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UNIVERSITY OF FLORIDA
Cooperative Extension Service
Institute of Food and Agricultural Sciences

Circular 1012

Managing Pesticides for Sod Production and Water Quality Protection[1]

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WATER QUALITY CONSIDERATIONS IN SOD PRODUCTION

Concern about the harmful effects of pesticides on surface water and groundwater quality should motivate sod producers to select pesticides with the least potential to cause water quality problems. Many sod producers live in rural areas near where they and other producers grow sod, therefore, their personal water supply is susceptible to contamination. Unfortunately, information that allows producers to select pesticides less likely to affect water quality has not previously been readily available.

Our purpose is to provide information that can help producers select pesticides that will have a minimum adverse impact on water quality. The procedure considers the soil properties of the application site, the mobility and persistence of pesticides in these soils, and the toxicity of the pesticides in water to humans and aquatic species. A proper selection will decrease chances of adversely affecting surface water and groundwater quality. Certain combinations of soil and pesticide properties (along with weather conditions) can pose a significant potential hazard to water quality. Our goal is to identify and avoid these circumstances. Information contained in this circular can help sod producers make better decisions about the pesticides that they use. This document in no way endorses any particular pest control product. All products must be used in accordance with the label.

MATERIALS NEEDED TO USE THIS PROCEDURE

To effectively use this procedure you will need the following source materials:

1) A copy of the current IFAS Pest Management Guides or other appropriate information sources that identify pesticides that control specific pests.

2) A copy of your county soil survey report to identify the soil types found in your sod fields. (See Note 5, page 4)

3) A copy of the Soil Science Fact Sheet entitled "[Name of your county]: Soil Ratings for Selecting

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1. This document is Circular 1012, Soil and Water Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. First published: May 1991. Last revision: January 1998. Please visit the FAIRS Website at **http://hammock.ifas.ufl.edu**.

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Pesticides" for your county, available from your county Cooperative Extension Office. The basis of these ratings are given in the IFAS Extension Circular 959 entitled "Soil Ratings for Selecting Pesticides for Water Quality Goals," which is also available from your county Cooperative Extension Office.

Note: If your county has not yet been mapped by the Natural Resources Conservation Service (formerly the Soil Conservation Service), you will need to contact the local NRCS office for a site evaluation and determination of soil types and ratings for leaching and runoff of pesticides.

IMPORTANT FACTORS THAT AFFECT PESTICIDE SELECTION

How pesticides behave in the soil is determined by many factors including properties of the pesticides and of the soil at the application site. Some of the factors that should be considered when selecting pesticides with minimal potential for water quality impacts are:

Pesticide Properties

1) The organic carbon adsorption coefficient, K_{oc}, describes the relative affinity or attraction of the pesticide to soil materials and therefore its mobility in the soil.

2) The biological degradation half-life, $T_{½}$, is a measure of persistence of the pesticide in soil.

3) The maximum contaminant level (MCL), or the lifetime health advisory level (HAL), or equivalent (HALEQ), is a measure of health risk to humans of pesticide contaminated drinking water.

4) Aquatic toxicity, LC_{50}, is a measure of the ability of the pesticide to cause 50% mortality in aquatic test species.

Soil Properties

1) Hydraulic permeability is a measure of the soils ability to allow water to percolate through it.

2) Organic matter is important for providing binding sites for pesticides, thus reducing their mobility and increasing their opportunity to be degraded by soil microorganisms.

3) Slope affects the potential for water to run off the land surface.

Management Practices

1) Pesticide application frequencies and rates determine the total amount applied. Lower frequencies and rates reduce the potential for contamination.

2) Application methods affect the amount of pesticide subject to transport by water. For example, if applied directly to the soil, there is a greater probability that more of the product will be available for leaching or runoff than if applied to the foliage. If the product is incorporated into the soil, leaching may be the most important loss pathway. Pesticides applied to the foliage may be lost to the atmosphere, decomposed by sunlight, or absorbed by the foliage, thereby reducing the amount available for wash-off and transport to water bodies.

3) Irrigation practices can also determine the loss pathways of pesticides. Pesticides often move with water, so the less excess water that is applied, the less potential there is for a pesticide to move past the crop root zone or to run off in surface water. Rainfall or overhead irrigation can wash off significant quantities of pesticides from foliage immediately after application.

INDICES USED TO SELECT PESTICIDES

Table 1 contains two important indices, the pesticide leaching potential (RLPI) and the pesticide runoff potential (RRPI). Both indices are relative. For a given soil, these indices rank the pesticides by their potential to move from the application site by the indicated pathway (leaching or runoff). The indices are based on the organic carbon sorption coefficient and degradation half-life values of each pesticide. Values for these parameters have been taken from scientific literature, technical manuals, and company product literature.

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Relative Leaching Potential Index

The Relative Leaching Potential Index (RLPI) defines the relative attenuation (reduction in mass as it moves through the soil) of each pesticide in soil, and therefore its potential to leach to groundwater. Pesticides that are very mobile, for example, those that have K_{oc} values less than 100 in sandy soils, or 50 or less in fine-textured soils should be used with caution. There is some uncertainty in the data used to calculate this index. However, since the values are relative they can still be used. It is important to realize that the smaller the RLPI value of a pesticide, the greater is its potential to leach.

Relative Runoff Potential Index

The Relative Runoff Potential Index (RRPI) defines the relative immobility and availability of each pesticide in soil, and therefore its potential to remain near the soil surface and be subject to loss in the aqueous phase or sediment phase of runoff. There is some uncertainty in the data used to calculate this index. However, since the values are relative they can still be used. The smaller the RRPI value of a pesticide, the greater is its potential to be lost in runoff.

Maximum Contaminant Level, Lifetime Health Advisory Level or Equivalent

Table 1 also contains information on the toxicity of pesticides to humans and aquatic species. This information can be used as a secondary consideration in the pesticide selection procedure.

The Maximum Contaminant Level, MCL, is the highest allowable concentration in drinking water supplied by municipal water systems. It is a Primary Drinking Water Standard based on health considerations and is enforceable by the USEPA. Pesticides that may potentially cause chronic health effects such as cancer, birth effects, miscarriages, nervous system disorders or organ damage are assigned a MCL value by the USEPA. Although the MCL is usually expressed in milligrams per liter (mg/L), in this circular it will be expressed as micrograms per liter (µg/L, or ppb). The Lifetime Health Advisory Level, HAL, provides a measure of pesticide toxicity to humans. The HAL as defined as the USEPA is the concentration of a chemical in drinking water that is not expected to cause any adverse health effects over a lifetime of exposure (70 years), with a margin of safety. If the chemical has not been assigned a MCL or HAL value, a health advisory level equivalent, HALEQ, (denoted by an asterisk) has been calculated using the same formula as the USEPA (HALEQ = R_fD x & 7000) where R_fD is the reference dose determined by the USEPA. For non-carcinogenic pesticides the calculated HALEQ should not differ by more than a factor of 10 from the value forthcoming from the USEPA. The Hal and the HALEQ have units of micrograms per liter (µg/L or ppb). If a pesticide has a MCL value assigned, we use that value rather than the HAL or HALEQ. The smaller the value the greater is the toxicity to humans.

Aquatic Toxicity

The Aquatic Toxicity provides a measure of pesticide toxicity to aquatic species. The values given in Table 1 are the lethal concentrations at which 50% of the test species die (LC_{50}). Unless otherwise noted by a lower case letter following the value, the test species was rainbow trout. The smaller the value the greater is the toxicity to aquatic species.

Data for K_{oc}, RLPI, RRPI, MCL/HAL/HALEQ, and aquatic toxicity are given for the active ingredient (common name) of a product. When using a product that is a mixture of two or more active ingredients use the RLPI, RRPI, MCL/HAL/HALEQ, and Aquatic Toxicity value for the most restrictive active ingredient in the mixture.

Important Note: The information presented in Table 1 **DOES NOT** supersede or replace the information on the pesticide container label or product literature.

PROCEDURE FOR SELECTING PESTICIDES TO REDUCE ADVERSE WATER QUALITY IMPACTS

A "Pesticide Selection Worksheet" is provided as a convenient way to organize the information needed to select pesticides to avoid water pollution by pesticides in a particular production or management unit. Instructions for using the worksheet are provided. The function of the worksheet is to match the soil leach and runoff ratings at the application site with the pesticide RLPI

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(leaching) and RRPI (runoff) indices and toxicity values given in Table 1.

This will indicate the relative potential for pesticides to leach or run off from a particular site and consider the toxicity of the pesticides to humans or aquatic life if the pesticides leach into groundwater or if runoff enters surface impoundments or streams. The last two columns are for recording the sod producer's choices and reasons for selecting particular products.

Our intent is to provide a decision support tool for the turf producers. The producer is responsible for making the final choice. The completed worksheet can serve as a permanent record of the selection process used and decision made by the producer.

Using the Worksheet

1) **Target Pest:** Correct identification of the pests that need to be controlled is essential! Check with knowledgeable experts and utilize competent diagnostic laboratories so that a proper diagnosis can be made. Misdiagnosis results in the wasteful use of unnecessary pesticides and needless increases in production costs. List confirmed pests in column 1 of the PESTICIDE SELECTION WORKSHEET.

2) **Recommended Pesticides:** Use the current IFAS Pest Management Guides, or other appropriate information sources to identify the pesticides that control the pests of concern. List these pesticides in column 2 of the PESTICIDE SELECTION WORKSHEET.

3) **Pesticide Properties**: For each pesticide listed in column 2 on the PESTICIDE SELECTION WORKSHEET, copy the numeric value for K_{oc}, RLPI, RRPI, MCL/HAL/HALEQ, and Aquatic Toxicity from Table 1 into columns 3, 4, 5, 6, and 7 of the PESTICIDE SELECTION WORKSHEET.

4) **Soil Properties**: Consult the County Soil Survey Report soil map sheets to locate your production fields and to identify the soils that occur in these fields. Use the Soil Science Fact Sheet entitled "[Your County]: Soil Ratings for Selecting Pesticides" (available from your county Cooperative Extension Office) to determine the leaching and surface runoff rating of the soils in your fields. As you determine the soil leach rating and the soil runoff rating for each soil in each field, list the soil name, soil leach rating, and soil runoff rating in columns 8, 9, and 10, respectively, of the PESTICIDE SELECTION WORKSHEET.

5) **Selection of Pesticides**: Using information that you have compiled on the PESTICIDE SELECTION WORKSHEET, select appropriate pesticides using the **Pesticide Selection Criteria** to match soil and pesticide properties. The selection made can be recorded in column 11 and notes relating to the selection can be recorded in column 12.

Notes:

1) If the pesticide product selected is a formulated mixture or a tank mix, each active ingredient must be considered. The most restrictive pesticide in the mixture will determine the choice. Trade names in Table 1 followed by (M) are formulated mixtures.

2) Sometimes there may not be a clear choice from among the alternative chemicals available to control a particular pest. In these cases, first order screening using the RLPI or RRPI only can suffice.

3) Depth to groundwater and local geohydrology may influence your final selection. Shallow groundwater is more vulnerable to contamination Deep water tables with intervening impermeable geologic layers are much less vulnerable.

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Criteria for Matching Soil Ratings with Pesticide Indices

Pesticides with less potential to adversely affect water quality can be selected by matching the soil ratings and pesticides with the following criteria:

PESTICIDE SELECTION CRITERIA				
IF SOIL RATINGS ARE:		THEN		
LEACH	RUNOFF	SELECT PESTICIDE WITH:		
HIGH	LOW	Larger RLPI value,	AND	Larger MCL/HAL/HALEQ value.
MEDIUM	LOW	Larger RLPI value,	AND	Larger MCL/HAL/HALEQ value.
LOW	LOW	Larger RLPI and RRPI values,	AND	Larger MCL/HAL/HALEQ and Aquatic Toxicity values.
HIGH	MEDIUM	Larger RLPI and RRPI values,	AND	Larger MCL/HAL/HALEQ and Aquatic Toxicity values.
MEDIUM	MEDIUM	Larger RLPI and RRPI values,	AND	Larger MCL/HAL/HALEQ and Aquatic Toxicity values.
LOW	MEDIUM	Larger RRPI value,	AND	Larger Aquatic Toxicity value.
HIGH	HIGH	Larger RLPI and RRPI values,	AND	Larger MCL/HAL/HALEQ and Aquatic Toxicity values.
MEDIUM	HIGH	Larger RRPI and RLPI values,	AND	Larger Aquatic Toxicity and MCL/HAL/HALEQ values.
LOW	HIGH	Larger RRPI value,	AND	Larger Aquatic Toxicity value.

4) Distance to surface water bodies may also influence your final selection. Surface waters adjacent to or near the pesticide application site are more vulnerable to contamination than those further away. If surface runoff from the application site usually infiltrates into the soil off site before reaching a surface water body, then the MCL/HAL/HALEQ should be considered as the secondary screening index.

5) Continual harvesting of sod may affect the soil properties at the production site. If this is the case, the soil may need to be re-rated for pesticide leaching and runoff.

ACKNOWLEDGMENTS

The development of this document was supported by the USDA/ES Water Quality Initiative Project #89EWQI-1-9134 and the Center for Natural Resources, University of Florida, Gainesville, FL.

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Herbicides										
2 Plus 2(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
2 Plus 2(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
AAtrex	atrazine	x	x	100		16	16	3		4.5
Acclaim	fenoxaprop-ethyl		x	9490		>2,000	11	20	*	0.48
Ace Lawn Weed Killer(M)	dicamba salt		x	2		1	1	200		28
Ace Lawn Weed Killer(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Ace Lawn Weed Killer(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Asulox	asulam sodium salt		x	40		57	57	350	*	>5000
Avail	glyphosate amine salt		x	24000	E	>2,000	1	700		8.3
Balan	benefin	x		9000		>2,000	2	2100	*	0.37b
Banvel	dicamba salt		x	2		1	1	200		28
Basagran	bentazon		x	34		nd	nd	0		510
Basamid	dazomet		x	10	E	14	14	nd		toxic
Benefin Granular	benefin	x		9000		>2,000	2	2100	*	0.37b
Betamec	bensulide	x		1000	E	83	8	50	*	0.7
Betasan	bensulide	x		1000	E	83	8	50	*	0.7
Brominal (M)	bromoxynil butyrate		x	1079		1540	132	90		0.05

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Brominal (M)	bromoxynil octanoate ester		x	10000	E	>2,000	14	140	*	0.1
Buctril	bromoxynil octanoate ester		x	10000	E	>2,000	14	140	*	0.1
Bueno	MSMA sodium salt		x	7000	E	388	1	nd		12b
Calar	CAMA		x	nd		nd	nd	0		nd
Chickweed Spurge(M)	dichlorprop ester		x	1000	E	1000	100	40	*	1.3
Chickweed Spurge(M)	2,4-D acid		x	20		20	20	70		1.1
Chickweed Spurge(M)	dicamba salt		x	2		1	1	200		28
Chipco Turf Herbicide	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Clout	MSMA sodium salt		x	7000	E	388	1	nd		12b
Confront (M)	Clopyralid amine salt		x	6		1	1	4000	*	1035
Confront (M)	Triclopyr amine salt		x	20	E	4	4	200	*	148b
Crabgrass Preventer	benefin	x		9000		>2,000	2	2100	*	0.37b
DMA	2,4-D dimethylamine salt		x	20	E	20	20	70		100
DSMA Liquid	DSMA		x	7000	E	388	1	nd		>1000jb
Dacamine	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Daconate	MSMA sodium salt		x	7000	E	388	1	nd		12b
Dacthal	DCPA	x		5000		500	2	4000		100a
Devrinol	napropamide	x		700		100	20	700	*	16.6

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		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Dimension	dithiopyr	x		nd		nd	nd	0		0.5
Dissolve (M)	2,4-D acid		x	20		20	20	70		1.1
Dissolve (M)	MCPA acid		x	nd	f(pH)	nd	nd	11		117
Dissolve (M)	dicamba salt		x	2		1	1	200		28
Dowfume	methyl bromide	x		22		4	4	7	*	2.5
Finale	glufosinate-ammonium		x	100	E	142	142	3		320
Formula	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Gallery	isoxaben	x		1400		140	7	400	*	not tox
Gramoxone Super	paraquat dichloride salt		x	1000000	E	>2,000	1	30		15
Halt	pendimethalin	x		5000		555	2	300	*	0.199b
Halts	bensulide	x		1000	E	83	8	50	*	0.7
Horizon 2000	fluazifop-butyl		x	3000	E	1430	15	70	*	1.6
Horizon	fenoxaprop-ethyl		x	9490		>2,000	11	20	*	0.48
Illoxan	diclofop-methyl		x	16000		>2,000	2	10	*	0.35
Image	imazaquin ammonium salt		x	20	E pH7	3	3	2000	*	>100
Kerb	pronamide	x	x	800		133	20	50		72
Kleenup	glyphosate amine salt		x	24000	E	>2,000	1	700		8.3
Lesco	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Lesco Eight-One(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Lesco Eight-One(M)	dicamba salt		x	2		1	1	200		28

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		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Lesco TFC	chlorsulfuron		x	40	pH7	10	10	350	*	>250
Lesco Three-Way(M)	2,4-D acid		x	20		20	20	70		1.1
Lesco Three-Way(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Lesco Three-Way(M)	dicamba salt		x	2		1	1	200		28
Lescogran	bentazon		x	34		nd	nd	0		510
Lescopar(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Lescopar(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Lescopex	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Lescosan	bensulide	x		1000	E	83	8	50	*	0.7
MSMA	MSMA sodium salt		x	7000	E	388	1	nd		12b
Manage	halosulfuron-methyl		x	0		nd	nd	0		
Mecomec	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Mecoprop	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Pennant	metolachlor	x		200		22	22	100		2
Phenaban(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Phenaban(M)	dicamba salt		x	2		1	1	200		28
Pre-M	pendimethalin	x		5000		555	2	300	*	0.199b
Prefar	bensulide	x		1000	E	83	8	50	*	0.7

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Presan	bensulide	x		1000	E	83	8	50	*	0.7
Princep	simazine	x	x	130		21	21	1		2.8
Profume	methyl bromide	INJ		22		4	4	7	*	2.5
Prograss	ethofumesate		x	340		113	98	nd		>180
Prompt (M)	bentazon		x	34		nd	nd	0		510
Prompt (M)	atrazine		x	100		16	16	3		4.5
Proturf Goosegrass(M)	bensulide	x		1000	E	83	8	50	*	0.7
Proturf Goosegrass(M)	oxadiazon	x		3200		533	5	40	*	>320
Purge	atrazine	x	x	100		16	16	3		4.5
Quadmec(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Quadmec(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Quadmec(M)	dicamba salt		x	2		1	1	200		28
Ronstar	oxadiazon	x		3200		533	5	40	*	>320
Round-Up	glyphosate amine salt		x	24000	E	>2,000	1	700		8.3
Rubigan	fenarimol	x		600		16	4	500	*	1.8
Sencor	metribuzin	x	x	60		15	15	200		76
South Wdgrss Cntrl	pendimethalin		x	5000		555	2	300	*	0.199b
Super D II Weedone(M)	dicamba salt		x	2		1	1	200		28

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Super D II Weedone(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Super Trimec(M)	dichlorprop ester		x	1000	E	1000	100	40	*	1.3
Super Trimec(M)	dicamba salt		x	2		1	1	200		28
Super Trimec(M)	2,4-D acid		x	20		20	20	70		1.1
Surflan	oryzalin	x		600		300	83	400	*	3.26
Team(M)	oryzalin	x		600		300	83	400	*	3.26
Team(M)	benefin	x		9000		>2,000	2	2100	*	0.37b
Team(M)	trifluralin	x		8000		1330	2	5		0.041
Terrogas	methyl bromide	PRE,INC		22		4	4	7	*	2.5
Three-Way Selective (M)	MCPA acid		x	nd	f(pH)	nd	nd	11		117
Three-Way Selective (M)	dicamba salt		x	2		1	1	200		28
Three-Way Selective (M)	2,4-D acid		x	20		20	20	70		1.1
Tres-San (M)	MCPA acid		x	nd	f(pH)	nd	nd	11		117
Trex-San (M)	2,4-D acid		x	20		20	20	70		1.1
Trex-San (M)	dicamba salt		x	2		1	1	200		28
Trex-San (M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Trex-San (M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Trimec Encore(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox

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		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Trimec Encore(M)	dicamba salt		x	2		1	1	200		28
Trimec Encore(M)	MCPA dimethylamine salt		x	20	E pH7	8	8	11		nd
Trimec Southern (M)	MCPA acid		x	nd	f(pH)	nd	nd	11		117
Trimec Southern (M)	2,4-D acid		x	20		20	20	70		1.1
Trimec Southern (M)	dicamba salt		x	2		1	1	200		28
Trimec(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Trimec(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Trimec(M)	dicamba salt		x	2		1	1	200		28
Turf Kleen(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Turf Kleen(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Turflon	triclopyr amine salt		x	20	E	4	4	200	*	148b
Turflon II Amine(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Turflon II Amine(M)	triclopyr amine salt		x	20	E	4	4	200	*	148b
Turflon(M)	2,4-D acid		x	20		20	20	70		1.1
Turflon(M)	triclopyr amine salt		x	20	E	4	4	200	*	148b
VPC	metam sodium	INC		10	E	14	14	nd		0.079
Vantage	sethoxydim		x	100	EpH7	200	200	600	*	170

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Vapam	metam sodium	INC		10	E	14	14	nd		0.079
Versar	MSMA sodium salt		x	7000	E	388	1	nd		12b
Weed-B-Gon(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Weed-B-Gon(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Weedar	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Weedar MCPA	MCPA acid		x	nd	f(pH)	nd	nd	11		117
Weedestroy Tri-ester(M)	2,4-D esters or oil-sol. amines		x	100	E	100	100	70		2
Weedestroy Tri-ester(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Weedestroy Triamine(M)	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
Weedestroy Triamine(M)	dicamba salt		x	2		1	1	200		28
Weedestroy Triamine(M)	MCPA dimethylamine salt		x	20	E pH7	8	8	11		nd
Weedmaster(M)	dicamba salt		x	2		1	1	200		28
Weedmaster(M)	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Weedone	2,4-D dimethylamine salt		x	20	E	20	20	70		100
Weedone DPC Herbicide(M)	2,4-D acid		x	20		20	20	70		1.1
Weedone DPC Herbicide(M)	dichlorprop ester		x	1000	E	1000	100	40	*	1.3

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Weedstroy	mecoprop amine salt		x	20	EpH7	9	9	7	*	low tox
XL(M)	benefin	x		9000		>2,000	2	2100	*	0.37b
XL(M)	oryzalin	x		600		300	83	400	*	3.26
Brom_O_Gas	methyl bromide	x		22		4	4	7	*	2.5
Insecticides/Miticides										
Amdro Bait	hydramethylnon	x		730000		>2,000	1	2	*	0.16
Crusade	fonofos		x	870		217	28	10		0.02
Cythion	malathion		x	1800		>2,000	555	200		0.2
Diazinon	diazinon		x	1000	E	250	25	0.6		0.09
Dipel	bacillus thuringiensis		x	nd		nd	nd	nd		95b
Dursban	chlorpyrifos		x	6070		>2,000	5	20		0.0071
Dylox	trichlorfon		x	10		10	10	900	*	0.4
Ethion	ethion		x	10000		666	1	4	*	0.5
Gramma-Mean	lindane		x	1100		27	2	0.2		0.027
Lannate	methomyl		x	72		24	24	200		3.4
Logic Bait	fenoxycarb	x		1000	E	>2,000	1000	nd		1.6
Mavirik Aquaflow	fluvalinate		x	1000000	E	>2,000	1	70	*	0.0029
Mocap	ethoprop	x		70		28	28	0.1	*	13.8
Nudrin	methomyl		x	72		24	24	200		3.4
Oftanol	isofenphos		x	600		40	11	7	*	2d

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Orthene	acephate		x	2		6	6	30	*	730
Pounce	permethrin		x	100000		>2,000	1	350	*	0.0041
Primicid	pirimiphos-ethyl	x		300	E	66	66	nd		0.22c
Proxol	trichlorfon	x		10		10	10	900	*	0.4
Pydrin	fenvalerate		x	5300		1510	5	200	*	0.0006
Sevimol	carbaryl		x	300		300	300	700		114
Sevin	carbaryl		x	300		300	300	700		114
Talstar	bifenthrin		x	240000		>2,000	1	100	*	0.00015
Trithion	carbophenothion		x	50000		>2,000	1	1		nd
Triumph	isazofos	x	x	100		29	29	0.1	*	0.008
Turcam	bendiocarb		x	570		1140	350	40	*	1.55
Nematicides										
Mocap	ethoprop	INC		70		28	28	0.1	*	13.8
Nemacur	fenamiphos	INC		100		20	20	2		0.11
Fungicides										
ATO Maneb	maneb		x	2000	E	285	7	40	*	1.9
Aliette	fosetyl-aluminium		x	20		2000	>1,000	20000	*	428
Apron	metalaxyl	x		50		7	7	400	*	>100
Banner	propiconazole		x	650	E	59	13	100	*	1.3b
Banol	propamocarb	x	x	27		nd	nd	nd		410

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Bayleton	triadimefon	x	x	300		115	115	200	*	14
Chipco	iprodione		x	700		500	102	300	*	6.7
Clean Crop Evade	chlorothalonil		x	1380		460	24	2		0.049
Clean Crop Mancozeb	mancozeb		x	2000	E	285	7	20	*	1b
Clean Crop PCNB	PCNB	x	x	5000	E	>2,000	9	20	*	low tox
Cleary's PCNB	PCNB	x	x	5000	E	>2,000	9	20	*	low tox
Clearys 3336	thiophanate-methyl	x	x	nd		nd	nd	nd		20d
Curalin	vinclozolin		x	100	E	50	50	200	*	52.5
Daconil	chlorothalonil		x	1380		460	24	2		0.049
Dithane T/O	mancozeb		x	2000	E	285	7	20	*	1b
Dow Elanco Broadway (M)	chlorothalonil		x	1380		460	24	2		0.049
Dow Elanco Broadway (M)	fenarimol		x	600		16	4	500	*	1.8
Duosan (M)	mancozeb		x	2000	E	285	7	20	*	1b
Duosan (M)	thiophanate-methyl		x	1830	E	1830	54	600	*	11d
Echo	chlorothalonil		x	1380		460	24	2		0.049
Engage	PCNB		x	5000	E	>2,000	9	20	*	low tox
Fore	mancozeb		x	2000	E	285	7	20	*	1b
Formec 80	mancozeb		x	2000	E	285	7	20	*	1b

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Fungo	thiophanate-methyl	x	x	1830	E	1830	54	600	*	11d
Koban	etridiazole	x	x	1000	E	97	9	nd		4
Lesco Granular Turf cide	triadimefon		x	300		115	115	200	*	14
Lesco Mancozeb	mancozeb		x	2000	E	285	7	20	*	1b
Lesco Revere	PCNB		x	5000	E	>2,000	9	20	*	low tox
Lesco Twosome (M)	fenarimol		x	600		16	4	500	*	1.8
Lesco Twosome (M)	chlorothalonil		x	1380		460	24	2		0.049
Manex(M)	maneb		x	2000	E	285	7	40	*	1.9
Manex(M)	zinc		x	nd		nd	nd	0		nd
Manicure	chlorothalonil		x	1380		460	24	2		0.049
Manzate 200	mancozeb		x	2000	E	285	7	20	*	1b
PBI Gordon's Fomec	mancozeb		x	2000	E	285	7	20	*	1b
Pace (M)	metalaxyl		x	50		7	7	400	*	>100
Pace (M)	zinc		x	nd		nd	nd	0		nd
Pace (M)	mancozeb		x	2000	E	285	7	20	*	1b
Penstar	PCNB		x	5000	E	>2,000	9	20	*	low tox
Prodigy	fosetyl-aluminum	x	x	20		2000	>1,000	20000	*	428
Protar	flutolanil		x	0		nd	nd	0		5.4
Protect (M)	zinc		x	nd		nd	nd	0		nd

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Protect (M)	maneb		x	2000	E	285	7	40	*	1.9
Regal Consyst (M)	thiophanate		x	nd		nd	nd	nd		20d
Regal Consyst (M)	chlorothalonil		x	1380		460	24	2		0.049
Rubigan	fenarimol		x	600		16	4	500	*	1.8
Scott's Proturf	chloroneb		x	1650		126	4	90	*	>4200b
Scott's Proturf Fcide II	triadimefon		x	300		115	115	200	*	14
Scott's Proturf Fcide III	triadimefon		x	300		115	115	200	*	14
Scott's Proturf Fluid	iprodione		x	1650		126	4	90	*	>4200b
Scott's Proturf Pythium	metalaxyl		x	50		7	7	400	*	>100
Sentinel	cyproconazole		x	66		nd	nd	0		19
Spotrete	thiram		x	670		446	99	40	*	0.13
Stoller Maneb	maneb		x	2000	E	285	7	40	*	1.9
Subdue	metalaxyl	x	x	50		7	7	400	*	>100
SysTec 1998	thiophanate-methyl		x	1830	E	1830	54	600	*	11d
Terraclor	PCNB	x	x	5000	E	>2,000	9	20	*	low tox
Terramec	chloroneb		x	1650		126	4	90	*	>4200b
Terraneb	chloroneb		x	1650		126	4	90	*	>4200b
Terraneb	chloroneb		x	1650		126	4	90	*	>4200b

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]		Relative Losses		Toxicity		
		Soil	Foliar	K_{oc} (ml/g)		Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)		Aquatic LC_{50}[7] (ppm)
Terrazole	etridiazole	x	x	1000	E	97	9	nd		4
Thalonil	chlorothalonil		x	1380		460	24	2		0.049
Touche'	vinclozolin		x	100	E	50	50	200	*	52.5
Turfcide	PCNB	x		5000	E	>2,000	9	20	*	low tox
Turfco Accost	triadimefon		x	300		115	115	200	*	14
Vorlan	vinclozolin		x	100	E	50	50	200	*	52.5
Vorlan Flo	vinclozolin		x	100	E	50	50	200	*	52.5
Fumigants										
Basamid G	dazomet	INC		10	E	14	14	nd		toxic
Brom-O-Gas	methyl bromide	INJ		22		4	4	7	*	2.5
Terr-O-Gas (M)	methyl bromide	INJ		22		4	4	7	*	2.5
Terr-O-Gas (M)	chloropicrin	INJ		62		620	620	nd		nd
Vapam	metham sodium	INC,INJ		10	E	14	14	0		0.079

[1]**Tradename:**	**(M) indicates that the product is a mixture of two or more active ingredients.**
[2]**Application Type:**	**INC: incorporated; INJ: injected; PRE: preemergence; X: applied to soil surface or foliage**
[3]**Sorption Coefficient:**	**E: estimated G: educated guess**
[4]**Relative Leaching Potential Index (RLPI):**	**Smaller number indicates greater leaching hazard.**
[5]**Relative Runoff Potential Index (RRPI):**	**Smaller number indicates greater runoff hazard.**
[6]**Drinking Water:**	**Maximum Contaminant Level (MCL), Lifetime Health Advisory Level (HAL); * Lifetime Health Advisory Level Equivalent (HALEQ);**
[7]**Aquatic Toxicity LC_{50}:**	**value is for rainbow trout 48 or 96 hr exposure time, unless otherwise specified. a=channel catfish b=bluegill c=carp j=fat head minnow**

Table 1. Sod Production-Pesticide parameters for selecting pesticides to minimize water quality problems.

Trade name[1]	Common name	Application Type[2]		Sorption Coefficient[3]	Relative Losses		Toxicity	
		Soil	Foliar	K_{oc} (ml/g)	Leaching RLPI[4]	Runoff RRPI[5]	MCL, HAL or HALEQ[6] (ppb)	Aquatic LC_{50}[7] (ppm)
nd: no data available								

PESTICIDE SELECTION WORKSHEET

Landowner/Operator Name:_____ County:_____ Date:_____

Crop:_____ Farm ID:_____ Field ID_____ Sheet____of_____

Target Pest (1)	IFAS Recommended Pesticides (2)	K_{oc} Value (3)	Relative Losses		Toxicity		Soil Type (8)	Soil Leaching Rating (9)	Soil Runoff Rating (10)	Selected Pesticide (11)	Comments (12)
			Leaching RLPI (4)	Runoff RRPI (5)	MCL/HAL HALEQ (6)	Aquatic Toxicity (7)					

If the K_{oc} value is 100 or less or if the RLPI value is 10 or less and the soil leach rating is high, then the pesticide has a high potential for leaching and should be used with extreme caution. Alternative pesticides and reduced rates should be considered if possible. Apply pesticide during periods with low potential for rainfall if possible.