Orchard*A*Syst

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Pesticide and Nutrient Management for Orchards

Traditionally, pesticides and fertilizers have been an important part of growing high-quality tree fruit, but today growers are under increasing pressure to manage orchards in ways that reduce environmental, health and other risks. The public is concerned about the possibility of agricultural pesticides and fertilizers showing up in water samples taken from private wells, lakes and other water bodies. Growers have faced legal problems from pesticide drift and spills. Improved pesticide and fertilizer use is viewed as an important step in protecting the health of workers, neighbors and wildlife. This publication series treats comprehensive orchard management as a three-part process of nutrient management, safe and effective pesticide use, and integrated pest management.

Michigan Groundwater Stewardship Program

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The most sophisticated and effective pest management programs rely on farming systems that build soil quality and enhance the crop's ability to withstand pests through proper nutrition and crop management. Proper management of nutrients from chemical fertilizers and organic sources is critical to maximizing fruit production and preventing environmental problems. Evidence is increasing that farming practices have resulted in nitrogen (N) and phosphorus (P) finding their way into both surface and groundwater in Michigan. Managing N is challenging because trees grow for a relatively short period and have an even shorter period of significant N uptake. Nitrogen becomes available for tree use when it is converted into nitrate (NO_3), and it is then also subject to movement with water. On fine-textured (clay) soils, runoff is the most serious problem. On coarse-textured (sandy) soils, percolation or leaching is the most serious problem. Part 1 of the assessment tool (page 3) will help you assess your nutrient management practices and identify areas where you can make improvements.

Safe and effective use of pesticides is fundamental to managing pests and protecting the environment. By their nature, pesticides are designed to destroy certain life processes of plants, fungi and/or insects. These same properties pose threats to humans, livestock and wildlife. Improved pesticide use can prevent pesticides from polluting surface and groundwater. At every stage, from pesticide selection to application decisions, growers have opportunities to reduce the impacts from pesticide use. Safe storage and mixing practices can prevent large quantities of pesticides from entering a drinking water supply and causing acute (immediate) health problems for people or livestock. There are many strategies to use pesticides more efficiently without sacrificing good pest control. Some actions, such as spraying in spots or alternate rows, may reduce risks and potentially save money. Better pesticide management and practices may reduce on-farm exposures to pesticides that can result in chronic (long-term) health problems. Part 2 of the assessment tool (page 6) will help you assess your pesticide practices and identify ways to prevent pollution.

Integrated pest management (IPM) helps growers use pesticides wisely in combination with other approaches to minimize economic, health and environmental risks. IPM provides a system for growers to use knowledge instead of pesticides to control pest problems. To make good choices about control, growers need knowledge gained from training and observations in the field. This includes education about pest life cycles, scouting for pests and the impact of pesticides. IPM's systematic approach helps growers use information to make sound decisions about pest control that take into account cost, effectiveness, resistance management and potential environmental impacts. IPM emphasizes a range of options to prevent pest problems — including solutions based on mechanical (e.g., mowing or pruning) or cultural practices (e.g., planting cultivars that match site conditions or are disease resistant). With improved spray timing, IPM enables growers to use pesticides more efficiently, effectively and safely. Growers can reduce or eliminate practices such as application of broad-spectrum pesticides that disrupt natural processes for controlling pests. FAS 105, "Orchard IPM Checklist," available from your county Extension office, discusses IPM management practices for the orchard.

What is Orchard*A*Syst and how can it help me protect the environment and improve pest management?

Orchard*A*Syst will help you better control pests while reducing environmental and health risks and improving the quality of your product.

Part 1: Nutrient Management
This part has seven sections that help you identify areas of concern related to nutrient management and take actions to improve management practices. For each question that applies to you, select the choice that best describes your operation. Use the "Your Rank" box to fill in the number that corresponds to your choice: 3=low risk, 2=moderate risk, 1=high risk. You can identify improvements that reduce risks by referring to the descriptions to the left of the answer you selected. Develop the Action Plan (page 11) to target activities that reduce high (1) risks.

Part 2: Pesticide Management
This part has three sections that help you identify areas of concern related to pesticide use and take actions to prevent pollution and reduce health risks. Part 2 follows the same format as Part 1. Answer each question that applies to you by selecting from one of the three risk rankings. Add to your Action Plan (page 11) by outlining activities that will reduce high (1) risks identified in this part.

You may also want to complete the Orchard IPM Checklist (FAS 105).

Part 1: Nutrient Management for Fruit Trees

Instructions: For each category listed on the left, that is appropriate for your farm, indicate the rank that best describes the conditions on your farm or in a specific block (three spaces are provided for evaluating different farms or blocks).

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
1. NITROGEN (N) MANAGEMENT PRACTICES						
N fertilizer rates	N rates are based on tree vigor, terminal growth and pruning practices and do not exceed Michigan State University (MSU) recommendations.	N rates are based on previous practices that match inputs with plant needs but sometimes exceed MSU recommendations.	N rates are not based on N monitoring or plant assessment and often exceed MSU recommendations.	____	____	____
Time and placement of N	All N is applied in the spring through early summer, depending on the specific needs of the fruit crop. N is applied in split applications or metered through the irrigation system (if used). N is always banded, where appropriate.	Most N is applied in the spring through the early summer, depending on the specific needs of the fruit crop. Most N is applied early, but less than 30% may be applied later as a split application or fall application for next year. Fertigation is sometimes used. N is usually banded.	More than 30% of N is applied in the fall; OR, N is broadcast where it would be appropriate to band.	____	____	____
Fertilizer applicator calibration	Fertilizer applicators are adjusted and calibrated at least once a year.	Fertilizer applicators are adjusted and calibrated every 2 to 5 years.	Fertilizer applicators have never been calibrated.	____	____	____
2. SPECIAL MANAGEMENT PRACTICES ON SANDY SOILS AND OTHER GROUNDWATER-SENSITIVE AREAS						
Split applications of N fertilizer	Split applications of N are always used. Metered fertigation is used, if available.	Split applications and metered fertigation of N are sometimes used.	Split applications and metered fertigation of N are never used.	____	____	____

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
Cover crops	Cover or green manure crops are always used preplant; sod (or other cover crop) row middles are always used as a part of the orchard floor management plan to minimize fertilizer leaching, runoff and erosion by wind. The orchard is not cultivated post-plant, except to establish row middles in year 1. Cover crops or natural filter strips are used at field boundaries (especially near waterways) to minimize fertilizer runoff potential.	Cover or green manure crops are not used preplant. The orchard is cultivated during the early years. Sod row middles are established late. Cover crops or natural filter strips are seldom used at field boundaries (especially near waterways) to minimize fertilizer runoff potential.	Cover or green manure crops are never used on the farm. The orchard is cultivated, sod row middles are not used. Natural filter strips are never used at field boundaries (especially near waterways) to minimize fertilizer runoff potential.	____	____	____
3. SOIL NITRATE AND PLANT TISSUE TESTING						
Plant analysis	Plant tissue analysis is always used to confirm that an appropriate amount of N has been applied.	Plant tissue analysis is used only when deficiency symptoms appear.	Plant analysis is not used.	____	____	____
4. IRRIGATION SCHEDULING PRACTICES - *If you do not irrigate, skip to the next section.*						
Scheduling practices	Irrigation water scheduling is based on the soil water holding capacity and the estimated daily crop water use.	Irrigation water scheduling is based on either observed soil moisture content or estimates of daily crop water use.	Irrigation scheduling is based on so much water per week if it doesn't rain.	____	____	____
Water testing	Irrigation water annually tested for nitrates. Nitrate values are less than 3 ppm.	Irrigation water occasionally tested for nitrates. Nitrate values are between 5 and 10 ppm.	No irrigation water tests, or nitrate values are consistently above 10 ppm.	____	____	____
5. RECORD KEEPING						
Soil and tissue tests	All records of nutrient tests are kept.	Some records of nutrient tests are kept.	No records of nutrient tests are kept.	____	____	____

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
N applied	Complete records are kept on fertilizer materials and application rates for each orchard.	Some records are kept on fertilizer materials and application rates for each orchard.	No records are kept of fertilizer materials and application rates for each orchard.	____	____	____
6. SOIL, FERTILIZER AND SITE MANAGEMENT						
Soil organic matter	Soil is high in organic matter (4 to 8% in fine-textured soils, > 2% in coarse-textured soils).	Soil organic matter is at low to moderate levels (2 to 4% in fine-textured soils, 1 to 2% in coarse-textured soils).	Topsoil has little or no organic matter.	____	____	____
Soil pH	Soil pH is balanced for the fruit crop being grown and adjusted as necessary.	Soil pH is slightly high or low for the fruit crop being grown.	Soil pH values are excessively high or low for the fruit crop being grown.	____	____	____
Separation distance of fertilizer application from water sources	Fertilizer is applied more than 30 feet from an open water source or tile drain inlet and more than 200 feet from a well.	Fertilizer is applied less than 30 feet from an open water source, or tile drain inlet; OR, less than 150 feet from a well.	Fertilizer is applied adjacent to or over the top of a water source, tile drain inlet or well.	____	____	____
Soil characteristics, field conditions (e.g., soil moisture) and fertilizer applications	Soil characteristics and field conditions are assessed when deciding fertilizer application practices and site-specific or variable-rate technology is used.	Whole field soil conditions are assessed when deciding fertilizer application rates.	Fertilizers are applied at high rates regardless of soil characteristics, soil conditions or relative plant growth.	____	____	____
7. PHOSPHORUS MANAGEMENT PRACTICES						
Phosphorus (P) fertilizer	P applications are based on tissue and/or soil tests. Rates do not exceed MSU recommendations.	P applications are made every 3 to 5 years without laboratory tests indicating a need.	P applications are made every 1 to 2 year(s) without laboratory tests indicating a need.	____	____	____

Part 2: Pesticide Management for Fruit Trees

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
1. APPLICATION - *Even if you employ a custom applicator, most questions should still be answered.*						
IPM decision makers	IPM decision makers are trained and RUP certified, and they keep current on pest problems and control strategies by attending classes and receiving newsletters or alerts several times per year.	IPM decision makers are trained and RUP certified but do not keep current on pest problems and control strategies by regularly attending classes and receiving newsletters or alerts.	IPM decision makers ***are not certified RUP applicators** and do not keep current on pest problems and control strategies. (Growers only have to be certified if applying RUPs.)	____	____	____
Label directions	Grower reads pesticide label before purchase, before use, before storage and before disposal of waste. All label directions are followed.	Grower reads and follows pesticide label directions before use to match the rate with the specific pest.	Pesticide label is not checked for safety precautions or directions for use.	____	____	____
Pesticide handler/ applicator safety	Legally required safety standards are met for pesticide handler/ applicator protection, including notification, pesticide storage, signage, reentry times, emergency equipment, protective clothing, and supplies for cleanup of spills and treatment of injuries. Additional safety measures are employed such as daily washing and cleaning of protective clothing and daily changes of respirator pads and filters.	All legal requirements are met.	***Unsure if all legal requirements are met.**	____	____	____
Pesticide selection	Pesticide selection is based on price, effectiveness, minimizing human health concerns and reducing environmental impacts (e.g., low toxicity, narrow spectrum, no effects on predators, low leaching and runoff potential, low volatility and persistence).	Pesticide selection is based on price and effectiveness against known pests. Health and environment are not significant factors in selection.	Pesticide selection is based on price and effectiveness without consideration of health and environmental impacts.	____	____	____

*** Boldface type: This practice is high risk and violates Michigan and/or federal laws.**

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
Sprayer calibration and maintenance	All spray and granular application equipment is serviced and calibrated before each season. Sprayers are thoroughly rinsed and recalibrated between applications of different types of pesticides. Calibration is repeated at least once during the growing season.	All spray and granular application equipment is serviced and calibrated before each season. Sprayers are thoroughly rinsed between applications of different types of pesticides but not recalibrated.	A thorough calibration is performed infrequently ***or not at all;** OR, equipment is serviced only after it breaks.	____	____	____
Pest monitoring (including weeds, insects, diseases, vertebrates and nematodes)	Orchards are inspected for pests weekly.	Orchards are inspected for pests at critical periods, but not weekly.	Orchards are not inspected for pests.	____	____	____
Threshold for application	Pesticides are used only when pest levels are high enough to be at economic threshold.	Some pesticides are used at selected stages of pest development while others are applied at regular intervals.	Pesticides are applied at fixed times.	____	____	____
Rates of application	Pesticides are applied at reduced rates or targeted where possible (e.g., band vs. broadcast spray or tree-row volume spraying) and are combined with non-chemical approaches.	Pesticides sometimes are applied at reduced rates or targeted.	Pesticides are used without reducing rates or targeting applications.	____	____	____
Resistance management	Insecticides, miticides, fungicides and herbicides with different modes of action are rotated within a season or from one season to the next or used in tank mixes where permitted by label and manufacturer advice. Pesticides at highest risk of resistance are not used when alternatives are available.	Some but not all pesticide modes of action are rotated or tank mixed. Pesticides at highest risk of resistance are used sparingly.	Pesticide modes of action are not rotated or tank mixed. Pesticides are selected without regard to resistance risk.	____	____	____

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	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
Record keeping	Records meet all legal requirements (including date, chemical applied, application rate, targeted pest, site of application, weather conditions, EPA registration number, applicator's name and certification number) and document pest management activities (e.g., pest sampling routines, trap counts). Records are retained and used to guide management decisions.	Records meet some of the legal requirements but are incomplete. Records are retained and used to guide management decisions.	***Records of pesticide applications are not kept, are incomplete or not consulted in management decisions.**	____	____	____
2. DRIFT MANAGEMENT						
Application equipment	Equipment is used that minimizes the off-target impact of pesticide application (e.g., tower orchard sprayer, electrostatic sprayer, shielded nozzle sprayer, "smart sprayer").	Normal sprayer is used with items such as low-drift nozzles and anti-drift agents.	Standard equipment without special modifications is used for all applications.	____	____	____
Weather conditions during applications	Wind speed and direction and potential temperature inversions are checked before and during spray applications, and spraying is stopped when conditions favoring excessive drift occur. Spraying during the evening, morning and nighttime hours is common.	Wind speed and direction are checked before and during spray applications and spraying is stopped when conditions do not meet legal requirements. Some evening and nighttime spraying is done.	***Weather conditions are not monitored during spray applications.** Spraying is always done during standard working hours (e.g., 8 a.m. to 5 p.m.).	____	____	____
Drift management plan	A written plan has been developed that describes the measures used to manage drift and how those measures will reduce the impact of off-target drift. The plan is reviewed annually.	A written plan has been developed that describes the measures used to manage drift and how those measures will reduce the impact of off-target drift. (See *GAAMP's for Pesticide Utilization and Pest Control* for pesticide drift control measures.)	***No written plan is available.**	____	____	____

*** Boldface type: This practice is high risk and violates Michigan and/or federal laws.**

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
3. RUNOFF AND INFILTRATION						
Cover crop	Grass or other cover crop (a natural filter strip) is maintained to minimize the chance of leaching and runoff of pesticides. Cover crops are used during preplant and orchard establishment.	Cover crops are maintained only part of the year or only in some areas of the orchard. Cover crops are not used preplant, and little, if at all during orchard establishment.	Cover crops are not maintained; OR, cultivation is used during orchard establishment on slopes > 2%.	____	____	____
Leaching potential	Water table is more than 30 feet below the surface for fine-textured soils (silty clay, clay, sandy clay, very fine sandy loam and sandy clay loam) and medium-textured soils (loam, silt loam, silty clay loam and clay loam).	Water table is 10 to 30 feet below the surface for fine- and medium-textured soils; OR, water table is more than 30 feet below the surface for coarse-textured soils (all sands, loamy sands and sandy loam).	Water table is less than 10 feet below the surface for coarse textured soils; OR, water is less than 6 feet below the surface for all other soils.	____	____	____
Soil conditions (texture, pH, OM, soil moisture, etc.)	Soil characteristics and field conditions are assessed when deciding pesticide application practices, and site-specific or variable rate technology is used.	Field soil conditions are considered when deciding pesticide application rates.	Pesticides are applied at full labeled rates regardless of soil characteristics or field conditions.	____	____	____
Separation distance of pesticide application from water sources	Pesticide is applied more than 30 feet from an open water source or tile drain inlet and more than 200 feet from a well.	Pesticide is applied less than 30 feet from an open water source or tile drain inlet; OR, less than 150 feet from a well.	Pesticide is applied adjacent to or over the top of a water source, tile drain inlet or well.	____	____	____

	LOW RISK (3)	MODERATE RISK (2)	HIGH RISK (1)	YOUR RANK		
Irrigation frequency	Irrigation is scheduled according to soil moisture monitoring and adjusted for expected rainfall amounts.	Irrigation is sometimes scheduled according to soil moisture and/or expected rainfall amounts.	Irrigation is scheduled without regard to soil moisture levels.	____	____	____
Irrigation efficiency	Irrigation systems deliver water, nutrients and/or pesticides directly to the tree root zone with no runoff and little evaporation (e.g., surface or subsurface drip).	Improvements are made to increase efficiency and decrease soil crusting.	Irrigation systems allow water, nutrients, pesticides and soil particles to leave the system (e.g., overhead sprinkler systems).	____	____	____

In addition to this part, you may wish to complete Farm*A*Syst worksheets on pesticide storage, mixing and loading, container disposal and emergency planning for the farm.

***Boldface type: This practice is high risk and violates Michigan and/or federal laws.**

This bulletin was co-authored by the National Farm*A*Syst office, Madison, Wisconsin, and adapted for Michigan by Dr. Charles Edson, Dr. Allen Krizek, Dr. Roberta Dow, David Epstein, Dr. Larry Gut, Amy Irish-Brown, Gary Thornton and Don Lehman, Michigan State University. Also contributing were private crop consultants Doug Murray and John Bakker.

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Action Plan

What do I do with these rankings?

Step 1. List the practices that were given a ranking of 1 (high risk of contaminating groundwater) in the table below.

Step 2. List (in the table below) the alternative practices, structures or equipment that will help to reduce the groundwater contamination risk for each practice with a high ranking. You may want to consult with your MSU County Extension office, Conservation District, NRCS office, or a local agribusiness for additional information.

Step 3. Enter a target date for accomplishing the changes. Small changes that are inexpensive and easy may be made immediately; changes that involve building structures or purchasing equipment may take more time. Your goal should be to reduce the risk of groundwater contamination as much as possible.

High-risk practice	Alternative practice	Date planned to implement practice

New-10-01, 2M-KMF/BRD, Price 50¢, Single copy free to Michigan Residents.

Glossary

Nutrient Management

Ammonium N: The NH_4+ ionic form of inorganic nitrogen. Ammonium N has a positive electrical charge and is attracted to clay and organic matter. Under warm, moist soil conditions, the NH_4+ form of N is rapidly converted to the nitrate (NO_3-) form. Most plants can utilize both of these forms of N, though most of the nitrogen taken up by fruit trees is in the nitrate form.

Banded application: Applying chemicals such as fertilizer in a defined area near the plant. Compare with broadcast application, where chemicals are uniformly distributed.

Cover or green manure crops: A crop of close-growing grasses, legumes or small grains used primarily for seasonal protection and improvement of the soil. These crops can absorb leftover nutrients from the soil and may release them to the next crop. They may also help reduce leaching of nitrate N into groundwater. The use of cover crops is an important orchard preplant management practice. Cover crops are also used to a limited extent by some growers as a component of their orchard floor management practices in existing orchards.

Fertigation: The practice of applying N (or other nutrients) through a drip irrigation system. This practice usually results in a reduction of total N per acre and reduces the potential for leaching into groundwater by spreading out the application over time.

Legume: Any crop that has the ability to fix atmospheric N in its root system through a process known as symbiotic N fixation. Legumes such as alfalfa, clover and vetch can fix enough N for their own use and return additional N to the soil when they mature or are decomposed.

Mineralization: The microbial conversion of organic N to inorganic N (ammonium and nitrate). The process requires warm soil temperatures, usually greater than 50 degrees F, to proceed at a significant rate.

Nitrate N: The NO_3- form of inorganic N. Nitrate N has a negative electrical charge and is repelled by clay particles and organic matter. As a result, nitrate N is very mobile in soil and moves with water as it percolates through the soil.

Nutrient management: Managing the amount, form, placement and timing of applications of plant nutrients. It includes the management of both inorganic and organic sources of nutrients.

Preplant N: Any N applied prior to orchard establishment. N may be applied to help a preplant cover crop develop adequately, but N for young trees is generally not applied until after trees have been planted. N applied too far in advance of planting the orchard is subject to potential leaching and denitrification losses before the trees have a chance to utilize it.

Realistic yield goal: A yield goal that can be obtained at least 50 percent of the time. The yield goal should be specific to the field and soil type. Excessively high yield goals can lead to overfertilization and loss of income, and it may threaten water quality.

Split applications of N: Two or more applications of N fertilizer applied at different stages of plant growth. This type of application can reduce the risk of N being lost because of wet soil conditions early in the growing season. This method is particularly effective on sandy soils to prevent N leaching and on poorly drained soils where denitrification may take place in waterlogged soils.

Pesticide Management and Integrated Pest Management

Beneficial organisms: Arthropod (insects, spiders and mites), bacterial, fungal and nematode predators and parasites of pests.

Biological control: Control of pest populations by naturally occurring or introduced beneficial organisms.

Economic threshold: Costs/benefits of using pesticides or other pest management options. Applying control measures below this level of damage cannot be justified economically. Any damage above this level requires control.

GAAMPS: Generally accepted agricultural and management practices.

Insect pheromone: Chemical compound released by insects as a mating attractant. Typically released by female insects, this sex attractant helps male insects locate female insects for mating. In pest management, pheromones can be used to help monitor insects, as attractants in mass trapping and in mating disruption strategies.

Integrated pest management: Knowledge-based pest management system that utilizes multiple strategies, tactics and tools to maintain pest damage below an economic threshold level. The system relies on scouting to determine the presence and density of pests and a knowledge of pest and crop life cycles to determine which pest management approach will be the most cost-effective while minimizing the impact on beneficial organisms and the environment.

Mass trapping: Insect control strategy that uses an attractant such as a pheromone or floral bait to lure insects into a trap.

Mating disruption (pheromone disruption): Pest management strategy that utilizes pheromones to disrupt the mating patterns of insects. The orchard is flooded with pheromones specific for the target insect so that the males are unable to locate the females. Successful mating is usually reduced, as is the need for insecticides.

Pesticide class: Classification system that groups pesticides according to chemical structure and mode of action against pests.

Resistance management: Resistance to control in pests that are repeatedly subjected to one control mechanism (e.g., repeated applications of a single insecticide). In Michigan, for example, oblique banded leafroller (OBLR) has developed resistance to organophosphate insecticides when they are used repeatedly in apple orchards. Where resistance has developed, these insecticides no longer provide effective control of OBLR. Using multiple strategies and tools helps delay or avoid the development of resistance. Mixing non-chemical controls (where available) with chemical controls and/or using chemicals from different classes can both be effective resistance management strategies.

RUP: Restricted Use Pesticide.

Rinsate: Rinse water from pesticide or fertilizer container or spray tank cleaning.

Scouting: Sampling crops to determine levels of pest populations and to assess natural mortality, plant health and populations of beneficial insects.

Trap crop: Crop that serves to attract and concentrate insect pests in an area where they can be easily controlled to reduce infestation (and pesticide applications) in the main crop. This crop can be different from the main crop or trap rows of the same crop, usually at the orchard border.

Treatment threshold: The level of a pest population at which treatment should be initiated to prevent damage greater than the cost of control.