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Drip Irrigation for Windbreaks

This NebGuide contains information on designing and installing drip irrigation systems, which can help your trees become effective windbreaks at an earlier date than non-irrigationd trees.

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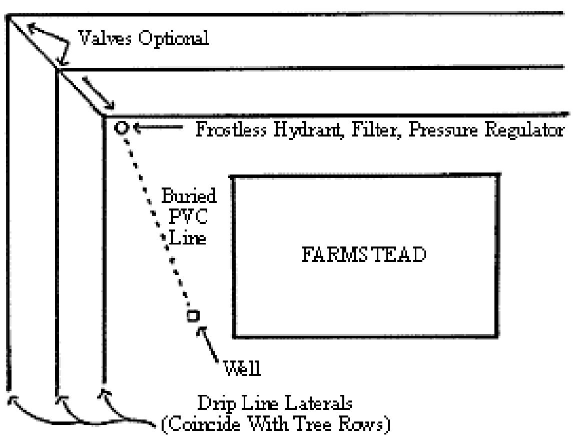


Figure 1. General layout of a windbreak's drip irrigation system.

Windbreaks can be a valuable asset to farmers ranchers and rural residents. A properly designed tree windbreak or shelterbelt provides protection for livestock, crops and farmsteads. A windbreak can also mean significant energy savings for heating a rural residence.

Drip or trickle irrigation can help establish successful tree plantings and help them become effective windbreaks at an earlier date than non-irrigationd trees. Drip irrigating windbreaks can mean significant labor savings and less water use than sprinkler or surface irrigation. In addition, drip systems create fewer problems with weeds and soil erosion.

System Layout

The heart of a drip irrigation system is the emitter. It is designed to let out water at a rate so slowly that the emitters tend to drip or trickle, hence the name. This allows the water to be precisely applied at the base of each tree, only where it is needed.

The emitter is installed on a lateral which is a black polyethylene pipe either 1/2 or 3/4 inch in diameter, depending on the length requirement. Laterals are laid down the tree rows and are intertwined with the trees (*Figure 1*). A number of laterals can be tied together with a manifold of the same size pipe for convenience. This manifold is connected to the main water supply by a frostproof hydrant and filter, with a pressure regulator in between them (*Figure 3*).

Water is conveyed from a water source to the hydrant by a buried PVC pipe. Temporary supply lines, such as garden hoses, may prove to be more of a nuisance and more expensive then permanent lines over the long run. It is necessary to use a filter of extremely fine mesh (50 mesh or finer; 100 mesh for pressure sensitive emitters) at the hydrant to avoid clogging the emitters. A paper element sediment filter ordered from a department store catalog works well. Filters are also available from drip irrigation dealers.

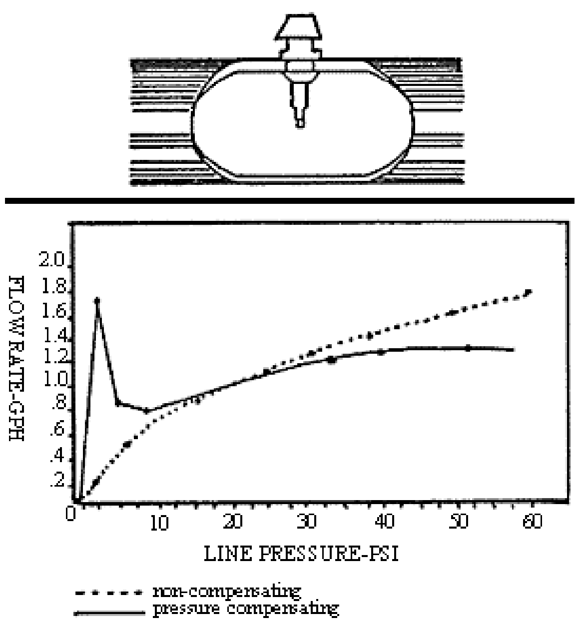
The emitters must operate at a specific pressure (15 to 25 psi) so a pressure regulator or a pressure gauge and a small globe valve is required to control the pressure properly. These items can be obtained from a hardware store or from companies that handle irrigation equipment. They can be connected to the hydrant with garden hose and the polyethylene pipe that is used as a supply line to the laterals. Drip irrigation suppliers have a wide variety of fittings that are ideal for installing a drip irrigation system.

System Design

The first step is to map the windbreak with a sketch (*Figure 1*) that includes the following:

1. Length of each lateral.
2. Species planted in each row.
3. Location of water supply and supply line.
4. Location of hydrant and manifold.
5. Difference in elevation between the highest and lowest point in each lateral.

Selecting an Emitter



An emitter is designed to put out one specific flow rate. Most commonly, there is a choice between 0.5, 1.0, 1.5, and 2.0 gallons per hour. The 1.0 gph emitter is recommended because the flow rate is adequate for the job but small enough to extend limited water supplies and avoid excessive pipe friction problems. Emitters with an output rate of 0.5 gph can also be used. In circumstances where the windbreak must be watered quickly, larger flow rates can be used. *Caution*: Higher flow rates will reduce the allowable length of laterals that can be used due to excessive friction losses that cause pressure variations in the laterals. A drip irrigation design expert should be consulted under these circumstances.

Figure 2. Emitter (above) and performance curve. Pressure compensating for flow rate variation with pressure. The flatter the curve in the 10 to 20 psi pressure range the better.

The flow rate variation of typical emitters with different lateral water pressure is shown in *Figure 2*. This example shows that a pressure compensating emitter is not 100 percent effective but does suppress major flow fluctuations as compared to the non compensating emitter. A pressure compensating emitter with a self-flushing capability is recommended. This type of emitter presents the fewest design problems and will not clog as often as other types. The maximum length of lateral that can be used with pressure compensating emitters is shown in *Table I*. Allowable lateral lengths and their influence on the selection of an emitter will be discussed later.

Many companies manufacture emitters that fulfill the requirements previously outlined and have wide product distribution. If the product is suitable, available, and meets the specifications, it can be used. However, the least expensive emitter that will do the job is desirable (as long as there is good dealer reliability) to keep the system's cost down. A pressure compensating emitter that is self-flushing will greatly simplify the design and operation of the drip irrigation system and is recommended even if the price is slightly higher.

Selecting Pipe Sizes

A drip system can be adapted to variable water supplies. Calculation of the water requirement is simple. Multiply the number of trees to be irrigationd by the gallons per hour delivered by each emitter. Divide by sixty to determine the gallons per minute. (Example: 120 trees × 1 gph ÷ 60 = 2 gpm). If this figure is too high for the available water supply, any combination of the laterals used can be operated independently with the proper placement of valves. For example, there are six separate laterals in *Figure 1*.

Use this water requirement as the design flow rate in the main supply line. *Table I* shows the maximum flow rate that different pipe sizes can handle. Pick the smallest size that will carry the required amount of water.

Table I. Maximum lateral length with pressure compensating emitters.

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Pipe Size	Maximum Flow in Mainline or Manifold Gallons per hour	Using Pressure Compensating Emitters	
		Maximum Lateral Length Shrubs	Maximum Lateral Length Trees
1/2 in.	300	453 ft.	586 ft.
3/4 in.	480	830 ft.	1075 ft.
1 in.	7800		
1 1/4 in.	1380		
1 1/2 in.	1920		
2 in.	3120		

The size of each lateral depends on the number of trees, the irrigation rate at each tree, and the length of the lateral. *Table I* shows the maximum allowable length of lateral that can be used with 1 gph pressure compensating emitters, depending on whether the row is planted with shrubs or trees. Pick the smallest size that will do the job.

If the drip irrigation system is to be installed on a relatively flat site, pressure sensitive emitters can be used and may be less expensive than pressure compensating emitters. To ascertain if it is possible to use pressure sensitive emitters, determine the required length for each lateral, the maximum difference in elevation for each lateral, and the species that will be planted on that lateral. Compare the required length of lateral with the maximum allowable length shown in *Table II* for both the 1/2 inch and the 3/4 inch pipe. If the maximum allowable length is greater than the required length, a pressure sensitive emitter can be used. For example, a lateral must be 500 ft long. It will be planted with shrubs and the difference in elevation between the highest and lowest point is 6 ft. A 1/2 inch pipe's maximum allowable length is only 309 ft and the 3/4 inch pipe is 567 ft. Thus, the 3/4 inch pipe size is acceptable and pressure sensitive emitters can be used.

Table II. Maximum lateral length in feet for emitters without pressure compensation.

Pipe Size	Species	Elevation Difference, ft									
		0	1	2	3	4	5	6	7	8	9
1.2 in.	shrubs	453	434	414	393	368	341	309	270	218	120
	trees	586	562	536	508	477	441	400	350	282	155
3.4 in.	shrubs	830	797	760	720	676	626	567	496	400	220
	trees	1075	1031	984	932	875	810	734	642	518	285

It should be noted that if the difference in elevation is over 9 ft, pressure compensating emitters must be used. Using pressure compensating emitters eliminates the need for a survey of the elevations along each lateral, but if the dead end of a lateral is higher than the manifold, an approximation of that difference must be made to select a design operating pressure.

It is recommended that black polyethylene (P.E.) pipe be ordered in 400 foot rolls. This reduces the number of connections that have to be made. If part of the laterals can be irrigationd with 1/2 inch diameter pipe but the rest must use 3/4 inch, consider using all 3/4 inch for convenience.

Design Pressure

Follow the manufacturer's recommended design pressure for all emitters unless there is an elevation difference greater than 10 ft between the manifold and the dead end of a lateral. When using pressure compensating emitters, add 5 psi to the operating pressure for every 10 ft rise in elevation above the manifold. For example, the normal design pressure is 20 psi but the dead end of the lateral is 20 ft higher than the manifold. Increase the design pressure by 10 psi to 30 psi. This does not have to be done if the lateral ends are lower than the manifold. The pressure can be adjusted with a pressure gauge downstream from a globe valve by adjusting the valve until the proper pressure is found. A drip irrigation supplier will also have pressure regulators.

Installation

The components should be assembled as shown in *Figure 3*. The lateral pipes should be intertwined or "snaked" through the tree lines with about one extra foot of polyethylene pipe per 100 feet of tree row. This is done to keep the emitters near the tree when there are changes in air temperature. When the temperature rises, the line becomes longer but the emitter does not pull away from the tree. The same is true in reverse for colder temperatures. During installation, if the temperature is above normal operating conditions, the emitters should be installed about six inches from the tree toward the dead end of the lateral; if it is cooler than normal, install the emitter six inches toward the start or fixed end of the lateral.

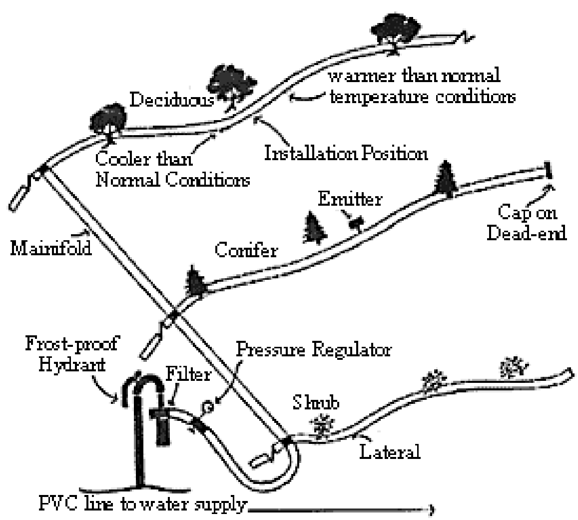

Figure 3. Proper installation of components of a typical drip irrigation system.

Emitters are installed in the lateral with a punch tool obtained from the emitter supplier. Specific instructions for each manufacturer should be followed. The lateral is flushed to remove any debris that might have accumulated during installation, and is usually filled with water when installing the emitter. The lateral will become quite warm if it is in sunlight for a period of time. This softens the polyethylene and makes punching clean holes more difficult. The ends of the laterals can be opened to allow cooler water from the lateral to offset this problem.

System Operation

Once the system has been designed and installed., proper operation is necessary to get the best service from the system. While there are no absolute guidelines for system operations, general recommendations can be made to improve growth rates.

Trees should be planted with adequate soil moisture available. Depending on the location in the state, trees should be irrigationd with about 8 to 16 gallons of water per week the first year. Tree plantings in the western parts of Nebraska require more water than those in the eastern areas. For example, a system with one gallon per hour emitters should be run four to eight hours, twice a week. The amount of water should be increased by two to four gallons per week each year in succeeding years.

Self-flushing emitters will generally not plug up, but an inspection to determine if any of the emitters are not working is required for the first few times the system is operated after installation, and periodically from then on.

The weather and type of soil affect tree irrigation. Rainfall should be taken into account when deciding if irrigation is necessary. Sandy soils cannot retain moisture as well as heavier soils and must be irrigationd more often. Frequent waterings of short duration are not desirable because they tend to produce shallow root systems. Watering twice a week helps the trees develop good root systems, but watering three times a week may be necessary on very sandy soil with trees that are less than three years old. *Caution*: Damage to seedlings can occur on sandy soils where chemical weed control has been used.

After the fifth year, trees and shrubs will be large enough to catch snow to provide moisture for some of their water requirements early in the year. The windbreak should be able to survive on its own after about eight years, which is the approximate life expectancy of the drip systems. By this time, the plants have developed root systems capable of supplying the needed moisture.

The irrigations should be discontinued in late August to allow the trees and shrubs to "harden off" before winter. The planting should be irrigationd once more around the middle of October, after the first freeze, to help prevent winter burn. The time of the last irrigation will vary in different parts of the state and from year to year.

It is a good idea to store filters and regulators over winter. However, removal and storage of the drip system laterals is not recommended as it would be difficult to realign the emitters with the trees in the spring. The laterals should be self-draining but low spots should be checked to prevent damage due to freezing. All pipe openings should also be sealed.

Costs

As a rule of thumb, expect the cost of irrigating a shelterbelt to be on the order of $1.25 to $1.50 per tree. This will depend on the number of trees available to spread the common cost of the supply line. Actual cost ranges for the various components in 1980 are listed below:

1. Pressure compensating emitters, 25¢ to 60¢ each.
2. Black polyethylene pipe (1/2 or 3/4 inch), 8¢ to 10¢ per foot in 400 foot rolls.
3. Pipe fittings, about 25¢ to 50¢ each.
4. Sediment filter, $15.00 to $25.00.
5. Pressure gauge and gate valve, $7.00 to $10.00.
6. Water supply line, valves, etc., cost will vary.

For additional help or information in designing and installing drip irrigation systems, contact the USDA Natural Resources Conservation Service or your county Extension office. Cost-share on drip systems is available in some county Agriculture Stabilization and Conservation offices.

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