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SUMMER 1970

BETTER TURF THROUGH RESEARCH AND EDUCATION

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The U. S. NITROGEN INDUSTRY

*a review
of what
happened
and why?*

When the profitability of an industry as basic as the U. S. fertilizer industry deteriorates to the point where it is today, it is superficial to simply accuse management of poor judgment in overbuilding and underpricing. Some elusive and complex factors have clearly been at work to permit such a situation to develop.

The investment in ammonia production facilities is probably greater than for any other fertilizer product, and many of the factors that resulted in the industry-wide deterioration developed initially within the ammonia industry. Let us analyze what has happened in this sector, examine the various factors in these developments, and look at the prospects for near-term recovery.

Simply stated, productive capacity has increased at a substantially faster rate than total demand. Individual companies in the industry reacted with the classic remedy of the free enterprise system—drastic price reductions in a competitive effort to maintain or develop their individual sales volumes. Because of the relative inelasticity of nitrogen fertilizer sales, there was little expectation that a general price reduction would increase the total market measurably. Predictably, the price reductions by the individual companies worked to their advantage in only a few cases. In total, they essentially destroyed the profitability of an entire industry.

Price reductions have stemmed the buildup of further capacity since returns on investment in production facilities at current price levels are clearly insufficient to support financing of new plants and to assure minimum acceptable returns on new investment. Current high

interest rates are an additional damper on new construction.

Before further analysis, we should consider developments in the ammonia industry during the past decade.

Ammonia capacity at the end of 1959 stood at about 5.5 million short tons per year. In the next decade, 14.9 million tons of new capacity were added, and at least 2.7 million tons of uneconomic production were shut down. The net capacity after these shutdowns increased by a factor of 3.2 in this ten-year period, for an average net annual increase of 12.5% per year.

During this same decade, the domestic consumption of nitrogen fertilizers (the principal demand component for ammonia) has increased by a factor of 2.5, averaging an annual increase of just under 10% per year.

This difference in growth rate may not seem great but, when compounded over ten years, the differences are substantial. The chart shows the growth in net ammonia capacity in the U. S., together with the growth in agricultural consumption of nitrogen fertilizers, and also indicates the proportion of total capacity represented by agricultural consumption. This is obviously not a net supply/demand relationship since additional supplies of nitrogen fertilizer are obtained through imports and by-product sources, and additional demand components are found in industrial use and exports. However, these factors do not materially alter the total picture, and the chart gives a graphic picture of the extent of the overbuilding.

The predictable result of this overcapacity has been a drastic fall in prices of nitrogen fertilizers.

*This article was prepared by
George C. Sweeney, Jr., Arthur D.
Little, Inc., Cambridge, Massachusetts*

(Continued on Page 4)

(Continued from Page 3)

The combined effort of the lower prices and below capacity operation in many plants has been a catastrophic drop in profitability with many companies operating substantially in the red. To date efforts to increase prices have been notably unsuccessful, and the industry seems to have resigned itself to waiting until consumption increases and further plant shut-downs bring the supply/demand situation into better balance.

Two basic questions can be asked. First, how did it happen that this massive overcapacity developed? Second, does an industry such as the fertilizer industry have no recourse other than self-defeating price reductions?

Let's look at the first question. Overcapacity was not an over-night phenomenon. On the contrary, it developed steadily over a period of several years. What was happening was apparent to many in the

industry but new construction nevertheless continued.

Several factors, to an extent independent, but interacting to a substantial degree led to this unfortunate situation.

—A new generation of ammonia plants was developed based on the use of centrifugal compressors and with costs very much lower.

—A substantial overoptimism developed regarding the future growth rates in the consumption of nitrogen fertilizers, both in the U. S. and throughout the world.

—Many new companies entered the fertilizer industry, and a new group of decision-makers with relatively little experience in the industry were in charge of much of it.

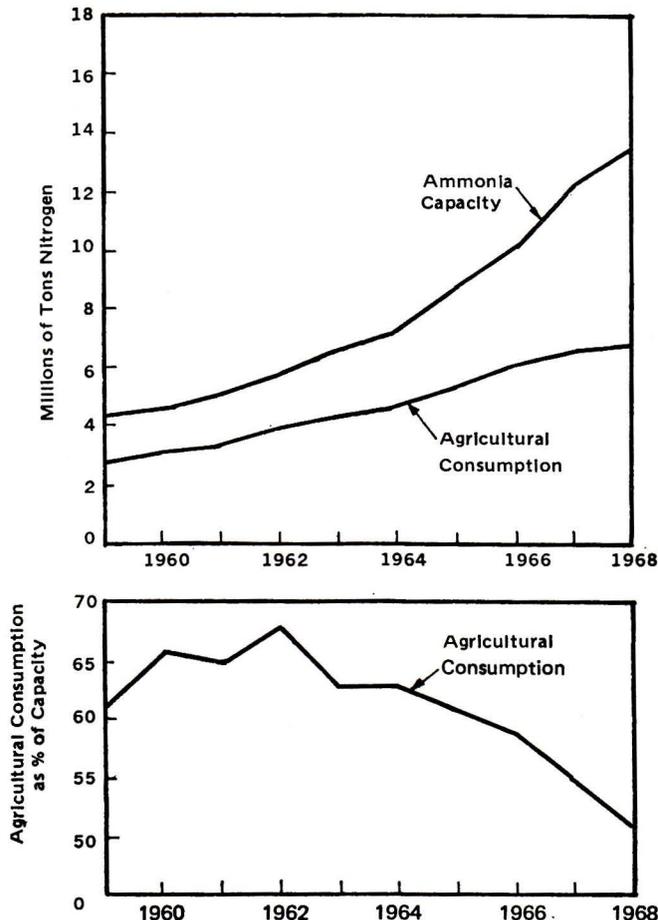
The technological breakthrough, based on the use of centrifugal compressors is perhaps the most easily identifiable factor. Through the introduction of this more efficient compressor, and other refine-

ments in the ammonia manufacturing process, production costs were reduced substantially. Pressures to adopt this type of plant were felt both by those with higher cost ammonia plants, and those considering new production facilities. Unfortunately, these process improvements were only viable in large plants, with capacities of 600 tons per day or more.

The economics of the newer type of plant were so attractive and so compelling, that many companies tended to overlook the greatly increased output that these plants individually and collectively represented. Management thinking was production-oriented; attention was focused on potential cost reductions, and marketing considerations were secondary.

This lack of concern for potential marketing problems was partly the result of the second factor, an overly optimistic view of the future growth in demand for nitrogen fertilizers. Many companies, particularly in the oil, gas, and chemical fields, had "discovered" fertilizers and were persuaded that they represented a major answer to the well publicized world population explosion. These companies were not alone: organizations such as the United Nations and major financial institutions echoed the feeling that major breakthroughs in the rate of increase of fertilizer consumption were just around the corner. Thus, little concern was felt for the additional volumes of fertilizer that would be coming from the larger plants. There presumably would be no problem disposing of almost unlimited quantities to developing countries, and fertilizer consumption would grow at unprecedented rates.

Unfortunately, few examined the basic arithmetic of this premise. In 1961, nitrogen fertilizer consumption in the 35 easily-identifiable "developing" countries (including Mainland China) comprised only 17% of world fertilizer nitrogen consumption. Even the most optimistic growth rates in these coun-



U.S. AMMONIA SITUATION

tries would affect world nitrogen consumption growth rates to only a minor degree.

Domestically, the same optimism seemed to prevail. There was a tendency to look at growth rates in the better years (16% in 1963) as normal, and to lose sight of the fact that in any span of years there are normally years of slow growth as well (6% in 1965).

This heady optimism for the future of fertilizers fed on itself as it attracted new companies with no previous experience to the industry. These newcomers compounded the situation by continuing to forecast bright growth opportunities, and the stampede was on.

By 1968, some 42 oil, gas and chemical companies owned 73% of the total U. S. ammonia capacity. For most of these companies, fertilizers represented only a small portion of these total corporate activity.

In many instances, the decision to install nitrogen plants stemmed not so much from a misreading of the growth of the total market for nitrogen fertilizers, as from an underestimation of the difficulty in carving out the necessary share of the overall market. The trend towards vertical integration to controlled retail outlets was well-developed, and many apparently felt that the installation of an appropriate number of such nitrogen fertilizer stations would almost automatically develop the required market tonnage.

Most of these companies, particularly the oil and gas companies, had ample cash flows to support the large investments necessary both in plant and retailing facilities, a marked change from the capital-short industry of the mid-1950's. They also felt the incentive to upgrade their basic hydrocarbon resources to a higher-value product.

Adding to the confusion was a major shift in the type of fertilizer products and nature of fertilizer distribution. Use of anhydrous ammonia and nitrogen solutions was growing far more rapidly than solid

nitrogen fertilizers, and required totally different types of distribution and marketing organizations. Similarly, local retailing outlets in the form of bulk blending stations and liquid mixed fertilizer plants were displacing the conventional dealer type of distribution. The extent and speed with which these new products and modes of distribution would dominate the industry were not at all clear.

For these reasons, the nitrogen industry rapidly developed a production capability far in excess of requirements, not only in basic ammonia plants, but also in retailing facilities. The result has been a major drop in prices for nitrogen products over the last two years.

The second and more fundamental question is "Could the industry have been expected to cope with this situation in any other way?" Unfortunately, it is difficult to find an alternative course of action that the industry or individual companies could reasonably have been expected to pursue. This may, in fact, be a fundamental weakness of the workings of our economy in such a drastic surplus situation. Management is being castigated for lack of statesmanship in using price reductions to cope with this situation, and much is being said about the need for more sophisticated total marketing efforts, using service, rather than price, as the focus of sales programs.

There is little opportunity for product differentiation in the quality of materials offered by the various products—ammonia and nitrogen fertilizers are, with minor exceptions, essentially the same product regardless of the plant in which they are produced. Up to the present, the amount of service which could be offered by individual producers to the farmer has not been sufficiently important to overcome more than a minor difference in price. It is likely that this will continue.

The production of ammonia and derivatives involves a relatively high fixed investment per ton of

product, and therefore the pressure is great to operate at a high rate of design capacity. Furthermore, the new generation of ammonia plant can be throttled back only to a limited extent, and either has to operate close to design capacity, or be shut down. Thus, it was not difficult to rationalize pricing policies that hopefully would permit sales of total plant capacity.

The pressure on prices acted from two directions. New producers, in view of their number, could not hope to obtain important markets solely through serving new consumers. They had to penetrate markets held by existing manufacturers and price cutting was the principal tool. Defensively, established producers were forced to go along with these prices to protect their existing markets. The emphasis on pricing as the principal competitive tool was aggravated by the highly seasonal nature of fertilizer sales, and the need to act within a very short period of time.

In retrospect, it was probably inevitable that this pricing action followed the developing overcapacity. Other commodity industries in the U. S. would probably react in a similar manner to such a massive buildup in excess production facilities.

Therefore, it appears that the basic errors in judgment were those leading to the overcapacity, rather than in relying solely on pricing action to cope with it. Once the overcapacity was in operation, there was probably little else the industry could have done.

The lesson which might be drawn is that attention must be focused on the orderly development of new construction at the proper pace, compatible with the rate of increase in demand, rather than on a futile search for less traumatic ways in which to cope with such a situation.

In retrospect, it is not surprising that an industry undergoing a series of diverse and fundamental changes fell victim to basic errors of judgment. It is, however, highly un-

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likely that the industry will go through a coincident series of changes of this magnitude in the foreseeable future, although cycles of profitability and supply/demand balance will undoubtedly continue as in any industrial sector.

It also seems quite clear that a substantial recovery from current price levels will develop within two to three years. The rate of growth in consumption of nitrogen fertilizers will continue at a healthy level, although perhaps not at the sustained growth rate shown during the past 20 years. Within two or three years, demand will have increased to the point where the construction of additional plants will be necessary.

Additional capital will have to be found for these projects, and prices will have to provide minimum acceptable returns on this new capital. Therefore, through the classic workings of our economy, prices will be forced to higher

levels. This may take place prior to the development of a national shortage, and permit the orderly construction of new plants to meet the increasing demand. Or, price recovery may be delayed until an actual shortage develops. In any case, it is difficult to see a continuation of present price levels indefinitely.

It also seems unlikely that an over-capacity of the current magnitude will develop again. While there may be continued misjudgments as to the size of future markets, it is not likely that such another wholesale change in the character of the industry will take place. Some of the disenchanted may leave the industry as precipitously as they entered, but it seems probable that the present companies will continue in their dominant positions. Furthermore, it seems unlikely there will be further technological developments that will have the impact of the introduction of the centrifugal com-

pressor, although caution is always advisable in anticipating technological progress.

On the other hand, while future profitability cycles are unlikely to fluctuate as widely as in recent years, the industry will continue to be burdened with some rather unique operational problems: the vulnerability in demand to adverse weather conditions, and the extreme seasonality of demand. Farm cooperatives will probably maintain their important share of the industry, and this competitive aspect will continue. While it will not be an easy industry in which to operate profitably, it does have a basically attractive growth rate compared with many, and there is little danger from technical obsolescence that many industries continually face.

But let the lessons learned—more realistic market appraisals and a better balance between production and market judgment—not be forgotten.

—Reprint from *Agricultural Chemicals*, Vol. 25, No. 2

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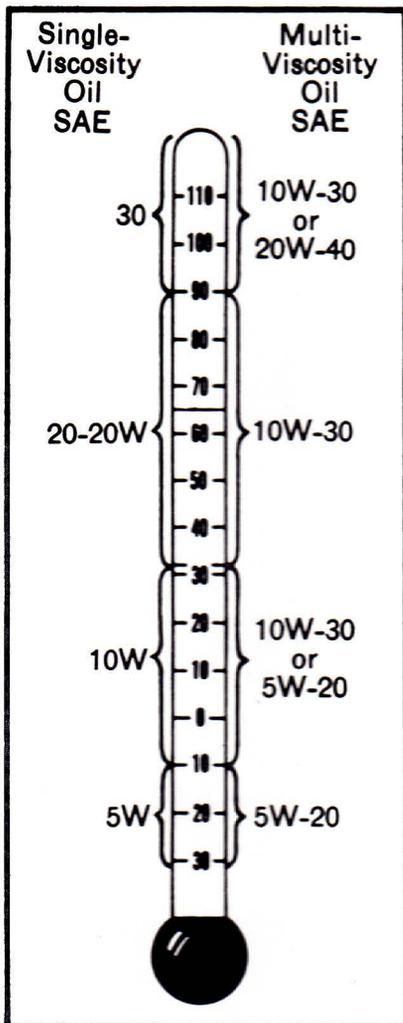
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Learn the oil alphabet



—Reprint from *Big Farmer*, Vol. 42, No. 1

LEARN the oil alphabet! Why? So you can pass the information along to your service personnel. You can save time when changing oil or buying oil if you are familiar with the oil alphabet or service classifications.

It's especially important to memorize these alpha codes when you keep oil for both diesels and gas tractors. Such knowledge will protect the engines you depend upon.

Oil fights wear and friction. It prevents scuffing and scoring of metal parts. It absorbs shock and provides rust protection. It keeps parts clean and helps cool the engine. It can't foam or thin out when heated. It's a big job—this job of protecting your machinery investment. So frequent, regular oil changes are insurance.

Your operator's manual is the place to start. It spells out the proper oil for your needs by recommending oil service classifications. Then you purchase oil which meets these requirements.

Letter combinations like MS and DS are service classifications devised by the American Petroleum Institute. They are divided into gasoline (M) and diesel (D) classes. Here's what they mean:

ML—for spark ignition engines doing light and favorable service. This includes light trucks and tractors.

MM—for spark ignition engines that have trouble in controlling deposits or bearing corrosion when crankcase temperatures are high. This covers farm tractors, trucks, autos and engines on balers, combines and forage harvesters.

MS—for spark ignition engines having special lubrication requirements for controlling deposits or bearing corrosion because of operating conditions, fuel or design characteristics.

DG—for diesel engines with no severe requirements. This covers some wheel and crawler tractors plus stationary engines for generators, irrigation pumps and feed mills.

DM—for diesel engines with moderately high operating temperatures and loading.

DS—for diesel engines with high operating temperatures or severe loading. It's also used in engines using fuels or having design characteristics that tend to produce deposits or wear.

Some oil serves more than one classification. So manufacturers with oil suitable for more than one service

condition will classify said oil, for example, like this: "For service DG and MS." This means, in this particular case, this oil would be suitable for less severe service conditions in diesel engines as well as the most severe conditions in gasoline engines.

Since oil temperatures affect viscosity, viscosity tests are made with oil temperatures of 210° or 0° F.

Results of such tests are reported in terms of SAE viscosity numbers. The full range of these numbers is 5W, 10W, 20W, 20, 30, 40 and 50. Numbers with W's indicate that viscosity was measured at 0° while the others were measured at 210°. Each SAE viscosity number represents a range of acceptable flow. Thus, two different oils may have identical SAE viscosity numbers even though viscosity varies.

The ability of an oil to resist thinning as its temperature increases is called its viscosity index. An oil with a high viscosity index thins out less as temperature increases. Ideally, an oil should have a low viscosity at low temperatures to provide easy starting of an engine and a high index at operating temperature so it can provide maximum protection. See above.

Viscosity index improvers can be added during processing to light-bodied lubricating oils to provide the desired high viscosity index. This means an oil can meet low temperature requirements of SAE 5W as well as high temperature requirements of SAE 20. Such an oil is designated SAE 5W20. Other multiple viscosity oils, such as SAE 10W30 and SAE 20W40, are available.

In addition to viscosity, another characteristic, pour point, is important in cold weather operations. Wax in the oil may congeal at low temperatures and reduce the oil's ability to flow. Thus, pour point is a measure of the minimum temperature at which an oil should be used.—*Melvin E. Long*

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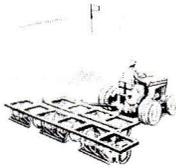
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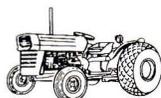
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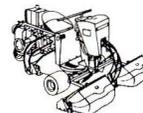
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Weed Control With Repeated Applications Of Tordon® Herbicides¹

By JOHN W. GIBSON²
The Dow Chemical Company

INTRODUCTION

A number of research workers have found that herbicidal mixtures containing picloram³ are effective for control of many broadleaf weed species, including such noxious plants as field bindweed (*Convolvulus arvensis* L.)
1, 2, 3, 4, 5, 6, 7, 8

This very aggressive perennial species is a drought-resistant weed with deep roots and low-growing, twining stems, and even small infestations can drastically reduce crop yields. Field bindweed spreads both by seeds and by lateral growth of underground parts. As a result the control of infestations in such areas as right-of-ways, roadsides, ditchbanks, on farm headlands and around buildings is almost as important as their control in grasslands and croplands, in order to prevent further spread of present infestations and to prevent establishment of new ones.

Field bindweed has been effectively controlled and established stands have been

eradicated with one application of TORDON herbicides as well as with a few other herbicides.^{1, 3, 4, 5, 6, 8} Single rate application for eradication usually is limited to use on small patches because of the relatively high cost.

The control of large areas of bindweed, as well as certain other perennial noxious weeds along highways, railroads, pipeline and utility rights-of-way, and in publicly-owned lands such as rangeland and forests has been limited to the use of less expensive materials such as 2,4-D. In the same sense, farmers who have large infestations of bindweed have been limited to the use of 2,4-D alone or in combination with intensive tillage for effective control. These practices are laborious since they call for frequent application and often are of limited effectiveness.

Earlier research has shown that repeated application of TORDON herbicide containing low rates of picloram will give effective control of bindweed.⁷ A practical and effective repeat-treatment program would permit the immediate containment and eventual control of large infestations over a period of years, with the cost spread over a longer period of time.

This study was undertaken to further determine the effectiveness of repeated applications of low rates of picloram and 2,4-D, each alone and in combination, for control of bindweed.

A second objective was to observe the effectiveness of these herbicides in controlling other perennial and annual weeds in connection with application for bindweed control.

The third objective was to determine the herbicidal effectiveness under field condi-

¹ These investigations were conducted with the cooperation and assistance of Mr. Gerald L. Crathorne, District Director and Herbicide Specialists, Noxious Weed Division, Kansas State Board of Agriculture; and Mr. Ed H. Foster, Weed Control Director, Reno County, Kansas. Their assistance, advice and loan of equipment is gratefully acknowledged.

² Formerly Regional Technical Specialist, Field Research and Development—Herbicides, Agricultural Department, The Dow Chemical Company, Oklahoma City, Oklahoma.

³ Picloram has been proposed by WSA as a common name for the chemical 4-amino-3,5,6-trichloropicolinic acid. Formulations of The Dow Chemical Company containing this active ingredient are designated with the trademark TORDON®

(Continued from Page 9)

tions from applications made by county-owned conventional field sprayer equipment with regular equipment operators.

EXPERIMENTAL PROCEDURES

The study site was a sandy loam soil with a uniform field bindweed infestation located near Pretty Prairie, Reno County, Kansas. The longtime average annual rainfall in this area is under 30 inches. Rainfall for 1965, 1966, 1967, and 1968 at the Hutchinson Station was about 30.11, 15.56, 30.62 and 29.60 inches, respectively.

Plot site was 21 feet by 1037 feet, or 0.5 acre. The plot design consisted of alternate treated and untreated strips, with each treated strip bordered by two untreated strips. This is essentially a paired plot design.

The herbicides were applied with a field power sprayer equipped with a 21-foot boom. Total spray volume varied from 20 to 35 gallons per acre. The rate of herbicide actually applied was within 10% of the intended rate. The materials were applied by regular operators in a routine manner under the constant observation of G. L. Crathorne and J. W. Gibson.

The initial application was made in October, 1965, using TORDON 22K and/or FORMULA 40® herbicides. In October, 1965, picloram was applied at rates of 0.25 lb., 0.5 lb., and 1 lb. ae per acre. 2,4-D was applied at rates of 1 lb. and 2 lbs. ae per acre. Combinations containing picloram at 0.25 lb ae plus 2,4-D at 1 lb. or 2 lbs. ae per acre were also included.

In October, 1966, the formulation now known as TORDON 212 Mixture became available and was applied at the rate of .5 lb picloram ae plus 1 lb. ae 2,4-D per acre. Retreatments using the same materials and rates were applied as needed. These retreatments were made only when the field bindweed was in good growing condition and with ample foliage growth needed for maximum effectiveness from 2,4-D foliage applications.

The test site was inspected in late spring and early fall of each year of the study. An evaluation by two observers was made independently if bindweed in the untreated checks had an appreciable amount of top growth. Observations on presence and growth of broadleaf weeds were also made.

The entire area was cultivated to control excessive growth of annual weeds and grass and, as far as practical to prevent the vegetation from setting viable seed. Usually the entire area was cultivated about 4 weeks after each herbicide application and once in midsummer if necessary to control weed growth.

RESULTS

The control of bindweed resulting from treatments involving several rates and combinations is presented in Table 1.

2-4-D Alone

Complete control of the established stand of field bindweed was not obtained with either of the 2,4-D rates, even with five applications. However, when 2 lbs. 2,4-D per acre was used, retreatment steadily improved the control as compared to retreatment with 1 lb. of 2,4-D per acre. The two treatments with 2,4-D were the only ones needing or receiving retreatment on May 27, 1969. A total of six herbicide applications have been made on the treatment areas using 2,4-D alone.

The primary tall-growing annual vegetation present in this study was kochia (*Kochia scoparia*). Both rates of 2,4-D gave control of all kochia which had emerged when it was treated.

Picloram Alone

Complete control of bindweed with 0.25 lbs. of picloram per acre alone was achieved with four applications applied over a 24-month period when evaluated six months after the fourth application. However, a fifth application was needed at the end of the third year to maintain this control. The control at the end of 42 months was almost complete.

The 0.5 lb. per acre rate of picloram alone gave at least 90% control at each evaluation date, with complete control noted at the 30-month evaluation date. At the last evaluation, 42 months after test was initiated, the area receiving this treatment was bindweed-free.

The application of 1 lb. picloram herbicide alone per acre gave at least 95% control at each evaluation date. There were several bindweed plants present in this treatment except on three evaluation dates when no bindweed growth was present.

While a total of four broadcast applications of 1 lb. picloram per acre have been made, it has been concluded that at least one and probably two of the retreatments could have been merely spot treatments with a probable saving of considerable herbicide. This area was retreated in May, 1967 and remained bindweed free until October, 1968, when there were enough scattered plants present to justify retreatment. Here, again, there was a question as to whether spot treatment would have been the more practical method of retreatment on the scattered plants present.

TABLE I. Field bindweed control from applications of picloram¹ and/or 2,4-D² herbicide in Reno County, Kansas, beginning in September, 1965.

Herbicide	Rate lb. a. e/A	Application Dates	Cumul. Total Lbs/A	6 10 66	% Control on x dates				
					5 19 67	10 13 67	5 22 68	10 25 68	5 27 69
Picloram plus 2,4-D ³	0.5 + 1	b, c, d, e	2 4	*	78	90	100	97	100
Picloram plus 2,4-D	.25 + 1	a, b, c, d, e	1.25 5	20	40	75	100	95	99
Picloram plus 2,4-D	.25 + 2	a, b, c, d, e	1.25 10	25	35	60	100	88	98
2,4-D	1	a, b, c, d, e	5	20	30	20	70	35	50
2,4-D	2	a, b, c, d, e	10	28	40	50	70	70	88
Picloram	.25	a, b, c, d, e	1.25	30	75	80	100	93	98
Picloram	.5	a, b, c, d, e	2.5	90	92	93	100	90	100
Picloram	1	a, b, c, e	4	95	96	*99	100	90	100

¹ Potassium or triisopropanol amine salt of 4-amino-3,5,6-trichloropicolinic acid.

² Alkanolamine or triisopropanol amine salts of 2,4-dichlorophenoxyacetic acid.

³ A TORDON[®] 212 Mixture herbicide.

Application dates: a-10/12/65; b-10/25/66; c-5/19/67; d-10/13/67; e-10/25/68.
First treatment made in 1966; first evaluation made 5/19/67.

Picloram Plus 2,4-D

The tank mix combinations applied compared 0.25 lb. picloram plus 1 lb. 2,4-D per acre, with 0.25 lb. picloram plus 2 lbs. 2,4-D per acre. Both combinations gave steadily increased control with subsequent retreatments, as compared with 2,4-D alone.

The first application of the combination known as TORDON 212 Mixture, was made in October, 1966, one year after the other materials were first applied.

After the second application, TORDON 212 Mixture gave control of 90% and higher at each subsequent evaluation. Complete control was achieved after the third application of TORDON 212 Mixture at active rates of 0.5 lb. picloram + 1.0 lb. 2,4-D. This treatment compared very favorably in effectiveness with the control obtained with the same number of applications using 1 lb. per acre of picloram alone.

Kochia was the primary tall-growing annual vegetation present. The herbicide 2,4-D alone or in combination with picloram gave adequate control of kochia.

Common milkweed (*Asclepias syrica*), a perennial, was present in sufficient numbers for visual evaluation in each treatment area. Good control was observed where as much as 0.5 lb. picloram was applied per acre.

The treatments which gave the most complete control of both kochia and field bindweed were the combination tank mix applied at 0.25 lb. picloram plus 1 lb. or 2 lbs. 2,4-D per acre, and TORDON 212 Mixture applied at rates of 0.5 lb. picloram and 1 lb. 2,4-D per acre.

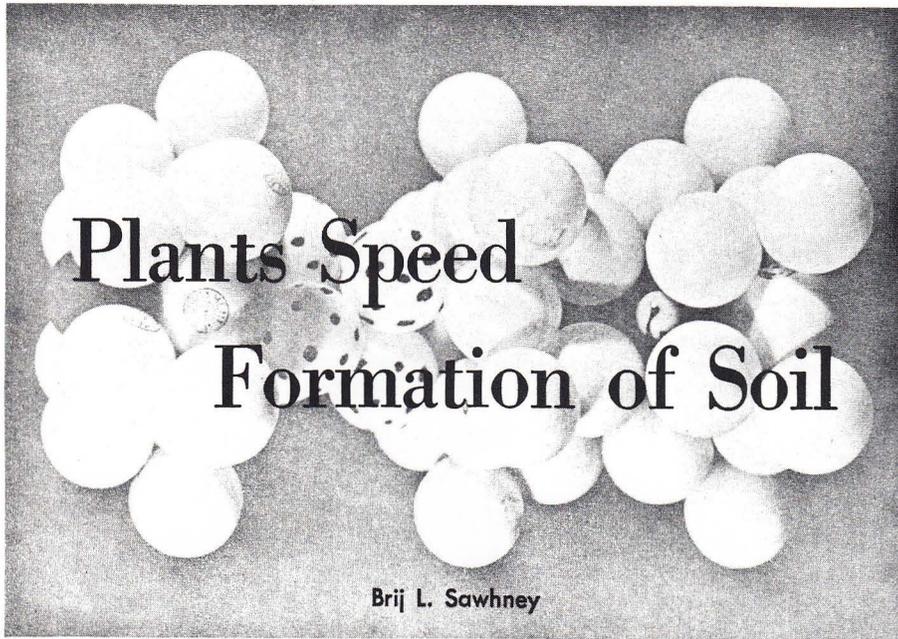
CONCLUSIONS

The results obtained with repeated applications of TORDON herbicides applied with commonly used field sprayers and application methods show that it is possible to eliminate established stands of bindweed with from 3 to 5 applications of TORDON herbicides containing 0.25 lb. to 0.5 lb. picloram each over a period of from 1.5 to 3 years. These treatments were much more effective than were repeated applications of 2,4-D alone. A combination product would appear to offer more complete containment at lower cost and suggest the probability of eventual practical elimination.

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—Reprint from *Frontiers of Plant Science*

The weathering of rocks creates tiny clay particles. Each particle may consist of several hundred mica plates, so small that they can be identified only by electrons or X rays. Plants not only feed upon the nutrients stored on the clays but also change the clays of the soil.

THE SOIL MANTLE of the earth provides a vast and changing spectacle which we cannot resist investigating. In addition, the soil is our principal means of sustenance. This lends importance and even urgency to learning how plants feed upon the soil and how the soil is changed by their feeding.

Of the mineral components in the soil, clay is the most important because it stores most of the plant nutrients and holds much of the water. In Connecticut, this clay is predominantly vermiculite that is formed by the weathering and expansion of mica in the bedrock. A small speck of unweathered mica may contain several thousand mica units, each consisting of a layer of alumina sandwiched between two layers of silica. These units are negatively charged and have cavities in their surfaces. Positively-charged potassium ions fit into these cavities, and hold the units together in a mica particle.

When the mica is weathered, the potassium ions are replaced by hydrated ions such as calcium, and the negative charge on its surfaces is decreased by several chemical changes including the oxidation of its iron. Consequently, the mica units are held together less tightly than before and become the expanded

vermiculite lattice of our clay. These alterations give the clay the important property of ion exchange. Biologically, this new property is of great importance: a storage site for nutrients is created. The nutrient elements, such as calcium, reside on the exchange sites of the clay and can be taken up by plants. At the same time, they are retained tightly enough to prevent their loss by leaching through the soil profile.

In order to understand this course of weathering, the investigator tries to simulate the process in his laboratory. Several investigators have weathered mica to vermiculite by leaching mica with solutions of calcium or magnesium salts or by treating mica with chemicals which extract potassium from the interlayers

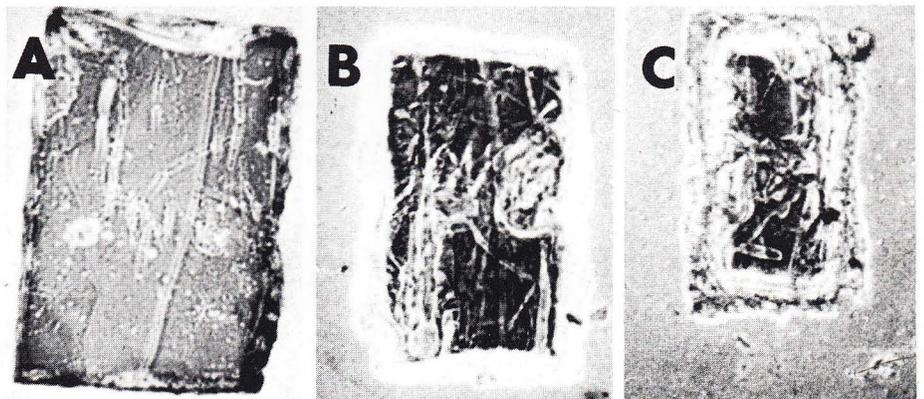
Background photo shows molecular structure of clay.

of mica. In the field, biotite (a form of mica) has been changed to vermiculite by growing crops of wheat upon it.

Our soil in Connecticut is acid, however, and most of it grows trees. Since a large portion of the potassium for feeding the trees comes from mica, an understanding of the weathering of mica by trees is particularly important. Furthermore, in some forested acid soils, a bleached zone containing amorphous or non-crystalline clay is known to develop beneath the forest litter. (Such soils occupy vast acreages of land throughout the world and are known by their Russian name, Podzols.) As tree growth is affected by such soils, so is the formation of these soils affected by the trees.

For these reasons, J. R. Boyle and G. K. Voigt, of the Yale School of Forestry, and I investigated the weathering of biotite mica by roots of tree seedlings and associated microorganisms. We also studied the effect upon mica of the organic acids which are released either from the living tree roots or from decaying trees. We found that mica weathered much differently in these acid environments than in salt solutions or in the neighborhood of wheat roots and their associated microorganisms.

The dramatic differences shown by the different weathering agents is one of the most pleasing outcomes of this investigation. These can be seen in the photographs. When the original flake shown in Fig. A is placed in an organic acid, the weath-



ering produces a translucent band along the edges of the flake as seen in Fig. B. The weathering band advances and eventually covers most of the flake; photographs B, C, and D show the changes in the same flake after one, two, and three weeks in one molar oxalic acid. Similar but slower advance of the translucent band was produced by *Aspergillus niger*, a fungus, growing in an 8% glucose solution, Fig. E, or by a solution inoculated with a suspension of soil from a tulip poplar stand, Fig. F. Both E and F show flakes after eight weeks' weathering.

This is strikingly different from the weathering caused by salt solutions or by wheat. When placed in salts, the band of weathering, Fig. G, is a dark one rather than transparent or translucent.

The darkening of the band by salt solutions has been attributed to the replacement of the potassium between the mica layers of the hydrated cation of the salt. The translucent band produced by the acids and seen in the photographs is at-

tributed, on the other hand, to the removal of iron and magnesium from *within* the mica crystal. The organic acids extract iron, magnesium, and aluminum, leaving behind a fragile silica matrix seen as the translucent band. This silica matrix disintegrates easily and the mica structure collapses.

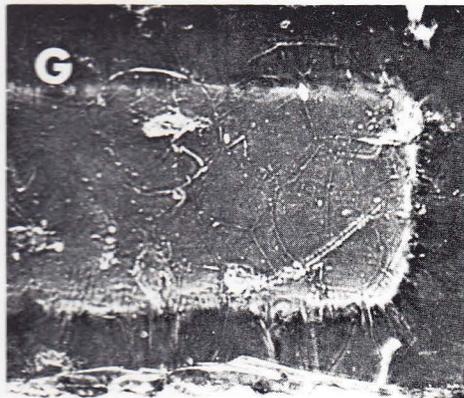
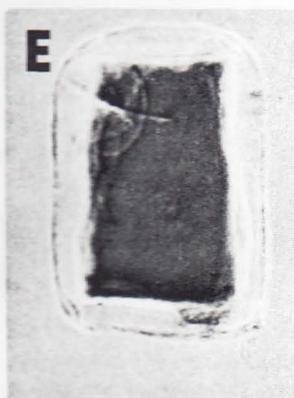
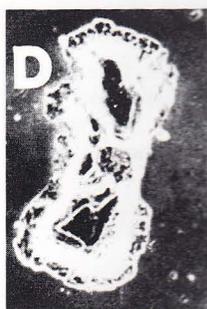
An examination by X rays of the products of weathering confirmed what could be seen in the pictures. Weathering by salt solutions expanded the mica units from 10 to 14 angstroms. But weathering by organic acids and by solutions growing microorganisms destroyed the original, regular structure of the mica and left only an amorphous residue. Apparently, weathering of micaeous minerals by microorganisms and acids is responsible for the bleached zone containing amorphous clay in the podzols of the cool forest. Thus, the organic substances from tree roots and the associated microorganisms play an important role in the weathering of bedrock and the forming of our soils.

Contributors

Brij L. Sawhney, soil scientist, has been a member of the Station staff since 1958 except for 2 years with the Canada Department of Agriculture. Born in Rajoya, North-West Frontier Province, Pakistan, he earned his doctorate in soils at the University of Wisconsin in 1957. Much of his work has been on the sorption and fixation of cesium by clays.

Saul Rich, who writes in this issue on air pollution, is a plant pathologist. His research at this Station during the past 20 years has dealt with fungicidal mechanisms, physiology of fungi, and disease control as well as with effects of air pollutants on plants.

George R. Stephens is primarily concerned with research on tree physiology and ecology. A full-time member of the staff since 1961, his graduate study was at Yale University.



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ST. AUGUSTINE DECLINE (SAD) - A VIRUS DISEASE
OF ST. AUGUSTINE GRASS

Norman L. McCoy, Robert W. Toler, and Jose Amador¹

Abstract

A new mosaic disease of St. Augustine grass (*Stenotaphrum secundatum*) characterized by a chlorotic mottling was first observed in the Lower Rio Grande Valley of Texas in 1966. The causal agent is a mechanically transmissible virus different from either sugarcane mosaic virus or maize dwarf mosaic virus, which have previously been reported on this host.

INTRODUCTION

Lawn and turf grass production is a major enterprise in Texas. These grasses represent a permanent investment in better living, the value of which cannot be calculated in dollars alone. Cost of turf and lawn maintenance in Texas annually is estimated at \$211,856,126 (3). It is estimated that 41% of the home lawns in Texas are in bermudas, 56% in St. Augustine grass and 3% in other grasses. In the Gulf Coast area of Texas 96% of the lawns are in St. Augustine grass.

Two virus diseases of St. Augustine grass have been reported. Todd (8) has reported the natural occurrence of sugarcane mosaic virus (SCMV) on St. Augustine grass at the USDA Sugarcane Field Station, Canal Point, Florida in 1964. Abbott and Tippett (1) reported that St. Augustine grass grown from stolons and inoculated with an airbrush became infected with four strains of SCMV, A, B, D and H. The virus was transmitted from St. Augustine grass back to sugarcane. In 1966 Dale (2) reported that St. Augustine grass seedlings became infected when experimentally inoculated with maize dwarf mosaic virus (MDMV) and SCMV.

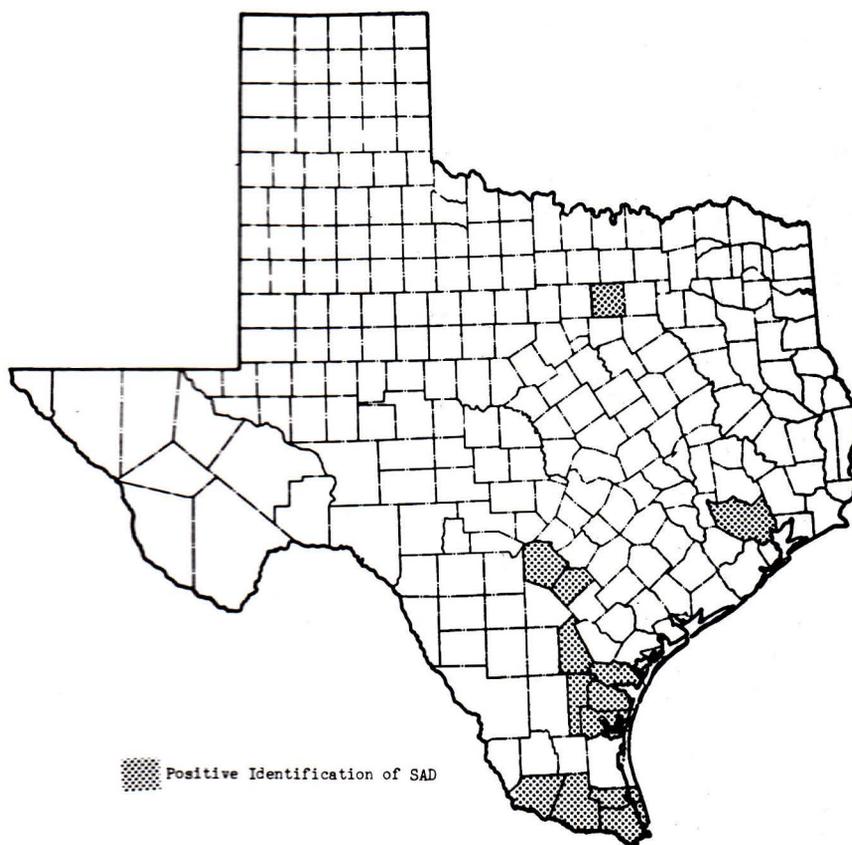


FIGURE 1.
Occurrence and distribution of St. Augustine decline in Texas, June 1, 1969.

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This work was supported in part by a grant from the Coastal Bend Lawn Improvement Association, Corpus Christi and King Ranch, Inc., Kingsville, Texas.

(Continued from Page 15)

Grain sorghum has been reported as a host for both MDMV (1, 4, 5, 6) and SCMV (2, 7), but it has not been demonstrated to be a host for St. Augustine decline virus (SADV). St. Augustine decline was first observed in the Lower Rio Grande Valley of Texas in 1966 (9). By March of 1969 the disease had been observed in 13 counties of the State (Fig. 1). In Nueces County it is estimated that 85% of the lawns are infected. Severity of the disease in infected lawns ranged from trace amounts to as high as 100%.

SYMPTOMS

The first symptoms appear as a mild chlorotic mottling of the leaf blades. The mottling becomes more severe the second year after infection until a general chlorotic appearance exists (Fig. 2). Stolon growth is retarded and is a result of short internodes. During the third year necrosis of the leaves and stolons occurs, which causes dead areas in the turf and native grasses and weeds invade.

The disease may sometimes be confused with iron or zinc deficiencies. The virus causes a mosaic, which appears as a stippling effect. Deficiency symptoms, on the other hand, appear as continuous stripes parallel to the leaf veins. When St. Augustine grass is under stress because of low fertility, nematodes, drought, insects and poor management, the decline progresses more rapidly.

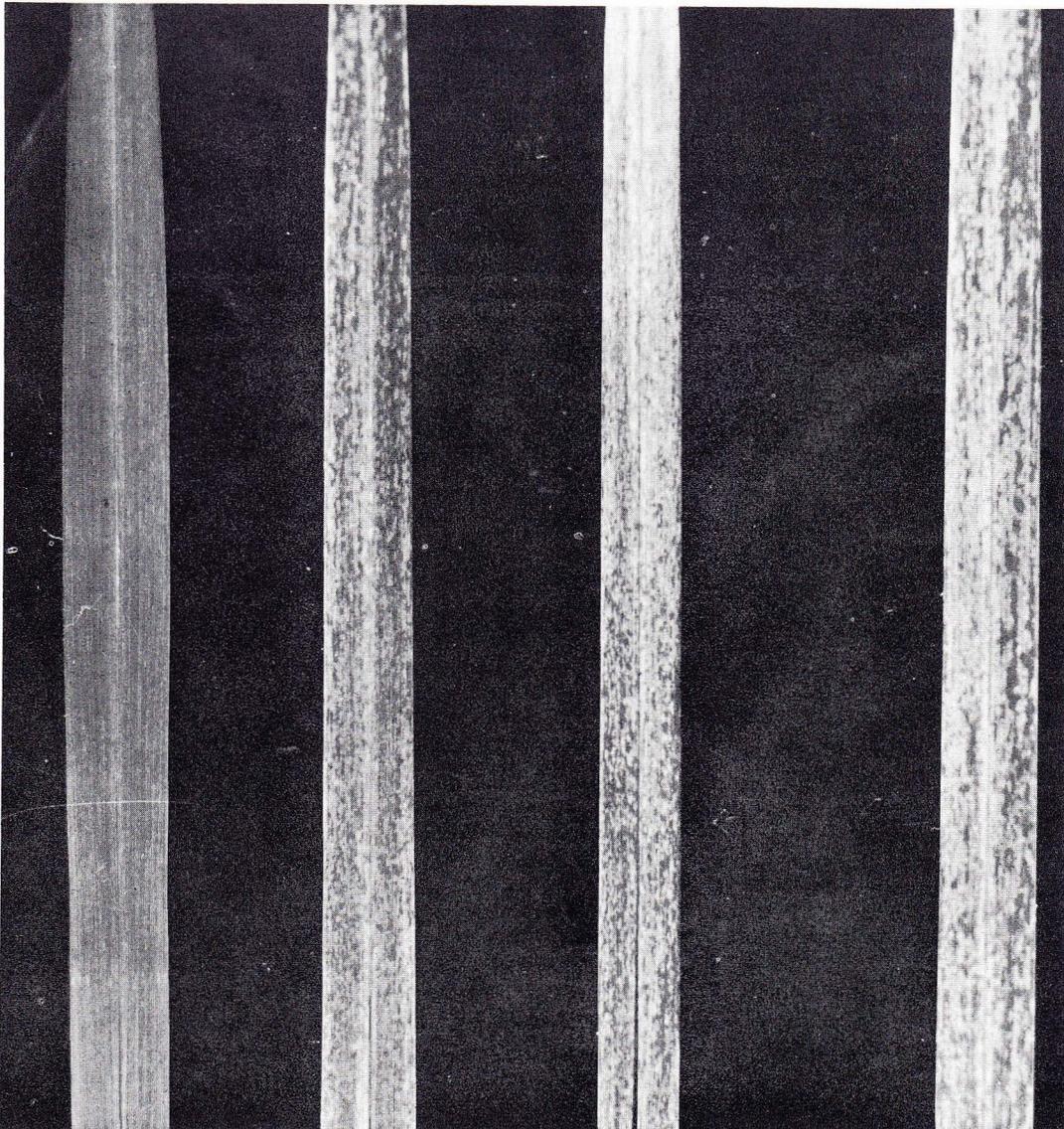


FIGURE 2. Typical symptoms associated with the mosaic disease of St. Augustine grass. Healthy leaf on the left.

TRANSMISSION STUDIES

Sap expressed from naturally infected St. Augustine grass was mechanically applied with an abrasive to healthy St. Augustine grass. Symptoms occurred on the inoculated grass in approximately 21 days.

Soil transmission has been investigated. Soil was collected from diseased lawns and placed in 6-inch clay pots. Healthy St. Augustine grass grown from seed was sprigged in the potted soil. After 12 months no symptoms appeared on the grass and attempts to transmit the virus to an indicator host failed.

Diseased St. Augustine grass leaves were surface sterilized in a 10% sodium hypochlorite solution for 1 minute and plated on beef-extract agar and potato-dextrose agar. No fungi were isolated from the infected leaf material; however, a bacterium was isolated on the beef-extract agar. When healthy St. Augustine grass seedlings were inoculated with the bacterium no symptoms developed after 45 days.

HOST RANGE

Proso millet (Panicum miliaceum), an indicator host, produces mottled symptoms similar to those in St. Augustine grass 6 days after inoculation. The virus is lethal to Proso millet. Death occurs 14 days after inoculation of 3-week-old millet. Other host plants include pearl millet (Pennisetum glaucum) and German foxtail millet (Setaria italica).

No symptoms were observed on, and no virus was recovered from, inoculated plants of the following species of the Gramineae: Avena sativa 'Alamo X'; Cynodon dactylon, common; Eremochloa ophiuroides; Hordeum vulgare 'Blackhulless'; Oryza sativa 'Nato'; Pennisetum glaucum 'Gahi-1' and 'Gahi-2'; Phalaris arundinacea; Sorghum halepense, Johnson grass; Sorghum vulgare [= S. bicolor]; Triticum aestivum 'Commanche'; and Zea mays.

The following herbaceous species likewise were not infected following mechanical inoculation: Chenopodium album; Lycopersicon esculentum; Nicotiana tabacum 'Samsun NN'; and Phaseolus vulgaris 'Bountiful'.

PHYSICAL PROPERTIES

In vitro properties of the virus were determined by using sap extracted from naturally infected St. Augustine grass. The results of the tests were as follows: Dilution End-Point - St. Augustine grass tissue was macerated in a Waring Blendor in a .05 M phosphate buffer of pH 7.5. Dilution was at a 1:1 ratio (g/v). Serial dilutions were prepared on a logarithmic scale from 10^0 to 10^{-5} . Each dilution was rubbed on an equal number of Proso millet plants. Infection occurred at 10^{-2} but not at 10^{-3} . Thermal Inactivation - Two ml of the 1:1 juice prepared during the dilution end-point study was pipetted into 5-ml serological tubes. The tubes were subjected to a series of temperatures ranging from 48 to 66°C at 2° intervals for 10 minutes. The water bath of a Gilson Differential Respirometer was used for maintaining a constant desired temperature. After heating the tubes were removed and immediately cooled in an ice bath. The contents of each temperature-treated tube was rubbed on to Proso millet seedlings. Infection occurred at 58° but not at 60°. Longevity In Vitro - Crude juice (from dilution end-point) was held in a stoppered flask at room temperature (22-24°C). Two-ml aliquots were withdrawn on a geometric progression interval beginning at 24 hours for the first series and rubbed on Proso millet. Infection occurred at 72 hours but not at 144 hours. A second series of intervals, with sap extracted in the above manner, began at 72 hours and continued through 156 hours at 12-hour intervals. Proso millet was used as an indicator host. Infection occurred at 132 hours but not at 144 hours. Longevity In Frozen Tissue (ca. -10°C) - Leaf tissue from diseased St. Augustine grass was placed in plastic bags in a deep freeze on March 18, 1968. Leaf samples were removed at 1-month intervals and macerated in a mortar with pestle in a .05 M phosphate buffer of pH 7.5. Sap was rubbed on Proso millet seedlings. Expressed sap was still infectious on 100% of inoculated test host plants 15 months after initial freezing.

DISCUSSION

Sugarcane mosaic virus is the only other virus that has been observed to occur naturally on St. Augustine grass (8). Maize dwarf mosaic virus has been experimentally transmitted to St. Augustine grass (2), but has not been observed to occur naturally. Grain sorghum (*Sorghum bicolor*) has been reported to be a host for both SCMV and MDMV, but has not been demonstrated to be a host for SADV. F. W. Zettler supplied us with a specimen of St. Augustine grass infected with the Todd isolate of SCMV. The SCMV symptoms on St. Augustine grass appear as linear elongated chlorotic islands. R. W. Toler provided a specimen of St. Augustine grass infected with MDMV for symptom comparison. Maize dwarf mosaic virus symptoms on St. Augustine grass are similar to SCMV symptoms; the symptoms of both are readily distinguished from mottled chlorotic stippling caused by SADV.

It is our opinion that SAD is probably caused by a new virus or a mutated strain of an existing virus that attacks this host. Studies are currently underway on morphology, serology and biochemistry of the infectious particles.

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—Reprint from *Plant Disease Reporter*, Vol. 53, No. 12

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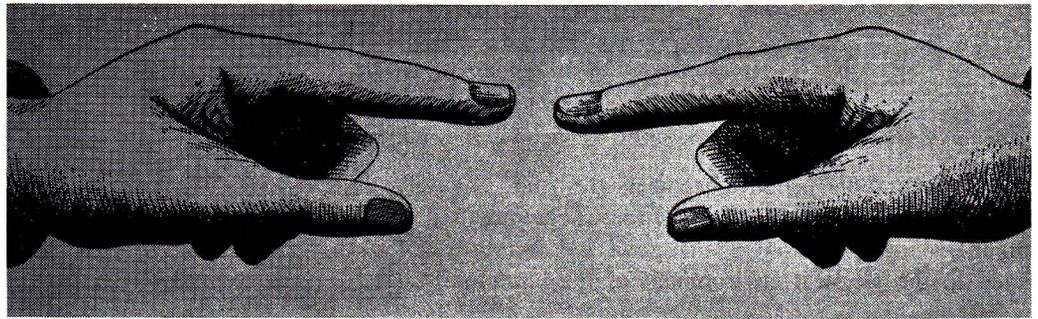
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RESPONSIBILITY FOR RECREATION

by RONALD F. PAIGE

THE UNIVERSAL POPULARITY of the recreation movement and its exceptional adaptability to a variety of types of tax-supported resources and services has produced chaotic involvement by multiple agencies at all levels of government. Federal, state and local jurisdictions have independently projected their specific roles and responsibilities with little coordination at any level.

Inflationary costs and the rapid dissipation of available resources has created a crisis of national interest and concern. Politicians, educators, sociologists and planners all join the chorus of voices pleading for action. Confused goals and a curious inability to define needs in terms that engender public support prohibit effective action.

One cannot question the need for government's involvement in the field of recreation. It is clearly evident that extended effort is essential if man is to achieve a living environment consistent with his technical abilities. It is submitted that a more realistic approach to the concept of recreation as it relates to the government function could clarify goals and assist all agencies in performing their service in a more effective manner.

A new responsibility must be assessed against the social structure if the full value of recreation opportunity is to be realized for the benefit of future generations.

The Public Recreation Process

Consistent with the performance of most governmental services, the provision of leisure-oriented programs and facilities has evolved into three separate and distinct functions that can be divided and identified as the three "P's": Planning, Programming and Politics.

Planning projects the physical resources necessary to service the public needs while programming covers all operational responsibilities that implement the use of resources. Politics, for want of a better term, becomes the establishment — the structure that dictates the method of accomplishment. Ideally, the three functions should work as a unit to achieve predetermined goals of performance. Each function is dominated by professional and lay disciplines of diverse backgrounds and motivations. Uniform objectives become confused and effective communication is hampered by an inability to understand the motivation and dedication of the various disciplines involved. The singular thread of continuity seems to be a "blind" faith in the virtues of the *good life*, even though this faith is individually interpreted under a polymorphous definition of the leisure need.

To clarify the problem facing the social structure, it is necessary to analyze the objectives and motivations of the three functions of government as they relate to leisure.

Planning

The planning function is dominated by a total dedication to the physical elements. Architects, landscape architects, engineers and urban planners exert their influence to effect change to the physical landscape and the urban profile. Aesthetics and function become the guidelines of performance and, unfortunately, regimentation usually becomes the end product. What is good for Detroit is good for Cucamonga. The planner's interpretation of the *good life* is totally related to the physical environment of the community.

Within the federal, state and private sectors, planning becomes an all-inclusive obsession, devoid of specific relationship to the existing social structure. In contrast, the local planner restricts his efforts to the

(Continued on Page 20)

Mr. Paige is chief deputy, Los Angeles County Parks and Recreation Department.

(Continued from Page 19)

EDITORIAL

Alright! What the hell do you kids think you're doing here?? Get off this golf course before I run you off!!

Sounds familiar, doesn't it? How many times last summer did you run some trespassers off just like that? Bet you even used the same words too, didn't ya? Well, consider this while you're reading this by the fireplace this evening; A superintendent named Herman Miller from Champaign, Illinois tried the same technique at shooing some vandals off his course. Result - they turned on him and ironically enough, beat him to death with golf clubs!

There was another case in Long Island where a super wound up in the hospital from exactly the same thing.

Case in point - we are not police. We are hired to maintain the golf course. Maintenance does not encompass any phase of police work unless you have an unusual contract.

It seems that the majority of the supers, in accepting more salary each year, are expected to take on more responsibility to prove their merit. This is good to a point, but let's not forget one small thing. We are paid for our professional knowledge. We are trained in turf management, not police work. NO golf green, clubhouse, or piece of equipment is worth jeopardizing your health, safety, or your life for. Police officers are not expected to know and do our job, so doesn't it seem logical that we shouldn't try to do theirs?

However, for those of us who call the police and see the vandals apprehended, then immediately released because of fear, apathy, or whatever, on the part of the club officials, we are faced with a serious problem. This is the case at several area courses, one of which is all too familiar. If this is your particular situation, then welcome and good luck. Security is always a problem where there is a vast expanse of open space with no fence around it for protection. Let's hope club officials become aware of the problems that come with a laxness in punishing the people who damage their investments on the course.

Know the phone number of the closest police station and USE it!

Don't jeopardize yourself and try to be a J. Edgar Hoover. It's not worth the effort!

* * * * *



confines of his particular political entity, projecting facility needs geared to provide the entire gambit of leisure opportunity for his "community," with little or no regard for adjacent or overlapping jurisdictions. Despite this apparent conflict of purpose, planners will generally unite behind a relatively uniform classification system and standard of need. Rarely does this support for facility needs encompass an understanding of the actual function of the recreation program within the total community.

The park facility has long been the symbol of the public recreation process and its universal exposure generates acceptance, if not support, from all quarters. It is this acceptance and understanding by the public that allows the planning function to exploit the physical element as the basis for establishing goals and objectives for the vast majority of leisure-oriented agencies.

Programming

Leisure programming is unique within the government service for a variety of reasons. The recreation profession, like all new services, has attracted leadership from a wide variety of disciplines. The field is now experiencing its second generation of progress. The concepts of the educator, the athlete, the politician and the traditions of society are still exerting strong influence over the direction of the movement. Leisure as a social problem has attracted the economist, the philosopher, the psychologist and the sociologist, with independent interpretations of the leisure need. Freedom of expression, elimination of crime and delinquency, physical well being, mental adjustment, productive use of leisure and preservation of the natural heritage are just some of the objectives expounded by the numerous promoters of recreation. This multipronged approach to the complex effect of increased leisure on society is vital to achieve a logical solution. However, the inability to establish a meaningful dialogue between disciplines inhibits the effective definition of objectives.

The recreation professional has grown accustomed to and somewhat complacent within this chaotic atmosphere. His transition through the preschool playlot, the youth movement, the physical fitness interest and the senior citizen program has been shielded by the hazy, undefined *good life* syndrome of the American public. He is accountable only to the special interest and a continuous demand for justifying the perpetuation of the physical plant.

Politics

The term politics, most generally, is used as a derogatory definition of the "establishment." This connotation is usually associated with a control that has been applied to a planned program or action that is

motivated by a singular discipline. In reality, politics is the image of our social structure. Unfortunately, the social structure was not created to fit the specific needs of the recreation professional nor is it readily adaptable to resolving our current social problems. It is, however, the basis for accomplishing all government services.

The need for a restructuring of our governmental pattern to meet today's social challenges is almost universally endorsed by experts across the nation. Obviously, the problems facing this type of change are monumental and rooted in our basic belief in the democratic form of government and the public concern to protect the image of "home rule."

Suffice it to say, any function of government must first relate to the establishment and secondly, direct its attention to resolve the problems assessed to that function by society itself.

The Problem

The public recreation agency has established a defense mechanism that not only demands over-justification, but also encourages each agency to be the universal supplier of all that is good and sacred. To illustrate this point, two examples may be cited. First, the City of Monrovia, California, population 27,000, applied for and received a State grant-in-aid for the acquisition and development of a regional recreation area to service the specialized needs of the metropolitan Los Angeles area. Secondly, in a recent address before the annual meeting of the Society of American Foresters, George B. Hartzog, Jr., director of the National Park Service, described the involvement of his federal agency in the management and operation of urban recreation programs and facilities: "the National Park Service manages more urban parks than any other single government agency — at any level." They range in scope from swimming pools, tennis courts and golf courses to wilderness areas such as Theodore Roosevelt Island in the Potomac near Washington. "Summer in the Parks" was an example of urban programming initiated and conducted by the National Park Service this past sum-

mer. The program involved children's trips, dancing, concerts, movies, volleyball and many other typical elements of local programming.

These paradoxical approaches to responsibility could be likened to a small elementary school district developing and staffing a research center for advanced learning using state subsidies or similarly, our federal government issuing traffic citations at the corner of Sunset and Vine.

The dominance of the planning function within the total park and recreation movement is evidenced by the general acceptance of the physical element as the basis for definition of goals and standards of achievement. Programming is forced to conform and consequently becomes activity-oriented instead of experience-oriented and facility-conscious instead of community-conscious. This approach prohibits the logical definition of responsibility.

Confused concepts invariably add to the dilemma facing agencies in justifying their very existence. This inability to define goals and objectives in terms acceptable to the taxpayer and relevant to society's needs forces the programmer to exploit the only objective measurement available — numbers served. "The basic error in such argument is that it applies the philosophy of mass production to what is intended to counteract mass production. The value of recreation is not a matter of ciphers. Recreation is valuable in proportion to the intensity of its experiences, and to the degree to which it differs from and contrasts with workday life."¹ Unfortunately, this philosophy of Aldo Leopold's requires a subjective analysis and justification that presents a difficult challenge to government. Consequently, competition for recognition develops competition for participants and a resultant diffusion of responsibility.

The impact of leisure, the increased desecration of natural resources, the devaluation of the tax dollar and today's urban problems are all vivid indications of the need for action. Unfortunately, competition between agencies has caused critical duplication of facilities and programs and more important it has fostered a reaction

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of self-preservation and perpetuation of existing bureaucracies under the guise of "home rule." Efforts to achieve coordination and cooperation usually receive paper "hurrahs" and guarded political endorsement, but little in the way of implementation authority.

A Suggested Hypothesis

What is the answer to this dilemma? It seems logical that the profession must first strip the frills and adornments that shroud the basic objectives and define government's role in the leisure field. It is then essential to establish a new frequency or wave length to facilitate effective communication between the three functions of government.

The basic element of the planning function is the classification of areas. The vast majority of classification efforts are agency-oriented and therefore include physical descriptions and broad functional categories as the basis for definition. It is submitted that the identification of responsibility requires classifications that are based on people-oriented factors such as service radii or the attraction capability of a specific recreation experience or facility. One cannot compare a camping experience at Yellowstone National Park with an overnight camp-out with the Cub Scouts at the local park facility. The function is similar — the experience is graphically different. A picnic in the High Sierras versus a backyard barbecue; a visit to the Smithsonian Institute versus an afternoon at the local historical so-

ciety display; a baseball game at Yankee Stadium versus a little league battle for local honors; all of these illustrations depict related functions, yet describe experiences and attraction capabilities of significant difference.

It is submitted that the park and recreation administrator must challenge the standards and classification systems currently used as a basis for planning efforts by the numerous agencies striving to resolve the leisure problem. Obviously, standards and classification systems affect the establishment of goals and similarly the definition of responsibility. The widespread confusion that exists related to the question of "Who does what?" is a graphic illustration of the need for a new approach to the problem of providing the necessary areas and facilities to serve the leisure needs of America. Assuming the need is there — it becomes obvious that the provision of facilities to service future needs within urban centers is a problem of monumental proportions. Efforts to date have been woefully short and programs for expansion face overwhelming competition for the tax dollar. Success will require the marshalling of all resources through the establishment of accepted standards of service and recognition of logical responsibility patterns within the various levels of government and private enterprise.

Analysis of the recreation programming function produces similar results. As a general rule, today's recreation professional is facility-oriented and dominated by the specific functions that have traditionally been accepted as public responsibility. He ignores the vast area of recreation interest that is privately initiated and individually pursued. His inability to sell his abilities to the "establishment" in terms of "living" improvement has placed this function totally subservient to the special interest. With minimal exception, the programming function will emphasize "activity" rather than "experience." It is submitted that responsibility in programming can only be established when the recreation professional dedicates his efforts to the recreation experience of people and the maximizing of effective use of all possible resources. The role should be guidance and coordination — not regimentation and programming geared to justify the functional facility.

The political function is primarily interested in serving a specific clientele and the relationship of the operational functions of government to this end is essential. The total value of any government entity must be measured in terms of its contribution to the well-being of its people. This objective becomes the challenge of today's park and recreation administrator.

The beauty of our urban city becomes the symbol of its living environment while the ability of the people to constructively use their leisure time is an indication of their success in achieving moral and physical fulfillment. The need is apparent to project the park and recreation service in terms of its relationship to the living environment of people and to effect accomplishment of goals through the logical assessment of responsibility against the existing structure of government. ■

¹Barry S. Tindall, "Aldo Leopold — A Philosophy and a Challenge" *Parks and Recreation*, Vol. III, No. 10 (October, 1968), p. 30 citing Aldo Leopold, *Almanac*, 1949.

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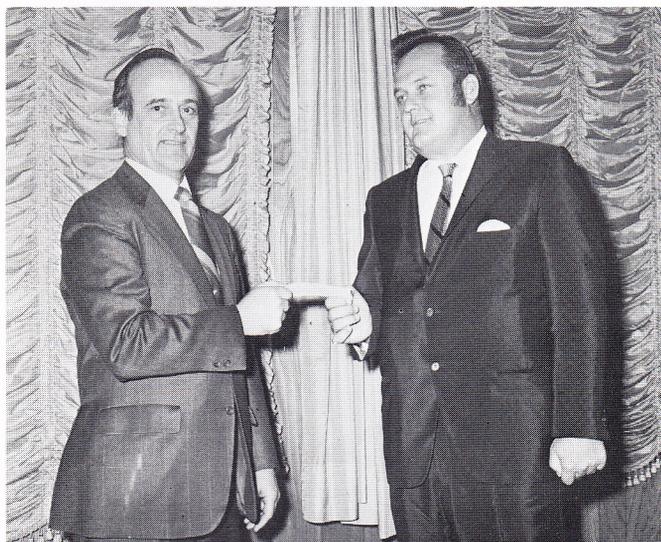
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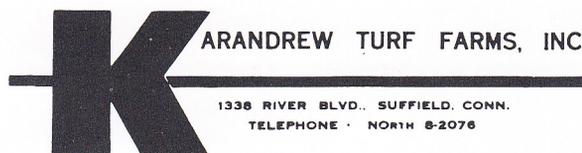


Bob Osterman, 1968 Winter School for Turf Managers, U. of M., presenting check to Trol for Dickinson Memorial Fund.



Joseph Moisa, G.C. superintendent, Tam-O-Shanter Golf Club, President Long Island Golf Course Superintendant Association.

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