Knotweed, left, and broadleaf plantain. Center of page, henbit, left, and purslane. Bottom of page, mower injury to leaf blades.

stemmed species such as chicory require extra careful mowing to remove them effectively.

Fertilization

Studies show a direct relationship between the development of several weed species and the general availability of soil nutrients. While accurate timely fertilizations will maximize turf development and provide a good competitor, too much fertilizer can promote weed growth.

Annual bluegrass (*Poa annua*), crabgrass and many other species grow rapidly after receiving high N levels.

Excess fertilizations, particularly with soluble N sources, can injure turf foliage. Even if the injury is short-term, opportunistic weeds can develop before the turf has a chance to replenish the canopy.

Irrigation—or soil moisture—also has a dramatic effect on the growth of many weeds. Nutsedge, annual bluegrass, crabgrass, goosegrass and many other weeds are better adapted to high soil moisture. Drying out turf or less frequent irrigation will help the turf gain a competitive advantage over these water-loving weeds.

Cultivation

Core aerification, vertical mowing, spiking, or slicing provide a more conducive rootzone for turf growth. This better growing environment allows the turf to compete strongly with weed populations.

These same practices can also move buried weed seeds to the surface and allow them to germinate. Topdressing might also introduce foreign seed and provide a new avenue to weed infection.

Mechanical devices or materials such as topdressing, mulch or similar items should be closely examined for any plant parts—particularly weed seed—that might be deposited into the turf. Many annual weeds are best managed by reducing their production of viable seed through timely mowings, using plant growth regulators or collecting clippings when seedheads are present.

Herbicides

In a well-designed IPM program, each cultural strategy is selected to reduce weeds. Practically, however, some weeds will always survive even your best management. Herbicides—particularly post-emergence herbicides—can be used to reach your desired weed management goals. Many materials are available for direct control of both annual grasses and broadleaf weeds.

The post-emergents

One of the original selective post-emergence herbicides was 2,4-D. This and other similar compounds—such as mecoprop, dichlorprop and dicamba—control a wide spectrum of broadleaf weeds.

Each controls a select group of weed species. Often, they are used in combination, which allows you to reduce their individual single use rates through a synergistic action. Double and triple combinations of these materials provide effective control for almost any broadleaf species found in turf. Likewise, the materials are formulated either as esters or amine based compounds, to provide more control or a higher level of turf safety (Table 1).

Two particular materials, triclopyr and clopyralid, are broad-spectrum post-emergence herbicides that can be targeted toward a wide range of weeds in many turfs. Triclopyr is often formulated by itself or in combinations with 2,4-D to broaden its effectiveness across a wider group of weeds. Confront is a combination of both triclopyr and clopyralid, which is particularly effective with many tough-to-control broadleaf weeds, such as wild violets and creeping charlie.

Several additional materials are available for a smaller group of weeds or for special uses. Bromoxynil will not injure seedling turfgrasses and is often used as the initial material for cleaning up newly-seeded turf. Several materials such as Basagran, Vantage and DCPA are targeted toward a small group of species. Manage and Basagran can be used effectively for controlling yellow and purple nutsedge.

Grassy weeds

For grassy weeds, particularly annual grasses, several products are available for selective control. Additionally, non-selective herbicides can be used for spot control of both annual and perennial weeds.

Ethofumesate, fenoxaprop and dithiopyr can all be used to control annual grasses after they have emerged. Each material has its own unique spectrum of species it is effective on. In general, each of these herbicides is most effective when applied to young grass seedlings. As with the broadleaf herbicides, the grass seedlings should be actively growing under good conditions.

Non-selective herbicides

For tough-to-control weeds or

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HERBICIDE

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TABLE 1. HERBICIDES FOR BROADLEAF WEED CONTROL IN COOL-SEASON TURF

Common Name	Trade Name
2,4-D	AM-40; 2,4-D granular; 2,4-D L.V. ester, solution (Riverdale); 2,4-D amine 4; 2,4-D LV4; SEE 2,4-D LV4 (Riverside/Terra International); Weedone LV4 (Rhone Poulenc);
2,4-D+dicamba	81 Selective Weedkiller (Riverdale); Four Power Plus (Turfgo/United Horticultural Supply); Lawn Weed Killer (Bonide); Triple D Lawn Weed Killer (Rockland)
2,4-D+dichlorprop	2D+2DP Amine; Turf D+DP (Riverdale); Fluid Broadleaf Weed Control (The Scotts Co.); Weedone DPC Ester; Weedone Amine (Rhone Poulenc)
2,4-D+dichlorprop+dicamba	Strike 3 (Riverside/Terra International); Super Trimec (PBI/Gordon)
2,4-D+mecoprop	2D Amine + 2 MCPP (Riverdale); 2 Plus 2 (ISK Biosciences); MCPP-2,4-D (Cleary)
2,4-D+MCPP+dicamba	Bentgrass Selective Weed Killer (Lesco); Brushfire; Brush-out; Brush-Whacker; HS-130; SNSW-2000 (NCH); Granular Broadleaf Weed Killer (Lebanon); MecAmine-D (Turfgo/United Horticultural Supply); Three-Way Lawn Weed Killer (Rockland); Three-Way Selective; Three-Way DG (Lesco); Trimec Bentgrass Formula; Trimec Classic; Trimec Southern (PBI/Gordon); Triplet Selective; Triplet Water Soluble (Riverdale)
2,4-D+MCPP+dichlorprop	Dissolve; Triamine; Triamine Granular; Triamine Jet-Spray; Tri-Ester (Riverdale); Jet Spray 3-Way Weed Control (The Scotts Co.); Three-way Ester (Lesco)
2,4-D+MCPP+MSMA+dicamba	Trimec Plus (PBI/Gordon)
2,4-D+triclopyr	Chaser (Turfgo/United Horticultural Supply); Turflon II; Turflon II Amine (Lesco)
DCPA	Dacthal (ISK Biosciences); Garden, Turf & Ornamental Herbicide 5G; Turf & Ornamental Herbicide (Bonide); HS-110 (NCH); Super Dacthal 686 (Rockland)
dicamba	Vanquish (Sandoz); K-O-G Weed Control (The Scotts Co.)
isoxaben	Gallery (DowElanco)
triclopyr	Turflon Ester (DowElanco; Monterey)
triclopyr+clopyralid	Confront (DowElanco)

All products listed—except DCPA—are labeled for selective, post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled by each product. DCPA provides selective, post-emergence control of creeping speedwell and pre-emergence control of selected broadleaf species.

TABLE 2. HERBICIDES FOR GRASSY WEED CONTROL: COOL-SEASON TURF AND NON-SELECTIVE

Common name	Trade Names	Uses
bentazon	Basagran T/O (BASF); Lescogran (Lesco)	Selective post-emergence control of nutsedges and some broadleaf weeds.
chlorsulfuron	TFC (Lesco)	Selective post-emergence control of tall fescue in Kentucky bluegrass, fine fescues, bentgrass.
DCPA	Dacthal (ISK Biosciences); Garden, Turf & Ornamental Herbicide (Bonide); HS-110 (NCH, Irving, Texas); Super Dacthal 686 (Rockland)	Selective post-emergence control of creeping speedwell; pre-emergence control of selected broadleaf species.
diquat	Aquatate; HNS-210; Vegetrol; Watrol (NCH); Reward (Zeneca)	Non-selective, post-emergence contact product.
dithiopyr	Dimension (Lesco; Rohm and Haas)	Selective post-emergence control of annual grasses; pre-emergence control of selected broadleaf species.
DSMA	DSMA 4 (Riverside; Terra International); DSMA Slurry (Drexel); Methar 30 (Cleary)	Selective post-emergence control of annual grasses.
ethofumesate	Prograss (AgrEvo)	Selective pre- and post-emergence control of selected annual grasses and broadleaf weeds.
fenoxaprop	Acclaim (AgrEvo)	Selective post-emergence control of annual grasses.
glufosinate-ammonium	Finale (AgrEvo)	Non-selective post-emergence herbicide.
glyphosate	Avail (Lesco); HNS-220; Hoedown; Quick Claim; Trailblazer (NCH); Roundup Dry Pak; Roundup Pro (Monsanto)	Non-selective post-emergence herbicide.
halosulfuron	Manage (Monsanto)	Selective post-emergence control of sedges, such as yellow and purple nutsedge.
MCPA	MCPA-4 Amine (Riverdale)	Selective post-emergence control of annual grasses.
MCPA+MCPP+ dicamba	Eliminate (LESCO); Hat Trick (Turfgo/ United Horticultural Supply); Tri-Power Selective Herbicide (Riverdale)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.
MCPA+MCPP+ dichlorprop	Triamine II; Tri-Ester II (Riverdale)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.
mecoprop (MCPP)	Certi-CM; Chemweed 265; HS-167; Milpro 360 (NCH); MCPP (Cleary); MCPP-4 Amine (Riverdale); MCPP-4K (Turfgo/ United Horticultural Supply; Mecomec (PBI/Gordon)	Selective post-emergence control of broadleaf weeds. See label for tolerant turfgrasses and species controlled.

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SOURCE: DR. FERMANIAN

TABLE 2. CONT.

Common name	Trade Names	Uses
MSMA	Crabgrass Killer (Bonide); Daconate 6; Daconate Super (ISK Biosciences); Drexar 530 (Drexel); MSMA (Bonide; LESCO); MSMA Turf (Turfgo/United Horticultural Supply); 912 Herbicde; 120 Herbicide (Riverside/Terra International); Super Crabrass Killer (Rockland); Weed Hoe (Monterey)	Selective post-emergence control of annual grasses.
MSMA+cacodylic acid	Broadside; Moncide (Monterey)	Selective post-emergence control of annual grasses.
sethoxydim	Vantage (BASF)	Selective post-emergence control of annual grasses in fine fescues.

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perennial grasses, non-selective materials such as Roundup Pro or Finale can be used effectively. These products will remove both the unwanted weeds and any underlying turf. They should be made only during periods of the year when the weeds are actively growing and ample opportunity is available for renovating or re-establishing the turf.

General tips

Post-emergence herbicides should be applied when temperatures are moderate (less than 85 degrees F.) and growing conditions are good for both weed species and turf. Ideally, early fall applications are most effective. This is a time when weed species are actively transporting materials to below-ground portions of the plant. Late spring or early summer applications can also be very effective. These applications should be made when soils are still moist and the weeds are actively growing. With the summer heat and possibly drought, the effectiveness of post-emergence herbicides will be much reduced.

Apply most post-emergence herbicides—and materials which contain phenoxy—judiciously around sensitive ornamental plantings. In spring and fall, many sensitive species can be injured through drift or volatilization of these materials. Follow label instructions carefully to reduce the potential for non-target injury.

Cultural weed control programs can be developed to minimize the potential for weeds. Make herbicides one part of a comprehensive turf care program. Follow manufacturers' labeled instructions closely for best control and maximum safety with any selected material. □

—The author is an associate professor of turfgrass science at the University of Illinois Department of Natural Resources and Environmental Sciences.

Down South, control product *tolerance* a key

by TIM R. MURPHY, Ph.D. / University of Georgia

Proper turf nutrition and soil moisture will help you achieve maximum product efficacy.

Properly-maintained warm-season turfgrass is a good defense against strong weed competition.

Using correct fertility programs; following water requirements, mowing heights and schedules; and proper insect and disease control products all increase turfgrass vigor. They also improve the tolerance of warm-season turfgrasses to herbicides, and increase a weed control program's effectiveness.

Using herbicides without proper turfgrass management practices may control problem weeds, but will not produce high-quality turf.

Turfgrass managers in warm-season climates have a wide array of pre- and post-emergence herbicides that can be used to control weeds (Tables 1 and 2).

Tolerance factors

The single most important factor in se-

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lecting a herbicide is the tolerance of the turfgrass to the herbicide. Generally, most pre-emergence herbicides can be used on all established warm-season turfgrasses. There are exceptions. Ronstar is not labeled for use on centipedegrass or home lawns.

Goosegrass germinates about two weeks later than crabgrass, at soil temperatures of 60-65 degrees F.

Southern crabgrass species germinate during February through April.

There is a dramatic difference in the tolerance of warm-season turfgrass species to post-emergence herbicides. Bermudagrass has good tolerance to MSMA and DSMA; however, carpetgrass, centipedegrass and St. Augustinegrass are severely injured by these herbicides.

Cultivars withing a species may also respond differently to the same herbicide.

Post-emergence herbicides should be avoided when turfgrasses and weeds are stressed due to high air temperatures or drought. The tolerance of warm-season turfgrasses to post-emergence herbicides decreases at air temperatures greater than 90 degrees F., when turfgrasses are drought-stressed or when turfgrasses are growing under high soil moisture and high humidity.

Do not use post-emergence herbicides when turfgrasses and weeds are stressed by high air temperature or drought. Tolerance of warm-season turfgrasses to post-emergence herbicides decreases at air temperatures greater than 90 degrees F., when turfgrasses are drought stressed, or when they are growing under high soil moisture and high relative humidity. Herbicides that contain 2,4-D, mecoprop, dichlorprop, imazaquin, MSMA and DSMA should not be applied at high air temperatures greater than 90 degrees F. because there is an increased risk of unacceptable turfgrass injury. Always follow the most restrictive warning that is shown on the label.

The tolerance of warm-season turfgrasses to post-emergence herbicides is generally lower during spring green-up than when the turfgrass is dormant or after full green-up. Research shows that the decline in turfgrass quality from the use of post-emergence herbicides during green-up is temporary and persists for two to six weeks after application. If a dense weed population dictates using a post-emergence herbicide during green-up, use only the lowest recommended rate or one-half the recommended rate to minimize herbicide injury to the turfgrass. If needed, the application can be repeated after green-up is complete.

Know the weed

Correct weed identification is a prerequisite for selecting an appropriate herbicide. After the weed has been identified, the herbicide label should be reviewed to determine if the herbicide will control the problem weed. Consult land grant university weed control guides for the effectiveness of herbicides in controlling weed species that are not listed on the herbicide label.

Application frequency

For some herbicides, particularly post-emergence products, a repeat application is necessary. For example, two applications of

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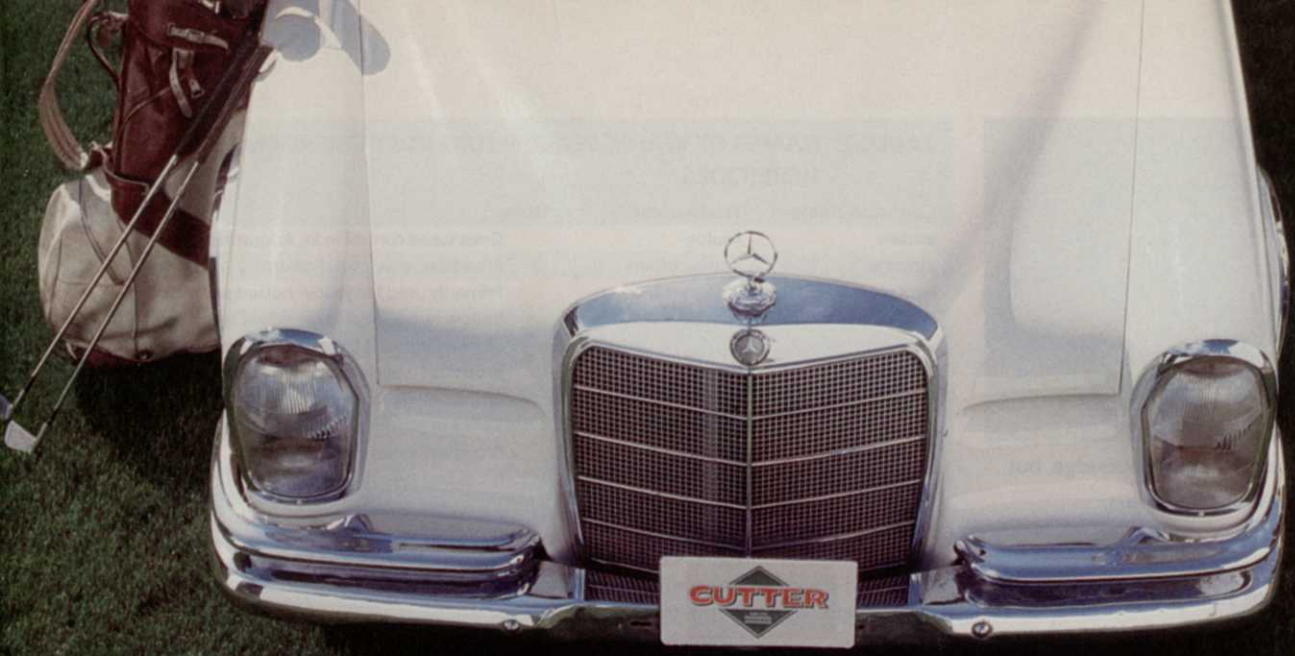
TABLE 1. COMMON AND TRADE NAMES OF WARM-SEASON TURFGRASS PRE-EMERGENCE HERBICIDES[1]

Common name	Trade name	Uses
atrazine	Aatrex, others	Annual broadleaf weeds.
benefin	Balan, others	Annual grass; some annual broadleaf weeds.
benefin+oryzalin	XL	Annual grass; some annual broadleaf weeds.
benefin+trifluralin	Team, others	Annual grass, some annual broadleaf weeds.
bensulide	Bensumec, Betasan, others	Primarily controls annual grasses.
bensulide+oxadiazon	Goosegrass/ Crabgrass Control	Annual grass control.
DCPA	Dacthal, others	Annual grass; some annual broadleaf weeds.
dithiopyr	Dimension	Annual grass; some annual broadleaf weeds.
ethofumesate	Prograss	Annual bluegrass control in bermudagrass and overseeded perennial ryegrass.
fenarimol	Rubigan	Annual bluegrass control in bermudagrass-overseeded cool-season turfgrasses.
isoxaben	Gallery	Annual broadleaf weeds. Does not control established perennials; provides residual control of some species that reproduce by seed.
metolachlor	Pennant	Controls yellow nutsedge and annual sedge; some annual grasses.
napropamide	Devrinol	Annual grass; some annual broadleaf weeds.
oryzalin	Surflan	Annual grass and some annual broadleaf weeds.
oxadiazon	Ronstar	Annual grass and some annual broadleaf weeds.
oxadiazon+benefin	Regalstar	Primarily controls annual grasses.
pendimethalin	Pre-M, Pendulum, others	Annual grass; some annual broadleaf weeds.
prodiamine	Barricade, Regalkade	Annual grass; some annual broadleaf weeds.
pronamide	Kerb	Winter annual weed control. May be used 90 days prior to overseeding bermudagrass with a cool-season turfgrass to control annual bluegrass.
simazine	Princep, others	Winter annual broadleaf weeds.

[1] Refer to the herbicide label for a complete listing of tolerant turfgrasses and labeled application sites.

SOURCE: DR. MURPHY



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cont. from page 26

Use Image to control purple nutsedge, but not in bahiagrass or carpetgrass.

MSMA, at a 7- to 10-day interval, are needed to control crabgrass in bermudagrass.

In contrast, one application of Vantage will usually control crabgrass in centipedegrass. Pre-emergence herbicides may be applied either as full rate single applications, or as sequential repeated applications. With the sequential application program, one-half the maximum labeled rate is initially applied, with the remaining half applied 60 days later. With most pre-emergence herbicides, sequential applications tend to improve crabgrass and goosegrass control over the control achieved with a single application.

Application timing

Most pre-emergence herbicides control susceptible weeds during germination of weed seeds. Additionally, most pre-emergence herbicdes require about one-half inch of rainfall or irrigation water to move the herbicide into the upper one to two inches of the soil profile.

A pre-emergence herbicide can undergo volatility losses and photodegradation the longer it remains on turfgrass foliage or thatch. Irrigation is advised unless a rainfall is anticipated within four to seven days of application.

Most species of crabgrass initiate germination when soil temperatures at the four-inch depth reach 53-58 degrees F. Depending on the geographical location, this will occur during February through April in the southern U.S.

Goosegrass germinates at a soil temperature of 60 to 65 degrees F., or approximately two to eight weeks later than crabgrass. On warm-season turfgrasses that are not fall-overseeded, pre-emergence herbicides control annual bluegrass and certain annual broadleaf weeds. Annual bluegrass germinates at soil temperatures of around 70 degrees F. Apply the pre-emergence herbicide early in fall.

Post-emergence herbicides should be applied to small, actively-growing weeds. Perennial and annual weeds that grow under good soil moisture conditions at moderate air temperatures are easier to control than weeds that are stressed due to adverse environmental conditions. **LM**

—The author is an agronomist in weed science at the University of Georgia Cooperative Extension Service.

TABLE 2. NAMES OF WARM-SEASON TURF POST-EMERGENCE HERBICIDES[1]

Common name	Trade name	Uses
asulam	Asulox	Grass weed control in St. Augustinegrass.
atrazine	Aatrex, others	Broadleaf, grass weed control.
bentzaon	Basagran T/O	Primarily used for yellow nutsedge control.
bentazon+atrazine	Prompt	Yellow nutsedge and broadleaf weed control in centipedegrass, St. Augustinegrass, zoysiagrass.
bromoxynil	Buctril	Broadleaf weed control on non-residential turf.
2,4-D	Numerous formulations are available	Broadleaf weed control.
2,4-D+dicamba	Eight-One	Broadleaf weed control.
2,4-D+dichlorprop	Weedone DPC Amine, Weedone DPC Ester	Broadleaf weed control.
2,4-D+mecoprop +dicamba	Trimec Classic Trimec 992, Three-Way	Broadleaf weed control.
2,4-D+mecoprop +dichlorprop	Weedestroy Triamine, Weedestroy Tri-Ester	Broadleaf weed control.
dicamba	Vanquish	Broadleaf weed control.
diclofop-methyl[2]	Illoxan	Goosegrass control in golf course bermudagrass.
diquat	Reward	Winter annual weed control in dormant bermuda.
DSMA	Numerous formulations are available	Grass weed control in bermudagrass and zoysiagrass.
ethofumesate	Prograss	Pre- and early post-emergence annual bluegrass control in overseeded bermudagrass; common bermudagrass suppression in St. Augustinegrass.
fenoxaprop	Acclaim	Annual grass control and suppression of bermudagrass in zoysiagrass.
fluazifop	Fusilade II	Bermudagrass control in zoysiagrass.
glyphosate	Roundup Pro	Winter annual weed control in dormant bermudagrass and bahiagrass.
halosulfuron	Manage	Controls yellow and purple nutsedge
imazaquin	Image	Purple nutsedge and wild garlic control in warm--season turfgrasses (except bahiagrass); controls certain annual broadleaf weeds.
mecoprop	Mecomec, Lescopex	Broadleaf weed control.
mecoprop+2,4-D +dicamba	Southern Trimec, Trimec Bent	Broadleaf weed control.
MCPA+mecoprop +dicamba	Trimec Encore, Encore DSC	Broadleaf weed control.
MCPA+mecoprop +dichlorprop	Weedestroy Triamine II, Weedestroy Tri-Ester II	Broadleaf weed control.
metribuzin	Sencor Turf	Goosegrass control in bermuda; prostrate spurge and numerous winter annual broadleaf weeds.
MSMA	Numerous formulations	Grass weed control in bermudagrass and zoysia. are available
MSMA+2,4-D+ mecoprop+dicamba	Trimec Plus	Grass and broadleaf weed control in bermuda-grass and zoysiagrass.
pronamide	Kerb T/O	Annual bluegrass control in bermudagrass.
sethoxydim	Vantage	Annual grass control and suppression of bahia-grass in centipedegrass.
triclopyr+clopyralid	Confront	Broadleaf weed control in bermudagrass, cen-tipedegrass and zoysiagrass.

[1] Refer to the herbicide label for a complete listing of tolerant turfgrasses and labeled application sites
[2] Diclofop-methyl has a state label for use in Alabama, Arkansas, Florida, Georgia, Lousiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee and Texas.

SOURCE: DR. MURPHY

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Drug testing:

'We have to do it'

Chris Kujawa of K.E.I. instituted a drug testing program two years ago, and he's glad he did.

by JOHN B. CALSIN, JR.

K.E.I. of Cudahy, Wisc., is a $4 million landscape management company with design/build and interior plantscape divisions. Owner Chris Kujawa realizes the need to have a drug-free workplace.

"Drug usage is prevalent not only in society, but in our particular industry," Kujawa observes.

When his company initiated a drug testing plan, it chose to do pre-employment screening, random testing and mandatory testing after major accidents. K.E.I. chose this rather than instituting a "wholesale" policy.

The tests began with owners and supervisors to show the rest of the workforce that the company was serious about having no drugs in the workplace. K.E.I. employs up to 85 people depending on the time of the year.

That was nearly two years ago.

Since then, two people have tested positive.

Two strikes, you're out

K.E.I. employees who test positive are immediately suspended. They may return to work if they take another test and there is a clean report. The employee must pay for the follow-up test. Second offenses result in dismissal.

The type of users that company drug policies generally unmask are "casual or recreational drug users," says agent Tom Childers of the Drug Enforcement Administration in Phoenix.

Childers said that Americans use about 60 percent of the world's supply of illegal drugs. Yet only 20 percent of that is consumed by hard-core, clinically dependent people.

So who uses the remaining 80 percent?

Childers said it's quite possible you work next to, or with, one of these casual or recreational drug users unless your company has a drug-free policy.

Facing the problem

"Quite honestly, we want to help our employees. We are not out strictly to catch people doing drugs," says Kujawa.

"Our employees are an extension of our family. But, as with any family, there may be problems that must be faced and then addressed head-on." K.E.I. does have a partial employee assistance program (EAP).

Experts say that K.E.I.'s approach is a sound one. Rather than trying to scare or intimidate employees, it communicates care and concern. While not every company can afford to cover the costs of treatment for drug abuse (including alcohol abuse), they can, at least, encourage employees to seek outside help and make it clear that help is available.

That help can be in the form of an employee assistance program (EAP) designed to assist employees with personal problems that affect their job performance. Although some EAPs focus primarily on alcohol and other drug problems, most address a wide range of employee problems: stress, marital difficulties, financial trouble and legal problems.

Most EAPs offer a range of services: employee education, individual and organizational assessment, counseling and referrals to treatment. In general, the more comprehensive the services, the

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Get your drug program reviewed by a professional

Thomas K. Schindler writes drug testing policies for companies.

"The law in this area is evolving. It's an active area of the law," says Schindler, a member of the law firm of Lamb, Windle & McErland, West Chester, Pa.

He says it's tough to generalize about testing and test-base employment decisions, but some observations are appropriate:

▶ A private employer has greater latitude to act than a public employer.

▶ A non-union employer has greater latitude to act than a unionized employer.

▶ Any employer, either public or private, has a greater latitude to act concerning applicants for employment, as compared with existing employees.

▶ It's vital that a company publicize the existence of a testing program; make it clear

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