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SURFACTANT LONGEVITY AND WETTING CHARACTERISTICS

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Observations of water repellency in soils made over the past 10 years throughout the world have indicated that this particular problem is more important than had previously been thought. There have been reports that water repellency in golf greens and lawns is responsible for drought Conditions even though the grass has had sufficient watering. This condition of water repellency has often been associated with thatch buildup. Nurserymen have noted that many of the soil mixes they use for potting plants are hard to wet.

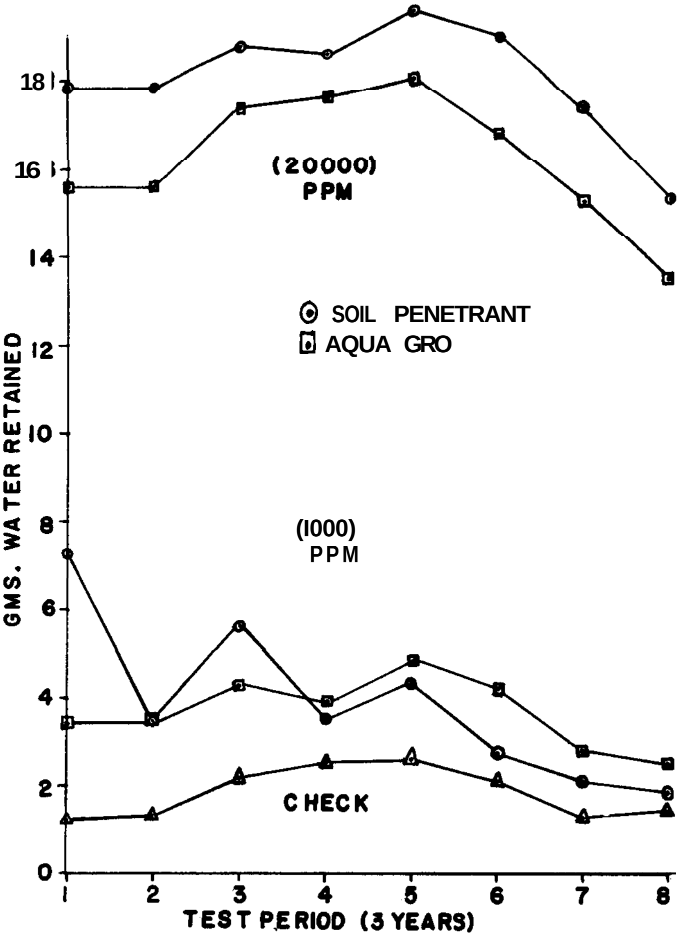
"Fairy rings" are often associated with drought conditions. There are many varying explanations of their cause. The most commonly held theory is that the fungal hyphae are water repellent and prevent water from getting to the feeding roots of the grass. The dark green ring around the periphery of the dead grass is probably caused by the fact that water moves from the water repellent center of the ring into the more wettable area.

It has been estimated that between 1/30 to 1/60 of the watersheds in southern California are consumed by wildfire each year. From many surveys it appears that about 60 per cent of this burn area is water repellent. During rain storms-even mild storms of low intensity-these areas are more subject to increased runoff and erosion. To reduce the damage to the watershed it has been necessary to find a method which modifies the water repellency of the soil. One such method is through the use of a broad classification of organic chemicals described as "surfactants" or "wetting agents."

The application of wetting agents to water repellent soils allows water to enter into the profile at a faster rate than in the soils not treated. This technique was demonstrated during an experiment in cooperation with the staff of the Pacific Southwest Forest and Range Experiment Station, U.S. Forest Service, near Glendora, Los Angeles County. A water repellent soil, which had previously been burned by a wildfire, was treated with a solution of one part wetting agent to 3,000 parts water. A measurement of runoff and erosion caused by each storm and tabulation of the results at the end of the rainy season revealed that erosion was reduced by 90 per cent, runoff was reduced 30 per cent, and there was a four-fold increase in vegetation on the plots treated with wetting agent.

Many uses for wetting agents are being found in agriculture and therefore further investigation of their various effects is required. They have been used to help spread insecticides and fungicides, and many soil amendments have been treated with wetting agents by the manufacturers to overcome any water repellent conditions.

Several important questions remain to be answered before any general applictions of wetting agents can be recommended. Health and safety must be considered along with economic factors. The prime interest of this study was to determine the wetting efficiency and long-term residual effects of the various wetting agents used.

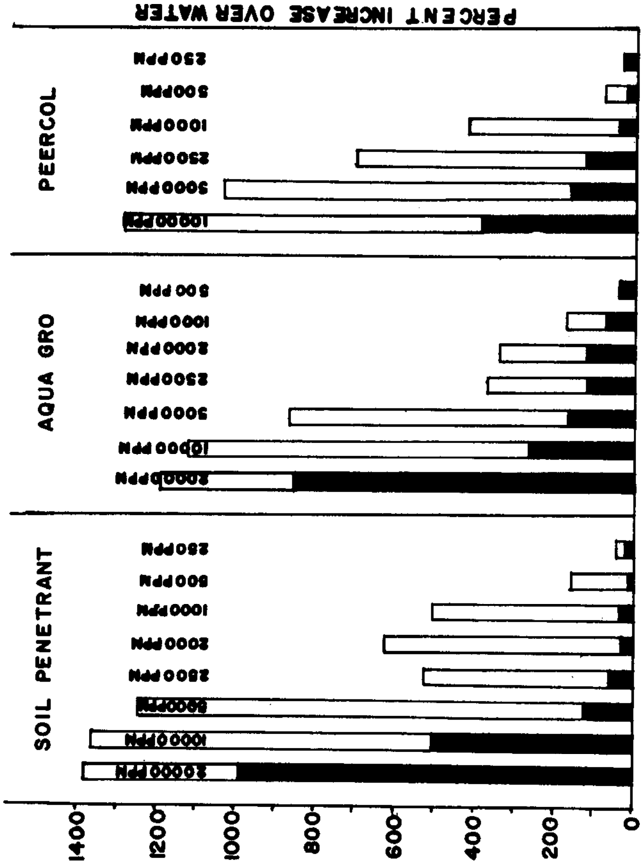


Graph 1. Residual wetting ability of two wetting agents at two concentrations over a three year period.

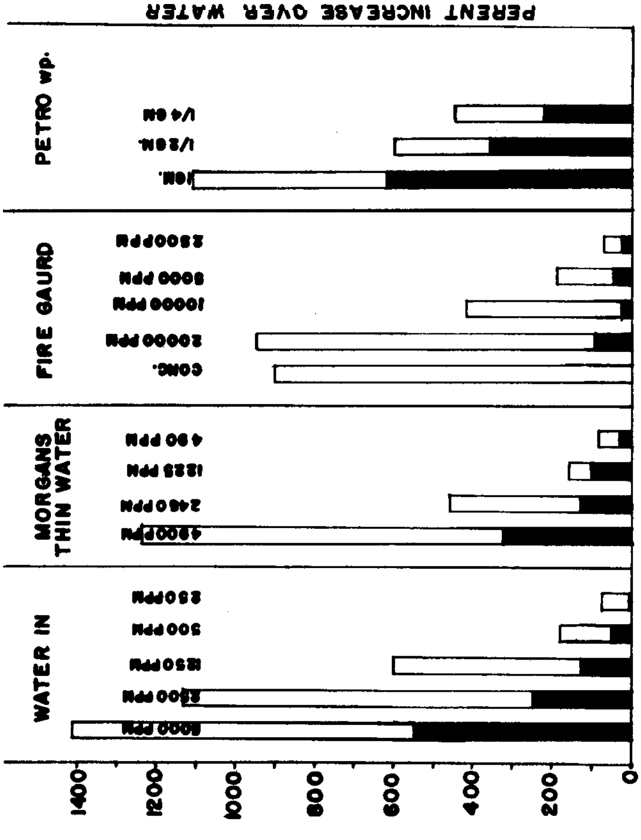
Water repellent peat pots were treated with various wetting agents and dilutions by pouring 50 ml of the test solution into the pot. After 15 seconds, the solution was poured out and the pots were weighed. The increase in weight was used as an index of wetting. More water was retained by those pots which were wet as compared with the water repellent pots.

Pot treatments

All pot treatments were triplicated and water was used as a standard treatment. The pots were allowed to air-dry between test periods. The technique described previously was used in each test period, except water was used on all pots for test after the initial treatment. There were eight test periods covering three years. The seventh test was at the end of the second year and the last was at the end of the third year. The pots were periodically leached with



Graph 2. Wetting efficiency of various wetting agents. Hollow bar represents the efficiency for the first test period. Solid bar represents the efficiency at the end of the three year period.



Graph 3. Wetting efficiency of various wetting agents. Hollow bar represents the efficiency for first test period. Solid bar represents the efficiency at the end of the three year period.

water. A total of 1,300 ml were used to leach each pot. This volume of water was approximately 40 times the solid volume of the pot.

The surfactants used, including the trade names, chemical names, and effective concentrations are listed in the table. In general, the nonionics are divided into ether and ester groups. Soil Penetrant, Water In, and possibly Peercol are ether types. Morgans Thin Water is an ester type. Although Aqua Gro is listed as 50 per cent ether, 50 per cent ester, it was placed in the ester group. Only anionics were tested in the ionic classification. Fire Guard was not included in the table because of its unknown chemistry but it is thought to belong in the ionics group.

SURFACTANTS USED

Trade name	Chemical name	Concentration
	NONIONICS	
Soil Penetrant	alkyl polyoxyethylene ethanol	100%
Peercol		
Aqua Gro	polyoxyethylene esters of cyclic acid	50%
	polyoxyethylene ether of alkylated phenols	50%
Water In	alkyl polyethylene glycol ether	25%
Morgans Thin Water	polyoxyethylene esters of dialkyl phenols	49%
	IONICS	
Petro Ag Special	alkyl naphthalene sodium sulfonate	98%
Petro S	complex sulfonated monodimethyl naphthalene	98%

Graph 1 shows a sample of the behavior of the two nonionic types. The ether type, represented by Soil Penetrant, had initially better wetting than the ester wetting agent represented by Aqua Gro. The residual efficiency was not as good for the ether group and generally fell below the residual efficiency of the ester group at the end of the threeyear period. However, at high concentrations, above 8,000 ppm, the ether performed better throughout the test period. This high concentration would not be considered for actual application because of the possibility of phytotoxic effects. The behavior pattern indicates that the ether groups have better wetting characteristics but offer less residual efficiency. The esters, however, are more tightly adsorbed and are less likely to be leached out over a period of time.

Wetting *efficiency*

The initial and final wetting efficiency for the wetting agents tested are presented in graphs 2 and 3. Various concentrations were tested for the percentage by which they were more or less efficient than water. The hollow bar represents the first test and the dark bar the last test at the end of the three years. All the wetting agents used were shown to be better than water alone by the end of the three-year period. It appears that the major loss in wetting ability over the three-year period was due to leaching.

When choosing wetting agents it is important to know whether initial wetting is sufficient, or if a long-term residual effect is needed. In general, if initial wetting is required to prevent erosion and increase infiltration, the most efficient nonionic would be one of the ether group. If long-term efficiency is required, the ester group would be better. There are many requirements between these limits and the selection of the wetting agent will depend on which is the most important.

CHEMICAL PEST CONTROL*

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As golf course superintendents you may or may not regard yourselves as philosophers. However you do think about your work; and since philosophers classify ways of thinking-the way you think is a subject of philosophy.

One classification divides philosophical systems into three main categories. One is *realism.* If you were a realist you would have in your mind an idea or concept of a perfect green. The concept would be important. It would not matter if your greens had scars, brown spots, grain, or puddles. This is simply fate, or God's will, and to be accepted until you achieve your ideal green, perhaps in an after-life where greens are unblemished and all golfers smile as they single putt birdies. I'm sure there are no realists among you.

The philosopher names a second major way of thinking, *materialism.* As a materialist you would expect your turf to obey the laws of nature, and you would evaluate green maintenance in terms of efforts and costs for goods accomplished; in terms of the most good for the least effort. We would all like to be materialists. If programming were that simple our job would be much easier But grass is not iron and doesn't lie inert while your compute the next machining operation, and golfers are a social phenomenon and not a law of nature. Soil compacts according to laws of nature but traffic depends on population, working hours and other social phenomenae. While managing living grass we are not materialists.

The thinking of the turf manager is *nominalistic.* The world we deal with is not an idea; it is not solely a series of machine operations. It is a world characterized by continuous change. The world of turf work is like a journey. You left certain problems this morning. When you get home tonight there will be new ones. Next month your greens will look different. How they look will depend in part on how you react to wind and weather, turmoil and traffic. July will make more demands on you than February did. There is only the journey of tomorrow and there is no destination. We watch our goals approach completion; the moment of achievement arrives; and before we can savor it, it is already past and fading as we occupy ourselves with the new scene. The world of turf is the nominalist's world of continual change.

The nature of turf not only calls for nominalistic philosophers, but it takes away the comfort of materialism in another way. That way concerns me because it relates to research.

Today you have greens in a certain condition. Between now and next July you will mow, water, fertilize, spray and otherwise manage the grass. In July the quality hopefully, will be good. But the grass will be growing more slowly, the weed content will be different, water use will be higher, fertilizer management trickier, but still you'll have good grass. Now there are a dozen ways to get from April to July. Some ways are wrong but there is no one single right way to get from good grass in April to good grass in July. Research cannot give you a one right way. There are many ways to achieve a result and each turf manager chooses the pattern he will use. He will, I presume, use research results. Research can tell him the consequence of each management action. It can indicate the consequence of mowing at x height or watering at y frequency, or spraying when the temperature is z degrees. But the manager has to assemble the parts into a program of how he will get from April to July. Research give you principles to use; you use them; but the program is yours.

While reviewing research that has been done on turf pests I have been disturbed by the difficulty of finding guiding principles. We have a lot of information. But it is presented largely as isolated bits of data or as limited studies. It is hard to find the general principles. And we need the general unifying principles to guide us in making sound judgments. To evaluate a chemical control program, we need some basis for understanding the consequences?

My talk today is about my attempt to find quiding principles to help us use chemicals wisely.

A biological principle that I find most helpful is this: *Organisms occupy the environment to its full capacity to support them.* First, let me notice how man stretches this principle. Obviously the San Francisco Bay area cannot support three million people. B ut highways extend man's environment. Man can transport food from one area to another and San Francisco is part of the demend on the environment of Kansas and Nebraska to the extent that it imports their meat and flour. So . . . with special meaning for man . . . organisms occupy the environment to its full capacity.

Some environments support very little life: polar regions and deserts for example, have limited environments and limited life. As an example of the above principle, consider Baha California. For over twenty years there has been a drought. People have been born and have grown up in a desert with a sparse flora that the meager rainfall could barely support. Now, after a couple of wet years these areas are a burgeoning jungle containing many plants that hadn't been seen in a generation. The new capabilities of the environment have been immediately used. As a more familiar example consider what happens to any piece of bare ground on a golf course. You know you can't keep it bare without continuous application of the hoe. There is a pressure on that piece of bare ground and it is soon covered with competing plants. But the pressure is not only from plants-it is from insects, animals, fungi, bacteria-from all forms of life.

Suppose you spray dandelions with MCPP. The dandelions die and leave bare spots. But the bare spots don't stay bare. Other palnts are soon growing there. This exchange of one organism for another is called replacement. What plants will replace dandelion? If turfgrasses replace dendelions, weed control has been successful. But if the turf was bluegrass mowed at 1/2", the soil is tight, and the month is June, there is great likelihood that dandelions will be replaced by knotweed. That is, germinating knotweed readily becomes estab lished in a weak turf on a compacted soil..

In weed control we are depending on replacement for success, Chemical spraying is only part of the program. The important part is to provide favorable conditions for replacement by grass. Otherwise you only get replacement by another weed-a resistant weed-a difficult weed. The use of chemicals followed by replacement has been partly responsible for great increases in *Poa annua,* goosegrass, Veronica, and knotweed as primary weeds. From this we can note a second principle which I would state thus: *Unless management favors the grass,*

**A talk given to the N. Calif. Golf Course Supt. Assn., 13 May 1969.*

herbicide use will result in replacing susceptible weeds resistant, hard to kill, weeds.

Replacement also works with insects and fungi. The field of insect control is full of examples. Using DDT to kill aphids in orchards has resulted in replacement by mites which are both damaging and hard to kill. Killing off one species of Anopheles mosquito in a malaria control project has resulted in replacement by other species of Anopheles that were previously rare, and minor pests.

Replacement phenomenae are hard to document in disease control. But *Fusarium roseum* was recognized as a devastating turf disease in the east only after two years of general use of a fungicide to control *Helminthosporium*. This may or may not be an example of replacement. Also noted have been increases of *Helminthosporium* after use of PMA; increased dollarspot following carbamate fungicides; increased copperspot following thiram; and increased *Curvularia* following use of Maneb. These all suggest replacement, where some fungi are killed-the space is then occupied by other fungi. Other equally good explanations can be proposed. We don’t yet know which is correct.

There are some very special and very important kinds of replacement. One of these results when we use a general inscticide (or other biocide) to which our target insect has become resistant. The insecticide kills susceptible insects including predators, and they are replaced by the pest which is resistant. Use of the insecticide results in replacement by the resistant pest we were trying to control and the problem is worsened. This has occurred with hairy chinch bug on turf. Hairy chinch bug has been on turf throughout the Northeast during the twentieth century but it was almost never a serious pest until the chlorinated hydrocarbons were widely used on turf. Now spraying turf with chlordane often results in a jump in numbers of resistant chinch bug.

Another special form of replacement is named resurgence or flare back. To illustrate this suppose we have armyworms in a green and we use a general insecticide spray. Some replacement will be of more armyworms as moths fly in and lay more eggs. If the spray has killed not only armyworms but predatory insects as well, armyworm may increase rapidly and a new generation may become ‘severely damaging before we are aware of it. Armyworm may have been killed by the first spray, but our problem may be doubled or tripled later, as new worms grow, freed from natural control. This large regrowth is resurgence. In resurgence we kill many species in trying to kill one, and replacement is with the species we were trying to control. Resurgence is common among insect populations, particularly in a monoculture such as orcharding, cotton, or turf. You probably remember that a few years ago the California alfalfa industry was threatened by resurgence of aphids. Malathion used to kill the aphids, destroyed predators of the aphids, and the resurgent increase in aphids almost destroyed alfalfa as a crop for the Central Valley.

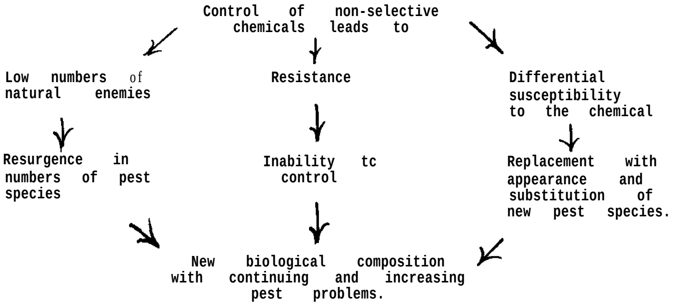
Resurgence is difficult to observe among fungi. When soil is pasteurized with steam, or with a fumigant such as methyl bromide, most fungi are killed-but not all. Those remaining spread rapidly and luxuriently throughout the soil. In New Zealand fumigation of greens soils has often resulted in death of the new turf from a resurgence of *Ophiobolus* patch, as *Ophiobolus* replaces the killed fungi. On the other hand, research workers in Canada couldn’t grow *Ophiobolus* on their steam sterilized soil. Replacement had been by a fungus that suppressed *Ophiobolus*.

These aspects of replacement have been summed up in the following figure after Rudd.* (Figure 1)

To sum this phase; consideration of the biological principles that organisms occupy the environment to full capacity has led to the concept of replacement and the special instances of replacement, resurgence, and resistance. These lead to a worsened pest problem except where replacement is by a benign or desirable species, as when turf replaces a weed.

In considering replacement other problems have been suggested which we now need to consider.

Figure 1



I have mentioned predators and this leads to talk about natural control by predation and parasitism. A balance of nature does not give control of all pests at all times. Changes in weather, in crops, etc., may result in damaging pest populations at times. But we cannot do without natural control either. An example may help lead to an understanding of this continually changing dynamic balance we call a balance of nature. When we have an introduced pest such as japanese beetle that has no natural enemies in its new environment, we fail to control it effectively with insecticides. Japanese beetle was a major pest for over twenty years, and a continually damaging and spreading pest so long as lead arsenate or DDT was used as its control. Three natural forms of control were introduced. One was *Bacillus pupillia*, milky disease; the second was a species of *Typhia* wasp; and the third a *Centeter* fly. Once these three organisms were established in the landscape, japanese beetle ceased to be a major pest of turfgrass. Pesticides are generally inadequate to control a pest unless natural control is at work. Replacement, resistance and resurgence and a continually worsening pest problem today result from use of wide spectrum biocides which kill natural enemies of pest species. And so we can set forth a third principle. *The most effective pest control will result when natural control is undisturbed, and chemicals are used which kill only the pest against which they are directed. Nondirective control leads to resistance, resurgence, replacement, and increased pest problems.*

The first thing that will occur to most of you is, this is contrary to recommendations that have been given in the past to use broad spectrum materials, especially against diseases. Use of broad spectrum sprays is largely from ignorance. It is hard to know exactly what fungus you are fighting as identification is a job for an expert. And so to be safe you fight all the possibilities and hope you hit the right one. ‘This will change once systemic fungicides are released. The fungus killed will be that inside of the plant and so your target will be specific.

Systemic pesticides are then, a kind of specific pest control. A second specific control is by use of baits which

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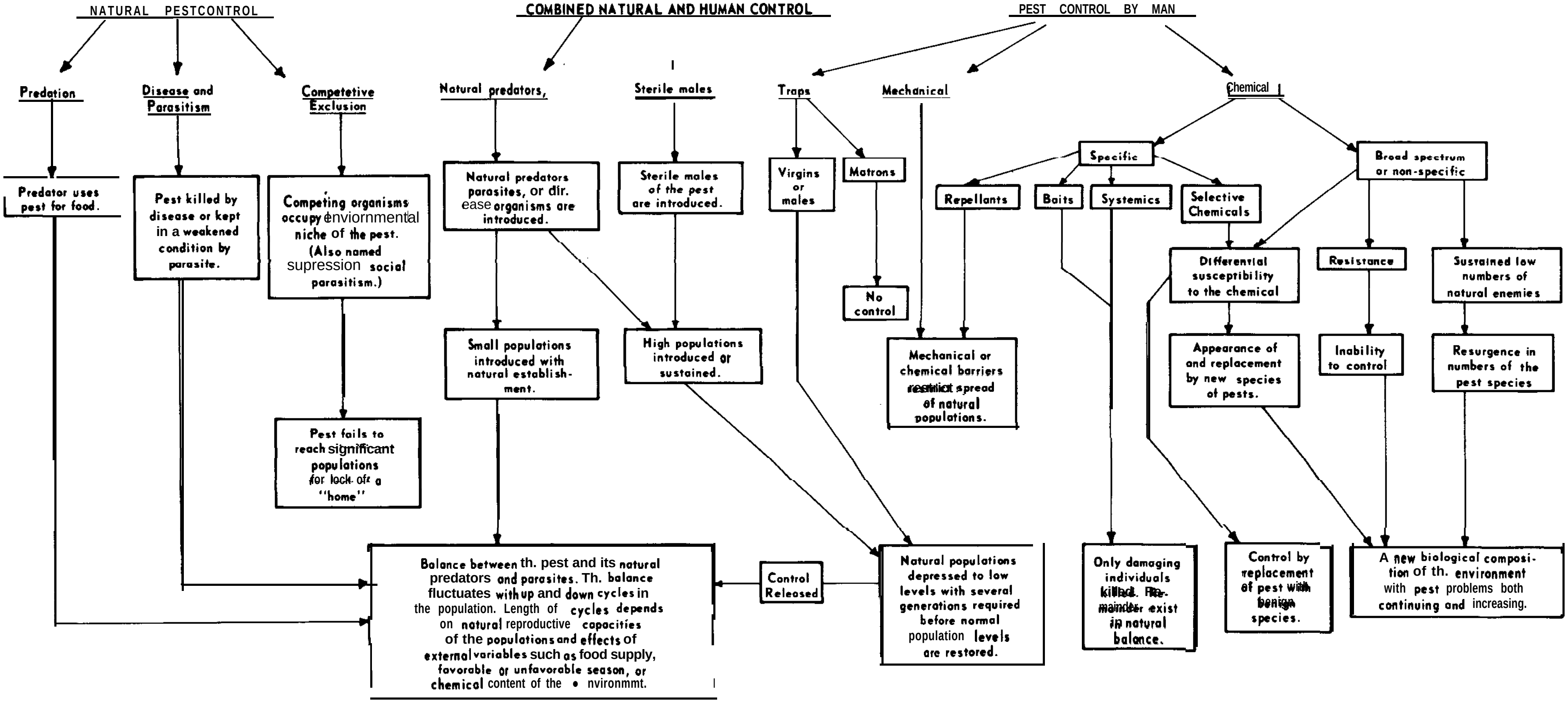
“R. L. Rudd. 1964. Pesticides and the living landscape. Univ. of Wisconsin Press. Madison, Wisc. p 276.

PEST CONTROL

(Based on insect control, it is applicable to disease, weed, and nematode pests.)



April, 1969
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kill only the insect eating the bait. Other specific methods apply mostly to insect control. These are some fairly specific chemicals for weed control, but as stated, they must be accompanied by practices to promote grass for replacement.

Among other specific insect controls are use of sex attractants to bait adults to a trap before they have laid their eggs. An interesting method of mite control was used by a USDA entomologist in Illinois. He sprayed orchard trees with flour and water. Mites are tiny and were stuck to the leaf and couldn't move. This is interesting because it shows we have not exhausted our ingenuity and that not all chemicals used have to be environmental poisons.

In summary, because organisms increase and occupy the environment to its limit we have a phenomenon of replacement. Replacement can be used to our advantage in weed control but is haphazard in disease and insect control and generally leads to worsening of insect problems. In general we cannot achieve control of any pest for long by chemical means alone, but normally require the assistance of natural predators and parasites. Use of non-specific biocides alone will take us along an intolerable path, but one from which it is increasingly difficult to turn. We need to keep alert to alternatives as they occur and to embrace specific methods wherever we can.

If you were an orchardist and were to ask me how to turn back from the present undirected methods of chemical insect control, without economic loss during the turn-around, I would have a hard time answering. But on the golf course I think there is a way to turn back. Because of severe cultural practices on greens, most problems appear on the green and on other overfertilized, overwatered areas. But we also have roughs. Roughs and to a large extent, fairways can serve as biologically enriched areas where biocides are not used or where use is limited to demonstrated infestations. This provides a reservoir of predators and parasites to assist you in natural control. On the green we use whatever methods we have available until better ones come along. To the extent we can, we use only what we need when we need it. For example baiting with hexachlor for caterpillars requires only two ounces per acre and it is specific. Spraying the grass requires several pounds per acre sprayed in such a manner as to kill predators as well as caterpillars. By limiting our use of biocides and by having biologically enriched areas we can use programs that contribute a minimum of pollution to the environment.

We are travelers thru time gentlemen. For twenty-five years we have watched the development of miracle biocides. They have not solved our pest problems, and today the scene is changing. There will be new surprises in the future. It is an exciting trip for us, because we help in the change. We help give form and substance to the scene that is coming up. Today I have tried to find some general principles for judging the valuable and the harmful from among the new.

SPRINKLER IRRIGATION TERMINOLOGLY*

HUGH McKAY, Pacific Toro Co.

The following terms are explained in reference to the way in which they are used in the sprinkler industry in general.

ABSORPTION RATE: The rate at which the soil will absorb water. It is not a static rate as it includes the infiltration rate and the infiltration capacity of the soil.

ANGLE VALVE: A valve in which water enters in plane 90 degrees from the plan at which it exits.

ARCH (or a sprinkler head) : The throw of a head from side to side. Usually expressed in degrees and measured looking down on the head.

BLOCK or BATTERY (of head) : A group of heads controlled by one valve.

BUSHING UP: Making a change in pipe size from smaller to larger. Usually done to accommodate a fitting or other component.

BUSHING DOWN: Making a change in pipe size from larger to smaller.

CLASS (of pipe) : A designation given to pipe usually expressed in maximum pressure for which the pipe should be used.

COEFFICIENT of UNIFORMITY: A percentage figure derived from the precipitation rates at various points of a sprinkler system. Used in technical circles to determine the efficiency of a sprinkler system.

CONTROLLERS or PROGRAMMERS:

1. Clock
    - a.) Hydraulic
        - 1. tubing control to valve
    - b.) Electric
        - 1. wire control to valves
    - c.) Non variable
    - d. j Variable
    - e. j Infinitely variable
2. Manual
    - a.) Remote control
    - b. j Spring loaded

COUPLER KEY: The hollow shaft used to connect the sprinkler head to the quick coupler valve. Water passes through the key to the head.

COVERAGE: Refers to the way water is applied to an area. Coverage can be in relation to the throw of a head against the spacing of it or the overall job the head or system is doing in irrigating the turf.

DISTRIBUTION: Refers to the way sprinkler head(s) apply water to the turf.

DISTRIBUTION CURVE (of a sprinkler head) : A plotted curve of the precipitation rate of an individual head at various points on its radius.

FLOW: The movement of water expressed in gallons per minutes (G.P.M.) .

FOOT-HEAD: A measurement of pressure based on the fact that a column of water one foot high has a one foot-head rating due to the weight of the water. One foot head is equal to .433 pounds per square inch (p.s.i.) .

‘from a paper presented at the Sixth Annual Sprinkler Irrigation Conference, 1968.

FRICTION LOSS: The amount of pressure loss due to friction in pipe, valves, or other components of a water system incurred with the movement of water in or through those components.

G.P.M.: The measure of water flow (gallons per minute).

GATE VALVE: A low friction loss valve used to manually control the flow of water. Sometimes used as a throttle value to induce a restriction in the water line which causes a pressure loss under flow conditions.

GLOBE VALVE: A valve in which water enters and exits in the same plane.

GRAVITY FLOW: The movement of water due to elevation differences. Water is often transferred from one place to another this way as no pumps are necessary.

HEAD to HEAD SPACING: The locating of heads so the throw of one head will reach the other head, giving 100% overlap.

“HOT” LINE: A water line which is under pressure at all times.

“HOT” SOIL: Soil containing a high degree of chemicals which cause rapid deterioration to metallic pipes and fittings.

INSERT FITTINGS: The type of fittings normally used with polyethylene pipe which slip into the pipe causing a restriction to the flow of water.

INSTALLATION COST: The cost of installing a system. Includes labor, overhead and profit.

INSTALLED COST: The cost of a system completely installed. Includes all materials plus the installation cost.

LATERAL: Any pipe line which takes off the main line of a system. Generally non-pressure lines, those downstream of the valve. Syn.: Branches.

LOOP: And endless connection of pipe in which water may floow more than one way to reach the point at which it is to be used.

MAIN: Generally, the pressure or “hot” line pipe in a system.

NON-PRESSURE LINES (or pipe) : Lines which are not under continual pressure. Lines which are downstream of the valve.

OPERATING COST: The cost of operating a system. Includes the cost of water, labor in operating system, and maintenance of the system.

OPERATING CYCLE: The time from when the controller(s) starts the operating of the system to the time when the controller(s) halts the operation of the system. Total elapsed time.

OPERATING PRESSURE: The pressure at a given point in the system when the system is in operation. Usually taken at the base of the head or at the nozzle.

OVERLAP: Expressed in percentage. The radius of a sprinkler head in relation to the distance between heads.

P.S.I.: The measure of pressure (pounds per square inch).

PRECIPITATION RATE: The rate at which water is applied in a pattern of heads. Usually expressed in inches per hour.

PRESSURE: The measurement of the relative force of water. Expressed in pounds per square inch (p.s.i.) or feet-head.

PRESSURE DROP: The drop of pressure due to friction or restrictions when water is in motion, or due to an elevation rise.

PRESSURE LINES (or pipe) : Lines which are under continual pressure.

QUICK COUPLER VALVE: A valve which can be opened to a surface outlet by use of a coupler key. Located off pressure lines.

RATING (of pipe) : A pressure rating given to pipe which denotes the maximum pressure for which the pipe should be used.

REMOTE CONTROL UNIT: A manually operated unit at which remote control valves, regardless of their location, can be operated.

REMOTE CONTROL VALVE: A valve which can be operated from a point distant from its location. Either electrically or hydraulically operated.

SADDLE: A type of fitting which encircles the pipe. A hole is usually burned or drilled through the pipe it encircles to furnish water through it.

SCHEDULE (of pipe) : A rating similar to class but relating more to the wall thickness of the pipe. The pressures which a schedule of pipe can operate on vary with the size of the pipe.

SECTION (noun): A section is a group of heads and valve(s) which operate on one station of a controller or at one time on a manual system.

SECTION (verb) : The act of sectioning a system in the design stage.

SECTIONING: The act of placing heads in sections in design work.

SLIP FITTINGS: A fitting for plastic pipe into which the pipe fits and is glued with a solvent. There are various combinations of slip and threaded outlets on fittings for plastic pipe.

SPRINKLER HEADS:

1. LAWN SPRAY
   - a.) Surface or stationary — a fixed or stationary lawn sprinkler as opposed to pop-up type of lawn spray.
   - b.) Pop-up — sprinkler which raises the nozzle above the surface of the surrounding grass to avoid interference.
2. SHRUB
   - a.) Spray or stream — sprinkler used to water all planted shrub area as opposed to bed spray sprinkler.
3. BED SPRAY — a sprinkler used in small restricted bed areas and narrow planter boxes for dispersing water better than a bubbler under heavy foliage.
4. BUBBLER — a spider stream or surface — flood — a sprinkler designed to soak restricted areas.
5. ROTARY
   - a.) Pop-up — a relatively large area sprinkler with one or more nozzles, which rises above the ground and rotates throwing streams of spray over a circular area driven by ball, cam, gear or impact.
   - b.) Above Ground — relatively large area sprinkler with one or more nozzles mounted above ground and driven for the most part by impact.

STATIC PRESSURE: The water pressure on a system when there is no water flowing through the system, thus incurring no friction losses.

STATION: Refers to the station on the controller which controls a group of heads and valve(s) or the heads controlled by that station.

SUMP: A pit utilized far draining. In sprinkler work, a gravel filled pit into which drain valves empty water from the sprinkler lines.

SURGE: The pressure increases caused by the velocity of flow of water and speed with which the flow is stopped.

SWING JOINT: The method of piping used when making a connection off a line so the line will be protected if the piping leading from it is placed under strain.

TAPPED COUPLING: A fitting, usually of cast iron, for use on asbestos-cement or cast iron pipe which couples the pipe together and furnishes an outlet which is tapped to pipe size so piping can connect into it.

THREADED FITTING: A fitting of plastic or steel which has threaded fittings on all openings. Threads are standard iron pipe size threads.

TRANSITE PIPE: A trade named asbestos-cement type of pipe often used as a general term for asbestos-cement pipe.

TYPE (of pipe) : A designation which denotes the material construction of the pipe.

VACUUM BREAKER: A type of anti-syphon device. Either atmospheric or pressure type.

VALVES: Refer to a wide assortment of devices for controlline a liquid.

1. Remote control
    a.) hydraulic
    b.) electric
    c.) thermal
2. Manual
    a.) angle
    b.) globe
    c.) gate
3. Check
    a.) swing
    b.) low pressure flow preventer
4. Pressure regulating

Air relief

6. Pressure relief
7. Anti-siphon
8. Quick-coupler

VELOCITY: The speed of water in a pipe. Expressed in feet per second. Not to be confused with pressure.

WATER LOAD: The maximum capacity a system will require for operation expressed in gallons per minute.

WATER DEMAND: The same as water load.

WATER HAMMER: The shock waves set up in pipe lines due to surge condition.

WATERING CYCLE: Refer to “Operating Cycle.”

WATERING REQUIREMENTS: Requirements demanded by the turf. Includes infiltration rate and infiltration capacity.

WORKING PRESSURE: The pressure at any point of the system while the system is in operation.

REFERENCES

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2. **Sprinkler Irrigation. Sprinkler Irrigation Association, Washington 6.,DC**

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