Chapter 3 Crops

Contents **NJ652.03**

NJ652.03 Crops

The primary crops irrigated in New Jersey are vegetables, sweet corn, melons, blueberries, cranberries, brambles, grapes, tree fruit, nursery stock, and turfgrass. Field corn, soybeans, hay and small grain are also irrigated.

(a) Critical Growth Periods

Aside from moisture needs to ensure a stand, most crops have critical periods during the growing season when good soil moisture levels must be maintained to obtain high quality and quantity yields. The critical period for most crops occurs during the part of the growing season of pod, fruit, tuber, or ear formation and development.

If sufficient growing season exists for the desired development of the crop, short periods of low moisture during the early part of the growing season may not be harmful except for leaf or forage crops. However, over stimulation of vegetative growth from a combination of high soil fertility and available soil moisture can also be objectionable. This may delay time of harvest enough to miss the period of highest fresh market demand, affect the grade for processing, or cause losses in late maturing crops from frost damage. If irrigation water supplies are limited, the best use of the irrigation water supply would be during the critical growth period of the crop.

Table NJ 3.1 CRITICAL PERIODS OF WATER NEEDS FOR CROPS

Crop		Critical Periods
Asparagus		Crown set and transplanting
Alfalfa		Start of flowering and after cutting
Apples		Bud stage, fruit enlargement, and pre-harvest period.
Beans, lima		No particular period
Beans, snap		Pod enlargement
Blueberries		Bloom through fruit sizing
Brambles	Raspberries Blackberries	Blossom through harvest
Broccoli		Head formation and enlargement
Corn, sweet and field		Tasseling, silking, and early stage of ear development
Cabbage		Head development
Carrots		Root Enlargement
Cauliflower		Entire growing season
Cranberries		Spring and fall frost protection; Blossom through fruit sizing
Cucumbers		Flowering and fruit development
Eggplant		Flowering and fruit development
Grapes		Blossom to beginning stages of fruit ripening
Greens		Continuous
Lettuce		Head development
Melons		Flowering and fruit development
Onions		Bulb enlargement

Pasture		During establishment and boot stage to head development. Maintain MAD < 50%. Moisture stress immediately after grazing encourages fast regrowth.
Peaches		Final fruit enlargement and pit hardening
Peas		Flowering and seed enlargement
Peppers		Flowering, fruit development, fast enlarging stage
Potatoes	White	Tuber set and tuber enlargement
Potatoes	Sweet	Root enlargement
Pumpkins		Fruit stage
Radish		Root enlargement
Small grain		Boot, bloom, milk, early head development and ripening stages
Soybeans		Flowering and fruiting stage
Squash		Bud development and flowering
Strawberries		Fruit development through harvest
Tomatoes		Early flowering, fruit set and enlargement
Turnips		Root Enlargement

(b) Salinity Tolerance

High levels of salt accumulation in the root zone of the soil may affect plant growth in several ways.

First, it decreases the availability of nutrients and water for easy and rapid uptake by plant roots. This could lead to the need for more frequent irrigation on "salty" soils even though less than 50 percent of the normally available water has been used in the root zone. Such plants are usually stunted and have a bluish-green color.

Second, plants may be affected by a direct toxicity of one or more of the constituents of the salt in the irrigation water. These more frequently affect tree fruit than field or vegetable crops.

Third, after a certain amount of sodium has been absorbed on the clay particles, the soil tends to puddle very easily, becomes less permeable to air and water, and forms into hard lumps and crusts when dry. When and if this happens, the grower should consult Rutgers Cooperative Extension for powdered gypsum application rates, to counteract the excess sodium in the soil.

In Table NJ 3.2, different vegetable, fruit, and field crops are grouped according to their salt tolerances. Table NJ 3.3 shows the number of permissible irrigations with salt water between leaching rains for crops of different salt tolerances. The number of irrigations permitted should be decreased on heavier soils (silt and clay loams). If there is any evidence of severe leaf burning after one or two irrigations owing to excessive salt accumulation on the plant leaves, no more irrigations should be applied unless the failure to irrigate would result in greater loss than that due to burning of the crop.

TABLE NJ 3.2 SALT TOLERANCE OF PLANTS [1/]

Plants that can tolerate [2/]		
Up to 8-16 Millimhos [3/] 5120 to 10,240 ppm (Good Resistance)	Only up to 4-8 millimhos [3/] 2560 to 5120 ppm (Moderate Resistance)	No more than 1-4 millimhos [3/] 640 to 2560 ppm (Poor Resistance)
FIELD CROPS		
Barley and rape	Rye, wheat, oats, sorghum, corn, soybeans, and sorghum (grain)	Field beans
FORAGE CROPS		
Bermudagrass and barley hay	Sweet clover, sorghum, sudangrass, alfalfa, tall fescue, wheat and oat hays, orchardgrass perennial ryegrass, vetch, smooth brome, soybeans, Proso millet, pearl millet, and Alsike clover	White clover, Ladino clover, and red clover
VEGETABLE CROPS		
Garden beets, kale, asparagus, and spinach	Tomatoes, broccoli, cabbage, peppers, cauliflower, lettuce, sweet corn, potatoes, carrots, onions, peas, squash, cucumbers, collards, radishes, and rhubarb	Radishes, celery, and green beans
FRUIT CROPS		
	Grapes, cantaloupe	Pears, apples, plums, peaches
OTHER CROPS		
Bermudagrass, Zoysia, creeping bentgrass American beachgrass (production of)		Red fescue, Ky. bluegrass, colonial bentgrass

1/ The information in this table was obtained from USDA Agricultural Research Service Publication ARS41-29, "Brackish Water for Irrigation in Humid Regions" 1960.
2/ Crops plants listed in order of increasing sensitivity.
3/ These figures represent the electrical conductivity (ECe) of the soil saturation extract, where 1 millimho equals approx. 640 ppm of salts.

TABLE NJ 3.3 PERMISSIBLE NUMBER OF IRRIGATIONS WITH BRACKISH WATER BETWEEN LEACHING RAINS FOR CROPS OF DIFFERENT SALT TOLERANCES 1/

Irrigation Water		Irrigations for Crops Having		
Total Salts	Electrical Conductivity	Good Salt Tolerance	Moderate Salt Tolerance	Poor Salt Tolerance
ppm	millimhos per cm at 25° C			
640	1		15	7
1280	2	11	7	4
1920	3	7	5	2
2560	4	5	3	2
3200	5	4	2-3	1
3840	6	3	2	1
4480	7	2-3	1-2	
5120	8	2	1	

1/ The information in this table was obtained from USDA Agriculture Information Bulletins Nos. 213 and 283.

(c) Irrigation-Related Management Factors

Management-Allowed Depletion Levels

It is essential to maintain available moisture in the soil within certain limits for good crop growth. The depletion of soil moisture by the crops must be limited to some level well above the wilting point, otherwise loss of production or permanent damage will result. Due to the time required to complete one irrigation, the application of water should be started in sufficient time to cover the entire field or fields before the soil moisture has reached the minimum allowed level in the last area to be irrigated. Crop growth is badly retarded after 75 to 80 percent of available moisture in the zone is depleted. For the purposes of both design and operation of sprinkler irrigation systems, this is the maximum allowed moisture depletion for most crops. Special crops, such as vegetables, potatoes, and strawberries, require that higher moisture levels be maintained. Trickle irrigation systems are usually designed to keep root zone moisture close to optimum level by daily applications. With drip irrigation systems, irrigate when 20% -25% of the available water in the active root zone is depleted.

The moisture level at which to start irrigation must be determined from a practical standpoint. Monitoring soil moisture depletion in the root zone is essential for determining when to irrigate. The irrigator generally is reluctant to start irrigation at too high a moisture level because the soil does not seem dry enough to warrant the trouble and labor of adding more water. As the moisture level is lowered by the delayed start and comes closer to the lower moisture limit, the allowed time to cover the field is lessened. The cost of an irrigation system designed to cover an area in a shorter period of time, particularly a sprinkler system, increases as the application time is reduced. Considering these factors, the logical level of available moisture at which to start irrigation, (with an overhead system) is when about 50 percent of the total available moisture has been depleted.

Rooting Depths (water extraction depth)

The effective root zone depth is the depth of soil used by the main body of the plant roots to obtain most of the stored moisture and plant food under proper irrigation. It is not the same as the maximum root zone depth. As a rule of thumb about 70% of the moisture extracted by the root is obtained in the top half of the root zone; about 20% from the third quarter; and about 10% from the soil in the deepest quarter of the root zone.

Root zone depth will vary according to the effective soil depth, fertility management, and the rooting characteristics of the plant. Each plant has its own root development characteristics, which vary only slightly under adequate soil moisture conditions in a given soil profile.

Application of irrigation water should be limited to an amount that will penetrate only to the effective root zone depth. Applications in excess of this amount will result in waste of water and added pumping cost. Also, in the lighter textured soils, heavy applications may cause leaching of plant food beyond reach of the plant feeder roots. Effective root zone depth for most of the irrigated crops is shown in Table NJ 3.4. These are generalized values for most crops and soils. The listed depths are generally satisfactory for management purposes. There may be occasions where field conditions indicate that effective root zone depth other than those listed may be more appropriate. The proper effective root zone depth can be determined in the field by observation and measurement. If moisture conditions and growth period have been sufficient to develop normal rooting characteristics, the effective root zone depth may be determined by digging a hole alongside the plant and carefully tunneling back underneath the plant to expose the hair like moisture feeder roots. The depth to which two or more rootlets are noted per six square inches of exposure indicates effective moisture utilization. Determination of the moisture content of each layer encountered will also show the moisture extraction pattern.

TABLE NJ 3.4 Effective Root Zone Moisture Extraction Depth in Unrestricted Soils (Top 50% of the root zone).

Truck Crops	**Effective Root Zone Depth (Inches)**	**Truck Crops**	**Effective Root Zone Depth (Inches)**
Asparagus	36	Lima beans	24
Beets	18	Melons	24
Broccoli	18	Okra	18
Cabbage	18	Onions - bunch	6
Carrots	18	Onions - dry	12
Cauliflower	18	Parsnips	24
Celery	12	Peas	18
Chives	6	Peppers	18
Collards	18	Potatoes	18
Corn (sweet)	24	Pumpkins	24
Cucumbers	18	Radish	6
Dandelion	6	Rutabagas	18
Eggplant	18	Shallots	12
Endive	6	Snap beans	18
Escarole	6	Spinach	6
Fennel	6	Squash	24
Horseradish	18	Sweet Potatoes	18
Kale	18	Swiss chard	12
Kohlrabi	18	Tomatoes	24
Lettuce	6	Turnips	18
		Watermelons	24
Field Crops and Grain	**Effective Root Zone Depth (Inches)**	**Fruits, Berries, and Orchards**	**Effective Root Zone Depth (Inches)**
Barley	24	Apples	30
Corn (field)	24	Blueberries*	30*
Millet	24	Cane fruits	24
Oats	24	Cranberries	6
Rye	24	Grapes	36
Sorghum	24	Peaches	24
Soybeans	24	Pears	24
Wheat	24	Strawberries	6
Grasses and Legumes	**Effective Root Zone Depth (Inches)**	**Grasses and Legumes**	**Effective Root Zone Depth (Inches)**
Alfalfa	36	Reed canarygrass	24
Bluegrass	18	Red clover	18
Bromegrass	24	Sudan grass	24
Ladino clover	18	Sweet clover	24
Orchardgrass	24		

*For Water Table Restrictions in Blueberries use 18” depth.

TABLE NJ 3.4 (CONT.)

Flowers	**Effective Root Zone in Inches**
Annual Flowers	6
Ericaceous ornamental plants (azalea, etc.)	12
Gladioli, peonies, iris	12
Other bulb or corm plants	12
Nursery Plants	**Effective Root Zone in Inches**
Bedded plants after propagation,	6
Finished landscape plants	18 to 24
Ground cover plants (vinca, ivy)	6
Lining-out plants	12
Perennial ornamentals - trees and shrubs (conifers and flowering shrubs)	24
Turf	**Effective Root Zone in Inches**
Athletic fields - in active use	6
Athletic fields - not in active use	12
Golf greens (bentgrass)	6
Golf fairways (bluegrass, fescue, zoysia, Bermuda grass)	6
Grass sod - being established or being prepared for immediate sale	6
Grass sod (lawns, sod being held for sale)	12

Each crop was given an effective depth based on:

1. Depth of soil to which the larger proportion of the total root system has developed when the marketable part of the crop is being produced or when the loss of water from turf and ornamental plants is greatest.

2. Research and experience regarding the overall water needs of each crop for maximum quality as well as yield or growth.

3. The kind of soil in which some crops, such as blueberries, Bermuda grass, and sweet potatoes, are commonly grown in New Jersey.

Note: Depth of irrigation while the crop is developing its root system should be determined by the actual depth to which roots have grown.