LITIGATION

- Employee Responsibility - Consumer Safety

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In court cases involving people who are injured on public lands, about 65 percent of the defendants are government or university employees - a number that is rapidly growing.Thus landscape managers of public lands must be concerned about both employee safety and consumer safety, particularly from a liability standpoint.

To be safe, an employer must know his or her responsibility, accountability and communication process. Let's examine each of these terms and what it means to the landscape professional:

RESPONSIBILITY

Many municipalities or businesses avoid even thinking about safety. Legally, however it is becoming negligent to take this approach. Omission is as bad as commission in negligence.

Top level management, if not establishing a safety philosophy, must support the one proposed and assign it as policy to implement. Policies, tailored to the organization, define the goals and objectives of the 'safety effort'

ACCOUNTABILITY

Many municipalities or businesses don't

Of course you're not negligent. But in court, all of a sudden, you'd better be prepared to prove it!

know what is safe or what is unsafe, either for the employees or for the customers.

The organization must possess the following:

- A complete inventory of its property or plant, especially areas subject to public use. Standards for these areas must be identified.
- A complete schedule of its activities or functions that are subject to public use. Standards for such use must also be identified and associated with such public involvement.
- A complete record of all incident forms, accident reports, logs, inspection sheet, patrol reports, medical and insurance forms, safety audits, insurance memos and other fact reporting files.
- A file of outside agency reports and record forms so that police, ambulance, hospital and other records can be coordinated.
- A manual which contains the aforementioned items and minutes of the Safety Committee meetings, including action and implementation schedule for follow-up on concerns discussed. It should contain personnel information of the safety officers, guidelines for investigating accidents or other safety related problems.

COMMUNICATION

The communication system must include:

- Information: getting the awareness of safety to the public.
- Discussion: creating a means for feedback from the public.
- Negotiation: establishing win/win situations by responding, accommo- dating, attending to and following up on any type of incident or accident. Nothing is too small.

[Editors Note: This is a summary of the address by Dr, Mittelstaedt at the 1993 Guelph Turfgrass Symposium. Dr. Mittelstaedt speaks from the American prospective where the propensity for litigation is much greater than in Canada. Unfortunately we tend to follow the American lead; so prepare your defence by keeping a paper blizzard on file]

RUST EPIDEMIC STRIKES GTI

By late July an off colour became apparent on the five hectare planting of 16 different ryegrass cultivars on the GTI research area. The colour was reddish brown and dead tissue became evident among the plants as the condition worsened. Examination of the leaves showed reddish to orange leaf pustules covering in excess of 50% of the leaf surface. The infection became so severe a red cloud could be seen rising over the reel mower. At the end of mowing the mower was coated with the reddish-orange spores. Growth ceased by the 2nd week in August; a combined result of dry weather, lack of nitrogen and the disease which was now rampant over the entire area.

The disease was identified by Prof. Tom Hsiang of the GTI as rust caused by the fungus, Puccinia spp. Leaf, stem and crown rusts may occur, each the result of a specific species of Puccinia. While leaf and stem rusts may attack all turfgrass species except bentgrass, the crown rusts are more prevalent on perennial ryegrasses and tall fescues. The disease is most common on Kentucky bluegrass, particularly the cultivars 'Merion' and 'Touchdown'.

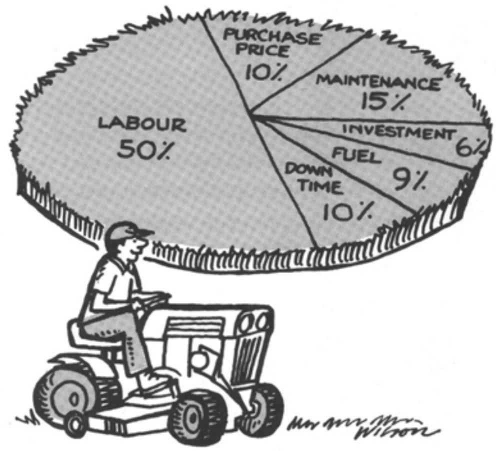
The complete life cycle of rust involves five distinct kinds of spores, not all of which occur on the grass plant. For example, common barberry is a secondary host on which the fungus spores overwinter. The spores are disseminated by wind and drift northeasterly, causing severe infections during warm, humid weather.

The appropriate control measure is good management, that is, maintaining vigorous growth through the use of nitrogen and water. The influence of nitrogen is related to the rate of vertical leaf growth. Rapidly growing leaves, although infected, are being removed by the necessary frequent mowings which essentially allows the grass to outgrow the disease. Adequate water is also necessary to maintain the rate of leaf elongation, thus irrigation may be necessary during the drier part of the summer. The return to cooler, more moist conditions in the fall generally result in a disappearance of the symptoms and a return of the grass to its original vigour.

Where infections occur which cannot be controlled by good management a preventative fungicide program may be necessary. Fungicides containing the chemical, Maneb, are recommended (see O.M.A.F. Publ. 162).

The disease seldom kills a turf stand, nevertheless, the reduction in photosynthetic tissue reduces the overall vigour of the turf. The occurrence of this disease on pure perennial ryegrass cultivars should be an alert to sports field managers that their management practices are lax. Where good management is practised - no problem! Where water is limiting or nitrogen rate and timing has been incorrect, a weakened turf may enter the high use period of the fall. Although the fall rains and a dressing of nitrogen may improve the cosmetic appearance of the grass, it will not be as robust and as resistant to wear.

Mowing Co$t Breakdown



Mike Bladon
Grounds Dept., University of Guelph

Grass cutting is the most time consuming of the maintenance programs conducted by a sports turf manager and the most important from the aspect of the appearance of a turf area. Proper selection of the mowing equipment is essential for success. Purchasing decisions are often reached without knowing the long term effect the equipment may have on your budget. This article addresses some of the factors you should consider before signing the purchase order.

Industry people say the *total cost per acre* should be the determinate to be employed in equipment selection. The total cost per acre is made up of several components; each will be discussed separately with an estimate of how much each component contributes to the total cost.

The Purchase Price (10% of the cost per acre)

A wide choice of models and designs are available. They may be classified into two basic cutting actions - shear or impact - and four systems - reel, rotary, sickle and vertical. The desired height of cut, the degree of contour following required (wooded, rough, swampy, hilly or formal), the type of vegetation, the desired finished appearance, each have advantages and limitations which should be considered.

The first consideration, however, is the productivity of the unit - the rate at which work is performed; usually in acres per hour. Published specifications generally indicate straight ahead mowing at average speed with no allowance for stops, overlaps, turns, trimming or manoeuvring of any kind.

In order to save money, but not necessarily cut capital costs, the unit must minimize time and labour costs: Does the unit have engine power to cut heavy grasses at high ground speed?; have trimming capacity?; float to avoid scalping?; have adequate traction and side hill stability?; have a sturdy frame construction?; provide operator comfort such as sufficient leg room, comfortable seats, automotive speed control devices to lessen operator fatigue?.

Maintenance Costs (15% of the cost per acre)

Depreciation, accelerated by new product lines, creates obsolescence. As a result there is little need to save old machines, even parts. Duration of the warranty and availability of parts and service for a new machine should be considered. Down time costs money.

During an eight year period , under normal conditions, 100% of the purchase price may be spent on the maintenance of a unit. Under severe conditions, as little as three to four years is required. Two kinds of maintenance are a given - 1) oil changes, blade sharpening, motor tune-ups and 2) engine replacement. Records are useful in determining the costs on a per hour basis and may serve as a basis for repurchasing a similar unit.

Remember properly adjusted belts, chains, bearings, and shafts will reduce friction, resulting in more power for more output per acre.hour.

Fuel Costs (9% of cost per acre)

Fuel costs equal fuel consumption X fuel prices. Over the life time of a machine the latter may change drastically and lead to an early consideration of replacement.

The type of machine should be matched to the application. Purchase the largest machine for the job that is practical. Larger mowers require less man hours per acre. Generally they are built for heavy duty use, are equipped with water cooled engines which run quieter and cooler and use less fuel per acre cut. They last several times longer than the equivalent horse power in an air cooled engine under demanding situations. The initial cost penalty of $1600, or more, may be saved in overhaul and replacement. However, if the machine is to be used for trimming the demand on the mower may not be so heavy and a lower horse power machine may be adequate.

With a sound preventative maintenance program, a hydraulic/mechanical system will give greater operator convenience and safety, will increase machine productivity and versatility and operating economy for rotary and reel mowers from 5 - 15 feet. Raising and lowering the reels and cutter decks by hydraulic power is less tiring on the operator and a hydraulic mower blade , set to turn at a selected speed rather than ground speed, can be energy efficient.

A hydraulic system delivers more power in a smaller package, resulting in reduce weight of the equipment and increase fuel economy. Tubes and hoses are easily routed to the point of need and are located more conveniently. The units are smoother and quieter in operation. Because of the reduced weight there is less compaction with its adverse effect on aeration, resulting in healthier turf.

Generally a hydraulic unit will require more horsepower per foot of cut to drive the blade. Bearings and hydraulic seal maintenance can be high. Nevertheless the limitations are outweighed by the versatility of a hydraulic unit.

Down Time (10% of the cost per acre)

Excessive down time may result due to poor equipment design, abuse of the machine and the incorrect use of light duty mowers. The result may be a high level of overtime and transportation costs and the bureaucracy of new equipment purchases. A significant part of the cost associated with down time is the disruption of the mowing schedule. The increase in inventory to offset down time is also worthy of consideration.

Labour Costs (50% of the cost per acre)

This is the highest portion of the cost per acre to cut grass. The cost may vary from minimum wage to over $16 per hour and depends on the geographic region. Labour costs include the time to load and unload or otherwise transport the mower and the fuelling and daily service of the mower which reduce the time for mowing although the operator is paid for an eight hour day. It is generally considered that only 6.5 hours are spent mowing out of an eight hour day.

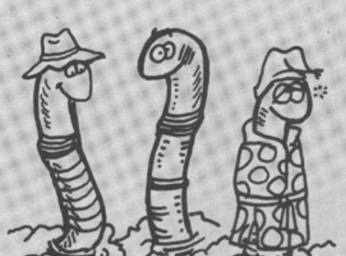
In addition to the base wage of the operator are the fringe benefits such as medical plans, pension schemes, workmen's compensation, federal and provincial taxes, educational and training allowances, and even safety shoes and hearing protection.

Investment Costs (6% of the cost per acre)

This is an allowance for the value of the money which could be invested and the mowing done by contract. Generally a mower will last for 8 to 10 years during which it will operate about 6,000 hours.

GRASS CLIPPINGS

Although 7,000 species of earthworms have been identified in the world, only three, the garden worm, the red worm and the night crawler are the most common types. Earthworms do not feed on living plants but are effective in reducing the accumulation of organic residues on the soil surface. Thus pesticides which reduce earthworm populations result in increased thatch accumulation.



GTI RESEARCH HILITES

The efficacy of many insecticides depends on the placement of the material relative to the zone of activity of the insect. An example is the control of the European Chafer whose larvae or grub feeds on the crown and surface roots of turf species. Insecticides left on the surface are not effective, therefore a system for moving the material into the active feeding zone is required.

The most common system is to water the insecticide in, but often insufficient water is applied to move the material to an adequate depth or an irrigation system is not available. The presence of a thatch layer increases the difficulty of moving the insecticide downward.

Prof. Mark Sears of the Dept. of Environmental Biology examined subsurface injection systems for the placement of insecticides below the turfgrass thatch layer for the control of the European Chafer at two locations in 1992. Prof. Sears applied emulsifiable concentrates or flowable formulations of Diazinon and Chlorpyrifos (Dursban) to plots at recommended and half rates. He used a conventional sprayer system applying 4.5 L water/100 m^2, a Toro Hydraject Liquid Pulse Injector at a rate of 57 L water/ m^2, and a Pattison Bros. Liquid Spoke Injector at the same rate. At a location on the OVC lawn he also applied a insect parasitic nematode with the sprayer system and with the Spoke Injector.

Three weeks after application the plots were examined for live grubs within a 0.33 m^2 area. The results of his findings are recorded in Table 1.

Both the commercially available insecticides were effective in controlling the grubs when applied with a sprayer at Cambridge where there was a high grub numbers. Less consistent data was found on the OVC lawn where Dursban 480EC was the better material.

The use of the two types of injectors did not consistently improve the efficacy of the insecticides. The potential for the Toro Hydraject system to relieve compaction in addition to providing a system for applying an insecticide is an additional benefit where a combined problem of grubs and compaction exists.

Significant control of the Chafer was obtained with the insect parasitic nematode. The nematodes applied with a conventional sprayer appear to be more effective than those injected with the spoke system. This non chemical approach to control is worthy of further investigation.

Table 1. The percentage reduction in grub numbers due to insecticide applications by three systems in 1992.

Application System	Insecticide	Rate	Cambridge*	OVC Lawn*
		(kg a.i./ha)	(% of check)	
Toro	Dursban 480EC	1.8	79.4	33.3
Toro	Dursban 480EC	0.9	80.4	45.8
Toro	Diazinon 500EC	4.5	93.8	91.7
Toro	Diazinon 500EC	2.25	60.8	50.0
Spoke	Dursban 480EC	1.8	95.9	16.7
Spoke	Dursban 480EC	0.9	90.7	50.0
Spoke	Dursban 50 WSP	2.25	80.4	58.3
Spoke	Dursban 50 WSP	1.13	68.4	37.5
Spoke	Diazinon 500EC	4.5	93.8	70.8
Spoke	Diazinon 500EC	2.25	66.0	37.5
Spoke	Nematode	Full	-	54.2
Sprayer	Dursban 480EC	1.8	80.8	95.8
Sprayer	Dursban 50 WSP	2.25	92.8	45.8
Sprayer	Diazinon 500EC	4.5	94.8	0.0
Sprayer	Nematode	Full	-	83.3
Sprayer	Nematode	Half	-	54.2

*Grub Number in Control: Cambridge = 24; OVC Lawn = 12.

UNDERSTANDING TURF MANAGEMENT
The tenth in a series by
R.W. Sheard, P.Ag.

SOIL POTASSIUM

Most soils contain relatively large amounts of the essential element for plant growth - potassium (K^+); often as much as two percent of the weight of the mineral portion. At the same time the concentration of potassium in the soil solution from which the grass draws its needs may be only 50 to 100 ppm. This relationship illustrates the reason why the total chemical analysis of a soil has little correlation with its ability to supply grass with a nutrient and why soil testing procedures were developed which were more closely related to plant growth.

A healthy grass leaf will contain 2.5 to 3.5 % potassium. The potassium in the leaf is not associated with the structure of any specific compound such as protein or carbohydrate in the leaf. It appears, however, as a free ion in the cell sap and functions as an aid in maintaining the ionic and pH balance within the cell as well as with some enzyme functions. In fact when a leaf dies most of the potassium contained in the leaf will be leached out by the rain and returned to the soil.

The major portion of the potassium in the soil is found as a element in the structure of clay minerals and sand grains originating from the minerals known as mica and feldspars in igneous rock. An example of the partitioning of the potassium in a fertile soil is outlined in Table 1.

Over a long period of time, measured in years, if not centuries, the potassium containing minerals, feldspars and mica break down. The potassium released on this breakdown may become part of the structure of secondary minerals known as clay minerals or become exchangeable ions in the soil solution. The potassium which is part of the clay structure is considered slowly available to the soil solution and can slowly recharge the potassium in the soil solution over a period of weeks or months.The rate at which the restructuring or breakdown of clay minerals releases potassium is known as the potassium supplying power and can vary significantly between soils. Finally,the readily available potassium for immediate plant uptake is made up of potassium in the soil solution and the exchangeable potassium. These various steps are illustrated in Figure 1.

In the above discussion we have mentioned exchangeable potassium which is potassium associated with the exchange complex of the soil. Cation exchange is a phenomena of compounds or minerals which have a sphere of negative electrical influence surrounding them, resulting in the ability to attract ions which have a positive charge. Ions such as potassium, calcium and magnesium, which carry a positive charge are attracted by the negative charge the same as the north pole of a magnet attracts the south pole (thus the general term cation because the positive charged ions are attracted to a cathode).

Cation exchange is also a property of large organic matter molecules, particularly when in the stable form known as humus, because they also have a sphere of negativity about them. Since clay minerals and humus have a negative sphere of influence and hence have the ability to attract the cations in the soil solution to their surface, the cations are held from leaching in the percolating ground water.

Figure 2 illustrates the concept of cation exchange. Visualize a clay particle or large, complex organic molecule floating in water (i.e., the soil solution). The clay mineral or organic molecule is negatively charged, the intensity of the charge diminishing with increasing distance away from its surface. In the water surrounding the particle are a swarm of dissolved ions of calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+), sodium (Na^+) and many other cations such as iron, manganese, zinc, and copper which plants require for their growth. When a potassium ion is close to the surface, the negative influence is strongest; as the potassium drifts away from the surface the effect decreases and at some distance from the surface the potassium may finally be considered as free floating or part of the potassium available for plant uptake. As the com-

Table 1: The partitioning of potassium (K^+) in a fertile soil into categories of availability for plant growth.

Form of Potassium	Kg K+/ ha.15 cm
Total K^+	26,000
Relatively Unavailable K^+	23,400
Slowly Available K^+	2,080
Readily Available K^+	520
Exchangeable K^+	468
Soil Solution K^+	52

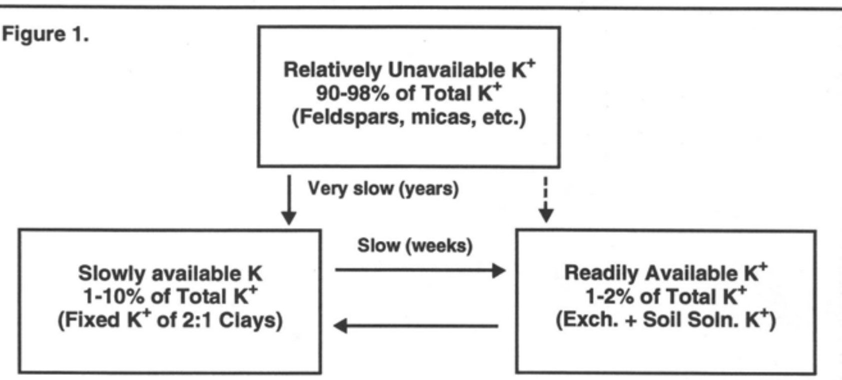
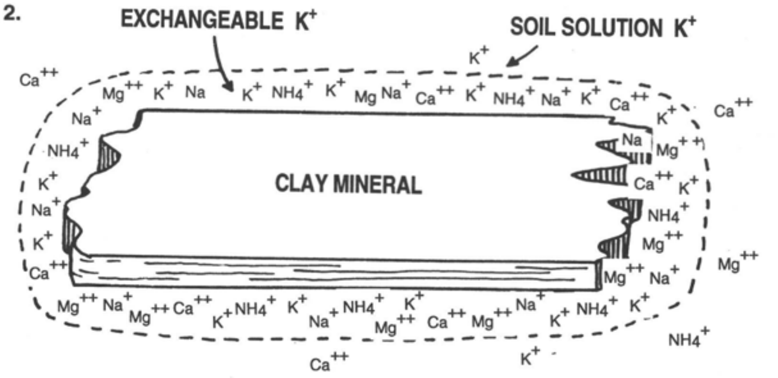


Figure 1.

Figure 2.



position of the cations in the soil solution changes so does the composition of the ions close to the negative charge.

An illustration of the principle of cation exchange can be found in the operation of a water softener (Figure 3). The resin in the softener tank is negatively charged. When the resin is conditioned and ready for action the negative charges of the resin are neutralized (covered) with positively charged sodium ions. As the hard water from the city main flows over the resin the calcium and magnesium (ions which create the 'hardness' of water) replace the sodium on the resin because there are many orders of magnitude more calcium and magnesium ions around the resin than sodium. The sodium, therefore, migrates into the water leaving the calcium and magnesium on the resin. The water leaving the tank to the household tap is 'soft' and no longer flocculates the soap.

When the majority of the sodium on the resin has been displaced by calcium and magnesium the water from the softener begins to feel 'hard' again and the resin must be recharged. This is done by back washing the resin with a saturated solution of sodium from the brine tank in which you have placed salt - sodium chloride. And so the cycle is repeated.

The ability of clay and humus to exchange cations has great importance in plant growth. The exchange system acts as a reservoir which prevents cations from leaving the rooting zone in the percolating ground water. It allows the reservoir of elements required for plant growth, such as potassium, to be built up by a regular fertilization program, or, it allows the pH of the soil to be modified through liming.

Let us use liming as an example. As we mentioned in a previous article, acid soils have a high concentration of hydrogen, aluminum and manganese in the soil solution. Since these elements are all cations they will be the major ions in the negative sphere of influence. If limestone is added to the soil, the soil solution becomes saturated with calcium ions. When their number become sufficiently large they begin to displace the hydrogen, aluminum and manganese from the clay and humus. As the ion swarm around the clay and humus becomes increasingly saturated with calcium the hydrogen and aluminum are forced away from the negatively charged surface and are washed out in the percolating water. The soil thus becomes increasingly alkaline and the pH rises. As the pH rises the solubility of aluminum and manganese decreases, resulting in an even more favourable environment for grass root growth.

A similar process takes place when potassium fertilizer is applied. When the potassium fertilizer is dissolved in the soil water the potassium ions displace calcium and magnesium ions from the clay, building up the level of readily available potassium, hence the fertility, of the soil.

The ability of a soil to retain all cations by the exchange system is called the cation exchange capacity; commonly termed the C.E.C. of a soil. The C.E.C. of a soil depends on the amount of organic matter, the amount of clay and the type of clay found in the soil. The silt and sand fractions do not have a negative charge so they have no effect on the C.E.C.

Soil chemists measure the C.E.C. in the soil in units known as milliequivalents per 100 grams. To compare some

Figure 3.

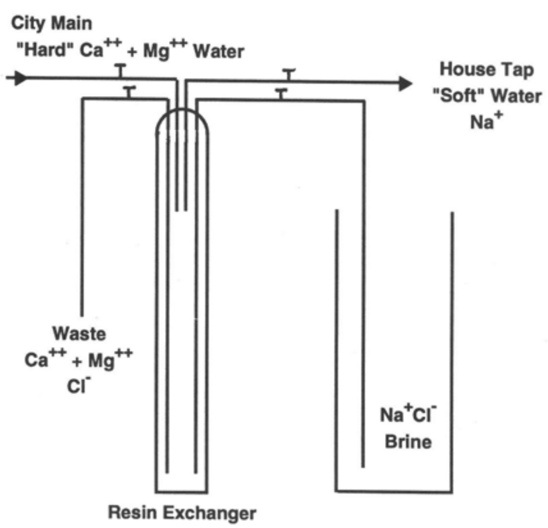


Table 2: A comparison of the ability of humus and types of clay minerals to retain potassium by cation exchange.

	(grams potassium/kg material)
Humus	78
Montmorillonite clay mineral	39
Illite clay mineral	15.60
Kaolinite clay mineral	3.12
Sandy loam low in organic matter	0.76
Sandy loam high in organic matter	3.90
Clay loam having kaolinitic clay mineral	1.56
Clay loam having illite clay minerals	21.45

soil conditions let us assume the only cation in the soil is potassium. With this assumption the weight of potassium which could be retained under some soil conditions is recorded in Table 2.

These values demonstrate the very important role the decomposition product of organic material, humus, plays in the ability of a soil to retain cations. In a sandy loam soil the increase in organic matter percentage from 1.5% to 6% could result in an increase 5-fold in the C.E.C. Similarly the type of clay mineral which makes up the clay fraction has a large influence. Clays found in the tropics tend to be the kaolinitic types with a low C.E.C. On the other hand clays found in the temperate regions such as Canada have illite to montmorillonite type clays and thus are more fertile due to a higher C.E.C.

There is little which the turf manager can do to alter the amount or type of clay in his soil. He can, however, increase the humus content by returning clippings, top dressing with composted organic materials and using management practices which favour a dense, deep root system. Don't look for immediate results - the process is slow.

Sports fields constructed on an all sand rooting medium will have a very low C.E.C. as evident from the above discussion. The lack of any C.E.C. in sand is one of the reasons many designers will advocate the inclusion of a small amount (3 -10%) of natural top soil in the mix. The important factor, however, is the management procedures which will favour the long term build up of organic matter in the sand.

Furthermore, attention to the potassium nutrition of turf growing on a sand system is critical. More frequent applications will be required. A soil testing system, which, in fact, measures the exchangeable potassium plus potassium in soil solution, in a sand system will be giving a reading on the potassium primarily in the soil solution, potassium which may be quickly lost by excessive rain or irrigation. There will be little reserve in the cation exchange system.

Controlled release forms of potassium fertilizer are becoming available which have a type of coating to delay the release of the potassium. The turf manager must decide the economics of frequent light applications of soluble forms of potassium versus the cost of the coated materials. There is little research available to guide him regarding the application timing of slow release potassium.

An additional factor to consider in potassium nutrition of turf is the problem of luxury consumption. When a grass plant is exposed to an abnormally high level of potassium in the soil solution it will continue to absorb potassium to concentration levels in the leaf tissue which are in excess of what is required for normal growth. While not directly harmful, luxury consumption is wasteful if the clippings are removed from the site. Of more concern is the suppression effect the high levels of potassium has on the uptake of other cations such as calcium and magnesium. Where turf is produced on normal mineral soils with an average C.E.C. luxury consumption and depression of calcium and magnesium uptake is not a concern. Where the rooting medium is sand, however, it becomes an additional positive factor when debating the use of controlled release potassium.

All potassium fertilizers, with the exception of controlled release forms, are water soluble. As a result they can cause foliar burn when applied at high rate or where there has been an over application due to equipment failure or operator error. It is recommended that not more than 1.0 kg K^+/ 100 m^2 be applied in any application.

Estimating the rate of application of potassium is best done on the basis of a soil test for turf grown on normal soils. On sand rooting system a rule of thumb which calls for 3/4 to one kilogram of potassium for each kilogram of nitrogen may be used.

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Be Prepared

A pending litigation involving a ball player who was rendered a paraplegic due to a neck injury emphasises the need for records of field maintenance and playing conditions. A file of paper will carry more weight when presented to a judge than the memories and impressions of a score of witnesses a year or more after the event.

The City of Cambridge Community Services Dept., is an example of a serious effort to maintain a file of records. They are in the form of an Inspection Summary sheet which is completed weekly by their staff for each sports field. They also provide the user with a Concerns Summary sheet where the user can register complaints, and which allows dialogue to develop to resolve the concerns.

A record of the date of each maintenance operation, such as mowing, machine used, topdressing, coring, pesticide application, etc., would complete the record file. Keeping the file for up to three years before shredding would be a sound procedure.

Some might suggest these records add to the deluge of paper we face today. The records, however, may save a million or more dollars in a litigation proceedings in the future.

With the permission of Don Bridgman of Cambridge Community Services, we reproduce their forms as an example of the type of information which may be of value in a litigation proceedings.

GRASS CLIPPINGS

Bunch grass type turf species such as perennial ryegrass, tall fescue and annual bluegrass spread primarily, if not exclusively, by tillering. If the plant populating is sufficiently dense a uniform turf will develop. At low seeding rates or where winter kill has reduced the density a clumpy, non uniform turf will result.

CITY OF CAMBRIDGE
COMMUNITY SERVICES DEPARTMENT
SPORTSFIELD INSPECTION SUMMARY

Date: ____________ Location: ____________

Type: ____________ Checked by: ____________

	Condition	Comments
Backstop Fencing:		
Foul Line Fencing:		
Outfield Fencing:		
Goal Posts:		
Foul Posts:		
Turf:		
Infield Area:		
Player Benches:		
Line Box:		
Lighting:		
Litter:		
Pitcher's Rubber:		
Home Plate:		

CITY OF CAMBRIDGE
COMMUNITY SERVICES DEPARTMENT
SPORTSFIELD CONCERNS SUMMARY SHEET

Date: ____________ Park: ____________

Sportsfield: ____________ Type: ____________

Group Name: ____________ Contact Person: ____________

Phone Number: ____________

	Condition	Comments
Backstop Fencing:		
Foul Line Fencing:		
Outfield Fencing:		
Goal Posts:		
Foul Posts:		
Turf:		
Infield Areas:		
Outfield Areas:		
Player Benches:		
Bleachers:		
Line Boxes:		
Lighting:		
Litter:		
Pitcher's Rubber:		
Home Plate:		
Changeroom/Washroom:		
General Site Condition:		
Other Concerns:		

FOR OFFICE USE ONLY:

Action Taken: ____________

Day Work Completed: ____________

Checked by: ____________

Maximizing Sprayer Performance for Boom Sprayers

by Helmut Spieser, Ag. Eng., O.M.A.F. Ridgetown, ON, and Ralph Winfield, Ag. Eng., Glanworth, ON.

Boom sprayers are an integral part of the equipment inventory used in turfgrass production in Ontario. Over the years sprayer have changed, sprayer operators have become more educated in the operation and use of their sprayers and the spectrum of products applied with the sprayers is constantly changing. Because of these changes, increasing chemical costs, and a heightened concern for the environment, everyone involved in turfgrass production is striving to maximize the performance of the spray chemicals used. This not only involves applying the appropriate product at the correct time but also ensuring that the sprayer is being operated such that the spray solution gets to the target and controls the problem. You, as the sprayer operator, can make adjustments to your sprayer which can result in a more effective spray program.

The hydraulic sprayer which has a tank, pump, boom and nozzles has been around for many years. It has performed a useful function in the application of a wide variety of spray products. Looking to the horizon, it appears that this type of sprayer will be with us for some time.

How nozzles work

Let's look at the basics of how nozzles work. Nozzles come in a range of types, sizes and spray angles, but they are all designed to do one thing. The nozzles are manufactured in such a way that the spray liquid is squeezed through an orifice and deposited to the target in a predetermined pattern. As the liquid is forced through the nozzle the orifice squeezes the liquid into a sheet, this sheet becomes thinner and tears into ribbons and finally the ribbons become thinner still and form droplets. The droplets produced by this process are not all uniform in size. Rather they range in size from very fine droplets to very course droplets. All nozzles produce this wide range in droplet sizes. In order to quantify the droplet size, a number of different techniques have been used. The one which is possibly most useful to you is Volume Median Diameter or VMD. The VMD is merely a means of expressing droplet size in terms of the volume of the liquid sprayed. Thus 50% of the volume of spray is contained in spray drops greater than VMD and 50% of the volume is contained in droplets less than the VMD. This droplet diameter is usually described in microns. To give you some idea of micron size, a human hair is approximately 70 microns in diameter. As we make changes to the orifice such as size or spray angle, a change is evident in the VMD. Very simply here is how the VMD is affected by certain changes to the nozzle.

1. A large orifice will have a higher VMD (produce more larger droplets) than a small orifice nozzle.
2. A narrow spray angle will have a higher VMD (produce more larger droplets) than a wide angle nozzle.
3. A low operating pressure will result in a higher VMD (produce more large droplets) than a higher operating pressure.

Calibration

Calibration of the sprayer is important because it is the only way of knowing exactly how much spray you are applying per unit area. There are many calibration methods which can be used to determine your application rate. Not only do you need to know how much area you can cover with a full load of spray, but you should also measure what the output is for each and every nozzle. If individual nozzles are not checked you are only doing half a calibration job. By checking each nozzle you will see how the output compares to the other nozzles on the boom. Wide variations can be found due to a variety of reasons such as:

- mismatched nozzles
- uneven nozzle wear
- plumbing problems
- plugged or partially plugged screens
- damaged nozzles.

Don't assume that because the nozzles are all the same age they are all delivering the same amount of liquid. Catching the liquid from each tip is the only way to know what the nozzle is delivering. Even when a new set of tips is installed they should all be checked. The liquid output from any one nozzle should not vary more than $\pm$ 5% from the average output of all nozzles on the boom. If a nozzle falls outside this range, it should be replaced and its replacement nozzle should also be checked. Please note that you visually cannot see a difference in flow rate of 20, 30 or even 50%. Using a graduate cylinder is the only way. One limitation of calibration is that it will not show you what the distribution pattern is like. The only true means of evaluating spray distribution is with a patternator. A patternator consists of a boom mounted over a series of Vee shaped channels which drain into individual graduated cylinders.

Nearly all calibration methods require some means of determining sprayer travel speed. If you spray over rugged terrain on golf courses or parks, your travel speed may change as the machine travels up or down these slopes. Variations of travel speed of up to 5% are still acceptable. If speed variations are greater than 5% you should make some adjustments. These adjustments could be; changing gears thereby reducing the lugging on the engine, taking part loads which reduces the weight of the machine and work required to move it up slopes, or spraying across the slopes if possible. Changes in spraying speed will change your rate of application. As you travel up a slope, if the speed drops, the application rate will increase. As you travel down the slope and your speed increases, the application rate will decrease. Both of these conditions could result in problems with reduced control or possible damage to the turf from improper rate of application of product.

Nozzle wear and tear

Let's look at nozzle wear. Nozzles wear with use. The rate at which they will wear depends on these factors:

- nozzle materials
- nozzle type

- nozzle size
- materials sprayed - abrasion, corrosion
- carriers sprayed - abrasion, corrosion
- area sprayed
- boom plumbing layout

Choose the nozzle material for your application based on its performance with the materials you will be spraying. As a nozzle tip wears it not only delivers more spray material but its distribution pattern changes as well. In general terms as a nozzle wears its distribution pattern becomes poorer. A good rule of thumb is to replace nozzle tips when the flow rate is more than 10% greater than its rated flow when the nozzle is new. These nozzle flow rates can be found in the manufacturers' catalogues.

Looking strictly at abrasive wear, here is how the nozzle materials stack up:

Hardened Stainless Steel	SLOW WEAR
Thermo plastic	
Stainless Steel	
Nylon	
Brass	RAPID WEAR

Know your nozzle pressure range

All nozzles are designed to work within a pressure range. When a nozzle is operated within its designed pressure range it will deliver a given quantity of liquid and distribute this liquid in a predetermined spray pattern. When you operate a nozzle outside its designed pressure range the flow will change to a point, but also the spray pattern will not be as designed.

To eliminate the possibility of operating a nozzle outside its working range, you should sense the pressure at the boom with a good quality liquid-filled gauge. Second, the nozzle size should be selected so that it can deliver the flow rate required. Adjusting sprayer speed or operating pressure only offers flexibility in adjusting the application rate. To make large adjustments you have to change the tip size.

This simple formula can be used to determine the size of the nozzle required. By entering your values into this formula you can quickly determine the nozzle size required for the job.

$$GPM\ per\ nozzle = \frac{gal/1000ft^2 \times mph \times w}{136}$$

where; GPM = gallons per minute
gal/1000 ft^2 = gallons per 1000 square feet
mph = spraying speed in miles per hour
w = nozzle spacing on the boom in inches

Having calculated the gallons per minute you wish to apply, consulting the nozzle manufacturers' catalogues will show you which nozzle size is required. When you install these nozzles into your prayer remember to calibrate. The values should result in the same application rate as you entered into the previous formula. This calibration is a way of double checking your calculations.

Nozzle-to-target distance

In addition to sizing the nozzles for the job you also need to determine the correct height. This is accurately called the nozzle-to-target distance which for spraying turfgrass is the same as the boom height. Three factors affect the nozzle-to-target distance;

1. nozzle spray angle
2. nozzle spacing on the boom
3. nozzle type

Operating the nozzles too close to the turf will result in a non-uniform distribution of spray material. You will have bands of high concentration alternating with bands of no spray. The problem with this is that the chemicals used will only work in bands. On the other hand, if the boom is operated higher than required these bands of overspray and underspray do not occur. You do, however, cause the spray material to be more prone to drift.

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