	71.1
Cucumbertree	46	23	11	12	65.7
Red maple	351	16	47	288	5.3
Total	1,952	1,426	170	356	80.6
Total (red maple omitted)	1,601	1,410	123	68	95.4

heavy blow with the injector to assure that the herbicide is deposited in the wood.

The low per cent kill for yellow-poplar and cucumbertree was somewhat surprising since these species give no trouble when frilled and treated with 2,4,5-T ester or amine. Investigation of those trees that appeared properly treated, but were still alive, indicated that the handle of the injector had not been lowered sufficiently after the injector had been inserted. Because of this, when the herbicide was released it probably was absorbed by the porous bark and did not contact the wood. It appeared that if the injector handle had been properly lowered, a much higher per cent kill might have been obtained for these two species (Figure 4).

The low per cent kill for witch-hazel is attributed to the close spacing of the small stems within each clump, making it extremely difficult to inject stems on the inner face. Where witch-hazel stood alone, it responded to treatment satisfactorily.

Table 1 indicates that the herbicide and rate of application was adequate for the majority of the species included in this study. The low per cent kill for red maple was not surprising, since this tree is generally considered one of the most difficult to kill regardless of the herbicide and method of application employed. It is anticipated that a higher per cent kill of red maple could be obtained if continuous injections were made around the base of the bole. Such treatment would take more time, however, and involve greater cost. At the present time, studies on methods of obtaining higher kills of red maple are in progress.

SPROUTING. In the fall 1966 evaluations, the number of root suckers or sprouts from the injected trees was recorded. Whenever either natural or artifical regeneration is desired in the openings created by the dead trees, sprouts from roots can be a serious objection to any herbicide treatment, since fast-growing sprouts compete strongly with tree seedlings for light and moisture. Therefore, when preparing for planting or natural seedlings the amount of sprouting is very important. On the other hand, where scattered cull trees are injected in pole-sized, even-aged stands, and it is anticipated that the crown openings will be filled by expansion of the surrounding crowns, the degree of sprouting from treated trees is of little importance. Table 2 gives the per cent of the total number of treated stems that produced sprouts.

It appears that sassafras is the only species that, when properly injected, produces sufficient root suckers to interfere with seedling establishment. Although the apparent kill (Table 1) for sassafras is high, it may be that more herbicide must be applied to obtain sufficient penetration throughout the root system.

HERBICIDE COST. Table 3 was prepared to show the comparative costs of herbicide for frilling and injecting. These figures indicate that the herbicide cost for injecting is somewhat greater than for frills. This does not imply, however, that frilling is necessarily less expensive than injecting, since costs for labor for each method would have to be determined before a true comparison could be made.

TABLE 2

Per Cent of All Treated Trees That Produced Root Sprouts

Species	Per Cent of Total Trees that Produced Sprouts
Sassafras	64.9
Chestnut oak	36.8
Red maple	24.7
Cucumbertree	23.9
Witch-hazel	21.1
Northern red oak	18.6
Scarlet oak	12.8
Black locust	12.5
White oak	9.6
Black cherry	7.9
Hickory	0.0
Aspen	0.0
Black birch	0.0
Fire cherry	0.0
Yellow-poplar	0.0
Blackgum	0.0
Hawthorn	0.0
Dogwood	0.0
Serviceberry	0.0

TABLE 3

Herbicide Costs for Frilling at a Convenient Chopping Height Versus Injection at the Root Collar[1]

Diameter Breast High	Frills (dosage)[2]	Cost of Herbicide for Frills	Number of Injections	Cost of Herbicide for Injections
inches	*cc*	*cents*		*cents*
4	38	0.47	8	0.82
6	56	0.69	10	1.03
8	75	0.92	13	1.34
10	94	1.16	15	1.54
12	113	1.39	18	1.85
14	132	1.62	20	2.06
16	151	1.86	23	2.36
18	170	2.09	26	2.67

[1]Based on current costs of $11.64 per gallon for 2,4,5-T ester formulation for frills, and $3.89 per gallon for 2,4-D amine formulation for injection.

[2]The dosage of 2,4,5-T ester, 2 per cent (weight of acid) in a water carrier at the rate of 3 cc per inch of circumference.

Weed Control and Zoysia Meyer (Z-52)

O. E. Schubert, C. W. Collier, and G. E. Steyers

*Schubert is Horticulturist; Collier is State Extension Specialist—Landscape Architecture; and Steyers is University Landscape Architect.

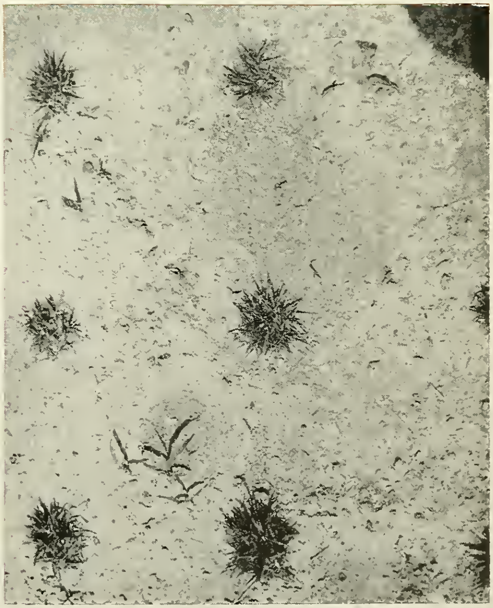
The authors are indebted and grateful to Jerry Andrick, Computer Programmer, for his assistance with the analysis of data. The cooperation of the following companies in supplying the herbicides used in this experiment is also gratefully acknowledged: Diamond Alkali Company, Eli Lilly and Company and Geigy Agricultural Chemicals. Appreciation is also expressed to Summit-Hall Turf Farms, Gaithersburg, Maryland, for supplying the Zoysia grass plugs.

INTEREST IN the use of special grasses for specific purposes has increased greatly within the past few years. One of these grasses is Zoysia Z-52 (Meyer's Strain). Though not widely used or recommended in West Virginia, it does possess certain qualities which lend themselves to fulfilling specific requirements and conditions — planting on heavy clay soils, in full sunlight, or to provide contrast in a landscape design. Zoysia grasses may also be mowed close, and, once established, are almost weed free.

Zoysia grass is by nature a slow-growing, warm-season grass, and West Virginia is considered a borderline state for its cultivation. Weed control, therefore, is vitally important in order to give the grass the best possible chance to become established within a short growing season. Zoysia lawns started from small plugs of sod may fail to become established or their growth may be greatly retarded due to weed infestation.

The method of planting Zoysia grass (2-inch plugs spaced 6 to 12 inches apart) allows considerable open space in which weeds may grow. For the first few weeks the weeds may be removed by hoeing. Later, however, new growth of the grass may be cut off or seriously

Figure 1 (left). Check, or untreated Zoysia grass plot, six weeks after plugging into freshly-tilled soil. Barnyardgrass, crabgrass, and common ragweed were the most prevalent weeds in this plot. Figure 2 (right). Simazine-treated Zoysia grass plot six weeks after plugging into freshly-tilled soil. Weed control was excellent.



injured by using this method. Hand-weeding then becomes necessary. If weeding is neglected and the weeds are allowed to mature before removal, stolons may be damaged or even Zoysia parent plugs may be pulled from the ground along with the weeds, as the root systems may be interwoven.

In 1964, three pre-emergence herbicides applied before and after plugging were evaluated. Previous experience determined that the best time to apply herbicides is when the soil is free of established weeds; in this case, at the time of planting, when the soil has been properly prepared.

METHODS AND MATERIALS

About the middle of June, 1964, two plots were prepared (Plot A—pre-plugging treatments on a silty clay loam, and Plot B—post-plugging treatments on a heavy clay loam) for the evaluation of the herbicide program. The soil in each plot was broken up with a rotary tiller, raked smooth, and firmed slightly. Organic matter, lime, and fertilizer were added to each plot according to soil fertility practices.

Each plot was divided into 16 four-foot squares (16 sq. ft. each) for treatment and plugging. The treatments were assigned at random within each of the four replications. Measured aliquots of herbicide spray were applied one at a time so each plot would receive the designated application rate. A two-gallon compressed air sprayer was used in applying the herbicides.

The herbicides, formulations, and application rates were as follows: (1) DCPA 75wp (dimethyl 2,3,5,6-tetrachloroterephthalate) at 12 lb/A ai (12 pounds per acre calculated as active ingredient); (2) simazine 80wp [2-chloro-4,6-bis(ethylamino)-s-triazine] at 2 lb/A ai; and (3) trifluralin 4ec (**alpha, alpha, alpha**-trifluoro-2,6-dinitro-**N,N**-dipropyl-**p**-toluidine) at 1 lb/A ai. All herbicides were applied as a spray to the soil surface. Trifluralin was incorporated into the soil with a garden rake. A special tool for removing a core of soil two inches in diameter was used to make holes to receive the Zoysia Z-52 (Meyer's Strain) plugs with a minimum of disturbance to the treated area.

Immediately after setting, these plots were given about one inch of water with an oscillating sprinkler. No additional water, other than rainfall, was added during the remainder of the growing season.

RESULTS AND DISCUSSION

PRE-PLUGGING HERBICIDE APPLICATIONS

A small amount of injury was noted as a slight brown discoloration about two to three weeks after treatment in the trifluralin plots. These symptoms were no longer evident at the end of the first month. No injury was observed from simazine or DCPA applications.

The predominant weed species found in check plots were: smooth crabgrass (**Digitaria ischaemum**); barnyardgrass (**Echinochloa crus-galli**); annual bluegrass (**Poa annua**); Purslane (**Portulaca oleracea**); common ragweed (**Ambrosia artemisifolia**); galinsoga (**Galinsoga cili-**

TABLE 1

Average Weights of Weeds Pulled from Zoysia Plots Given Various Herbicide Treatments

Treatment and Rate (ai)	Pre-Plugging Applications (Weeds Harvested Aug. 19-20, 1964)		Post-Plugging Applications (Weeds Harvested Aug. 20-28, 1964)	
	Broadleafed Weeds (grams/plot)	Grassy Weeds (grams/plot)	Broadleafed Weeds (grams/plot)	Grassy Weeds (grams/plot)
Check	772[1]c	2658c	16a	3312ab
DCPA 12 lb/A	130b	356b	47a	2314ab
Simazine 2 lb/A	2a	46a	0a	4901b
Trifluralin 1 lb/A	438bc	370b	50a	1276a

[1]Averages followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

TABLE 2

Average Minimum Diameter of Zoysia on May 20, 1965, from Plugs Set June 15, 1964 After Spraying with Herbicides

Treatment and Rate (ai)	Diameter of Zoysia May 20, 1964	Average Per Cent Increase in Area Covered by Zoysia Over Check Treatment
	(*inches*)	
Check	3.1[1]b	0b
DCPA 12 lb/A	3.6a	60a
Simazine 2 lb/A	3.8a	86a
Trifluralin 1 lb/A	2.9b	−21b

[1]Averages followed by the same letter are not significantly different from each other according to Duncan's Multiple Range Test at the 5 per cent level.

ata); ladysthumb (**Polygonum persicaria**); and carpet weed (**Mollugo verticillata**).

On August 19 and 20, 1964, the weeds from individual plots were pulled and weighed. The treatment averages are shown in Table 1. The best control of broadleaf and grassy weeds was in the simazine plots. Simazine at 2 lb/A was significantly better with respect to weed control than the DCPA and trifluralin plots. Trifluralin was better than the unhoed check for the control of grassy weeds.

By the following spring many of the Zoysia plants had stolons reaching adjacent plugs. The order of treatments with respect to production of new stolons, from largest to smallest number, was simazine, DCPA, trifluralin and check. Considerable heavy growth of leaves and stolons from the original plug increased the "mat" of Zoysia which would be capable of competing with most weed species. On May 20, 1965, the minimum diameter of the dense portion of each plant was measured. The Zoysia plants in the simazine and DCPA plots were significantly larger in diameter than those of the check and trifluralin plots (Table 2). If the new growth (beyond the two-inch plug) were calculated as the area of a circle, then the additional area covered by new growth was 60 and 86 per cent greater for the simazine and DCPA plots, respectively, than for the check plants. The growth from plants in the trifluralin plots did not differ significantly from the check plants.

Buckhorn plantain (**Plantago lanceolata**) and broadleaf plantain (**P. major**) were found in these plots in addition to the weeds listed previously for the pre-plugging treatments.

POST-PLUGGING HERBICIDE APPLICATIONS

Broadleafed weeds were not a problem in any of these plots and no differences were noted (Table 1). Although trifluralin controlled grassy weeds better than simazine, the degree of control was not judged good. Simazine and trifluralin applied topically after setting caused a slight amount of injury. The plants recovered well, so little evidence of injury was observed later in the season. It is possible that transplanting shock may have influenced the apparent degree of injury.

SUMMARY

Simazine at 2 lb/A ai was most promising for the control of weeds in a freshly tilled soil which was subsequently plugged with Zoysia Z-52 (Meyer's Strain). Crabgrass and other grassy weeds may be a problem under some conditions in simazine-treated plots. DCPA and trifluralin gave marginal weed control. Herbicides applied before plugging resulted in greater growth of parent plugs and new stolons than where herbicides were applied after plugging.

Financial Statement for the Year July 1, 1965 to June 30, 1966

Classification of Receipts and Disbursements	Hatch	Hatch RRF	McIntire-Stennis	Non-Federal Funds	Total
RECEIPTS					
Received from the Treasurer of the U.S.	$701,976.00	$129,508.00	$51,829.00	....	$ 883,313.00
State appropriations:					
Main Station	....	....	....	$ 578,623.85	578,623.85
Special:					
Oak Wilt Research	....	....	....	9,705.66	9,705.66
Forest Products Development	....	....	....	66,746.56	66,746.56
Special endowments, fellowships and grants:					
Private corporations:	....	....	....	27,600.00	27,600.00
Fees	....	....	....	....	....
Sales	....	....	....	217,534.57	217,534.57
Balances forward July 1, 1965	....	....	1,316.59	131,293.67	132,610.26
Total Available	$701,976.00	$129,508.00	$53,145.59	$1,031,504.31	$1,916,133.90
DISBURSEMENTS					
Personal services	$513,881.63	$ 94,825.57	$42,305.75	$ 534,900.33	$1,185,913.28
Travel	19,768.43	3,295.61	1,015.08	13,817.02	37,896.14
Equipment	58,279.52	21,527.49	7,766.05	42,443.98	130,017.04
Personal benefits	....	....	....	3,575.07	3,575.07
Supplies and materials	80,456.94	8,678.59	1,121.38	184,318.06	274,574.97
All other	29,589.48	1,180.74	937.33	101,827.07	133,534.62
Total Disbursements	$701,976.00	$129,508.00	$53,145.59	$ 880,881.53	$1,765,511.12
Unobligated Balances Available for 1966-67	....	....	....	$ 150,622.78	$ 150,622.78