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USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association

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Cover Photo — The 16th hole at the Cypress Point Golf Club on the Monterey Peninsula of California. A par 3 hole across an arm of the Pacific Ocean, this is considered perhaps the most scenically spectacular hole in golf.

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A Guide to Turfgrass Fungicides For the 1970s

by STANLEY J. ZONTEK, Agronomist, USGA Green Section

Imagine this fictitious scene. A group of superintendents is sitting around a dinner table discussing turf problems. One fellow comments that the Chloroneb he used for snow mold didn't give him such good control.

One of the other men says, "Well, then, try Tersan SP. It's new and will really do the job for you."

The third one says, "Well, I got some of this Demosan and, boy, did it clear up the snow mold. Try this one on your greens." As it turns out, all the superintendents were talking about the same chemical produced under different trade names.

There is much confusion of this type in the turfgrass field today. This article will attempt to clarify some of it and serve as a handy cross-reference for the fungicide user. In a later section the cost of some of these fungicides will be compared on a cost-per-1,000 square foot basis. This again can serve as a reference for the fungicide applicator.

The following is an alphabetical listing of the more commonly recognized trade names used in the Northeast. This could vary in other parts of the country, but some starting point is needed. The section titled "Other Names" holds particular importance, because these are the different trade names under which one type of chemical is sold. For example, Thiram is sold under 26 different trade names. It is therefore possible to purchase the same chemical with the same amount of active ingredient from a different company for less money.

The "Uses" category lists the types of diseases that the chemicals are supposed to control. We realize that in some geographic areas a particular fungicide is not recommended for the use under which it is listed. This is regrettable, but the "Uses" section should generally be apropos.

The "Combination" section was included because of the many different fungicide mixtures used to control diseases. With the number of fungicides that are compatible and can be mixed together, this section could be endless. Therefore, only those combinations manufactured and sold under a trade name are listed.

The final listing is the "Formulations" section. This contains most of the formulations available through the manufacturers. Because there could be some variations from different manufacturers, any mention of application rates is avoided.

The following contains an alphabetical listing of some of the most commonly used turfgrass fungicides. Prices shown are retail prices from Northeastern United States supply houses. These prices could vary in different parts of the country and according to the quantity of the fungicides purchased.

The cost per 1,000 square feet is the main criteria for comparison. This is the cost of the fungicide itself as it is applied to the turf at the given rate, minus labor. The cost was computed in this manner:

$$\frac{\text{Cost per case}}{\text{Pounds per case}} = \frac{\text{Cost per pound}}{\text{16 oz. per pound}} =$$

$$\text{Cost per ounce x rate per 1,000 sq. ft.} =$$

$$\text{Cost per 1,000 sq. ft. of the fungicide}$$

By using this same formula, any applicator can quickly and easily compute the cost per 1,000 square feet for any turf fungicide not listed.

Summary:

It is our hope that this information can prove helpful in eliminating some of the confusion and doubts regarding turfgrass fungicides. Hopefully the "Costs" section will allow the applicator to use his fungicide dollar more efficiently.

TRADE NAME	COMMON NAME	OTHER NAMES	USES
Actidione	Cycloheximide		Antibiotic fungicide. Rusts & leaf spots on grasses, powdery mildew, dollar spot, melting out, *Helminthosporium. Caution:* Incompatible with most wetting agents.
** Benlate	Benomyl	Tersan 1991	Systemic turf fungicide. Controls pink snow mold, dollar spot, brown patch. *Shows curative effect.* Broad spectrum. *Fusarium* blight, powdery mildew.
Caddy	Cadmium Chloride	Caddy, Vi-Cad, C-A-D	Turf fungicide. Prevention & Control of dollar spot, copper spot, *Helminthosporium* & *Curvularia* leaf spots, brown patch, melting out, damping off.
Cadminate	Cadmium succinate		Turf fungicide. Prevention & control of dollar spot, copper spot, snow mold, red thread.
* Calo-Clor	Corrosive Sublimate plus Calomel	Bi-Cal, Dap-Cal, Calocure, Fungchex Vesicol, 2-1 Fungicide	Turf fungicide. Snow mold, dollar spot, copper spot, *Fusarium* blight.
* Calomel LD_{50}-210 mg/kg (less than corrosive sublimate)	Calomel	Mercurous Chloride	Fungicide. Controls brown patch, dollar spot.
Captan	Captan	Merpan, Orthocide 406	Dollar spot, brown patch, damping off complex, melting out, *Fusarium* patch, copper spot.
Copper Carbonate, Basic	Malachite Green	Malachite	Excellent seed treatment fungicide (smut), brown patch.
Copper Sulfate	Copper Sulfate	Bluestone, Blue vitriol, Blue Copperas	Fungicide — *Fusarium* patch or snow molds. (Algaecide)
Daconil 2787	Chlorothalonil	Bravo, Forturf (formerly)	Fungicide, broad spectrum brown patch, copper spot, dollar spot, *Helminth.* complex, snow mold, melting out.
** Demosan LD_{50}-over 11,000 mg/kg	Chloroneb	Chloroneb, Tersan SP	Fungicide, gray snow mold, damping off, *Pythium* blight & (grease spot, cottony blight, spot blight)
Dexon LD_{50-60} to 150 mg/kg Dermal-100 mg/kg	Dexon	Bay 22555	Fungicide, seeding diseases, *Pythium* blight (grease spot, cottony blight, spot blight)
Dithane-45 LD_{50}-8000 mg/kg	Fore	Mancozeb (Europe)	Fungicide broad spectrum, *Helminthosporium* species diseases.
Dyrene LD_{50}-2710 mg/kg	Dyrene	Direz, Kemate, Triasyn, Turf-Tox D-50	Foliar fungicide, brown patch, dollar spot, red leaf spot, melting out, rust, snow mold. *Caution:* incompatible with DDT.
Koban	Koban	MF-344	Turf fungicide, Controls pythium blight, (grease spot, cottony blight, spot blight), damping off.
Kromad	Kromad (Cadmium Sebacate)		Brown Patch, copper spot, dollar spot, fading out, *Helminthosporium* red thread, melting out.

COMBINATIONS	FORMULATIONS
Acti-dione PM, Acti-dione Ferrated, Acti-dione TGF, Acti-dione Thiram, Acti-dione RZ (with Terrachlor (PCNB))	Wettable Powder.
	50% Wettable Powder.
Cad-trete; thiram plus cadmium chloride hydrate	Liquid (Caddy) 20.1% equivalent to 12.3% elemental cadmium
Kroma-Clor, Ultra-Clor★★ (contains 3.3% cadmium, 14-15% Hg plus urea and iron. Kroma-Clor contains a turf dye.	Wettable Powder.
	Wettable Powder, Granular
Blended with corrosive sublimate to form Calo-Clor and Calocure. Fungchex — 1 part mecuric chloride, 2 parts Calomel.	
	Wettable Powder or Dusts.
Combined with other turf fungicides as a color dye plus some action of controlling brown patch, dollar spot, etc. Malachite Green & Auramine & Crystal Violet = Auragreen.	Wettable Powder.
Mixed with lime and water to form Bordeaux mixture.	Crystalline or Powder (snow) Forms.
	75% Wettable Powder.
	10% Dust 65% Wettable Powder.
	80% Wettable Powder.
	50% Wettable Powder.
	35% Wettable Powder.
Kromad contains 5% Cadmium Sebacate, 5% Potassium Chromate, 1% Malanchite Green, 16% Thiram	Wettable Powder.

TRADE NAMES	COMMON NAMES	OTHER NAMES	USES
Maneb LD_{50}-6750 mg/kg	Maneb	Chloroble M, Dithan M-22, Dithane-22 Special, Kyp-man 80, Maneba, Manesan, Manzate, Manzate D. Sopra-nebe, Trimangol, Tri-manzone, Vancide, Maneb 80, Tersan LSR	Fungicide, Dollar spot, brown patch, melting out. *Helmintho-sporium* sp. leaf spot.
Nabam LD_{50}-395 mg/kg	Nabam	Parzate, Chem Bam, Dithane A-40, Dithane D-14, DSE, Spring-Bak	Fungicide, dollar spot, brown patch, melting out.
PCNB	PCNB, terrachlor, quintozene	Terrachlor, Avicol, Botrilex, Brassicol, Folosan, Tilcarex, Tri-PCNB, Tritisan, Fungiclor, Best Turf Fungicide	Soil fungicide, brown patch, dollar spot, *Fusarium* patch, snow molds, leaf smuts.
Phaltan	Folpet	Thiophal, Folpan, Ortho Lawn & Turf Fungicide	Protective fungicide. Controls melting out.
* PMA LD_{50}-of 20% solution, 100 mg/kg	PMA	PMAS, Agrosan, Gallotox, Hong Nien, Liquiphene, Mersolite, Phenmad, Agway Mer-cury, Merbam, Erad, Metasol, Quicksan, Tag-c-lect	Eradicant fungicide, selective herbicide (crabgrass). Bacterial control, brown patch, dollar spot.
Puraturf	No common (cadmium-copper-zinc chromate complex)	Miller 531, Cragturf Fungicide 531	Turf fungicide. Brown patch, copper spot, dollar spot, snow mold.
Thiabendazole	Thiabendazole	Mertect 140-F, Thibenzole, TBZ, Tobaz	*Systemic fungicide.* Brown patch, *Fusarium* patch, dollar spot, Broad spectrum.
** Thiophanate Ethyl LD_{50}-15,000 mg/kg	Thiophanate	Cleary's 3336*, TD-1604, Topsin-M, Cercobin-M, MF-44	Broad spectrum *systemic turf fungicide* showing curative effect.
Thiophanate Methyl LD_{50}-7,500 mg/kg	Thiophanate Methyl	TD 1771, MF-509, Topsin-M, Cercobin-M, MF-44	Broad spectrum *systemic turf fungicide.* Shows curative effect.
Thiram LD_{50}-780 mg/kg	Thiram	Thiramad, Arasan, Arasan 42-S, Fermide 850, Hexathir, Mercu-ram, Nomersam, Poly-ram-Ultra, Pomarsol Forte, Spotrete, Ter-san, Thimer, Thiotex, Thirasan, Thylate, Tirampa, TMTDS, Trametan, Tripomol, Tuads, Vancide, TM-95, Vancide-TM Flowable, Turf tox, Pandram, D&P Turf tox	Fungicide. Controls dollar spot, snow mold, brown patch, copper spot, melting out, damping off.
Zineb LD_{50}-5200 mg/kg	Zineb	Aspor, chem Zineb, Dithane Z-78, Hexa-thane, Kypzin, Lona-col, Pamosol 2 Forte, Parzate C., Polyram Z, Tiezene, Tricarbamix, Tritofterol, Zebtox, Zidan, Zinosan, Fungi-kill.	Fungicide for turf. Fading out and *Helminthosporium* complex, melt-ing out, pink patch or red thread.

*Does not have final USDA label.
**Denotes mercury product—may be restricted or prohibited in some states.

COMBINATIONS	FORMULATIONS
Chem Neb 54—maneb and zinc. Dithane M-22 Special, Vancide and Maneb also contains zinc (inert)	80% Wettable Powder.
With zinc to form *Zineb.* (Mixed in tank.)	Liquid containing 22% active ingredient or 93% wettable powder.
PCNB plus Captan = Ortho Lawn Disease Control	
	50% Wettable Powder, plus various dusts.
With 75% thiram & 3% PMA to form *Thimer* (controls dollar spot, snow mold, copper spot).	10% and 20% liquids (10% most common)
	60% Wettable Powder. 5% and 10% flowable dusts (experimental).
	50% Wettable Powder.
	Wettable Powder.
Thiuram 75—tetramethyl thiuram disulfide. Thiuram M—Thiram 75 mercurous chloride + mercuric chloride Thiram + PMA = Scutl Mercuram—75% thiram, 4.5% PMA, 313% malachite green	Dust, Wettable Powder, water suspension.
Thimer—75% thiram, 3% PMA. Cad-Trete-Cadmium chloride plus thiram.	
Mixed with nabam and zinc sulfate in spray tank will form Zineb.	80% Wettable Powder

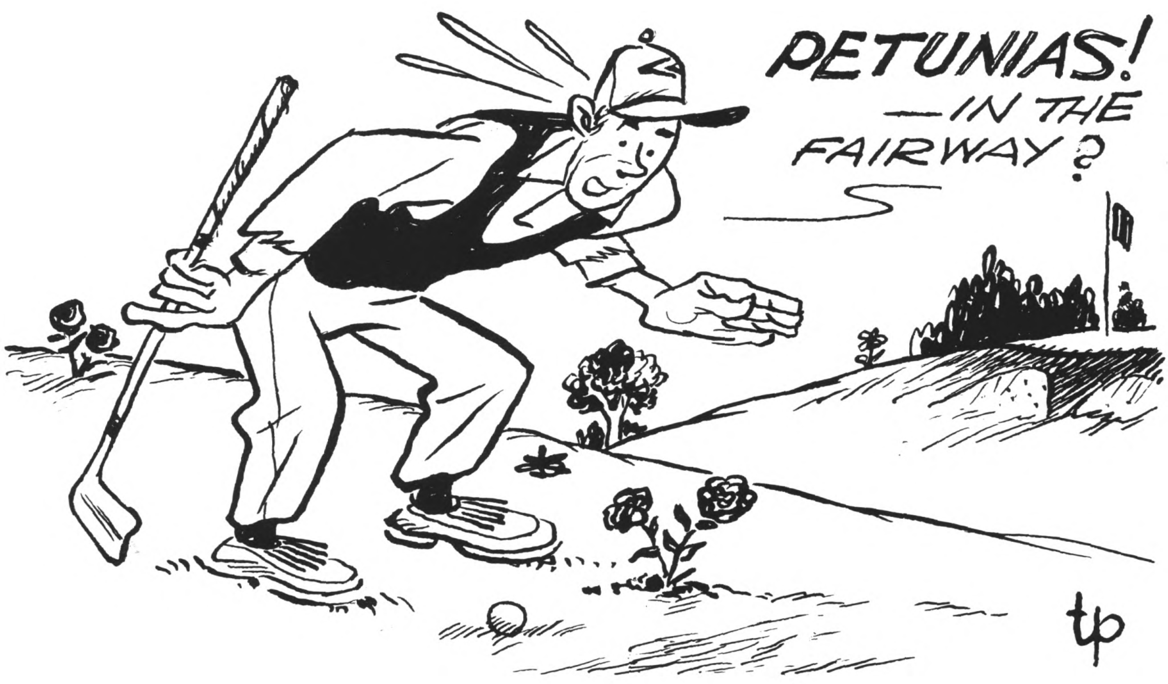
Material	Ingredient	Cost per unit and package	Rate per 1000 sq. ft.	Cost per oz.	Cost per 1000 sq. ft.
ACTI-DIONE FERRATED	Actibiotic Actidione	81.00/case 8.50/box, 14 oz. 12 box/case	1 oz.	.607	.61
ACTI-DIONE THIRAM	Actibiotic Actidione	76.20/case 6.50/bag, 12x20 oz./case	2 oz.	.325	.65
ACTI-DIONE RZ	Actibiotic Actidione	100.20/18# case 12 x 24 oz. bag	2 oz.	.354	.71
CADDY	Cadmium carbonate	92.50/5 gal. 18.50/gal.	1oz.	.144	.14
CADMINATE	Cadmium carbonate	10.70/#/25# drum	½ oz.	.668	.334
*CALO-CLOR	Mercuric & mercurous chloride	11.22/#/25# drum	1 oz. 2 oz.	.700	.70 1.40
*CALO-GRAN	Mercuric & mercurous chloride	.70/#/10x 30# bags	6 lb.	.043	4.20
CLEARY'S 3336	1,2 bis-(3-ethoxy-carbonyl-2-thioureido) benzene	99.00/12#	2 oz.	.543	1.09
DACONIL	Tetrochloraiso-phthalonitrille	62.40/case 12x2#/case	4 oz.	.162	.65
DEXON	p-Dimethylamino-benzenediazo sodium sulfonate	91.20/24# 8x3# cans	4 oz.	.238	.95
DYRENE	2, 4-Dichloro-6-o chloroanilino-S-triazine	68.00/32# case 8x4# bags	4 oz.	.165	.66
FORE	Manganese dithio-carbamate, zinc	67.00/50# drum	5 oz.	.084	.42
KOBAN	5-ethoxy-3-trichloro methyl-1, 2, 4 - Thiadiazole	7.92/#/25# drum	4 oz.	.495	1.98
*KROMA-CLOR	Mercuric dimethyldi-carbamate	3.22/#/25# drum	3 oz.	.201	.60
KROMAD	Cadmium sebacate, potassium chromate, thiram	2.50/#/25# drum	3 oz.	.156	.47
*PANOGEN	Methylmercury dicyandiamide	4.65/gal./30 gal. drum	1½oz.	.072	.11
*PMAS	Phenyl mercuric acetate	13.50/gal.	1 oz.	.107	.11
SEMESAN	Hydroxmercuri-chlorophenol	121.00/25# drum	3 oz.	.30	.90
SPOTRETE	75% thiram (tetramethylthiuram disulfide)	40.50/36# 12x3# bags	3 oz.	.07	.21
TERSAN 75	Tetramethylthiuram disulfide	47.00/36# case 12x3# bags	3 oz.	.081	.24
TERSAN SP	1,4-Dichloro-2,5 dimethyloxybenzene	172.80/36# 12x3# case	6-9 oz.	.300	1.80-2.70

TERSAN LSR	Manganese ethylene bis-dithiocarbamate	30.60/36# 12x3# case	3 oz.	.053	.16
TERSAN 1991	Methyl 1-(butylcar bamoyl) -2 benzimid-azolecarbamate	99.60/12# 6x2# bags	1 oz.	.546	.55

# denotes lb.

*Denotes Mercury Product — May be restricted or prohibited in some states.

SUPER SAM by Paprocki



Pick the right kind of seed for divots.

Drought Stress as a Factor Triggering Fungal Diseases of Turfgrass

by DR. R.M. ENDO and P.F. COLBAUGH, University of California — Riverside

Fungal diseases of crop plants, such as potato and wheat, usually worsen with continued monoculture since pathogen populations tend to increase in the crop debris and in the soil. Although turfgrass diseases occur on golf courses each year, their amount and severity vary from year to year and from location to location, bearing little relationship to the age of the planting.

The erratic occurrence of turf diseases is also evidenced by the limited areas of grass that are diseased even under the most favorable conditions. The frequent failure of disease to develop is difficult to explain since even a small lawn consists of millions of ground-hugging plants of similar genetic make-up and disease susceptibility. The crowded plantings and grass debris (mat and thatch) at the soil surface favor the formation and retention of high humidity and even temperatures required for the growth and rapid plant to plant spread of the disease. Guttation and dew formation is almost a daily occurrence and the population of fungal pathogens apparently increase yearly in the soil, in the mat and thatch and on infected plants. Furthermore, turfgrass pathologists have had to rely on natural disease development for fungicide evaluations, because most attempts to create disease artificially in the field have failed. The factors responsible for this failure, and the erratic development of disease are probably biological in nature.

Facultative fungal parasites of turfgrass (e.g. *Rhizoctonia solani, Sclerotinia homeocarpa, Pythium aphanidermatum, Helminthosporium sativum,* etc.) are constantly being exposed in the following ways to antagonism and competition from the flora and fauna, and therefore their development is subject to biological influences throughout their lifetime:

1. The dense planting and the short, prostrate growth habit of the grass plant place it in contact, or in proximity to the microbiologically active surface litter and soil.
2. The plants are constantly being exposed to microorganisms by means of foot traffic, by maintenance practices such as mowing, fertilization, and irrigation, and by the varied activities of the macrofauna such as earthworms, nematodes, birds, and insects.
3. The grass clippings and the death of lower leaves, stolons, rhizomes, roots and tillers form the surface litter which is composed of fresh and decaying grass debris in various stages of decomposition. The constant addition of fresh clippings to the litter during the growing season is unique and

Helminthosporium Vagans *spores.*

constitutes an effective and continuing source of food for the litter-inhabiting microorganisms which actively compete with the fungal parasites for food.

4. Depending upon the depth of the litter, a variable amount of the stems and roots will be covered by the biologically-active litter.
5. Because of the extreme root density and their surface location, the nutrients which leak out from fresh grass clippings may influence the growth of microorganisms living on or near the root surfaces as well as the litter-inhabiting microorganisms.

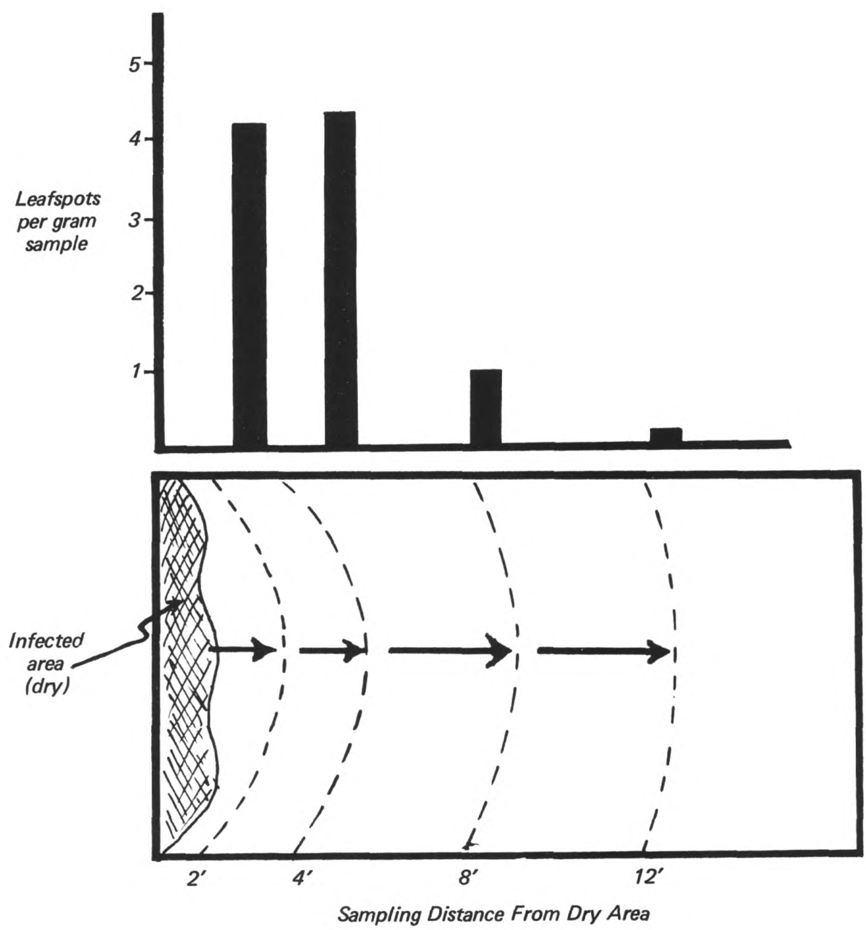
Thus, the total microbiological activity may, at times, be very high in the litter and in the soil, and undoubtedly influences the activity and survival of parasitic fungi.

We suspect that the erratic occurrence of turfgrass diseases caused by these parasites is due to the suppression of them by competitive and antagonistic activities of the flora and fauna. Disease usually occurs when resistance of turfgrass plants has been reduced, or when conditions favor the development of the pathogens more than they favor the development of the competing and antagonistic flora and fauna. Drought stress is an example of a commonly occurring condition or "trigger" which probably frees the fungal parasite from the restraining influence of the competing microorganisms, and allows the parasite to develop. The occurrence of localized dry spots in turf is a commonly occurring problem due to compacted soil, infrequent irrigation, uneven terrain, lack of rainfall, excess mat and thatch, wind disruption of sprinkler patterns and a high degree of water runoff.

The first experimental evidence that low soil moisture may increase certain turfgrass diseases was presented by Couch and associates. They demonstrated this relationship for dollar spot caused by ***Sclerotinia homeocarpa*** (3) and for greasy spot caused by the water-mold fungus, ***Pythium ultimum*** (4). Bean (1) has not only noted that the field occurrences of ***Fusarium*** blight of bluegrass caused by ***Fusarium roseum*** is correlated with the occurrence of dry spots but also that the disease can be greatly reduced by proper watering.

The mechanisms responsible for this increase in disease in dry soils have not been investigated in turfgrass. It may therefore be instructive to consider the research of Cook and Papendick (2) who found that foot rot of

Figure 1. Disease incidence of Helminthosporium *leaf spot with increased sampling distance from an infected dry area of bluegrass.*



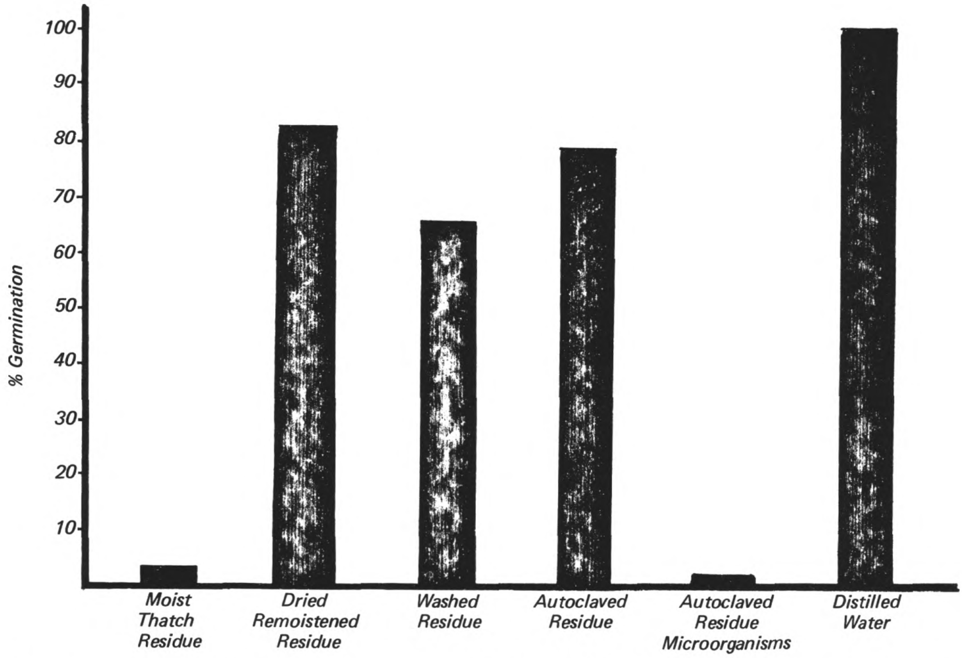


Figure 2. Germinability of Helminthosporium sativum *(T431) conidia on thatch residue of Kentucky bluegrass.*

wheat caused by ***F. roseum,*** the same fungus that causes ***Fusarium*** blight of turfgrass, is favored by dry soils. They found that the number and activities of soil bacteria were reduced greatly at soil moisture levels below -8 bars, that the resistant thick-walled spores of ***F. roseum*** germinated in soil well below the permanent wilting point of plants (-15 bars) and that after germination occurred, the threads of the fungus were able to germinate and infect plants. They also reported that soil bacteria were not only able to inhibit fungal germination but were also able to dissolve the walls of the fungal threads. Cook and Papendick therefore attributed the heightened parasitic activity of the fungus in dry soils to the reduction in populations and activities of soil bacteria.

Following the lead of Cook and Papendick, the effects of drought stress are presently being investigated in turfgrass by P. F. Colbaugh, graduate student at the University of California, Riverside. He has found that disease activity of ***Helminthosporium sativum,*** which causes leafspot and foot rot of Kentucky bluegrass, is increased under conditions of low soil moisture. Field observations on the incidence of the disease indicated that leafspot symptoms decreased with increasing distance of sampling from drought-stressed areas of bluegrass lawns (Figure 1). Severe foot rot and spore production by the fungus on thatch and on infected plants were observed in drought-stressed turf but not in areas receiving adequate water; only occasional leafspots were found in watered areas of the lawn.

The fungus has been recognized by previous workers to be a very weak competitor in the presence of other microorganisms. Evidence which strongly supports the involvement of microbial activity in suppressing the ability of the fungus to develop on the thatch debris is shown in Figure 2. Spores placed on moist thatch residue do not germinate, even though adequate moisture is present, but when washed from the surface of moist debris, they germinate readily. The inhibitory effects of moist thatch residue can be removed by thoroughly washing, sterilizing, or drying debris. The inhibitory property can be restored to the sterilized thatch debris if microorganisms are added to the residue. Immediately after rewetting the dried thatch, it greatly favors germination of ***Helminthosporium*** spores but the inhibitory property of moistened thatch debris returns after a few hours. At the time of rewetting dried thatch debris, large quantities of sugars and proteins are released. Carbohydrate release curves are shown in Figure 3 for both dry and moist thatch residue. Both the level of release and the rate of release were greater from dried debris which was remoistened than from moist debris. Since abundant nutrients are present when the dried debris is remoistened, there is sufficient food to nourish not only the ***Helminthosporium*** fungus, which is a poor com-

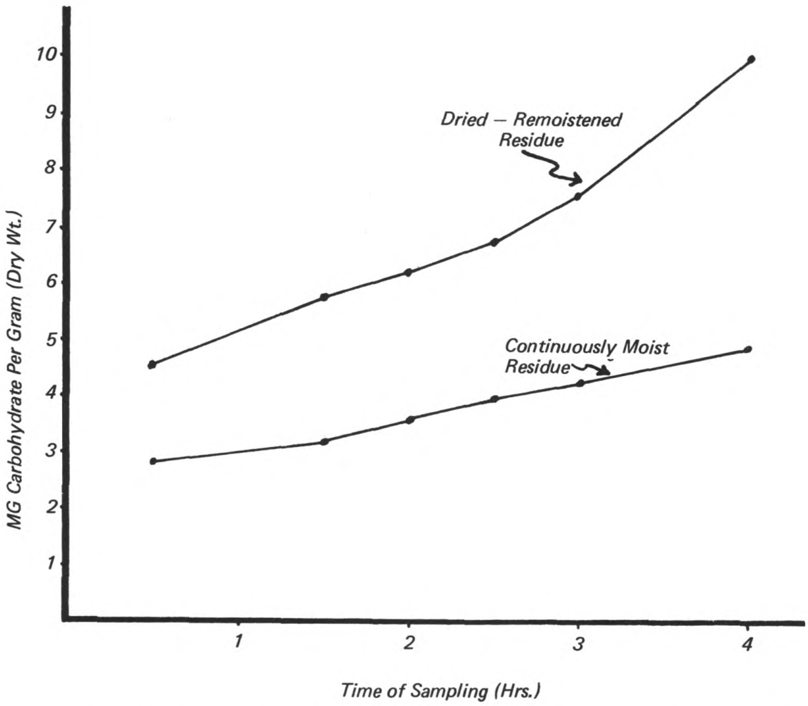


Figure 3. Release of soluble carbohydrates by bluegrass thatch residue.

petitor, but the numerous competing microorganisms as well.

It appears that the inhibitory property of thatch debris is active only when the debris is in a moist state and when microorganisms are present and active. This coincides with the period of greatest microbial activity on the decomposing residue. Drought lowers both microbial numbers and their activities. Upon rewetting, the dried thatch growth and microbial activities are resumed at high levels until equilibrium is once again established with the available food supply.

Another important aspect of drought stress is its effect on stopping plant growth. When growth stops, *Helminthosporium* infections on the lower part of the bluegrass plant tend to develop into the lethal foot rot stage. But when growth is continuous as in the presence of moisture, such infections tend to develop into harmless leaf blade infections.

Effects of drought on reducing microbial activities and increasing the competitive ability of *H. sativum* have been briefly described. Other influences of drought and its effect on turfgrass disease activity await further investigation. Our goal is an understanding of the nature of facultative fungal parasites. Our goal is an understanding of the factors responsible for "triggering" them into activity.

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POA ANNUA—What to do With It

Even today, Poa annua occassionally comes along with good, permanent grass seeds. Here, Dr. R. Kneebone, University of Arizona, points to a Poa annua straggler in a 1971 overseeding of red fescue.

by **CARL SCHWARTZKOPF**, Agronomist USGA Green Section

P*oa annua* continues to be one of the most popular topics when turf managers meet. It has been discussed for the last 50 years and is probably good for at least another 50.

Although a native of Europe, *Poa annua,* or annual bluegrass, is now found around the world. Many turf experts view it as a weed, and, therefore, it is seldom planted intentionally today. However, at one time it was a straggler in nearly all seed mixtures used on golf courses in the northern, cool, humid regions of the world. Because of its universal presence, it will invade and continue to become the dominant specie in an irrigated, close-cut, high-fertility area, if given the opportunity and if not controlled with chemicals or conscientious cultural programs favoring perennial varieties. Occasionally, when *Poa annua* becomes the dominant species, the cultural program is changed to meet the demands of this particular plant.

Annual bluegrass resembles other bluegrasses morphologically in the folded-leaf bud and boat or keel-shaped leaf tip characteristics. However, it is readily distinguished from Kentucky bluegrass by its lighter green color, larger ligule, the absence of rhizomes, and prolific seedhead production. For these reasons, many superintendents and professional turf managers have attempted a number of methods to eradicate *Poa annua.*

CHEMICAL CONTROL

Over 40 years ago, greenkeepers observed less *Poa annua* in greens that were treated with lead arsenate for the control of worms and insects. Today, arsenates are the most widely used chemical for reducing and controlling annual bluegrass. The principle involved is the gradual build-up of arsenate in the soil to a level that provides toxicity to the annual bluegrass plant. When using a calcium or lead arsenate compound for this purpose, several factors must be considered and given attention: (1) low areas must have good drainage, (2) maintain a

Newly germinated seed after the "scorched earth" procedure was implemented.

soil pH between 6.0 and 7.5, (3) use a minimal amount of phosphorus in the fertilizer program, (4) overseed often with desirable bentgrass or bluegrass varieties.

SCORCHED EARTH

Another successful method is the "scorched earth" procedure. When attempting to control *Poa annua* this way, a non-residual contact herbicide, such as sodium arsenite, is applied twice with four or five days between applications. A week after the initial herbicide treatment, seedbed preparations are accomplished by removing excessive thatch, aerifying at least six to eight times and breaking up the soil cores with a thatching machine adjusted so that it penetrates the soil at least ½-inch. Mascerating the aerifier cores with a thatching machine will prepare a desirable seedbed.

The renovated area should then be fertilized and overseeded with a desirable grass species. Maintain a judicious irrigation program for the encouragement of the young seedlings.

PRE-EMERGENCE HERBICIDE

Several pre-emergence herbicides such as bensulide, benefin and DCPA products, have been introduced for control of crabgrass and have shown variable control of *Poa annua* as well. Another chemical reportedly suppresses seedhead production and theoretically controls the annual plant in this way.

CULTURAL METHODS

Aeration alone, aeration and thatching, or thatching alone, followed by overseeding, are some of the cultural methods that have been used to discourage *Poa annua* and encourage the perennial varieties. Discouraging *Poa annua* by cultural methods alone is a long process. The program must be repeated for several years (at least four to five) until the permanent turf is able to compete successfully against the annual plant.

As mentioned earlier, when *Poa annua* becomes the dominant specie in fairway or tee turf, a cultural program is sometimes adopted to meet the requirements of this unique plant. In northern, cool and humid regions *Poa annua* will usually produce acceptable fairway and tee playing conditions. It maintains good color for most of the year and greens up earlier in the spring than bentgrass and stays greener longer in the fall. It can be cut from 1/4 to 3/4-inch, and most golfers will agree this is the way a fairway should be.

What are some of the cultural practices necessary to keep it alive? For one, judicious watering during the summer is essential. As summer soil temperatures increase, *Poa annua* roots decrease until they exist only in the top inch or two of the soil. This demands good watering practices. Syringing during the hot days of July and August is often necessary. The "wilt watch" or "wilt patrol" is made up of crew members who are responsible for syringing wilting fairway turf. By applying a small amount of water to the wilting area, this annual plant can be preserved for another day. Should wilting *Poa annua* fail to be syringed, it will very likely die, turn brown and remain in this condition until the late fall or next spring.

Sound fertilization is another cultural practice needed in any *Poa annua* preservation program. Most success is achieved with slow-release type materials that allow uniform, healthy growth during the year. Initial amounts of phosphorus can be helpful in strengthening the *Poa annua* plant. The use of potassium or potash helps to stiffen the leaf blade and adds to disease resistance of the plant.

A fungicide program should also be followed. *Helminthosporium spp.* (leaf spot), *Sclerotinia homeocarpa* (dollar spot), *Rhizoctonia solani* (brown patch) and *Fusarium Nivale* (Fusarium patch) cause large amounts of *Poa annua* to die each year.

Finally, good drainage and timely aeration must be practiced in order to maintain this grass and help it to grow. If all of these practices are followed and if the weatherman cooperates, *Poa annua* can usually provide a reasonable playing turf that is not always unattractive.

Several different strains of *Poa annua* have been observed. Some perform better during stress periods than others. We have often heard the suggestion that the plant breeder should develop a type of *Poa annua* that will withstand climatic stress conditions. Genetic improvements have been attempted. The problem is that *Poa annua* is not a single, apomictic strain as are other bluegrasses. This fact makes developing hardier *Poa annua* varieties far more difficult. For this reason and others, stronger types of perennial bluegrass are favored by researchers. Strong perennial types can be very competitive with *Poa annua.*

Poa annua can survive and provide a desirable playing surface in northern, cool humid regions if properly managed. However, whenever and wherever high summer temperatures prevail, one can expect difficulty in managing this grass. Therefore, the control measures outlined earlier and the development of a more desirable, permanent turf seems advisable.

Poa annua lost on a green due to high temperatures.

Updating the List for Golf Course Maintenance Equipment

by LEE RECORD, Mid-Continent Director, USGA Green Section

How modern is the maintenance equipment at your golf course? What value has been placed on it should it be lost in fire, flood, or vandalized? How accurate is the inventory of the equipment and tools? Is the maintenance area clean and well organized? Are employees positively motivated by the equipment they have to use? These are just a few of the questions a superintendent, an owner, a manager and green chairman should ask himself.

It is true that equipment alone will not produce a manicured and well-groomed course. It takes good people to do this, but good people are at their best with adequate and good equipment.

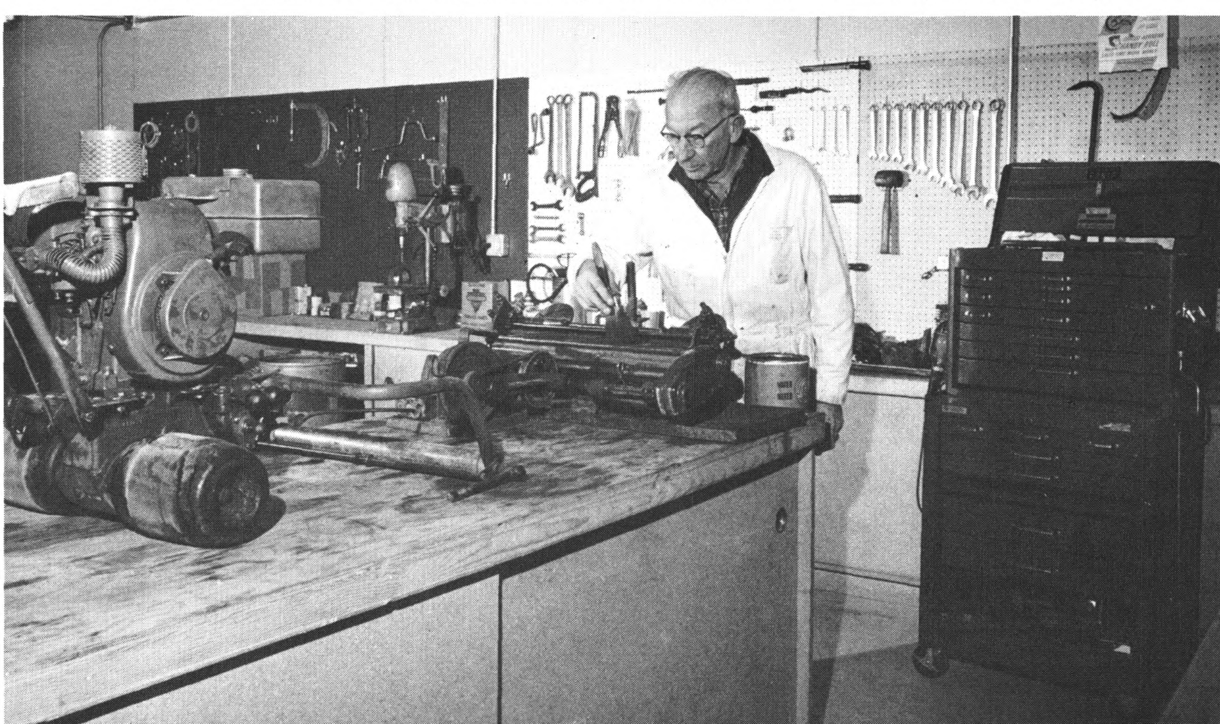
The following is a suggested list of equipment that should be adequate at most 18-hole courses, depending upon total acreage and degree of maintenance perfection.

GREENS AND TEES

The following suggested list of equipment is interrelated for greens and tees, as many tees are maintained under a green management program.

2	Riding triplex putting green mowers and optional equipment; vertical mower, spiker, brushes (used on greens, tees and collars)
5	Hand putting green mowers
2	Power aerators
1	Vertical mower designed for greens
1	Power spiker
1	Power drag mat
1	Power top-dresser
1	Power sprayer (fungicides) (may be used on truckster)
1	Proportioner (regional — optional)
2	Hand rotary fertilizer spreaders

A clean, well-organized work shop provides good working conditions and improves efficiency.



1 Power rotary fertilizer spreader (may be used on truckster)
2 or 3 Utility turf trucksters
1 Power blower (sm.)

FAIRWAYS AND ROUGHS

1 Seven or nine gang hydraulic tractor and mower (optional — 2 seven gang units for fairways, depending upon region)
1 Fairway aerator
1 Fairway sweeper
1 Fairway thatcher
1 Power sprayer (300 gallon) (herbicides) and attachments
1 Power rotary fertilizer spreader (tractor drawn)
1 5-gang mower (roughs)
1 3-gang roller (optional)
1 72 inch PTO rotary mower with leaf mulcher attachment
1 Power leaf blower

GENERAL EQUIPMENT

1 Power sand trap rake
2 or 3 Utility turf trucksters
1 General construction PTO tractors (2 if fairway units are not hydraulic)
1 Dump body golf tractor
1 Pickup truck — Jeep, etc.
1 Dump truck (2½ ton min.)
1 Snow plow (regional)
1 Front end loader with backhoe and landscape blade
1 Power sod cutter
1 Power soil shredder
1 Power screen
1 Power hand sweeper
1 Water ballast roller
1 Power grass edger
3 24" or 30" rotary mowers
2 hand mowers
1 21" power reel mower
1 Power wood chipper (regional)
1 Tractor drawn trailer
1 Trencher
1 Rotary hoe
1 Portable pump

MISCELLANEOUS HAND EQUIPMENT

(This list will go from A to Z.) Axes, burners, crow bar, duster, cup cutter, wheelbarrow, ladder, sod edgers, sod lifters, shovels, rakes, funnels, spade, picks, forks, jacks, pruners, tree saws, traps (animal), pumps, gas cans, scales, pullers, hose, bamboo poles, soil testers, soil probe.

MAINTENANCE TOOLS (for repair of)

All power equipment (trucks, tractors, mowers, etc.), plumbing, drains, electrical equipment, sewers, roadways, cement and concrete, water systems, painting and wood working repairs.

SHOP EQUIPMENT

Lapping machine, air compressor, steam cleaner, table saw, bench grinders, bed knife grinder, reel knife grinder, pipe threader, paint sprayer, welder, drill press, vises, arbor press, work benches.

IRRIGATION EQUIPMENT

Irrigation equipment and pumping station will be completely dependent upon the type of system you have, manual or automatic, and the location in the country where your golf course is situated.

This list may not include the one piece of equipment, the hand tools, or necessary shop tools you feel are required under your conditions. By all means, add them to the list; these are only basic suggestions.

Safety and health regulations dictate that the following suggestions concerning the maintenance building be adhered to:

1. Adequate heating and ventilation
2. Toilet facilities (showers, etc.)
3. Herbicide — fungicide storage room
4. Fertilizer storage area
5. Adequate working and storage area for equipment
6. Paint spraying room (ventilated)
7. Adequate electrical outlets and fire safety devices (first aid equipment)
8. Lunch area and lockers for employees
9. Superintendent's office (desk, cabinets, chairs, adding machine, telephone, bookcase, etc.)

In addition to the maintenance building, a building is necessary for storing and mixing topdressing. Topdressing should be kept in a dry area so that it will be available at any given time of the season.

The following named personnel are necessary to make the nucleus of your work force and should be maintained on a year-round basis.

1 Superintendent
1 Assistant Superintendent or Foreman
1 Mechanic
3 Laborers

ADDITIONAL HELP

2 Laborers should be hired as the outside maintenance season begins and their employment concluded when fall maintenance is completed.
3 Laborers to be hired as summer help.
11 Total

A Perspective on Pesticides

by **DR. ROBERT WHITE-STEVENS,** Rutgers University, New Jersey

There is a gathering reaction to the progress of science in our time particularly among the young, who though happily secure in the munificence provided by modern technology, nevertheless despair over its miscarriages. They are oppressed with a sense of decay and regression, by a fear of a world deteriorating through technological innovation. Artificial chemical fertilizers and pesticides are said to be undermining their health; the soil and the sea are being poisoned by chemical and radioactive wastes; drugs merely substitute one form of disease for another, and modern man oscillates continually under the influence of stimulants and sedatives.

This feeling of despondency seems to prevail everywhere. Even knowledgeable, intelligent people are 'seeking refuge in an elevated form of mystical nuttiness.

Thus we condemn the antibiotics because they elicit allergic reaction among a few, while they restore the health of many. We decry the use of medicaments in livestock feeds because minuscule and innocuous residues may occur in our food supply, the quality and quantity of which is vastly enhanced by their use. We accept as our rightful heritage the total elimination of vast areas of hunger and disease, yet we clamor furiously over the exaggerated and imagined dangers of pesticides.

There is a tendency, even a perverse willingness, to suppose that the despoliation sometimes produced by technology is inevitable and

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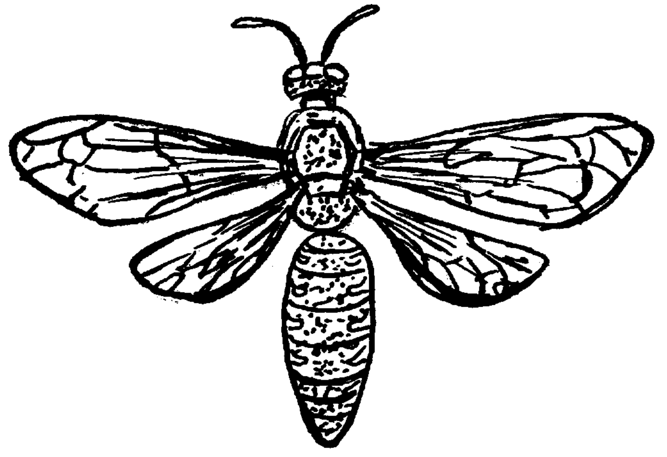
The Author

Dr. Robert White-Stevens is Professor of Biology and Chairman of the Bureau of Conservation and Environmental Science at Rutgers University, New Brunswick, N.J. The following text has been condensed from an address delivered by Dr. White-Stevens at the 52nd Annual Meeting of the American Farm Bureau Federation.



irremediable, a trampling down of nature by some huge inexorable machine. Actually, of course, whatever environmental deterioration is induced by technology is a problem for which science has either found or will shortly find a solution.

Complaining about the rape of our environment by technology when the need is to seek and apply adequate regulation of unwanted side effects is futile. Panning scientifically established uses of certain pesticides when the overwhelming facts dictate that our food supply, our health and the entire measure of our living standards would clearly be threatened and ultimately impaired by such rash and ill-considered legislation is ridiculous.

Billions of Babies

The major environmental insult in the world today is the accelerating increase in the human population. Even conservative estimates now concede the world level will exceed 6 billion by the year 2000, and a more realistic figure is 7 billion. The major thrust of this fantastic increase continues to be in Asia, which may well support a population almost equivalent to the rest of the world combined by the year 2000. However, both South America and Africa are increasing as rapidly as Asia today. Although western Europe has virtually reached a plateau, eastern Europe continues to increase. Even North America may well exceed 400 million people by the turn of the century. In a recent Census Bureau projection, the United States population alone is expected to reach nearly 322 million. Either man will find an effective solution to curbing his numbers or nature will do it for him.

In the meanwhile, scientific agriculture can hold "a finger in the dike" certainly through the year 2000, and perhaps beyond, to provide food for up to 10 to 12 billion humans through the worldwide application of food production technology now on the books, together with new developments achieved over the next 30 years.

This, however, can only be done if the work is allowed to continue and expand without hampering legislation and regulations promoted by an irresponsible and uninformed minority.

Nonnegotiable Demands

There are two approaches to meeting the stupendous demand for food over the next 30 years.

The first—horizontal expansion into new and, as yet, untapped potentially arable land—is the most obvious and perhaps the more readily achieved. However, it will constitute the more serious threat to the environment and will press wildlife into extinction more rapidly.

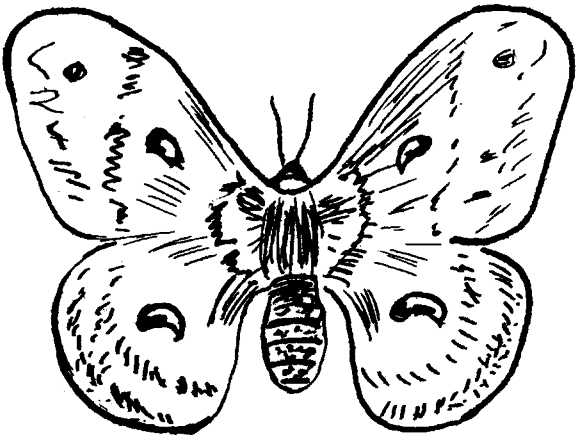
The second approach—vertical expansion, or increased productivity per acre—will, therefore, become mandatory, even if the present arable area is increased by 33 per cent.

The possibilities for such a vertical increase are exceedingly promising. For example, in the United States within the past 30 years, grain yields have more than doubled and grain production per farm worker has advanced sixfold. These advances are reflected by the lowest cost in food supply to the consumer for the most abundant and highest quality food supply at all seasons of the year that any nation has ever achieved in history. It also allows five per cent of the population to provide all the food for all the people.

About the Bugs

No amount of productive efficiency or reliance upon natural controls of pests can ever be expected to attain a productive margin ahead of their ravages. Their rate of reproduction is far too rapid for farmers to be able to raise food in sufficient amounts to feed both pests and humans. The pests will win it all virtually every time.

In India, for example, where chemical pest control is minimal, as much as 50 per cent of the food from the very low yields harvested never reaches the consumer's mouth. Thus the application of simple protective pesticide measures could virtually double the effective food production in a land where 300 million people are continually on the verge of starvation.



A Matter of Life or Death

Pesticides, particularly the persistent organo-chlorine compounds, effect their most significant impact in the field of controlling insect-borne human diseases. DDT alone has saved more human lives than all the wonder drugs combined.

Malaria, as far back as history records, has been the greatest disease killer of mankind. More human beings have perished from malaria than all other infectious diseases combined.

When DDT was first introduced into India through the UN World Health Organization program to fight malaria, there were over 75 million cases a year with upwards of 5 million deaths. Within 10 years, intensive spraying of houses and breeding sites so reduced the vector that the total incidence per year was down to less than five million cases, with less than 100,000 deaths, probably the most fantastic achievement in the history of public health medicine.

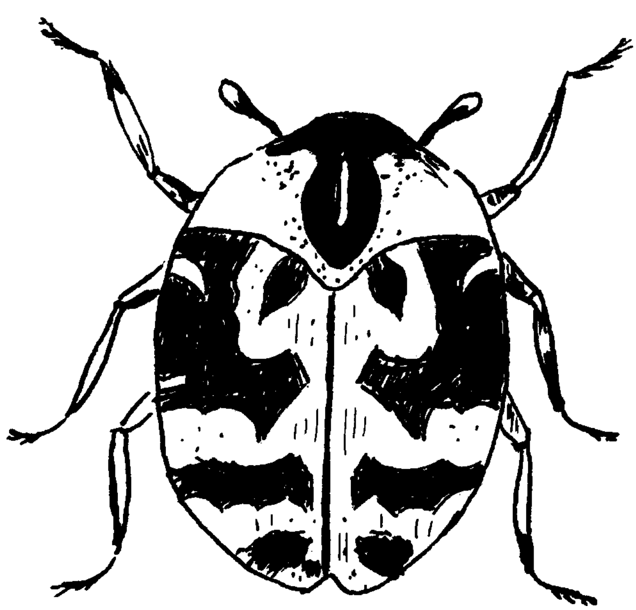
On the island of Ceylon, where malaria had raged for millennia, the disease was virtually eradicated by 1950. Except for a few imported cases, malaria remained absent until the DDT spray was abandoned for questionable political reasons. Gradually, but with accelerating momentum, the Anopheline mosquito returned. By 1968 nearly 500,000 people came down with malaria and its incidence in 1970 exceeded one million in a population of eight million. The Singhalese Government wisely decided to return to the use of DDT.

In spite of all the furious clamor of late by a vociferous minority, no evidence of injury, cancer, or death to the one billion humans who have been exposed to DDT has ever been authoritatively reported after 25 years of use. Not one invidious claim has ever been medically established. Even workers in DDT plants, heavily exposed to the technical compound daily at a level at least 200 times that of the general population for upwards of 19 years, revealed no significant clinical effects.

Wrapped in DDT

Essentially, many ecologists and conservationists are concerned primarily with the persistence of pesticides in the environment to which they are applied. It has even been stated that over 95 per cent of all the DDT ever applied is still present as such, or as its biologically active derivatives, and continues steadily to impregnate the entire planet, land, water and air.

This is absolutely untrue. To begin with, the older pesticides such as lead arsenate, the mercuries and coppers are indeed permanent, as they never degrade. This is not true of the organic pesticides including DDT and the other organo-chlorines. Some, such as the organo-



phosphates, have half lives measured in hours or days, although many of them are exceedingly toxic to wildlife for the period they are around. Others, such as DDT and the other organo-chlorines, have half lives measured in days, weeks, months and in a few instances, years. Their rate of decay is subject to many environmental factors including temperature, moisture, light and the presence of organic matter and microflora. The particular combination of these factors determines the actual half life in each case.

Organo-chlorines are, as a group, highly insoluble in water so their movement in water is both slow and minute. They do, however, have a strong affinity for fats, oils and related fatty substances and they tend to be easily absorbed by organic matter. When streams or rivers do become contaminated at measurable levels with DDT, it is usually through erosion of treated soil which carries the absorbed pesticide into the water where it remains, settling with the soil into bottom muds. There it slowly decays. This has been verified by long-term monitoring of estuarine waters and bottom deposits at the mouths of our major river systems. The Mississippi delta is particularly significant in these studies, as this mighty river system drains a vast agricultural area where millions of pounds of pesticides are applied annually. If, indeed, there actually was a steady drift and accumulation of DDT and derivatives in our waterways, the mouth of this great watershed would reveal it. It does not, after nearly eight years of intensive investigation.

In sandy, dry soils in mild climates DDT and derivatives do persist, in some cases, with a half life of up to 10 years.

Pesticides in Perspective

Small quantities of DDT and derivatives have been detected in remote places on the planet where, presumably, no direct application has been made. This is true of many other toxic substances, including arsenic. Many of these studies are more an accolade to the exquisite refinement of our modern analytical techniques than an ominous warning of the poisoning of the total environment.

DDT and derivatives found in Antarctic penguins is a case often singled out. Actually, the amount is so trivial that if the entire Antarctic penguin population carried the same level (which it does not) the total amount of DDT or its equivalent would aggregate about half a pound for the entire continent. Nor was DDT detected in snow samples taken, so there is no evidence that the wildlife data indicates a universal contamination of this remote area. It seems far more probable that the observed DDT came from Antarctic explorers' wastes and

rubbish. Similar sources are suspect for the occurence of DDT and derivatives among fish caught far out to sea.

There have undoubtedly been fish kills among inland streams and waterways that are in small part, at least, attributable to pesticides which entered the water either by direct application or by erosion of treated nearby soils. In a few cases, irresponsible dumping of residue sprays or old containers directly into streams has killed fish.

However, the published records of unnatural fish kills in the U.S. over the past seven years reveal that only one to three per cent of the total kill can actually be assessed against pesticides. Municipal and industrial wastes, on the other hand, account for over 70 per cent of the kill each year.

Bird Facts

Concern over the impact of pesticides upon terrestrial wildlife, particularly birds, is not entirely void of justification, but again it has been exaggerated out of all proportion to actual facts.

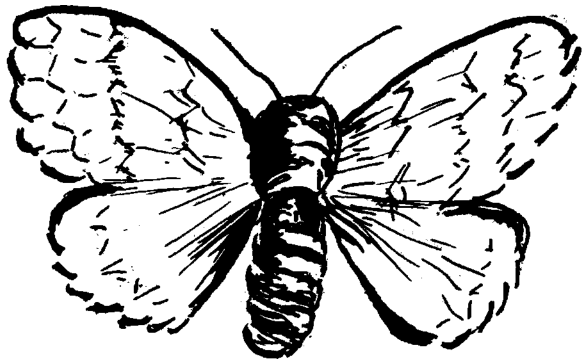
Consider that insects and disease destroy each year more than 30 times as much lumber and trees as all the forest fires combined, and with that insect destruction go vast ecological areas for feeding and nesting of birds and other wildlife. Consider also that insect-borne avian diseases, a number of which are transmissible to man, destroy literally millions of desirable birds—e.g., pheasants, quails, ducks, doves, etc. It would seem a very strong case for the contributions made by man's use of pesticides to the welfare of wildlife. Certainly an unrestricted plague of grasshoppers readily destroys the wildlife along its extended paths. Last summer the gypsy moth denuded over 100,000 acres of forest in northern New Jersey: the wildlife—birds, mammals and even snakes—left the ravaged areas in droves, for they had no food, no nesting place and no shade.

Contrary to the oft-quoted myth initiated in Rachel Carson's *Silent Spring*, where the main concern was over the alleged rapid decline in bird life in America, careful bird counts made over the entire country and published by the National Audubon Society reveal that many favored species of birds have actually increased in numbers in many areas of the country. Thus robins, starlings, sparrows, seagulls, ducks, wild turkeys, blue jays, cardinals, pheasants, quail and grackles have all increased at least twofold and some more than 40-fold in the past 25 years since the organic pesticides (including DDT) were widely introduced. Surprisingly, a number of raptorial species (hawks) which, being at the top of the carnivorous food chain, are alleged to being rapidly poisoned into extinction, have also shown that they are either holding their own or are increasing. Unfortunately, several do show a steady decline and include among their number Cooper's hawk, golden eagle and the peregrine falcon. These declines, however, appear to be more related to the encroachment of man's civilization upon their wild breeding and feeding haunts than upon the direct effect of any pesticide. Certainly the peregrine falcon was driven from the Hudson River escarpments by man's intrusion long before DDT. In many areas of the world this superb raptor has shown a decline regardless of whether DDT was used in its environment or not.

New Habitats

The fish hawk, or osprey, on the other hand, though driven from its shoreline haunts on the East Coast has reinforced its numbers inland and a significant rise in the migration count has been recorded for several years at the Hawk Mountain Sanctuary Observation Post on the Great Appalachian Flyway.

The brown pelican's serious decline on the West Coast is furiously blamed on DDT. On the other hand, he is flourishing along the Florida coasts where DDT has been used as much if not more than in California.



Conservation or Conversation

Unreasonable public fear of scientific technology in general, and of agricultural chemicals specifically, gives rise to voracious criticism, but there is no point in banning pesticides until there is an equally efficient way found to do their job. Great strides have been made by the "Green Revolution" in producing food, clothing and shelter for billions of humans. Let's not negate these strides nor set an example for developing nations by hysterically restricting the use of pesticides.

There is no question that man's multiplication invokes a massive impact on the environment and impinges upon many of the wild creatures. Hopefully we can find a way to preserve and conserve both man and wildlife. Conservation is directed primarily at conserving man and those plants and creatures and areas which serve man: anything else is not conservation but merely conversation.

USGA GREEN SECTION RECORD
JULY, 1972

TURF TWISTERS

FUNGICIDES – COMBINE THEM

Question: The systemic fungicides are doing a good job at my course. Is there any reason to spray with any other fungicide? (Conn.)

Answer: By all means continue to use other fungicides in conjunction with your systemics. Even though the systemics do a good job, there are diseases that are not completely controlled with their use. Tests at a university show that the best results are achieved by using systemics in combination with regular fungicides.

CHINCH BUGS – CONTROL THEM

Question: Will chinch bugs attack bermudagrass? (Texas)

Answer: It has not been a problem in the past, as far as we know, but recently there have been reports of them in the south central areas of Austin and San Antonio. Trithion has been used to eliminate the ones present. We don't know how extensively this pest may develop, so keep close watch on your greens especially.

OVERSEED SEED – TREAT THEM

Question: Is it true that treated seed will be available this fall for bermudagrass overseeding? (North Carolina)

Answer: Yes, the EPA (Environmental Protection Agency) has approved the treatment of cool season grass seed for fall overseeding to reduce seedling diseases. Experimental results have been very gratifying although treated seed will be more expensive. However, this may solve a lot of our problems in establishing a winter overseeding.