SECOND ANNUAL TURF CONFERENCE

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GREETINGS

R. I. Throckmorton, Dean

Kansas State College

I am really delighted to have an opportunity to come before you people again. I remember with much pleasure our meeting of last year. My chief regret is that I can not be here for all of your sessions and the banquet.

I don't know why they say that somebody should give a word of welcome to a group such as this because I am sure you all know you are welcome. Many of you have been here before and we have had lots of visits together and also we have had some arguments once in a while. We are delighted to have you here and I want to congratulate you people on the progress you have made in a very short period of time in developing this turf organization and in making plans for these conferences. I think your program is excellent this year and I know you are going to have a good conference.

I do want to make two or three remarks. I am pretty deeply steeped in this matter of research and what it means to us. It is important to us in every walk of life and its relationships touch us not only an economic way but in our living conditions. Therefore, it is of great importance to all of us.

You know in no place else in the world has research been so well supported by the government as it has in this country for the last 50 years. The primary function, by law, of the United States Department of Agriculture and of the state experiment stations is to do research. The federal department of agriculture has digressed far and their primary functions today include many things other than research. The state experiment stations have stayed pretty close to their primary function for the conducting of research for the benefit of all people. We have developed plants that are better adapted to our conditions than we had before. We have learned how to diagnose, prevent or cure many types of plant andanimal diseases. We have learned enough about soils to know how to solve many of our soil fertility and soil conservation problems. We have developed a lot of fungicides, insecticides and herbicides that are of vast importance to us in our agricultural program regardless of what they may be. We have learned much about the nutrition and management of livestock and poultry of various types. Farmers have put the results of this research work in-

to practice and, consequently, we have increased the production of meat and poultry, eggs, milk and so forth. Also through research we have done a lot to lighten the load of the woman in the home. So all of those things have come out from research and they have had a tremendous influence.

In the light of these statements of all the things that has happened and been brought about because of research, you might ask if it isn't time to let up with some of this research. As a matter of fact, we simply cannot draw such a conclusion although a lot has been done through research. The actual facts are just the opposite. Although much has been accomplished there is still much more to be done. You know it seems that as research men develop ways and means and varieties to overcome certain hazards. I am thinking for example, of the case of rust in wheat. Plant breeders developed a variety of wheat that had resistance to rust and they no more than got it out and into production than nature produced a new race of this particular rust to which all known varieties are susceptible. So the plant breeders must start over again. We get that same thing in other branches of our work. As agriculture gets older, it becomes more complicated and consequently we get many new problems coming before us.

There is a tendency I feel during these years of increasing costs of everything you can think of for people to forget that research is costing more and more every year just as other things are costing more and more. In Kansas the situation has improved materially due to the action of the state legislature. The same is ture in some of the other states and is not ture in some others. The United States Department of Agriculture has had very little change in money available for research. The states have helped in general in keeping pace with this increase in cost for less and less federal funds in proportion to the needs and costs of research than we had a few years ago. As a matter of fact, the only national legislation that is of importance to us right now as a possibility of getting increased money for agricultural research is the Research Marketing Act which was passed in '46. Only a small percent of the total money provided for in that act has been appropriated. Whether or not that will be increased, no one knows. But it so happens that other activities of the United States Department of Agriculture have grown to the point that today less than 10% of the total appropriation to the United

States Department of Agriculture is available for agricultural research, whereas 20 years ago the percent was way up the scale. So that is another factor that is of great importance to us.

You know, we have shown remarkable ability in this country of adapting the results of basic research. We have been outstanding in our ability to take the results of basic research, much of which was done in other countries, and apply it and thereby reap dollars and improved living conditions and improved facilities but as a nation, we have done very little in the field of basic research. That is of great concern to me today insofar as research programs of the United States both national and state are concerned. I think we are going to continue to devote much of our attention to applied research rather than basic research as long as there is a constant demand which exceeds facilities and personnel to do research on those problems that are immediate. Our research in general is of an emergency nature. The funds and personnel are made available solve emergency problems that are coming before us. At the National level the committees of Congress at budget hearings ask how soon can results be obtained and what will they be worth in dollars and cents. That is all right for applied research but, after a while the well of new facts will go dry and then you will have no new truths upon which to base applied research. So we as a nation do need to put much more emphasis on basic research than we have in the past. You men have some problems that I have talked with you about that we are not going to solve in my opinion from the information available today through basic research. It will be necessary for us to go back and do some fundamental research to establish facts upon which to base the needed applied research.

You may say why not decrease the amount of effort you are putting on your applied research and devote more of your activities to fundamental research and develop new truths. The answer is, the pressure is so great that we just can't do it. If we can keep abreast of the emergency problems, we are doing very well. So I feel that we are going to find it necessary in the future to look more and more to the states for funds with which to support research and less and less to the federal government. Maybe that is right; maybe it is wrong. I don't know but I think it is the trend today and some evidence points to the continuation of the trend. So it is going to be more of a state job rather than a national job.

Research results have no value unless they get into the hands of the people. We are attempting to get the results in them through the radio, the press, the extension service and many other means throughout the year. I think our only answer to many of our problems is more and better research and more fundamental research that we may have the information on which to base our applied research that will solve many of our problems.

I would like to say that we appreciate all the assistance you are giving us in our turf project here at the college. You have put some money into it and it is an example of what can be done by two groups of people going together. By going together as a team, we carry on this project which I think will improve and increase in a year or two and be of value to you.

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OFFICIAL OPENING OF THE SECOND ANNUAL TURF CONFERENCE

Chester Mendenhall, President
Central Plains Turf Foundation

I am indeed happy to see so many here again this year. To those of you who were here last year, we are happy to see you back again and to those of you who are here for the first time, we hope you will feel benefited by the program during the next three days.

I was interested in Dean Throckmorton's story about gossip. I am wondering if this could be where we are falling short. When you hear about people gossiping you think about a couple of old ladies talking over the back fence but I believe if all you fellows here would do a little more gossiping about the Central Plains Turf Foundation and these conferences, there would be more turf people attending these conferences.

I know you are far more interested in hearing the speakers on the program than me so I only want to extend to you a hearty welcome in behalf of the Central Plains Turf Foundation.

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CARE, OPERATION AND OVERHAULING TRACTORS

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The agricultural tractor gets more use and abuse than any other agricultural machine. It is expected to start easily and operate at various loads regardless of the climatic conditions. It has been estimated that there are 3,778,000 wheel tractors operating in the United States on over 5,000,000 farms and 162,000 tractors on 131,382 farms in Kansas. These figures indicate that practically every worker engaged in agriculture should have a working knowledge of the internal combustion engine.

Some say that tractors of today are designed to operate in spite of what the operator might do as long as there is plenty of fuel, oil and water. In the next few minutes I hope to point out some of the important factors to observe in order to get good satisfactory trouble-free performance. Much of this trouble free performance can be obtained by giving the tractor good care, operating it properly and keeping it in adjustment. Of course, the number one rule is to study the Instruction Manual on that particular tractor. This does not seem to be the answer because many tractors are lacking proper care. I have often thought that the manufacturer should have perhaps a plate with pertinent instructions stamped on it and attached in a convenient place on the tractor for the operator to observe. You know as well as I do that the manual is often misplaced or lost and from then on servicing is done by guessing or not at all.

There are four things necessary to make a tractor engine run. They are: (a) proper air-fuel mixture, (b) good spark at the proper time, (c) good compression, and (d) proper valve action, and then there are two very important additional things to keep it running. They are (a) good lubrication and (b) proper cooling.

All these factors have a great influence on how efficiently the fuel is burned. It is common knowledge that liquid fuel will not burn until it is in the vapor state and also that it is mixed with the proper amount of air. Adjustment of the carburetor is very important and will be discussed later. All connections between the carburetor and the intake part of the combustion chamber must be air tight in order for the

carburetor to meter the right amount of fuel with the incoming air. Also, in order to insure clean air all connections between the air cleaner and the carburetor must be air tight. It has been stated by a tractor engineer that a late model tractor might be expected to operate 3,000 hours under full load in dusty conditions provided it had a satisfactory air cleaner before expensive repairs are needed.

The ignition system must be in good condition to deliver a good hot spark for igniting the air-fuel mixture. The ignition system should be capable of delivering a spark that will jump at least $\frac{1}{4}$" to $\frac{1}{2}$" when the spark plug wire is held away from a grounded surface such as the head or block while the engine is pulled through several revolutions at cranking speed. A good hot spark has a light blue appearance.

The magneto or distributor assembly in the case of battery ignition systems are complicated pieces of equipment. If the trouble is traced to this part ofa system any extensive repairing should be done by an expert who has the necessary equipment to test the ignition coil, condenser and condition of ignition breaker points, etc. Some of the new high speed tractor engines are using automatic spark advance mechanism along with battery ignition which further complicates the system. It may be a surprise to some of you that the breaker point gap in some cases is now set by observing a reading with a cam angle meter in place of the common method of using a thickness gauge between breaker points.

The spark plug electrodes operate at the highest temperatures ever encountered in the combusion chamber. They actually wear out with use and using the wrong type for the service given will very likely shorten the life of the plug.

The appearance of a plug operating properly will have a light toasted brown color. A plug which becomes coated with black carbon will usually miss occasionally, especially on heavy load. This may be traced to a rich fuel-air mixture, but usually black smoke would also be visible in the exhaust gases or it may be excessive oil consumption which will appear as a bluish smoke in the exhaust gases. If neither is the case it might be traced to a too cold type plug being used. A spark plug must run hot enough to burn clean to prevent fouling when idling and at light loads, and must remain cool enough under full load operation to give it long life and to prevent pre-ignition which could

cause excessive heating. It is possible for dirty fuel to cause fouling of the plugs. If you are doing a lot of light load operation it might be wise to use a hotter type plug than is generally used. Some recommend that plugs be examined at each 200 hours of operation and the point gap checked with a round wire gauge. If you don't know what the gap should be, .020 to .025 inch is a fair figure. Always bend the outside arm or grounded electrode when adjusting points. When removing spark plugs, the dirt in the spark plug well in head should be blown out prior to removal.

The spark plug is usually the first item that needs replacing on a new or rebuilt tractor engine.

Good lubrication is very important. The most important physical property of a good lubricant is its viscosity in other words the SAE number. All manufacturers insist upon the use of high-grade oils in their tractors because they know that these oils will hold their body and lubricating qualities longer under heat and pressure than low grade oils. Today, there is available three general groups of oils, regular grade,which is suitable for ordinary conditions. Premium grade oils which contain oxidation and bearing corrosion inhibitors and is generally recommended for heavy service. The heavy duty oils contain, in addition to bearing and corrosion inhibitors, a detergent additive-which is required especially in Diesel engines. Some of the premium grade oils today also contain certain amounts of detergent additive which helps to keep the internal parts of engine relatively free from sludge. The question often arises-- Do oils wear out? Generally speaking, a high quality, well refined oil which is very stable does not wear out. But the catch is--as soon as an oil is placed in the crankcase it is contaminated with particles of dirt, carbon particles, moisture and metal particles from the engine and will become diluted with any raw or unburnt fuel that might work past the piston. Therefore, since oils become contaminated it is necessary to drain the crankcase periodically in order to get rid of these impurities.

How often should oil be changed is a frequent question. Color of the lubricant is no indication of how well the engine is being lubricated. The amount of contamination in crank case oil is going to vary with operating conditions and mechanical condition of engine. As the various engine parts wear the degree of contamination will tend to increase at a faster rate. The number of hours suggested in the instructional manual is usually on the safe side. A lot of start-

ing and stopping, and light load operation in cold weather is going to encourage more of this so called "cold engine sludge" which is a combination of a dirt, oil and water. Alternate heating and cooling of the engine will cause condensation of moisture in the crankcase, also low operating coolant temperatures will encourage accumulation of moisture. Any blow-by of exhaust gases past the pistons contains moisture from products of combustion which might be even corrosive in nature. It may be a surprise to some of you that there is actually more water formed during the process of combustion than there is fuel burned which is expelled with the exhaust gases.

The oil filter will remove, in varying amounts, some of the contaminants, particularly the abrasive particles. However, no oil filter will have sufficient capacity to restore any used oil to its original quality. In fact, the so-called "detergent oils", those that contain detergent additives will hold fine soot particles in suspension which are not removed by the oil filter and make the oil appear dark. The oil will hold only a certain maximum amount of these fine soot particles so if crankcase is not drained often enough you will very likely have an acculation of sludge.

A good practice is to change filter element when draining crankcase because if you don't there is not much point in having a filter. When the oil begins to get dirty that is also an indication that the filtering element needs replacing. Incidently, for best results, the oil should be drained when the engine is hot.

Just a few pointers regarding cooling systems. Did you know that for every gallon of fuel burned about 30% to 40% of this fuel, goes out in the form of heat in the cooling system. When burning 2 to 3 gallons per hour there is enough heat dissipated to heat a 5 or 6 room house -- so it is very important that the cooling system is kept clean and free from scale to prevent hot-spots and over-heating.

The thermostat in the cooling system has the purpose of warming up the engine quickly and keeping it up to operating temperature for efficient operation. Overheating can cause burnt valves, scored pistons, cylinders, and bearings, warped and cracked heads and engine blocks.

Overheating from a clogged system can usually be avoided by flushing occasionally and using a rust in-

hibitor. Today, there are several rust inhibitors on market for use in cooling system and many of the Anti-freezes have this property included. A good flushing solution might be a strong solution of washing soda and running the engine10 to 20 hours at regular work after which completely drain the radiator and flush with clear water. If the accumulation of scale is not removed by the above solution, an acid solution such as hydrochloric acid (mariatic acid) may be needed. If you use an acid solution be sure to follow the instructions closely as it is quite corrosive in nature. Of course, if possible use soft or rain water to prevent the formation of scale from hard water. Factors such as a loose fan belt, stopped up radiator fins, defective thermostats, overloading, leaky water pump seals and deteriorated hoses will encourage overheating.

When does an engine need a major repair? There is no set rule for the number of hours an engine should be run before it needs a major repair such as a ring job. Every repair and adjustment should, however, be taken care of just as soon as the need is found. A few years ago, the University of Illinois kept records on a general purpose tractor which was operated a total of 14,830 hours during a period of 18 years. Although this is not the average life of the general run of tractors it does indicate however, that a tractor can be kept in operation until they become obsolete. The average life of a tractor in Kansas is about 11 years. Some of the jobs which are generally considered for the expert are fitting piston rings, fitting pistons, fitting bearings, refacing valves and valve seats, overhauling magnetos and carburetor and transmission, and even soldering a gasoline tank from a safety point of view.

Since there is no fixed number of hours before major overhaul then what method should be used to determine when it is needed? We are interested in fuel economy since it represents about 40% of the total operating costs. An engine in very poor mechanical condition will burn fuel inefficiently and there will be a noticeable loss in maximum power. We also want to eliminate false repairs if possible. It is possible by periodic tune-ups of inexpensive adjustments such as checking spark plug gaps, breaker point gap, ignition timing, valve tappet clearance, flushing cooling system to actually delay expensive jobs before the drop in power has become a complaint.

It is believed that oil holes provided in piston and oil control rings with present improved lubricants

will stay open until replaced so that power loss rather than oil consumption might determine time at which a ring job is required.

The reverse has too often been the case. Complaints of high oil consumption may not be traced to piston rings. Oil can be consumed or lost in three general places on an engine. They are the crankcase breather or ventilator, various gaskets and bearing seals and through the combustion chamber.

Excessive oil consumption through the combustion chamber is indicated by bluish smoke in the exhaust gases. Oil vapors passing out the breather could be caused by excessive blow-by past the rings and pistons. Oil leaking by the oil seals on main bearings could be due to a stopped up breather which is easily remedied or a loose main bearing. Loose connecting rod bearings can also cause excessive amounts of oil to go past rings into the combustion chamber.

One simple test for determining general condition of rings, pistons, and valves is by noting the amount of pull required of each cylinder when pulling through with the crank on the compression stroke. Run engine prior to making test. If a compression, tester is available it will give a better indication. If all cylinders indicate lower pressure than normal it is possible the rings are badly worn. If one cylinder shows up much lower than the others it is very likely a bad leaky valve.

A further check might be by inserting a heavy weight oil into cylinder in question - enough to make a good seal between piston and cylinder wall and making sure that this oil does not get on valve seat when pulling crank through compression stroke. A low pressure would indicate a bad valve. An engine with one bad leaky valve will run very rough at slow speeds.

Whether new pistons and cylinder sleeves or reboring is needed will be determined after engine is disassembled. Generally, a cylinder on the average size tractor worn .012 inch on the diameter will need to be replaced or reconditioned.

In conclusion, always keep in mind that the engine should be kept up to normal operating temperature in order to keep cylinder wear at a minimum, fuel consumption at a minimum and to attain the maximum power when needed.

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CARE, OPERATION AND OVERHAULING POWER MOWERS EQUIPPED WITH 2 CYCLE ENGINES

Roger J. Thomas
Jacobsen Manufacturing Company

It is indeed a great pleasure to be here because very seldom do manufacturers have the opportunity of addressing a group like this. I haven't anything novel to produce nor an engine for you to see other than this small cutaway. I think that since most of you are users, owners, dealers, and turf maintenance men, you are familiar with our units.

The 2-Cycle Principle

We have a simple engine and I am going to explain care operation and overhauling to insure long life for it. To do this properly I would like to give a brief explanation of the 2 cycle principle. In contrast to the 4 cycle engine, the 2 cycle principle is such that each time the piston comes up to the top, ignition takes place. Each time the piston comes to the top you have that smooth flow of power -- power every stroke. In contrast to that, a 4 cycle engine fires every other time the piston comes to the top. There are but three major moving parts involved in this action: the piston, connecting rod and the crankshaft as compared to 19 moving parts in the 4 cycle engine. The proven power of which I speak is contained within those parts and therefore the concentration of effort will be on those elements which may effect power and long life.

Care

Since small engines do not have oil filters, as you have witnessed on the tractor engine slides, dirt can enter the engine through the air cleaner or the gas and oil mixture. The first, and I feel the most important, is a clean air cleaner. If the air cleaner is not clean, dirt will enter the engine. Engines will not burn dirt. Only a clean air cleaner will prevent dirt from doing excessive harm to the moving parts. If the mixture isn't clean, it can cause wear. The dirt and oil form a lapping compound. This lapping compound causes an unnecessary amount of wear on the cylinder, piston, the rings, and the main bearings. Don't forget, dirt and oil make up this "compound" so keep those air cleaners clean.

As was pointed out before on the tractor, it is im-

portant to keep the cooling system clean. In the case of the 2 cycle engine, it is important to keep the cooling fins clean. The job of the fins is to direct air across the head and the cylinder, by causing a turbulence of air which, so to speak, wipes off the heat. If they are not kept clean, the engine will overheat which can result in scoring of the piston and the cylinder wall.

Since we are using a 2 cylcle engine, it is important that we use the proper gas and oil mixture. The proportion is one quart of non-detergent oil to four gallons of regular gas or one-half pint of soil to one gallon of gas. When you mix them in a can, be sure to shake the can. This year we have noticed corrosion in the gas tanks, so we are asking that you remove the gasoline at the end of the cutting season. This corrosion that takes place will or may be evidenced by a stale gas odor. The moisture formed in the tank will cause rusting. If the tank is rusted, remove it, put some nuts and bolts in it and shake it well. Wash it out with clean gas and you are back in business.

Overhauling

Of course, it isn't necessary to overhaul the engine every year but when you do, there are some things that should be done as standard operating procedure.

First, clean the carbon from the exhaust ports, the intake ports, the intake side on the top of the piston and from the cylinder head itself. Possibly in an older machine if there is still evidenced a loss of power, check the muffler to see if it has carboned up. Second, since the gas and oil are mixed and are not heated before entering the crankcase, cold gas and oil hit the underside of the warm piston forming small flakings. You may find the bearings somewhat sticky when doing a major overhaul. It is not necessary to tear the engine down simply to clean them but check them when doing a major overhaul job. To clean these bearings and test them, simply wash them out with pure gasoline, apply a light oil and spin on the crankshaft. They should spin freely. Those bearings may last for many years depending on how clean the engine is kept.

Third, when the engine is torn down, it is important to clean all bearing surfaces and install new gaskets. It is very poor practice to do an overhaul job on any engine and leave an old head, exhaust or carburator gasket on. It is foolish, as well, to tear down an

engine and not replace crankcase seals. One way to tell if a seal is worn before tearing and engine down is to put a little oil around the outside of it while the engine is running. If the oil is taken in, the seal is worn. You may conclude that before that time however, since worn seals will cause the engine to race or affect idling.

Fourth, there is a proper timing procedure and it is not a guessing matter. One can hardly get into overhauling without mentioning the timing procedure which is very simple. First of all, reassemble the engine, keeping everything clean, and set the points at 20 thousandths on the high side of the can. Second, turn the piston top to top dead center and then back it off 1/8 from top dead center. Since we have a movable stator plate, move the plate to the position where the points just begin to break. Secure the screws holding the plate and the engine is timed properly. An engine out of time is usually evidenced by a loss of power or a weak spark.

Operation

The importance of a clean and properly gapped spark plug cannot be overlooked. On all Jacobsen engines the gap should be set at 35 thousandths. It is important to have the right plug in an engine, and in most cases the factory recommendation should be followed. If consistent fouling takes place and oil mixture, carburetor settings, etc. are carefully followed, then a plug other than the factory recommends may be needed. By inspecting the fouled plug, you can determine the plug in heat range needed. If the plug consistently burns black, then the next step hotter plug may be needed. For example, plug burns white then the next step colder plug is needed. For example, on the Putting Green engine, the recommended plug is a #7. If consisten black fouling takes place, you may want to use a #9 which is a hotter plug.

It is important that the carburetor be set properly. It is especially important for users like yourselves who operate the machines 6,7, or 8 hours a day. At present we use a dual jet carburetor which has a high speed needle and idling mixture screw. The initial settings are a turn and a quarter on the high speed needle and three-quarter turn out of the seat on the idle mixture screw. To correctly adjust the carburetor, first start the engine and let it warm up. Second, pull the throttle all the way out to speedup the engine. Begin slowly to turn the high speed need-

le in until the engine smooths out and the speed begins to drop away; then back it out one-quarter turn from that position. Third, close the throttle so that the engine idles and begin to turn the idle mixture screw in slowly. When the engine speed begins to drop back the screw out of the seat about one-eighth turn from that position. All engines are pre-set at the factory; however, climatic or atmospheric conditions may vary these settings slightly.

In the operation of a machine, if the engine stops there is a good method to follow to find the cause. A step by step procedure eliminates the loss of time and sometimes a loss of patience. The first, and most obvious step, is to take off the gas cap and see if there is sufficient fuel in the tank. Next, be sure the pet cock is open on the tank for that will reasonably assure you that there is gas in the carburetor. It follows then without disassembly to check the spark. To do this, pull the spark plug wire off the plug and crank the engine over, holding the wire about 3/16 inch away from the plug. The spark must be blue and constant. If the spark is not blue, the magneto may be weak or the points dirty or pitted and in need of replacement. If the spark is not constant but is intermittent, chances are the trouble lies in a weak condenser. Reasoning tells us that if the condenser acts as a storage place and regulator and the spark is irregular, then something is wrong with the condenser. If the answer isn't evident yet, remove the spark plug and inspect it. It is now a matter of inspection and reasoning. If the plug appears wet, it means the engine is flooded, but if the plug appears dry, the engine isn't getting fuel. Since the carburetor supplies the fuel check that is the next step. Remove the three screws on the top of the float bowl cap and look inside. If there is no gas in the float bowl, the trouble lies between the float bowl cap and the tank. If there is gas in the bowl, check for dirt in any of the passages or dirt behind the reed valve on the carburetor body.

Summary -- Conclusion

If a man will take care of machinery, keeping it properly cleaned and adjusted, he can get long life on any piece of equipment. Remember the importance of keeping the air cleaner serviced, the fins clean and fuel mixture clean. Be sure to store the machine properly after the grass cutting season ends. When overhauling be sure to follow the instructions given by the manufacturer.

In operation keep in mind that it may be necessary to use your present equipment for some time. It is estimated that less than 70% of the machinery demanded will be produced this year. On this basis we are not trying to urge you to by new equipment but to maintain the machines you have in use.

Service-wise we can deliver the parts necessary to help you. Our factory training schools are equipping men in your area with the knowledge necessary to do good work. If we are coming into a situation where there will be shortages, depend on these men and our authorized service stations. Your help is solicited in caring for and operating your equipment so that you get good service from our quality merchandise for a long time. Thank you.

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CARE, OPERATION AND OVERHAULING SPRAYERS

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Department of Horticulture
Kansas State College

After following these experts on motors, it will be quite a bit out of place for me to say anything about spray motors. Consequently my remarks will be confined to the sprayer proper.

During the past several years in human medicine probably the greatest strides have been made in preventative medicine. Most of you can remember what happened in the first World War when we lost more people from contagious diseases than we did from enemy action. We know that condition was very much corrected during the past war and it is being improved all the time. You know also that many of the insecticides and fungicides that are used by all of you here are used essentially as protectants. They are applied to the plants or the plant parts prior to the arrival of the disease or insect organism. It might seem then desireable to approach care of spray equipment from a preventive maintenance angle.

The Army had a system by which they attempted to take care of the vehicles divided into about three echelons. The first echelon maintenance consisted of work that was done by the driver on his vehicle to maintain its workable conditions. This maintenance was very simple

but none-the-less of a very important nature. It consisted of proper lubrication, keeping the ratiator clean and full, keeping air in the tires, keeping the ignition system and lights working.

The second echelon maintenance was a little bit more complex. It consisted of the type of repairs that could be done in the field or at a central position with field equipment. The driver might or might not do it. In some cases there were mechanics that would do this type of work. The third echelon maintenance was done in rear areas by experts where more equipment was available and the motors and machines were torn down and worked on with proper equipment. I am going to confine our discussion today to what you might call the first and second echelon maintenance.

There was a time not so far distant, when one man might be expected to know everything there was to know about the different types of sprayers simply because therfiwerenn't many types. There are only 3 or 4 that varied much one from the other. That is no longer true. I should qualify that statement somewhat. The principles are still pretty much the same but there are many different models and makes.

We might say that sprayers -- and we use that term advisably here to include any type of equipment to apply chemicals-- might be broken down into 3 large groups. First, there is what we call the conventional hydraulic type sprayer, which consists of a sprayer in which the chemical is carried in the water and then the dilute mixture is sprayed upon the plant or whatever you are applying it to. These might further be subdivided into what we might think of as low and high pressure sprayers. I don't know where a line of demarcation between these types is. I think in general those sprayers which generate somewhere around 100 pounds or more of pressure per square inch are referred to as high pressure sprayers and those below that figure as low pressures. Again I don't try to defend that particular figure but that will give you an idea of where the breaking line might be.

The second group of sprayers would be what we might refer to as the concentrate type. Rather than having the spray material suspended in dilute quantities, they would be present in concentrated quantities. They are applied in this manner to the plants. This type is enjoying a lot of new found popularity and many are being used at the present. As new engineering practices are put into effect I expect more of them to be used. The principal seems to be sound.

In the third equipment group would be found the dusters. A duster is a machine that applies chemicals in the form of dust. A liquid duster is a modified duster. It is a machine that applies dust to which a wetting agent has been added to aid in sticking to the foliage.

Now let's pay some attention to the topic that has been assigned to me to discuss, the operation and overhauling of spray equipment. We might discuss first the care of the sprayer during the spraying season. We get back to the first echelon maintenance or the care the operator gives to the piece of equipment. This important maintenance can be practiced by all of you regardless of your aptitude for handling machinery and equipment. Certainly, any type of motor, requires frequent and thorough lubrication of all working parts. You have some very fast moving parts -- the chains and belts -- and these should all be lubricated at various intervals. They should be lubricated according to directions. Practically all commercial companies realize that their staying in business depends on satisfactory performances of their products and so they strive to give you a good quality product and to see that you get full value out of it they provide instructions on the care and operation of their equipment. You will be doing the correct thing, to follow these instructions and follow them to the letter unless you have had a lot of experience with machinery.

At the end of each days operation the tank, hose, guns and nozzles all should be very thoroughly rinsed. They should be washed out with clear water just as soon as the spray operation ceases. Spray material should not be allowed to stand in the tank over night. You get into a lot of trouble if you let it stand and attempt to use it the next day. This may clog or gum up the machinery, also you run the risk with certain types of spray material of corrosion of the metal parts. You are also running the risk that certain chemical changes will take place in the spray material which would detrimental, to plants upon application. Pay particular attention to mixing up corins the late part of day only that amount of material that you are sure of being able to use. If you can't get it on, the cheapest thing for you to do is to drain it out and not attempt to save it for the next days use.

Special care of the hose will greatly increase the length of usefulness that you will obtain from it. Hoses are of good quality rubber for the most part but even so they must have certain care. We have already

mentioned that they should be cleaned thoroughly. When you are spraying they should not be dragged along unnecessarily. Of course, when you are operating, you have to drag them but be careful even then. Don't drag them around sharp objects of any kind because a hose under pressure is very easily cut and it is extremely easy for you to ruin one by being careless with it. When it is not in use, it should be either disconnected and allowed to lay on the ground or it should be coiled in loose, easy coils on special hangers on the machine. Above all avoid kinking and bending it.

Another thing that will save the spray operator lots of time is to have a good stock of repair parts for the engine, the pumps, guns, booms and the hoses. In the event of a breakdown you can get pretty good service from the sprayer companies but to reduce the time lost, it is to your advantage to stock many of these often needed items. Before you use your sprayer very much, you will have a pretty good idea of what those items are.

Another thing that you should have is a number of different sizes of nozzles and disc openings. Many times the failure of your machine to function right is due to the incorrect size of nozzles. The correct discs to use depend somewhat on the machine, the plants you are spraying and the spray material you are applying. So you should have a number of different sizes available.

Another item that you should consider is the periodically check ins of your pressure gauge. If you can't check it, I would suggest buying a new one every two or three years. It will be money well spent. Pressure gauges, if they are not working right, can get you into alot of trouble. You think you are operating at 500 or 600 pounds pressure and you may be only operating at 200 pounds pressure. You may spend much time looking all over the machine trying to find out what is wrong with it. It will save you a lot of trouble if you have a gauge that you know is accurate. About the only way to know it is accurate is to have it checked periodically or buy a new one. They don't cost much.

Now to the care given to the machine at the end of the season. Let's call it second echelon maintenance. Before you put your machine away for the winter, it is important to do a number of things. To be real sure that you clean it out, it is a good idea to run some more water through it to give it one final flushing

out. Another extremely important thing to do is to drain the pump, engine, the various valve seats, the tanks. Doing this will save you a lot of grief. I would take out every drain plug you can find. You can find quite a few of them on some machines. I would take them out and paint them a bright red so that you won't lose them. It might be a good idea to smear a little bit of red paint on the place where you took them from so that you can put them back easily.

On two different occasions I have been called out to look at machines that weren't working right and in both cases plugs had been left out. You can't get pressure if the drain plugs haven't been put back in. It may seem a rather simple thing to you but it is a very common cause of trouble with spraying machines. Some certain types of spray pumps have boll seats and you will have to raise these balls to drain otherwise they will house water and it will be just enough water to freeze, crack and cause you to install replacement parts. To prevent rusting of the pump during the winter, pump used lubrication oil through the machine. Some people don't like to use used lubrication oil if you are one of these use clean oil. I don't care what you use but it is a good idea to pump some oil into it. It will cut down on the rust formation. If your machine is clean in the first place, it won't clog up. If you haven't cleaned it and add oil to it you are just making a bad mess worse. But if it is clean, the oil will do a lot to prevent rust. If you have a steel tank and the inside has been well painted, and well taken care of and is not rusted, you don't have to do much to it. Most of our tanks aren't like that. They should be oiled or an application of light grease will do much to save you a lot of trouble next spring when you start spraying. Just a little bit of rust will cause you a lot of grief.

Getting back to the hoses. Store them in a cool, dark place. Rubber tends to deteriorate in the light and also when the temperatures are high. If you have a cellar where it is reasonably dark, put the rubber hose there. Again don't kink it or roll it too tightly. If you have a barrel, roll it around that or coil it loosely on a shelf or on round hooks. Don't hang it on nails.

We use our sprayers for a great number of things. They are used to apply insecticides, to put on fungicides, to whitewash our walls, to apply herbicides. If you are going to use them to put on herbicides, it is a good idea to have two spray machines if you can afford them.

you can't have two machines you should exercise a lot of caution in using a machine for any other purpose that you have used to apply 2,4-D or any of the other herbicides. What are some of these precautions you can exercise? One is the use of water immediately after use. Flush it out. Some boys have suggested using detergents. I have seen no scientific justification for doing this but is has been suggested for use. There are two methods of cleaning your machine and equipment that supposedly give good results. One is the use of household ammonium and the other is the use of charcoal. If you use ammonium, first of all rinse the sprayer out with clean water and then use a 1% solution of household ammonium. You can prepare a simple 1% solution by using two teaspoonfulls of ammonium per quart of water. Fill the sprayer and leave it in the spray tank, boom, hoses for from 12 to 24 hours. Then remove and rinse your equipment very thoroughly again. Cleaning with activated charcoal is a faster method. It is a little more expensive and frankly I can't tell you whether it is more or less efficient than by using ammonium. Again you rinse the sprayer thoroughly with clean water and then rinse it with a 1% solution of this activated charcoal followed by a rinse with clean water. However, the best method of preventing contamination is to use two separate sprayers, one to apply the herbicide and the other to put on the spray material.

I have comiled some suggestions for the care and operation of spray machines that you can take with you and I hope they will be of some value to you. These were taken for the most part from suggestions from commercial firms and in some respects will not apply to all pieces of equipment but in the main they will apply to most sprayers. The principles of operation are essentially the same for all makes of spray machines.

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SOIL PREPARATION FOR SEEDING TO TURF

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This topic of preparing soil for turf is an interesting one. Some of the pictures we have just looked at have given us some lessons on that. It is a topic on which there are a lot of opinions. I suppose we can agree pretty well on what we want and any discussion and exchange of opinions is largely on how to get what we want.

I have listed some of the things that I suppose we want in establishing a good soil for turf. In the first place, we want a soil that absorbs water readily and drains rapidly but we want a soil that holds a lot of available water. We want a soil that is open and well aerated for healthy root growth. We want a soil that is firm and solid when wet so that it will take trampling and not get muddy or slippery. But we are quite likely to want soil that is soft and resilient when it gets dry and not hard and cement like. We want soil that will stand up under trampling when wet and not become compact, and dense, and impervious to water. At the same time, we want soil that will stand up under trampling when it is dry and not become loose and incoherent. The last picture we saw illustrated the point that we want a soil that supplied enough nitrogen, phosphorus, potash and all the other elements that are necessary for good, healthy, vigorous growth of grass. At the same time, we want a soil that is not so rich and out of balance as to produce a lush, tender, easily injured grass. While we are at it, we might as well keep on and ask all of the impossible things. We want a soil that is toxic to all the weed and insect pests and diseases that attack the grass, and not toxic to any of the desirable grasses. I am sure many of you can think of some other things we want when we look for a soil on which to grow grass.

Now the question is how to get what we want. I think the answer is that we probably won't get it. There are certain things to keep in mind in preparation to soil for growing grass. I am going to talk first about building soil mixtures for synthetic soils for golf greens and similar small areas where expense is not a serious item.

We can pretty well mix what we think we want; whether we have what we want after it is mixed is another

question. Soil texture and structure are highly important for the production of grass. a proper balance of sand, clay, and organic matter is important in order to attain the kind of soil structure and condition that we want. I suppose the addition of screened cinders to the mixture may have some value. I don't know why I should be standing here talking to you greenkeepers on making up a synthetic soil for greens because you have had a lot of experience on it and I have not. Perhaps I can discuss some of the principles involved. The texture, structure, and organic matter content of the soil have an important bearing on the amount and nature of the pore space in the soil and that is important. The pore space has to do with the air and water relationships and the growth of grass roots.

In general, there are two kinds of pore space in the soil. There is capillary pore space which consists of very fine pores, many of them too small to be seen with the naked eye and that is the pore space that holds water available for the grass roots. You can't get water out of the capillary pore space by any other means than evaporation or by contact with plant roots. The non-capillary pore space consists of larger pores. These larger pores do not retain water but on the contrary they permit rapid water intake and rapid drainage of surplus water from the soil and the penetration of air and grass roots.

A dense, compact, impervious claypan subsoil has a lot of pore space, in it, usually about 35% to 45%. It is all capillary pore space. Most of it is so small you can't even see the pores. When such a soil becomes wet, nearly all the pore spaces fill with water, and the water does not drain out. The capillary pores are so small that the surface tension of the water holds it in the small pores with tremendous force. There is no room for air in such a soil; therefore, very little penetration of roots of the kinds of grass that we consider desirable in most places; because grass roots must have air. Most of the desirable soil bacteria and organisms that convert unavailable forms of nitrogen and other elements to the available forms must have air also and they cannot do their work in the absence of air in a tight, compact, water-logged sod.

Soil that is mostly sand usually has no more pore space than a clay soil. In fact, it has a less amount of pore space but the pores are larger. They are non-capillary. They permit rapid movement of water through the soil but they do not hold much water. They permit air and grass roots to penetrate freely but they tend

to be droughty. Sandy soils that do not have enough clay or organic matter tend to be infertile. It is the clay and organic matter that hold most of the phosphorus, potash, lime, nitrogen, and various other mineral elements that the grass needs. Sandy soils not having much clay and organic matter tend to be infertile.

We need a soil that is pretty well balanced as to sand, clay and organic matter if we are to have the necessary physical, chemical and biological properties for good growth of grass. The question now is how much sand, clay and organic matter. I think it is pretty difficult to set any arbitrary figure on this. It is a little difficult to judge just how much clay and how much organic matter are present in some of our desirable soils. It is probably better to try for the desired qualities of the soil mixture, the proper blend of cohesion, friability, porosity, granulation, loaminess, firmness, and so on. The soil scientist would say that no more than 30% clay at the most should be present in a suitable soil for turf. In most cases, one-half or one-third of this amount would be better.

Organic matter content is variable. It depends on a lot of things. It depends on soil texture, climate and so forth. Many good soils contain only 2 or 3% organic matter. The quality of the organic matter varies tremendously. Some of the organic matter we put into the soil decays and disappears very rapidly; some is more persistent. There is a difference between manure and humus. There is a difference between humus and peat moss. Only experience will tell us the value of organic matter and of any particular kind of organic matter used for making up soil. Since the amounts of clay and organic matter in the soil should be kept down pretty well, then obviously sand, including fine gravel, sand and silt make up the bulk of good turf soil.

One of the qualities necessary in a soil for use on greens and other areas where there is continual trampling is a solidity of that soil even when it contains a lot of water. I mentioned screened cinders a minute ago. They should have some value in such a soil because the rough particles tend to lock together and form a solid framework on which we can walk whether it is wet or dry. It will hold up and retain within the large pore spaces, many aggregates of clay and organic matter to hold the necessary available water and mineral substances for the grass roots.

In making a synthetic top soil it is not sufficient to spread the different components on the area and pack them down, because a layered effect is very undesirable. A layer of clay will not permit water to penetrate, a layer of coarse sand will not retain water and therefore, will not encourage root growth in or below that layer. The necessary components must be thoroughly mixed and if possible screened before spreading on the area.

Let's go on to discussing seed bed preparation in more extensive areas where we must take the kind of soil we have and do the best we can with it. Fortunately Kling Anderson has pointed out some of the requirements for a good seed bed. Seed bed preparation for fine turf grasses is rather similar to seed bed preparation for the hay and pasture grasses.

It involves some kind of working of the soil to loosen it up, aerate it, make it mellow and loamy and also to incorporate manure or compost and lime and fertilizer if they are necessary. Another important step in preparation of the seed bed for seeding areas is a fallow period of 6 or 8 weeks in which all vegetation is kept down and the weed seeds are encouraged to germinate and the seedlings killed by tillage. This fallow period also allows the settling and packing of the soil to form a hard, firm seed bed. The fallow period must be during the growing season when the weather is such that the germination of weed seed will be encouraged. For the cool season grasses, fall seeding is especially desirable and the ground should be worked for a period of 6 or 8 weeks in order to get rid of the weed competition and give the cool season grass a chance to get started in a weed-free seed bed. In the case of seeding grasses in the spring, it is desirable to have the fallow period the previous summer and fall to get rid of the weed seeds and eliminate as much as possible the weed competition that spring seeded grass always has to contend with. That, in my opinion, is very important in the preparation of a seed bed for grasses.

Of course, any necessary grading should be done before the first tillage operation. Grading should accomplish several purposes. It should accomplish good surface drainage if such drainage does not already exist. Another important point, grading should never any eroded or excavated spots with good top soil of suitable texture, structure, and organic matter content, if possible, so that we will have a rich soil over the entire area. Dr. Anderson discussed the re-

seeding and establishment of grass on eroded area. One of the important points on establishing grass on eroded areas is to have fertile soil to give the grass a quick start in a difficult spot.

With regard to soil fertility, there are a number of things to be considered. For one thing, soil reaction is important. Grass, like most other crops, generally grows best at a pH of 6 to 6.5. In most of the literature you can find, recommendations are that the soil be kept acid for the grass at a pH of 5.5 It should be remembered that a pH value below 5.5 will decrease the availability of nitrogen and phosphorus. Certain toxic substances in the soil become more soluble at low pH values. These conditions are rather unfavorable for the growth of grass as well as other crops. On the other hand, an excess of lime in the soil is not to be desired. At pH values above 7, iron and phosphorus compounds become insoluble and, therefore, are not available to grasses and other plants; chlorosis due to deficiency of iron may develop as a result of excessive lime in the soil. If the lime is naturally there, we must take steps to counteract these effects.

I might make special mention here of sandy soils. The sandy soil at a pH or 6 may be considered to be more acid in some respects than silt loam at a pH of 5.5. Since it has less clay and less organic matter, it contains smaller amounts of available calcium, magnesium, potassium and other bases than the heavier soils at a lower pH. So in sandy soils it may be desirable to adjust the reaction to a pH of 6.5 or above rather than below that point.

As to fertilizers, I mentioned manure a few minutes ago. Mr. Noor mentioned the use of manure and showed us a picture showing the result of top dressing and established sod with manure containing weed seed. Nevertheless, manure may be valuable in preparing the seed bed, provided the fallow period is used to kill off the weed seed. There is no better fertilizer for grass than manure in preparing the seed bed. After the turf is established, it is an entirely different story because of the weed seed problem. Manure, compost, and organic fertilizers generally are effective fertilizers and cause little or no injury if used in moderate excess. They have more lasting effects than the inorganic or chemical fertilizers. Of course, manure and compost may carry weed seeds and give off objectionable odors. These objections are usually not serious when we are preparing the land for seeding.

The inorganic or chemical fertilizers are clean, free from weeds but we take it for granted that the fellow who uses them must know what he is doing. He must know what kind of fertilizer is needed and the rates at which it is effective and the excessive rates at which injury may result. His equipment for spreading chemical fertilizer has to be fool-proof. A spreader that dumps some ammonium sulfate here and there will make a fool out of the smartest man.

As to the soil fertility requirements of grass, grasses seem to require a maximum of available nitrogen and a minimum of phosphorus and potash in comparison with many field crops, vegetables and flowers. A plentiful supply of available nitrogen stimulates vegetative growth and that is the thing we want in the turf grasses. Liberal use of phosphorus and potash fertilizers tend to encourage the growth of clover. That may become quite a serious problem. In soils that are moderately well supplied with available phosphorus and potassium, including many soils in the middle west, the use of fertilizers containing considerable amounts of phosphorus and potash may tend to encourage the clover. It seems like lost motion and expense to put on phosphorus and potash fertilizer to promote the clover and then use the methods which we have seen in the pictures to eliminate the clover. That refers to the fertilization of the turf once it is established. In preparing the seed bed I think in many cases it is desirable to use a fertilizer containing some phosphorus as well as nitrogen because the phosphorus fertilizer stimulates the early growth of the seedling. The use of fertilizers containing phosphorus as well as nitrogen is desirable as a safe-guard in getting rapid establishment of the turf grasses. It takes both nitrogen and phosphorus to promote the growth of an extensive root system in the grass.

By way of summary, the objectives in preparing the soil for the establishment of turf are the selection of soil of medium texture and the preparation of it should be in such a way that it will be firm but porous, loamy but well packed, moist but well drained and aerated, free of weed seeds, free of excessive trash, fertile, well supplied with organic matter but not excessively rich. From ther on the subject has been pretty well discussed. I would like to emphasize once more what Dr. Anderson emphasized so well and that is the value of mulch in protecting seedlings on a well prepared seed bed.

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ESTABLISHING TURF TO CONTROL EROSION ON SLOPES

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Wherever native cover is distrubed soil erosion is made possible, and on sloping land it becomes a serious threat unless control measures are undertaken. In certain situations these control measures may be as simple as the abandonment of cultivated land to allow natural revegetation. Serious soil degeneration resulting from long exposure to erosion losses may make this a slow procedure, but it is as sure a method as the original development of the native cover that was first broken. Studies have shown that complete natural revegetation may take from a few years under ideal conditions to 50 yards or more where soil degeneration has been severe and where the natural sources of seed are limited. Obviously, then, natural revegetation by the mere abandonment of land is not a proper solution where other methods can be used and where their application is practical.

It is proposed in this discussion to examine the basis for establishing grass for erosion control on slopes. Rather than discuss specific details, this paper will deal with the principles involved, and these can be applied as needed and varied as local conditions differ.

In the search for erosion control material we naturally turn first to grass cover because grasses (in this central grassland climate where they make up the natural cover) are nature's most effective erosion control medium. Once established, a cover of adapted grasses will contribute more to the prevention of soil loss than any mechanical treatment, save actual surfacing of the eroding area with concrete or other paving material. Such drastic treatment will stop erosion, but may create water disposal problems below the original trouble area. Terraces, water diversions, and other structures may aid greatly in the establishment of vegetative cover, but in the end it is the cover itself that actually accomplished the control. Once the cover has become fully established, the mechanical structures are seldom needed and, under certain circumstances may, indeed, be more of a hindrance than a help. They often interfere with mowing and other maintenance operations or with the use, especially of recreational areas. Therefore, the need for machanical structures should be given careful consideration before they are applied. Grass cover may, in itself, give sufficient protection.

Secondly, we turn to grass cover because of its utilitarian nature. It can be used in a wide variety of situations. Grass planted for some specific purpose may, in fact, give perfect erosion control as an extra benefit, incidental to its use as a turf, provided, of course, that it is properly maintained. In such an event the emphasis is on the ultimate use and the management practices are adjusted accordingly.

And third, we plant grass cover for its beauty and relative ease of maintenance. These are important factors in most turf areas, even in such situations as pastures and farm waterways or terrace outlets.

For purposes of this discussion we shall consider areas where erosion control is the principal objective and where actual utilization and appearance of the area are more or less secondary considerations.

Where permanent cover is planned for erosion control, the native grasses are given first consideration because they represent the natural cover and are better adapted than any other type of vegetation to the local climate, and especially to its variation. The native grasses are able to compete successfully against any other vegetation in this climate belt because they are adjusted to the environment. Encroachment by other forms of plant life is not possible except where disturbance has occurred. Therefore, where locally adapted native grass mixtures are established maintenance is simpler and less expensive than under other types of plant cover. It is important to stress that locally adapted native strains are needed because those brought from afar may be even less well adapted than certain exotic species. Experiments have repeatedly demonstrated that native grasses from sources to the north give small, weak, disease-susceptible plants and that those from too far south lack winterhardiness.

Planting of the so-called tame, or introduced, grasses may also be of great value in the control of erosion. Usually these species are less well adapted to the local environment than are the native species which have evolved here thru countless generations of natural selection. Only the fit among them could survive this test of time, and the exotic species can not be expected to compete successfully with them for light, moisture, and plant nutrients. More care is thus needed for maintenance of introduced ones especially for the protection against encroachment by other species such as weeds or sometimes even the native grasses.

Occasionally there may be introduced to some grassland region a grass species that came from some similar environment elsewhere and which is, therefore, quite well adapted to its new environment. Such a species can be expected to compete successfully. It may even "make itself at home" in the native complex. In the eastern and more humid part of the great central grassland, the introduced grass which most nearly meets those conditions in Kentucky bluegrass, and farther south bermudagrass behaves in this same manner, but neither can maintain itself in a pure stand against the encroachment of native grasses without special care. Such care may, of course, simply be the treatments employed in keeping it presentable as a turf, that is, mowing and fertilizing.

An examination of the growth habits of grasses will reveal the reasons for their great value in erosion control and may help understand how to use and maintain them in this role.

Any erosion control cover must perform two distinct, yet, intimately related functions in accomplishing its purpose. It must obviously prevent or reduce runoff and its attendant transportation of soil materials from the area to be protected, but first it must prevent the detachment of these particles by the beating and tearing action of rain drops striking bare soil. A dense sward of perennial grasses is more effective in this type of protection than any other form of vegetation adapted to this area. Not only does grass provide protection against the physical force of raindrops and moving (flowing) surface water, but it improves the ability of soils to absorb water quickly, thereby reducing runoff and saving both soil and water. Under grass the soil becomes filled with tiny passages left there by decomposing grass roots, and the increased humus content improves its physical condition, actually increasing its resistance to erosion. This condition is impressively demonstrated by the high degree of resistance to erosion that is found in newly broken native grasslands. It persists until substantial loss of organic matter has occurred.

Seriously eroding areas may require immediate cover, making necessary either complete or partial sodding, or it may be possible with some species to obtain quick cover with sprigs or sod plugs. Bermudagrass and buffalograss are examples of grasses that can accomplish this. These methods require so much labor and are, therefore, so expensive that their use is more or less limited to special problem areas or to sites on which cost is not the principal consideration.

The most widely used method of establishing grass for erosion control is direct seeding, and the time and method will depend upon whether or not supplemental watering is possible.

In this region, seeding is more or less limited to two relatively short seasons, determined largely by the growth requirements of the grasses involved. Cool-season growers respond best to early fall seeding but may, if necessary, be sown in early spring. Spring seeding is made hazardous by the increased difficulty in controlling weeds and by the fact that spring seeding make necessary for these cool-season grasses to go through their first summer as seedlings rather than as fully established plants and therefore less tolerant to heat and drought than the same species sown in the fall.

The warm-season grasses, lacking winter-hardiness in their seedling stages, can only be sown in the spring and then only after the soil becomes fairly warm. They would not be likely to survive fall emergence and, fortunately, newly harvested seed of most species of this group is relatively dormant the first fall after harvest. Certain ones like switchgrass and sand lovegrass remain somewhat dormant until the second spring. There is, then, not much point in planting grasses of this group at any other time of year than fairly late spring or very early summer.

While it is true that spring sown, native grasses must emerge with any spring weeds, they are better adapted than are the introduced ones to withstand competition. They can, in fact, invade stands of tame grasses or of weeds. However, the late planting to which they are adapted often makes it possible to till in the spring after numerous weeds have germinated and thereby to reduce the pressure of competition.

One of the principal considerations in successful establishment is the seedbed, and its requirements may be briefly reviewed as follows:

1. It must be firm but at the same time, mellow and well worked.
   (a) To permit accurate control of planting depth.
   (b) To place all seed at the proper depth for prompt germination and emergence.
   (c) To insure close contact between seed and moist soil.

2. It must be fertile.
   (a)To induce vigorous seedling growth and rapid establishment. Use of fertilizers will be governed by needs and these may be estimated by soil tests. Slopes deteriorated by erosion are almost sure to need fertilizers.

3. It must be protected from erosion during the period of seedling establishment, by one or more of the following means:
   (a)Terraces or contour furrows, or perhaps contour tillage.
   (b)Surface mulch of straw, hay, netting or other material.
   (c)Prepared stubble cover, the tops of some crop sown for its ability to produce fibrous material that will carry over through grass seeding and establishment without undue loss by decomposition.

To obtain such a seedbed requires considerable time and careful planning as it may be necessary to grow a preparatory crop, or at least, if a crop is to be grown ahead of grass seeding, it must be one that can be matured or perhaps even harvested in time to allow for seedbed preparation.

The soil fertility problem may need to be considered during these planning stages. Soil tests can be made and fertilizer applied according to the needs, perhaps even for the preparatory crop. Certainly, if a mulch crop is being produces for grass seeding, it should give a sufficient yield of tops to provide the needed cover and that may require fertilizing. For plantings on fairly large acreages, it may be practical to prepare the soil by growing some soil improving crop like sweetclover or other legume. All practices of this nature should be designed to aid in rapid emergence and establishment of the sod crop being planned for the control of erosion.

It must be emphasized again that in dealing with slopes, special procedures such as sodding or sprigging may be required. These are fairly well understood and need not be discussed here. These special methods may however be too costly to be widely applied on large areas. Direct seeding is the only other alternative and its success depends, in addition to the factors just discussed, on controlling erosion. The most inexpensive method of accomplishing this is with

a prepared stubble mulch.

Stubble mulches are prepared by seeding some annual crop that will "kill out" sufficiently far ahead of grass seeding time to allow soil moisture to accumulate. Summer growing annuals like sudangrass or any of the other sorghums drilled in solid stands will provide such cover for the spring plantings. The sorghum is drilled fairly late in the summer, usually after July 1, and allowed to grow undisturbed unless it threatens to produce seed. In such an event it is mowed before seeds can form because volunteer sorghums are not desirable in the new grass planting the next year. The cut material usually is allowed to remain where it falls and the grass is drilled directly into this the following spring without further seedbed preparation.

Stubble mulches for fall sown crops are more difficult to provide as any crop grown in the summer will continue its growth into the fall, thus exhausting the soil moisture and making planting of the sod crop impossible unless the mulch crop is tilled to destroy it. This, of course, tends to defeat its purpose. Perhaps someone will one day devise a chemical spray for killing such stubble mulch crops at the proper date before seeding time. The production of stubble mulches for fall sown grasses needs much study.

The prepared stubble mulch provides cover for protection against erosion. It shades the soil and prevents excessive evaporation. It delays weed growth, but provides ideal conditions for germination of the grasses. The grass seedbed prepared in this manner fulfills the requirements ofa good seedbed. It is firm, protected from erosion, and ready for planting as early in the spring as grasses can be sown.

Grass seed may be broadcast into such a mulch, but accurate seeding rates and placement of seed are still important, and that makes drilling superior to broadcasting. To get adrill through this stubble mulch is not an easy task, but special drills are now available. These have double coulter openers and the disks are equipped with depth flanges to prevent deep drilling. The double coulters cut through the fallen stems and other debris left by the stubble mulch but only to the depth allowed by the flanges attached to them. Press wheels follow to firm the soil, thus completing the operation.

These special drills are equipped with forced-feed

planter boxes adapted from cotton planters instead of with ordinary drill boxes. These will plant light, chaffy, or fluffy seeds. In addition, other boxes handle small seeds like those of sand lovegrass or the legumes so that mixtures can be sown.

Drills such as this are costly, but various organizations often purchase such machinery for use on a rental basis. This often is done in Soil Conservation Districts.

It has been the purpose of this discussion to focus attention principally on the problems of establishing sods on the slopes for erosion control rather than to give specific directions for seeding and other procedures. These will vary with local site conditions. Application will have to be governed to some extent by these local needs.

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RENOVATION OF EXISTING TURF

O. J. Noer
Milwaukee Sewerage Commission

I am happy to be here this morning. My topic was assigned but also is one of my choice. Turf renovation is a simple problem farther north. It is in the transition belt which extends from Kansas City through Cincinnati, Louisville to Washington and Philadelphia where most trouble is encountered. Of necessity I shall deal with the renovation of fairways because golf courses are the ones most interested in this kind of work.

The original work with herbicides was done by Fred Grau when he was with the Green Section in the early 30's. He worked with sodium arsenite, arsenic acid and the chlorates. They were used at that time not only to control chick weed, clover and Poa annua but also to kill the broad leaf weeds -- principally dandelion, plantain and buckhorn. When 2,4-D came into the picture it looked as though the arsenicals were thru. As a matter of fact, that has not been true. If anything, they are being used more extensively today than they were in the old days although methods and rates have changed because they are no longer used to control the broad leaf weeds. With this brief intro-

duction I shall rely on pictures to tell the story of what I wish to present this morning.

When herbicides are stressed we must remember that they are only another tool in any turf improvement program. Before we had them we were able to do a good job of turf development and improvement. However, herbicides speeded the program and made it possible to accomplish the objective which took much longer before we had them. The first picture is of a fairway and green in the background at Milwaukee Country Club. Herbicides have never been used to control weeds on this golf course. In the early 30's it was decided to install a watering system in order to improve the turf. After one or two years the fairways were largely clover. As a result, the chairman promoted the idea of developing a turf nursery to sod all of the fairways. I was consulted in '32 and told them that I was glad to see one club with plenty of money. I had heard of resodding greens but 60 acres was another problem. Instead of doing all 60 acres, it was suggested to do one or two each year. I asked what would be done in 3 or 4 years when the resodded fairway looked like it did before. As a result the idea of sodding was abandoned. Turf improvement was accomplished by the correct use of water accompanied by fertilization. No seed was used on these fairways to produce the fine stand of dense turf which you see in the picture.

The next picture is from Minneapolis and was taken a short time ago. It is a watered fairway. You can see that the character of the grass coverage is changing as a result of waterway. Originally it was a bluegrass fairway, now with watering and fertilization the bluegrass is disappearing and bent is automatically taking its place. Before long this fairway will have only bent grass similar to the one at Milwaukee just shown.

The next picture is of a fairway in Milwaukee, largely dandelions although there is some grass also. When a turf improvement program was started, it was decided to use 2,4-D. The results were so striking that officials felt 2,4-D alone was the answer. I want you to use the trees in the background as a land mark.

The next picture shows dandelion control with fertilizer only. So even before 2,4-D, it was possible to eliminate broad leaf weeds with a program of good management.

The clump of trees that you saw in the sc ...d last

picture are in the background. The 2,4-D broad leaf weeds eliminated but a heavy infestation of clover followed. Clover is a prized plant to the farmer but is a weed on the golf course. Failure to use fertilizer along with 2,4-D to stimulate the growth of grass solved one problem but brought another bad one.

The next picture is a close-up on a fairway in Peoria, Illinois. This course was renovated with sodium arsenite. The purpose was to kill clover. The kill was exceptionally good. Clover was present in rather large clumps. Nothing was done to obtain a stand of grass in these areas after killing the clover. The next year every clover patch was a solid mat of crabgrass. The program should have included reseeding after killing the clover.

The next picture shows the first large scale use of herbicides on this continent for selective weed control. It was at Toronto Golf Club. They had a fairway turf problem. Purdy and the chairman went to Washington, to see Fred Grau's experimental work with herbicides. As a result they decided to spray the fairways with sodium arsenite not only to kill clover and Poa annua but to rid the fairways of plantain, dandelion and crab grass. This is the home-made boom which was mounted on their sprayer. Notice the hinged arms and the man standing above the boom to lift the arms around bunkers and other high areas. The next picture is of a fairway after the sodium arsenite had been applied. At that time it was customary to use from 8 to 12 pounds of sodium arsenite per acre. Purdy sprayed 3 or 4 times at these high rates to kill dandelion, plantain and so forth. A small skipped strip down the center gives you some idea of the burn produces by sodium arsenite. The next picture is one of Purdy and his chairman examining a plant of buckhorn to determine the amount of injury.

The next picture shows the first renovation job in the United States. It was at Oak Park, Illinois. This is a watered fairway which has become largely Poa annua and clover. It was sprayed with arsenic acid at a rather heavy rate then fertilized and seeded with a mixture of Seaside and Astoria bent. You can see the quality of the resulting turf. The work was done the fall before.

The next pictures shows a near-by fairway on the same course, to give you an idea of what happened from the excessive use of water and extreme close cutting. Notice the clover. Those of you who are interested in

golf know that players would rather play the fairway in the preceding picture than this one.

The next picture shows the difference in burn resulting from liquid and dry sodium arsenite. This is one of the courses in Milwaukee. The rate for sodium arsenite was 8 ounces per thousand square feet which is a rather heavy rate. This is the spray method and this is the dry. Not only does the spray discolor the grass more than the dry method, but it is more drastic on the weeds also. You can see the dandelion heads in this picture.

This is on a course in Chicago. The fairways were sprayed with arsenic acid using about 15 pounds of arsenic acid per acre. Notice the discoloration. The fairways were treated with sodium arsenite but the dry method was used. Approximately the same amount of sodium arsenite was applied to the fairways as was used on the roughs. Discoloration is less severe. The next pictures shows the spreader used for making the dry application. Notice the dust which is principally sodium arsenite.

The next picture is of a fairway at Brnywood in Milwaukee showing the character of coverage before a turf improvement program was started. The amount of grass was sparse but there was considerable bluegrass even though it was thin. The principal weeds were dandelions and buckhorn. The next picture is one of the same fairway taken two years later. The weeds are gone and there is a good coverage of turf. No seed was used. When Ike Rabbitt of the Navy visited Brnywood we stood on #15 fairway. Les Verhallen asked if I recalled when he and I were on that fairway before.

Naturally I did not. He told me he had suggested using some seed in addition to the sodium arsenite and fertilizer and I told him that seed was not necessary. If the existing grass was given an opportunity, it would provide coverage. After that remark he thought to himself that I was in the right business, namely fertilizer rather than seed. This transformation was accomplished with sodium arsenite and fertilizer. The turf is all bluegrass and is as good as this on the entire course. Fairways are cut at just under an inch in the spring and fall and the mowers are raised to 1½ inches during the summer.

The next picture of a plot located at our plant in Milwaukee. This was treated five times in 1939 and in 1940 with sodium arsenite. I think you can see the line where the treatment stopped. The picture was ta-

ken in 1949, ten years after the first treatment was made. Right after the war the entire area got a dose of 2,4-D. Yet dandelion returned except where the original sodium arsenite treatments were made. In this strip only the occasional dandelion plant appeared. The contrast is quite striking.

The next picture is from Ames, Iowa at the Ames Golf & Country Club. This is Professor Lantz who heads the turf program at Iowa State College. He sprayed the area on the left with 2,4-D. The rate was approximately 3/4 of a pound per acre. Notice the striking results obtained with one application of 2,4-D. In the days when we used arsenic acid or sodium arsenite, it was necessary to treat 3 or 4 times. Anybody who has a dandelion problem would certainly be crazy to attempt their elimination with arsenicals when one shote of 2,4-D does such an exceptionally good job.

The next picture is a fairway in Philadelphia. It is a renovation job at the Philadelphia Country Club. This is Marshall Farnham. The area on this side was treated with 2,4-D immediately after seeding; the area on the left got no 2,4-D. Notice the good stand of grass on the left as compared with the treated area on the right. If 2,4-D is to be used in the renovation program and seeding is necessary, the 2,4-D should not be used within two to three weeks before seeding. We prefer to use 2,4-D in May or June and then seed in August or September depending on the location.

The next picture was taken in Milwaukee. There is a clover problem on this area. Plenty of grass but it is not growing as it should because the level of soil nitrogen is too low. Clover, being a legume, does not depend entirely on the soil to obtain its nitrogen and will flourish when the soil level of nitrogen is low.

To obtain satisfactory control it is necessary to raise the level of soil nitrogen high enough to stimulate the growth of grass. Then it can compete with the clover.

This is a fairway at Chapultepec in Mexico City. This club installed a watering system and expected it to solve the turf problem on their fairway. All the water did was to stimulate the growth of burr clover because the level of soil nitrogen was too low for the bermuda. The only green part of bermuda plants were the growing tips. The bermuda was re-utilizing the nitrogen, moving it from the older to the younger growing parts of the plant. Grass just as every other

living thing can't live on liquids only. It must have some solid substances as well. Since Chapultepec have augmented their water with a sensible feeding program, they have gone a long way toward solving the turf problem on the fairways.

This is a picture taken on a golf course some years ago in the New York area. Before the water system was installed, they had good grass not only fescue but some bluegrass. In order to provide nice turf all season, a water system was promoted and installed. The fairways were watered heavily and were cut at approximately ½ an inch. If you wish to be rid of bluegrass or fescue, there is no better plan. You can see the outline of the sprinklers by the absence of bluegrass in the circular area. Out beyond the circle covered by the sprinkler, there is a good stand of bluegrass. A month later in the spring the contrast wouldn't have been as noticeable because of Poa annua on the bare areas. In the cooler weather of spring and fall turf is good but in July and August as the Poa annua weakens, clover and knotweed become bad. The players start to complain.

The next picture is at Pittsburgh on a watered course. Notice the footprinting which is evidence that the grass is wilting. The Poa annua is on the way out. Notice how the clover is present and it is not going to be long until it takes possession due to lack of competition because of the loss of Poa annua. In the fall Poa annua is sure to return and then complaints will subside somewhat.

The next picture shows clover control with solium arsenite. It is on one of the courses in Milwaukee. We made two applications, one in the background and twice in the foreground at approximately 4 ounces per 1000 square feet by the dry method. These treatments were made in late May and early June. It is some of the first work we ever did and the results were some of the best we ever got. We have never since been able to accomplish as good control of clover with two applications. Maybe it was fortunate that we got as good results because it encouraged us to continue the work.

The next picture is a fairway in Cincinnati. It was taken in the spring. You can see that there is a little bit of bluegrass. The brown areas are crabgrass from the year before. Very likely if we could grow a good crop of Poa annua in the spring and fall and then follow with crabgrass, we would have coverage all sea-

son. Maybe a cool-warm season combination. The reason for the heavy infestation on this golf course was because the chairman was a dairy farmer and he had every confidence in dairy manure. Each spring the fairways were covered with it. Although the manure furnished some food it contained a good many crabgrass seeds to create a crabgrass problem on all the fairways.

The next picture is a cemetery, at Philadelphia. It is of a new section under development. You can see the old section in the background. The brown area is crabgrass. The browning resulted from the use of sodium arsenite. The green areas are the bluegrass. At that time heavy rates of sodium arsenite were used because we were not only trying to control crabgrass but also to reduce the population of buckhorn and dandelion. This area was treated at the rate of approximately 15 pounds of sodium arsenite per acre with the dry method. Sodium arsenite when used on crabgrass, serves to give you a good kill. But in a week or two you become disappointed, even though new crabgrass does not develop from seed. The reason is this. New growth starts at the nodes of seemingly dead crabgrass. That is why it is necessary to make more than one treatment to obtain decent control.

Here is Fred Grau, Charlie Wilson and Al Radko, his assistants. The picture was taken several weeks ago when I was at Beltsville. It is a plot on which potassium cyanate was used to control crabgrass. The rate of application in the plot which you see was 16 pounds of actual potassium cyanate per acre. Treatments were started sometime in late August. The picture was taken on the 26th, of September. The original area treated measured 10 x 50. The second time they moved 10 feet into the plot and 10 feet out beyond. This area received one application, this one two and the other three. Notice the only clump of bluegrass in the plot which stood 3 treatments of potassium cyanate. I doubt if potassium cyanate will be used extensively on large areas because it is so much cheaper to treat with sodium arsenite or arsenic acid.

The next picture is of a fairway in New York which got sodium arsenite by the dry method. It was in conjunction with a renovation program. The only good way to show knotweed is to show the burn obtained after using sodium arsenite. The reason those fairways were extremely bad was because of the knotweed. It is one of the first plants to germinate in the spring. Knotweed covers bare areas quickly and for a time it is the greenkeepers friend because the blemishes disappear.

Later in the season when the long stems start to grow the golfers complain. Knotweed grows particularly well on areas subject to soil compaction. Rather than wait until later in the season to kill it, the best plan is to use light rates of sodium arsenite in the spring before grass starts to grow. It can be killed then with rates of ½ an ounce to 1 ounce per thousand square feet providing the spraying is done when the knotweed is in the two and three leaf seedling stage.

The next picture shows how sodium arsenite is now being used in renovation programs. This is on a fairway at a Country Club in Cleveland. The sodium arsenite is being used to rid the fairway of clover, chickweed and Poa annua. The rate is 1½ pounds per acre with less than 10 gallons of water. This is a low gallonage sprayer with about 30 pounds pressure. For chickweeds and clover there is no point in using the old heavy rates which were applied to kill broad leaf weeds. The next picture shows the pump and the container used to hold the spray solution.

The next picture shows a fairway after spraying with sodium arsenite at about 1½ pounds per acre. The discoloration is not too bad and notice that the ball set up on the turf. The reason why the discoloration is not excessive on this fairway is because the turf population is good and there is only the occasional area containing clover or chickweed.

The next picture is on the same course showing a much more extensive discoloration because on this fairway the clover patches were large. In order to kill the clover when the infestation is heavy, discoloration is bound to be bad such as in this instance. I might say that even these light rates of sodium arsenite are effective on some of the crabgrass areas, not on silver crab, but on the common crabgrass. But with rates of one to two pounds a little wetting agent should be used along with the sodium arsenite. For clover and chickweeds the wetting agent is less important. Any of the detergents sold for household use can be used.

The next picture was taken a month or so ago at Pittsburgh. This is at the St. Clair course where Dave Boll is in charge. The fairways there have been heavily infested with Poa annua. He is now about through with the renovation program. His program called for treating and seeding a few fairways each year. Dave Boll uses fertilizer, he believes in heavy rates and when he used sodium arsenite he does the same thing. As we walked out toward this fairway, I kidded him and

told him the vegetation looked like wheat stubble. The application of sodium arsenite on that fairway was 35 pounds per acre. It was applied dry and you can see the scorch was severe but grass coverage now is good. After making several treatments he fertilized and seeded with a combination of bents because the fairways are watered. The next picture is a picture of another fairway at St. Clair. It was renovated three years ago. When I was there on the 10th of September, there wasa good coverage of permanent grasses on the renovated fairways. There was a bit of consternation when he treated the first fairway. Since then the members asked him when he is going to finish the job.

The next picture shows 2,4-D at 1 3/4 pound per acre on a fertilized area at the Milwaukee Country Club in 1946. One square was not treated. The 1 3/4 pounds rate of 2.4-D, ammonium salt was used once, twice and three times on the other three squares. Even one application, caused some injury to the bent grass.

The next picture is an adjacent plot. You can forget about Milarsenite which is simply a combination of sodium arsenite and Milorganite. We applied 200, 300 and 400 pounds per acre and made three applications as you can see in the picture. The grass is brown on the untreated check. The others are green because of the fertilizer supplied by the Milorganite in the Milarsenite.

The next picture is a fairway at Milwaukee following an application of sodium arsenite. To kill chickweed the dry method was used but I presume they will switch to light rates by the liquid spray method. About 6 fairways are treated each year which means that treatments are spaced approximately three years apart. The work is done in late October and November because chickweed is still green and can be killed at that time. From 2 to 4 applications are needed for a satisfactory kill. It is important to do the killing before the infestation is much heavier than you see in this picture.

This is a fairway in the New York area. The grass is largely bent. 2,4-D was applied at almost 1½ pounds per acre in September. While it did a good job on the weeds, it is also doing a job on the bent. I have seen other places where I felt 2,4-D was damaging the year before.

The next picture is a picture of some plots at Milwaukee along side of a fariway where the creeping bent population was heavy. The treatments were made in

late May and the picture was taken in June. The application rates were ½, ⅔, 1 and 1⅓ pounds actual 2,4-D per acre. This is the 1⅓ pound rate. We got no discoloration from ⅔ pound. The one and 1⅓ pound rates were the only ones that caused discoloration of the grass. I was on the course on the 4th of July and left for the west coast on the 5th. I told John to watch these plots and if the discoloration got no worse to take the approach to #8 and spray it with 3/4 of a pound actual 2,4-D to the acre. That was done in mid-August, at least 90% of the broad leaf weeds were gone without any visible damage to the grass. Last fall we established additional plots along #3 fairway and we made applications at rates of 3/4 and 1⅓ pounds per acre. The next picture will show the discoloration resulting. The picture was taken on the 13th day of October, 1950, about a month after the applications were made. We used the sodium salt. Notice the 1⅓ pound and 3/4 pound and the effect on the grass.

The next picture was taken on the 18th day of May, 1951. They are the same plots as in the previous picture. This is the 3/4 pound rate. There has been some thinning of the turf as a result of the treatment which was made the fall before. The next picture is the 1⅓ pound rate. I think you can see the thinning effect of using 2,4-D at 1⅓ pounds in September on bent turf. This year we have repeated the treatments and we are not getting as severe injury as we got last year. Why, I don't know. As a result of this work it would seem safer to use 2,4-D on bent fairways before July rather than in the early fall. It might be possible to wait until the grass stops growth in the fall. This year we are making applications on the first of September, the 15th of September, the first of October the 15th of October and the first of November to find out if the time element is important. At the Stillwater, Okla. conference, Professor Elder mentioned the possibility of damaging bermuda with 2,4-D. I have seen damage on greens in the Houston as a result of 2,4-D treatments.

The next picture is of the Rosebowl in California. We were there in May last year. U-3 bermuda has performed so well in southern California that the Rosebowl authorities are attempting to introduce U-3 bermuda into the players field. This is their method. An electric augar makes the holes. Then a workman inserts U-3 plugs into the holes and covers each one lightly with top dressing. Here is the completed job. By putting the plugs a little below the surface and covering with soil they think the U-3 starts off a

little better than with any other method of planting.

This, I believe, is the last picture. It is one I enjoy looking at. When in Philadelphia one fall, I noticed this patch of green grass on the rough alongside the fairway. There had been dry weather for about 3 or 4 weeks before I got there. I assumed the green spot to be bluegrass and thought the area around it was Philadelphia bent, otherwise called crabgrass. Much to my surprise I found it was all bluegrass. In these patches the bluegrass was growing and resisting the effects of drought. It puzzled me so I asked the greenkeeper if he could offer any explanation. He answered my question by relating what happened. A new green was built near by. The old one was used until the new one was ready for play. Then the soil from the top of the old green was used to fill depressions in the rough. These are the areas where the soil was used. So with a good physical soil condition and a high level of fertility, the grass can resist the effects of drought longer than otherwise. Those who attempt to keep grass green with water only should remember that water is just one factor. It is necessary to keep a satisfactory level of soil fertility for the water to be beneficial. If you do that, less water will be required to produce and keep good turf.

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HOW NOT TO PRUNE SHADE TREES

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McPherson, Kansas

I am not sure why a tree man is on a grass program. All I know about grass is that it grows sometimes and you have to cut it. But this is a very diversified organization and I know we are trying to cover all fields so I will try to tell you all I can about tree pruning.

I will talk about what to do and what not to do on pruning shade trees. I used to work around Chicago and that brought me to the famous Michigan Boulevard. A kid and I were driving up there one day and we some how got tangled up with a very pleasant little lady who was driving a big fancy Cadillac and knocked off a fender or two. I got out and politely addressed her down and told how how to drive and all that and it wasn't too good. When we got all finished she said,

"I hopest when thou returns to thy kennel this evening thy mother will bit you". I was reminded of that by this topic of what to do and what not to do in pruning.

I believe that some time or other there isn't a shade tree that doesn't need pruning. You people with golf courses and parks certainly realize the value and assets of good shade trees. I am sure you are willing to give them the best care and attention. The topic of how not to prune shade trees can best be discussed by just looking around the country side and in some villages and cities and observe how trees have been pruned. Sadly enough some of these jobs have been done by men who call themselves tree experts. I don't however, hold it against a man for trying to make a living but I still maintain that it is just as easy to do a job well as incorrectly. I don't say that about all arbor culture work but in the line of pruning, I don't think it is too much harder to do it right than wrong.

This afternoon I want to speak generally about pruning. Of course, in that we will find things not to do and improper methods of pruning shade trees. I think when we prune shade trees we have about three reasons in mind. One is for the beauty of the plant. Another is for the preservation of the plant and the third one generally is for safety reasons. I think on areas such as golf courses, parks and so forth, safety is an important factor. By that I mean trees having a lot of large dead branches on them certainly aren't safe on public grounds.

In doing this pruning it must be done properly or the job for which we do with defeat one or the other purpose. You certainly can't let a lot of stumps in the tree, tear the bark down, forget to paint the cuts. To me, it doesn't improve the beauty of the tree and certainly doesn't do a plant any good from a preservation standpoint. One of the things in pruning to beautify is that we certainly should not cut back the top. By that I mean we usually consider the top of the tree the crown. It is one of my pet peeves to see trees flat topped. Many times we see it and are called on to do that kind of work and it is a difficult problem to convince the property owner not to flat top his trees. The same holds ture for trimming down the sides. In the first place no tree will stand that type of treatment. I am thinking of the maples, sycamores, American elm. If you cut back the crown, you open up the remaining structure to excessive sun in

the summer which may cause sun burning. You then have a flat topped tree and are left with a lot of stumps, which is something I can't tolerate. The sap flowage of a tree is usually up and down. You leave a stump and the sap flows up to that in its natural flowing angle and it won't heal. It had no place to go; it is a dead end. When you have a case of that kind, you certainly leave the tree open for wood decay fungus, insects and various other troubles. So a stump is simply out of the question.

It might be very true, after we round over a top of a tree it may grow to be very dense the next year and might look pretty good. But that happens on a lot of these jobs is that you are getting a very luxuriant growth coming off from the cambium layer of the cut. It might look like a birds nest. The first year it may work out very well and continue to grow and look pretty nice if you can class it as a thing of beauty. But the second and third year a big share of the new growth begins to die. While that process is going on you will get a lot of sucker growth around the sides of the tree and along the sides of the branches. Naturally if you take off 50% of the crown, the root system doesn't have as much to support. It will continue to function but it will shoot out new sucker growth over the remaining part of the tree. By and by that will get so crowded that much of it will die. I have seen some trees that were so treated by pruning back the top that they had to be removed in two or three years.

I ran into a case in my own home town about two years ago. Some would be arborist was in there from one of the neighboring cities. There were beautiful American elms growing up about 35 to 40 feet high. When he got all finished he had about 4 stumps left on each tree. He had nerve enough to ask me what I thought about the job and in no certain polite terms told him what I thought about it. It so happened he was about 210, pounds and a bit bigger than I, so I came out of it with a black eye and a few more battle scars. He said that the lady liked it and that was what he was going to do. I went to the mayor about it and he laughed at me. I went home and put a steak on my eye.

We see that same thing done every day. Another tree are the poplars and you find it the same with them. It doesn't look bad and they will put out a lot of new growth. But they are very, very soft wood and you will soon find a lot of decay. There are various canker diseases and decay that get into them that are not always caused by improper pruning.

We see Chinese elms cut back severly. I don't know if it is good or bad. I have no particular love for that tree. There again we see them topped off and while they will begin to heal it certainly isn't a way to prune a tree.

I would like to mention here that I know there are some highway, utility and park people here. We do run into cases where that type of pruning is just the only way. I am thinking now of "line clearance". Trees and wires simply don't get along whether they are on the parkway or wherever they happen to be. We need both, the shade tree and the wires. I will not go into detail on line clearance because I think it is a topic that will take too much time. I will say this about the line of clearance and the utility people. In the last 15 to 20 years the utility people have come a long way in line clearance and in pruning for wires. Most times they employ competent arborists to do their line clearance. Many organizations have sent men to training schools and had them trained in how to do top trimming for line areas. I think that is a wonderful idea because the utility people are showing an interest in the care and preservation of shade trees. Some highway departments are very particular about pruning along highways where there are wire using companies. They watch it very carefully. There are cases where it is a very difficult problem but they are working on it and collaborate with park and highway people and a very nice feeling is developing on line clearance problems.

If we think we need to lower the crown of a tree, it can be done in a mild or judicial manner without butchering. I have worked on trees where we go into the crown very high up depending on the size of the tree, and prune back some of the branches. Don't make a square cut. Make an angle cut to conform to the general contour of the remaining branch from which you are cutting. On an angle cut it will heal because you have a point below and above this cut where the sap comes up and will go around forming a callous growth and the cut will heal over. I have done some of that work and have seen it done where the tree still remains symetrical after the top has been lowered.

On some trees I don't even recommend that. If a tree is high and unsafe because of wind or sleet it isn't necessary to go in there and cut the top out of it. The tree can be cabled by going high up in the crown and cable it together branch to branch. I might mention also, in a program of that kind you certainly do not put a wire or cable or hook around the branch. It

should be through the branch and draw it together. By cabling you make the entire crown of a tree a unit in helping to support itself. In other words, you won't have one branch out by itself to resist the elements but tie it with others. That is cabling. So try to avoid topping. Its not good for the tree and there are other ways to handle the situation.

Here is something else about pruning and it comes within the three reasons of beautifying, safety, and preservation of the plant. That is, a tree that has a lot of dead branches on it. A tree having a lot of them certainly is not safe from the standpoint that those branches are apt to fall on some one who is passing underneath them. They are harbor for insects and fungi and they drop out after being in there a long time by rotting off from where they are attached to the tree. If the branch is left the sap continues to flow and it will try to form a callous growth around this dead branch as it would normally. Eventually the branch will fall off leaving a hole in the trunk of the tree or the branch from which it fell. It certainly is not a pretty thing to see. It isn't safe, and isn't helping the tree. Wood decay fungus starting in those spots can work into the main trunk which later may call for surgery. That can be prevented by having the tree pruned before decay starts. Many times in proper pruning we can cut behind the decay making a smooth cut and the callous will grow over. Of course, it should be painted. Removing those dead branches and making cuts flush is something to remember in shade tree pruning and shade tree care.

I would like to say more about flush cuts. I know you have seen pruning jobs where some one has left stumps anywhere from two inches to two feet long, it looks bad and certainly is bad. There is no reason for leaving stumps. It is just as easy to saw the branch off close as it is to reach out and saw it off leaving a stump. As I said before the sap will not flow out to the end to form a good heal. If it does heal over, as in the case of a short stub, decay may start and keep on working. I have seen that quite often. If you try to correct that situation it means digging out the decayed wood and if the cavity is large enough it will require bracing and filling with cement. I have a very good friend in the National Shade Tree Conference and also the National Arborist Association who does not advocate cement fillings. A lot of cavity treatment can be eliminated by proper pruning and proper cutting. If we do have to do cavity work, it certainly is not economical from the client standpoint

because it takes a lot of time and the way the labor situation is now a days, the less of what we have to do, the happier we are. Making cuts flush and eliminating stumps is certainly very important to remember in shade tree pruning.

Another important factor in pruning is painting the pruning wounds. Most of us in the field do not leave a cut unpainted if it is more than one inch in diameter. In doing that you prevent a certain amount of check in the wood, keep out the weather, and a lot of tree wound dressings do have a disenfectant in them to help prevent wood decay fungus. What kinds to use is not too important. However, we recommend not to use anything containing a great deal of creosote. It is a good wood preserver but it will kill the cambium layer. That is a very thin, almost microscopic layer between the bark and the sap wood. That is the healing layer.

Let's talk a little bit about the correct way to prune a shade tree. After seeing some shade tree pruning done over the years, I just wonder how some of these operators can stay in a tree and still do a job. There is more or less a prescribed way of doing it. Most of us safety ropes which will enable us to get across the tree very easily. It will help to work this tree and will certainly save you from falling out and breaking your neck and necks are hard to get these days. A saddle of some kind is used. A good pruning saw is also used and Iam not thinking of a carpenters saw. There are special pruning saws made. I am sure some of you have seen them. A pole pruner is another good tool to use. I have seen them anywhere from 6 feet long to 16 feet long. I still maintain that if a man in a tree can't get within 8 feet of that little branch he wants to cut off, he shouldn't be in the tree. I usually operate with a pole 8 or 10 feet long. Those are standard tools and you are all set to go into the tree. Providing of course you have the knowledge of how to use them.

It takes a little time to undercut a branch you are going to drop off and then cut it down from the top and it will jump out clean. If you have a long branch and start cutting without first making an undercut, it will tear the bark down and it will take a long time to fix that. If you have a branch that is too big and don't want to tear up the turf, lower it with a line. I think pruning is one of the simplest things in shade tree work. Of course, you must have tools. I mention this to you because there is a shortage of good tree men, and it might be difficult for you to get an ar-

borist. I think in some cases if you have some slack time, you might be able to coach a man or two of your own to do your pruning. I like to hold it to pruning. Don't let them go in a tree and start cutting out cavities, because it requires a lot of experience and they may do more damage than good. But I think you can do your own pruning. I think some fundamental training will enable you to do a little of your own work. You must remember safety, beauty and the preservation of the plant.

Here is another point and I think it is something to consider. Trees can be pruned for vistas. I don't play golf and don't know too much about it. Nevertheless, possibly on some golf courses you can create a beauty spot by pruning out a vista or a view. You may have a spot you want to play up. Possibly you may have to do some pruning to get more air or sun on a green. I think that can be accomplished by judicial type work, and not severely cutting up the trees. There are a lot of ways you can prune it. In some cases we have gone in and pruned trees to eliminate wind resistance.

Many times we find old shade trees that have branches crossing and rubbing together. The friction has worn it until you have a cavity and one branch breaks off leaving an unsightly hole in the tree or the wood decay fungus gets so bad that both of them break off. Things like that can be eliminated by proper pruning when the trees are small. Sometimes in order not to leave that unsightly hole by cutting off one of the branches, we can go in and spread the branches apart by putting in safety cadmium plated rods.

You may wonder when is the best time to prune. I used to know an old forester from Michigan who said to prune when the knife was sharp. I think he had something there. I see nothing wrong with winter and fall pruning. The only thing that goes wrong sometimes is in winter, when it gets cold and freezing and the wind is blowing. I think it is wrong for me to be up in the tree. But other than that as far as the plant is concerned, you can prune any time. In dormant periods you have the general structure of the plants. You can identify the dead wood from the living because the living has new buds on it and the color of the bark is different.

As far as sap flowage from cuts, it might even be better to do late fall and winter pruning on some trees than in the spring. I am thinking now about the maples. About the time they begin to bloom in the

springtime when the sap becomes more active and the leaves begin to break open, you will get an excessive sap flow on some trees. If that sap doesn't dry up within a period of a few months, you will get as a result what we call wetwood. It is still an unsolved problem. It will form many times on American elm. Below the cut a slime ooze forms. The sap will come out from the center of the cut, run down the bark and when it contacts the air, usually forms an acid or a killing agent that will kill the new bark that tries to heal over this cut. Along with that it will granulate and get cursty. Over a year or so it will get white and very unsightly. It is even seen after a branch has broken off. I have also seen it happen as a result of machine injuries on the trunks of trees. The pressure that is created inside the tree will be released through the opening. It is very difficult to paint cuts when the sap is running because paint won't stick. That is one thing to think of in spring pruning.

You also find slime flux in wet crotches in American elm tree. There again here are some corrective pruning thoughts. I don't think you get crotches if they are properly pruned when they are young. You can more or less train them to be almost a straight stemmed tree. If these are left in and if the tree gets larger and heavier, it will split open and you will find the slim flux coming out there.

I'm sure I spoke longer than the time I was allotted and I apologize for it. I like this work so well that I sometimes don't know when to stop talking about it.

Before I close I'd like to leave with you this brief summary on Shade Tree Pruning. Avoid leaving stumps. Don't tear down bark by making improper cuts, and don't leave unpainted cuts. Don't have the trees topped if, it is possible to avoid it. Prune out interfering wood, preferably when the trees are young and small. If you plan to do any of your own work be sure you men are careful and have had a little training. Safety is an important factor, and we don't want to injure anyone.

You have been a very kind audience and I have enjoyed talking to you. Thank you very much.

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MAINTAINING PLANTINGS AROUND BUILDINGS

Ray A. Keen
Department of Horticulture
Kansas State College

No doubt all of you men who have charge of grounds, be they golf courses, cemeteries or anything else, have some plantings around buildings, that are composed more or less formally. You have to take care of those plantings as a sideline to your regular job. The same is true here on the campus and that job happens to be my headache. Both you and I have to do that job on what seems to be a minimum budget. To many people these things are not very difficult, nothing much ever happens to those plantings. But any one of you who is taking care of such plantings is quite familiar with a variety of troubles; many of them difficult to diagnose.

(Following this introduction Kodachrome slides were shown illustrating many common and unusual maintenance problems and possible solutions were offered.)

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MAINTAINING TURF IN PARKS AND PLAYGROUNDS

John G. Firsching
Wichita, Kansas

Good maintenance is good management. Invariably most of us entertain the idea that we must stress technical knowledge. For the past few days of this conference you have heard many fine speakers. Subjects pertaining to maintenance, namely, fertilization, watering, renovation, equipment operation, weed control, etc. were thoroughly discussed by some of the speakers who preceded me. These speakers are, without doubt, more competent in their individual technical subjects than I could ever hope to be.

Therefore, since most of the basic technical subjects have been thoroughly and efficiently covered, one may be left with the impression that nothing remains for me to discuss as pertains to the topic assigned to me. Actually, I could easily say that I have nothing to talk about and thus avoid prolonged agony and take my

leave from the platform at this point. This is far from true. Technical knowledge is important. You must have some of it and develop the technique to obtain additional technical information as required from the best sources. A most important ability, but one which is usually lacking in supervisors is now required for the best results. This is the ability to screen the technical knowledge and resources at a hand, and put these into efficient operation. It is my firm belief that a good supervisor, a foreman, or even a straw boss must possess a combination of technical knowledge and administrative ability. In this brief discussion, I will hit only on some of the techniques employed. Please be assured that there are many more.

Yesterday Bruce Harris gave an excellent talk. His mention of keeping in mind the subject of maintenance when designing a golf course is worthy of reiteration. A maintenance supervisor should consider it his administrative duty to make recommendations to the designer in regard to preventative maintenance. It is advisable that the supervisor, in making his recommendations, consider the opinions of every man under his management. Then he will be less liable to overlook some important points. Who is more familiar with maintenance problems than the man who has them? The initial design should give a lot of thought to the adtual problems that may come up later on maintenance.

There are times when a maintenance supervisor must conduct some research. I am not referring to the research conducted by Colleges and Universities. That type of research would be ridiculous for a supervisor to undertake. In the first place, he doesn't have the time, training or facilities. He must take the research information obtained from the colleges and universities and test it on a small scale to find out whether he can apply it to his conditions. If it works out satisfactorily, he may then put it into operation on a well organized program.

Many of us are extremely conceited in regard to our retentive powers. We seem to feel that we can pack all of the information as to our job into our heads and draw upon any portion of it whenever we need it. I doubt very much if many mortals have that ability. If such an individual exists, the information he retains in his head will in all probability lack organization. The accumulation of statistical data written down in good form and not jotted down on numerous pieces in paper, such as the inside of match boxes, etc. is invaluable to the supervisor. This statistical data

will give him an idea of what he has to do and how he can improve his operations. This information will also be of inestimable value to him and tothe man who succeeds him if written up into a sound "Standing Operating Procedure". There is nothing I detest more than to accept a supervisory position wherein I am forced to guess as to the operation of the man or men who preceded me. Not only will this lack of written information embarrass me, but it will also delay or even retard progress. Surely, the man or men who previously held this position had some or many good methods of operation which could be continued if known. Particularly, in regard to policies, any sudden change could be most drastic to the entire organization.

Have you ever tried to supervise a job and obtain satisfactory results when you did not have the full cooperation of all of your employees? All of the technical knowledge in the world would be of little value on any job if the supervisor does not have all of his men behind him. Therefore, good personnel management or knowing how to handle men is important. Earlier, I hinted that every man under your management should be allowed to make recommendations. To go even furthur, they should play an important part in formulating your plan of operation. They should know what you expect to do first. Then their recommendations should be given consideration in making up the plan to accomplish the job most efficiently. Try asking for comments, suggestions or recommendations of your gardeners, laborers, tractor operators, etc. You will be surprised how much you will learn! Sometimes you may run across an employee who is a bit reluctant to get behind you on a project, one you are absolutely sure is worthwhile. A technique may be employed here by temporarily dropping the discussion, and in a few days are so indirectly make him feel that it was his idea. He will then cooperate with you one hundred per cent. Remember, that a man is a man and don't try to treat him any other way.

I have observed many supervisors, and I have been guilty of the same, start men out on a different job each morning. These men did not know from day to day what their resposnsibilities were. They were given no opportunity to think for themselves. They merely worked by the clock and did not care a plugged nickel how the job theory were assigned to was done as long as they could say to their supervisor or foreman, "It's finished". But how I Have you ever thought of merely telling a man that he Had a definite job to do? that he should start out doing it as was done before ? That

he will be on his own, and not forget to inform him that if he has any ideas how to more efficiently perform his job to be sure to let you know?

Consideration should also be given to programs, schedules, reports, inventories, etc., in order to acquire the best results. Your overall plan of operations should be flexible in order to make modifications in the plan without having to revise the whole plan.

There is much more that can be said in regard to the angle from which the topic "Maintaining Turf in Parks and Playgrounds" was approached in this discussion. If I have merely given you some encouragement to review your management practices and strive to develop your administrative ability, your time, as well as mine, will not have been wasted.

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MAINTAINING TURF ON ATHLETIC FIELDS

Harold W. Glissmann
Boys Town, Nebraska

I am going to talk to you a few minutes about athletic fields. If I were to start out tomorrow to build a new football field, the first thing I would do is to see that it was properly graded with the proper elevation and the proper drainage. Then I would install a water system if I could. I would then start to prepare my soil. We have had a lot of conversation on proper soil preparation so we don't have to go into that too far. I am an ardent believer in the heavy side of fertilizing and especially in the preparations of seed bed.

Our football field at Boys Town I am quite proud to say it is one of the nicest football fields that I have walked on. In respect to Dr. Grau and our college when we built our football field we were pretty hot on Highland bent. There was 10% Highland bent put in and we are sorry it is there. Nevertheless, in the football field constructure we did put a nice crown in it. You can't do it by eye. It is 360 feet long and 150 feet wide and it is a little hard to do that without the proper stakes. We prepared our soil with humus, organic matter and fertilizer.

I think if you are going to go and build anything as big as a football field it is going to take some planning. I think a season planning should be in the construction of anything like that. In this part of the country and especially up in our part, don't try to do anything as big as a football field with spring planting.

I just finished a cemetery of 60 some odd acres and didn't get too much compensation for it. I did kick it around for over a year before I would seed it because it wasn't ready. I did not want to apply fertilizer and seed and know that it wasn't going to make a stand of grass. I do have a stand now. We all should plan to work our soil during summer if possible and get it ready for fall planting. Once you get the area ready and seeded, I don't care if you use Merion bluegrass, creeping red, Alta fescue or what have you. This is what I would use 50% blue or Merion, 25% creeping red fescue and 25% Alta or Kentucky 31. This is what I would use, not what you fellows need in your locality. Once you get this seeded, I would keep it wet. That is work, but it really pays off.

If you get it up, don't do like too many small towns do with the football fields. They get it seeded and forget about cutting. We all know we can't take too much grass off at one time and be successful. A good football field or a good baseball field is not different from a front lawn. It is just bigger, used harder and consequently it takes more work. When you have an area that you have sold somebody a bill of goods on, to spend as much money as you intend to spend, you have failed if you haven't already thought about what it is going to cost to maintain it. You can't mow it every week but must mow it about every four days. Any nice turf should be mowed every four or five days.

Once you get any football field or athletic in play you have the trouble of compaction. We know we have that on football fields because they practice in all kinds of weather. Once you get the field in use you must aerify it. You need aerification not only on a football field but any place where people walk because you can save water and grow better grass. Fertilize it. You should know how much it needs and when it needs it. This goes for water as well as fertilizer.

The first thing we want in an athletic field is color. Kids don't like to play on brown grass or dirt. If you do have trouble, don't hesitate going into a renovation program in the spring. You can do that quite

cheaply. I think the dormant renovation program is the answer to the football field. A baseball diamond is different because the season is over in September. We at Boys Town are going into an extensive dormant seeding program. We tried it on a small scale against spring season planting this last winter. This spring where we couldn't get to work until nearly June it worked out very well. Prepare the ground after the football season. Work the ground in some way, get some fertilizer and seed on there and get in into the soil in some way. I know you will have a better turf next spring than you will have if you get in there and work it in the spring. In the spring the ground will be wet, and you will be working when you should not be on it under any circumstances.

It all comes to one end whether it is athletic fields, home lawns, greens or fairways. Have a plan and work toward it. Be reasonable about your decisions because your boss or employer may cut you off. If you talk things over, know what you are talking about, you will get the money. At least I always have been able to.

This is the first operation in the preparation of new football fields. That is a D-7 caterpillar tractor with a 6000 pound, 24 inch tandem disk. This is about the second or third time over getting ready to get it smoothed down to put in the water system.

The pet tool I have in my construction program is a spring tooth cultivator that I have altered somewhat myself. It has what is called "bull tongue" shovels. I can plow an area quicker with this than a plow. I can keep it level and get deeper penetration than with an ordinary gang plow.

This is just a picture to give you some idea of the growth when we started. If you have a football field or playground that is open, and has no protection from the wind during the winter I would erect a series of snow fence across the area to cut down the wind and help to keep what snow falls on the field or playground.

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NEW AND OLD SPRAY MATERIALS FOR INSECT CONTROL

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Department of Entomology
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We like to think in Entomology that we are a progressive group and in this connection there probably is nothing more startling than the recent development of insecticides and the accompanying improvement of insect control in many instances. This talk will deal with four major categories. The first will be those insects that attack lawns, golf greens and pastures. Included in this first group will be some soil infesting forms and some above ground pests. In the second category I should like to say something about insect attacking shade trees and shrubs since I feel that some of you may be confronted with control problems on these plants. Third, I want to mention briefly those insect pests found in and about buildings. Last I would like to say something about insects that attack and annoy man. The major emphasis will be on the type of injury and control of the insects involved.

INSECTIDES

You are all familiar with many of the insecticides by name. Materials which are in the "new" category are DDT, DDD, methoxyclor, lindane, chlordane, toxaphene, aldrin, parathion and allethrin, a synthetic compound similar to pyrethrum. Many control measures are still carried out using older materials such as arsenicals, cryolite, pyrethrum, nicotine, and rotenone. We are dealing in this particular field with a large number of materials both old and new. We are forces to use a specific chemical for a particular job. In addition, we find various formulations for these materials. Many insecticides are formulated as oil solutions, dusts, wettable powders and emulsifiable concentrates. The point I want to emphasize is that you must know pretty well what materials are going to do the best insect control job. In general, if you read the directions on the label of each insecticide formulation, you will have answered most of the problems that arise in connection with using these materials.

INSECTS THAT ATTACK LAWNS, GOLF GREENS, PASTURES AND HAY GRASSES

In the first category are those insects that attack lawns, golf greens and pastures. I have selected the problem of ants first. Time does not permit a detail-

ed description of the various species of ants which are troublesome in various parts of the country. In general, ants are troublesome because of their habit of making a large dirt mound and destroying the grass in this area. Fortunately, we have a new development in controlling ants. We are able to use chlordane very effectively. For instance, as little as 1/8 of a teaspoonful of 50% wettable chlordane powder in each ant nest or introducing a 0.25% chlordane emulsion or a 5% dust into the main gallery of each nest will generally eliminate the problem for that particular nest. Sometimes you may encounter a generalized infestation over a rather large area and in this case it is possible to affect control by using from ½ to 1 pound of 50% wettable powder Chlordane in 100 gallons of water over each thousand square feet. Aldrin and Dieldrin have also proved to be very successful control agents against ants and have been used at approximately one-half or less the rate just mentioned for Chlordane. I feel in these new materials there is a solution to most ant control problems.

Next, I should like to talk about cutworms. As was the case with ants there are a great many species of cutworms. They generally tend to eat off the plants just above or a short distance below the surface of the soil. Subterranean cutworms feed on the roots and underground parts of the stems. Those species that attack the plants at the surface of the ground can be controlled by using a poison bait similar to that used for controlling grass hoppers. In general, the poison bait should be applied in the evening. It is also possible to use insecticide dusts of some of the insecticides. Dusting plants on which cutworms are feeding, with a 5-10% DDT or DDD, 2% lindane, cryolite, or calcium arsenite has also been effective. Unfortunately, in the case of those cutworms that feed below the surface of the ground, we do not have a really effective control. However, treating the soil with chlordane as described for the control of ants or white grubs may be of some value in controlling the subterranean species.

A third group of pests in this first category are webworms and particularly the sod webworm. Webworms tend to cut off plants near the surface of the ground in much the same manner as where attacked by cutworms. Webworm control has been reported by using such materials as DDT from ½ to 1 pound per 1000 square feet of area and chlordane or parathion from ½ to ½ pound per 1000 square feet. These insecticides should be applied to the upper three inches of soil in constructing

a new lawn or as a spray or dust to establish sod. Aldrin has shown promise as a chemical control agent for webworms at the rate of 2 to 4 pounds per acre of actual aldrin. Lead arsenate, pyrethrum, and carbon disulfide have also been used in various ways for controlling these insects but would appear to be a second choice.

Last on this list of important pests that live below the soil are the white grubs. Grubs are probably the most destructive of all soil insects. They tend to feed below the surface, eating off the roots of the plants. There are several species of white grubs having different lengths of life cycles which tend to complicate the control picture. The chemical controls for white grubs are very similar to those listed above for webworms . DDT, chlordane, and lead arsenate have all been effective when applied to the soil. At rates of up to 10 pounds of actual chlordane per acre there has been no noticeable injurious effect on common grasses. Experiments have shown also that when chlordane was applied to the soil the effects have lasted for several years.

There are many other pests in this category, but I have tried to mention the ones that are most common. Other pests that are troublesome in various areas from time to time include: wireworms, the green June beetle, billbugs, the Japanese beetle, and the Asiatic garden beetle.

Next I should like to mention some insect pests that work above the ground. Chinch bugs, including the false chinch bug, a closely related insect frequently mistaken for the true chinch bug, are very serious pests. Chinch bugs have been known to injure severely lawns and golf greens due to the fact that when they occur in large numbers they can move into these grassy areas and literally suck the juices out of the grass. Chinch bugs are believed to feed only on plants of the grass family. Chemical control measures that have been used against chinch bugs include barriers of creasote and 2-8% 4, 6-dinitro-cresol, using ½ to ⅔ a pound of the latter dust per rod of barrier. These barriers are used to trap the bugs as they migrate on the ground from small-grain fields to grasses such as corn. Where a large number of chinch bugs have concentrated in a small area, spraying or dusting the area with nicotine sulfate, 10% Sabadilla in lime, 4% dinitro dust as above, or 5% DDT may be effective.

A second insect pest that feeds above ground is the fall armyworm. Like the army cutworms and the true

armyworm this insect often develops the marching habit, the caterpillars crawling in great droves. They will eat the foliage and tender stems of many plants, often eating everything clean as they go and then they disappear suddenly. Plants of the grass family are probably their preferred food. Parasites are nature's own way of taking care of these pests. If the parasites are not doing the job, chemical controls may be necessary. Lawns can be dusted at the rate of 20 to 30 pounds to the acre with any of the following materials: 3-5% DDT or DDD, 1-2% parathion, 1-3% lindane, 5-10% toxaphene, and 5% chlordane. Baits containing 1.5% chlordane or 3% Paris green can also be used. If sprays are easier to apply, the following materials can be used: 2 pounds of 50% DDT wettable powder or, 1½ - 2 pounds of 50% toxaphene wettable powder in approximately 40 gallons of water per acre.

I should like to discuss grasshoppers next. Here some very spectacular results have been achieved in the last few years through the use of these new chemicals and it is pretty generally accepted now that aldrin, chlordane, toxaphene, are standard remedies for grasshopper control. If sprays are used, as little as 2 ounces of aldrin, 3/4-1 pound of chlordane and 1½ pounds of toxaphene per acre should be applied. Baits can be prepared using even smaller amounts of these materials. A summary of how these three insecticides can be used from grasshopper control can be found in Program Aid 149, a leaflet published by the U.S.D.A. and obtainable from your extension entomolgist or department of entomology.

INSECTS ATTACKING SHADE TREES AND SHRUBS

Included among these insects attacking shade trees and shrubs are the bag worms. The bag you actually see on the tree is an overwintering depository for the eggs of the insects. One of the simplest means of control, if you have the time, is simply to hand pick and burn these bags during the winter months. That fairly simple control measure is frequently overlooked. A second effective control method is to spray the trees affected in the late spring or early summer, depending upon the locality, with toxaphene at the rate of 4 pounds of 25% wettable powder or lead arsenate at the rate of 6 pounds plus soy bean flour per 100 gallons of water.

Cankerworms are familiar to many of you. Some of you have probably used sticky barriers to trap the wingless females as they climb the sides of trees to lay their eggs in the foliage. These barriers are reasonably

effective but require proper installation and maintenance. Cankerworms feeding on the leaves of trees can be controlled by spraying with lead arsenate at the rate of 3 pounds or DDT at 2 pounds of 50% wettable powder per 100 gallons of water. I think that I should also mention that one of the very nice recent developments in cankerworm control is in the use of aerial sprays. As little as ¼ of a pound of DDT in oil solution per acre applied by aircraft has been very effective in killing cankerworms. Timing of spray operations, whether from the ground or air, to coincide with early cankerworm feeding is important. Proper atmospheric conditions are especially important in aerial spraying.

Fall webworms are frequently found attacking shade trees. DDT is an effective means of control for these insects using two pounds of 50% wettable powder per 100 gallons of water and spraying this suspension onto the foliage of the trees.

The walnut caterpillar is seen in numbers in this area. The caterpillars tend to form webs among the branches and strip the foliage off the tree. This insect seems to be quite susceptible to DDT. Spraying trees with 4 pounds of 50% wettable powder in 100 gallons of water has been an effective means of control.

I want to mention a few scale insects found on trees and shrubs that may be troublesome to you. The oyster shell scale is known to a good many of you. Here the eggs overwinter under the little scales. In the case of the European elm scale, the nymphs overwinter. Scale insects have many natural enemies. When spraying is necessary, the dormant oil sprays containing 3 to 5% oil have been very effective. The European elm scale requires the same sort of treatment except that 16 pounds of 50% DDT wettable powder per 100 gallons of water has been recommended. Spraying should be started about a month after the first eggs have been hatched. Several sprayings with a 2% summer oil emulsion, nicotine sulfate and soap, or2 pounds of 50% DDT wettable powder per 100 gallons of water have also been effective against the "crawlers" or newly hatched nymphs.

INSECT PESTS IN AND ABOUT BUILDINGS

Many of you have been confronted with the problem of controlling insect pests in and about buildings. Some of thesepests include boxelder bugs, ants, termites, silverfish or firebrats, cockroaches, clothesmoths,

and paper nest wasps. Boxelder bugs are rather difficult to control. Various things have been used. Hot water washes have been effective in some instances. However, some of the newer insecticides, especially chlordane, have been effective. Ants have been very easily controlled by the use of chlordane as mentioned above. Termites are a perpetual problem. Here I would like to recommend that you refer your problem to a termite control expert. Effective termite control usually involves a great deal of labor and most people do not have the time and knowledge to do a good job. Silverfish can be controlled by various poison baits, dusts, and sprays. Chlordane and DDT control cockroaches well. Chlordane is the treatment of choice for all roaches and DDT has also been effective for controlling the large American roach. Sprays of DDT, methoxychlor, and chlordane have been effective for clothes moths. Paper nest wasps have been controlled by spraying the nest and surrounding area with chlordane. Unfortunately, time does not permit more detailed statements of each of these control measures. Again, I strongly recommend that you read the label on the product you buy since specific instructions are included there.

INSECTS THAT ATTACK OR ANNOY MAN

In the last category are the insects that attack and annoy man. As in the case of the preceding group, I shall take time to mention only the pests involved in this category and a brief statement of chemical control measures that are available. This list of pest includes mosquitoes, black flies, blackwidow spiders, fleas, ticks, chiggers and flies, but particularly house flies. In controlling mosquitoes, their breeding areas must be eliminated. To control the adults, you can use residual sprays of DDT and aerosol "bombs". Black flies are not generally so troublesome in this area. Good control of black flies has been achieved through the use of DDT applied to the areas where they breed. Black widow spiders have been controlled by spraying with chlordane and also DDT. Ticks and chiggers have been more of a problem. If you are working in an area where ticks and chiggers occur, you can apply repellant chemicals to your clothing and body. I want you to think of a repellant for yourself. DDT and benzene hexachloride (BHC) have been used for spraying in areas for tick control.

Chiggers should be of some interest to you. Here again we can report advancements in their control. In addition to the use of repellants for personal protect-

ion as mention above, it is now well established that chiggers can be controllad very effectively by spraying or dusting lawns and grassy areas with chlordane, toxaphene, or lindane. Some of you might be interested in the amounts of these materials. They can be used either as a spray or dust and in either case the chlordane and toxaphene should be applied at the rate of two pounds per acre and lindane at the rate of ½ of a pound per acre regardless of the amount of diluent.

These chemicals have provided chigger control for periods of from one to two months after application.

House fly control is helped by using screens and practicing careful sanitation. Residual protection has been achieved by using sprays of DDT, methoxychlor, and lindane for the most part. The recent development of flies resistant to DDT and similar chemicals in certain areas may force us to pay stricter attention to all the aspects of fly control and not rely so heavily on chemicals for control.

HAZARDS ASSOCIATED WITH THE USE OF INSECTICIDES

I have made no mention of the hazards associated with the use of these insecticides. Most of these materials are not hazardous to use if used correctly. The most hazardous material I have mentioned is parathion, and if you are going to use it, you should always observe the well publicized safety requirements. Some of these elements of safety include the use of a respirator or gas mask depending upon the method of use. Protective clothing, goggles, and rubber gloves are also needed. The other materials should be used with reasonable care. Avoid getting oil solutions on your skin. If you do, wash them off promptly. Avoid inhalation of sprays and dusts as much as possible.

Another consideration you must keep in mind is the effect of insecticides on trees and man and animals. Here you should observe certain precautions with regard to the use of formulations that cause the least harm to foliage. Dusts and wettable powder are generally safer than emulsifiable concentrates and oil solutions. Avoid applying insecticides to flowering plants to avoid killing bees. Due care must be given to the use of these insecticides around small children pets, and pools containing fish.

INSECTICIDES AND THE SOIL

Another thing I want to mention is the effect on the

soil from these materials. Several of these insecticides are quite stable chemically. They do not break down or decompose rapidly. DDT and lead arsenate are excellent examples. If you are applying these to the soil or in such a way that they fall or are washed onto the soil, you can expect a gradual build-up of them in the soil. In some areas where you are using these materials this might be an objectionable feature. This accumulation affect need not be a serious factor, particularly where the materials are applied to grass sod.

This talk has touched on only a few of the insect identification and control problems you may encounter. I should like to leave you with an invitation to consult your State Department of Entomology and extension entomologist associated with the State Agricultural Experiment Station and the Federal Bureau of Entomology and Plant Quarantine. The people associated with these activities are happy to serve you.

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CULTURAL PRACTICES AND TURF DISEASES

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The discussion about turf diseases must be directed toward bentgrass greens because that is where diseases are most prevalent. Fungicides are needed and they must be used. However, their effectiveness depends in some measure upon management practices. At most clubs greens are treated regularly to prevent attacks of disease. It is far easier to avoid than it is to stop or courses where cost is a considerable item, they do not treat regularly but keep alert and treat promptly at the first sign of disease.

In my travels I see courses where disease is extremely bad and where the efficiency of fungicides is questioned. Yet at a nearby course across the road disease is much less of a problem despite the fact that climate and soil are identical. It emphasizes the fact that management is an important factor.

To conserve time I will briefly outline what the pictures will show. Climate affects disease in several ways. Where the weather stays cool all season the

principal disease is dollarspot. Brown patch is seldom a problem. There the fertilizer practices should be designed to supply nitrogen to prevent serious attacks of this disease into dollarspot areas where you must be on the alert for dollarspot. Where spring and fall are the only cool seasons and summer months are hot and humid brown patch is apt to be bad in July and August. Less nitrogen should be used then to reduce the likelihood of severe attacks of brown patch. Some grasses are relatively immune to disease of all kinds. Others are more susceptible to one kind of disease and resistant to others. The old example is the Metropolitan and Washington bent. Metropolitan is much more susceptible to brown patch and more resistant to dollarspot, whereas Washington is much more immune to brownpatch and is much more susceptible to dollarspot. Mention was made by the first speaker yesterday about the relationship of crops and diseases. A strain of wheat is developed that is quite resistant and then newer organisms come into the picture and it is necessary to get new strains. We have the same situation with grasses although most of them that have been good grasses have stayed that way and have stood the test of time.

Soil is extremely important because of its effect on the moisture relationship. There are two courses near Hartford, Connecticut where snowmold has been a serious problem. Attacks have been bad when other courses had no trouble. In my opinion the reason is the larger amounts of organic matter in the greens. Both clubs used top dressing with high percentages of organic matter so that the greens became almost peat bogs. As a result, the surface stayed wet during the spring. The fact that it did not dry out favored snowmold. Since they have changed top dressing practices, snowmold has been less of a problem with them, and fungicides have given control.

Then there is the problem of lime usage and soil reaction, fertilization and watering. When we think about feeding fertilizer has often been blamed for troubles actually due to faulty use of water. It is important to provide enough phosphorus and potash to take care of the minimum requirements. Incidentally potash tends somewhat to offset the tendency of nitrogen to develop weak structure. Then fertilization becomes a matter of nitrogen. In Milwaukee nitrogen levels are kept pretty uniform throughout the season. By doing that dollarspot has become much less of a problem. Leo Feser, in Minneapolis and Les Verhaalen, in Milwaukee have not used any fungicide during the

summer for several years. They have gotten by very well because they use management practices which are producing good turf.

Where brownpatch is a menace, it seems to me less nitrogen should be used in hot weather. Dollarspot is a disease which is encouraged by too little as well as too much nitrogen. For brownpatch this is not the case. A high nitrogen level encourages it. Then we have the problem of chlorosis due to a temporary shortage of iron. It is apt to occur during wet weather especially on heavily humid and over phosphated greens.

This is a picture of a green in Manchester, New Hampshire. Had I taken the picture without the snow, I could have told you it was an attack of brownpatch and you would not have disputed the statement. The grass underneath the snow is just as green as it normally would have been in July. As the snow disappears the snowmold takes effect and the grass turns brown. I was are excessive amounts of nitrogen had been used in the late fall and questioning verified the fact. They applied 8-6-2 at 20 lbs. per 1000 square feet in October. Snow came in early November and stayed until March. You can see what happened. I don't think any fungicide would have stopped the attack.

The next picture is one showing control of snowmold with Calo-clor. The grass was treated right out to the slope. Notice how effectively the fungicide was in preventing disease. The turf on this green was allowed to harden off before winter.

The next picture shows some plots we had in Milwaukee. The three strips got phosphorus and potash. The purpose of this picture is not to condemn sulfate. Calo-clor was applied once a month from spring until fall, with the last application in mid September. On the no nitrogen there is no snowmold even on the check plots. The next picture is a close-up showing the effect of nitrogen so far as disease is concerned. On the Milorganite fertilized series there is plenty of snowmold on the plot that got no Calo-clor, one spot where one ounce was used, none on the two and four ounce rates. Notice that even the 4 ounce rate didn't completely control the snowmold where sulfate was the source of nitrogen. The reason is that the last treatment was made at a time when the sulfate of am continued to work. It kept the grass green until snow came.

The next picture was taken many years ago in Winnipeg. I was called there because a tournament was to be played on this course. It looked like the grass would be very slow in coming back. I told them I thought they had had very little snow that winter and high drying winds. This is an example of wind burn injury due to shallow roots.

The next picture shows a similar situation in Milwaukee. The drying and wind burn is occurring on the high parts of the green. When these greens came out of the winter, it looked like they would be all right but in two or three weeks the grass turned brown. The turf was shallow rooted because of heavy compact soil. Since Les has aerated, to develop a good root structure, he has had no more trouble of this kind. As I said yesterday, in the Minneapolis area it is customary to place saplings on the wind swept greens in order to collect snow and provide coverage for the winter. The blanket of snow prevents wind burn.

The next picture was taken about 25 years ago. It is at Merion Country Club. This is a turf nursery of Washington bent. When I got there, there was no dollarspot on this half of the nursery and on the right disease was bad. When I asked Joe what fungicide was used I was told that a good dose of lime had been applied on the left hand half about three weeks before the picture was taken. Here lime was as good as an application of fungicide. Just because I say that, don't get the idea that I am trying to tell you to throw lime everywhere. There are times when lime is very beneficial and occasionally even though the soil has a reaction above pH 7.

The next picture is of some plots at Rhode Island. I think you can see the strip in the foreground has been attacked by disease. It is copperspot. Although the velvet bent on this strip was badly hit there was no copperspot on the other strips. Lime was not used on the diseased strip. The others got increasing amounts of ground limeston.

The next picture is a fairway in the Chicago area which was badly hit by dollarspot. You can see the disease. This picture is of the adjacent fairway with almost no dollarspot. The only difference in management was the fact that an application of lime had been made on this fairway to see if it was needed by the turf.

The next picture was taken quite a few years ago in the

Chicago area. I think you can see the scars of dollarspot on this area and the almost complete absence of it on each side. The only difference between the two was the fact that when fertilizer was applied, the operator missed this area. Here we have an instance of a low nitrogen level making the turf more susceptible to dollarspot.

The next picture is one of a scalded green, in Kentucky. The copper sulfate being used in the swimming pool was blamed for the loss of grass. The plugs I took out showed that the soil was dripping wet. In my opinion it was faulty use of water.

Here is a picture of a rather bad green in the Detroit area. We had a trying summer in 1948. This green should have been a bathtub rather than a golf green. It is surrounded by high banks and is low in the center so surface drainage is impossible. The next picture is a close-up of the green showing the loss of grass resulting from poor drainage and excessive wetness at the surface.

This is a green in Grand Rapids in 1948. The grass isn't one of the better strains. I told the man I thought the green was better on a Friday than on the following Monday. The remark was prompted by the absence of roots under the grass. They had watered the green Friday night and expected it to go through until Monday. The grass wilted and died. The next picture shows a plug taken from the same green the following year. Because of bad soil conditions, I induced them to drill. Notice the long roots in the drill holes. With deep roots I am sure mid day syringing is not necessary.

I mentioned something about susceptibility of grasses. This happens to be a turf nursery at one of the courses in Akron, Ohio. In the background is metropolitan bent. This is a period when the two types of disease overlap. The Metropolitan bent had plenty of brown patch but no dollarspot. The Washington had plenty of dollarspot but no brownpatch.

The next picture is a mixed bent green. Notice that the grass in this area has no dollarspot whereas the other grass nearby is badly attacked.

This is a turf nursery in New York. Astoria bent is on this side and C-15 on the other side. Notice the complete absence of brownpatch on the left or C-15 side. This was in 1948.

The next picture is one that I took this summer and it is the first time I have ever seen any brownpatch on C-1. This is the experimental pie green at Louisville. There you can see brownpatch on C-1 or Arlington.

It is my belief that there are many reasons for avoiding a thickly thatched turf on greens. Aside from its effect on root development, when dollarspot hits a heavily thatched green, the scars are deeply pitted and the green looks as though it had small pox. The fungicides are not nearly as effective when there is a heavy thatch. The reason is that they probably stay near the top and the disease does its work underneath.

The next picture is of some plots which we operated during the war. We felt that nitrogen levels were important so far as dollarspot was concerned because fellows like Dave Bell who are heavy nitrogen users, seldom have trouble with dollarspot. Some men in New England fear disease and think fertilizer the principal cause. They starve the grass and are riddled with disease scars. They confuse dollarspot with phythium because there is no cure for it. There is no stigma for having a disease for which there is no cure. These plots got phosphorus and potash. This is the nitrogen and this is the no nitrogen strip. The nitrogen fed turf got 1½ pounds of actual nitrogen per 1000 square feet per month. The next picture is a close-up of the two strips. The scars are smaller and are less in number on the nitrogen fed plots.

We used the fungicide only once each month. It was applied on the first day of the month and the fertilizer was used on the 15 of the month. The spacing was rather severe so far as fungicide usage was concerned. This is a Calo-clor plot with nitrogen. The next picture shows the corresponding no nitrogen plots. You can see that the one ounce Calo-clorrate is not doing nearly as well as when used with some nitrogen. This happens to be Tersan. Notice that the use of nitrogen made more disease than the fungicide. With materials such as this applications should be more frequent than with some of the others.

The next picture is one which John Monteith gave me many years ago. This is from one of the plots where a calomel corrosive mixture was used at a high rate each week throughout the growing season. It was done to find out if mercury would build up in the soil to a point where it would adversely affect the growth of the grass. Treatments had not started that year before the first attack of dollarspot. Disease was bad

on the checks but not on the other plots due to the hold over effect of the calomel corrosive mixture used the year before.

The next picture shows a green in Cincinnati. It was taken last September. When I saw the first bad green I was not sure about the cause. It looked like brown-patch. The clue was found in this green. It is the first stage of iron chlorosis. It was so bad elsewhere that the grass had withered and turned brown.

The next picture is one that many of you have seen but it is an example of iron chlorosis on a green in the Detroit area. This was in the summer of 1948. I was told it was scald but from the yellow color where the grass was beginning to go out, iron chlorosis was unmistakable.

This is a picture of a man spraying a green in Miami where iron chlorosis was somewhat of a problem. They are applying about ½ of a pound of iron (ferrous) sulfate per 5000 square feet and not using over 20 gallons of water to the green. It is important when iron chlorosis is showing to place the iron on the leaf and not wash it into the soil. High organic matter content and high moisture seem to aggravate chlorosis; along with high calcium and high phosphate. I saw some chlorosis the week before last on a green where hydrated lime had been put on the outside edge. It was a direct burn where the hydrate was too heavy, and chlorosis around the edge.

The next picture is one which I have used before but I think it is only appropriate to use it again. It is a green in Springfield, Mass. The greens were all going bad. I felt it was a case of iron chlorosis. This green had been sprayed with iron sulfate the day before. A fertilizer bag was placed on this rectangular area. The grass is still yellow where it got no iron sulfate. Bill Daniel told me that he saw benefits from iron show in about 30 minutes on one of the greens in Louisville, when he was there in September.

The next picture was taken a short time ago in Pittsburgh. It shows iron chlorosis on a green. There had been some rains several days before. The areas where iron chlorosis is bad are velvet bent. This is a close-up of one of the spots.

In Cincinnati the course you saw in the first picture had used a little iron sulfate regularly all year at about ½ of a pound per green. When I was there Thursday of last week the greens were in perfect condition

and they had been that way all year.

When to water is a frequent question. If you overwater time does not matter whether it is at night or in early morning, so far as disease is concerned. I think there are more greens overwatered than underwatered. I was at Rutgers a short time ago. This is Ralph Engel who has charge of the turf investigations there. That morning I arrived early and when I reached the turf nursery, each one of the localized dry spots could be spotted very easily by the absence of dew on the grass. Besides lessening disease this is another reason for watering in the morning. Workmen can spot dry areas in the absence of dew. However, it is important to use water correctly. Turf diseases are caused by fungi. Contagious diseases that attack man are caused by bacteria for the most part. Fungi are water loving micro-organisms. I can illustrate that by the fact that you never see mold on stale bread. Fresh bread molds because of its higher moisture content. Watering in the morning destroys the droplets of dew and dries the grass. The use of a lot of water during the night is very bad in muggy weather. High humidity slows up direct evaporation of water and as a consequence the grass stays much wetter. It does not dry quickly as it should and disease attacks are aggravated.

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