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SIDURON CONTROL OF BERMUDAGRASS IN COOL-SEASON TURFGRASSES

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University of California studies have shown that common bermudagrass seedlings can be controlled with siduron without injury to some cool-season grasses. Rooting of common bermuda stolons can also be prevented with siduron indicating a possible means of preventing invasion of cool-season grass turfs from surrounding areas of bermudagrass. However, this is not at present a recommendation as variations in susceptiblity of various cool-season grasses have been observed. Additional research is needed to determine interactions with various environmental and management factors.

Siduron 1-(2 methylcyclohexyl) -3-phenylurea, is marketed under the brand name of Tupersan for the pre-emergence control of crabgrass and some other annual grass weeds in turf. Callahan (1966) reported that bermudagrass and some other warm-season grasses were severely injured by siduron while several cool-season grasses showed a high tolerance. This was confirmed by by later studies at the University of California, Riverside, which showed that common and hybrid bermudagrasses, Zoysiagrasses and St. Augustine grass were injured by siduron rates as low as six lbs. active per acre. In the same tests and others performed later Kentucky bluegrass and tall fescue were uninjured at rates up to 30 lbs. per acre. Dichondra and Seaside creeping bentgrass were tolerant of siduron to 12 lbs. active per acre but were injured at higher rates.

Because cool-season and warm-season grasses showed this great difference in susceptibility to siduron several experiments were conducted in the greenhouse, controlled environment chambers and field to determine if the herbicide could be used to control bermudagrass in cool-season grass turfs.

Effects on sprigs and seeds

Seed is the most common source of common bermudagrass contamination of cool-season grasses. Occasionally sprigs or sections of stolons may be carried into a cool-season grass lawn and become established. These problems may be especially acute when a new turf is being planted since a good seedbed exists and competition is low.

To determine if siduron might be used to prevent bermudagrass contamination of a new turf from these sources the following greenhouse study was conducted. Standard greenhouse flats of a soil, sand and organic matter mixture were planted to common bermudagrass seed, Newport Kentucky bluegrass seed, a mixture of the bluegrass and bermudagrass seed, unrooted stolons of common bermudagrass and a combination of the bluegrass seed and the bermudagrass stolons. Three flats of each were then sprayed with siduron at the rate of 12 lbs. active ingredient per acre. Three flats of each were left untreated.

The number of established plants of each species were determined four weeks after planting (Table 1) . Kentucky bluegrass establishment did not appear to be affected by siduron whether planted alone or with bermudagrass. In contrast, bermudagrass seedling establishment was prevented by siduron. The few plants that did survive the treatment were at the edges of the flats; most likely from seed that escaped contact with the herbicide.

Table 1. Kentucky bluegrass and common bermudagrass establishment four weeks after planting when treated with siduron at olantine time.

Planting Material	Mean number of established plants per flat: Siduron 12 lbs. ai/A		Control (No Siduron)	
	Blue-grass	Bermuda-grass	Blue-grass	Bermuda grass
Bluegrass	152	--	161	--
Bluegrass + Bermudagrass seed	133	5	137	156
Bluegrass + Bermudagrass sprigs	118	18	164	50
Bermudagrass seed		9		148
Bermudagrass sprigs		23		54

Bermudagrass sprigs were not killed by the single application of siduron but many had not rooted in the 4-week period since planting. Roots that were formed were stunted with darkened tips. Eventually most of the sprigs in the siduron treated flats did root but establishment was much delayed compared to those in the untreated flats most of which had vigorous root systems in four weeks.

Field tests on bermudagrass seed'

To determine if bermudagrass seedling establishment could be prevented under field conditions treatments were made on old Kentucky bluegrass and dichondra plots at the South Coast Fielcl Station, Santa Ana. The bluegrass turf was thin and open and there was little live dichondra but abundant seed in the dichondra plots at the start of the experiment.

Siduron applications were made in March, May and July at the following rates: 0, 2.5, 7.5, 10 and 12.5 oz. actual ingredient per 1000 sq. ft. in each application. Following the third treatment the entire area was seeded to common bermudagrass at two lbs. per 1000 sq. ft.

Evaluations in September showed a heavy stand of bermudagrass with dichondra, oxalis, prostrate spurge and Kentucky bluegrass in the control treatment (no siduron). The plots receiving the 2.5 oz. rate contained a few weak bermudagrass plants but abundent dichondra and Kentucky bluegrass. All plots receiving higher rates were devoid of any vegetation except Kentucky bluegrass which appeared perfectly healthy.

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Effects of climatic factors

A series of controlled environment studies at the University of California, Riverside, showed the effects of air temperature, root temperature and light intensity on siduron toxicity to Kentucky bluegrass and Santa Ana bermudagrass (De Mur, Youngner and Goodin, 1973). These factors were considered to be important because siduron is absorbed by the root system and transported by the transpiration stream to other parts of the plant. Siduron treatments were 0, 1 and 5 ppm in the culture solution.

Results showed that bermudagrass was susceptibile to both rates of siduron at both high and low temperatures (30/20 and 22/15°C, day and night temperatures respectively) . However, toxicity to bermudagrass was greater at the higher temperature. Shoot growth was reduced more than root growth. Although bermudagrass was injured at both high and low light intensity, toxicity was decreased by the low light intensity. Root temperature did not affect the toxicity to bermudagrass. Kentucky bluegrass was tolerant of siduron at all concentrations and at all temperatures and light intensities. These studies indicated that differential rates of absorption are not the basis for siduron selectivity between cool- and warm-season grasses.

Field studies on creeping bentgrass greens

Since many experiments and field trials in California and other states had indicated creeping bentgrass tolerance as well as bermudagrass susceptibility to siduron a practical test was established on a putting green of a Southern California Golf Course. The objective of the test was to determine if siduron could be used to control common bermudagrass invasion of creeping bentgrass greens. The test plots were set up on the periphery of a Seaside creeping bentgrass — annual bluegrass green that was being invaded by bermudagrass from the surrounding area. Siduron rates were 6, 12, 18, 24 and 30 Ibs. active ingredient per acre. The first applications were made in the spring of 1972. In the fall of 1972 and again in the early summer of 1973 these plots were split and siduron again applied at the same rates on part of each plot. Thus, some subblocks received, in total, double and triple the amounts initially applied.

Periodic examination of the test plots showed the following: At no time and at no rate was any toxicity to the bentgrass or annual bluegrass apparent. Bermudagrass stolons invading the treated area were reduced in length by the higher siduron rates. At rates of 18 lbs. per acre and above nodal rooting of the bermudagrass was prevented. Repeated applications at these rates were necessary to maintain bermudagrass root inhibition.

Conclusions

Although these studies indicate that siduron may be an effective control for bermudagrass in cool-season grasses it is not at the present time a recommendation. Observations by a number of research workers indicate that creeping bentgrass cultivars and perhaps those of Kentucky bluegrass differ in their tolerance to siduron. Furthermore cultivar responses have not been consistent among locations. A cultivar showing tolerance in one study at a specific location may not be tolerant in another. These variations may be due to differences in soils, climatic factors, management, or growth stages of the grass. Additional work is needed to delineate these factors before firm recommendations can be made.

Siduron control of common bermudagrass seedlings in cool-season grasses at planting time appears very promising. As application rates for this purpose are relatively low, toxicity to cool-season grasses may be less likely.

The control of established bermudagrass without injury to cool-season grasses is more uncertain. As high rates are necessary there is a greater danger of injury to the cool-season grasses. Invasion of creeping bentgrass greens by stolons from surrounding areas through a prevention of rooting may be possible. However, use of the chemical must be coupled with edging or vertical mowing and sweeping to remove the unrootcd stolons. The effects of siduron on possible invasion through the soil by rhizomes has not been determined.

More or less permanent combinations of bermudagrasses and cool-season grasses for year-around green turf is possible in some parts of California. Management is the key to success in this practice. Siduron, by a suppression but not killing of bermudagrass, may be an additional management tool to make these combinations easier to maintain and more useful over a wider area.

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HUMAN COMFORT AND BLUEGRASS "COMFORT" IN THE HOT CLIMATES OF CALIFORNIA

Iohn H. Madison”

Theory predicts that when grass is mowed higher it should be a few degrees cooler. This theory was tested by mowing a mixed Kentucky bluegrass, perennial ryegrass turf at l/2”, 1 1/2" and unmowed at 4” and temperatures were measured with an infra-red temperature sensing device. At noon the taller 4” grass was 67° F, 11° below the air temperature of 78° . The short 1/2” grass was 83° or 5° above air temperature; and the intermediate 1 1/2" grass was 79° .

Interestingly, the hottest thing in our landscape was our golf tee of plastic “turf.” It was 125°F, 46° hotter than the air temperature.

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We have built-in mechanisms that respond when we are too hot. We respond to the signals of heat overload with feelings of discomfort. Whether bluegrass can be "comfortable" or not, we don't know, but when temper atures are in the 90's bluegrass responds by changes- inside the plant. Metabolic changes result in a plant that operates less efficiently in the heat. It does poorly. As temperatures rise, photosynthesis, nitrogen metabolism, and respiration are upset and create a stress which, if prolonged, may result in death.

An experienced turf man can recognize, in May, areas where bluegrass will show dead spots in July. Bluegrass turf next to sidewalks and driveways where concrete stores heat; on south and west facing slopes; and where heat is reflected' from bare south and west facing walls and fences; these will all show dead bluegrass plants following a heat wave.

From 1953-55 I worked with a research group concerned with human comfort in the hot California valleys. It is not surprising, then, that I should be interested in climate effects on grass. The problem of the hot climate is the same for plant or man. Heat comes into the environment in certain ways — we get rid of it in certain ways. The output balances the input. If the heat balance is achievucl without getting too hot for the organism, the organism can be "comfortable".

Let's look at where heat comes from and where it goes.

The most important way heat moves is by radiation. Energy flows downhill as water does. The flow of radiation is through space from high energy to low energy. Place two objects in sight of each other and the hotter will lose energy to the colder, even if it is hundreds of feet away. Stand out in the sun blindfolded. Turn, until your orientation is confused, and you will find you can still locate the sun, because you can feel its radiant heat. You can face the sun by balancing the heat load on each cheek.

Heat also moves by conduction. Heat the bowl of a spoon and soon the handle is hot. The heat is conducted along the metal. Sun's heat is conducted from the ground's surface down into the soil — into walls and rocks and into paving, and these get hot. At night, as surfaces cool by radiation, heat is conducted in the other direction and comes out of the stones and paving and walls.

A special form of conduction is convection. The heat is conducted to a fluid — such as air. The heated fluid rises. Currents of air movement develop, and these carry heat away from the hot body.

Radiation, conduction, and convection are three ways heat energy moves back and forth and in and out of the environment. Heat can also be removed by being used up. When plants use sun's energy to make sugar or wood, the heat energy is changed to chemical bond energy. Chemical energy is changed back to heat when the sugar is metabolized or the wood burned.

When water changes from a liquid to a gas, heat disappears. Heat energy is physically changed into molecular motion. So evaporation (transportation) cools grass and people, wet pavings and ponds. At night condensation (dew) warms the same leaves and forms a fog layer over the pond.

These heat changes are all important to human comfort. But radiation is probably most important for human discomfort. While the summer sun strikes only the head and shoulders, radiation from paving or hot ground strikes the belly, the back, and flanks, the large areas of the body. Heat radiated from hot ground can be greater than that from the summer sun and cause more distress. This is illustrated in Figure 1.

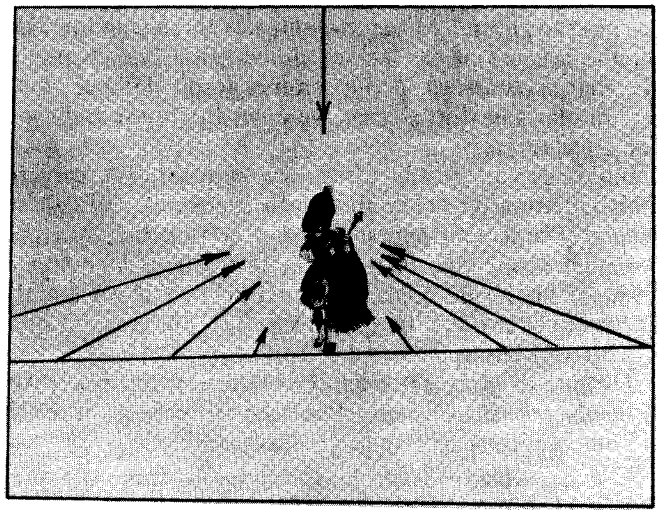

Figure 1. Heat radiated from hot ground can be greater than that from the summer sun.

What can we do to reduce this radiation heat load? We could put on a sombrero or stand in the shade. This would reduce the heat load from the sun; but not the big heat load on belly, back, and flanks.

We could cut off the heat load from the sides by surrounding ourselves with a hedge. Heat from underfoot could be reduced by standing on a turf or wetting the ground.

By having plant material above us, around us, and under us, we can greatly reduce our radiant heat load, Figure 2.

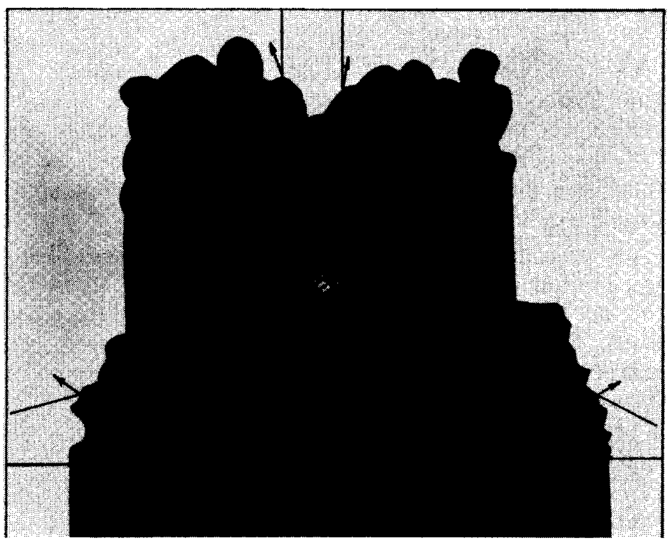

Figure 2. Plants give protection from heat radiation.

The next thing we can do to greatly improve comfort is to place a fan in front of us. This does two things. First, it increases heat movement by convection. If air temperatures are already 100°, this may not be an advantage. Secondly, the moving air aids evaporation and, as our perspiration evaporates, body heat is used up in changing water from a liquid to a gas (>75 calories for each drop of water evaporated).

A fan helps our immediate comfort. If we can move into a neighborhood heavily planted to huge trees, our total daily comfort will be increased. Tall trees catch the solar heat high in the air and convect it away before it reaches the ground. When the sun sets there is immediate cooling because of the lack of stored heat. The change is like that experienced in the summer forest. Hiking along the meadows in shirt sleeves, we enter the forest and soon put on sweaters.

Buildings can greatly affect our comfort. It's easy to limit radiation on north and south exposures, difficult to keep east and west exposures from getting hot. Massive buildings (concrete) tend to stay near the mean temperature on the inside. Light construction (e.g. sheet metal) fluctuates to extreme temperatures. But, our concern here is with vegetation.

Turning to bluegrass, when leaf temperatures reach 90" lowered performance begins. In a hot climate we want to aid our bluegrass to stay as cool as possible.

The heat load on the grass is mainly from the sun. Hot winds can add heat, and nearby structures can reflect and store heat. The grass can use l-2% of the solar energy in photosynthesis. Energy that gets through the grass to the ground, can be conducted into the soil. The rest must be convected to the breezes, reradiated, or used to evaporate water in transpiration.

In theory, the leaf is able to get rid of all of its extra heat by reradiation alone. The hotter a leaf gets, the more it radiates. By the time a leaf reaches 175°, it could reradiate all of the solar energy it receives. Unfortunately, is would be dead. However, before it reached that temperature hot air would begin to rise and convection losses would aid radiation losses in cooling the plant. With water plentiful, transpiration rates in the California summer are at times sufficient to use 1/2 calorie/cm^2/min. As a result grass leaves reach a maximum temperature only a couple of degrees different from the surrounding air temperature, as long as there is some air movement. Considering that temperatures in the 90's are already critical for bluegrass, even a few degrees difference can be important to survival. We noted the importance of these few degrees earlier when describing the hot spots where patches of dead bluegrass would appear.

What can be done to help grass to be cooler? Shade has limited value. Bluegrass doesn't grow well in shade, but open shade during midday greatly aids summer survival. North slopes have the effect of reducing turf temperatures as the grass faces more away from the sun. North slopes are accidents of location. We can't all have a north slope made to order. But where we have it, a north slope of 5" has the same effect as moving a level turf about 325 miles north — that is, from San Francisco north into Oregon, for example.

Spraying turf with water can either cool it or warm it depending on wind and time of day. With even a slight breeze, an 11:00 syringe can drop the daily peak temperatures a couple of degrees. But, in still air, the higher humidity around the leaf may reduce transpiration and result in leaves becoming a degree or two hotter.

There is little we can do for the grass except when we can mow higher. Theory predicts that when grass is mowed higher it should be a few degrees cooler (see Appendix A). There is more leaf surface to handle the same amount of incoming energy. An average square centimeter of leaf receives less energy and doesn't get as hot in the getting and giving. To go from theory to actually measuring leaf temperatures is difficult. Measuring the temperature of many leaves to get an average is too slow. Continuous changes in temperature spoil the accuracy.

Theory was not checked until October '72 when I had access to an infra-red temperature sensing device. A mixed bluegrass, 'Manhattan' ryegrass, turf was used, mowed at l/2", at 11/2", and unmowed at 4". At noon the taller 4" grass was 67°, 11v below the air temperature of 78°. The short 33" grass was 83° or 5° above air temperature; and the intermediate 1 1/2" grass was 79° - close to air temperature.

Interestingly, the hottest thing in the landscape was our golf tee of plastic "turf". It was 125°, 46° hotter than the air and hotter than loose stones at 92°.

Why was the plastic "grass" so hot? The plastic "leaves" absorb solar energy. No energy is used up. No water is evaporated. The plastic is underlain with a "shock" pad that acts as an insulator and prevents conduction of energy into the ground. The plastic "turf" presents a uniform surface that convects little energy. Almost all of the energy must be lost by radiation (Appendix B) . By comparison, an asphalt paving conducts heat into the ground and gets less hot.

The gist of my story is this: we can improve human comfort in California heat in several ways. Use high tree shade to intercept the heat high above us. Use hedges or borders to screen heat radiating from sinks such as paying or bare soil. Use a high mown turf to cover the soil beneath us.

When we insist on using bluegrass where summers are too hot, we can do little to help the grass keep cool. We can keep it supplied with water and mow high.

To substitute plastic "grass' is to install radiant heating. Summer temperatures of plastic "turf" in the sun will exceed 160°* and I'm already uncomfortable at 90".

Appendix A

From Gates (2), $\frac{1}{A}\frac{dQ}{dt} = h_c \Delta T$.

In the formula, hc represents convection as a function of shape, size, and orientation of leaves; and, since leaves arc similar in turf mowed at 2" and 4", h_c is essentially a constant. If the amount of heat to be lost, $\frac{dQ}{dt}$, is the same the difference between leaf and air temperature ΔT is a function of leaf area $\frac{1}{A}$. Consequently, for each ΔT of 1" for 2" grass (LAI = A = 2.3 cm^2/cm^2), 4" grass (LA1 = A = 4.9 cm2/cm2) will have a ΔT of $\frac{2.3}{4.9} = 0.47$". For a 5" rise in 2" turf we might expect only a 2.35" rise in 4" turf.

Of greater importance but more difficult to estimate is the difference due to transpiration. At the midday temperature peak, turf may be stressed for water and unable to supply water fast enough. Taller mowed grass has more roots (5), a greater succulence, and can extract more soil water. As an example, grass mowed 2" was able to extract 13% more water than grass mowed 1" (4). Data are scattered in the literature in different kinds of experiments so quantative estimations are questionable.

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*(So long as the sun is 57" above the horizon and the sky is clear.)

Appendix B

Because of interest in plastic turf, some information is given below. Please, recognize that our information is preliminary and will be rechecked this coming summer.

Our installation is made of material by Monsanto. Reference books give the following information. Nylon has a specific gravity of ca 1.12-1.14, a specific heat of 0.3-0.5 cal/g and a temperature dependent conductivity ranging near 0.035 cal/cm2/min/°C/cm. Our data gives an emissivity of 0.905. We find 16, 1.2 cm long plastic "leaves" per tuft and 8% tufts per cm^2. The exposed "turf" area is 14.7 cm^2/cm^2. The weight is 0.216 g/cm^2 with 9.5-10 mg per tuft and the balance in the base fabric.

Assume we have 2 conditions of weather — good and bad. The good represents an October game plaved with a 65" air temperature, 0.8 $cal/cm^2/min$ solar radiation and a steady 4 mph wind. The bad represents a July game with 95° air temperature, no wind, and radiation of 1 $cal/cm^2/min$. Using $Qr = \varepsilon \sigma T^4$ where ε = emissivity (0.90), σ = Stefan-Boltzman constant (7.92 x 10^{-l}), T is the absolute temperature and Q_r = the energy to be lost by reradiation (1) . Solving, we will get a temperature rise under July conditions to 160°. Under the good conditions we can expect a loss of 0.11 cal/cm2/min to the 4 mph wind (1) . The resulting rise in temperature of the plastic rug is to 101°.

Substituting the above information into an example' from the literature (3) we get the following: assume a person standing in the middle of a plastic ball field on the above July day; assume he has an outwardly exposed area of 20,000 cm^2 (ca 2 yards'). He could experience a radiant heat load of 0.93 $cal/cm^2/min$ or 18.3 K cal/min. To this would be added advective heat stress from the hot air over the 160" plastic rug, and conduction stress from the feet standing on the hot plastic. In contrast, a person standing on grass would experience a radiant heat load of ca 14.7 K cal/min without the added convection and conduction heat loads.

Appendix C

Data were taken on October 12 on a day following rain, with clear air as evidenced by a -25°C cold north skv. Theoretical noon insolation with clear air is 0.8 cal/ cm^2/min, at 35" latitude on that date.

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CONTROL OF NEMATODES ON TURF IN A LANDSCAPE MANAGEMENT PROGRAM*

Iohn D. Radewald**

Nematodes are recognized as important pests on turfgrass in California; however, there is still much information needed within the state on control and distribution. We do know that California problems with nematode diseases of turf are probably not as severe as they are in southeastern United States because 1) we do not have the lance nematode or the sting nematode, which is extremely important, 2) we may have different varieties of turf, and 3) our soils and climatic conditions may not be as favorable for nematode diseases as theirs.

What are the nematode problems on California turf and sod?

The nematode of primary importance on the Gramineae in southern California is a species of root-knot nematode, *Meloidogyne naasi.* Like all root-knot nematodes, *M. naasi* is a sedentary endoparasite which lays its eggs in masses either within the root tissues or outside the root (Fig. 1) . Characteristic of its genus, this nematode also forms small galls on grass roots which are visible to the naked eye.

M. naasi reproduces over a relatively wide temerature range; the optimum soil temperature for reproduction is 79°F. The symptoms of grass infected with *M. naasi* include lack of vigor, poor growth, chlorosis and premature wilting during the warmer periods of the day. These above ground symptoms are not peculiar to nematode attack as other organisms may cause similar symptoms. The only positive way of diagnosing root-knot on turf, therefore, is to dig roots and look for galls. The reader should be reminded at this point that other nematodes sometimes associated with turf in California do not form galls and consequently both soil and root samples should be submitted to the diagnostic laboratory for nematode identification. Nematodes in this category include Reniform *(Rotvlenchulus* — only found in Imperial Valley), Lesion *(Pratylenchus),* Ring *(Criconemoides),*Dagger *(Xiphinema),* Stubby-root *(Trichodorus),* and Pin *(Paratylenchu-*Zus) (Fig. 1).

Meloidgyne naasi is unique in its host range because of its preference for members of the grass family (Table 1). Plants which would normally be thought of as hosts of the root-knot nematode, such as the cucurbits, are in fact non-hosts (Table 1) .

Dichondra

Surveys conducted on established dichondra laws in southern California have shown that approximately 65% of this sod is infected with root-knot (predominantly *M. incognita* with occasional isolates of *M. hapla* and *M. javanica).* Recent studies have proven that *M. incognita* is a pathogen and a serious problem for dichondra growers. Symptoms of infected dichondra include chlorosis, dying out and premature wilting. Root galls are numerous and together with fungi and bacteria oftentimes kill the dichondra.

Control — Clean sod · preplant control postplant control

The best and most logical way of controlling nematodes on grass or dichondra is to start with nematode-free ma-

*Reprint from: Proceedings, 1973 Turf and Landscape Institute, 61-65.

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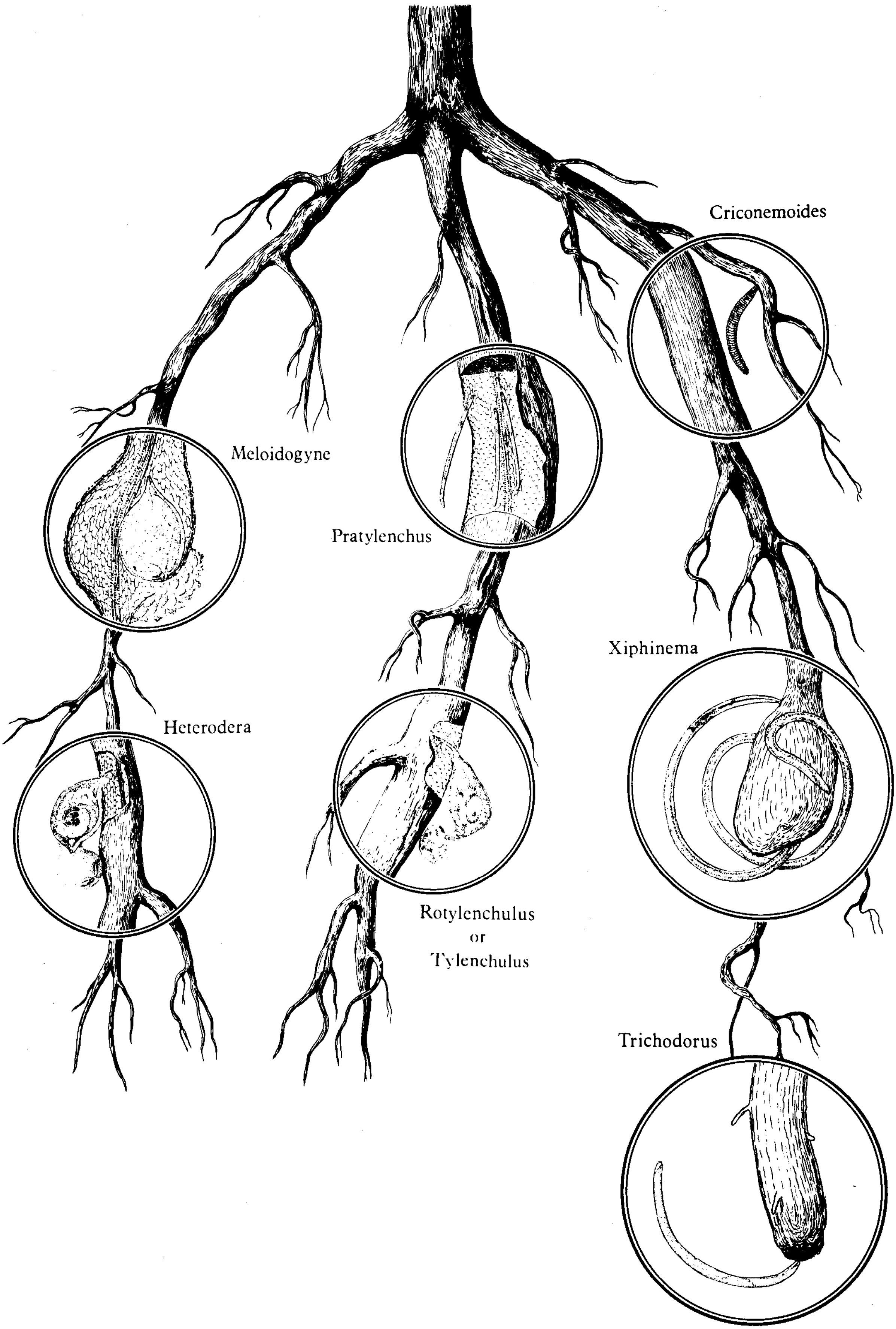
FEEDING HABITS
OF PLANT PARASITIC NEMATODES



terial (if you buy sod). Care should be taken to avoid introducing nematodes into this material by practicing sanitary procedures, using clean equipment, avoiding water run-off from contaminated to clean areas, using nematode free soil in filling excavated sites, etc. If you direct seed and have sampled the area and know that nematodes exist in the soil where you are going to plant, you should use preplant chemical treatment to help avoid the problem. Several of these preplant treatments will not only control nematodes but fungi, weeds, insects and rodents as well (Table2). In addition to preplant treatments, chemicals for postplant control of nematodes on established sod are listed in Table 2. Consult your local farm advisor for assistance on any additional information you may need on nematode diagnosis or control

Table 1. Recorded Host Range of MELOIDOGYNE NAASI

Scientific Name	Common Name	Host
Gramineae		
Agrostis ulba	red top	110
A. palustris Penncross	Penncross creeping bentgrass	yes
A. palustris 'Seaside'	Seaside creeping bentgrass	yes
A. tenuis 'Highland'	Highland colonial bentgrass	yes
Avena *sativu* 'Sierra'	Sierra oat	yes
Festucu arundinacea 'Alta'	Alta tall fescue	yes
F. elatior	meadow fescue	yes
F. rubra	red fescue	yes
F. rubra var. ***commutata***	Chewings fescue	yes
F. rubra 'Illahee"	Illahce red fescue	yes
F. rubra 'Rainier'	Rainier red fescue	yes
Hordeum *vulgare* 'Wocus'	Wocus barle)	yes
Lolium multiflotum	Italian ryegrass	yes
L. ***perenne***	perennial ryegrass	yes
Oryza sativa	rice	yes
Poa annua	annual bluegrass	yes
P. prutensis	Kentucky bluegrass	yes
P. prutensis 'Merion'	Merion Kentucky bluegrass	yes
P. prutensis 'Newport'	Newport Kentucky bluegrass	yes
P. pratensis 'Park'	Park Kentucky bluegrass	yes
P. ***trivialis***	rough bluegrass	yes
Secale cereale 'Merced	Merced rye	yes
S. ***cereale*** 'Svalof Fourex'	Svalof Fourex rye	yes
Sorghum sudanense 'Truclan I'	Trudan I Sudan grass	no
Triticum *uestivum* 'Ramona 50'	Ramona 50 Wheat	yes
Zea mays 'Dekalb 640'	Dekalb 640 corn	no
Amaryllidaceae		
Allium ***cepa***	Sweet Spanish onion	yes
Caryophyllaceae		
Stellaria media	chickweed	no
Chenopodiaceae		
Beta vulgris	sugarbeat	yes
Cucurbitaceae		
Citrullus lanatus	watermelon	no
Cucumis melo	muskmelon	110
C. sativus	cucumber	no
Cucurbita pepo var. ***medullosa***	Zucchini squash	110
Leguminosae		
Phaselous vulgaris	pinto bean	no
Medicago sativa 'Moapa'	Moapa alfalfa	yes
Vigna sinensis	Cowpea	no
Malvaceae		
Gossypium hirsutum 'Delta Pine Smooth Leaf'	Delta Pine Smooth Leaf cotton	yes
Plantaginaceae		
Plantago lanceolata	buckhorn	no
Polygonaceae		
Rumex crispus	curly dock	yes
Solanaceae		
Lycopersicon esculentum var. ***commune*** 'Rutgers'	Rutgers tomato	no
J. peruvianum		110
Nicotiana glutinosa		no
N. tabacum		no

Table 2. A List of Chemicals for Preplant and Pcstplant Nematode Control on Turf

Chemicals	Pests Controlled*	Requires Tarping†	Method Applied
	Preplant materials		
Methyl bromide	1,2,3,4	Yes	Inj. and #1 cans under tarp
Chloropierin	1,2,3,4	No	Injection
Vapam	1,2,3,4	No	Sprinkle on and water
Mylome	1,2,3,4	No	Mix in soil
Vorlex	1,2,3,4	Yes & No	Injection
DD mixture			
Telone	1	No	Injection
Vidden D			
	Postplant materials		
Nemagon	1	No	Injection & water
Fumazone			

NOTE: The chemicals listed above are registered and recommended by several chemical manufacturers for nematode and other pest control on turf. Users of these chemicals should be certain to investigate local restrictions on handling and applying any of the listed chemicals. Read the labels on containers and follow instructions carefully.

*Pests controlled: 1) Nemas, 2) Fungi, 3) Insects, 4) weeds.

†Several of these pesticides do not require plastic tarping, however their efficiency usually is improved if a tarp is used.

BROADLEAF WEED CONTROL IN TURF

*Edward J. Johnson, Leland S. Frey and Clyde L. Elmore**

A trial was conducted at Tony Lima Golf Course, San Leandro, for control of broadleaf weeds in a fairway seeded to perennial ryegrass, Kentucky bluegrass, and bentgrass. Weeds present included purslane, bristly oxtongue, dandelion, curly dock, mouseear chickweed, common sowthistle, black medic and buckhorn plantain. The plots were treated March 23, 1973. The turf was about two years old. Materials tested included 2,4-D water soluble (w.s.) amine, 2,4-D oil soluble (o.s.) amine, mecoprop, dicamba and a mixture of 2,4-D, mecoprop and dicamba marketed as Trimec®. If 70% control is considered commercially acceptable, all materials tested gave this level of control. Refer to Table 1 for results.

Table 1. Broadleaf weed control in turfgrass

Herbicide	Rate (lbs/A)[1]	4/26/73	5/18/73
2,4-D W.S. amine	1.0	7.8[2] m, me[3]	7.2
2,4-D W.S. amine	1.5	9.2 m, me	9.0
2,4-D O.S. amine	1.0	8.2 m, me, d	7.2
2,4-D O.S. amine	1.5	7.8 m, me, d	7.0
mecoprop	1.5	8.8 me, 0	7.4
mecoprop	2.0	9.8 m, o	8.2
dicamba	0.125	9.2 me, d	8.0
dicamba	0.25	9.5 m, me	9.0
Trimec® (2,4-D equiv.)	0.5	5.8 o, d, me	7.0
Trimec® (2,4-D equiv.)	1.0	10.0	9.1
Trimec® (MCPP equiv.)	1.5		9.7
control		10.0 all	0.5

[1]Rate in pounds active ingredient per acre sprayed.
[2]0=no weed control, 10=all weeds dead and no regrowth; 7.0 and above considered commercially acceptable.
[3]Weed species remaining in plot after treatment: m=mouseear chickweed, o=bristly oxtongue, 4=curly dock, me=black medic.

*Farm Advisor, San Mateo County; Farm Advisor, Sacramento County, Extension Weed Control Specialist, University of California, Davis, respectively.

A similar trial was put out in William Land Park in Sacramento. The same materials at the same rates were sprayed on a bentgrass-common bermudagrass turf on April 10, 1973. Results of an evaluation 1 and 3 months later are shown in Table 2.

Table 2. Postemergence control of five broadleaf weeds

Herbicide	Rate (lb. a.i./A)	Weed Control* 1973 White clover 5/11	White clover 8/23	English daisy 5/11	English daisy 8/23	Broadleaf plantain 5/11	Broadleaf plantain 8/23	Soliva* 5/11	Dandelion** 5/11
2,4-D W.S. amine	1.0	4.8	3.4	4.8	5.3	5.5	8.6	9.1	8.5
2,4-D W.S. amine	1.5	6.2	2.5	5.5	7.3	7.0	7.9	9.9	10.0
2,4D O.S. amine	1.0	7.0	4.8	4.2	8.0	5.0	8.3	9.8	8.5
2.4D OS. amine	1.5	5.2	4.0	4.8	8.0	4.8	9.5	6.8	9.1
mecoprop	1.5	9.0	8.5	2.7	4.5	4.3	6.6	8.3	8.3
mecoprop	2.0	10.0	9.5	3.5	2.3	7.5	7.1	8.5	7.8
dicamba	0.125	9.2	9.0	4.5	5.0	0.5	4.5	8.2	8.5
dicamba	0.25	9.1	9.8	6.0	8.5	2.5	4.3	8.6	9.5
Trimec® (2,4-D equiv.)	0.5	8.2	6.1	4.0	6.8	5.5	6.0	7.2	8.8
Trimec® (2,4-D equiv.)	1.0	9.8	9.5	7.5	7.5	6.8	8.4	9.9	8.2
Trimec® (MCPP equiv.	1.5	9.9	10.0	8.9	7.8	9.1	8.9	10.0	10.0
BASF 3517	1.5	2.0	4.3	1.5	3.0	0.8	3.3	10.0	0.5
BASF 3517	3.0	1.8	2.5	2.0	7.5	0.5	0.5	10.0	1.0
control		0.0	2.3	0.0	4.3	0.0	2.5	0.0	0.0

*O=no effect; IO=complete control.
**not an adequate pupulation to evaluate on 8-23 73.

These trials indicate that the newly introduced material, is a useful herbicide for a wide range of broadleaf turfgrass weeds. With broadleaf herbicides, timing of application may be equally as important as the selected product. The younger the weed, the easier it is to control and the less herbicide required for the job. If weeds are established, spring applications when temperatures are from 60 · 80°F. give best control.

Considering the concerns with the energy crisis and environmental quality, it is imperative that turfgrass weed control be conducted efficiently. It is advisable to know which product will be most effective on a particular weed problem and when to apply that product. The California Agricultural Experiment Station Manual 41, TURFGRASS PESTS, can be helpful in this regard.

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