MID-ATLANTIC TURF CONFERENCE

1951

ERNEST N. CORY, DIRECTOR

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WEST POINT LAWN PRODUCTS

West Point, Pa.

WELCOME

G. M. Cairns, Dean
University of Maryland

Dr. Cory expressed in part what my interest and duties were prior to the time that I became responsible for the administration of the work in agriculture at the University of Maryland. Being a dairyman I have been interested in turf from a different standpoint.

We are pleased that your group meets here in the state of Maryland. One of the most vital things to me in attending conferences is that you have a chance to rub elbows with men who are engaged in similar work in other areas. It gives you an opportunity to discuss problems you may have with them and to get possible leads as to how you can improve your operations. If we were to take a poll at many of these meetings, we would find that informal discussions with others who have problems similar to yours prove to be most valuable.

I want you to know that at any time that we who are responsible for the administration of agriculture at the University of Maryland can assist your group, we will be only too happy to do so. I hope that you will continue to work with our people and that you have a most successful meeting here at Baltimore.

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INSECTICIDES FOR GRASS

G. S. Langford
University of Maryland

Dr. Cory has asked that I talk to you this morning about insecticides for grass. We will not have time to go into the details of the many new insecticides that are coming on the market. I will briefly discuss those that you are most likely to need in your work and review a few new ones that you will come in contact with from time to time.

Progress in Development of Insecticides

We might first go into some historical background that may be of interest to you as it relates to the devel-

opment of some of the new insecticides. Among the outstanding accomplishments in the field of science during World War II was the development of new and efficient insecticides. All of us remember that immediately following the war, scientists, news reporters and the public generally had a "field day" discussing the atomic bomb and DDT. Many stories were told about both. Some were true, others were not quite true, but very interesting and some were fantastic. Today we are beginning to find out with some degree of accuracy what we can expect from the atomic bomb. Likewise our concept of DDT has been modified. We know the atomic bomb is dangerous and something to be feared, but probably will not be as devastating as some of us once thought it would be.

Likewise DDT is still a good insecticide, but we are finding out that it will not do all the things we once thought it might do. As a matter of fact, we are finding that some insects can resist DDT. Flies as well as other insects that were once effectively controlled with DDT are now becoming resistant to it. Nature is finding ways to compete with some insecticides that we once thought might be used to eliminate certain pests. But in spite of the facts just set forth the discovery of DDT has resulted in real progress for the development of new and effective insecticides.

Several new and powerful insecticides, as you know, came into prominence during World War II. Folks often ask why so much progress was made on insecticides during the war. The fact is insects cause loss of life. It has been said that in many wars more soldiers lost their lives from insects than enemy bullets. We have insect-borne diseases which are real problems as far as the armed forces are concerned. For that reason, considerable money was spent during the recent war on research in an attempt to develop new and efficient insecticides.

As a result of this basic war-time research, we have coming on the market today many new insecticides. As a matter of fact, so many outstanding insecticides are coming on the market that people are confused as to which is best. This confusion increases when we listen to details on the merits of this insecticide or that insecticide. One hardly knows which is best to use. From reading the papers and the publicity given DDT back in 1946 many were convinced that DDT was the solution to all problems. About 1947 you were confronted with another new one, BHC. In 1948 Chlordane

was being publicized and in 1949 Aldrin and Dieldrin were hitting the headlines. This confusion grows all the time, particularly when we hear such terms as Methoxychlor, Rothane, Toxaphene, Parathion, Metacide, etc. The facts are that all of these insecticides are good. Some are more efficient than others for given pests, but all are good when properly used.

Insecticide Formulations

Formulation often becomes a point of confusion. Many of the materials mentioned are marketed as wettable powders, emulsions, dusts, aerosols, etc. The question - which formulation is best? - is usually in the mind of one contemplating the use of a given insecticide. The dosage for control is usually based on the technical material. Therefore, quite often it doesn't make much difference whether you use wettable powder, emulsion or some other formulation, provided it is used so that the proper dosage of technical material is attained. But I think it is well to know something about these different formulations.

Wettable powders are just what the term implies. They are powders that wet easily and are used as sprays. They are formulated by thoroughly mixing the technical material with some inert carrier and a wetting agent. A 50% wettable DDT simply means DDT and carrier are mixed half and half and treated so that the resulting product wets and suspends easily in water.

Emulsions are liquids. They are prepared by dissolving the technical material in some solvent and then emulsified or made miscible so that they will mix with some inert material that is finely ground and will dust well. If you have a 1% DDT dust, you have one pound of DDT and 99 pounds of an inert carrier.

Aerosols represent another type of formulation. When they are used, the insecticide is distributed through a gaseous medium. They are prepared by dissolving the insecticide in methyl chloride or some other material that is a liquid under pressure, but boils when pressure is released. This boiling into the air distributes the insecticide over the area under treatment.

Some New Insecticides

My discussion on new insecticides will be very brief. I am not going to talk about the old insecticides with which you are now familiar. I think all of you are familiar with the old ones like arsenate of lead, nic-

otine, pyrethrum and the oil sprays. You have used them for years. The lead arsenate treatment for grubs and turf is quite old, and I am sure each of you has had experience with it.

Under the term new insecticides, I am going to give consideration to those synthetic organic insecticides such as DDT, Chlordane, Methoxychlor, BHC, Lindane, TDE, Toxaphene, Aldrin, Dieldrin, Parathion etc. These are some of the newer insecticides which are now being advertised and which salesmen will talk to you about.

DDT and Chlordane

Greenkeepers probably do not need an introduction to DDT and Chlordane. They are two of the new synthetic organics that have been studied and used generally for the control of grubs in turf. Both are excellent soil insecticides and may be used to good advantage if used at the proper dosage level. Normally 25 pounds of technical DDT is effective for eliminating Japanese beetle and related grubs from turf. Ten pounds of Chlordane is frequently used where it is desirable to eliminate grubs in the sod. Where chinch bugs are involved, Chlordane has been found to be effective. It is also a good grasshopper remedy. Both DDT and Chlordane are useful for spraying trees and shrubs for the control of the Japanese beetle and many other insects. Where the adult Japanese beetle is involved, DDT, while probably not better than Chlordane for killing, will give a much faster knockdown. For ants in turf, Chlordane is a wonderful insecticide.

Methoxychlor and Toxaphene

The other organic chlorinated insecticides such as Lindane, Toxaphene, Rothane and Methoxychlor have not been tested as widely and thoroughly against turf pests as DDT and Chlordane. Nevertheless we do have some information which shows that all of these insecticides have some promise. Methoxychlor is one of the least toxic of the new insecticides where man and animal are involved. While probably not quite as toxic as DDT, it has given excellent performance in the control of grubs in turf, and will be found effective for protecting foliage around the golf course against Japanese beetles. Toxaphene is effective for controlling a wide range of insects which the greenkeeper, on occasion, may encounter. It kills armyworms, cutworms, webworms, leafhoppers, and lygus plant bugs. DDT will not kill bagworms, but Toxaphene will.

Aldrin and Dieldrin

Two new synthetics; namely, Aldrin and Dieldrin, have come to the forefront within the past year as insecticides with promise for the control of turf insects. They are so new that I can't give definite information on just how effective they will be for your problems. Dieldrin shows definite promise for the control of such soil-inhabitating insects as wireworms, and white grubs of various kinds. Promising results for the control of the tropical earthworm have been obtained with it. Indications are that it will be an excellent remedy for the control of chinchbugs.

BHC and Lindane

Benzene hexachloride (BHC) and Lindane are useful for killing a wide variety of insects. The killing agent in both of these insecticides is the same; namely the gamma isomer content. Lindane is the name given to the relatively pure gamma isomer and is more pleasant to use than BHC because it is practically odorless. BHC has a very strong musty odor, and for this reason care must be employed not to use it in areas where the odor might be objectionable. Down at the University of Maryland we have obtained excellent results with BHC for freeing turf of Japanese beetle grubs. So far we have not recommended it for that purpose, because if it is used excessively there is a possibility of doing serious injury to the grass.

Allethrin

Everyone is familiar with pyrethrum as a non-toxic insecticide, and knows it as a useful material for the control of many sucking insects and for its use in the Club House in the control of flies. In the past all pyrethrum has been derived from a chrysanthemum like plant. Recently several of the active ingredients in pyrethrum have been synthesized. The new synthetic product will be marketed under the name Allethrin. This material will be used as a substitute for natural pyrethrum in many insecticide formulations where pyrethrum is now used.

PiperonylButoxide and Pyrenone

There are chemicals which if mixed with certain insecticides will boost their killing action. These are termed synergists. A relatively new synergist that is being used and much discussed today is piperonyl butoxide. This chemical has the peculiar ability to

function in combination with pyrethrins to produce an insecticidal effectiveness many times that of either component. The combination of these two materials is often referred to as pyrenone.

Sabadilla

Sabadilla as an insecticide should probably be mentioned. It is an excellent material for the control of certain plant bugs. Greenkeepers have found it useful for the control of chinchbugs, especially when used in combination with DDT.

Dilan

One of our newest insecticides is known as Dilan. It is a nitro-paraffin based on propane and butane. Sufficient work has not as yet been done to determine whether it will have use in turf work. It has shown promise for the control of certain vegetable crop insects, especially the Mexican bean beetle. It looks as though it will be a good insecticide for many purposes.

Systemic Poisons

Probably the most interesting of all the new insecticides being offered are the so-called systemic poisons. For years pest control people have been looking for a remedy that could be fed to a plant and in that way relieve it of its insects. Ten years ago those that offered such remedies, and they were offered, were fakes. Such insecticides are now becoming a reality. Several years ago sodium selenate gained prominence for its effectiveness in the control of red spider or some greenhouse insects when it was applied to the soil and taken into the growing plant.

Within the past few years tremendous progress has been made with systemic insecticides. When applied to soil or plant leaves, stems, roots or even seed the insecticides are absorbed and distributed through the plant where they remain and function to kill certain insects for long periods of time.

These insecticides are based on phosphorus. The Germans and English have pioneered the investigations which led to the origin and development of these materials. They are on the market under such names as Systox and Pestox. Octamethyl is another name under which one of these materials is often referred.

Organic Phosphorus Materials

Synthetic insecticides based on phosphorus are gaining prominence. Generally speaking they are good insecticides, but quite poisonous to man and other animals. If used every caution should be taken to protect the operator. For the present, in my opinion, one should think twice before using them on such public places as golf courses. Included among the organic phosphorus insecticides are: HETP, HEPP, EPN 300, Metacide, Parathion, etc. HETP and HEPP are excellent contact insecticides for controlling aphids, red spiders and many soft bodied insects. EPN 300 at present is best known as a miticide. There is one phosphorus-bearing insecticide that I want to give special emphasis. Everybody is talking about it. We don't recommend it in Maryland and hate to see anyone use it unless he employs some one who knows how to use it and will follow every precaution suggested for its use. That insecticide is Parathion. It is a good killer and will destroy most insects. Ants, Japanese beetles, armyworms, cutworms, spider mites, etc. all succumb to its effects. Considerable effort is now being made to develop materials with the insecticide qualities of Parathion, but with reduced human hazards.

Read the Label

In closing, I would like to leave a few words of caution. All insecticides are poisonous, at least to insects. They may be poisonous to man and his pets. Some are very dangerous and may strike without too much warning. The user should therefore observe all warning and precautionary statement on the container. Read the label and follow all directions explicitly.

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TURF FUNGICIDE TRIALS - 1950

S. H. Davis
New Jersey Agricultural Experiment Station

These tests were conducted on the Seaside Bent (Agrostis palustris) plots of the fine turf experimental area at Rutgers University in New Brunswick, New Jersey. Mowings were made three times weekly at a height of 5/16 inch.

Three replicated and randomized plots of approximately

50 square feet each (3' x 16' 8") received each of the 28 treatments.

Spray treatments were applied with a spartan power sprayer operating at 150 lbs. pressure. A special boom, equipped with three #7 Dolavan flat-spray nozzles covering the 3-foot width was built on the sprayer. The two quarts applied to each plot required 15 seconds to cover the 16'8" length of each plot. This application rate was equal to approximately 100 gallons/10,000 square feet.

Ten treatments (Control, Tersan, Caloclor, PMAS, Puraturf, Crag 531, Puraturf 177, Crag 1025, Orthocide 406 and Actidione) were used in accordance with the American Phytopathological Society's National Cooperative Turf Fungicide Trials recommendations. In addition, Tersan and Puraturf were used with various spreader-and-sticker formulations and application times. Treatments were made nine times at approximately 10-day intervals from June 29 to September 18.

Dry fertilizers, applied to each plot individually with a fertilizer spreader covering 3-feet, were used one or two days prior to each spray treatment. A commercial 8-6-4 formula was used on all plots (except those receiving the organic "Milorganite" fertilizer) at the rate of five pounds of nitrogen/10,000 square feet.

Additional Control, Tersan, Puraturf and Crag 531 treatments were used on plots receiving a soluble 12-12-12 formula (tank mixed) or Nugreen (tank mixed) fertilizer with each fungicide application in addition to the standard 8-6-4 fertilizer. These four treatments were also applied to plots receiving only the dry "Milorganite" fertilizer applied at the rate of five pounds of nitrogen/10,000 square feet, one or two days prior to each spray treatment. (See Table I for fungicide dosages.)

Brownpatch (Rhizoctonia solani) was active on July 15, August 8, 11, 20, 24, 30, and September 8. Counts and measurements of the spots were made on the first six outbreaks from which the percent of area infected was calculated. On September 8, three observers made independent gradings (0-10) of the amount of infected areas on each plot from which the average grades were converted to a percentage figure by means of the table recommended by the A.P.S. committee on Turf Fungicide Trials. (Brownpatch results - Table II)

Definite injury occurred on some plots as a result of treatments. On July 15, three days after the second spray application, two observers made independent gradings of turf color and injury. These average grades for each treatment are listed in Table III on the basis of a grade of 5.0 indicating perfect turf to a grade of 1.0 indicating severe toxic effect from treatment.

No weed-killers were applied to these turf areas during the year so that rather heavy and consistent outbreaks of crabgrass (Digitaria sp.) occurred throughout the area. By mid-summer some plots were free from crabgrass and two observers made independent gradings of the amount present in each plot. These average grades for each treatment are listed in Table III on the basis of a grade of 3.0 indicating a heavy infestation to a grade of 0.0 indicating complete freedom from crabgrass.

On August 30 counts were made of individual disease spots of Copper Spot (Gloeocercospora sorghi). The total number of spots in the three replicates of each treatment are listed in Table III.

Table I
Materials Used in 1950 Turf Fungicide Trials - Rutgers

Material	Rate 100 gals./10,000 sq. ft.	Active Ingredient	Manufacturer or Supplier
1. Control	-	-	-
2. Tersan	2 lbs.	Tetramethyl thiuramdisulfide	Du Pont
3. Caloclor suspension	20 ounces	Mercurous chloride (60%) mercuric chloride (30%)	Mallinckrodt
4. P.M.A.S.	1 pint	Phenyl mercury complex	Cleary
5. Puraturf	2 pints	Phenyl mercury trieth-anol ammonium lactate	Gallowhur
6. Crag 531	2 lbs.	Calcium-zinc-copper-cadmium-chromate	Carbide & Carbon
7. Puraturf 177	1 lb.	p-amino phenyl cad-mium dilactate	Gallowhur
8. Crag 1025	2 lbs.	Crag 531 plus mercury complex	Carbide & Carbon
9. Orthocide 406	2 lbs.	N-trichloromethylthio tetrahydrophthalimide	California Spray
10. Actitione	0.31 ounces	Antibiotic	Upjohn
11. VL600	2 quarts	Proprietory compound	Goodrich
12. Spred-O-Stick	½ pint	Proprietory compound	Andrew Wilson
Fertilizers - Tank-mix			
1. 12-12-12	3 lbs.	Soluble N-P-K	Andrew Wilson
2. Nugreen	3 lbs.	Soluble - 43% N.	Dupont
Fertilizers - Dry application			
3. 8-6-4	62½ lbs.	Commercial N-P-K	Open Formula
4. Milorganite	83 1/3 lbs.	Organic fertilizer-6%N	Milwaukee Sewerage

Table II
Brownpatch Control in 1950 Turf Fungicide Trials - Rutgers[a].

Percent Area Showing Active Brownpatch on Various Dates[b].

Treatment	7/15	8/8	8/11	8/20	8/24	8/30	Total	9/8[c]
Fertilizer: 8-6-4								
1. Control	1.8	2.3			10.7	6.0	20.8	22.3
2. Tersan	5.7				0.7	1.4	7.8	5.0
3. Caloclor					0.2	0.2	0.4	0.8
4. P.M.A.S.	0.7	1.1			1.1	1.7	4.6	4.7
5. Puraturf		0.5	1.3			7.1	8.9	5.0
6. Crag 531					1.6	2.6	4.2	2.0
7. Puraturf 177	1.1			4.0	10.4	47.6	63.1	13.7
8. Crag 1025	2.9				1.2	0.8	4.9	5.8
9. Orthocide 406	0.3					0.1	0.4	2.9
10. Tersan ⁄ VL600					1.5	8.6	10.1	7.8
11. " d.	2.4	2.0			9.6	19.7	33.7	5.8
12. Tersan ⁄ S.O.S.	0.5	0.3			0.5	7.6	8.9	9.0
13. " d.	0.6				5.7	48.1	54.4	15.6
14. Puraturf ⁄ S.O.S.	1.2				0.1	0.8	2.1	8.6
15. " d.	0.9				4.8	31.6	37.3	24.2
16. Actidione					7.3	31.7	39.0	28.0
Fertilizer: 8-6-4- plus 12-12-12 (soluble)								
17. Control	3.8	2.0	1.1	1.9	9.3	14.6	32.7	17.5
18. Tersan	0.8	3.2			5.3	5.4	14.7	5.0
19. Puraturf	0.5				0.7	5.2	6.4	11.8
20. Crag 531	1.1				3.2	0.8	5.1	11.8

Table II (cont.)

Treatment	7/15	8/8	8/11	8/20	8/24	8/30	Total	9/8[c.]
Fertilizer: 8-6-4 plus Nugreen (soluble)								
21. Control	1.6	2.0		0.9	8.1	46.1	58.7	52.5
22. Tersan	0.1		0.2		2.7	11.2	14.2	16.6
23. Puraturf	1.0		0.1			13.3	14.4	4.7
24. Crag 531	1.1				0.4	0.5	2.0	2.9
Fertilizer: Milorganite								
25. Control	1.6	1.1		1.3	7.5	5.1	16.6	8.2
26. Tersan	1.6				2.7	4.1	8.4	5.8
27. Puraturf			1.3		0.2	1.7	3.2	2.6
28. Crag 531	1.5						1.5	2.6

a. Spray dates for all treatments except #11, 13 and 15; June 29; July 12, 20; August 1, 10, 19; September 2, 8, 18.
b. Actual measurements of active brownpatch areas from July 15 to August 30.
c. Average of independent ratings by three observers on September 8, computed to percentage figures based upon Horsfall and Barratt method.
d. Treatments applied on alternate spray dates, commencing on June 29.

Table II A

Mean Rank of Treatments on each date Brownpatch was active in 1950 Turf Fungicide Trials - Rutgers

Treatment	7/15	8/8	8/11	8/20	8/24	8/30	9/8	Mean Rank
Fertilizer: 8-6-4								
1. Control	23	26	11.5	12.5	28	16	25	25
2. Tersan	27	9.5	11.5	12.5	10.5	8	10	11
3. Caloclor	3	9.5	11.5	12.5	6.5	3	1	1
4. P.M.A.S.	11	21.5	11.5	12.5	12	9.5	7.5	9
5. Puraturf	3	20	26.5	12.5	2.5	17	10	14
6. Crag 531	3	9.5	11.5	12.5	15	11	2	4
7. Puraturf 177	16	9.5	11.5	28	27	27	21	24
8. Crag 1025	24	9.5	11.5	12.5	13	6	13	12
9. Orthocide 406	7	9.5	11.5	12.5	2.5	2	5.5	2
10. Tersan ⁄ VL600	3	9.5	11.5	12.5	14	19	15	8
11. " a.	25	24	11.5	12.5	26	23	13	23
12. Tersan ⁄ S.O.S.	8.5	19	11.5	12.5	9	18	18	17
13. " a.	10	9.5	11.5	12.5	21	28	22	20
14. Puraturf ⁄ S.O.S.	18	9.5	11.5	12.5	5	6	17	7
15. " a.	13	9.5	11.5	12.5	19	24	26	21
16. Actidione	--	--	--	12.5	22	25	27	--
Fertilizer: 8-6-4 plus 12-12-12 (soluble)								
17. Control	26	24	25	27	25	22	24	27
18. Tersan	12	27	11.5	12.5	20	15	10	18
19. Puraturf	8.5	9.5	11.5	12.5	10.5	14	19.5	10
20. Crag 531	16	9.5	11.5	12.5	18	6	19.5	15

Table II A (cont.)

Treatment	7/15	8/8	8/11	8/20	8/24	8/30	9/8	Mean Rank
Fertilizer 8-6-4 plus Nugreen (soluble)								
21. Control	21	24	11.5	25	24	26	28	26
22. Tersan	6	9.5	24	12.5	16.5	20	23	19
23. Puraturf	14	9.5	23	12.5	2.5	21	7.5	13
24. Crag 531	16	9.5	11.5	12.5	8	4	5.5	5
Fertilizer: Milorganite								
25. Control	21	21.5	11.5	26	23	13	16	22
26. Tersan	21	9.5	11.5	12.5	16.5	12	13	16
27. Puraturf	3	9.5	26.5	12.5	6.5	9.5	3.5	6
28. Crag 531	19	9.5	11.5	12.5	2.5	1	3.5	3

a. Treatments applied on alternate spray dates only.

Table III

Color Intensity Ratings; Crabgrass Control; and Copperspot Control in 1950 Turf Fungicide Trials - Rutgers

Treatment	a. Turf Color Intensity	b. Crab-Grass	c. No. Copper Spot
Fertilizer: 8-6-4			
1. Control	4.0	3	3
2. Tersan	4.2	3	0
3. Caloclor	2.8	2½	3
4. P.M.A.S.	2.7	0	0
5. Puraturf	3.2	½	0
6. Crag 531	4.0	3	0
7. Puraturf 177	4.2	3	0
8. Crag 1025	4.0	3	0
9. Orthocide 406	4.2	3	0
10. Tersan ⁄ VL600	4.8	3	16
11. " " d.	4.5	2½	85
12. Tersan ⁄ Spred-O-Stick	4.7	3	43
13. " " d.	4.8	3	68
14. Puraturf ⁄ Spred-O-Stick	2.7	½	0
15. " " d.	3.3	1	0
16. Actidione	--	2½	0
Fertilizer: 8-6-4 plus 12-12-12 (soluble)			
17. Control	4.2	3	0
18. Tersan	4.5	3	6
19. Puraturf	3.3	0	0
20. Crag 531	4.2	3	0
Fertilizer: 8-6-4 plus Nugreen (soluble)			
21. Control	4.3	3	4
22. Tersan	4.5	3	37
23. Puraturf	2.7	½	1
24. Crag 531	4.5	2½	0
Fertilizer: Milorganite			
25. Control	4.5	3	4
26. Tersan	4.0	3	0
27. Puraturf	2.8	0	0
28. Crag 531	4.2	2	0

a. Average of independent ratings by two observers on July 15 (three days after last spray); 1 - Brown turf, to, 5 - rich green.
b. Average of independent ratings by two observers on August 30; 0 - no crabgrass, to, 3 - heavy infestation.
c. Total number of Copperspot infections in three replicates on August 30.
d. Treatments applied on alternate spray-dates only.

THE SUPPLY OUTLOOK

Mr. Grady
National Agricultural Chemicals Ass'n

In the emergency facing us all today teamwork of the highest order will be the required thing of all interests. I am convinced that everyone here is in agreement that the needs of our armed forces must come first. Then by careful planning see that civilian defense receives its just share. Some disinterested parties in looking at the overall picture might feel that scarce materials should be strictly allocated to the exclusive production of food and fibre crops. There are some important factors that would knock that philosophy into a cocked hat.

We all know the results obtained in the control of Jap beetle by greenkeepers have materially aided in the reduction of Jap beetle attacks to surrounding agricultural crops. The control of fruit and shade tree insects and diseases on golf courses has materially reduced the incidence of infestations to surrounding fruit and forest plantings. The same situation exists for the control of weeds, flies, mosquitoes and everything else. If these pests are allowed to run rampant on and within the confines of any given area, it would take more materials to control these infestations on surrounding agricultural crops and everyone would suffer in the process.

Due to the fact that conditions within the pesticide industry are not the same by any means as they were ten years ago when the last emergency raised its ugly head, the question arises whether the pesticide industry is in a better position to meet the present situation. Ten years ago our chief insecticides were based on arsenicals such as arsenate of lead, calcium for use against the leaf feeding insects. Petroleum oil sprays, pyrethrum and nicotine were used against the sap sucking insects.

Our chief fungicides today require copper, sulfur or mercury for their production. We have in the last ten years experienced a wide-spread usage of pesticide chemicals and the field is expanding each and every year. We still have the same chemicals that we had ten years ago and they can be of valuable assistance in aiding in the control of insects and diseases. Fortunately, the National Agricultural Chemicals Associa-

tion is working closely with the federal government authorities to see that the entire field of agriculture gets its share of the old established ones as well as the new basic chemicals needed for pesticides.

I don't think any one of us would have believed even two years ago that we would ever see sulfur short in this country. The demand for that in this country is about six million tons per year and our domestic production today is only about 5.7 million tons. Unfortunately, neither do we produce sufficient copper in the states to meet normal domestic requirements and we must, therefore, import more year by year. With the price of pig lead at 17¢ per pound, many marginal lead mines will probably be coming back into commercial production to help relieve the lead arsenate situation. As most of you also realize, the bulk of our mercury must be imported.

All our new developments in the pesticide field such as DDT, BHC, Lindane, Chlordane, Aldrin, Dieldrin and so forth are all organic chemicals requiring benzol, chlorine or alcohol someplace along the line in their manufacture. These basic chemicals were in short supply during the last emergency, but they were of little concern to the pesticide industry. Today we are vitally concerned. A shortage of benzol is adversely affecting the production of more of our new pesticides and will probably continue to do so throughout the entire year of 1951.

Benzol is one of the basic chemicals needed for the production of many of our newer insecticides such as DDT. Large quantities are used by the synthetic rubber plants and also for the production of high octane gasoline. The production of benzol is actually tied currently to the coke production. Also there are limited quantities made available by a new process of extracting it from petroleum. This has promise of doing some thing to alleviate the condition. However, the production of benzol from petroleum is not feasible unless the price is in the range of 40¢ a gallon. Currently the contract price for benzol is about 35¢ a gallon against 22¢ a gallon at this time a year ago.

Chlorine is used as an intermediate chemical in the production of all of our new organic chlorinated pesticides. While the capacity of our chlorine producers has been constantly increasing, it is materially insufficient to take care of the ever increasing demands of the defense program without cutting severely into civilian use.

One of the first things we must examine in connection with the availability is what is known in our industry as balance. That is to say, if we are going to produce the 40 or 50 million pounds of technical DDT needed for agriculture in 1951, there is no sense in having a supply of benzol unless it can be balanced with the proper amount of chlorine, alcohol and other chemicals. These are of no consequence in the final availability of DDT unless you have the labor, power and equipment to convert it, unless you have the containers in which to ship it and unless you have the transportation to ship it to the points where it is required. All of these factors must be in balance to finally deliver a pound of finished DDT formulation ready to use against pests when needed. It is in this field of proper balance that one of the great dangers to availability lies.

We need containers. These items both in metal and paper are extremely tight at the present time and there is every prospect that they will be scarcer as the military defense program moves ahead. Some of the very same raw materials that we use in making our pesticides are used in the production of some containers. Here again it is necessary to bring those into balance in order to serve our production best.

In periods of shortage there are always questions pertaining to the effectiveness of distribution of the available materials and we always hear some talk about the government taking over distribution from industry and handling it on a ration basis at the consumer level. The pesticide industry has time and again demonstrated its unusual capacity for taking care of all its distribution needs upon an equitable basis and upon a time limit. With our years of experience in handling unforseen outbreaks and with our wide-spread facilities for local production of formulations, warehousing and distribution through established distributors and dealers, we feel that the best possible results for you are now being secured and that a change in any might lead to chaos.

I sincerely hope that this rough insight into the over all picture of the problem did give you some of the facts facing all of us. To sum up briefly, in the face of all these uncertainties our industry feels that on the whole we are in a good position to take care of the pesticide needs of the industry providing we use all pesticides both the old established and the new ones to the best advantage possible. You should all cooperate in the following manner. First, decide now

what pest control program you are going to follow. Stick to it. Order your material and get at least 80% of your anticipated requirements for the coming season on your premises as soon as possible.

Second, decide now several possible alternates if you are unable to secure the material of your first choice. Remember that a reasonably effective pesticide is better than none at all.

Third, see that your equipment for applying the pesticide is in good running order ahead of the use period. Fourth, don't hoard more pesticide than you expect to use. Fifth, don't buy pesticide on the black market at premium prices. It increases mal-distribution and is definitely frowned upon by the responsible manufacturers. Again we are all facing a serious situation, but with our will to cooperate we in the pesticide industry feel we are in a pretty fair position to take care of both our military and civilian needs.

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WEED CONTROL

H. B. Musser
Pennsylvania State College

The whole picture of weed control breaks down into two definite approaches. The one is cultural practices and the second is chemical control. From a practical standpoint those two dovetail very closely. Cultural practices sometimes fall far short of giving the percentage of control needed. By the same token chemical practices also fall short a great many times, unless they can be supplemented with good maintenance and cultural practices.

Cultural practices cover the entire field of good maintenance work. In many cases this also covers the matter of adjusting maintenance so that you get a maximum effect on your weeds. For example, time of fertilization has a very definite effect on weed infestation. Watering is another thing that must be considered. I think one of the most interesting things that grew out of some of the work that we did on watering at Penn State during the last four year period was the very definite difference in crabgrass infestation under certain watering and resulting compaction conditions. That brings me to the next point-- aerifica-

tion-- because so many of our weeds do persist and do increase under soil compaction conditions because of the fact that they are able to better survive. I don't need to go into clipping. Height of cut and many other common everyday practices with which we are all familiar have a definite and important place in the weed control program. I am simply noting them here to refresh your mind on them and to tie them up with the whole weed control picture.

I am going to spend the time we have available on the exploration of just where we are as far as chemical control is concerned. As I said before, chemical control, if it is to achieve the maximum results, should be tied in with the proper cultural practices. I am quite sure that eventually we are going to come to a combination of the two. I think that we must recognize that chemical control should be used only as one item in our renovation program. Just as a doctor uses blood analyses as one item in diagnosis of diseases, yet does not depend on it entirely for his final diagnosis, so we are going to come to recognize that no chemical is a panacea for all our weed troubles. We are going to come to recognize that certain chemicals are specific for certain classes of weeds,and as such, have a definite place as a tool in our general maintenance picture.

The proper use of chemicals in a weed control program assumes, in the first place, the proper timing of treatments. Probably the best illustration of that is the results we had when we were making our first tests of 2,4-D on broadleaf weeds at State College. We made applications at different periods throughout the season. The treatments that were made in the late spring were just as effective in controlling weeds as they were at any other time. That is, they produced just as good an immediate kill. But we came up at the end of the summer with more weeds on those treated areas than we had to start with as determined by actual count of the weeds on the area. If we had depended on a count at the end of the season from treatments that were made in the spring, we would have thought that 2,4-D was no good. The weeds present in the fall were practically all seedlings that had developed during the season. The late spring treatments killed weeds present at that time but did not allow sufficient time for the grass to spread in and occupy the bare areas where the weeds had come out. During the summer months the grass doesn't come in as it does during the periods when growing conditions are better.

The place of chemicals in a weed control program also will depend on such items as fertilization, strong

grasses, soil conditioning and many other things.

Since most of our chemical herbicides are specific for certain groups of weeds it is definitely necessary that we have a working knowledge of the value and limitations of each herbicide. Based on our present knowledge of the effectiveness of a number of these herbicides, I think we could class them into three groups from the standpoint of their effect on the weeds themselves. The first group would contain those broadleafed weeds for which 2,4-D has become practically a standard control. We don't hesitate any more to use 2,4-D for dandelion, broadleafed plantains and that class of weeds. We know that it will do an efficient job on these weeds when handled properly.

Then we have a second group to which the chickweeds, knotweeds, veronica, and that type of weeds belong. These are somewhat more difficult to control. While tests have shown that it is extremely difficult to control them with 2,4-D, this group is severely injured by the arsenicals, particularly sodium arsenite. Potassium cyanate, also, is quite effective on them. I think, however, that we must answer a great many more questions about the use of these materials before we will be in a position to set up anything like a standardized procedure for them.

Our third group of weeds is the one that is the worst. Crabgrass is its most prominent member. I would like to spend a little more time and go into a little more detail on this group and on the extent of our present knowledge of crabgrass control, because of the fact that there has been so much interest in this subject in the last two or three year period. We probably have more people working on crabgrass control, we have a greater variety of results and, therefore, are more confused as far as crabgrass control is concerned than for any other of our more troublesome weeds.

Many chemicals have been tried during the last two or three years for crabgrass control. Among these, the three that have come nearest to being standard are the phenyl mercury compounds, potassium cyanate and sodium arsenite. Also we have some new ones which are still in the experimental stage, but are promising on the basis of preliminary tests. Among the most important of these are dichloral-urea that was tested in New York State during the past season and the boronium compounds that Ralph Engel worked on in New Jersey.

Just where do we stand at the present time in our

knowledge of chemicals for controlling crabgrass? I have tried to get some of the more definite and more interesting data together in summary charts, covering the more recent work at various experiment stations.

This first table is a summary of work at the Rhode Island Experiment Station as reported by Dr. DeFrance. One of the chief problems with these materials is the method of application. I picked out these comparisons to show you how widely results can vary with different methods of application. Granted, none of us would use a sprinkling can on a large area to put on the treatments. But the results that we get with a fine nozzle watering can, from the standpoint of the way the solution concentrates on the leaf, are probably quite typical of what happens in a number of cases where we are varying volumes, spray nozzles and pressures. There you have the picture of a very wide difference in control with the same quantity of material, the same gallonage of solution per acre. The only variable is the way in which it is applied.

This second table gives you a picture of the extent of our present knowledge of the use of phenyl mercury compounds on putting green turf. The rate of PMAS application is on the basis of 10% equivalent material. That is, 4.3 pints of a 10% material applied at 435 gallons to the acre with 10 day intervals between the treatments. After three treatments applied at 20 day intervals and five treatments applied at 10 day intervals, Dr. DeFrance got practically perfect control of crabgrass. This gives you a fairly good idea of what can be expected where you use the number of applications shown.

This 3rd chart is some of the work at New Jersey. Dr. Ralph Engel is present and can tell you more about it than I can. But I was very much interested in the results that were secured here where treatments were started at varying periods. I used this summary because I wanted to tie some additional comments to it, that are related to practical use of these materials. I think Ralph would be the first one to recognize that one application of sodium arsenite at the rate which is indicated is not a fair comparison with three applications of mercury over the period of time indicated, so that you can just forget about that as far as any comparison is concerned. You will note that there is some difference in control when the treatments were started at varying periods, still a fairly decent control, from a practical standpoint, for all treatment periods.

I am of the opinion, that eventually we are not going to be interested nearly as much in getting maximum kill as we are in a practical reduction of the crabgrass stand. Particularly, if while we are reducing that, we can stop seeding. It seems to me that this is going to result in a limited number of applications trying to hit the early peak of the crabgrass infestation. In other words, if we can catch that early peak with chemical treatments and then follow up with cultural practices, I think we will eventually come up with a pretty practical procedure regardless of which of these chemicals we use. My reason for feeling that it may develop into something of that sort is that we do know very definitely that the earlier we can get a treatment on, the easier it is to stop the crabgrass. We can use smaller quantities of material and we can use them less frequently than if we were attempting to secure a complete kill. This apparently would require four or five repeat treatments.

The next table also shows some of the work at New Jersey. I think we get a very much more satisfactory comparison of materials here than we had in the previous tests. Dr. Engel presented this material at the weed control meetings in New York last week. You will notice that sodium arsenite at 2½ pounds with a wetting agent left no crabgrass plants per square foot while there was some injury to the grass. Sodium arsenite without a wetting agent was not as effective. PMAS on a 10.4% basis with three and four quarts left very few crabgrass plants and also very little injury to the permanent grasses.

We have some interesting results from the work in New York State during 1950. On the basis of a 10% solution the wet application was at a rate of 5.5 pints per acre. This dry application on the same basis was at a rate of 21 pints and the other dry application at a rate of 42 pints. Potassium cyanate was applied at a rate of 12 pounds, Milarsenite - 217 pounds and arsenic acid - 4 pounds per acre. The percent control speaks for itself. Here again we must know how the test was run before we can get a complete picture of exactly what the situation is with regard to control. You will notice that the treatments were on June 26, August 9 and August 26 with the final reading on September 26. There is the possibility always of having reinfestation come after the last treatment had been made even though the last treatment was effective. That doesn't explain the drop off in control on the five pints and on the 12 pounds of potassium cyanate and probably on the poor control with Milarsenite. We

can always say those quantities were not the proper amounts to give us the same degree of control that the other rates did.

This chart shows some results in Canada. They used potassium cyanate. With one treatment of six pounds they got 47 percent control; with 12 pounds - 79% and with 25 pounds - 90%. Those figures look very much more interesting for potassium cyanate than the previous ones. With two treatments the results were even better for comparable rates of application. The readings were made a relatively short time after the applications were put on. It is another illustration that we do kill existing crabgrass plants with these materials. If they had waited for another month to get those readings there might have been a tremendous reinfestation of crabgrass following the treatments.

Just a few words about some of the work that we have done this summer in Pennsylvania. Treatments covered a period from June 22 to the 30th of August. They are listed in the table under the percentage crabgrass survival following 1, 2, 3, 4 and 5 treatments. The chart shows both the initial control readings made one week after each one of those treatment periods, and the final control readings made a week following the last treatments on the 30th of August. We did not get any additional crabgrass germination this year after this date. I am not going to spend too much time on these results except to point out that there was a progressive decrease in the percentage survival of crabgrass as determined by actual count of the number of plants per area following each one of the treatments, the percentage being based on the actual count of the crabgrass on the individual plot before the treatments were put on.

One of the very interesting things to me is the little table at the bottom. Some very interesting differences began to show up late in the fall in recovery of the grasses following the treatments. On this table you will note there was an average of 20% permanent grasses on all the plots that were not treated. The rest of the area was covered with weeds or clover or was bare ground. Most of the grass present was bent, with a scattering of Kentucky bluegrass. On the potassium cyanate plots the final percentage of permanent grasses for the plots receiving only one treatment was 15%. After two treatments, 35%; three treatments, 41%; four treatments, 50%; five treatments 60% permanent grasses. The figures go up in the same way with the phenyl mercury material and the sodium arsenite. With the sodium

arsenite they started at a higher level. It is quite apparent that none of the treatments injured the permanent grasses. The increase is no doubt due to less competition from crabgrass.

One other thing of interest is the very satisfactory control that we got from extremely small quantities of sodium arsenite when we used it with a wetting agent. We started out with the first application at a two pound rate. That seemed to scorch the grass a little more than necessary and it gave us a good immediate crabgrass depression, so the next application we cut down to a half pound per acre. That didn't seem to be quite enough. For the third, fourth and fifth treatments we finally settled on one pound to the acre.

One more thing in which we have been interested, in the use of potassium cyanate, is the possible effect of different quantities of solution on the crabgrass. We used 4, 8 and 16 pounds in four replicated plots with 25, 50, 100, 200 and 400 gallons of water. As far as the 400 gallons is concerned, it doesn't show any difference from the 200 except where we used the smaller amounts of cyanate. I think you can see from the figures that the 8 to 16 pound rates have given us fairly good control. I think we are going to come to the point where we will recognize that it isn't necessary to kill every plant of crabgrass on an area. If we can get 75% control with one or two applications by the peak period of crabgrass infestation followed by light later treatments to check seeding of surviving plants, we can check the pest effectively.

This shows the general layout of the tests at the Philadelphia Country Club. The work was done on a practice fairway. At this point I want to express my appreciation to Marshall Farnham for the very definite help he gave us, not only in laying out this whole area, but also in helping us to make individual counts. The next slide shows the layout of the plots, which were 5 x 10.

Can we reach any general conclusions from all of this work? I think it is quite apparent that any of these materials will do a good job if they are understood, if they are handled properly, and if they are applied at the proper concentrations. We still need much more information on proper rates particularly for wet vs. dry treatments. We also need a clearer picture of solution concentrations for uniform coverage. Also, weather relationships are important. We know that we can't possibly use sodium arsenite when the soil is

extremely dry and when temperatures are high. But I think there is enough leeway in weather conditions so that satisfactory periods for making treatments can be selected.

As far as rates of application are concerned, I think that the results in general show that with the phenyl mercury compounds, we must get up to eight pints of 10% solution. Where potassium cyanate is used with a wetting agent when the crabgrass is fairly young, eight pounds in 2 or 3 applications within rather narrow intervals of 6 or 7 days will do a pretty effective job. There will be some discoloration of the turf. As for sodium arsenite, I believe that we do need to explore very carefully the use of smaller quantities with a good dispersing agent to spread it over the leaf. We may be very much surprised at what two treatments with small quantities can do, if handled properly.

What constitutes proper application? In the first place, I would say uniform distribution. Sprayer nozzles must be functioning properly. The right nozzles must be used for the gallonage to be applied, and they must be adjusted so that there will not be a disastrous overlap which will cause injury. Also, I think some satisfactory method of marking the area that has been treated must be used.

Another item of application that is important is that we must know within reasonable limitations what will constitute a sufficient quantity of material to give us good coverage. This is particularly important for dry applications. In practically all the cases where I have had anything to do with the application of dry materials, particularly PMAS and 2,4-D we had to use them in relatively higher rates of the toxicant than for spray solutions, simply because we are depending on the material lodging on the plant to give us our control. In dry applications some of the material does not stick to the leaves and so is not immediately effective.

I believe that we need to know more about wetting agents primarily from the standpoint of minimum quantities that can be used. I think that any one of a half-dozen or more wetting agents can be used, but we would like to know more about the minimum quantities that are necessary.

That is about the general picture on crabgrass control as far as I have been able to dig it out of these many different series of tests, supplemented with a good

deal of observation of practical results.

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FERTILIZER STUDIES IN NEW JERSEY

Ralph E. Engel
Rutgers University

Fertilizer practices are of first level importance in turf management. We all agree to this, yet too few agree as to what are the correct sources of fertilizer, quantity of fertilizer, or time of application. This means one thing-- we do not have enough facts and figures to show us what is good, what is bad, or has no value. When we get more of these, many of the much discussed theories will be settled.

I do not imply from these preliminary statements that nothing has been done in the past, Much to the contrary, a lot of valuable work has been done. If we review the past research, we find that a wide variety of nitrogen carriers have been studied. We gind limited but valuable information on the effects of phosphorus and potash. A number of tests have been made with inorganic nitrogen and organic nitrogen carriers. These have enabled us to classify the merits of each which aids us in selecting the type for the job that needs to be done.

The New Jersey turf program is currently working on several turf fertilizer problems. One Project is concerned with ureaform, a new, slow acting nitrogen carrier. We wish to know how the material performs in comparison with inorganic nitrogen and other organic nitrogen forms. The first slide gives us an indication of the type of performance ureaform gives in the New Jersey area. This graph includes three of the nitrogen treatments. Ureaform 4910B, inorganic nitrogen (equal parts of nitrogen from ammonium sulfate and sodium nitrate), and Milorganite are given.

The fertilizer was applied at the rate of 70 lbs. of nitrogen per acre (approximately equivalent to 350 lbs of $(NH_4)_2 SO_4$ or 1200 lbs. of Milorganite per acre) on April 12. The test area was a mixed turf that was predominantly Colonial bentgrass. The first clipping weights were taken 16 days after the fertilizer application. Weights were taken once per month throughout the remainder of the summer. Note that growth was

much greater in April for the inorganic nitrogen treatments (significant at 19 to 1 odds). Ureaform gave the slowest initial response. This same rank of response was shown by the intensity of the green color of the grass on the clipping date.

As is typical of inorganic nitrogen treatments, the growth rate drops rapidly. Note that by May it had already approached the values for the slower acting fertilizers. During the remainder of the summer the values were lower than for Milorganite and Ureaform.

The growth curve for Milorganite and Ureaform was quite uniform from month to month. Milorganite gave somewhat higher clipping yields during four of the five months. However, none of these values analyzed statistically significant at 19 to 1 odds. Ureaform has performed similarly in other tests. In essence, it has performed similar to an organic nitrogen carrier.

When using fertilizer, we must remember that factors other than type and quality are highly important. For example one of these is time of fertilizer application with regard to season. Does early spring fertilization encourage Poa annua? Does heavy summer feeding encourage clover? We have two studies at Rutgers that we hope will answer some of these questions. One test is on seaside bent turf that is mowed at ¼ inch. The other test is on a mixed turf that has two mowing heights (3/4 inch and 1½ inches). These tests are two years old-- as yet we have not been able to observe any pronounced differences with regard to Poa annua or clover. However, we have seen several reactions that illustrate the influence of time of fertilization. The second slide shows the effects of time of fertilization on the amount of ryegrass and bentgrass in a mixed turf.

Two classifications of plots were made on the time of fertilization area that was maintained at 3/4 inch. One group received no fertilizer in September. A second group received a minimum of 49 pounds per acre of a complete fertilizer by mid-September. Observe that these fertilizer treatments had more than twice the quantity of perennial ryegrass than the plots receiving no treatment at this season. The encouragement given the ryegrass by fertilization in September had a depressing effect on the bentgrass. I like this example because it shows what can be done with time of fertilizer application. In this case it has no general application, but we hope that the study will show

the best time for us to apply fertilizer to help with such problems as Poa annua.

This study was set up to give a treatment with organic nitrogen only and a treatment that included 35% organic nitrogen. It is of interest to note that the average values of bentgrass for the September treatments were equal (50.9 each). The plots receiving no fertilizer in September had an average of 69.5 for those receiving some organic nitrogen and 63.9 for those receiving no organic nitrogen.

We all know that time of fertilizer application has a profound effect on factors other than relative composition of the several grasses. Everyone who has worked with bentgrass, knows that fertilizer practices have a very marked influence on disease. We have learned that severe dollarspot attacks may be associated with low nitrogen-- that overfertilization in hot weather encourages large brownpatch.

Unfortunately, we know very little about the effect of fertilizer conditions on the disease commonly known as copperspot. By chance we did obtain a bit of information in 1950 from the time of fertilization study on bent at ¼ inch cut. Luckily a severe attack of copper spot occurred on this test in August. Of course, Dr. Spencer Davis felt very badly because we did not get much on the Fungicide test area. We made counts and the data are summarized on slide 3. Observe that the plots receiving the heaviest nitrogen fertilization during the period of June through August had the most copperspot. It is not possible to distinguish between the medium rate and the lower fertilizer rate. However, both of the lower rates were superior to the high rates. The performance of the treatments containing organic nitrogen was very similar to that of the treatments receiving inorganic nitrogen only, except for the medium rate. The difference for this rate appeared to be a little out of line according to the data.

The results obtained indicate that the severity of the copperspot attack was intensified by the high nitrogen levels. Yet, far more information is needed on the effect of fertilization on the diseases. We have not set up our time of fertilization studies with disease with a forethought in mind. However, we did obtain this one bit of information with regard to nitrogen. Other problems with regard to nitrogen-disease relations remain to be answered. Dr. Davis gave you some information on our trials with soluble nitrogen in the

fungicide. We also need information on the role of K and Ca in relation to disease.

We have been concerned with another problem on time of fertilization-- namely, the warm season grasses Zoysia and U3 bermuda in combination with our cool-season grasses. To date we have been discouraged with attempts to grow Kentucky bluegrass, bent, or fescue in U3 bermuda. We have not had sufficient observations to hazard a guess as to the possibility of growing the cool-season grasses in combination with Zoysia. I can show you some slides later that portray some of our experiences in fertilizing U3 bermuda.

A test was started in 1947 in cooperation with the USDA and USGA to determine the effect of 2,4-D and fertilizer in turf renovation. The slide shows the four treatments used:

No fertilizer - No 2,4-D
Fertilizer - No 2,4-D
2,4-D - No fertilizer
Fertilizer and 2,4-D

These tests were repeated four times. The dates for the start of each test are Spring 1947, Fall 1947, Spring 1948, and Fall 1948. Comparison of the first two lines of figures in the table show that fertilizer alone was effective in reducing the number of broad-leaved weeds. Comparison of the last two lines of the table shows that after two years, fertilizer has aided 2,4-D in controlling broad-leaved weeds. This benefit from fertilizer did not show in the treatments that were one year old. These results show that effect of fertilizer can be measured by factors other than making the grass grow.

Two years ago at Rutgers a grass nutrition study was conducted in the greenhouse as a special problem. It was not a fertilizer study but it portrays a situation that should be considered in turf fertilization. The test had low, medium and high rates of potassium (the essential nutrient in potash). The rest of the nutrients such as nitrogen and phosphorus were at an optimum. The results were an average yield of

16.0 grams for the low level
30.8 grams for the medium level
64.1 grams for the high level

This serves as a nice illustration of the influence of potassium on growth. In addition it gives us an idea

of the degree to which we handicap turf when we compel it to exist on soils deficient in potash.

Like other sections, we have a lot of variation in the turf fertilization programs in New Jersey. However, certain fundamental procedures are quite consistent. I do not claim these principles apply to your area. Neither do I offer them because I feel the golf course superintendents in our area have all the answers.

Fairways are the greatest problems for us. This is largely due to the trouble caused by Poa annua and clover. Like everyone else, we would like to discover a good sure-fire control for these nuisances.

Drs. H. B. Sprague and Glen Burton published the most comprehensive study available on Poa annua. I regret to say that this bulletin is no longer available. They found no single reason that gave rise to this pest. In essence their work points to the fact that any of a variety of conditions that cause turf to fail, may in turn give rise to the invasion of Poa annua. A healthy bent turf was suggested as a good antidote for Poa annua. Since bentgrass is a "heavy feeder", we do not feel that nitrogen starvation enables bentgrass to hold its own against Poa annua.

It is easy enough to suggest that bent be kept vigorous by using nitrogen, but this has led to considerable disease injury when fertilizer stimulation occurs in late June, July and early August. For this reason there is a trend towards a fertilizer program that keeps the nitrogen supply low during this season. Fertilizer applications are started in late August to take advantage of the cooler weather. At least two applications are then made before late fall. Fertilizer can be used again in the spring as long as excessive nitrogen stimulation does not extend into the large brownpatch weather of summer. Several of the superintendents in our area are trying this program. A few years experience should enable us to evaluate this type of procedure. Obviously this technique may not apply in your area, especially if you are working towards bermuda. I give it to you because it represents one of the trends in our area.

We consider that increased use of nitrogen fertilizer is one of our best techniques for reducing the clover problem. Of course this procedure should be accompanied by other factors that promote good turf. However, like everywhere else, money does not grow on trees and many of our courses cannot afford the purchase of

large quantities of fertilizer. This situation and other factors are expected to give difficulty in maintaining the solid stands of Colonial bent that are required to keep clover at a minimum.

Greens also present clover and Poa annua problems. Clover can usually be dispensed with by using sufficient nitrogen. Most superintendents in our area keep Poa annua under control by maintaining a healthy turf and by using enough nitrogen to keep the turf vigorous. Some have trouble where improper soil conditions exist or severe compaction occurs. Where heavy traffic creates a problem, correct fertilization will be helpful. Usually this situation requires smaller and more frequent applications. However, this is only one step that is needed. Some courses are using a lot of cultivation in an effort to save the grass on these compacted areas. In addition, it appears that some will have to resort to controlled play and larger greens.

(Kodachrome slides followed)

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REVIEW OF THE RESEARCH OF 1950

Marvin Ferguson
U.S.G.A. Green Section

I think these talks that we have had this morning have been a representation of the type of turf research that is being done in the United States. They have made my job easier because we have some examples that I can cite of what is being done.

Turf research has been accelerated very greatly since 1945 or at the end of the last war. It still seems to move very slowly. Also you people who are growing grass on a practical basis wonder what we do accomplish. Research seems to be so slow. On a Friday evening when we go home, if we sit down and try to ascertain what has been done during the past week, we get a feeling that we haven't accomplished very much. If we look back over a month, it is pretty much the same thing. If you look back as much as a year, you begin to see that maybe we have learned a few things that we didn't know the previous year. If you take a ten-year period, we can cite some real progress.

We think of DDT and Chlordane for the control of insects. This morning Dr. Langford mentioned that DDT and the atom bomb were spoken of in the same breath. I think that pretty much illustrated the impact that those things had in greenkeeping practices. 2,4-D came along during the war and was put into practice shortly after the war. I think that made turf growing much easier than it had been previously. There are also such things as Tersan and the cadmium materials that have done such a good job on dollarspot. There are new grasses. I don't believe there was a single green planted to any of the improved bentgrasses at the time I came to work with the Green Section in 1940. Very shortly afterward Bill Glover at Fairfax planted the entire course to the improved strains of bents.

The job of the research organization or worker is to try to keep a lot of these investigational studies going along at the same time and to keep them all moving forward. While in one phase of work we may not accomplish very much very rapidly, if we engulf all the problems that come before us in growing turf and keep the whole mass of investigational work moving slowly forward, once in a while we find out something and when you begin to total them up over a period of years research certainly has done something to make the growing of grass easier.

I would like to mention the Green Section's place in turf research. The Green Section tries to inventory the research work that is being done at the various experiment stations and tries to keep each experiment station informed as to the type of work being done at other experiment stations. In that way we can prevent overlapping and do something towards coordinating the work. We ourselves have a small staff and we can't actually do a lot of research work. So we feel that we serve a more useful purpose by trying to keep the other experiment stations working together and do as much as we can in helping them keep up to date.

Turf Research Review was published for the first time in 1950. That publication was an attempt to outline the research work at all experiment stations and to make a list of research projects available to all our subscribers and to all experiment station workers. There are plans to revise this publication each year to keep it up to date and to try to summarize as much as possible the research accomplishments of each year. In 1950 there were 22 experiment stations in the United States that reported that they had some work going

on turf lines. Not all of them had a turf research project, but they held a turf conference like this one where they got all the turf interests together. Others may simply have had a bit of extension work in turf. But at least there were 22 states in the United States doing some work along the line of turf research. That is one of the Green Section's jobs-- to try to keep all that work going and to try to stimulate interest at all experiment stations in the hope that those experiment stations can help us to serve our member clubs and furnish more information.

Another one of our jobs is the encouragement of greenkeepers themselves to do some research work for us. Maybe you don't consider it research when you go and plant new strains of grass in your greens. Actually it is. The experiment stations and Green Section can do some research. We can develop new ideas and partially prove them, but it is up to the greenkeepers who use these things in a practical way to actually finish the proving process and put the developments in to practice.

Another one of our functions is maintaining a liason with industry. I can remember that not very many years ago we shied away from any industrial companions. We were scared of commercial people. That picture has changed completely. Now we encourage industry to do some research on their own. We have prevailed upon many commercial firms to make contributions to turf research and a lot of them have. For example, there is the Wagner Fellowship at Penn State working towards new bents and fescues. There is the West Point Fellowship at Penn State for the study of aeration in the soil. The American Cyanamid Company has made various experimental grants which have been placed at various stations for the study of weed control. Mr. Geary, another Oregon seed grower, has made money available for a project at the University of Maryland on leaf analysis of grass. I believe that these commercial grants have helped us very greatly in our turf research program and I know that we are much better off to have the situation that way.

Besides contributions from commercial firms the Green Section has what it calls "subscribers"-- commercial firms and other interests who are not eligible to be USGA members but who are invited to take out a subscription whereby they may support Green Section activities. Those funds have been used to establish research grants at various experiment stations and that is the way many experiment stations got started on

turf research work. There have also been some fellowships established at state institutions. They have been very gratifying because there you spend the money for a double purpose. You get some work done on some phase of research and you also train a man to take his place in turf at another state institution in some phase of turf work. When you make a fellowship grant, you almost assure the accomplishment of some research project because I think it is generally true that most institutions require that the student do a piece of worthwhile research or he doesn't get his degree.

In 1940 there were probably less than a dozen men in the United States who were engaged in turf work at state institutions or in turf research work or extension work. The Turf Research Review for 1950 listed 72 men who are now spending at least a part of their time in turf research. We know that the list is not complete. Dr. Grau said he would think there are 100 people who are now engaged in turf research at least part time. I think that certainly is an encouraging picture.

This increased amount of turf research effort makes itself felt. We can spend more time working on the big turf problems that confront us and also we can spend some time on little problems that ordinarily could not be considered important but are things that we would like to know the answers to. As we move along, we are able to work out some of those things incidentally.

One of the big problems and one of the things that was stressed this year was water-- the relationship of water to the soil and to the plant and how we can save water and use less water and still maintain the quality of turf. Dr. Jim Watson, who is now at Texas A & M received his Ph.D. degree at Penn State. His thesis problem was done on irrigation and compaction of fairway turf. Dr. Bill Daniel, who is now at Purdue, did his thesis at Michigan State College on fairway irrigation studies. Dr. Richard Davis, who is now at the Wooster, Ohio, Experiment Station, got his doctor's degree at Purdue and worked on the physical characteristics of putting green soils. Don Likes, also of Purdue, who is now a greenkeeping superintendent at Cincinnati, worked out his Master's thesis on irrigation studies. Dr. Bob Hagan at the University of California, has been assembling all the information that the University of California has accumulated on irrigation practices and is attempting to summarize all that information as it applies to turf.

New grasses have received quite a little bit of emphasis. There have been no new ones released this last year, but we have been able to encourage the build-up of seed stocks of B-27, we are a step nearer to the testing of the bents and fescues and they will be coming out soon. I won't say very much about grasses because Dr. Grau will discuss that tomorrow.

You have heard about crabgrass control this morning, about the National Cooperative Fungicide Trials. Ralph Engel has given us a little bit about nutritional studies. My own work at the University of Maryland was done on the nutrition of zoysias. There has been nutrition work done at Penn State, California and some at Purdue.

Slides: These are the nutrition studies with increasing quantities of nitrogen from left to right. The quantities of nitrogen are on the labels on the pots. There is a median in the center where the greatest amount of zoysia seed is produced. Low rates produce very little seed as do very high rates. There is a definite limit to the amount of nitrogen that should be used on zoysia for seed production.

This simply gives you a line picture of the relationship between the nitrogen content and the number of seed heads. It tells you pretty much what you saw in the previous picture.

Here with phosphorus there is not nearly the response that we have with nitrogen. You can detect very little real difference between the various phosphorus levels. You can see from this that phosphorus is less important than nitrogen for zoysia seed production.

Here is the picture with regard to potassium. I think there, too, potassium is less important than nitrogen. There is more in the realm of phosphorus. Calcium is a little bit different although there is not nearly the response to calcium as to nitrogen. Magnesium seemed to be a little more effective than calcium.

This is boron which is one of the surprises. It is an amazing thing. Boron has been used in agriculture for many years. Its chief response has been on the leguminous plants. I don't believe previously in the literature there was any reference to its giving beneficial response to the production of grass seed. Here it definitely has. The highest amount of boron used was not enough to show the limit to which you could use boron. The seed production was still going up and

I was at the end of my treatments.

This work is based on leaf analysis. The figures of concentration of the various elements were actually found in the leaf of the grass by chemical analysis. We feel that since we have established the curves showing the relationship between nutrient element concentration and seed yield, we could go into a field of zoysia now and take clippings, analyze them and tell you whether you needed more of any particular element to give you maximum growth or yield. I mentioned before that we have set up with Mr. Geary's money a grant at the University of Maryland with the agreement that the University make any tissue tests for us that we need. The next thing we want to do is build up a similar amount of research in other grasses. If we can get enough samples of other grasses to analyze so that we can determine the levels of nutrient elements associated with optimum growth, then we will be able to do a real service.

Soil tests are very valuable in telling us whether or not you have the mineral elements in the soil that the grass needs. Soil tests don't tell you if the grass is getting them. In conditions of poor aeration, poor drainage, you might possibly have plenty of nutrient elements in the soil but your grass isn't getting them. Tissue testing has that advantage. You know if the elements are in the grass or not. It is quite a job correlating these tests with the actual growth you are getting in the field. It is going to take us some time to draw up sufficient information to interpret the leaf analysis that we make. I think possibly you are going to hear a little more about it when Dr. Gauch speaks.

For a long time we have seen this thing we call yellow tuft on greens. Nobody has known exactly what causes it. I think it first was mentioned in literature by Dr. Piper in 1923. At that time he decided that it couldn't be a disease but he didn't know what it was. Later Dr. Monteith referred to it in his disease bulletin in 1932. He also said that it must be some physiological thing. He had examined it and couldn't find any trace of disease. Recently we thought that it might be caused by nematodes. So I asked one of the boys at the University of Maryland who was doing some work on nematodes to take a look at it. We gathered up these little yellow tufts and found them to be just loaded with nematodes. We have been bothering the Washington boys all summer with this problem and without exception wherever we found yellow tuft, we

found a large population of nematodes.

I think as more research is done and as we can get more men in the field and more effort is applied, we are going to find that we will learn the answers to our problems more rapidly and we will have time to work out a lot of these annoying problems that heretofore we have not been able to spend any time on because there were so many more important problems to be solved.

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WHAT'S IN THE BAG

The National Fertilizer Association

"What's in the Bag" was produced to give a broad under standing of the fertilizer industry and establish correct nomenclature. We often hear about filler in fertilizer. There is such a thing as filler in fertilizer, but the word has been used loosely and often used incorrectly. The terms "filler" and "carriers" were being confused.

Pure phosphorus cannot be handled because it will burst into flame when exposed to the air. To make phosphorus usable and safe to handle, it must be combined with other elements. When certain elements combine with phosphorus to make a stable compound, those combining elements are called carriers. They are the vehicle that carries phosphorus safely.

Similarly, pure potash will react violently when it is in contact with water, but when combined with carriers it can be handled safely.

Likewise, pure nitrogen is a gas and can't be easily handled and used as such. When combined with carriers it too can be moved and handled easily.

For example, in an 8-8-8 fertilizer there is 24 pounds of plant food in every 100 pounds. The fertilizer compounded contained 71 pounds of carrier and only 5 pounds of filler.

It took about 1-1½ years to make this picture. The fertilizer industry is well distributed over the United States, as you will see, and to present the fertilizer story I was in 35 states to obtain pictures of

the facilities necessary to supply the fertilizer for our nation.

As world conditions are today, I know that you gentlemen are wondering what the situation will be for grasses should we get into a shooting war more serious than we are in now. I don't know. I would be prophesying by all means if I would try to tell you that. You know what happened during the last war. So that may be a guide. We are not too pessimistic about the supply of fertilizer. There may be some locations where people are going to be short, but not too much as indicated by present conditions. As was mentioned this morning by Mr. Grady, sulfur is in short supply. The world consumption is about 5.7 million tons and we use slightly more than that. As far as phosphorus is concerned, we are not going to be in too bad shape. Some acid for making superphosphate can be obtained from by-products. Our normal superphosphate has been decreased a little and concentrated super has stepped up, consequently the total tonnage reduction will not be drastic. Our total superphosphate capacity now is about 13 million tons. The nitrogen picture is good.

What may happen is this. The users of superphosphate may have to cut back. PMA and others that distribute phosphoric acid or material may have to be curtailed. In the compounding of fertilizers, it might be possible that the amount of phosphorus going into it will be cut back and make savings there. I don't think we are going to be in a very serious situation from the supply standpoint.

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"ROUND-UP" (Discussion)

Led by O. J. Noer
Milwaukee Sewerage Commission

Noer: As a starter, what about insecticides? Are there any questions that you want to ask about them?

Question: Does the timing of application have any effect on control of June beetle grub?

Langford: Yes, it would have some effect. If you get the soil impregnated with material, it will last for several years and you should get ultimate kill regardless of when you put it on. If you treat on a warm

day, the action of the material would be too late because the bugs are not feeding at the surface. If you treat at a period when they are feeding at the surface, your results will be much quicker. Probably that would be the ideal time of the year to treat.

Cory: There are a variety of life histories. We have a Japanese beetle which has a one year life cycle. We have the annual life cycle grub. The June bug has a two year life cycle and the May beetles run from 2 to 4 years and so it goes. It is a question of getting the material on when they are feeding. The young are easy to kill; the old difficult to kill.

Noer: With Chlordane you will obtain 60% to 70% kill or higher, within a few weeks if grubs are up at the feeding zone, whereas with lead arsenate you may not see the effect for almost a season.

Langford: These materials will have to be washed in very well. Under certain conditions, you can get the grubs cleaned out very well, but under some conditions they may survive somewhat longer, but will eventually be killed.

Question: What about the effect of Chlordane upon birds or other animals?

Langford: Chlordane, DDT and all of them are toxicants. However, they are not as toxic to animals as the arsenicals. I don't know of any reference where chicks, ducks etc. have been killed by feeding on treated grass.

Question: Do we have any insecticide for work on the eel worm?

Ferguson: We haven't done much on them in the way of control.

Noer: What about fungicides? Of course, this past summer was a good one. Washington had Maine weather all season and the grass had a fine time. Does anybody have any questions?

Question: In view of the fact that this international situation might complicate our supply of fungicides, do you believe it would be possible to have the Green Section send out a questionnaire and correlate the existing information and thus enable greenkeepers to use the minimum requirements of the scarce material in combination with others that are not so severely re-

stricted?

Noer: I think that is a question for Fred Grau to answer. On the other hand, there was a time during the last war when we couldn't get mercury. Tersan was used as the substitute and the boys got along pretty well. If fungicides get tight, some of you may have to change your method. Instead of routine treatments you will have to be more alert and make treatments when you see the disease and stop it then. Isn't that the best thing? Fred will you take over?

Grau: That is a very good thought. You work that from several angles. That is one of them. Another is that during the past five years we have been able to maintain quite satisfactory putting surfaces without any fungicides at all. So if it comes to that and if no fungicides are available, we can tell you which grasses to put on the greens and how to maintain them so that you will have an acceptable putting green without the use of fungicides. That won't be as good as the greens you have now, but they will be acceptable under those circumstances.

Question: That is a longe-range program, though. You can't change the strains overnight.

Grau: Long-range, no. Several practices can be put in to effect that will help the existing grasses to resist diseases. For ourselves we know that the better a grass is fertilized, the more resistant it is to disease. We know definitely that the drier you keep a turf, the more resistant it is to diseases. Twenty years ago we determined that early morning watering helps the grass to resist disease. We know today that liming and fertilizing greatly reduces them. You can keep that out of the greens by putting Milorganite on the greens. So there are a number of things that can be done to greatly reduce the amount of fungicides that have to be applied. Changing the grass is one thing. One of the most practical things that any greenkeeper can do today is to establish nurseries of those grasses that have high disease resistance.

Noer: I hesitate to bring this up because I know Milwaukee is a desirable spot with respect to climatic conditions. But Brynwood got through this year and last without using much fungicide. This year they treated once. The application was made because they were having the district championship tournament and they didn't want to run any risk of having the players come there and have disease on the greens. I don't

mean to say that down here the same thing is going to apply because I think your weather conditions are much more severe and that disease is more of a factor than it is with us. But I do believe that the judicious use of lime, fertilizer and water will help so far as minimizing disease. They are things we should be working toward. We must have a fungicide to put the fire out but I think the work you are doing with these other factors is going to pay out and give you some valuable information which will be of practical value.

Question: We have had a showing of fairy ring around here, especially on greens. Is there any answer to that?

Noer: That question has been raised not only here but a good many places around the country. Some years ago I was at Minnesota and saw the worst dose of fairy ring on greens at one of the courses that I have ever seen. In fact I thought that they would probably have to strip the greens and rebuild them. I attributed the incidence of the disease to the thick, heavy mat of partially decayed stems and leaves and also to the high content of peat which was being put into the top-dressing mixture. I was on the same course in October this year. it had almost no trouble with fairy ring this year. They have taken off the mat. I don't think it would have been wise to top-dress those greens for several years because of that thick mat of turf. The top-dressing would never work down into the soil. The greenkeeper worked on getting that mat off and did a pretty good job. He got it so that the turf was reasonably tight. Then he used a Graham spike disc and put pretty much weight on it. He went over each green enough times to tear up the turf. Some lime was used. As a result of reducing the amount of cellulose material and changing the water practices, he hasn't had too much trouble since. Whether that was the reason or not, I can't tell you, but it seems like the reasonable explanation to me.

Noer: I can remember fifteen years ago at Tripoli in Milwaukee I went out there to take pictures of the fairy rings on the fairways. They had beautiful fairy rings and plenty of them. I don't know of anything they did to rid the fairways of them but in the last ten years I have seen almost no fairy ring on these fairways. Why they disappeared, I don't know. They appeared on fairways cut out of wooded areas. I believe the cellulose material in the decaying tree roots was partially responsible for growth of fairy ring.

Grau: We summarized pretty well the history of fairy ring in a recent issue of the Journal. When I was doing graduate work at the University of Maryland, Dr. Norton sent me out to the front of the campus and I wrote a little paper on fairy ring because the front of the campus was just literally covered with fairy ring. I don't know that they have reappeared since.

Noer: In other words, just get Fred to walk over the area and your problem will be solved. More seriously, fairy ring is a problem which should receive more attention.

Grau: The Seaside Course at Long Island has had one of the worst infestations of fairy ring that I have ever seen and there are practically no tree roots there at all. They have a heavy soil that has a tremendous amount of mushroom soil. What effect that has, nobody can determine. You can see that if the fungus is there, sooner or later it will show up. The stuff comes and goes.

Noer: As soon as it begins to get dry and warm, you don't generally see them as you do in the spring and fall. They are a saprophytic organism and must get energy material from decaying organic matter, whether it be tree roots, dead grass or other vegetation.

Question: Any thing new on pythium?

Noer: A passing comment about pythium may be in order, based upon a study made at Purdue. They found that a change in reaction either one way or the other frequently has a retarding effect on the growth of the causal organism.

I am convinced there have been more complaints about crabgrass on greens since the war than there were before. It may be associated with the switch from lead arsenate to Chlordane for the control of grubs and earthworms. I have a feeling that the lead arsenate used before to control these insect pests helped to keep the crabgrass population in check. A year ago I had some crabgrass on my lawn for the first time. This spring instead of using Milarsenite I put on a good dose of lead arsenate. It was about 7 to 10 pounds per thousand square foot, but I didn't leave a strip to check. This past fall I picked all the crabgrass by hand in less than two hours. I feel encouraged enough so I intend to give the lawn another dose next spring. Do any of you have anything to add along that line? Is my observation sound or is it wrong?

Langford: I don't know that I can offer any assistance. We have used arsenate of lead for the control of grubs and feel it did give us more crabgrass control. But we don't have any comparative results.

Grau: Twenty years ago when I came to Washington with the Green Section, some of the first plots I put in were comparisons of sodium arsenite, arsenic acid, lead arsenate. Lead arsenate seemed to be best at 20 pounds per thousand square feet. For five to ten years afterward that was the only strip that had no crabgrass. It definitely checked the crabgrass for several years.

Question: Will 2,4-D prevent the production of crabgrass seed?

Engel: 2,4-D will kill the crabgrass seedling. You must remember that crabgrass starts to germinate during April in Washington and continues until September. Therefore, you will have to continue applications throughout that season. Then it will kill the plants.

Grau: Several of you have seen the Turf Research Review? What does that mean to you. Is it worthwhile?

Noer: I would hate to see you discontinue publishing it. The Green Section should be the medium to assemble material of that kind and reproduce it in a readable form so the man confronted with practical problems will get what he wants. I think everybody here will agree with that.

Glover: I think that piece of literature and the book that came out edited by Burt Musser are the finest things that have happened to the profession of greenkeeping during this current year. Whether this is the time and place or not, I certainly want to express myself that this group should go on record to that effect. I think we of the Mid-Atlantic Greenkeepers Association must never take anything away from the picture as far as research is concerned.

Noer: This is the kind of attitude I have tried to foster. It seems to me that local meetings such as this one do not detract one iota from the National picture. Dr. Cory and the group that worked with him in getting up the program should attempt to focus attention on the local problems confronting you and emphasize the overall problems which have more or less wide-spread application.

WHAT MAKES GRASS GROW

H. G. Gauch
Botany Dept., University of Maryland

I want to talk to you for a few minutes this morning on the subject of what makes grass grow. As a plant physiologist, that subject is interesting to me. A general definition of physiology is that "it is a study of what makes plants go", and to me it is fascinating. I am just like a little boy who likes to take watches apart to see what makes them go, because I like to take plants apart and see what makes them go. So I want to talk about a few factors that effect the growth of plants. I realize I can't cover everything in the short time we have.

I am just going to talk about a few factors. The first one I want to list is favorable temperature. I am not going to say anything further about that. The rest of the factors I am going to divide into above ground factors and below ground factors.

The first of the above ground factors is light. Only certain wavelengths of the total spectrum are actually used by the plant. Duration of light is an important factor in relation to plants. That is where day length comes in. Just to show you how complex some of these things are, we had Dr. Parker and Dr. Borthwick give a one semester course this past spring on this topic of light.

Intensity of light as it effects photosynthesis is next. Plants are different from us in that they can manufacture their own food. Considering the cost of food these days, I think that they are pretty lucky. That process is called photosynthesis. It means "light synthesis". The equation we write for that calls for carbon dioxide, water, light and chloroplasts, and the end products are sugar and oxygen. Under photosynthesis I think you might be interested to know that plants are very efficient absorbers of the carbon dioxide from the air. There are only three parts of carbon dioxide in 10,000 parts of air, yet the leaf is so designed that it is a very efficient absorber. Only about one to three percent of the leaf surface is actual pore space through which gases like carbon dioxide can actually diffuse. It is a funny thing about diffusion of gases through small pores. The diffusion is primarily a function of the perimeter. If you decrease the size of the pores, you decrease the area

relatively more than you decrease the perimeter. So if the holes are tiny ehough and numerous enough as they are in leaves, you can get diffusion almost as rapidly as if the entire surface were opened up for absorption. That is the unique thing about it.

Photosynthesis is a very important process going on. I think it is the most important process occurring on the face of the earth because indirectly all other forms of life derive their energy from this energy-storing reaction that plants carry on. From the carbohydrates made by plants they can in turn make other compounds like proteins, fats and many other compounds characteristic of plant products. As you know, animals in turn are dependent on those plants, or animals that have, in turn eaten plants.

Photosynthesis is carried on in the green parts of plants. We might say then that the leaves represent the factories. I think that has some real bearing on your interests, namely, that you must take care of those factories. They are the food producing portions of the plant. If you decrease that factory too much, there won't be enough carbohydrates made to send any surplus down to the roots and rhizomes. Anything that cuts down on the size of the factory or the supply of raw material that makes that factory go round, is injurious. One of those factors is light. Under shading you would expect those factories to carry on less photosynthesis. Another thing that would have a bearing is the size of those factories. If you cut grass too closely, or frequently you can literally scalp it to the extent that there is not sufficient food produced so that an excess can go to the roots and rhizomes to nourish those portions of the plant.

Also certain diseases, leaf spot particularly, cut down on the efficiency of the photosynthetic process. I doubt that carbon dioxide is very frequently a limiting factor on the growth of most of our plants. Under rather unusual conditions it may be. If I had to name the factors that most frequently limit plant growth, I would name water and nitrogen. So much for the above ground factors.

I want to talk briefly now about a few below ground factors, the first one being water. I am talking from a plant standpoint now-- not from the standpoint of the soils angle of it. The root tips are the region of primary absorption of water. Those root tips and the condition of the root tips are important considerations. In Hawaii when they want to know whether or

not a plant is in condition to take up fertilizer, one of the things they do is to pull up some of the plants (pineapple) and see the condition of the root tips. If they are nice, white, root tips, they are healthy and ready for the absorption of water and mineral salts both.

One point I would like to stress about water relations in plants is that the "available water" is not equally available between the "field capacity" and the "wilting percentage". As a plant dries out a soil the wilting percentage is approached, the force with which that soil is hanging onto that water that is left goes up very rapidly. So for awhile it is "easy come, easy go", and not much energy is required by the plant to take up the first part of the available moisture, but as the wilting percentage is approached, the force does go up very markedly. That explains why plants can look so happy one minute and look so droopy the next.

If you were concerned with western soils, you might have an additional factor involving a high concentration of soluble salts. There as the moisture content decreases, the plants get subjected to and accustomed to an increased stress slowly and they are not suddenly exposed to a great moisture stress. When, as in the east, it is primarily a physical retention of moisture, the curve rises very steeply near the wilting percentage, and you have to relieve that stress (if severe) by watering since the grass has made no slow adjustments to permit their withstanding so great a stress.

The next below ground factor is oxygen. I think you have had some excellent talks in past meetings by Drs. Noer, Ferguson, Grau, and others, and I just want to say that I concur in everything they have told you on the importance and significance of oxygen and how important it is that roots get oxygen. I think aerification is certainly a step in the right direction and that oxygen is more frequently a limiting factor in plant growth in soils than we are often aware. There is a current tendency to consider oxygen in more and more cases where growth is not up to par.

I am not sure whether some of the other speakers have stressed this, but mineral absorption by roots is an energy requiring system. The plants must carry on respiration and they won't do that unless they have oxygen. In fact there are a couple of things that plants need in order to carry on respiration. They need, in addition, carbohydrates which come from the tops of

the plants. Roots can't make carbohydrates-- they get it from the tops. So you begin to see how interdependent things are within a plant. They must carry on respiration and must have energy to take in these salts. Incidentally, for most cases they will take them in against a concentration gradient. They must do work in order to do that. If the salts were just diffusing in because there was a higher concentration on the outside than in the inside, they would have pure simple diffusion and they would not need oxygen for respiration. They not only have to carry on respiration to absorb and accumulate salts, but if they have a lot of salt tucked away in the roots and you shut off the external oxygen supply, they can't hang on to this excess supply of salts and they lose them. They not only need oxygen and respiration and energy in order to take up salts, but they need to continue that energy to hang onto the excess of salts.

I thought you might be interested to know that anytime you detach leaves from plants, it doesn't matter what you feed those leaves, you can't keep the protein level up. It will continually decrease even if you give them sugar and various forms of nitrogen compounds. Now what significance do we attach to that? That means that the roots of plants provide certain special amino acids that the leaves can't make. Some of the amino acids that the leaves incorporate into their proteins comes from other portions of the plant-- probably the roots. This example just points out the importance of coordinated activity within a plant.

I just want to say that with respect to the mineral elements we formerly had to talk in rather vague terms for the actual function or role of some of these elements in plants. In the past few years we have accumulated information on what some of these elements do. I am thinking particularly of the minor elements. Many of those elements are turning out to be parts of enzymes. They make up part of their chemical structure. We have actually gotten out certain enzymes and found a certain element associated with them. We now know why certain of those elements are required.

This movie I would like to show you this morning was put out by the American Potash Institute and is called The Plant Speaks Through Leaf Analysis. I think you will find it very interesting. There is no excuse for letting the plant suffer a lack of mineral elements. If we know what is needed, we can supply it and not let it be a limiting factor. I think when we get enough information accumulated it will be possible to

do that sort of thing. Dr. Nightingale says it is important to know what the limiting factor is at any time even though it is a factor over which you have no control. Why is that important if you can't do anything about it? Well, if it is a factor over which you have no control, at least you don't knock yourself out trying to do something about it. You don't then apply fertilizer if it wouldn't do any good. You don't apply moisture if that isn't a limiting factor. I think we need more and more information so that we can say at any time what is the pace setter (or limiting factor.)

If I may make a personal reference, Dr. Ferguson made a good start on that in connection with his study on zoysiagrasses. We should be able to say when we see an analysis whether calcium is low, or potassium, or something else is low. Many surprises came out of Dr. Ferguson's work particularly the high requirement for boron. That was quite interesting. Another thing that interested me was how little magnesium it took to get maximum yields. If we had more studies like that we would know more about the economy of plants and what factors are limiting.

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GRASSES FOR VARIOUS PURPOSES

Fred V. Grau, Director
U.S.G.A. Green Section

The selection of better grasses has been one of the strongest points of the Green Section's work during the past 30 years. We were responsible also for bringing about many of the answers in disease control, but no longer do we maintain disease control plots at Beltsville because others are able to do it better than we. The same is true for herbicides and insecticides.

Because of increased assistance at the other state and regional levels our limited time and facilities have been released for other things. Primarily that means more time to devote to the development and testing of better grasses. That has been an especially strong point of our program during the past five years. Some of the first correspondence in our files relates to seeds and the use of grass mixtures. Never have the grasses used on golf courses been entirely satisfac-

tory until fairly recently and many of you are still not at all satisfied with the grass you have to take care of.

Speaking of grass and turf management particularly, in the days ahead it seems to me that last Monday we got a pretty good blueprint of what's ahead of us especially in turf management when President Truman in his State of the Union Message said that "there will be rigid economy in all non-defense activities". Construing that into our terminology, so far as we are concerned, it seems as though we will have to learn to do a better job with less-- less water, less fertilizer, less labor and that means using those grasses and management practices that have the lowest maintenance requirements. At our Field Day Taylor Boyd spoke on labor management, Bill Glover gave an excellent talk on maintenance of machinery, and all in all the men who spoke on our program at Prince George's Country Club gave a blueprint of economy and efficient turf management.

Apparently the program that we have embarked on for a number of years is really beginning to bear fruit. When I took over as director of the Green Section in August, 1945. realizing the limitations in labor and facilities we decided that so far as most of our plots were concerned, we would maintain them under strictest economy. There has been no artificial irrigation except to help the grass get established, no fungicides on any of our bentgrasses used either for putting greens, fairways or lawns. That work is paying off now.

Most of the grasses that we have been using and that everybody would like to have are those with the highest maintenance requirements. Do you realize that? Almost everybody would like to have a bluegrass lawn. Bluegrass requires a higher maintenance level than almost any other grass except bermuda. Those are the grasses we have been using. If we are going to adhere to the policy of strictest economy in all non-defense activities we may need to make some changes. I may be pessimistic, but I think there is a difference in being pessimistic and being prepared for an eventuality.

There are economies that can be effected in mowing. People don't like to mow grass. The less mowing we can do, the more it will mean in economy in maintenance, all other things being equal. I ran across a grass in North Carolina that hadn't been mowed in five or six years. They couldn't remember when it had been

mowed last and then it wasn't more than an inch high. It is quite weed free. I saw a lawn in southern Florida that hadn't been mowed in eight years and didn't need mowing then. So it is possible, but we will have to consider some other things.

So far as fertilizer is concerned, as long as it is available, I will be the last one to recommend that fertilizer be cut in any way because proper nutrition is an absolute necessity to maintain the standard of turf maintenance to which we have been accustomed. During the last war, however, fertilizer was pretty tight in many sections and turf had to get along with less fertilizer than it had been getting before. So let us be prepared again if fertilizer should become tight. We will have to recognize those grasses that can exist and produce satisfactory turf with the minimum of fertilizer. When it comes to a choice between fertilizer for turf and fertilizer for food, nobody is kidding themselves as to where the fertilizer will go. Survival comes before anything else.

So far as water is concerned, already we are receiving letters in our office asking us to review plans for converting golf courses from watered fairways to unwatered fairways. O. J. and I have been severely criticized on our stand and we have been together on the thought that a watering system on golf course fairways is not necessarily a requirement in many areas. Good golf course fairways can be maintained in the East without watering systems. But a lot of courses put in watering systems and many of them were misused with a lot of weeds resulting from the misuse of water. There is one of the places economy will come into the picture because we are learning how to grow better turf with less water.

The whole subject of aerification is going to get increased attention. We have been hammering it hard now for several years. We are not going to stop because we know that we can maintain a more adequate content of moisture in the soil by keeping the soil aerated and cultivated. There isn't any doubt about that. We have facts and figures to prove it even though we don't have as many facts and figures as we would like to have.

So far as pest control is concerned, there is a chance for real economy and chance for false economy. In insect control, there is real economy in maintaining a first class insecticide program because unless you control the insects and keep them from eating the

grass, there is not much use in setting up a weed control program to control the weeds that wouldn't have come in if you had controlled the insects in the first place. Do I make myself clear? Control the insects first and you will have a lot less weeds. A good insecticide program is primarily a weed control program. If the disease is controlled, there will be less damage to turf and fewer weeds. About the only place where disease can be controlled with the application of materials is on the small highly specialized turf areas such as putting greens, tennis courts, and a few other places.

In so far as the larger areas are concerned, we are coming to the improved grasses that have high disease resistance in order to achieve our ends. Already we see common bluegrass and Merion bluegrass side by side and the Merion bluegrass is practically without disease and the common bluegrass is being invaded with disease which is coming in because the grass is weak. I think we have not been willing to face facts here. We have somehow side-stepped them and hoped that some miracle would bring us out of the difficulty. I think Poa annua is one of them. Poa annua wouldn't be there if the grasses we had planted in the first place were strong enough to withstand the conditions to which we subjected them and also withstand the Poa annua that came in as a result of those conditions. We just have not been smart enough to analyze those conditions and provide the turf grass that would be strong enough to keep the Poa annua out. It is an admission of weakness in the system.

During the last war we found that we could provide excellent putting greens without top-dressing. That was one of the outstanding contributions out of an economy measure that was forced upon us during the last war. There are golf courses that have been running for 12 to 15 years without any top-dressing. They are championship golf courses. So a lot of top-dressing is not necessary according to our knowledge of maintenance today. In the south a number of golf courses that I visited were spending at least $500 everytime they top dressed the greens on an 18-hole golf course. If it comes to economy measures, again that will certainly be one of the things we will eliminate.

We would like to set up a kind of turf made up of the kind of grasses that have low maintenance requirements, yet will respond to good treatment. When the period of economy is over and we have enough to do with again and we want to provide a higher quality

turf, we might still be able to keep those same grasses, treat them a little better and have a higher quality turf. I think that is approaching nearly the ideal.

Grasses that will provide us rigid economy, tolerate low maintenance requirements, yet will respond to good treatment are just what we want. Let's analyze the grasses that we have available today and see if we can agree that these grasses that I am naming are the ones we want to work with. When I set these things up, we are drawing on the information that we have gotten from many of you who have tested these grasses under practical conditions. As Dr. Ferguson told yesterday that is the final answer.

Among the bentgrasses without question the number one bent that I put down on my list is Arlington C-1. It is more universally adapted than any bentgrass that I have seen. It is in use from New England to Southern California. It is fitting into more situations than any bent I have seen. Under 10, 11, 12 years without a fungicide, at putting green height, that grass is still a near perfect turf. It has required less water than any bent we know of, yet it will respond quickly and well to good treatment. It does require considerable feeding but will still survive at a fairly low level of maintenance. The worst things you can do to Arlington bent are to give it too much water and starve it.

The number two in our book in this area is C-115, Dahlgren bent. In the four years we have had this grass, we have detected no disease on it. It has been maintained without any artificial irrigation and to our knowledge has never been off-color in the drought periods we have had it at Beltsville. To us it is one of the high-type bents. It is a faster growing bent than Arlington and will cover more quickly. We think it has real promise for economy measures.

Congressional bent (C-19) is still with us and is one of the really good bents. We have some good new ones but we are still not mentioning them because they have not been tested long enough.

Among the seeded bents, there is one that answers our specifications of economy and that is Highland Colonial bent. We practically destroyed all the seeded bents with a misguided application of chemicals, but the Highland bent popped back. That was a very fortunate accident and told us a great deal that we would

otherwise not have known in five years of normal research.

I have already mentioned Merion bluegrass. Many of you have asked where you can buy it. Well, right now, I don't believe you can buy a pound of seed because it has all been sold. Canada bluegrass in a rigid economy scheme comes into our thinking. Canada bluegrass will grow under very poor soil condition-- poor soil, low moisture and provides a fairly decent cover. In this plug I have here, there is growing U-3 bermuda with it. That is ten years old. Canada bluegrass will provide a fairly decent winter color and it has long been a favorite in Pennsylvania.

Probably the number one fescue from a low fertility requirement is sheep fescue, but that just isn't any good for some turf purposes, so we will have to fit them in where they belong. Chewings fescue, of course, is a grass that is drought-tolerant and has a relatively low fertility requirement, yet it will respond to good fertility. Creeping red is much the same. Among the creeping reds, those of you who have visited the station have seen our plots of the newer strains of creeping red fescue. There is going to be further economy in planting improved grasses because even though you may pay several times more per pound than the common strains will cost, the improved grasses will stay with you so much longer that it is going to mean a lower cost in the end, particularly with these better creeping red fescues that are able to survive under putting green height and withstand crabgrass infestation under the same conditions. There will be good economy in using grasses like that.

Alta and Kentucky 31, will definitely find a place in many kinds of turf. They will survive at a lower level of fertility. They will respond to fertility whenever you want to give it to them. Where they fit into your program, you will have to determine. Alta fescue is finding a real place in golf course roughs, in airfields, athletic fields, roadsides and even in lawns and fairways.

Of all the grasses that we have worked with there is none that so nearly meets the low maintenance requirements as the zoysias. They require little fertilizer. In fact we know of many areas that have not used an ounce of fertilizer for twenty years and yet they are well turfed and nearly weed free. Yet they respond to fertilizer. So if we have a grass that will do well both ways, we are in a good position. True, it doesn't

have good winter color, but when we think of economy, that is a minor consideration in our book. If we could give them everything, we would want to give them color too. The principal zoysias today are common japonica, matrella, Z-52, Z-65 and Z-73.

In the bermudagrass line there is, of course, one we would recommend for this area and that is U-3, but being a high fertility grass, it will be used on limited areas where it will be given good treatment. That means tees, athletic fields and maybe tennis courts.

Question: Have you done anything to bring the color in to bermuda faster in the spring by fertilizing?

Definitely, we can hold that same color and you can do that with zoysias. Also close mowing and heavy nitrogen fertilizer will maintain the color in the fall and start it earlier in the spring.

I have mentioned briefly the grasses. Now let's run through some of these different types of areas and see what we might be doing for these areas in the interest of a long spell of rigid economy. There again I want to repeat that I hope that we won't be forced to it, but let's be prepared for it. Let's consider the club house lawn. It will be declared non-essential and no water and practically no fertilizer will be used on it. What would you use under those conditions? Well, in looking at all of those things that we have seen and the things we have at Beltsville, the choice we would make would be zoysia and red fescue. As a logical combination both grasses will survive under a low fertility level with a minimum of moisture and survive long periods of drought and provide a fairly decent appearance. Then you can go down to zoysia and Canada bluegrass, zoysia and chewings fescue, zoysia and Highland bent. Maybe if you have zoysia as the base grass, you can make a mixture of those grasses that are more fertile and let the best one win. There again you can introduce that zoysia either by seeding or by stripping.

Question: Would you rather plant zoysia on shaded lawns?

I can't recommend it but I certainly would plant some to see what it would do. Further south zoysia is doing an excellent job in shade and it is much more shade tolerant than bermuda. How far it will go into the shade, I don't know. We haven't studied it. I thought at one time the National Shade Tree Conference would

work with us and help to support that shade work, but we haven't had the help.

Our number one choice for tees in this area is U-3 bermuda. I believe that C-115, Dahlgren bent, has a place on tees because of its drought resistance, its freedom from disease, its rapid healing ability after taking a divot out and its non-matting characteristics. It is far better than Arlington from that stand point because it is faster growing.

I have in my notes here that in every single case we will do well to save water, either to save and reduce the amount of applied water or to save the rainfall and prevent it from running off. We are going to continue to hammer on that point because we must conserve every single natural resource.

On fairways we are up against a real problem because we have large turf areas that must be maintained at a certain height of cut to provide pleasurable play. If we have to maintain them economically without water and with a minimum of fertilizer our choice would be to convert to zoysia. Zoysia will fill that summer period with ideal playing turf when you don't have Poa annua. In the fall when the Poa annua begins to come back is the time when the zoysia tapers off and goes into dormancy and you have the perfect balance according to what we have seen. Maybe it won't work with you, but if you don't try it something is wrong. We think it is a natural because in many cases bermuda and Poa annua make a perfectly good natural combination.

Question: If you had all bermuda tees and all bent greens and are working bermuda into the fairways, what would you do? Would you still work zoysia in at the same time?

Yes, definitely.

Question: Well, why would you do that?

For the sake of econimical maintenance. Maybe I have not made myself clear. The big reason we are working with the zoysias and especially in terms of rigid economy is the fact that the zoysia requires little fertility. It will survive at a much lower level of fertility with less mowing and less everything than bermuda except, perhaps, water.

When it comes to the roughs on golf courses, we have a

real possibility in zoysia, Alta or Kentucky 31 fescue. They will survive under low maintenance requirements, virtually weed free, need a minimum of attention and yet they can be maintained so that a ball can be found quickly and easily even though it does provide a penalty on the next shot. At the PGA meeting in Chicago recently the pros said that they would like the roughs on golf courses brought back up to three to six inches. I think that would have to be brought up before the membership of the club first. If you can get the membership to accept a six inch rough in the normal play, you have different members than I think you have.

So far as airfields are concerned, we are in a much better position today than we were in the last war. Quite a few of us were in that kind of service during the last war and one of the grasses that we would have liked to have used was Alta fescue. We can grow just as good turf on subsoil as we can on topsoil and we would much rather do that because we don't have the weeds to contend with. Alta fescue is one of those that will thrive on almost any kind of soil in almost any part of the United States. But in the last war we tried to get Alta fescue to plant in our airfields and we found that all of it had been bought up. We had to content ourselves with something far poorer than we would have liked to have used and it cost us a great deal more than it should have. Today we have much larger supplies of Alta fescue. That is just one of the advantages, but it is going to have a part in almost every airfield mixture that is seeded over a large part of the country.

Again I want to suggest that this conference group pass a resolution that topsoil is unnecessary because the military services are asking for more authentic statements concerning that sort of thing. The thing they are faced with in a good many instances are many uninformed people who write specifications and insert into them six to eight inches of topsoil before any seeding is done. That is an expensive proposition and cannot be justified by anything we know today.

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REVIEW OF EXTENSION WORK OF 1950

Charles Wilson
U.S.G.A. Green Section

When we think in terms of economy in turf management we should enter a period of re-evaluation. It was only last week that Agronomists in various departments of Defense were called out to Beltsville by the Division of Forage Crops and Diseases. The Division wanted to re-evaluate their program to see if it could not be geared to fit the present emergency. This is constructive action and we are going to see a lot more of it.

The talks of yesterday and today illustrate a very important function of turf extension. After all, scientific discoveries cannot become of practical value until you practical men have tested them. I think you appreciate that fact because your attendance would indicate that you do. The aims of the turf extension this year have been discussed by other speakers on the program. Therefore, I think it is probably appropriate in my instance to get back to this question of re-evaluation and to see how our present turf extension services stack up. In other words, the value of what we are doing now in turf extension and the limitations of our present program. Through this we hope that you will get a better idea of how you can better utilize what is now available.

First I will cover the Green Section activities, since I am more familiar with this form of turf extension work. Dr. Ferguson spoke to you yesterday on the research work we have been doing. The Green Section is the central coordinating authority on turf management on a national scale. Perhaps I should say on a world-wide scale because we carry on correspondence with nations all over the world. We answer problems not only in the United States but in other countries as well. Dr. Ferguson spoke of Turf Research Review and we got a nice bouquet from O. J. Noer and Bill Glover with regard to its value. It was the first attempt by anyone to gather together all the information in the states that are doing research work on turf and have it in pamphlet form that is available to interested parties.

Our cooperation with the state experiment stations, the Department of Agriculture and you fellows, the practical men on the golf course, bring about this in-

formation on turf. With the States we also contribute limited financial support to help carry research along. Regional testing is another item that is of great benefit to you. Look at all these better grasses Dr. Grau has mentioned. Where would Merion bluegrass be today without the cooperation of the Department of Agriculture, golf courses and the experiment stations in various states? Fellowships set up through the Green Section bring more and more men into the turf field. Another way that we work as a coordinating authority is through our personal attendance at field days and conferences. This again is national in scope, and is of definite value to you. Through all of these activities on research, we acquire information that can be disseminated in the form of actual turf extension.

Many of you are familiar with our extension methods, but it might be well to go over them again briefly. I have listed first our Turf Management section in the USGA Journal. Here we publish information that has been brought about by research and attempt to print it in a form that is easily readable. Another way we carry on extension work is through correspondence. Approximately ten thousand letters were received and answered in 1950. Most of these dealt directly with turf problems. I think that is rather remarkable as we look back on a year of relatively few turf problems. Our National Turf Field Days are another method of turf extension that is carried on in cooperation with the Mid-Atlantic group and the Department of Agriculture. Our demonstration plots are of value to each and every one. Our cooperative tests work both ways. I said we developed Merion bluegrass and we put it out for cooperative testing. On the other hand, plots of the fescues that you saw at our field day were developed at State College in Pennsylvania and we are cooperating with them by testing the fescues in this locality. Conferences such as this we are all familiar with.

Next I would like to discuss Green Section visits. For some time the Golf Association has felt that there was a decided need for more personal contact with the individual greenkeepers to discuss and determine their individual problems. Due to our limited staff and the fact that we are working under a budget, we have to get extra funds to make these service visits. I think there are several things concerning these visits that may be of importance to you gentlemen.

The support we give to the greenkeeping superintendent

is foremost. We have heard frequently that greenkeepers do not want an outsider to visit their course. It would mean that the consultant would tear down his program, arouse animosity and therefore be of little or no value. We do not feel that this is the case. The greenkeepers we have visited in the past now are requesting two visits yearly. We don't tear down what they have done, but help them decide on needed course improvements. After all, the man on the golf course knows what he is doing but often the ideas of someone on the outside who comes in and talks over his problems will mean a great deal in bringing about support for needed equipment and materials. We include written reports of recommendations that we think are of value. We cover the course in detail in these reports. This gives the greenkeeper something to put before his club officials in his budget recommendations.

The greenkeepers and ourselves benefit from these visits because they bring to light new problems that need research. It is through such methods that we get a lot of problems solved. We are thinking about establishing a fellowship on a problem that was brought to light on one of these Green Section visits. There is a cost, as I mentioned. It is $50 for the visit plus traveling expenses. You people close to the Green Section office will find traveling expenses to be extremely negligible.

Another Green Section activity that probably would seem dear to your hearts as well as to ours is the job of furthering the cause of higher living standards for greenkeepers. Last week I was doing a little reviewing of old publications that the Green Section published in 1923 when they first set up shop. From the beginning the Green Section advocated higher living standards for Greenkeeping Superintendents. Job qualifications for the position of greenkeeper are obvious to every one of you. Yet there are many uninformed parties who think that turf happens in spite of rather than because of you fellows. You still have quite a turnover in your own green chairmen and there is an ever present need to re-educate these new gentlemen coming in. So much for Green Section activities.

Next I have listed state activities. Pennsylvania is first because from the standpoint of turf extension work they probably lead the field. They have hired a fulltime extension agronomist for turf and pasture work in the state of Pennsylvania. Dr. Grau held that position for a number of years. I think that State extension work is very valuable and is definitely

needed in Maryland and Virginia. Pasture work may seem to be unrelated. However, if you stop and analyze it, I think you would find that is hardly the case. Some of the best developments in turf grasses have been rejects from pasture work.

Another form of turf extension that is popular in Pennsylvania is done in the Philadelphia area by County Agent Charles Hallowell. I know all of you are familiar with his activities. Here I am going to digress a minute from Pennsylvania's activities and mention what I consider to be the most outstanding turf extension job done last year. It was the turf survey in Southern California made by Charles Hallowell during the first half of 1950. He was hired as a professor by the University of California to do this work. It has proven so popular and valuable that California soon will hire a fulltime turf agronomist. Charles Hallowell is working very closely with Philadelphia Golf Course Superintendents. By arranging field days, conferences and meetings, he is furthering the cause of better turf. By publishing a short mimeographed sheet called "Turf Topics" he disseminates knowledge of turf that is directly applicable to individual problems in the Philadelphia area. We have mentioned Green Section activities on a national scale. It is also important to have these activities on a local scale.

New Jersey is next on my mind and I think among the younger men in turf we should certainly throw a bouquet of roses to Ralph Engel. I do not see how he carries on the program that he does. He teaches, carries on research, does extension work, keeps the test plots in shape and, at the same time, he is working for his doctor's degree. How he does it all and does it so well, I don't know. If you are ever in New Brunswick be sure to stop off for a visit to Rutgers. The extensive turf plots will be a revelation and of value to each of you.

Recently New York has started a turf program. I believe it started mainly through the efforts of Dr. Cornman who formerly worked with the Green Section. Here again the value is in attending meetings of the various organizations throughout the state. Publication of a timely turf topics that is called "New York State Turf News" is important. Dr. Cornman has been instrumental in getting a turf specialist established in West Chester county. Bill Bengeyfield is Westchester's excellent turf extension man. Those of you who read Greenkeeper's Reporter have noted that re-

ports on the Westchester meetings are always signed by Bill Bengeyfield.

I am not going to discuss any of the other states. You know, as Ferguson said yesterday, that there are 27 of them that are doing some type of turf work. The question we should ask ourselves now is where do we go from here? We think that the Green Section will be limited in further expansion due to this present emergency. Therefore I think our duty will be to add more encouragement toward getting an extension turf program set up within the states. Now I am getting down to home base-- the state of Maryland. Every state can have an extension turf agronomist. You heard Dr. Gwin yesterday. He is in charge of the extension work at the University of Maryland. The thing that impressed me most was the way that he became interested in turf. He traveled around Europe with Longnecker who is an exceptionally good turf man. He would be very happy to sit down with a committee from your organization and talk turf any time you want him to. I can think of no better incentive toward getting a turf agronomist working for the State of Maryland. The value is obvious. There are many problems in your locality that we don't have the time or money to take care of. Pythium is one problem that Bill Glover would definitely like solved. Maryland has several capable plant pathologists but you must go to them. They never come to you. You should be able to get a turf publication for your own group that would apply to local conditions. One thing you can be certain of and that is full Green Section support.

I don't think Maryland greenkeepers could swing it. You will have to include defense installations, athletic fields, various civic organizations and garden groups. But with all of them working together, a turf agronomist in Maryland would be a reality. Bill Glover mentioned yesterday that the National was concerned because of an overlapping between these local meetings and the fact that it might be infringing on the national convention that is held once a year. It has been our experience, and we consider ourselves a national organization, that a program of extension work within a state has helped us rather than being detrimental. I think the Green Section would benefit by such a move and that you gentlemen could well use a turf agronomist in Maryland.

This sums up the extent of our extension activities but I believe that it might be wise to restate the value of better utilization of our present services.

For instance the state of Maryland is only too happy to cooperate with you on specific problems. Green Section service is something that is available to you at slight cost. I think Charles Hallowell expressed the value of extension service and the turf program far better than I could in an article he wrote for Greenkeeper's Reporter in 1948. Charles said, "Persons growing turf wish for better grasses at least some time during the growing season. The extension worker is in the field to serve those who are interested and those who want helpful facts. He is in a position to assist in solving turf problems as they arise." It is up to you to carry the ball. I have asked Dr. Ferguson to put a drawing on the board that I hope will bring together an idea that he thought up showing how the various state and experiment stations work together in acquiring this turf knowledge that we disseminate to you.

This mound of earth represents unsolved problems. The ditch digger scoops into these unsolved problems and comes out with Merion bluegrass, cadmium fungicides, Tersan and all the various improvements that Dr. Ferguson spoke to you about. The Green Section is the hub of the wheel. The spokes are the various states carrying on turf work. These figures show what each state has developed. The power plant is the most important part and I would like to call on Dr. Grau to give you a few words concerning the juice needed to keep this power plant operating.

Grau: Money makes the wheel go around. That is the thing that we have been struggling with all these years. We have always had an insufficient amount of funds all along the line to do the job. It has been embarrassing in a way because in many cases we have had to ask for contributions to support a specific research project. The Congress of the United States has not seen fit to appropriate sufficient money to develop this phase of work in the Department of Agriculture. The total amount of money appropriated to this power plant in the USGA is $7500 a year to do turf work for the United States. You know that is a pitifully small amount of money against the problems we have. So the power plant is very small for this very useful and practical machine. We are trying to do the best we can. One of the things that has increased the power plant is the added number of generators to it and that is the Green Section subscription service. The service is $35 a year and has been bringing us between four and five thousand dollars a year for the last several years. That has been almost entirely the

source of funds for supporting the research. It hasn't been much but that added to what we could scrape up in the state and local groups has provided for the large number of men now working on turf. We are still searching for a better way to do it. The best way is not through contributed funds but through tax money. Today Penn State's entire program is based on tax funds because somebody asked for it. You can have the same thing if you ask. The squeaking wheel gets the grease, you know.

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TIMELY TOPICS OF 1950

O. J. Noer, Agronomist
Milwaukee Sewerage Commission

I have played with tissue testing from a selfish point of view. We would like to be relieved of the soil testing we do in our laboratories. If plant tissue tests can be made to work, we can stop making soil tests each year. I brought this test kit with me and will take it to Florida and use it there.

Most of you know the technique. Some grass clippings are placed in a filter paper and rolled like a cigarette. Then plant juice is squeezed into the paper with a pair of pliers. White powder is used for the nitrogen test. When there is a surplus of nitrates in the juice, the powder turns pink. The phosphorus test develops a blue color. Both tests seem to work pretty good. For the potash test we are using dipicrolamine. I have one solution standardized at 2000 parts per million of potassium. In other words, if potassium is 2000 parts per million or more in the tissue, the paper turns brick red after drenching with dilute hydrochloric acid. If it is less than 2000 per million, it bleaches out to a straw yellow. Then the grass is not getting enough potash. I have another test for potash which is the same except that the paper has three spots on it. We squeeze juice on each one of the spots and let it stay there for 30 seconds. Then it is drenched with hydrochloric acid solution diluted 1 to 6. If there isn't any potash present, all the spots will bleach to a lemon yellow. The lower one represents a thousand parts, the second one 2000 parts and the third one 3000 parts per million. When the 2000 ppm shows a brick red the grass has ample potassium for normal growth.

We had some trouble with the phosphorus. Phosphorus was always high. So I ran a blank test and got a beautiful blue color. At first I thought it was the filter paper because some papers contain traces of phosphorus. We finally found it was the ammonium molybdate that we were using to make up the solution. Just last week we got a satisfactory molybdate from Mallinkrodt Chemical Company.

The season of 1950 was as good as 1949 was bad. That situation was more or less true everywhere in the country. When I was in Fred Grau's state in mid-July, I slept under a blanket and didn't need an air-conditioned room. I am referring to Lincoln, Nebraska. Oklahoma had more rain than ever before. Just a week ago we received some samples from a course in Tulsa. One of the problems there is the accumulation of soluble salts. A year ago there was something like 3000 parts per million in the greens at this club whereas this year they were down to 500. Part of that was due to the rainy season. The rain water leached the chlorides out of the soil.

At Ames, Iowa, last year Ralph Bond of Madison asked about midget grass being promoted by a Milwaukee resident. His grass never needed to be mowed and needed no attention. From the description it sounded like pearlwort to me. When I got back to Milwaukee and inspected the lawn on 53rd Street, I found my suspicion to be correct. This enterprising resident was selling blocks of sod at $3.00 per square foot. This is the lawn as it looked in May. I didn't get back to see it later in the year.

In early spring and again in September I visited Cincinnati. About 12 years ago the fairways at Clovernook were renovated and seeded. The first ones were seeded with Kentucky bluegrass only and after that about 10% Colonial bent, Astoria, was used in the mixture. The fairways have been good and are not watered although you can see some crabgrass. It has been dry and the grass is just beginning to recover after a little rain. This fairway had been narrowed down. The fairways are cut at between half and three-quarters of an inch.

Last May on my way to Florida I stopped at Augusta and took this picture on a green composed of the common cotton patch bermuda. Notice how coarse and stubbly it is because the nitrogen level was skimpy. The nature of the grass wasn't good either.

The next picture was taken in Miami on a green of Tifton bermuda which was a local selection taken from one of the greens either at Bayshore or LaGorce. Notice the difference in the texture of this fine-textured strain as compared with common bermuda.

On my way home I stopped at Nashville and went out to Charlie Danner's Course. I saw a pile of well-rotted hardwood sawdust which is being used as the source of organic matter in the top-dressing used at that club. It appeared to be an excellent material. This is one of the bermuda greens on the course at Nashville showing the slow recovery of the bermuda after the rye disappeared after winter play. Usually the rye tends to delay the recovery of the bermuda. Some say it is due to depletion of the soil supply of nitrogen. Others think there must be some other reason. This is a picture of the C-1, Arlington bentgrass, green at Nashville. It went through last summer very nicely without any trouble. Of course, Nashville had a Milwaukee summer instead of the normal summer. It was very encouraging to say the least and Charlie Danner is very enthusiastic about the performance of the grass on that green.

In Milwaukee all our parks are operated by a County Park Commission. They have supervision of all the parks not only in the city, but in the villages around Milwaukee. In many of the parks there are athletic fields for football or baseball or for other sports. This happens to be a field where the turf was extremely poor. I was asked to go out there. They had used some fertilizer. My feeling was that the soil was so poor that the rate had been altogether inadequate. So we used from a ton to a ton and a half of fertilizer to the acre on these strips. The picture was taken about mid-June. The next picture was taken about three weeks after the dry weather started. I noticed the grass was greener along each one of the lime lines. So I thought that we had made a mistake in not making a soil test, by assuming that the soil was not acid. I picked up a sample from where the grass was green and one along side of it where the turf was turning brown. Much to my amazement, the soil away from the lime lines had a pH of 7.3 and over the lime lines it was 8. It was a very heavy soil. I had a hard time putting the sampler down in this area but it was quite simple to get the sampler into the soil where the grass was green. Granulation was improved by the lime. In other words, lime improved the soil tilth.

In August I was in Troy, New York. Ten years ago I

took a picture of the very same man on the exact same spot. At that time the grass along a straight line was greener than on either side of it. About ten years ago there was a rule on this course that permitted the player to lift the ball on the downhill slope of this hill. Lime was used to mark the boundary. After ten years the effects of lime are still visible.

In June I was in Cleveland and visited Shaker. While I had seen Tom Mascaro's new Aerifier demonstrated in Memphis, this was the first time that I saw it actually in operation on a golf course. They started using it at Shaker on the practice green instead of on the greens proper in order to judge whether it was suitable for the greens. The next picture shows Mal McLaren and Colin Smith measuring the depth of the holes with a pencil. After aerifying they waited a few minutes until soil plugs crumbled nicely. Then the green was poled to break up the casts.

When I went to Oakwood, Mal showed me some spots on several of the greens. Of course, I was curious as to what was wrong. "Dry spot" Noer said the soil underneath was dry. To prove it we used the profile sampler and I think you can see that the soil is dry. It is dry because the spot happens to be a little patch of a more dense type of creeping bent. Despite the fact that these greens had been cut close, notice the mat close to the surface.

In July Fred Grau and I were in Billings. The practice putting green at Hilands was not up to par. Of course, "Tree root" Noer said it was the cottonwood trees in the background. I asked the groundsman to lift the sod. The next picture shows the tree roots immediately underneath the turf.

This is something that was common in Wyoming, Colorado, Montana, and also in western Nebraska. I think this picture was taken on a bluegrass lawn in western Nebraska. To me it is a case of iron chlorosis. In the far West it is sometimes referred to as calcium chlorosis because a high calcium content in the soil tends to depress the solubility of the iron.

The next picture is a picture of fairway turf in the Denver area which has that yellowish or chlorotic condition scattered all over the bluegrass fairway. These fairways are flooded. That is the way they are irrigated and most of the spots where the grass was yellow was in the low depressions where water seeped away more slowly than it did on the high areas. It is my

belief that part of the clover problem there is the result of thinning due to chlorosis. Some of you may not agree but I feel convinced that that is the case. This is on the same golf course along a fence. You can see how yellow the bluegrass is. I believe that is a temporary iron deficiency.

In September while I was in Cincinnati I went out to one of the golf courses. The greens were rather bad. This is what I saw. To me it is another example of iron chlorosis. The next picture shows the same thing on one of the other greens where the chlorosis has been so bad that you might blame too much water--which is actually true. I got this man to put on a half pound of iron sulfate to a green and had him cover one spot with an empty bag so that the iron would not come in contact with the grass. He called me the next morning, twelve hours later, and told me there was a definite improvement in the color where the iron was put on. Where the turf was covered the grass was still yellow. When this kind of thing occurs, iron sulfate isn't going to bring the grass back after it is already dead. The treatment must be made promptly when turf starts to become yellow. Then there will not be any serious loss of turf.

This is a picture of the new version of the Jim Haines tree root pruner. I saw it when I was in Denver when he operated it for me. The next picture shows the root pruner in operation alongside one of the tees where cottonwoods surround the tee. The next picture is a close-up. I turned the turf back to show you the diameter of the roots that had been cut. You can see the pruner will cut roots of considerable size.

In August I saw some bad turf on some fairways in Cleveland which I thought was due to tree roots from trees alongside the fairway. In October when I got up to Minneapolis they were extending the water line on one of the fairways at Interlachen. This is what I saw along the edge of the trench. These are tree roots from the elm in the background. I paced off 35 yards from the trench to the tree.

I said there had been a wet season and it was, generally speaking, although in Troy-Schnectady area it was very dry in August. When I got on this green I was curious because of the brown overall cast due to localized drying. Yet the velvet bent was beautiful and showed no evidence of wilt, water shortage. The next picture will show that the soil under the creeping bent was bone dry. Notice the moisture underneath the

the velvet bent. I have felt for some time that many of the velvet bent greens have been overwatered and that part of the iron chlorosis was due to excessive watering. This tends to support that contention.

In August I went from New England to Philadelphia. Farnham took me to this fairway which he thought needed special treatment with sodium arsenite followed by seeding. I noticed this strip along the edge of good dense turf without any clover. It was excellent playable turf. I asked Marshall about it. Before the last time the National Open Tournament was played at Springmill course ten years ago, the outline of this fairway was changed. Before that time the strip had been rough. He cut it close, used a spike disc, tore up the surface and seeded with a mixture containing a little Astoria or Colonial bent. You can see how fine this turf is as compared with the clover infested Poa annua alongside.

In Grand Rapids, Michigan, one of the courses had very bad watered fairways. They started to do some renovation. Only the worst areas were treated and seeded. On part of this fairway the turf seemed good enough so nothing was done to it. Now there is complaint about the lies because the renovated area was so much better. I think you can see the dense turf free of clover on the renovated part, and the clover, Poa annua and thin stand of bluegrass on the other part of the fairway.

I was at Joe Ryan's course in August, soon after my visit to Grand Rapids. He showed me a small plot of Merion bluegrass which was seeded in April. This is a plug of the turf. The picture shows the large number of vigorous new rhizomes developed by August.

Two years ago I was on this course in the Minneapolis area. This happens to be No. 1 tee. There were many complaints about the condition of the turf, rightly so as you can see. I ventured the opinion that no greenkeeper could keep grass on that tee due to the tree roots and traffic along the back edge. The next picture was taken this fall. It is the same tee. They did some thinning and pruning of trees in the background and trenched to stop the tree roots. Our suggestion to put down a strip of black top along the back of the tee was followed. You can see that turf conditions improved as a result of doing these things.

The next picture shows 2,4-D damage to bent on a fairway. It was taken in the New York metropolitan area

several years ago. I had seen other similar examples and am sure at times 2,4-D is bad for bent in fairways. A test was started at Milwaukee Country Club in June. The fairways are mostly creeping bent. They have never used 2,4-D because of injury to the grass on some of the first plots we established there one September right after 2,4-D was discovered. The bentgrass fared badly. As a result, Ted Booterbaugh and his chairman were hesitant to use it. The plots this June were placed on the approach to a par 3 hole. The sodium salt of 2,4-D was used at the ½, 1 and 1½ pounds of actual 2,4-D per acre. When Charlie Hallowell came during late June I took him out to the course and he took a picture as I did. This is the line along either the one pound or the 1½ pound rate. We saw no discoloration on the bent at any rate below one pound.

I left for the west the day after July Fourth. Just before leaving I told John to watch these plots for another two weeks to see what happened. If there was no further discoloration I suggested spraying the approach to No. 8 with 3/4 of a pound of actual 2,4-D to the acre. This rate gave good control of the dandelion. When I got back in August I could see no injury to the bent. In September we established another series of plots in which we used the sodium salt, the butyl ester, the amine and morpholine type of 2,4-D. The rates were 3/4 of a pound and 1½ pounds of actual 2,4-D to the acre. I took the picture you see in October. At the 1½ pound rates it looked as though the 2,4-D would thin out the bent. I left town and when I got back in November, the ground was covered with snow. It has been that way ever since. So I can't tell you more about these plots until next spring. Where fairways are composed almost exclusively of bent, as these are, it would seem unwise to use 2,4-D at rates exceeding 3/4 of a pound actual 2,4-D per acre. I would be inclined to spray in June rather than in the fall despite Musser's emphasis of fall. I think bent is the exception that proves the rule. It is just a matter of avoiding possible injury to the bentgrass.

This is an example of sabotage damage to a green in the Chicago area. It is pretty well established that the damage was done either with sodium arsenite or arsenic acid. The next picture is another one of sabotage damage. It occurred at Winged Foot. When I was in the Westchester area on the second day of November, I went out to Winged Foot and took these pictures showing the sabotage damage. Fuel oil was used on these greens.

Last year the Country Club of Cleveland started a program of clover eradication on the fairways. They used a low gallonage sprayer and applied sodium arsenite at about 1 3/4 pounds to the acre with about ten gallons of water. The rate was reduced to 1¼ lbs. per acre after the first spraying. The next picture is a picture of a fairway which had a rather high percentage of bent in it. You can see that after the second spraying, discoloration of the fairway was negligible. The turf population was pretty good. The next picture was taken on one of the other fairways where clover existed in rather large patches. The bent population was not as uniform as on the previous fairway. As a consequence, the discoloration must be more severe here than in the other case because there is more trash to remove from the turf. Next spring when the ground is honeycombed, they plan to seed Colonial bent in the areas where the turf is thin. It was too late to seed last fall so Dunlap concentrated on getting rid of the clover. I am sure the Country Club will have good fairways next year.

You hear me talk about Milwaukee Country Club. This fall I took a few pictures there. This is No. 1 tee, No. 1 fairway and No. 1 green. Fairways are mostly creeping bent. It came in naturally under the program of watering and feeding. They have Washington bent greens. The grass has never given any trouble because it is handled properly. The next picture is a close-up showing the character of the turf on No. 3 fairway. I think you can see that the weed population isn't serious enough to make spraying a must. The next picture is a close-up on No. 16. From this picture you can get an idea of what the dandelion population is There are scattered plants through the turf. These fairways are cut just as close as the mower can be set. In other words, probably under a half an inch Here is the approach to the last green, No. 18. It is quite typical of what the turf condition is on the fairways and greens.

I put this in as the last picture. I took it when I was in Minneapolis. It seemed to me that it is a striking example of what native plants can do to enhance the beauty of the golf course. Note the sumac in the background with the native trees.

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TREES, SHRUBS AND THEIR CARE

G. S. Langford
University of Maryland

I am sorry that illness has prevented Dr. Hamilton from being present today to discuss trees, shrubs and their care for you. My remarks will be directed in the interest of the promotion of golf through the use of trees. Frankly, I am not an authority on trees and shrubs. I am just a bug man, so I hardly know just where to begin in developing this subject for you. I do, however, enjoy trees. As evidence of that, I have been associated with both the National Shade Tree Conference and with the Southern Shade Tree Group and I have attended their conferences to get all the information I could on trees.

I am going to begin by talking to you in philosophical terms. By that I mean I want to leave with you some ideas I have had in connection with trees and their protection.

Trees and American Heritage

It may be that I am getting just a little bit older. They tell me that when one gets older, he begins to reflect and reminisce. Within the past few years I have been thinking quite a lot about America, particularly in these times of stress. America has a real heritage in culture and lore that is associated with trees. This is something that we have not given enough consideration. We are still a young country and maybe our traditions are not as old as they are in some places, but I think there are certain phases of early American culture that we should attempt to retain. A lot of this evolves around trees. When the white man first came to this country, he carved America out of forests which were made up of trees and shrubs.

I was raised in the country and in my community there were some things which were relic of early America that impressed me. I recall a little poem "under the spreading chestnut tree the village Smithy stands" etc That poem, as I remember always gave me a thrill. It is reminiscent of a culture that came before my time. It represented to me a visible relic of early American life. I could see, hear and even smell it. Sometimes I could almost feel and taste it. During my boyhood days there were still a few chestnut trees. Blacksmith shops were still quite common and I could see and hear

the blacksmith working at the anvil. I could even smell the burning hoof of the horse when I was a boy that made one feel conditions as they existed in early America. Sometimes I wonder how the children of tomorrow will feel when they hear that poem.

Some of you probably wonder what that has to do with trees or tree care. The point that I am trying to make is that I feel that all of us should give more thought to trees and their place in American life past and present. The chestnut tree no longer exists. We don't have the chestnut tree any more to remind us of that phase of early American culture. If it was only the chestnut tree that was passing, that might be one thing but unless we give our trees more care than we have in the past, it may be that some of our other fine trees will pass from our landscape. We might for a moment think in terms of the honey locust. There are some very beautiful honey locust trees in Baltimore. They furnish very fine shade and have been excellent street trees. You recall that just a few years ago the mimosa webworm made its appearance. Present evidence indicates that this insect is going to make the honey locust an undesirable shade tree for this area.

Those of you who are interested in the elm know that it has had a prominent place in the development of America. All of you know that the American elm is now in trouble. You have heard something about Phloem necrosis and the Dutch elm disease. These diseases may result in the elimination of this tree from our landscape. Out in the middle west, particularly Illinois, Indiana, and Missouri, there is another serious tree disease that has made its appearance, namely oak wilt. This year it was found in Pennsylvania. Just what that is going to do to our oak trees, no one knows. In the areas where it is now present, it is killing trees. If it is not checked it may seriously jeopardize the great oaks scattered through this country.

I have pictures in my mind of beautiful junipers framing landscape plantings. Because of certain insects, they are no longer desirable trees, particularly in this area. These are just a few problems that I feel you people should think about in connection with the care and protection of trees.

Trees and Golf Courses

I feel that trees are very valuable to you as greenkeepers. Probably in the future trees will be of greater help on the golf course than you think. Trees

planted in certain areas may conflict with the growth of grass but that may not be as serious as some think. At luncheon today I heard one of our members, Mr. Hines, mention the fact that we could use trees to better advantage than the sand traps now in use. He thought there use was practical and would be more desirable than the sand trap. Properly used they will enhance the beauty of a golf course.

Your job as greenkeepers is in the interests of leisure and pleasure. I feel that each of you has an opportunity to interest people in early American culture and encourage their thoughts on the traditions of America. By putting tree work in your program, I think you can do that. Such programs could result in improving conditions for the course and might even aid in solving some of the financial problems you have been discussing. As people become older, they often develop an intense interest in tradition, early American life, trees, gardening and the like. These interests integrated with their interests in the sport of golf could result in much that is desirable. Undoubtedly you have people in your club with all those interests. With the proper direction they could develop your golf course into a playground and meeting place that is more attractive than it is today.

Greenkeepers probably do not realize it but I am convinced that they are probably "bigger shots" around the golf course than they think. I believe if you would make it your business to inform yourselves on some of the early traditions of the country relative to trees, and how these trees could be utilized to better advantage on your course, you would renew interest on the part of your people in the golf course. There is no question but that the value of trees on a golf course will enhance its value. Trees properly planted will give an area a charm and beauty that it could never have without them. Trees properly planted can harmonize beauty and sentiment. They afford an opportunity for changing many ordinary golf courses in to areas of distinction. Aside from aesthetic values, trees could make your course more pleasant for the players. Trees strategically placed will provide shade which is quite desirable during the hot summer months. In recent years the American Nurserymen's Association has given thought and study on the use of trees for modifying climate. They have accumulated much valuable and useful information on this subject. There may be places on your golf course where you need a wind break. You may modify temperatures in certain areas. There is a possibility of making the clubhouse

cooler in summer and warmer in winter.

Tree Maintenance

Now that we have reviewed trees in the light of some features involving sentiment, beauty and practical value, we might think for a minute about maintenance. I am sure that is what you people wanted to know about in the first place.

We have been in conference for the last two days and by now must realize that just keeping the grass is a real chore. When you take on tree maintenance in addition to grass, you have taken on another man-sized chore. If we should try to discuss tree and shrub maintenance in detail we should start right in and have another conference. There are many problems involved. I am not going to attempt to discuss these problems or go into details of them. I shall just mention a few of them.

Tree work includes planting and landscaping. It involves pruning and trimming. You should know something about the treatments of wounds and cavities. You will have to know something about spraying for insects and diseases. You should have information on cabling, bracing and working on damaged trees. You will need to know about the fertilization. Trees require fertilization just the same as grass. You will need to know how to handle and treat girdling roots. You will have the job of removing dead and injured trees, and you will need to know something about tree moving. Then there will be many special problems, such as the installation of lightning rods, getting borers out of trees. Important is what Dr. Grau and others have been talking about for the last two days, namely selecting grasses that are adapted to shade areas. You will also want to know which trees suit your particular conditions best and where they should be planted for the best effect.

Equipment for spraying

A few brief remarks on new types of spray equipment may be of interest to some of you. During the last two days there has been discussion on the use of sprays for killing weeds on the golf course. Studies on better ways of controlling pests quickly and cheaply have resulted in new developments in formulations and machinery for applying insecticides in what is termed "low gallonage" or concentrated sprays. With conventional equipment from 100 to 500 gallons of di-

lute spray is applied say to the acre. In the case of concentrates and low gallonage spraying, the insecticide or fungicide is applied in concentrated form in from ½ to 30 gallons to the acre. Low gallonage spraying is now an accepted practice for weed control with selective sprays such as 2,4-D. This type of spraying has been very successful for the control of many insects. Until better formulations are prepared it is my opinion that results with fungicides will be less effective. However I am sure good results can be obtained with less water than was once considered essential.

The so-called mist blowers represent types of equipment developed for applying concentrated spray. They use air instead of large amounts of water for breaking and distributing the concentrated chemical. They are useful for easy rapid work in the spraying of trees and shrubs. Where mosquitoes and flies are abundant on the golf course or around the clubhouse they can be used to good advantage in space spraying to relieve the premises of mosquitoes and flies.

If you have a conventional sprayer it can be adapted for low gallonage spraying where turf work is your only need. All you need is a spray boom fitted with the proper sized nozzles. There are nozzles available that will enable you to apply spray in almost any amount say from 5 gallons to the acre up. If you use powdered materials do not attempt to apply less than 30 gallons of dilute spray to the acre, otherwise nozzle stoppage may cause you trouble.

Every greenkeeper needs spray machinery. Because of the cost some of you have never had machines capable of doing all the spray jobs that need to be done quickly and efficiently. Recently there has been made available equipment that may aid you considerably. Most of you have tractors available for cutting grass. These tractors may be fitted quite cheaply with a barrel, a spray boom and a good gear or hydraulic pump (adapted for power take off) and used for spraying. This type of rig is well adapted for weed control and other turf spraying. You may use this type of rig if properly modified for spraying some of your trees and shrubs if they are not too high.

(Talk followed by discussion)

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