ALFALFA IRRIGATION PRACTICES

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The practices used in irrigating alfalfa have a vital influence on economic returns from alfalfa production. Soil moisture conditions are interrelated with other production factors in such a way that careful soil-water management is especially important.

Attention to good irrigation practices is of primary concern when the grower considers that alfalfa is competing with other crops for available water and land resources and perhaps even with future non-agricultural water needs. With beneficial use being the basis for appropriative water rights in California, allocations on dollar return per unit of water is a future possibility. Ever increasing water needs and competition for available supplies stimulate more demand for efficient use of this valuable resource.

There are no standard practices for irrigating alfalfa. What works well on one farm may not be as effective at another location. Conditions specific to a given farm might make it advisable to vary irrigation practices, even within small land areas.

Final decisions relating to irrigation timing and amounts will depend upon the following considerations:

1. Water requirements.
2. Availability and cost of labor, water and land.
3. Soil root zone.
4. Water holding capacity of the soil and soil-water storage capacity.
5. Water intake characteristics of the soil.
6. Soil drainage.

Water Requirements

Since water requirements for alfalfa vary from one area in California to another, the local farm advisor's office should be contacted for this data. Table I provides approximate monthly and total consumptive use values for the major alfalfa producing areas of California.

Peak consumptive use data for alfalfa is useful in designing a system to adequately meet peak needs. Peak use is expressed in inches of water per day. It will vary from 0.1 inch per day in the costal areas influenced by the fog belt, to 0.25 inch per day in coastal valleys, to 0.30 inch per day in the central valleys, to 0.35 inch per day in the hot desert areas.

Soil Root Zone

Alfalfa is a deep rooted crop under favorable soil conditions. Significant root development has been noted at depths of 6 to 10 feet. Rooting depths, however, are frequently limited by soil profile conditions. These include very slow water infiltration and intake rates, restrictive layers, and zones of water saturation. Rooting depths can be determined by sampling soil at various depths or by back-hoeing to obtain observation pits.

Water Holding Capacity of Soils

Available water holding capacities for different soils vary with texture approximately as follows:

Soil Type	Available Water Per Foot Depth of Soil
Sands	1/2" - 3/4"
Sandy loams	3/4" - 1 1/2"
Clay loams	1 1/2" - 2"
Clays	2" - 2 1/2"

Soil - Water Storage Capacity

To determine the total water storage capacity of the soil multiply the water holding capacity (per foot depth of soil) by the depth of soil root zone. In estimating soil-water storage capacity, textural differences within the soil profile must be considered.

Water Intake Rates

It is difficult to obtain the desired moisture penetration in many California soils. A careful study of water intake characteristics is necessary when selecting sites and designing irrigation systems for growing alfalfa. The use of a soil probe or auger can help to determine the depth of moisture penetration after an irrigation application or winter rainfall.

The irrigator will sometimes keep soil saturated too long in an attempt to obtain deeper moisture penetration. But alfalfa has very limited tolerance to poor surface and subsurface drainage conditions.

The following practices have been used in attempting to increase depth of moisture penetration on low intake rate soils:

1. Eliminating low spots in fields.
2. Not working soil when too wet.
3. Reducing field operations to a minimum.
4. Amending sodium soils with calcium.
5. Breaking plow sole and compacted layers.
6. Applying two irrigations, closely spaced, in place of one
7. Modifying soil surface such as with organic matter.

It is not within the purpose of this paper to discuss these practices in more detail. The extent of their possible benefits will depend upon specific soil conditions and water mangement practices.

Drainage

Alfalfa has comparatively low tolerance to a wet soil environment. Poor drainage conditions contributing to plant loss originate from (1) water standing on the ground surface too long, and (2) areas of subsurface saturation within potential root zones. Both of these problems can often be improved by correct irrigation design and system use.

Under many situations alfalfa cannot take water standing on the ground surface longer than 8 to 12 hours without some loss of stand. Research at the Imperial Valley Field Station shows that alfalfa is particularly susceptible to damage from extended flood periods after a recent mowing. Field observations have shown that mature plants are not adversely affected by poor drainage as readily as new seedlings are. Drainage hazards need to be evaluated in relation to: (1) soil profile conditions; (2) leveling requirements; (3) irrigation methods, systems and design; and (4) irrigation scheduling practices.

IRRIGATION APPLICATION

The preceding information is basic to water-soil-plant relations for alfalfa. The remainder of this paper develops approaches which should be helpful in making actual scheduling decisions and in evaluating irrigation practices.

Depth of Water Applied in Borders

To calculate an average depth of rrigation, the following relations are needed:

Border area (acres) = $\frac{\text{width X length}}{43,560}$

Unit head (cfs) = amount of water turned into each border

1 cubic foot per second (cfs or second-foot) s equal to a volume of 1 acre-inch each hour.

A flow of 450 gallons per minute (gpm) s also equal to a volume of 1 acre-inch per hour.

Total volume of water applied (acre-inches) s the unit head times the hours of irrigation.

Net volume of water applied is the total volume (acre-inches) applied minus water wasted (acre-inches) at end of check.

Average depth of water applied (acre-inches) is the net volume of water (acre-inches) used, divided by the area (acres) in each check.

Example

An alfalfa field is divided into border strips each 40 feet wide and one-quarter mile long. A pump delivering 2000 gpm is used for irrigating three borders at one time. The water flows in each strip for period of 8 hours. There is no tail-water runoff. Determine the average depth of water applied.

Area of each check = $\frac{40 \text{ X } 1320}{43560}$ = .21 acres

Volume of Water Applied

Unit head = $\frac{2000}{3}$ = 667 gpm per border

$\frac{667}{450}$ = 1.48 acre-inches per hour

1.48 X 8 hours = .8 acre-inches

Average Depth of Water Applied

$\frac{\text{11.8 acre-inches}}{\text{1.21 acres}}$ = 9.8 inches

Uniformity of Water Distribution in Borders

A soil probe can sometimes be used following an irrigation to determine the depth that the water has penetrated at different points along the length of the border strip. Advance and recession curves for the flow of water down the checks can also be used to determine the intake opportunity time for the water at each point along check.

Special care should be taken to check the depth of water penetration and the soil water status in areas of poor alfalfa growth. Areas of poor growth may be the result of:

1. Lack of water penetration because of soil compaction, clay streaks in the field, or alkali spots.
2. High areas in the field, resulting from improper land grading, have a reduced intake opportunity time for the water to enter the soil. Salts often accumulate in these high areas.

3. Low areas or lack of surface drainage at the ends of the checks allow the water to pond for excessive periods of time. Lack of soil aeration or disease problems are often related to water logged soils. The growth of water loving weeds such as dock, sedge, or water-grass often infest wet areas in alfalfa fields. Providing slopes adequate to remove excess waters and drainage ditches for removing waste water from the lower end of the field can often eliminate wet areas. The use of return flow systems provides a means of reusing tail-water.

Depth of Water Applied by Sprinklers

To determine the average depth of water applied by sprinklers multiply the precipitation rate (inches per hour) by the irrigation time (hours).

The precipitation rate by a sprinkler system can be computed from the discharge and spacing of the sprinklers. The discharges from sprinklers are given in the manufacturer's performance tables. This is a function of nozzle or nozzles size and operating pressure. The size is stamped on each nozzle. A set of steel drills can be used as caliphers in case there is any question as to size. A pitot gauge can be used for measuring the pressure at the nozzle in pounds per square inch (psi). With nozzle size and pressure known the performance tables will give the discharge of the sprinkler in gallons per minute. The area which each sprinkler has the duty of irrigating is arbitrarily assumed to be the product of the sprinkler spacing along the lateral lines (S_S) times the spacing between laterals (S_L). One GPM will cover 96.3 square feet of area 1 inch deep in 1 hour. The formula used for computing precipitation rates (inches per hour) is as follows:

$$\text{inches per hour} = \frac{\text{gpm} \times 96.3}{S_S \times S_L}$$

With the sprinkler precipitation rate determined, average depth of water applied by sprinklers can now be calculated (precipitation rate X irrigation period = average depth of water applied).

Relation Between Precipitation Rate and Soil Infiltration Rate

To obtain best use of a sprinkler system, the precipitation rate of the applied water should be less than the infiltration rate of water into the soil. When this occurs there will be no runoff of water from the area being sprinkled. Water will move into the soil as unsaturated flow which will assure that the soil is well aerated. Each area of the field will absorb the water at the point where it is applied. This is an important factor in obtaining uniform distribution of the irrigation water.

Experience has shown that the infiltration rate of water into most California soils, except the coarse sands, is less than 0.3 inch per hour when the water is applied for long periods (12 to 24 hours). Some soils have infiltration rates less than 0.1 inch per hour.

The first step in evaluating a sprinkler system is to see if the water is being absorbed by the soil. This should be done near the end of an irrigation set. If there is runoff from the area being irrigated, the precipitation rate by the sprinklers is excessive.

Uniformity of Water Distribution by Sprinklers

The uniformity of water distribution by a sprinkler system is dependent upon the nozzle size, operating pressure, and spacing of the sprinkler heads. Wind can also be a factor in disturbing the sprinkler pattern.

Experience has shown that relatively close spacing of the sprinklers must be used to obtain high uniformity with low precipitation rates (0.35 inch per hour or less). Sprinkler spacings of 30 feet along the lateral lines and distanced between lateral lines of 45 to 50 feet are commonly used for most field crops.

The uniformity of water distribution is often indicated by the density of plant growth relative to the setting of the sprinkler heads Inadequate irrigation due to poor water distribution is most likely to occur at the intersection of the diagonals between sprinkler settings. Uniformity of distribution can also be measured by the can test. The area between sprinklers is divided into small coordinate areas and a catchment can is placed at the center of each of the small areas. The water collected in each can after a period of irrigation is measured. Methods for making statistical evaluations of these measurements are available.

Evaluation of Irrigation Practices (Border and Sprinkler)

Once the average depths o ıter applied during each irrigation have been computed and the unifor ʳ of water distribution has been investigated, an evaluation can be le of the irrigation practices being used These figures can be compare th the following factors:

A. The depth of water applied in relation to the water storage capacity of the soil. Irrigations should be applied before the available soil water has been fully depleted. Good irrigation practices might require that irrigations be started when only 60 percent of the total soil-water storage has been utilized.

B. The frequency of irrigations and de of water ied in relation to the comsumptive use of water he alfalfa 'he frequency of irrigations is generally given as the er of irri ons between cuttings. The most critical period is ge lly the pe l between the last irrigation before cutting and th rst irriga ı after harvest. Refer again to Table I for esti s of month ıater use (evapotranspiration) by alfalfa.

ONCLUDING REMARKS

The most effective irrigation practices for alfalfa will vary widely with soil and climatic conditions. Water-soil-plant relations basic to alfalfa irrigation have been discussed to assist in deciding when to irrigate and how much water to apply.

Information obtained from the correct use of soil moisture detecting instruments such as tensiometers or conductivity blocks might be useful in making irrigation scheduling decisions. Better irrigation and alfalfa yields could result in many cases by more careful examination of soil moisture and rooting conditions. These observations can be made with shovel, auger or back-hoe equipment.

Growers are confronted with effectively coordinating irrigation applications with cutting and harvesting schedules. Under deep rooting conditions with good water holding capacity soils, only one large irrigation per clipping might be necessary. Alfalfa grown on soils that permit only intermediate rooting and holding capacities will likely need two irrigation applications for each cutting. Where unfavorable rooting conditions exist, three waterings per cutting might be necessary. Special consideration in managing irrigation water is needed if water tables are less than ten feet from the soil surface. Some subirrigation benefits could result from high water table if it's levels do not fluctuate too much in the root zone. High water levels will restrict rooting depths and might result in a leaching requirement to keep toxic salt levels moving downward.

Good alfalfa stand establishment can be largely controlled by correct irrigation practices. Light, frequent applications are needed to keep the surface moist. Properly used sprinkler systems are ideal for this need. Preirrigation of the soil is usually advisable during seedbed preparation. The prospective root zone should be filled at this time. This is especially true on slow infiltration rate soils.

Table . Estimated Monthly Consumptive Uses of Water by Alfalfa. (Inches depths of water)

Month	Imperial Valley 1/	San Joaquin Valley	Sacramento Valley
January	1.5	1.0	1.0
February	3.0	2.0	2.0
March	6.0	3.8	3.2
April	7.5	5.2	4.8
May	10.0	7.0	6.3
June	10.8	8.6	8.3
July	10.8	9.4	8.4
August	9.0	8.7	6.9
September	9.2	5.8	5.2
October	5.7	4.3	3.6
November	3.5	2.0	1.9
December	2.0	1.0	1.0
Total	79.0	58.8	52.6

/ See Univ. of Ariz. Tech. Bull. 169, Consumptive Use of Water by Crops in Arizona.

SELECTED REFERENCES

. Alfalfa Production in California. Univ. of Calif., Agric Ext. Cir. 442, 1954.

2. Alfalfa Irrigation. C.O. Stanberry Progressive Agriculture Univ. of Arizona, Progressive Agriculture, Vol. VI, No. 2, P9, 1954.

3. Evaluation of Border Irrigation of Alfalfa. L.J. Booher. Univ. of Calif. Unnumbered Extension Mimeograph. 1971.

4. Evaluation of Sprinkler Irrigation of Alfalfa. L.J. Booher. Univ. of Calif. Unnumbered Extension Mimeograph. 1971

5. Irrigation For Seed Production. D.W. Henderson, H. Yamada, and R.M. Hoover. Unnumbered mimeograph. 1969.

6. Irrigation of Alfalfa. Paul E. Martin, Luther G. Jones, and R.M. Hagan. 1963 Alfalfa Irrigation Progress Report.

7. Irrigation Practices for t Production of Alfalfa. C.O. Stanberry. Water The :arbook of Agriculture - 955 pp 435 - 443.

8. Pre-Plant Lanc ɔaration and Irrigation System Development L.J. Booher. . of Calif. Unnumbered Extension Mimiograph. 1

9. Water Managem or Alfalfa. J.R. Davis, A.W. Fry, and L.G. Jones. ornia Agriculture, Vol. 17, No. 4, April, 1963.