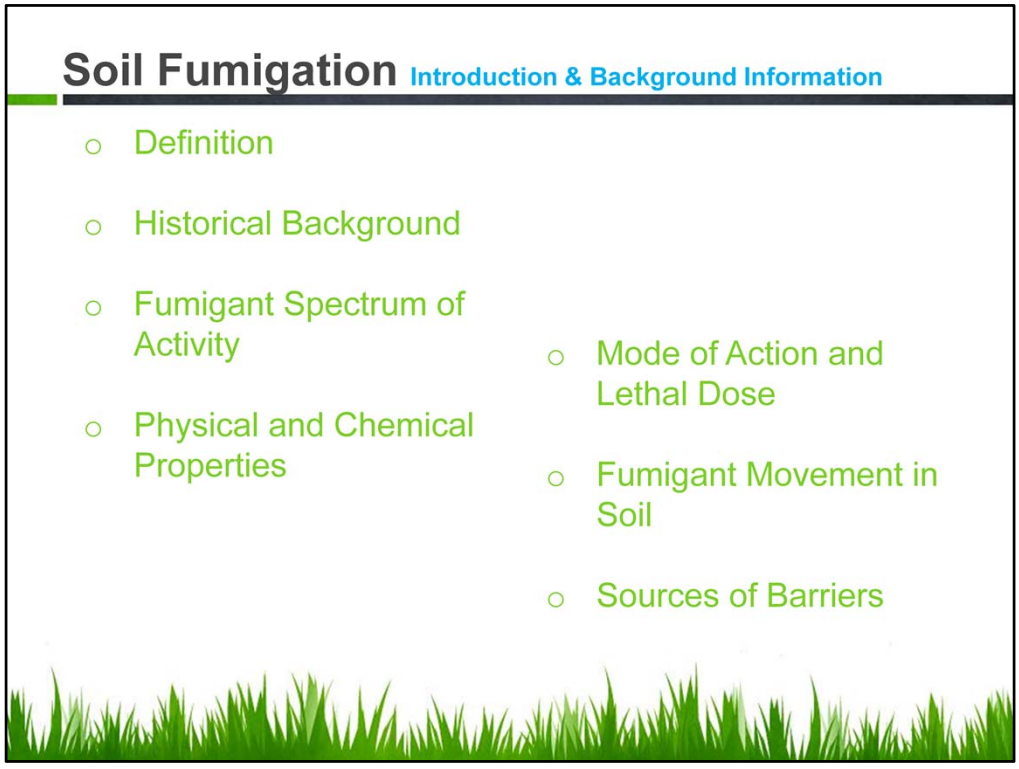
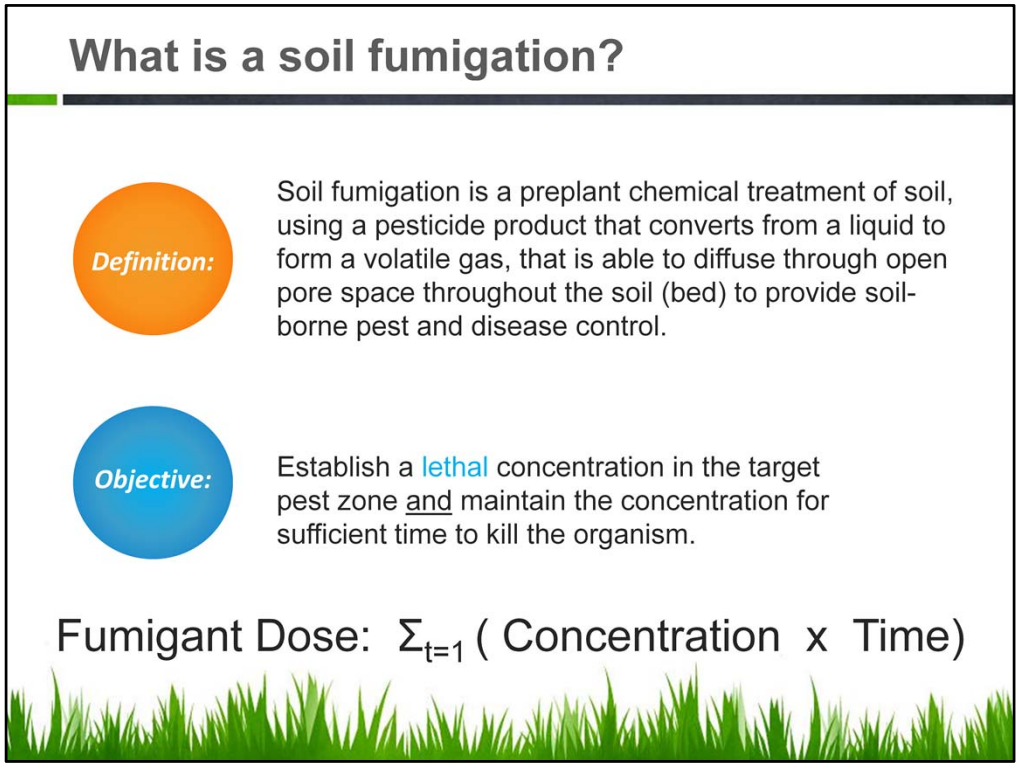

Module 2
Fumigant
Reregistration



Welcome to Fumigant Training Module No. 2

The purpose of this module is to provide an introduction and background information including

- a definition of what a soil fumigant is
- Provide a brief historical background of their use
- Characterize differences in the spectrum of pest control activity with some of the different soil fumigants
- Provide a Generalization of the differences in physical and chemical properties of some of the major fumigants
- And conclude with a description of their mode of action, lethal dose, and movement in soil.

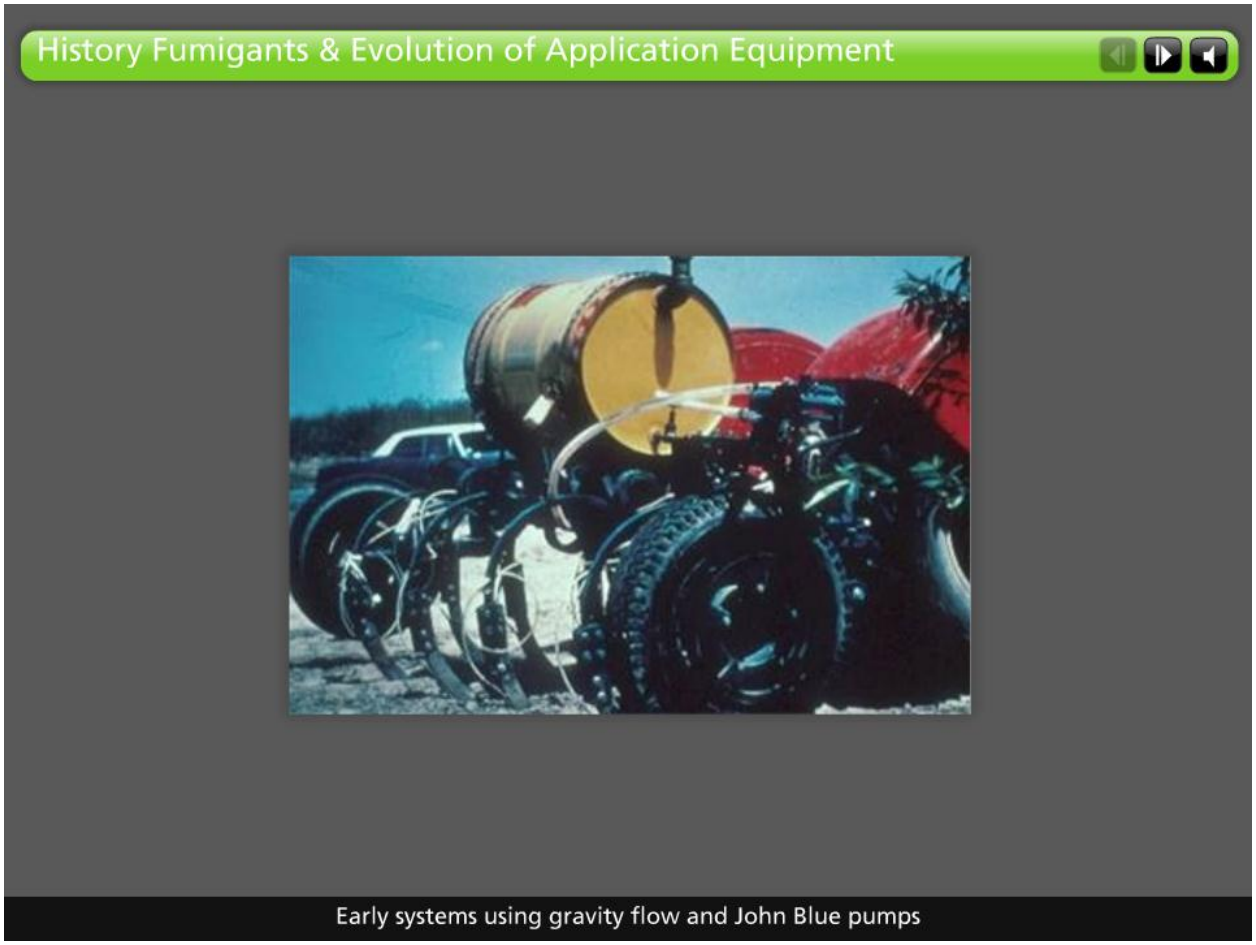


Let's define what soil fumigation is. Soil fumigation describes a preplant chemical treatment of soil, using a pesticide product that converts from a liquid to form a volatile gas that is able to diffuse through open pore space throughout the soil (bed) to provide control of various soilborne pests such as nematode, disease and weeds.

The objective of any soil fumigation is to establish a lethal concentration in the target pest zone and to maintain the concentration of the fumigant for a sufficient time to kill the organism. Since the concentration of the fumigant decays over time, the dose of the fumigant which a soil pest is exposed to is measured by the sum concentration and the time it persist in soil at that concentration. A summation of concentration times time products. This would suggests that soil borne pest and disease control is benefited by longer retention time of the fumigant in soil.

History Fumigants & Evolution of Application Equipment

ES using gravity.jpg



Item Text

Early systems using gravity flow and John Blue pumps

ES using gravity2.jpg

Item Text

Early systems using gravity flow and John Blue pumps

Deep Injection 30incout.png.jpg

Item Text

Deep injection behind 30” coulters

Rototiller incorp.jpg

Item Text

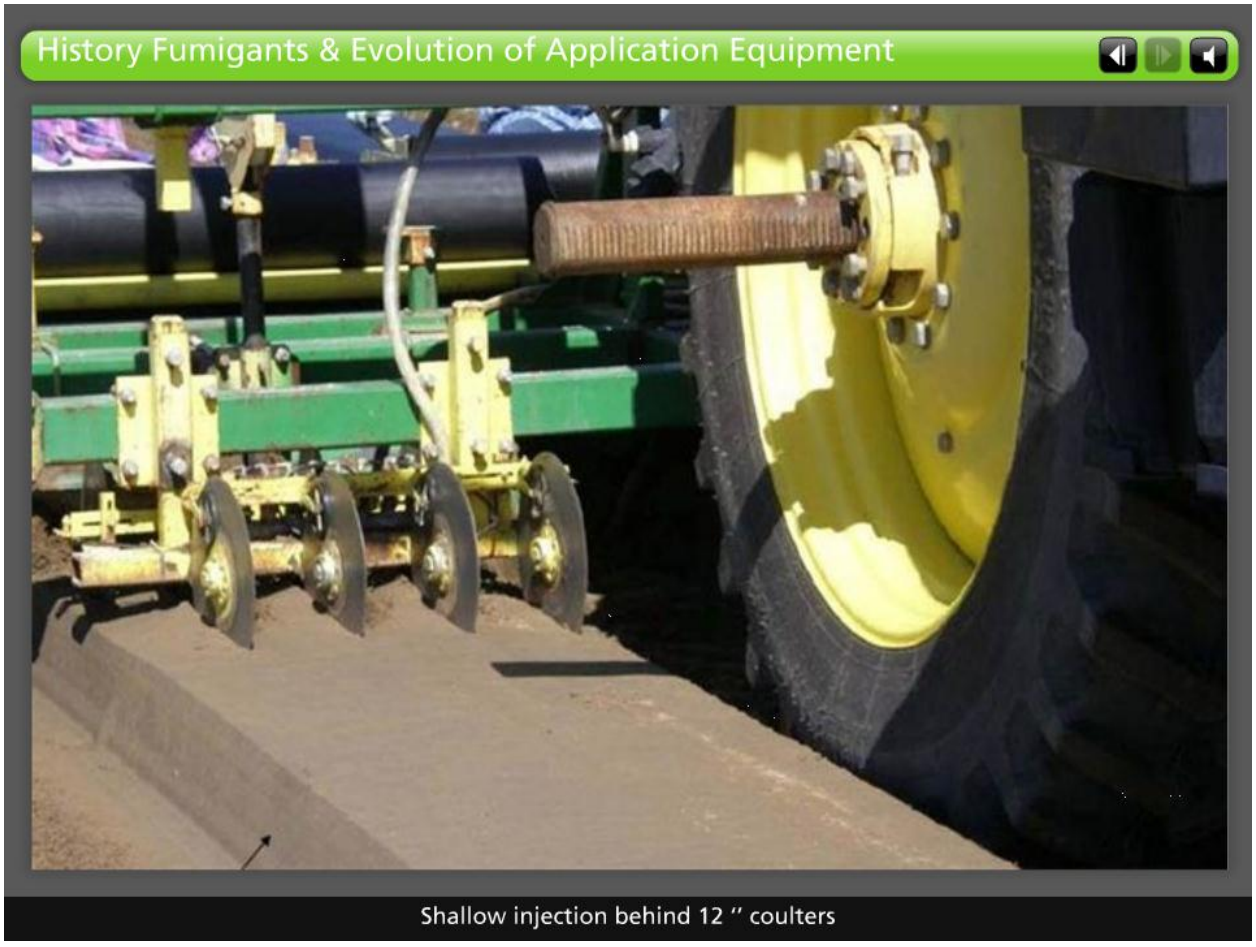
Rototiller incorporation / power roller

shank injection.jpg

Item Text

Shank injection into raised bed

shallow injection.jpg



Item Text

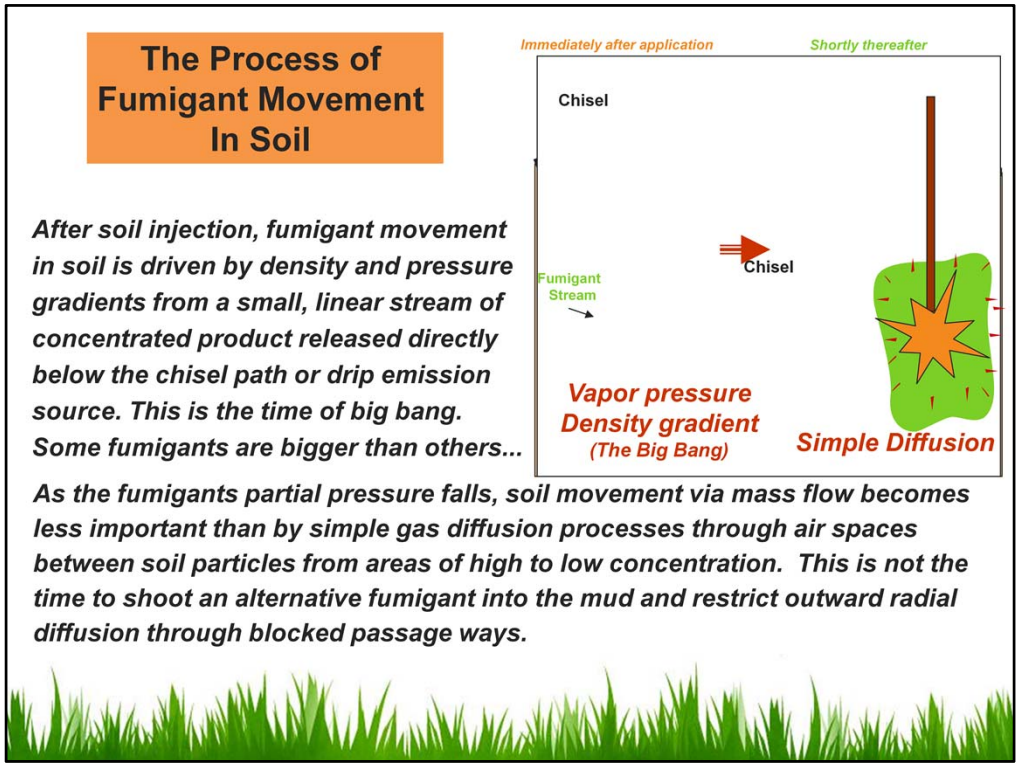
Shallow injection behind 12 '' coulters

Generalized summary of the relative spectrum of pesticidal activity or effectiveness of various soil fumigants for nematode, soil-borne disease, and weed control in Florida.

FUMIGANT CHEMICAL	Relative Pesticidal Activity		
	Nematode	Disease	Weed
Methyl bromide	Excellent	Excellent	Excellent
Chloropicrin	None to Poor	Excellent	Poor
Methyl iodide	Good to Excellent	Good to Excellent	Good to Excellent
Metam Sodium	Erratic	Erratic	Erratic
1,3-Dichloropropene Telone II	Good to Excellent	None to Poor	Poor
Potassium N – Methydithiocarbamate	Erratic	Erratic	Erratic

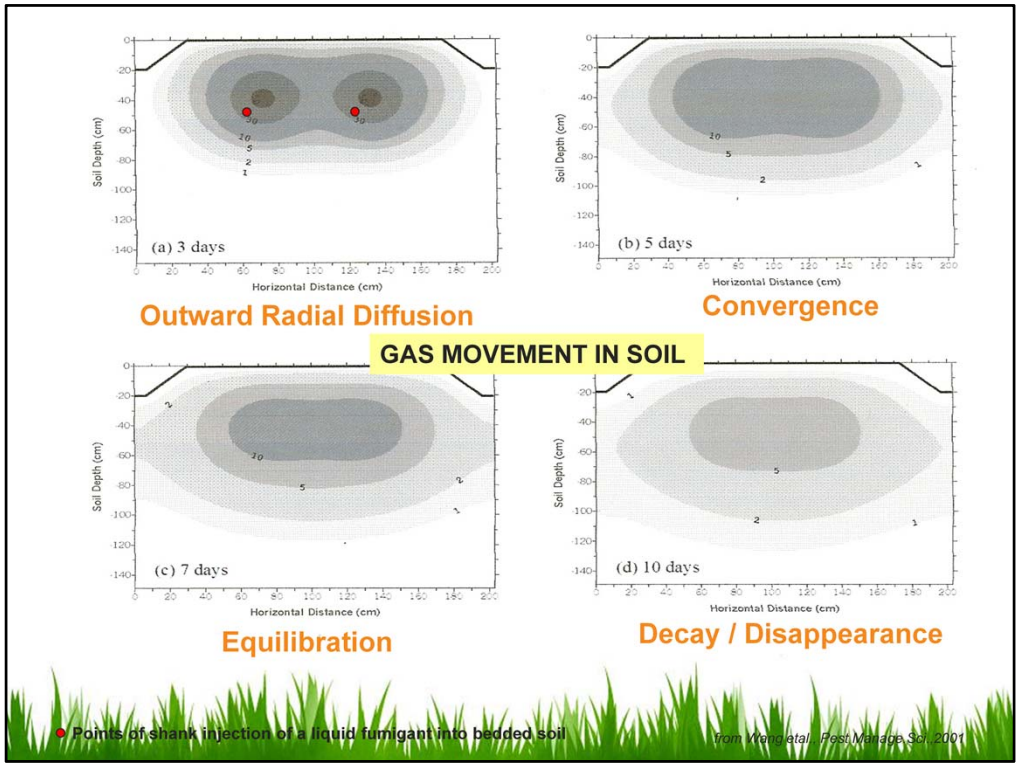
For all of the above, effectiveness is determined by many factors including chemical, cultural, physical, and environmental conditions

The results of many different field research trials have provided a basis for an overall generalization of pesticidal activity for many of the major soil fumigant chemicals. In general methyl bromide has proved to be very effective against a wide range of soilborne pests including nematodes, diseases, and weeds. Methyl iodide, a recent entry to registered fumigants in Florida, has shown similar broadspectrum pest control activity as that of methyl bromide. Chloropicrin has proved very effective against diseases but seldom nematodes or weeds. 1, 3-dichloropropene (Telone) is an excellent nematicide but generally performs poorly against weeds and diseases. Bacterial pathogens are generally not satisfactorily controlled by any of the fumigants. Metam sodium and metam potassium have proved to be more inconsistent in their control of weeds, nematodes and disease.

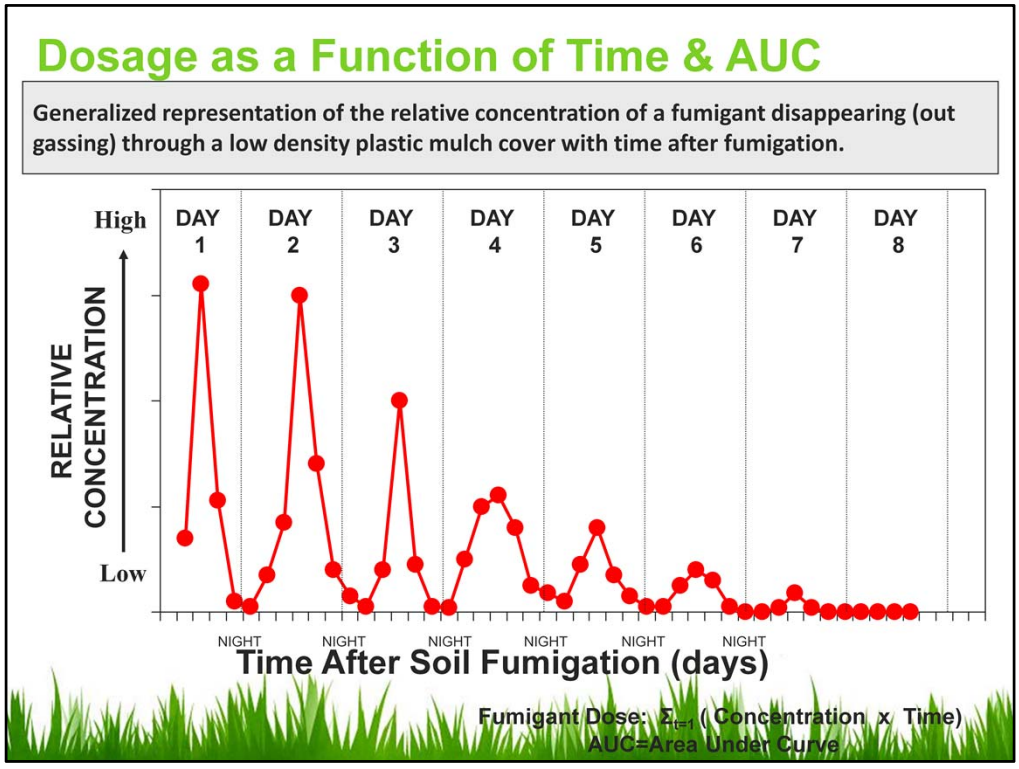


To understand soil fumigation, it would be helpful to provide a simplified description of the process of fumigant movement in soil.
After the fumigant liquid is injected to soil , fumigant movement in soil is driven by density and pressure gradients of gases evolving from a small, linear stream of concentrated liquid product released directly below the chisel path or drip emission source. This is the time of big bang, the volatilization of gases from the liquid. Depending upon their vapor pressure, some fumigants volatilize to a gas much more readily than others. For methyl bromide, it can almost occur as an instantaneous flash from a liquid to gas in soil.

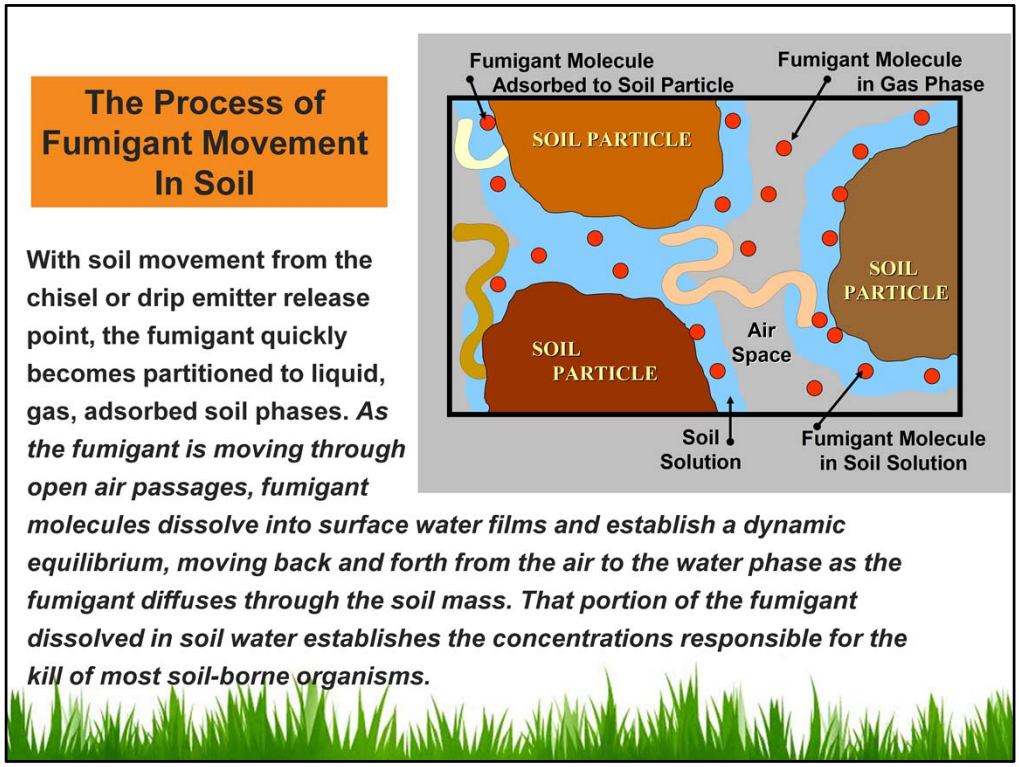
As the fumigants partial pressure falls, soil movement via mass flow becomes less important than by simple gas diffusion processes through open air spaces between soil particles from areas of high to low concentration. From a description of this process, It should be apparent that outward radial diffusion of the fumigant will be restricted if air passages are blocked.



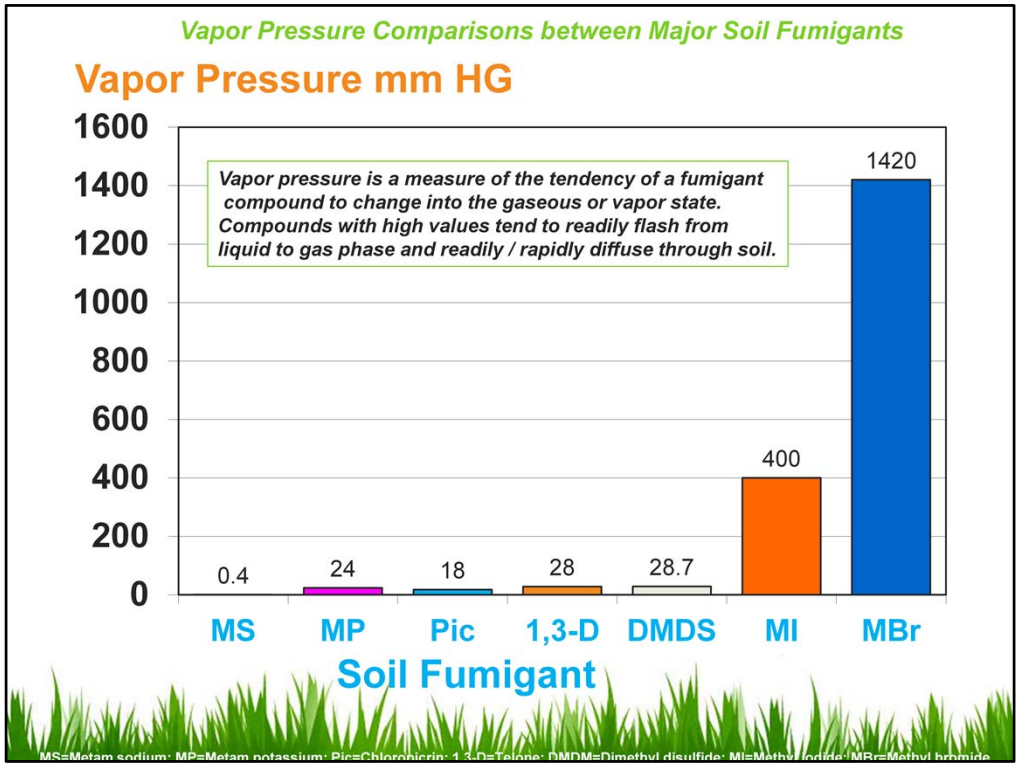
In general, gas movement in soil is defined by 4 separate phases or time steps. After injection, gases formed from the separate liquid streams delivered from the chisels or shanks begins radially diffusing outward through open air passages between soil particles from the points of soil injection (Panel A). Outward diffusion occurs along a density gradient where the fumigant wants to move from a soil area of high concentration to soil areas of low concentration. With time, concentrations of adjacent fumigant streams converge upon one another (B), and with continue outward movement and larger and larger soil volumes, soil concentrations begin to equilibrate to a shared, common and uniform concentration (C). These phases occur all the while the fumigant is structurally decaying and escaping the soil over time (D). It is hopefully apparent that open air passages are essential for efficient diffusion of gas, and that gas impermeable tarps or mulches over the soil could delay the disappearance of the fumigant from soil.



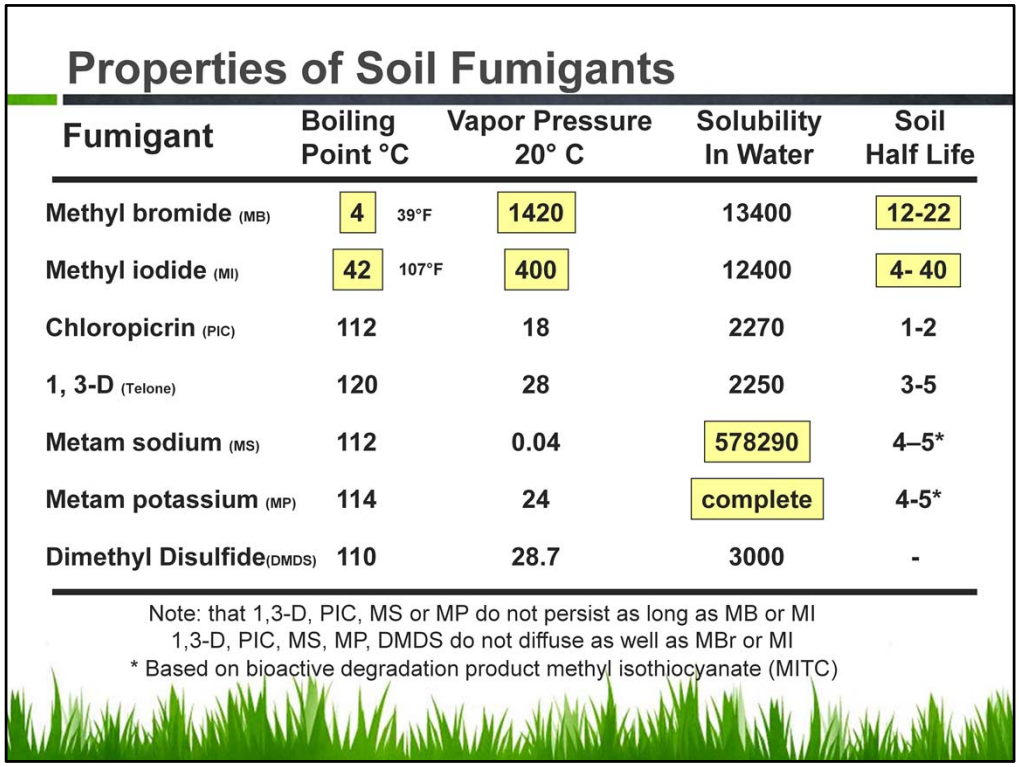
When fumigants are applied to soil, it is fortunate that the liquid or gas phases of the fumigant do not persist in soil forever. This graph illustrates how quickly a fumigant could disappear from soil, particularly when applied under a very gas permeable low density plastic mulch covering of soil. In general and under hot conditions, this illustration shows fumigant concentration decreasing to low levels during the first week after soil injection. Under warm soil conditions, the fumigant readily volitalizes to a gas in soil causing an increase in soil concentration during the day, and falling to lower levels at night when soil temperatures decline. As indicated previously, fumigant dosage and thus pest control should be considered as a function of a changing concentration over time. In this graph, the permeability of the plastic mulch to a fumigant gas should help to explain why different plastic mulches are becoming commercially available to improve containment and reduce the degree to which fumigant gases can move into the atmosphere, through the plastic mulch, from soil.



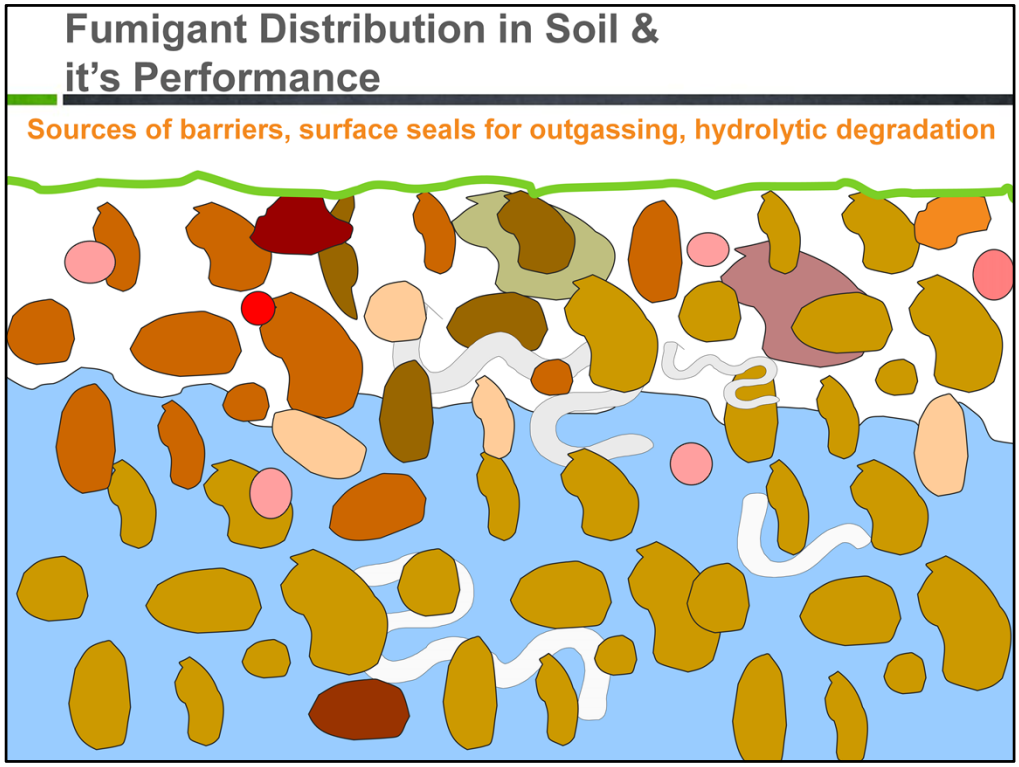
With soil movement of the liquid and gas from the chisel or drip emitter release point, the fumigant quickly becomes partitioned to liquid, gas, adsorbed soil phases. As the fumigant is moving through open air passages, some of the fumigant gases are adsorbed to soil particles, whereas other fumigant molecules dissolve into surface water films and establish a dynamic equilibrium, moving back and forth from the air to the water phase as the fumigant diffuses through the soil mass. Since nematodes and other disease organisms typically occur within the surface films of water surrounding soil particles, that portion of the fumigant that dissolves into soil water from the gas phase establishes the concentrations responsible for the kill of most soil-borne organisms.



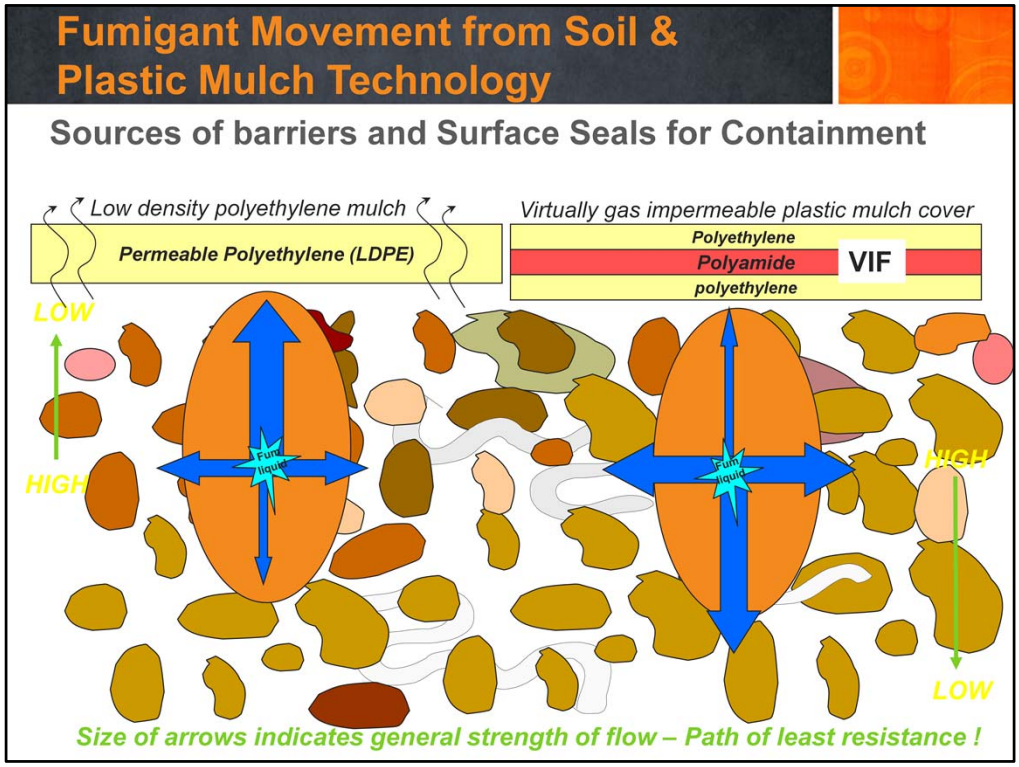
To describe soil movement of fumigant gases in soil requires scale to measure and compare the ease to which different fumigants volitalize to gases. Vapor pressure is a measure of the tendency of a fumigant compound to change into the gaseous or vapor state. Fumigant compounds with high values tend to readily flash from liquid to gas phase and readily and rapidly diffuse through soil. With the exception of methyl bromide and methyl iodide, most of the other major soil fumigant compounds have relatively low vapor pressures and thus evolve into and move as gases through soil much more slowly. The spacing and number of soil shanks or chisels used to deliver the fumigant into soil is largely determined by the vapor pressure of the fumigant compound.



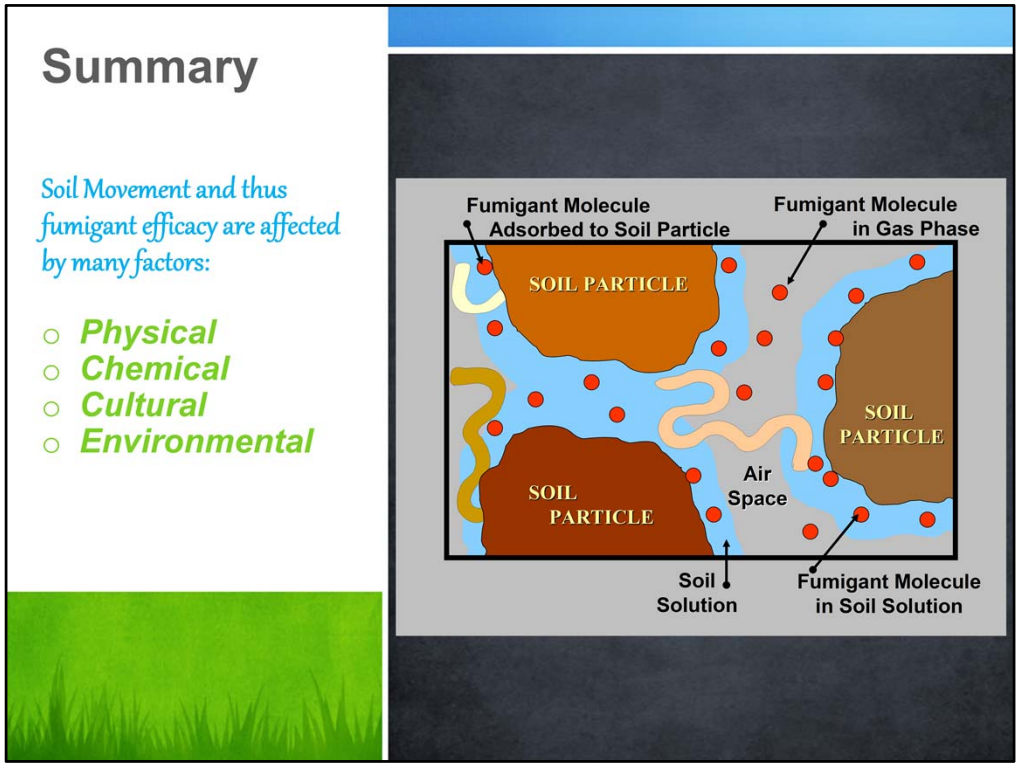
In addition to vapor pressure, the major soil fumigants also have major differences in boiling points, solubility in water, and half-life in soil, a measure of how long the fumigant persist in soil after application. The fact that metam sodium and metam potassium are so soluble in water, helps to explain why they are frequently used as drip fumigants, injected directly into the drip irrigation stream to be applied to soil. The table also shows that 1,3-D, chloropicrin, metam sodium, and metam potassium do not persist in soil as long as methyl bromide or methyl iodide do.



Fumigant movement within and out of soil can also be determined by physical and environment factors. In this scenario, a water saturated soil zone where soil air passages are displace by water, prevent any downward movement of fumigant gases in soil.



In this illustration, the presence of a gas impermeable plastic mulch cover can significantly reduce the upward movement and escape of fumigants from soil. With a virtually impermeable plastic mulch cover of scenario, a water saturated soil zone where soil air passages are displace by water, prevent any downward movement of fumigant gases in soil. The size of the different arrows generalizes the general strength of flow directional pathways fumigants move when injected under permeable (LDPE) and virtually impermeable (VIF) plastic mulch films. With gases continually escaping through the LDPE, fumigant movement is from the area of high concentration of the injection point to the plastic mulch layer, a zone of low concentration. Clearly fumigants want to move in a directional path of least resistance. For the permeable plastic, this translates to more rapid escape of gases from soil, and for the VIF plastic, enhanced downward and lateral movement of fumigant gases.



In summary, the ease to which fumigants volatilize from liquids to gases and the extent to which they move in soil are determined by many different factors including physical, chemical, cultural and environmental factors.

Module 2 Review Questions

Questions

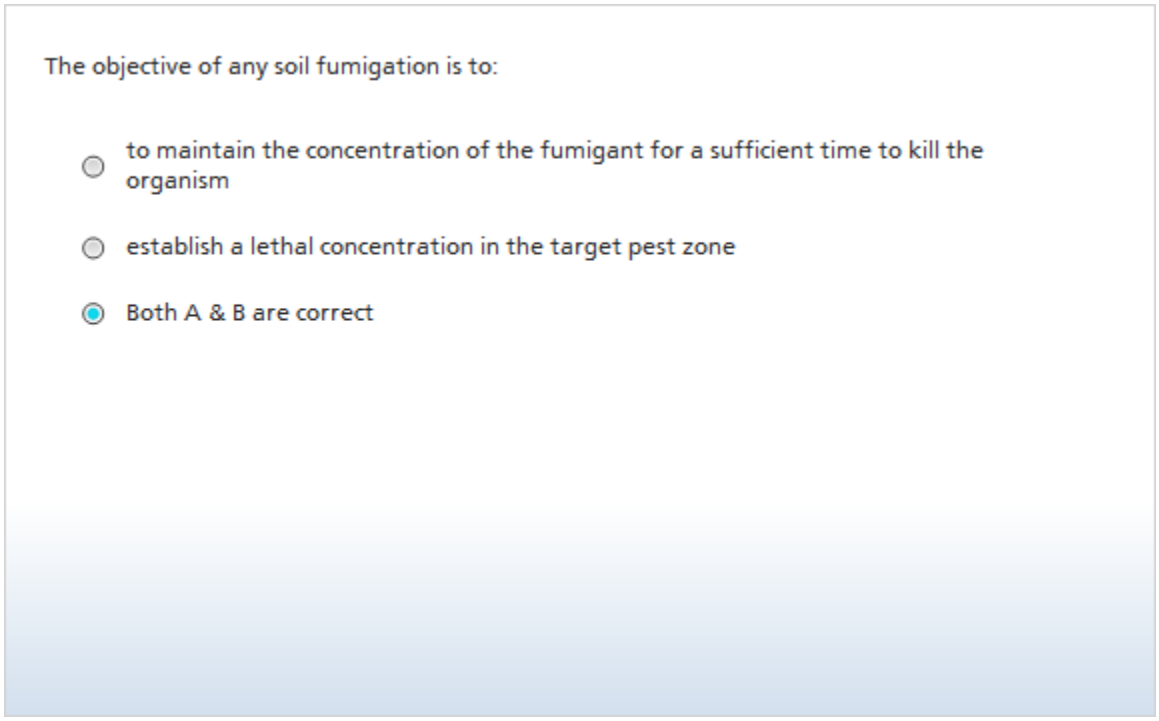
Question Group 1

1. Soil fumigation describes a _____ chemical treatment of soil, using a pesticide product that converts from a liquid to form a volatile gas that is able to diffuse through open pore space throughout the soil (bed) to provide control of various soilborne pests.

Soil fumigation describes a _____ chemical treatment of soil, using a pesticide product that converts from a liquid to form a volatile gas that is able to diffuse through open pore space throughout the soil (bed) to provide control of various soilborne pests.

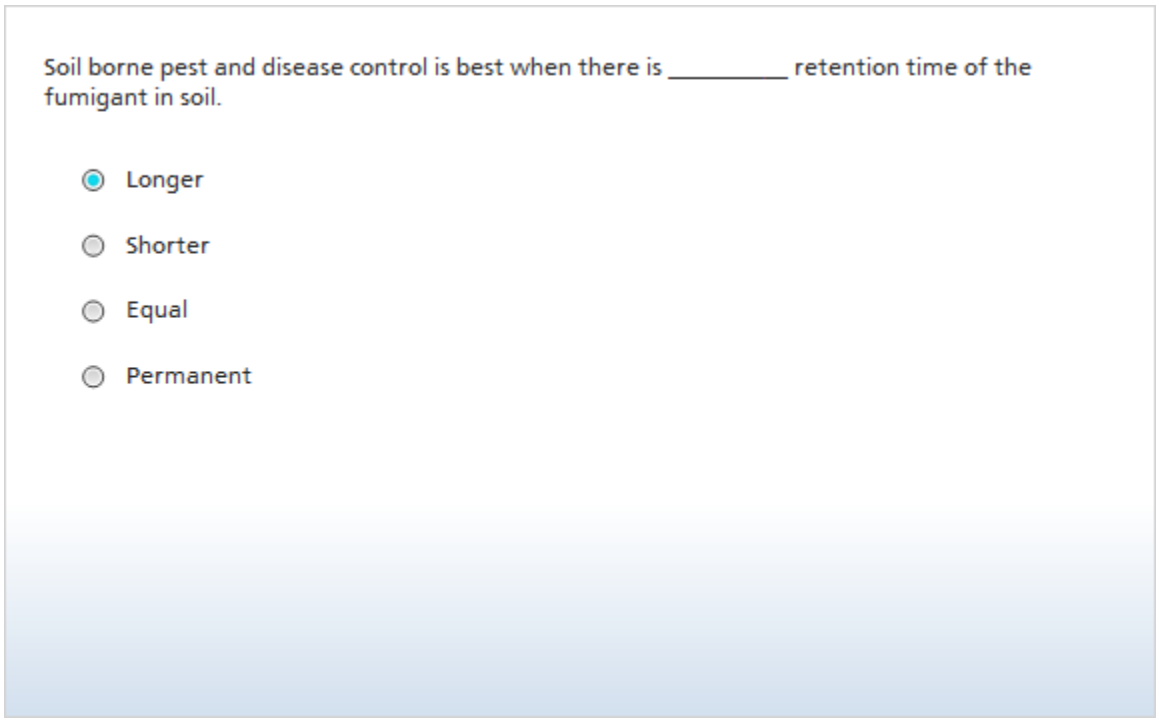
Choice
preplant
pre plant
pre-plant
pre - plant

2. The objective of any soil fumigation is to:



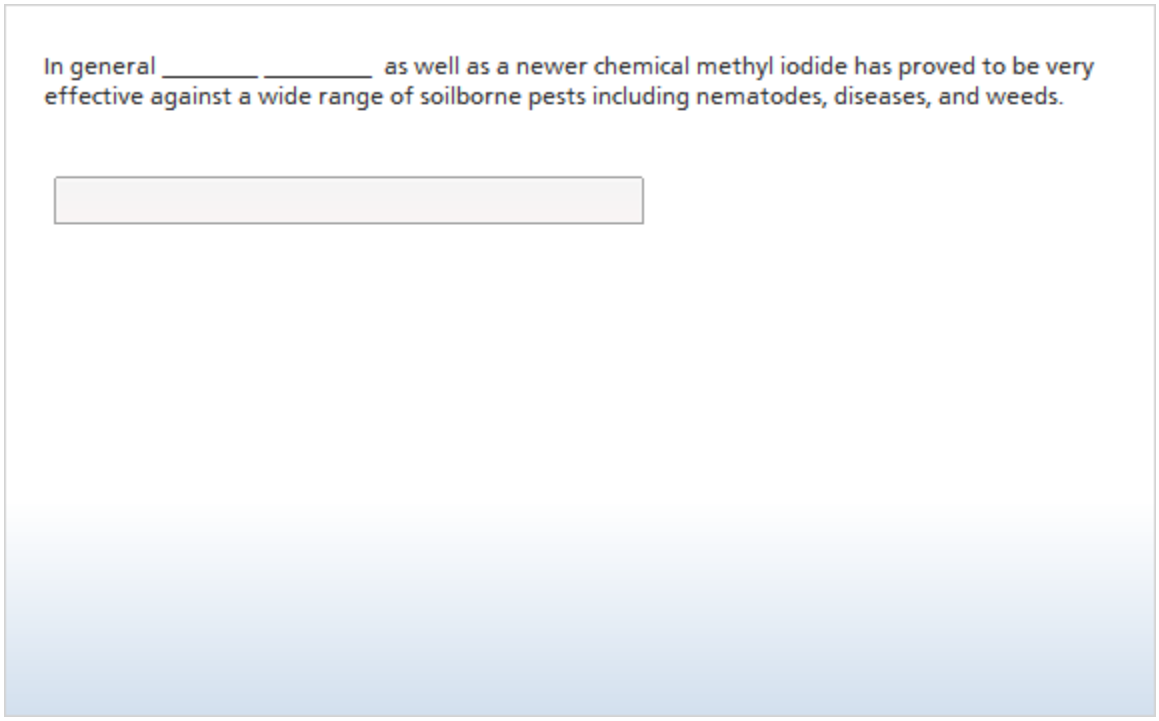
Correct	Choice
	to maintain the concentration of the fumigant for a sufficient time to kill the organism
	establish a lethal concentration in the target pest zone
X	Both A & B are correct

3. Soil borne pest and disease control is best when there is _____ retention time of the fumigant in soil.



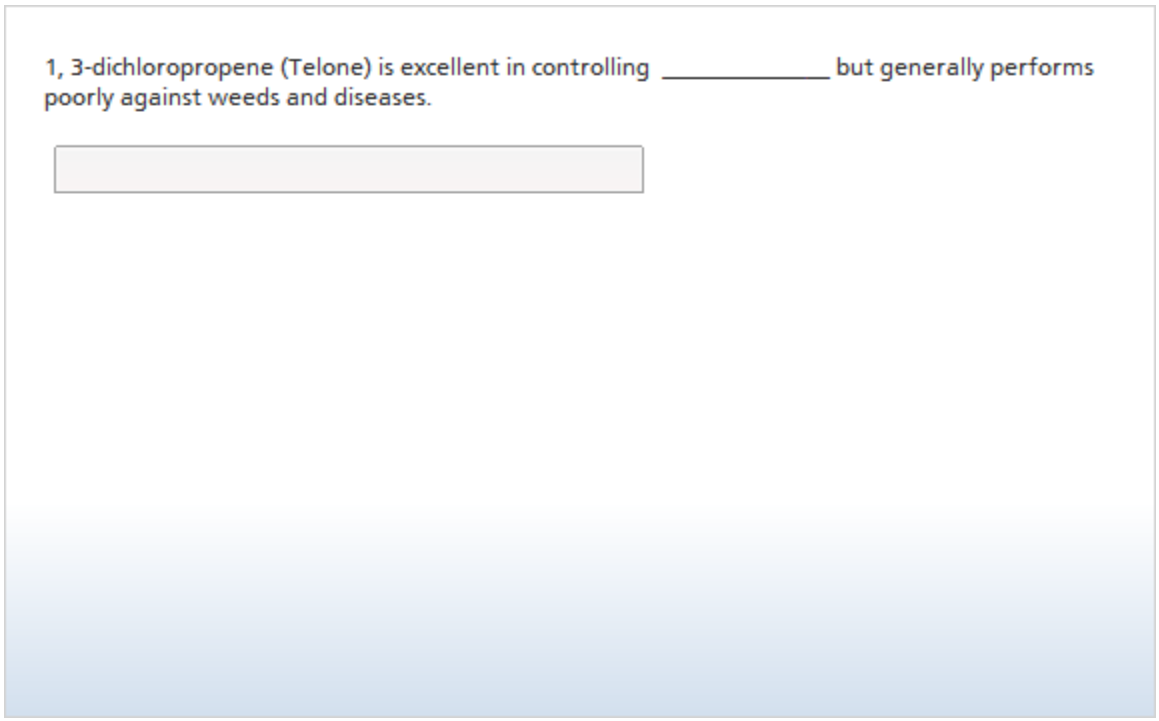
Correct	Choice
X	Longer
	Shorter
	Equal
	Permanent

4. In general _____ _____ as well as a newer chemical methyl iodide has proved to be very effective against a wide range of soilborne pests including nematodes, diseases, and weeds.



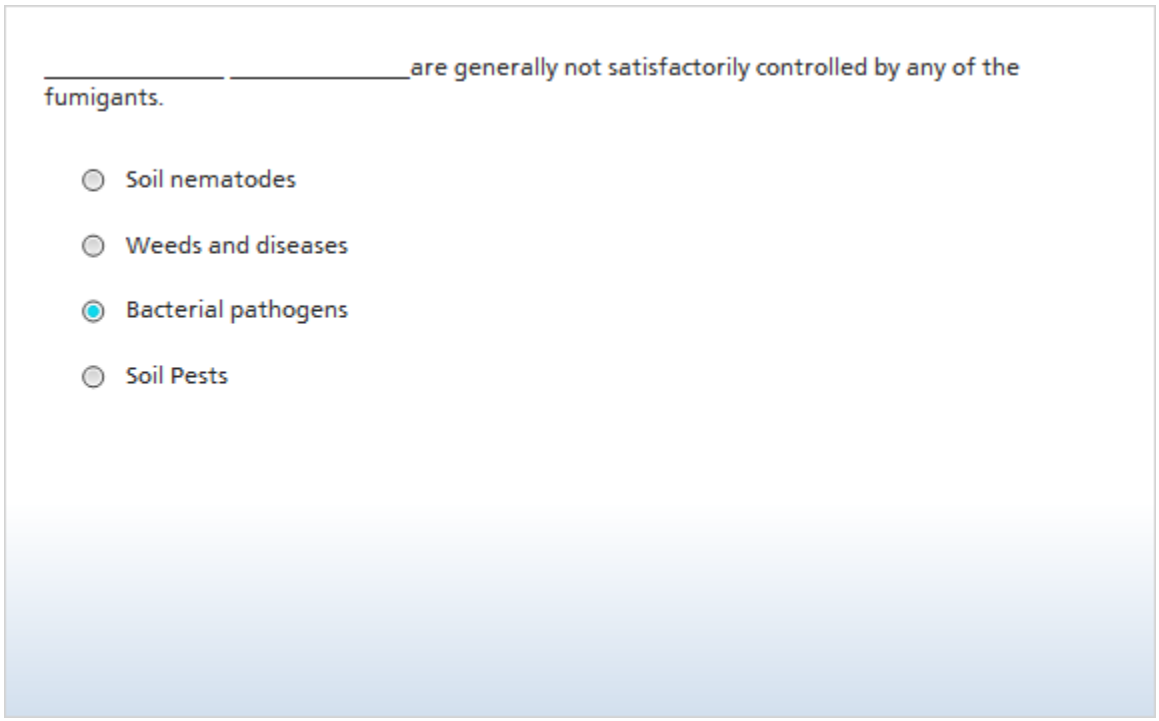
Choice
methyl bromide

5. 1, 3-dichloropropene (Telone) is excellent in controlling _____ but generally performs poorly against weeds and diseases.



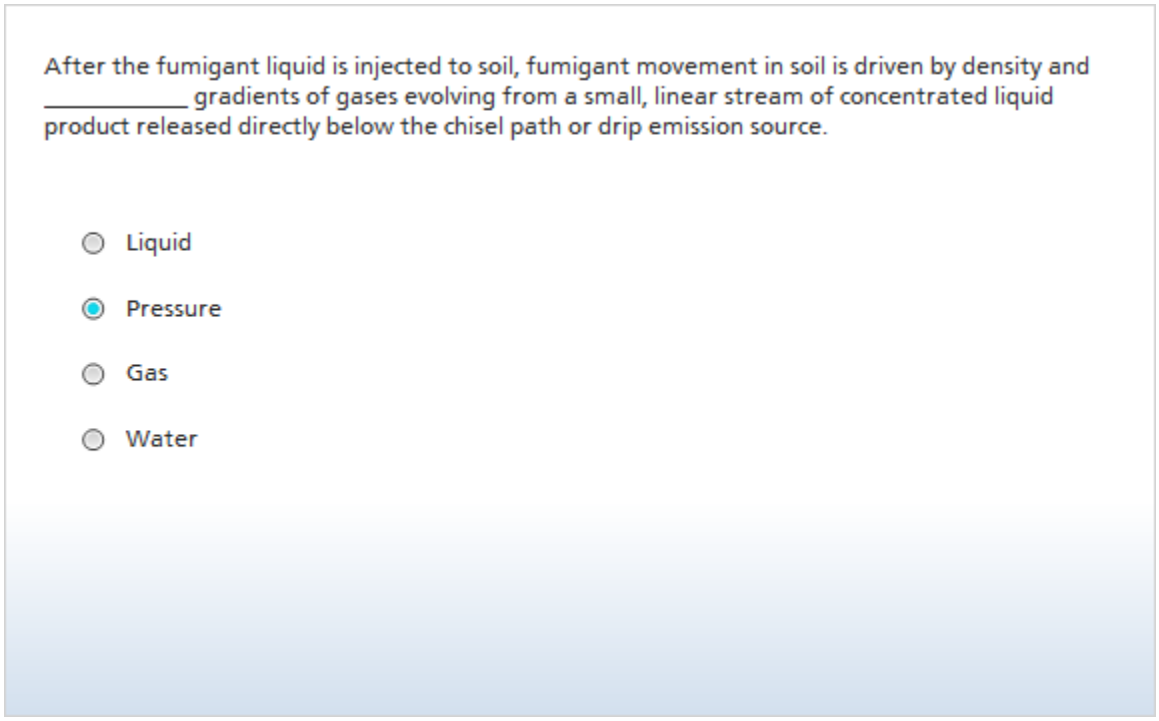
Choice
Nematodes

6. _____ _____are generally not satisfactorily controlled by any of the fumigants.



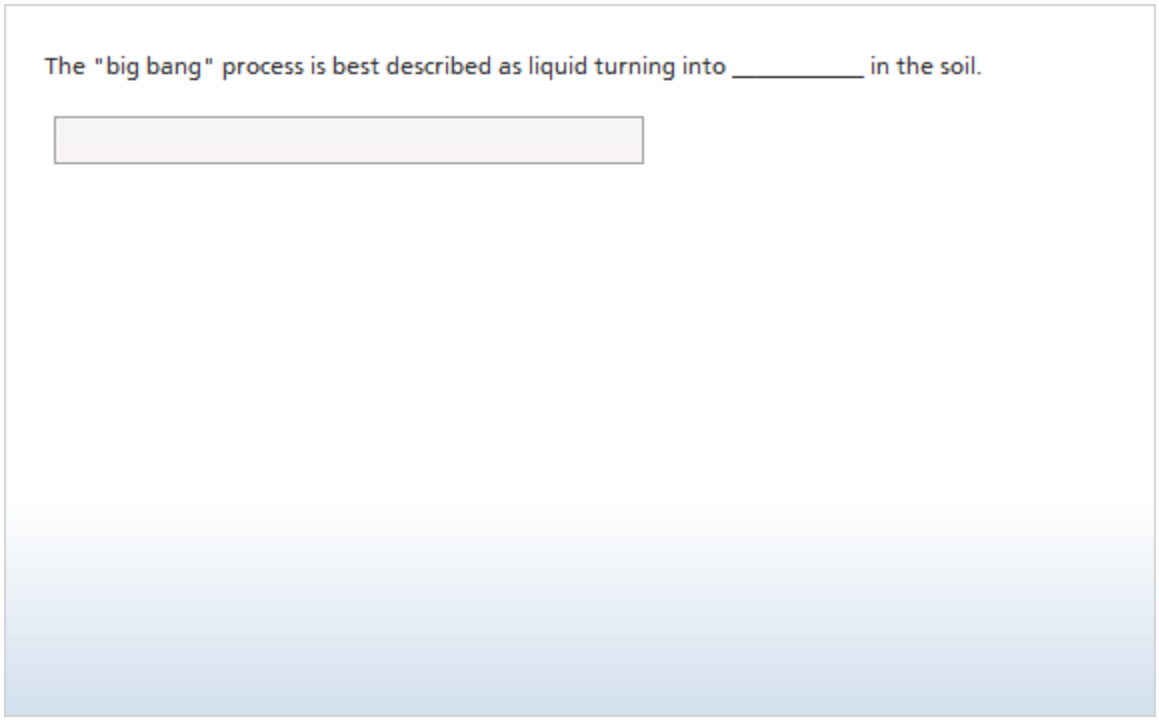
Correct	Choice
	Soil nematodes
	Weeds and diseases
X	Bacterial pathogens
	Soil Pests

7. After the fumigant liquid is injected to soil, fumigant movement in soil is driven by density and _____ gradients of gases evolving from a small, linear stream of concentrated liquid product released directly below the chisel path or drip emission source.



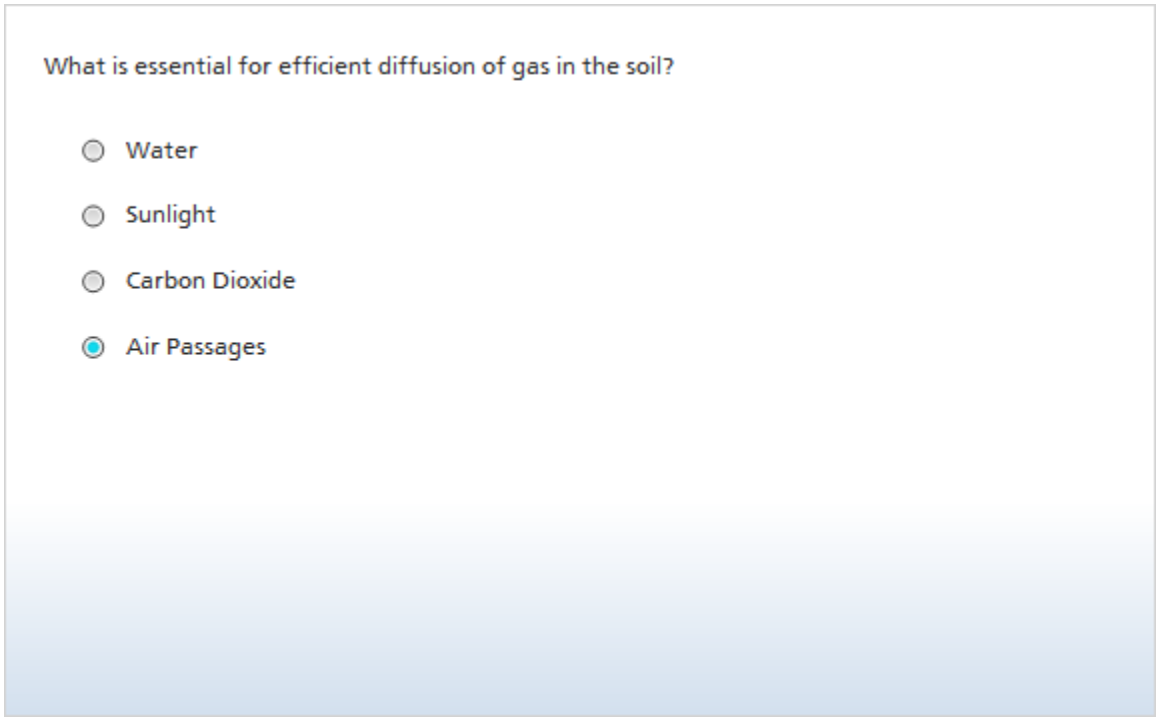
Correct	Choice
	Liquid
X	Pressure
	Gas
	Water

8. The "big bang" process is best described as liquid turning into _____ in the soil.



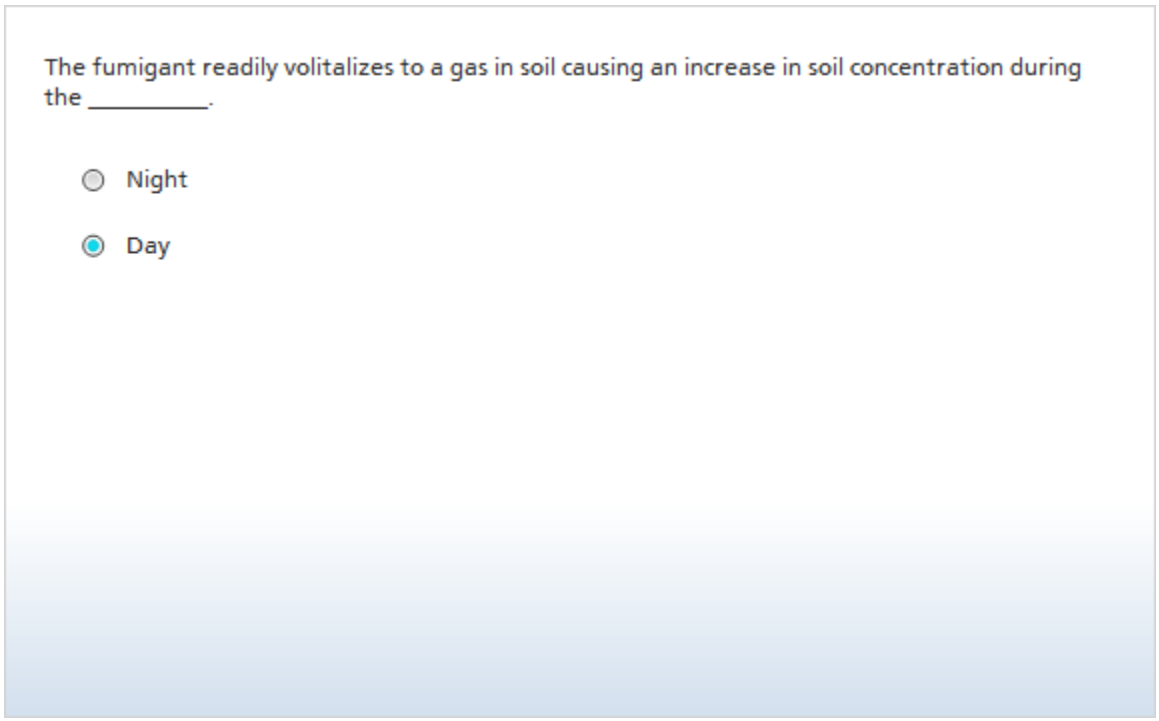
Choice
gas

9. What is essential for efficient diffusion of gas in the soil?



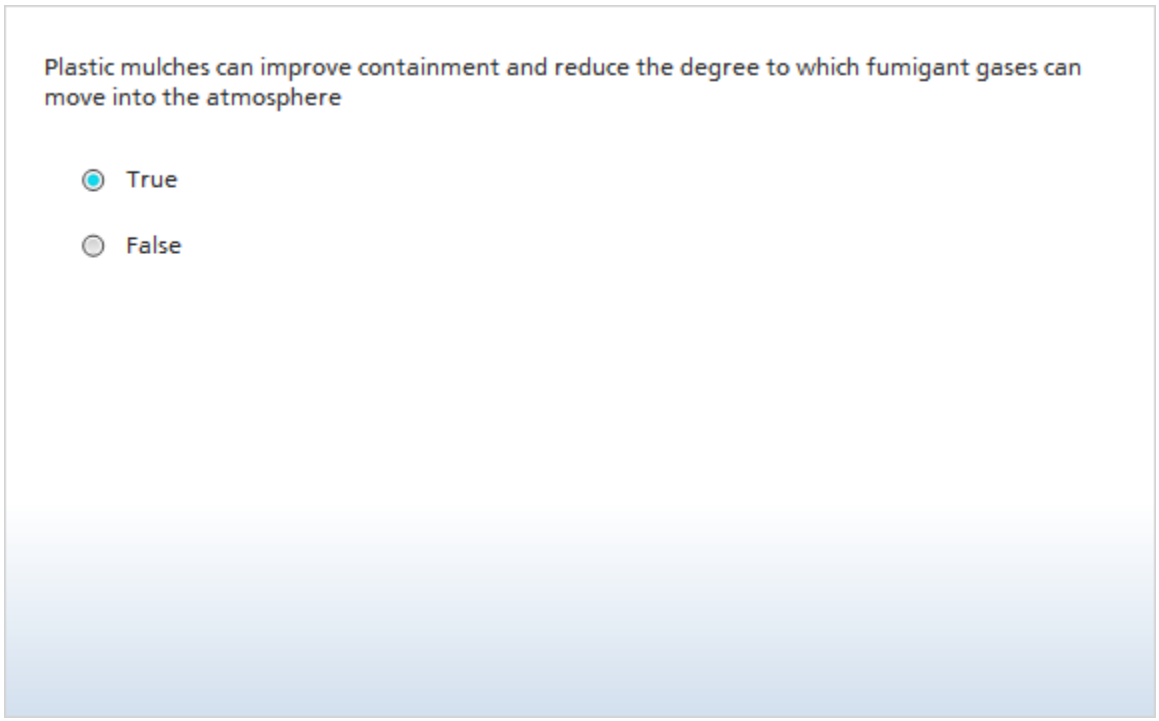
Correct	Choice
	Water
	Sunlight
	Carbon Dioxide
X	Air Passages

10. The fumigant readily volitalizes to a gas in soil causing an increase in soil concentration during the _____.



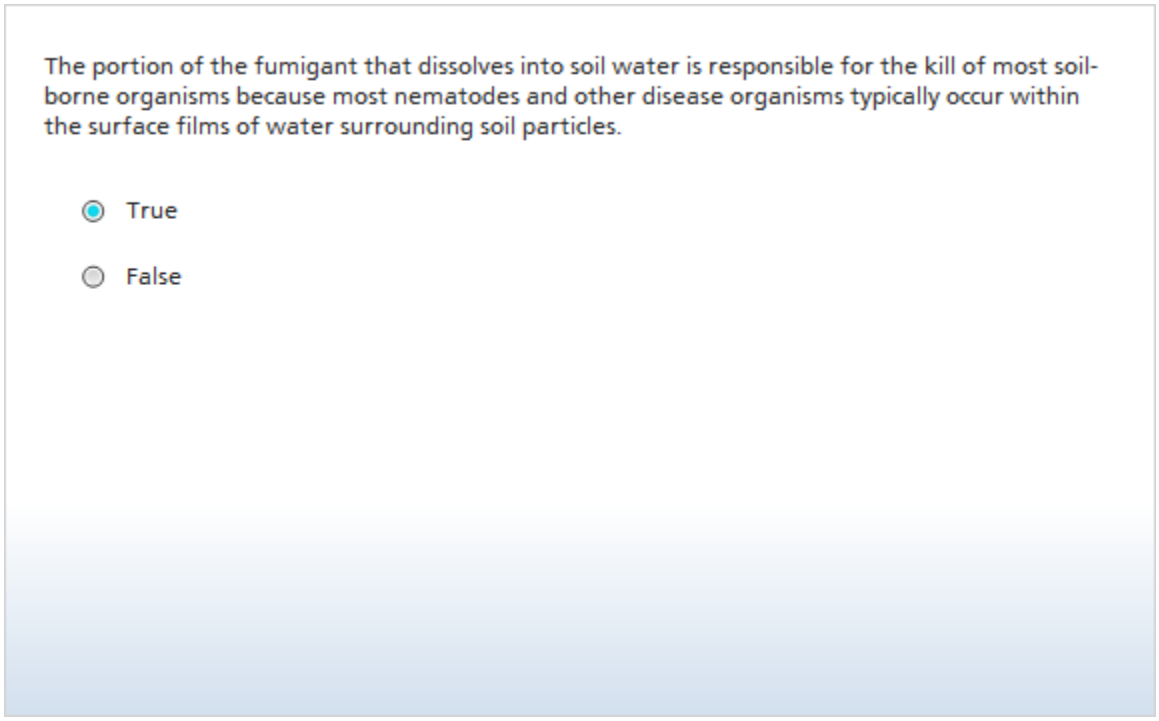
Correct	Choice
	Night
X	Day

11. Plastic mulches can improve containment and reduce the degree to which fumigant gases can move into the atmosphere



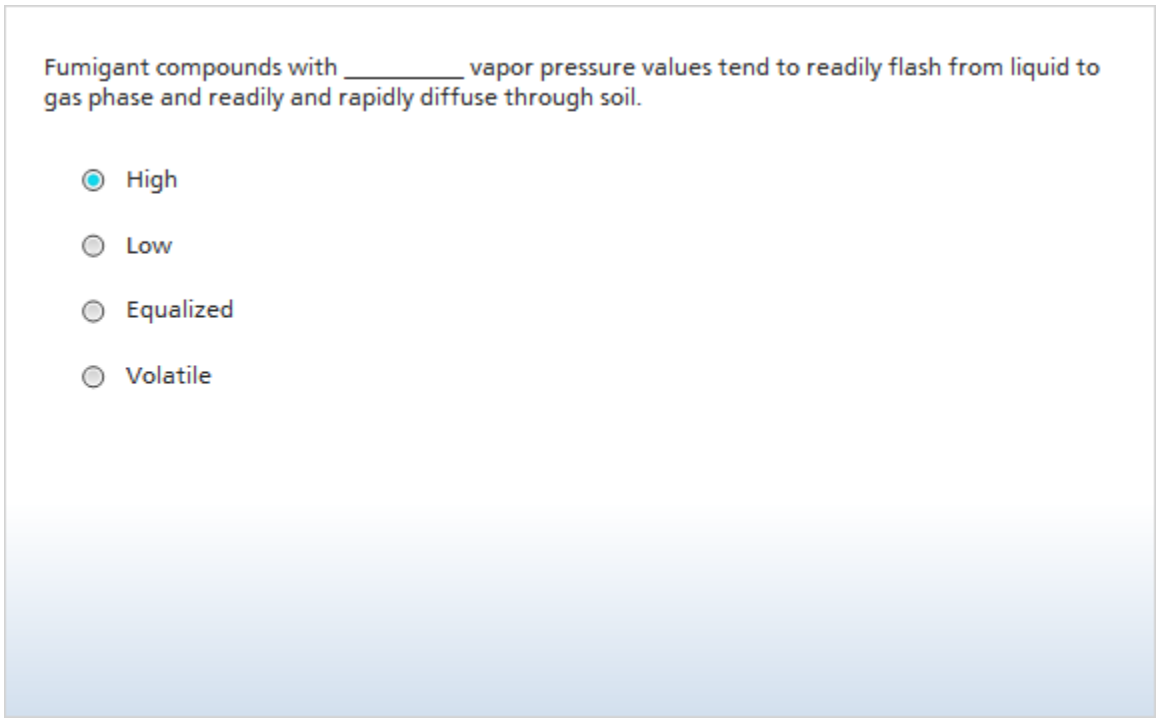
Correct	Choice
X	True
	False

12. The portion of the fumigant that dissolves into soil water is responsible for the kill of most soil-borne organisms because most nematodes and other disease organisms typically occur within the surface films of water surrounding soil particles.



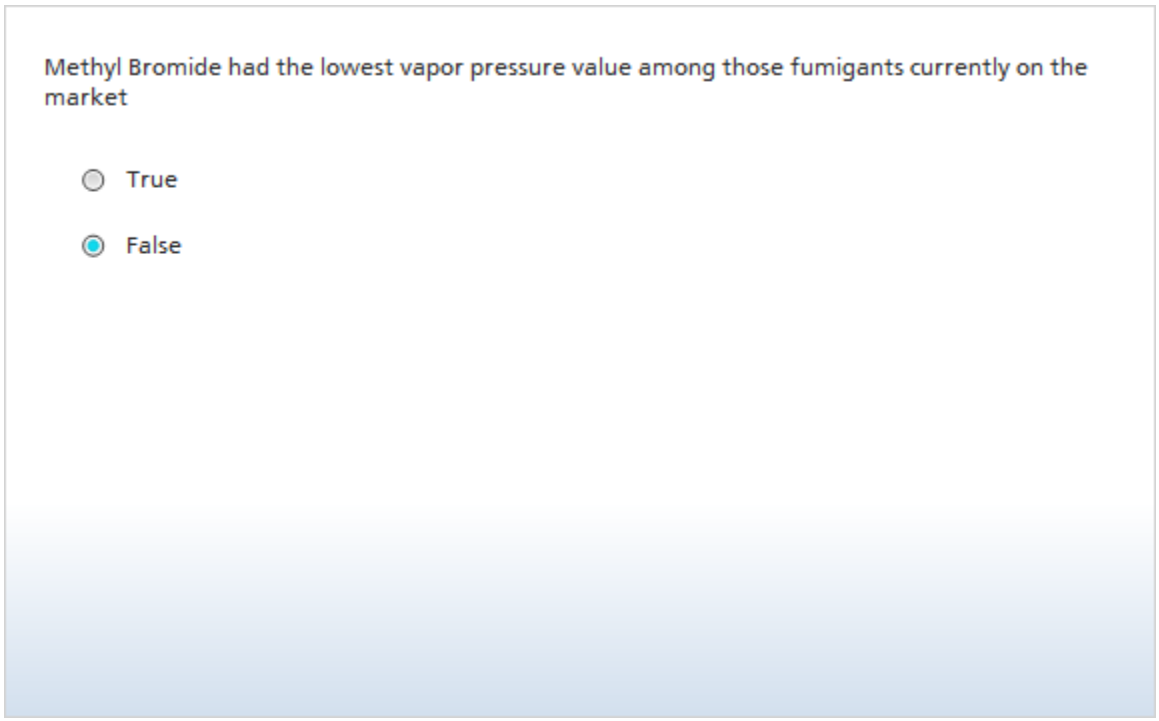
Correct	Choice
X	True
	False

13. Fumigant compounds with _____ vapor pressure values tend to readily flash from liquid to gas phase and readily and rapidly diffuse through soil.



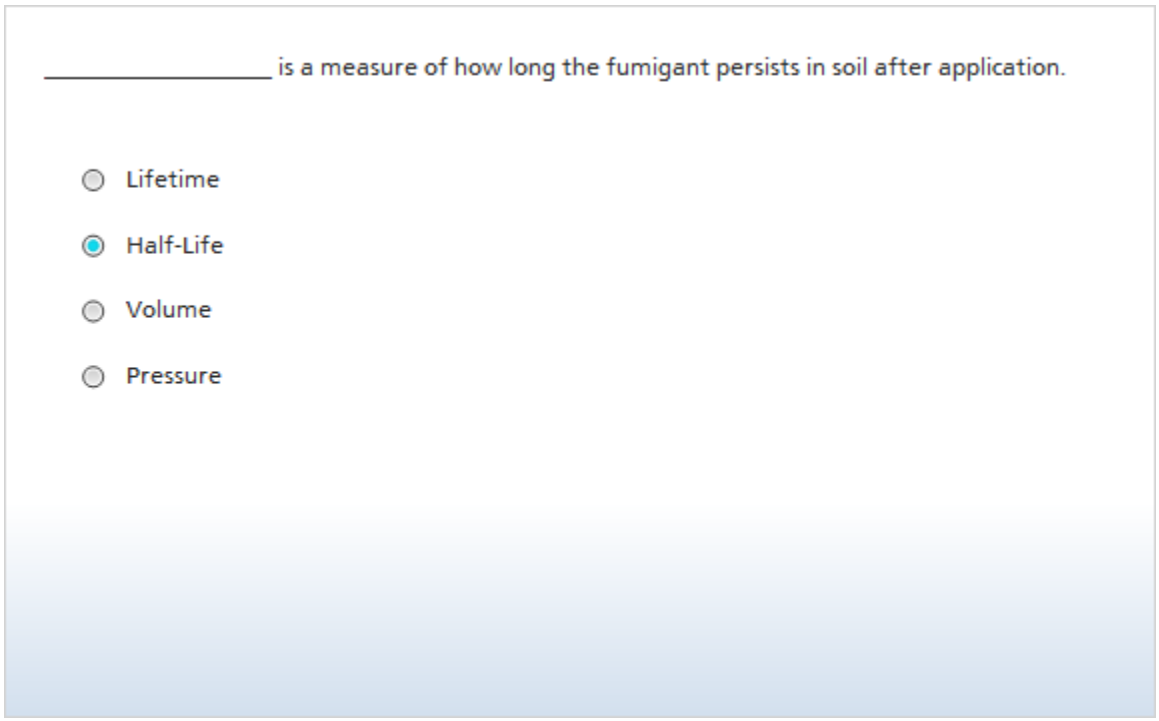
Correct	Choice
X	High
	Low
	Equalized
	Volatile

14. Methyl Bromide had the lowest vapor pressure value among those fumigants currently on the market



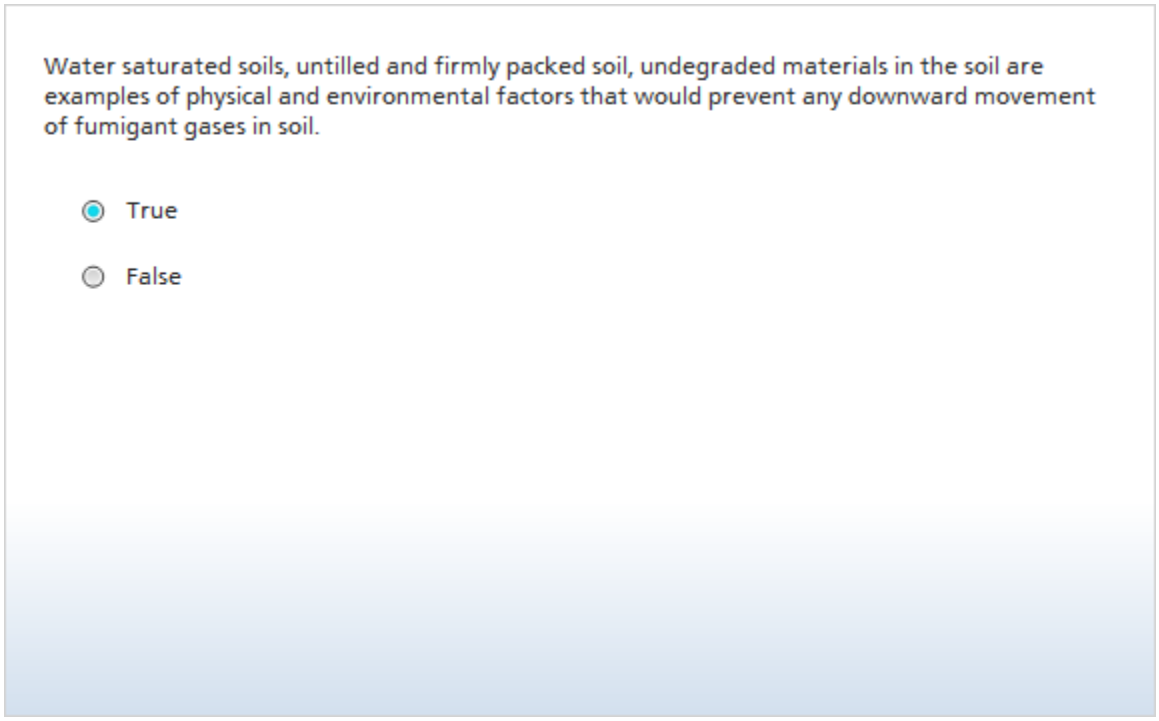
Correct	Choice
	True
X	False

15. _____ is a measure of how long the fumigant persists in soil after application.



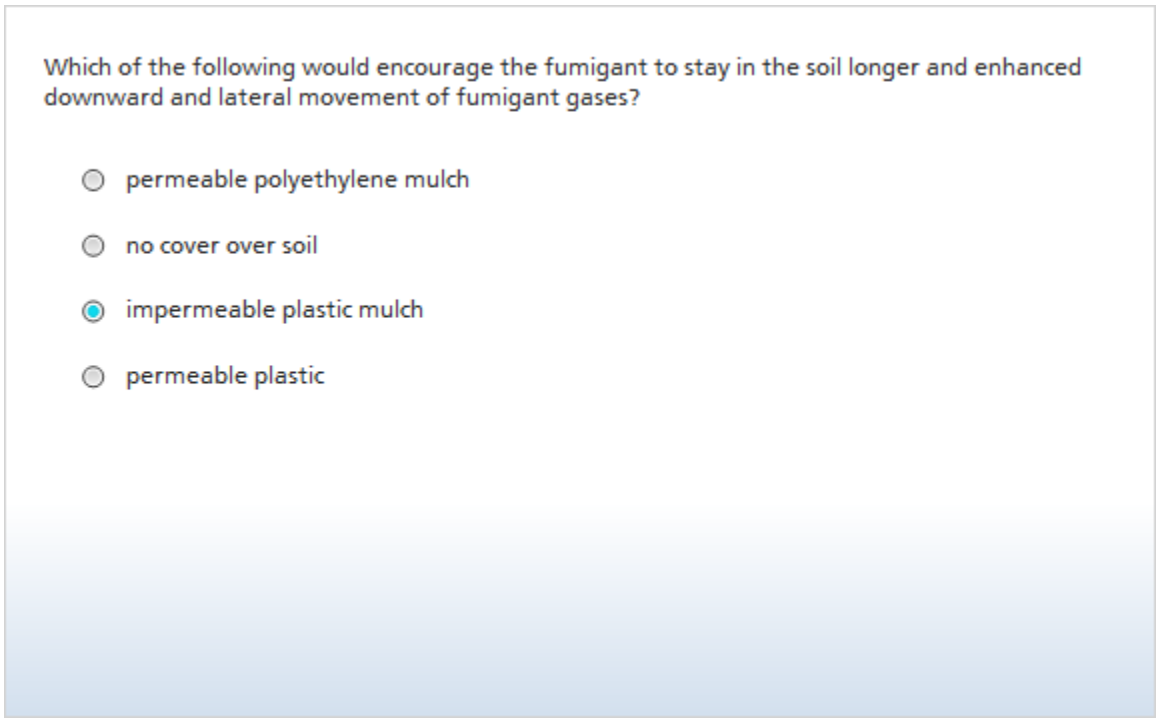
Correct	Choice
	Lifetime
X	Half-Life
	Volume
	Pressure

16. Water saturated soils, untilled and firmly packed soil, undegraded materials in the soil are examples of physical and environmental factors that would prevent any downward movement of fumigant gases in soil.



Correct	Choice
X	True
	False

17. Which of the following would encourage the fumigant to stay in the soil longer and enhanced downward and lateral movement of fumigant gases?



Correct	Choice
	permeable polyethylene mulch
	no cover over soil
X	impermeable plastic mulch
	permeable plastic