Department of Horticultural Science

Horticulture Information Leaflet 33-E

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VEGETABLE CROP IRRIGATION

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Vegetables are 80 to 95 percent water. Because they contain so much water, their yield and quality suffer very quickly from drought. When vegetables are sold, a "sack of water" with a small amount of flavoring and some vitamins is being sold. Thus, for good yields and high quality, irrigation is essential to the production of most vegetables. If water shortages occur early in the crop's development, maturity may be delayed and yields are often reduced. If a moisture shortage occurs later in the growing season, quality is often reduced even though total yields are not affected. Most vegetables are rather shallow rooted and even short periods of two to three days of stress can hurt marketable yield. Irrigation is likely to increase size and weight of individual fruit and to prevent defects such as toughness, strong flavor, poor tipfill and podfill, cracking, blossom-end rot and misshapen fruit. On the other hand, it reduces soluble solids in muskmelons and capsaicin in hot peppers if applied during fruit development.

Growers often wait too long to begin irrigating, thinking, "It will rain tomorrow." This often results in severe stress for the portion of the field that dries out first or receives irrigation last. Another common problem is trying to stretch the acreage that can reasonably be covered by available equipment. Both of these practices result in part or all of the field being in water stress. It is best that a good job be done on some of the acreage rather than a "half-way job" being done on all the acreage.

Drought stress can begin in as little as 3 days after a 1-inch rain or irrigation in such crops as tomatoes in soils like those in the Piedmont of North Carolina. Thus, frequent irrigation is necessary for maximum yield. Soil moisture requirements differ with the crop and stage of crop development. Soil moisture availability varies with the amount of water in the soil and the type of soil. Soil type is very important in planning for and using an irrigation system. Various vegetable crops are listed in Table 1 as to the critical stage and irrigation needs.

Up to 1.5 inches of water are needed each week during hot periods to keep vegetable crops that have a plant spread 12 inches or more. This need decreases to .75 inch per week during cooler seasons.

Droplet size and irrigation rate are also very important in vegetable crops. Large droplets resulting from low pressure at the sprinkler head can cause damage to young vegetable plants and contribute to crusting when soil dries. Irrigation rate is also important in sandy soils that absorb water more readily than clay soils. However, clay soils have a greater percent of the water available. Irrigation rate will depend on soil type but application rates should not exceed 0.40 inch per hour for sandy soils, 0.30 inch per hour for loamy soils or 0.20 inch per hour for

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clay soils. High application rates will result in irrigation water running off the field, contributing to erosion and fertilizer runoff.

Improving Stands – Most vegetables have small seed which are planted 0.75 inch deep or less. When seeds are planted shallow, the upper layer of soil can dry rapidly, leaving the seed half germinated with not enough soil moisture to complete germination. When this happens, no stand or at best an incomplete stand will result. An irrigation of 0.50 to 0.75 inches immediately after planting should be applied to settle the soil and to start seeds germinating. For larger seeded crops, irrigation a few days prior to seeding is desired. If seeds are slow to come up due to cool temperatures or slow germination, then irrigations of 0.75 to 1 inch per acre should be applied as needed. This should be done to keep the area around the seed moist until seedlings emerge. Irrigation is a valuable tool in getting a good, uniform stand which insure high yields. Good uniform stands also mean uniform harvest dates and more efficiency of production.

Vegetable transplants also require good soil moisture. A light irrigation of 0.50 to 0.75 inch per acre will help establishment by providing a ready supply of water to young broken roots.

Irrigation at planting time can also reduce soil crusting and hasten seedling emergence. If 0.50 to 0.75 inch of irrigation is slowly applied, either with low rates or by turning the irrigation system off long enough to allow water to soak in, crusting can be reduced and stand will be improved.

Product development and fruit set – Wide fluctuation in soil moisture injure fruit crop vegetable like tomatoes and peppers (Table 1). These fruits contain large amounts of water and depend on this water for expansion and growth. When soil moisture is allowed to drop below the proper level, the fruit does not expand to produce maximum size before it ripens, thus reducing yield. If moisture is allowed to fluctuate too much, blossom end rot can occur and fruit is no longer useable.

If moisture fluctuation occurs during the fruit expansion stage, fruit cracking will occur. Fruit cracking usually occurs when inadequate water has been applied and then heavy rains bring too much water (Table 1). The best way to prevent fruit cracking is a steady moisture supply. Second growth or knobs in potatoes are also caused by soil moisture fluctuations.

Rooting depth – It is important that the soil profile be filled with water at each irrigation. Frequent light irrigations result in shallow root systems. Shallow root systems result in plants being stressed even in short periods of water deficit, not Table 1 for crop specifics. On the other hand, excessive irrigation leaves crops vulnerable to leaching from rain or irrigation.

The rooting depth of various vegetables is listed in Table 1. It is important that shallow rooted crops receive more frequent irrigations.

Preferred minimum soil moisture – Soil moisture is measured with a *tensiometer* or *soil block*. The former is preferred for sandy soils and the latter for clays and loams. Tensiometers report soil moisture in centibars (.001 bar), suggested soil tensions for various vegetables are reported in Table 1. Soil blocks report available soil moisture (ASM) and Table 1 suggests minimum levels for most vegetables.

Amount and timing – Irrigation amounts and time between irrigations are critical to efficient irrigation practices. Some suggestions for amount and timing of irrigations are presented in Table 1.

Critical moisture periods – Critical periods of irrigation needs can best be defined as that time when soil moisture stress can most reduce yield in an otherwise healthy crop (Table 1). This is not to say that it is the only time in the life of the crop that moisture stress reduces yield. It is, however, the time when stress has the greatest effect.

Irrigation method – Vegetable crops differ in which method of irrigation can be used economically in their production (Table 1).

Drought tolerance – Drought tolerance is an indication of a crops ability to withstand short periods of drought without *significantly* reducing yield. We have classified vegetable for drought tolerance in Table 1.

Defects from stress – Most vegetables respond to water deficit with reduced yield and quality. However, most crops also express this stress with growth abnormalities, these are listed in Table 1.

Table 1. Vegetable Irrigation Needs, Critical Moisture Periods, Drought Tolerance, Rooting Depth, and Concerns.

Crop	Preferred Minimum Soil Moisture		Amount/ inches in "x" days	Irrigation Critical Moisture Period	Preferred Irrigation Method[2]
	Bars	ASM[1]			
Asparagus	-.70	40%	1/20	Crown set & transplanting	a,b
Beans					
Dry	-.45	50%	1/7	Flowering	a
Lima	-.45	50%	1/7	Flowering	a,b
Pole	-.34	60%	1/5	Flowering	a
Snap	-.45	50%	1/7	Flowering	a
Edible Soy	-.70	40%	1/14	Flowering	a,b
Beet	-2.00	20%	1/14	Root expansion	a,b
Broccoli	-.25	70%	1/5	Head development	a,b,c
Brussels Sprouts	-.25	70%	1/5	Sprout formation	a,b,c
Cabbage	-.34	60%	1/10	Head development	a,b
Carrot	-.45	50%	1/21	Seed germination, root expansion	a,b
Cantaloupes	-.34	60%	1/10	Flowering & fruit development	a,b
Cauliflower	-.34	60%	1/5	Head development	a,b,c
Celery	-.25	70%	1/5	Continuous	a,b,c,d
Chinese Cabbage	-.25	70%	1/5	Continuous	a,c
Collards	-.45	50%	1/14	Continuous	a,b,c
Corn, Sweet	-.45	50%	1/14	Silking	a,b
Cucumber					
Pickles	-.45	50%	1/7	Flowering & fruiting	a,b,c
Slicer	-.45	50%	1/7	Flowering & fruiting	a,b,c
Eggplant	-.45	50%	1/7	Flowering & fruiting	a,b,c
Greens (turnip, mustard & kale)	-.25	70%	1/5	Continuous	a,b
Leek	-.25	70%	1/7	Continuous	a,b
Lettuce (head, Bibb, leaf, Cos)	-.34	60%	1/7	Head expansion	a,b
New Zealand Spinach	-.25	70%	1/5	Continuous	a,b,d
Okra	-.70	40%	1/14	Flowering	a,c
Onion	-.25	70%	1/7	Bulbing & bulb expansion	a,b
Parsnip	-.70	40%	1/14	Root expansion	a,b
Peas					
green	-.70	40%	1/7	Flowering	a
Southern	-.70	40%	1/14	Flowering & pod swelling	a,b

Table 1. (continued)

Crop	Preferred Minimum Soil Moisture		Amount/ inches in "x" days	Irrigation Critical Moisture Period	Preferred Irrigation Method[2]
	Bars	ASM[1]			
Peppers	-.45	50%	1/7	Transplanting flowering up to ½" fruit	a,b,c
Potato, Irish	-.35	70%	1/7	After flowering	a,b
Pumpkin	-.70	40%	1/14	Fruiting	a,b
Radish	-.25	70%	1/5	Continuous	a
Rhubarb	-2.00	20%	1/21	Leaf emergence	a,b
Rutabagas	-.45	50%	1/14	Root expansion	a,b
Squash, Summer	-.25	70%	1/5	Fruit sizing	a,c
Squash, Winter	-.70	40%	1/10	Fruit sizing	a,b
Sweetpotato	-2.00	20%	1/21	First and last 40 days	a,b
Tomato					
Staked	-.45	50%	1/5	Fruit expansion	a,c
Ground	-.45	50%	1/7	Fruit expansion	a,b
Processing	-.45	50%	1/7	Fruit expansion	a,b
Turnip	-.45	50%	1/10	Root expansion	a,b
Watermelon	-2.00	40%	1/21	Fruit expansion	a,b,c

[1] ASM (Available Soil Moisture). Percent of soil water between field capacity (-0.1 bar) and permanent wilting point (-15 bars).

[2] Irrigation method: a = Sprinkler; b = Big Gun; c = Trickle; d = Flood.

Table 1, Part 2.

Crop	Drought Tolerance[3]	Rooting Depth[4]	Defects caused by water deficit	Comments
Asparagus	H	D	Shriveling	Will withstand most drought
Beans				
Dry	M	M	Poor pod fill & small beans	No irrigation after pods begin to dry
Lima	L-M	D	Poor pod fill & small beans	Cooling irrigation can increase yield
Pole	L-M	M	Poor pod & pithy pods	Steady moisture supply is necessary during flowering
Snap	L-M	M	Poor pods & pithy pods	Irrigation prior to flowering has little benefit
Edible Soy	M	M	Poor pod fill	Irrigation prior to flowering has little benefit
Beet	M	M	Growth cracks	
Broccoli	L	S	Strong flavor	
Brussels Sprouts	M	S	Poor sprout production	

Table 1, Part 2 (continued)

Crop	Drought Tolerance[3]	Rooting Depth[4]	Defects caused by water deficit	Comments
Cabbage	M-H	S	Growth cracks	
Carrot	M-H	S-M	Growth cracks misshapen roots	Avoid droughts during root expansion
Cantaloupes	M	S-M		
Cauliflower	L	S	Ricey curd, buttoning	
Celery	L	S	Small petioles	Moisture deficit can stop growth irreversibly
Chinese Cabbage	L	S	Tough leaves	
Collards	M	S	Tough leaves	
Corn, Sweet	M-H	S	Poor ear fill	Irrigation prior to silking has little value
Cucumber				
pickles	L	S-M	Pointed & cracked fruit	Moisture deficit can drastically reduce yield & quality
slicer	L	S-M	Pointed & cracked fruit	Moisture deficit can drastically reduce yield & quality
Eggplant	M	M	Blossom end rot, misshapen fruit	
Greens (turnip mustard & kale)	L	M	Tough leaves	Good continuous moisture essential to good yields
Leek	L-M	S	Thin scale formation	
Lettuce (head, bibb, leaf, cos)	M-H	D	Tough small leaves	
New Zealand Spinach	L	S	Tough leaves poor production	Irrigate to keep growth continuous and rapid
Okra	M-H	D	Tough pods	Irrigation can reduce yield
Onion	L	S	Poor size	
Parsnip	H	D		
Peas				
Green	L	M	Poor pod fill	
Southern	M	M	Poor pod fill	Plants will recover from drought but yield is reduced
Peppers	M	M	Shriveled pods,	Irrigate for increased pod size blossom-end rot and yield
Potato, Irish	M	S	Second growth & misshapen roots	Irrigate only under extreme drought during root development
Pumpkin	M	D	Blossom-end rot	
Radish	L	S	Pithy roots	Keep soil moisture levels high to promote rapid growth
Rhubarb	M	D	Pithy stems	
Rutabagas	M	M	Tough roots	
Squash, Summer	L	M	Pointed & misshapen fruit	Irrigation can double or triple yields

Table 1, Part 2 (continued)

Crop	Drought Tolerance[3]	Rooting Depth[4]	Defects caused by water deficit	Comments
Squash, Winter	M	D		
Sweetpotato	H	D	Small & misshapen roots	
Tomato, trellis	M	D	Blossom & root growth cracks	Continuous water supply helps avoid blossom-end rot and increase fruit size
Tomato, ground	M	D	Blossom & root growth cracks	Continuous water supply helps avoid blossom end rot and increase fruit size
Tomato, processing	M	D	Blossom & root growth cracks	Continuous water supply helps avoid blossom end rot and increase fruit size
Turnip	M	M	Woody roots	
Watermelon	M,H	D	Blossom- end rot	This crop can stand extreme drought, but some yield reduction

[3] Drought tolerance: L = low, needs frequent irrigation; M = moderate, needs irrigation in most years; H = high, seldom needs irrigation.

[4] Depth of rooting, of most roots: S = shallow, 12 to 18 inches; M = moderate, 18 to 24 inches; D = deep, 24 inches plus.