

Best Management Practices for Fertilizer Storage and Nutrient Management

Rationale

Fertilizers can cause harm if they reach surface or ground water. For example, high nitrates in potable water cause heart damage in unborn and newly born infants and excessively high phosphorus in wetlands and estuaries causes eutrophication and loss of aquatic life. Potential problems associated with fertilizers fall into four primary phases of use. 1. Storage – greenhouse fertilizer storage areas contain relatively large quantities of concentrated chemicals. Risks in storage areas include release through broken, damaged, or leaking containers; loss of security leading to irresponsible use; accumulation of outdated materials leading to excessive quantity of fertilizer thus unnecessarily raising risk level; and combustion of oxidizing compounds in fertilizer (e.g., nitrates) caused by fire or another disaster event. 2. Handling – opening fertilizer product containers,

measuring amounts, and transferring fertilizer to the delivery system involves some level of risk from spills. Since most products are granular, ease of containment and clean-up is possible. 3. Delivery – containment tanks used to store concentrated solutions of fertilizer can cause a significant hazard. Broken, damaged or weak containers can lead to spills that may contaminate surface or groundwater. The possibility of backflow to, or cross connection with, potable water supplies is reduced. 4. Management – luxuriant or untimely application of fertilizer leads to excessive release from the production system to surface and/or ground water. Potential problems can be minimized through adequate environmental awareness, employee training, and emergency preparedness.

Environmental Principle: Fertilizer and concentrated and dilute nutrient solutions can have a significant impact on surface and groundwater when accidents or misapplications occur. Care in storage, handling, delivery system management, and nutrient management are essential to environmental stewardship. Application equipment must be maintained for proper use rate and to prevent backflow into wells and community water supplies, as well as to avoid cross connection with potable water supplies within the facility such as drinking fountains.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	all staff know to call 911 in the event of an emergency; emergency contact numbers are posted	emergency contact numbers posted; all staff know the locations of spill kits and how to use them	emergency contact numbers posted; emergency response plan on file; all staff know the locations of spill kits and how to use them
Environmental Awareness	staff are made aware of hazard to surface and groundwater by spills from tipped, damaged, or weak storage tanks of concentrated solutions of fertilizer	staff receive training on environmental hazards, and hazards are being reduced	staff receive training on environmental hazards; hazards have been eliminated or are reduced and closely monitored

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Training	greenhouse manager assures all staff receive basic training	all staff receive basic training and updates, and are trained in the use and maintenance of the equipment used for fertilizer application and in the cleanup of small spills	all staff receive basic training and updates in: use and maintenance of equipment, clean-up of small spills, response to different emergency scenarios, proper interpretation of nutrient analysis reports, identification of nutrient deficiencies in plant material, and the correct selection of fertilizers and rates based on crop needs; staff attend annual fertilizer update trainings
Communication	greenhouse manager provides information to individual staff as necessary	greenhouse manager and all staff exchange information in a group setting	staff are encouraged to gain and exchange knowledge with the entire work group; meetings are held regularly
Management			
Application	application of fertilizer is at the discretion of the greenhouse staff	manage constant feed fertilization based on crop requirements	monitored by pour-through analysis, pH and EC readings or automated system with sensors that continuously monitor EC and irrigate at the proper rate based on crop/substrate nutrient status (such as substrate EC); EC sensors are calibrated periodically
Crop Nutrient Status	monitored as problems arise	monitored periodically through the crop cycle using pour-through analysis, pH and EC readings on each major crop	monitored throughout the crop cycle using pour-through analysis, pH and EC readings with a frequency appropriate for the crops; growing mix monitored before planting and two months into production of each crop
Employee Training	employees learn through on-the-job training	employees receive instruction from experienced users in monitoring crop nutrient status, selection and use of fertilizers, and selection and use of fertilizer injectors	supervisor provides employee with operating manuals plus instruction from qualified personnel; employees trained in identifying nutrient deficiencies, monitoring crop nutrient status, selection and use of fertilizers, and selection and use of fertilizer injectors, pH and EC meters

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Health and Safety	first aid kit, emergency shower, and eye wash are readily available outside the storage area	first aid kit, emergency shower, and eye wash are readily available outside the storage area and are inspected periodically with a record kept of checks	first aid kit, emergency shower, and eye wash are readily available outside the storage area and are inspected regularly with a record kept of checks
Leaching Volume	little consideration for the amount of water or fertilizer solution applied beyond saturation of the root zone; exceeds 10% leaching	conscious attempt to limit the amount of leaching of fertigated water to 10% of total volume applied, periodic leach with greater volumes allowable to flush high salts if high EC is indicated from pour-through EC	conscious attempt to limit the amount of leaching of nutrient solution to 10% of total volume applied; ebb and flow benches or other recirculating system used whenever practical
Record Keeping	short term records are kept of concentration and frequency of fertilizer application for each crop	records are routinely kept of concentration, frequency of fertilizer application and other records such as pH, EC, pour-through analysis for each crop	records are kept on quantities (concentration, volume, frequency) of fertilizer applied for each crop; records are kept of nutritional status and monitoring procedures for each crop
Storage Area			
Building Materials	common construction materials; no special properties; wooden shelves are not permissible; floors must be impervious to chemicals or secondary containment is in place	construction materials are largely fire resistant; no wooden shelves; floors must be impervious to chemicals or secondary containment is in place	almost all construction materials fire resistant; metal, water-resistant, or chemical-resistant shelves; floors impervious to chemicals
Chemical Compatibility and Segregation	oxidizers are not stored on wood; fertilizers and pesticides stored in separate designated storage areas	oxidizers are not stored on wood; fertilizers and pesticides stored in separate designated storage areas	oxidizers are not stored on wood; fertilizers and pesticides stored in separate designated storage areas
Containers	all chemicals stored in their original containers unless damaged; labels are visible and readable; food or beverage containers are never used for storage	all chemicals stored in their original containers unless damaged; if original container is damaged, fertilizers are stored in compatible container with complete and accessible labels; labels are visible and readable; food or beverage containers are never used for storage; partially used fertilizers will be stored in closed plastic containers	all chemicals stored in their original containers unless damaged; labels are visible and readable; food or beverage containers are never used for storage; partially used fertilizers will be stored in closed plastic containers with labels

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Container Arrangement	labels in plain sight; some containers in contact with floor; all unsealed containers stored up-right; containers are stored orderly and easily accessible	labels in plain sight; no containers in contact with floor; all unsealed containers stored up-right; aisles wide enough to comfortably accommodate workers; containers are stored orderly and easily accessible	labels in plain sight; no containers in contact with floor; all unsealed containers stored up-right; aisles wide enough to comfortably accommodate workers; containers are stored orderly and easily accessible in secondary containment
Containment of Storage Facility	no floor drain unless raised to provide a reservoir with a berm or temporary plug; some secondary containment used for open containers	no floor drain unless raised to provide a reservoir with a berm or temporary plug; secondary containment routinely used for open containers; bagged material on pallets or otherwise elevated above floor; spill kits are readily available for dry and liquid spills; routine cleanup of area is completed	no floor drain unless raised to provide a reservoir with a berm or temporary plug; floor provides containment in the event of a spill; secondary containment routinely used for most open containers; damaged or leaking containers are repaired and/or replaced as soon as possible; all spilled material is cleaned up upon discovery; and cleanup materials are discarded promptly and properly; spill kits are readily available for dry and liquid spills
Contents	storage area may also contain other greenhouse chemicals (no pesticides), and general greenhouse supplies; no food, drink, tobacco products, or livestock feed is present	storage area does not contain pesticides, or other greenhouse chemicals; may contain general greenhouse supplies with clearly defined space for fertilizer; no food, drink, tobacco products, or livestock feed is present	storage area does not contain pesticides, or other greenhouse chemicals; only fertilizers will be stored in the storage area; no food, drink, tobacco products, or livestock feed is present
Fire Prevention and Suppression	fire extinguisher available within general area	fire detection and alarm system present, oxidizers and flammable materials stored separately fire extinguisher immediately available	fire detection and alarm system present, oxidizers and flammable materials stored separately; fire extinguisher immediately available; fire department notified at least annually of current inventory

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Inventory and Recordkeeping	some inventory monitoring; materials no longer used are occasionally removed	records kept on amount of fertilizer purchased; materials no longer used are removed on a regular basis and discarded properly	inventory actively maintained as chemicals added or removed from storage; containers are dated when purchased; outdated materials removed on a regular basis; inventory is controlled to prevent the accumulation of excess material that may become difficult to use
Lighting	minimal electrical lighting provided	electrical lighting allows view into all areas and cabinets within storage area	electrical lighting allows view into all areas and cabinets within storage area
Location of Storage Area	some consideration in selecting storage area	fertilizer storage within building is structurally segregated from general work areas, with consideration given to location of storage area, away from environmentally sensitive areas; flooding is unlikely	fertilizer storage is separated from offices, workshops, laboratories, surface water, neighboring dwellings and bodies of water; flooding is unlikely; storage area is in close proximity to where it will be mixed and used; the area will be in a well ventilated, lockable, with no drain
Management of Humidity, Flood Damage, and Clutter	area is dry	area is dry; shelving is provided to keep materials off of the floor	area is dry, climate controlled, clean, and inventory arrangement is orderly; the floor, shelving and counters are kept free of debris and miscellaneous items
Inspection of Storage Area	occasional inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and addressed	quarterly inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and corrected	monthly inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and corrected
Security	fertilizer is stored in a secure locked facility	fertilizer is stored in a dedicated room that is locked	storage room is locked, access is restricted to trained personnel

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Signage	none	signs present; emergency contact information posted; necessary regulatory signage is posted	signs posted; warning signs used as needed (e.g., for oxidizers); emergency contact information posted; necessary regulatory signage is posted
Storage of Small Quantities of Chemicals	always stored on shelf or other solid surface; never on floor	always stored on shelf or other solid surface; never on floor; stored by compatibility and all containers are clearly labeled	always stored on shelf or other solid surface; never on floor; stored by compatibility and all containers are clearly labeled with secondary containment
Temperature Control	no mechanical temperature control; area not insulated	no mechanical temperature control; area insulated; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.); area will not freeze	active mechanical temperature control; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.)
Ventilation	room not particularly cool and dry; passive ventilation	mechanical ventilation available, working and used	automated climate control working and used
Handling			
Storage and Record Keeping	fertilizer stock tanks are labeled with fertilizer formulation and concentration; no records are kept of application information	fertilizer stock tanks are labeled with fertilizer formulation and concentration; records are kept of frequency and location of fertilizer application	fertilizer stock tanks are labeled with fertilizer formulation and concentration; records are kept of fertilizer formulation, concentration, date, and location of application; records are kept of media nutrient analyses
Containment of Fertilizer Stock Solution	concentrated stock solution stored near injector in heavy-duty plastic container; container integrity checked and changed in 2 to 3 years	concentrated stock solution stored near injector in high density polyethylene or polypropylene containers with extra heavy duty walls; container integrity checked and changed in 3 to 5 years	concentrated stock solution stored near injector in high density polyethylene or polypropylene containers with extra heavy duty walls; secondary containment provided; container integrity checked and changed in 3 to 5 years
Partially-used Containers	unsealed containers resealed and returned to storage	paper bags and boxes always opened with a box cutter or scissors; unsealed containers resealed and returned to storage; all open paper bags and boxes are sealed inside another, larger plastic container, sealed and labeled	paper bags and boxes always opened with a box cutter or scissors; unsealed containers resealed in an airtight containers and returned to storage; storage area is a humidity controlled environment; all open containers are sealed inside another, larger plastic container, sealed and labeled

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Damaged Containers	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled	containers checked often for damage; when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled
Disposal	unused fertilizer products and concentrates are discarded using methods approved by environmental protection authorities	uses of unused products and concentrates are sought to minimize disposal	sufficient planning is made to eliminate the need for disposal; empty fertilizer containers are discarded based on latest advice from environmental protection authorities
Precipitate and Residue Disposal	fertilizer systems are cleaned and rinse solution is flushed to sanitary sewer	when fertilizer systems are cleaned, solids are removed first and discarded with solid waste before rinse solution is flushed to sanitary sewer	fertilizer systems are cleaned and solids and rinse solution are composted: when possible have a low pest plant for rinseate usage
Personal Protective Equipment (PPE) - worn while mixing	staff wear appropriate PPE according to the label and conditions (e.g., dust)	staff wear appropriate PPE according to the label and conditions (e.g., dust); basic and label specific PPE will be provided by the employer	staff wear appropriate PPE according to the label and conditions (e.g., dust); basic and label specific PPE will be provided by the employer
Spill Prevention and Preparedness	secondary containment around fertilizer stock tanks is not used; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area	secondary containment is sometimes used for fertilizer stock tanks; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area; spill kits are readily available	secondary containment used for fertilizer stock tanks routinely; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area; spill kits are readily available
Delivery System			
Backflow Prevention (Building protection)	backflow prevention and inspection meets minimum local code requirements	backflow prevention and inspection meets minimum local code requirements; filters and check valves are installed on fertilizer injectors	backflow prevention and inspection meets minimum local code requirements; redundant backflow prevention provided at each fertilizer injector; filters and check valves are installed on fertilizer injectors

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Cross-connection Avoidance	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met; signage instructs staff and visitors not to drink from hoses	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met; signage instructs staff and visitors not to drink from hoses	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met; signage instructs staff and visitors not to drink from hoses
Equipment Maintenance and Stock Tank Integrity	injector equipment maintained and calibrated when problems occur; stock tank is dated when installed and inspected regularly	injector equipment maintained as manufacturer recommends; stock tank is dated when installed and inspected quarterly, integrity verified and replaced as needed	all fertilizer containment tanks, injector pumps, backflow preventers, monitoring equipment and fertilizer lines are inspected regularly; stock tank is dated when installed and inspected quarterly, integrity verified and replaced as needed
Equipment Selection	venturi-type (“hozon” style) injectors used reluctantly and with awareness of their inaccuracy when pressure and flow vary	positive displacement or metering device injection used exclusively and calibrated regularly	computer or automatically controlled injection systems used and calibrated regularly
Fertilizer Injector and Surrounding Area	periodically - fertilizer injector is repaired when impairment of function is noticed; area surrounding fertilizer injector and concentrated solutions is cleaned periodically	quarterly check of fertilizer injector accuracy through calibration by EC or volume method; clean surrounding area; inspect containment tanks, back flow preventers and any equipment that holds fertilizer in the dry or liquid form; choose a safe dry location for fertilizer injector	monthly check of fertigation equipment accuracy; inspect containment tanks, back flow preventers and any equipment that holds fertilizer in the dry or liquid form; manufacturer recommendations are followed when calibrating or working on fertilizer injector equipment; be sure injectors are clean inside; stock solution tanks and the areas surrounding fertilizer injectors and concentrated solutions are kept clean and free of debris; choose a safe dry location for fertilizer injector