Irrigation Scheduling

Cooperative Extension System v Agricultural Experiment Station CIS 1039

Introduction

The important decision as to when and how much water to apply to a growing crop must be repeatedly made throughout the growing season. This decision involves a commitment by the producer to optimally manage water, labor, and equipment. Poor management resulting in either under or over irrigation can reduce crop yields, degrade crop quality, enhance the field environment for disease, increase pumping costs, and leach soluble nutrients from the root zone.

Specific problems associated with over watering

Improper irrigation water management leads to a number of physiological disorders and diseases. Water stress can occur from too much as well as from too little water. Producers know that stress caused by too little water reduces yield, with the level of reduction depending on when stress occurs in relation to crop development. Quality can also be affected. Over irrigation may also stress the crop through reduced soil aeration and cause similar consequences. A major effect of excess water is the reduction of nitrogen levels within the root zone to less than favorable levels. Symptoms of excessive water application on some common Idaho crops are presented below.

Potato Excessive water can cause soft rot, early die, and promote brown center, which can progress into hollow heart. Excessive water reduces soil temperature, creating a favorable environment for Rhizoctonia root rot, black scurf, pink rot, and leak. Also, excessive water can contribute to a more favorable environment for foliar disease, possibly requiring additional applications of fungicides and increasing production costs.

Cereal grain Excessively moist conditions enhance a number of crown and root diseases. These diseases include take-all, foot rot (eyespot), and Rhizoctonia root rot. Excessively moist conditions from over or untimely irrigation promotes infectious diseases such as black chaff, bacterial leaf blight, black point, and scab.

Dry bean Dry bean is very susceptible to disease and physiological problems associated with excessive water. Diseases which tend to be favored by very moist conditions include Anthracnose, Fusarium, Pythium, Rhizoctonia, rust, white mold, and a number of bacterial diseases. Water-saturated soils can kill roots.

Corn Water-saturated soils turn lower leaves of young plants yellow and cause them to die. Extended periods of waterlogged soils kill the crown area of plants. Many of the fungal disease infections in corn increase under excess irrigation.

Soil-moisture balance method

A checkbook approach to irrigation scheduling

The checkbook method for irrigation scheduling can be used to accurately determine when and how much water should be applied. The checkbook approach sums daily crop water use and subtracts this quantity from the available water in the effective crop-root zone. When the available water falls to a predetermined level, then it is time to irrigate and replace the water that the crop has used from the root zone. Prior to advancements in technology, evaporative pans were used to calculate crop water use. Recent developments in automated monitoring of climatic condi-

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Using Water-use Tables

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Table 1 . Seasonal crop-root zone development for specific growth stages.

tions, data transmission, and readily available computing power makes the checkbook method more practical. This method requires knowledge of daily water use, rooting depth, water-holding capacity of the soil, times and amounts of precipitation and irrigation events, and periodic soilmoisture measurements.

In using the checkbook method, daily crop water use is recorded on the attached Soil-Moisture Balance Sheet (appendix A). The remaining amount of available water is then calculated. A minimum acceptable soil-moisture level is determined based on soil type, crop, growth stage, and depth of the effective crop-rooting zone. When moisture levels are drawn down to the predetermined level on the balance sheet, then it is time to irrigate the crop. Crop water use increases the soil-moisture deficit, while rainfall and irrigation reduces the soil-moisture deficit. By anticipating the daily water-use rate and knowing the amount of water available in the soil, a producer can accurately predict the next irrigation date and the amount of water to apply.

Effective crop-rooting depth

The *effective crop-rooting depth* found in the heading of the Soil-Moisture Balance Sheet refers to the depth at which crop roots extract the majority of the water utilized by the plant. Though the actual rooting depth may be greater, the effective rooting depth should be used in irrigation scheduling. The effective rooting depth varies for each crop

Crop Weeks After Stage of Growth Stage Indicators Total Depth of
Emergence[1] Development Effective Root Zone
for Irrigation Water

Management[2] **(Feet)**
Alfalfa
Established stands 4.0
New stand 0 - 5 Vegetative 0.5 - 1.0
5 - 13 Vegetative 1.0 - 1.5
13 to dormancy Vegetative 1.0 - 3.0
Cereal Grains, 3 Haun Scale Two leaves unfolded to four leaves 0.5 - 1.0
Spring 1 to 3 unfolded (tillering)
5 4 to 7 Five leaves unfolded to 1.0 - 2.0
eight leaves unfolded
6 8 to 11.6 Flag leaf through flowering 2.0 - 3.0
8 to end of season 12 to 14.5 Milk development to soft 3.0 - 3.5
dough
Cereal Grains, Haun Scale Two leaves unfolded to four leaves 0.5 - 1.0
Winter 1 to 3 unfolded (tillering)
4 to 7 Five leaves unfolded to 1.0 - 2.0
eight leaves unfolded
8 to 11.6 Flag leaf through Flowering 2.0 - 3.0
12 to 14.5 Milk development to Soft Dough 3.0 - 3.5
Corn, Field 2 3 leaf 0.6 - 1.0
6 12 leaf 2.0
8 Silking 3.0
11 Blister kernel 3.5
Dry Beans 2 to 3 V-4 4 leaf 0.8 - 1.0
4.5 to 5.5 V-10 First Flower 1.5
6 First Seed 2.0 - 2.5
Pasture
Established 1.5 - 4.0
New stand 0 - 5 Vegetative 0.0- 0.5
Reproductive Flowering 0.5 - 1.5
Maturity Mature seed 1.5 - 3.0
Potato[3] 4 I Vegetative Growth Emergence to 8 to 12 leaves 0.66 - 1.0
6 II Tuber Initiation Tubers begin to form at tips of 1.0 - 1.5
stolens
14.5 III Tuber Growth Early bulking to mid bulking 1.5 - 2.0
16.5 to 18 IV Maturation Late bulking to maturity 2.0

[1] Weeks After Emergence is a less dependable means of estimating root development than growth stage indicators. Abnormal weather can delay or speed the rate
of development.
[2] Total Depth of Effective Root Zone for Irrigation Water Management is reported for unrestricted root zones. Root zones may be restricted by physical (dry, water
saturated, or compacted soils) or chemical (salt, sodic) factors. Root-zone calculations should be adjusted to account for restrictions.
[3] Weeks After Emergence for Russet Burbank. This time will vary with weather and variety.

and with each stage of crop development. Expected effective rooting zones for specific stages of crop development are summarized in table 1. Figure 1 illustrates the maximum effective rooting depth of six crops grown in Idaho where no physical or chemical limitations exist. The effective root soil depth can be affected by impermeable layers in the soil and water-saturated soil conditions. Dry soil layers that may exist in the root zone will also limit root development. Plant roots cannot grow through dry soil layers; therefore, irrigators should always make sure the total root zone is moist at or near the beginning of the cropping season.

Effective rooting depth will need to be adjusted based on visible crop development stages and knowledge of any root-zone restrictions. Changes in rooting depth will affect the amount of water available to the crop and the amount of water applied during an irrigation. Changes in root depth should be considered on a weekly basis when adjustments are recorded on the Soil-Moisture Balance Sheet.

Available water and water-holding capacity

The producer needs a basic understanding of soil-water relationships. Water is held in soil as a film around soil particles and in spaces between soil particles and aggregates. The amount of water held in soils is dependent upon several factors, but texture has the greatest influence. Water-holding capacity is greatest in medium-textured soils (silt loam) and least in coarse-textured soils (sand). Soils have a limited capacity to hold water against gravity. This limit is referred to as *field capacity*. Water in excess of field capacity is subject to drainage or removal by gravity.

At field capacity, plant roots can easily absorb water. As roots absorb water and the soil becomes drier, movement of water towards the root is slowed. Water absorbed by the root moves into the plant at a slower rate than the rate of water use by the plant. Eventually a water deficit develops inside the plant and the plant wilts. A point will occur where essentially no additional water can be extracted from the soil by the plant. This is commonly referred to as the *wilting point.*

Available water is the water held in the soil between existing soil-moisture content and wilting point. Water in excess of field capacity (approaching saturation) will drive air from the soil, depriving roots of oxygen needed for respiration. If root respiration is limited, then root growth and function are curbed, resulting in restricted rooting depth and increased stress on the plant.

Soil texture refers to the relative portion of sand, silt, and clay particles in the soil. Texture is the major factor influencing available water-holding capacity. Water-hold-

0-
1-
2-
3-
4-
5-
6-
-0
-1
-2
-3
-4
-5
-6

Potato Sugar
Beet

Edible
Bean
Wheat &
Barley
Field
Corn
Alfalfa

Figure 1. Unrestricted effective rooting depths of selected mature crops.

The total available water that can be stored in the root zone is determined by multiplying the inches of water-holding capacity per inch of soil by the soil depth in inches of each soil layer in the root zone and adding these values together. This is the total water-holding capacity of the root zone.

Oftentimes more than one soil type is present in a field. If each soil type all occupies a significant portion of the field, the soil type with the lowest water-holding capacity should be used in determining when to irrigate and how much water to apply. If additional soil types cover only a small area, the predominate soil type should be used.

Determining soil-moisture deficit

Soil-moisture deficit is the difference between the available water that soil can hold after gravitational drainage (field capacity) and the actual available water in the croproot zone. The grower should maintain the soil-moisture deficit less than a predetermined level to avoid reduction in yield and quality.

The soil-moisture deficit needs to be estimated at the beginning and periodically throughout the growing season. Estimating the soil-moisture deficit at the beginning of the season is necessary to provide a reasonable initial condition estimate. Periodic review of soil-moisture content during capacities for various soil texture classifications and soil series can be obtained from county soil surveys available from the Natural Resource Conservation Service (formerly the Soil Conservation Service) and Soil Conservation Districts. Older soil surveys may not have water-holding capacity listed, but will have soil textures that can be used to estimate it. Once soil textures and depths are determined, water-holding capacities can be estimated from table 2.

Table 2. Water-holding capacity for various textural classes of soils. To be used when soil series is unknown.

Soil Texture class	Water Holding Capacity (in/in)	Water Holding Capacity (in/ft)
Sand	0.04	0.43
Loamy sand	0.08	0.94
Sandy loam	0.14	1.67
Sandy clay loam	0.14	1.67
Loam	0.17	2.10
Silt loam	0.20	2.44
Silt	0.18	2.12
Clay loam	0.16 - 0.18	2.0 - 2.16
Silty clay loam	0.18	2.16

Silty clay 0.17 2.04
Clay 0.16 1.94
Source: R.E. McDole, G.M. McMaster, and D.C. Larson. 1974.
Available Water-Holding Capacities of Soils in Southern Idaho. CIS 236.
University of Idaho Cooperative Extension System and Agricultural Experiment
Station.
Note: A ball is formed by squeezing a handful of soil very firm.ly
Source: Israelsen and Hansen. *1962. Irrigation Principals and Practice s*. Third Edition. New York: John Wiley and Sons, Inc .
Upon squeezing, no free
water appears on soil but
wet outline of ball is left
on hand. (0.0)
Upon squeezing, no free
water appears on soil but
wet outline of ball is left
on hand. (0.0)
Upon squeezing, no free
water appears on soil but
wet outline of ball is left
on hand. (0.0)
Upon squeezing, no free
water appears on soil but
wet outline of ball is left
on hand. (0.0)
Forms a ball, is very
pliable, slicks readily i f
relatively high in clay.
(0.0 to 0.5)
Easily ribbons out
between fingers, has slick
feeling.
(0.0 to 0.6)
Forms weak ball, breaks
easily, will not slick.
(0.0 to 0.4)
Tends to stick together
slightly, sometimes forms
a very weak ball under
pressure.
(0.0 to 0.2)
Appears to be dry, will not
form a ball with pressure.
(0.2 to 0.5)
Tends to ball under
pressure but seldom
holds together .
(0.4 to 0.8)
Forms a ball somewha t
plastic, will sometimes
slick slightly with
pressure.
(0.5 to 1.0)
Forms a ball, ribbons out
between thumb and
forefinger.
(0.6 to 1.2)
Appears to be dry, will not
form a ball with pressure.
(0.5 to 0.8)
Appears to be dry, will not
form a ball.
(0.8 to 1.2)

Somewhat pliable, wil l
ball under pressure .
(1.2 to 1.9)
75 - 100%
(100% is permanent
wilt point)
Dry, loose, single-grained,
flows through fingers.
(0.8 to 1.0)
Dry, loose, flows through
fingers.
(1.2 to 1.5)
Powdery, dry, sometimes
slightly crusted but easily
broken down into
powdery condition .
(1.5 to 2.0)
**Hard, baked, cracked,
sometimes has loos e
crumbs on surface .
(1.9 to 2.5)**
**Soil-Moisture Coarse Texture Moderately Medium Texture Fine and Very Fine
Deficiency Coarse Texture Texture**
0%
(Field capacity)
0 - 25%
25 - 50 %
50 - 75% Somewhat crumbly but
holds together from
pressure.
(1.0 to 1.5)
**Table 3. Feel method chart for estimating soil moistuer
(Number indicates inches of water deficit per one foot ofs sooil.i)l*)**

Crop water-use information

The effect of plant growth stage, solar radiation, temperature, humidity, wind speed, and soil moisture on crop water use is well documented. Fortunately, innovations in technology have made the collection and calculation of crop water-use values commonplace. The U.S. Bureau of Reclamation is currently collecting weather data and calculating crop water-use information for 14 locations in southern Idaho and areas of Oregon, Washington, and Montana. Locations in Idaho include Aberdeen, Ashton, Fairfield, Fort Hall, Glenns Ferry, Grand View, Kettle Butte, Malta, Monteview, Parma, Picabo, Rexburg, Rupert, and Twin Falls. Depending on the need at a particular location, crop water use is calculated for a number of crops. This information is presented in the form of crop water-use tables.

**Table 5. Percent of available soil water that may be used
without causing yield or quality losses
(Management Allowable Depletion or MAD)**
**Crop Stage of Percent of available
Development soil water[1]**
Alfalfa All stages 55
Corn,
field All stages 50
Cereal

Grains All stages except
boot through flowering
and ripening of wheat 55
Boot through flowering 45
Ripening (Wheat) 90
Dry Beans All stages 40
Pasture All stages 50
Potato All stages except vine kill 35
Vine kill 50

[1] This is the percent of available water that can be used by the crop at this particular stage of development that will not cause yield or quality loss due to moisture stress.

Source: Doorenbos, J. and W.O. Pruitt. 1984. *Guidelines for Predicting Crop Water Requirements.* (FAO Irrigation and Drainage Paper, p. 88.) Food and Agriculture Organization of the United Nations, Rome.

Obtaining water-use tables

Daily, cumulative seven-day, and cumulative seasonal water-use values are published by participating newspapers, weekly farm magazines, and broadcast by radio stations. Also water-use tables are available through your local cooperative extension system office. Individuals interested in obtaining water-use tables directly from the Bureau of Reclamation Agri-Met System can write the Bureau of Reclamation, 1150 N. Curtis Road, Boise, Idaho 83706 or call (208) 378-5282 or (208) 378-5283. See your local county extension office for further information on obtaining water-use tables. Examples of water-use tables available from the Bureau of Reclamation Agri-Met System, local University of Idaho Cooperative Extension System offices, and published in local newspapers can be found in appendix B.

ing the growing season will verify water use on the water balance sheet and allow for adjustments on the balance sheet when the estimated soil-moisture deficit does not equal the actual soil-moisture deficit due to site specific differences..

Soil-moisture deficit can be determined from information in table 2 (Water-holding capacity for various textural classes of soils) and table 3 (Feel method chart for estimating soil moisture).

Ideally, soil samples should be taken in 6-inch increments to the depth used for water management purposes.

Table 4 shows the calculations made to estimate water-holding capacity and estimated soil-moisture deficit using the feel method. This method can be used to estimate the percentage of water remaining in a soil sample by observing how soil ribbons, forms a ball, or rolls between the fingers.

If time for sampling is limited, one sample, taken at 1/3 the effective root zone depth, will give a representative soilmoisture level *if soil texture does not vary with depth*.

Table 4. An example of estimating water-holding capacity of soils and water deficit by the feel method for the effective root depth of spring wheat after flowering.

Effective Root Depth = 3.5 Feet *(From table 1)*
Water-Holding
Soil Texture Capacity (in/in)
Soil Depth (from soils map) (from table 2)
0 - 12" Silt Loam 0.20
12 -18" Loam 0.17
18 - 42" Sandy Loam 0.14
Soil Depth (in) Water-Holding Estimated
Capacity Deficit
Soil Depth (in) (feel method
(soil depth x whc (in/in)) from table 3)
0 - 6" 6" x 0.20 = 1.20" x 25% = 0.30"
6 - 12" 6" x 0.20 = 1.20" x 30% = 0.36"
12 - 18" 6" x 0.17 = 1.02" x 40% = 0.41"
18 - 24" 6" x 0.14 = 0.84" x 60% = 0.50"
24 - 30" 6" x 0.14 = 0.84" x 60% = 0.50"
30 - 36" 6" x 0.14 = 0.84" x 35% = 0.29"
36 - 42" 6" x 0.14 = 0.84" x 30% = 0.25"
Total Water-Holding Total
Capacity = 6.78" Deficit = 2.61"

Moisture level related to yield and quality loss

The percent of available water that can be used by a crop without loss of yield or quality will vary with stage of crop development. Table 5 gives the percent of total available water that a crop can extract without loss of yield or quality (sometimes referred to as Management Allowable Depletion or MAD) and should be considered when calculating the maximum allowable soil-moisture deficit for a crop.

Soil-moisture balance

A checkbook-like approach is used in the soil-moisture balance method of irrigation scheduling (appendix A). The goal of this method is to keep the soil-moisture deficit between zero and a predetermined level for the particular crop and stage of crop development. The maximum amount of water that the crop can remove from the soil without injury to yield or quality is calculated by multiplying the percent of available soil water for a specific crop stage (table 5) by the total available water capacity in the root zone. The soilmoisture deficit increases as the crop uses water and therefore adds (+) to the cumulative soil-moisture deficit in the right-hand column of the water balance sheet. Rainfall and irrigation decrease the soil-moisture deficit and therefore subtracts (-) from the cumulative soil-moisture deficit in the right-hand column. Rainfall of less than 0.05 inches is ignored and should not be subtracted from the moisture deficit. The soil-moisture deficit can never be less than zero. A zero deficit indicates that the moisture level in the soil is at field capacity. Attempting to store water beyond field capacity can increase the chance of disease and physiological problems, which will reduce yields and increase the occurrence of leaching valuable plant nutrients below the

root zone.
Irrigation needs should be projected several days in advance to avoid stressing the crop. The number of days to cross the field with an application of water should be considered. Center-pivot systems typically require approximately 18 hours to 72 hours to complete a cycle, depending on soil texture, slope, and equipment. Therefore, crop water use will need to be projected for the appropriate pivot rotation time to estimate the soil-moisture deficit. Use this projection to determine when irrigation should begin to avoid stress-causing deficits. More specific information for scheduling irrigation and management of various systems can be found in cooperative extension and experiment station publications.
Center-pivot systems are typically not designed to meet peak daily water use. Prior to clear, hot days that increases water use in excess of what the system is capable of applying on a daily basis, the root zone should be filled to field capacity and water applied to maintain a low deficit until application can keep up with water use in cooler, wetter weather.

Irrigation system application efficiencies—gross amount of water to apply

Only a portion of the water applied to the soil by the irrigation system is stored in the crop-root zone where it can be used. Under surface irrigation systems, that portion of the water that is not stored in the crop-root zone may be lost as runoff from the field or as deep percolation. Sprinkler irrigation losses result from evaporation and wind drift, and deep percolation resulting from non-uniform water application. Losses from drip systems are primarily due to evaporation and non-uniform water application.
Application efficiency describes the fraction of applied water that is stored in the crop-root zone. Application efficiency will vary with the system, soil, and weather conditions. This factor is necessary to determine how much water to apply with an irrigation system to store the desired amount of water in the crop-root zone.
For example, the calculation required to determine the amount of water that would need to be applied by a lowpressure center-pivot sprinkler with an application efficiency of 85 percent (table 6) to eliminate the soil-moisture deficit for the spring wheat crop on May 20 illustrated in table 7 would be:

A c tual amount to apply (inches) =
Net Irrigation Requirement (total deficit in inches)
Application Efficiency (as a decimal from table 6)
Actual amount to apply (inches) =
0.94"

= 1.1"
0.85

Irrigation scheduling–an example

Table 7 is an example of using the soil-moisture balance sheet to track water use of a spring grain crop under a center-pivot system for an entire growing season. The terms used in this example correspond to the headings in table 7 and appendix A.

Prior to the start of the irrigation season, the effective rooting depth is recorded under the appropriate heading. Rooting depths from table 1 should be used unless a restriction is suspected or known. In this example a root-zone restriction is known to occur at 30 inches. The Water-Holding Capacity in the Root Zone is calculated by multiplying the Effective Crop-Rooting Depth by the Water-Holding Capacity per inch of Soil Depth for the specific textural class found in table 2. Finally, to determine the maximum amount of water that can be used without injury to yield or quality, the Water-Holding Capacity in the Root Zone is multiplied by the Allowable % of Available Soil Moisture that can be depleted from the root zone (table 5) and the result recorded in the column Maintain Deficit Less Than.

The crop emergence date should be recorded in the appropriate space and used to determine which start date to use from Bureau of Reclamation water-use tables, available through extension system offices, newspapers, or the radio.

Daily water-use values are recorded in the Crop Water Use column. Rainfall, recorded at the field location, is recorded in the appropriate column for the day that it occurs.

Crop Water Use is added and Rainfall and Net Irrigation are subtracted. The result is recorded in the column Soil

Summary

Closely matching available water with crop needs throughout the season improves yields and quality. Use of the Soil-Moisture Balance/Checkbook Irrigation Scheduling Method can avoid over- and under-irrigation and their associated problems. Appendix A may be copied by producers to track water use by crop and irrigation scheduling.

Further information and help in using this method can be found at your local University of Idaho Cooperative Extension System office.

Moisture Deficit. When the total of the Soil-Moisture Deficit is nearly equal to the value calculated under the column Maintain Deficit Less Than for the specific stage of crop development, then it is time to irrigate. The amount of water to apply is calculated by dividing the total Soil-Moisture Deficit by the application efficiency decimal for the particular irrigation system (table 6).

The system illustrated in table 7 was designed for 6.8

gpm/acre and 85 percent application efficiency. A net application of 0.75 inches corresponds to a rotation time of 60 hours or 2.5 days. Thus, two irrigations can occur over a five-day period.

Since center-pivot systems are not designed for peak water usage, the soil-moisture reservoir is maintained nearly full with a slight soil-moisture deficit to take advantage of sporadic rainfall. Keeping the soil-moisture reservoir near full allows for downtime of one to three days due to mechanical failures without stressing the crop. After the peakuse period has passed, the soil-moisture deficit was allowed to increase slightly and then to 90 percent (table 5) during grain ripening stage. Additional comments are found within the example in table 7.

Table 6. Typical irrigation system application efficiencies

	Application efficiency (%)	Water required to put one inch of water in crop-root zone (inches)
Surface systems		
Furrow	35 - 65	1.5 - 2.8
Corrugate	30 - 55	1.8 - 3.3
Border, level	60 - 75	1.3 - 1.7
Border, graded	55 - 75	1.3 - 1.8
Flood, wild	15 - 35	2.8 - 6.7
Surge	50 - 55	1.8 - 2.0
Cablegation	50 - 55	1.8 - 2.0
Sprinkler systems*		
Stationary lateral (wheel or hand move)	60 - 75	1.3 - 1.7
Solid set lateral	60 - 85	1.2 - 1.7
Traveling big gun	55 - 67	1.5 - 1.8
Stationary big gun	50 - 60	1.7 - 2.0
High pressure center pivot	65 - 80	1.3 - 1.5
Low pressure center pivot	75 - 85	1.2 - 1.3
Moving lateral (linear)	80 - 87	1.1 - 1.2
Micro irrigation systems		
Surface/subsurface drip	90 - 95	1.05 - 1.1
Micro spray or mist	85 - 90	1.1 - 1.2

*For sprinkler systems, lower values should be used for wide nozzle spacing and windy conditions.

Source: Sterling, R. and W.H. Neibling. 1994. Final Report of the Water Conservation Task Force. IDWR Report. Idaho Department of Water Resources, Boise, ID.

Table 7. Example of soil-moisture balance sheet.

Appendix A

SOIL-MOISTURE BALANCE SHEET
for Checkbook Irrigation Scheduling

Use additional sheets as needed.

Source: University of Idaho Cooperative Extension System, Moscow, ID.

Appendix B

Examples of water-use tables available from the Bureau of Reclamation Agri-Met system, local University of Idaho Cooperative Extension System offices, and local newspapers.

Crop Key for Water-Use Tables

*Note "Peak'' chart values represent the "maximum" daily consumptive use for "mature" (uncut) stages of alfalfa growth. "Mean" values represent an "average" daily use that takes seasonal cuttings into consideration.

Notes:

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