

OPTIMIZING ALFALFA PRODUCTION IN DESERT AREAS  
OF THE SOUTHWESTERN UNITED STATES

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Management of irrigated alfalfa in the hot summer-mild winter valleys of the southwest, involves fundamental principles which apply regardless of where alfalfa is grown. It is the application of these management principles under the specific conditions imposed by soil variability, different irrigation systems, amount and quality of water available, crop rotation and length of stand desired, intended use, etc., which must be taken into account. It is the manner in which all these variables are brought together into a management system peculiar and necessarily applicable only to a specific piece of land and a specific grower, that make alfalfa production the challenge it is. The successful producer is like a computer -- integrating all of the various factors which aid or limit production into a system which is satisfactory and unique for his own production requirements.

Successful alfalfa production is not found simply in the choice of a variety, the control of an alfalfa pest, a peculiar irrigation frequency, or the use of a certain fertilizer. It is not that simple! It was the recognition of this complex system which we nonchalantly term "alfalfa production", that brought about the organization of the previous alfalfa symposiums, which have been dedicated to the idea of raising the level of understanding about the factors involved in alfalfa production.

In order to define those factors that are of greatest importance, we must be able to describe those that are of greatest influence in limiting yield. A check list of factors to optimize alfalfa yields was prepared in great detail and presented last year in the 1972 Proceedings of the California Alfalfa Symposium in an article entitled "Optimizing Alfalfa Production in California". This check list was composed of thirteen categories broken down in detail into their component parts. Some of the categories were interrelated, some relatively unimportant and others difficult to rectify. However, the development of a successful production scheme will involve the integration of these factors with each other. Check through this list and let your mind run over the different factors as they may affect or influence your own production situation.

The environmental diversity of the southwest desert area makes it impossible to put together one production scheme with such large variations in soils, climate, pests and disease problems, cropping sequences and uses. After looking at hundreds of alfalfa fields throughout the world it is my firm belief that those who have been most successful in maintaining alfalfa stands over a three to four year period and producing at a high production level of 9 to 10 tons, have been able to do this because they have taken into account and applied the most essential of these principles, which include the following 10 basic considerations:

- Select deep, permeable and/or reclaimable soils.
- Develop adequate irrigation system.
- 3. Provide enough water.
- 4. Control diseases.
- 5. Select right variety.
- 6. Don't shortcut establishment.  
Determine fertilizer needs.
- 8. Use right harvest schedule.
- 9. Develop integrated insect control.  
Control weeds.

It is not my intention to repeat all of the excellent information provided by the previous speakers. My contribution will be in the form of a tying together of the basic components of an alfalfa production system - the application of which are specific to every alfalfa field.

Select Deep Permeable and/or Reclaimable Soils

Production potential is often fixed before a seed is planted by choosing soils with problems that can't be altered or which can only be slowly changed. High yields are obtained

from soils with a minimum of three to four feet of rooting depth, free of hardpan and salt concentrations, with good infiltration and external and internal drainage characteristics, and with sandy loam to clay loam textures that will adsorb and hold high quantities of water. Highly productive soils should also be relatively free of salts with little alkalinity. Although alfalfa is moderately tolerant to salinity, planting in fields with salinity content above 3-4 millimhos will retard germination. Production of established alfalfa has been reported to be reduced 50 percent at extract conductivities of 8 millimoles. Soils high in soluble salt can be planted to alfalfa if a heavy irrigation before planting is applied to leach the salt from the upper root zone. Significant root development occurs to depths of six to twelve feet if not limited by lack of moisture, slow intake rates, restrictive layers, salt accumulation, zones of water saturation, or a water table.

Soils unsuited for alfalfa include those having extremely high salinity or alkalinity, clay that is compacted or with shallow root zones, hardpans or fluctuating high water tables. Alfalfa has a low tolerance to wet soil conditions during periods of active growth. Diseases associated with wet soils include Phytophthora root rot, Rhizoctonia root canker and scald, the latter caused by a lack of oxygen in the root zone for a prolonged period. Internal drainage can be improved, at least for a short period, by deep subsoiling or deep plowing to break compacted layers or to eliminate a plow sole. Many producers overlook the presence of textural differences within the soil profile. Layers of sand within a loam or clay loam soil, or clay layers within a sandy loam soil may act as soil moisture barriers, frequently holding up moisture movement for prolonged periods. These soils will respond to mixing by deep plowing. Many soils, including shallow hardpan or heavy clay soils can be modified to grow alfalfa if enough care is taken in the preplant land preparation, irrigation system development and irrigation techniques.

#### Develop a Well Designed Irrigation System to Meet Your Soil Conditions

Once installed, a poor irrigation system cannot be compensated for by altering irrigation practices. The proper design of a system should be the first consideration in planning an irrigation program. A well designed system can often increase yields by 50 to 100 percent. Three objectives should be kept in mind:

- 1) Maintain a continuously available soil moisture supply to avoid stress and allow continuous alfalfa growth throughout the cutting interval.
- 2) Maintenance of a healthy soil environment for root growth and development. Water logged soils exclude oxygen needed by the roots, and promote root rotting diseases that reduce yield or kill alfalfa stands.
- 3) A profitable return from the irrigation system investment through increased efficiency in the use of water, labor, power and equipment.

Most alfalfa in the desert areas of the southwest is irrigated by the border method. Alfalfa is also irrigated by flooding with contour ditches, flooding of basins, sprinkling and use of corrugations particularly where soils are very shallow or where side fall is excessive. Any system must permit uniform distribution of adequate quantities of water with a minimum labor requirement.

Border Irrigation. Standards for border widths, lengths and unit flow of water for various soil types and slopes are published elsewhere (1971 Proceedings, California Alfalfa Production Symposium, page 6). Where the strip check or border irrigation method of flood irrigation is used, it is not possible to change the slope of the field, fill in the low spots, vary the width of borders, or change the direction in which the water flows across the field after the crop has been planted. For this reason the engineering design is critical. Standing water will result in the death of the alfalfa plants, the invasion of water-loving weeds, and will serve as a source of mosquitoes. Minimum slopes of 0.2 percent are needed to provide surface drainage on tight, clay soils. Flatter slopes can be used on porous soils where no water will stand for periods longer than eight hours following an irrigation. The most serious problems occur on fields without sufficient slope to provide surface drainage and where no drainage ditch has been installed across the lower end of the field to remove excess water.

The width of the border is normally determined by (1) amount of slope in the direction of irrigation; (2) the amount of lateral slope or side fall; (3) amount of water available

for irrigation; (4) the soil type; (5) the length of the strip check; and (6) width of harvesting machinery. An often overlooked factor is the amount of side fall. The difference in elevation across each check should not exceed 0.1 foot (1.2 inches). For example, if the field has a cross-slope of 0.3 percent, the width of the check should be limited to 33 feet to insure uniform application.

Many irrigation strip check or border systems are installed based only on a multiple (usually four) of the width of swathing equipment, minus one or two feet for overlap in cutting. It is also important in planning the size of checks to have a knowledge of the other five important factors. Growers should become familiar with the words "unit flow per foot width of strip check". The unit flow is the amount of water suggested to be turned into each check per foot of check width. For example, alfalfa planted on a sandy loam soil with a slope of 0.2 percent with checks 54 feet wide (4 x 14 foot swath or width less 2 feet overlap) should have a unit flow of about 30 gallons per minute per foot of width, or approximately 1700 gpm turned into each check. With this type of calculation, one is then in a position to know whether or not this system will deliver the quantity of water needed during the peak water use months, and the time required to irrigate his field with his available water. A clay soil of the same slope would require only about half the unit flow per foot of width of strip check, thus enabling the use of wider checks, or the irrigation of more checks.

Other important considerations include: (1) how much moisture is required during the peak water use months in the desert of May, June, July, August, and September; (2) what is the irrigation efficiency; (3) how much available moisture each soil will hold per foot of soil depth (see Table 1); and (4) will the soil infiltrate that quantity of water in the proposed time period? Many soils in desert areas have slow infiltration rates with some heavy clay soils less than 0.2 inch per hour. Such soils need special attention to irrigation system planning to avoid having soil saturated longer than 24 hours. Shorter runs, narrower strip check widths, larger streams, and probably more frequent irrigation may be needed. Your objective should be to deliver an even distribution of water in the correct amount to maintain growth throughout the cutting cycle.

Table 1. Water holding capacity of soils.

Soil type	Available water per foot depth of soil	Soil texture classification	
		Appearance when 2/3 of moisture used	Inches water needed per foot
Sand	0.5 to 0.75	slightly moist, sticks together slightly	0.5
Sandy loam	0.75 to .5	makes weak bal	
Clay loam	.5 to 2.0	makes weak ball, clods flatten	.2
Clay	2.0 to 2.5	makes weak ball	

Sprinkler Irrigation. Many alfalfa fields are now irrigated by means of sprinkler systems of varying designs. Basic criteria of a good system includes:

- 1) Uniform water distribution to all parts of the field
- 2) A precipitation rate less than the infiltration rate of water into the soil.
- 3) An ability to deliver the depths of water at the frequencies needed to satisfy the peak water requirements (midsummer) of the alfalfa.
- 4) An investment that is economically sound.

Recent studies in Imperial Valley have shown that sprinklers used on clay soils did not puddle resulting in more than a 200% increase in seedlings established after five weeks, and a yield increase of 1/2 ton per acre after two cuts. Also, the slower application rate of sprinklers was more effective in reducing salt in the top three feet of soil, and in preventing the development of a dense, blocky soil structure.

A thorough knowledge of soil characteristics is essential to optimizing production under any irrigation system. Infiltration rates, soil-moisture storage capacity (determined by multiplying the water holding capacity per foot of soil depth x the depth of soil root zone), must be known if effective utilization is to be made of your irrigation system. Additional information on irrigation system development and preplant land preparation is available from the 1971 Proceedings, California Alfalfa Production Symposium.

### Provide Enough Water

To get the most out of each unit of water, we must know how much water to apply, when to apply it, and how frequently to apply it. Water management is the most important cultural practice that growers can control in improving yields. Once an irrigation system has been established, the only practices which can be changed are: (1) frequency of irrigation; (2) the size of the stream turned into each border check; (3) the time the water flows into each check. The specific application of these three variables to particular fields must be developed by individual growers. What works well on one farm may not be as effective at another location. Different soil conditions for individual fields might make it advisable to vary irrigation practices within small land areas. The most important considerations are recognized as including:

1) Know your water requirements. Water requirements vary from one area to another depending upon a number of interrelated factors such as age and vigor of the plants, limiting nutrients such as phosphorus, etc., depth and texture of the soil, topography, infiltration rate, method of application, depth of groundwater, rainfall, temperature, wind velocity, number of hours of sunlight, length of growing season, and presence of salt in the profile. Water requirement is usually defined in terms of consumptive use, which is the water used by the plant plus the water evaporated from the soil. With adequate moisture, suitable soil and a good stand, the most important factors increasing consumptive use are frequency of irrigation, length of growing season and temperature. Average consumptive use values in inches per month and total seasonal use are given in Table 2 for Mesa-Tempe, Imperial Valley, San Joaquin Valley and Sacramento Valley. These studies show a peak consumptive use, under desert conditions, in June and July of between 11 and 12 inches per month. When this is translated to a daily basis (Figure 1) peak use varies from 0.1 inches in January and February to 0.35 inches per day during June and July. In addition, in many areas of the desert there is an additional 10 to 15 percent water requirement to satisfy the leaching requirements to maintain the proper salt balance. Since some water is usually lost through deep percolation below the root zone and through runoff losses, an efficiency factor must be applied of between 80 and 90 percent in determining the total water requirement.

Table 2 Estimated monthly consumptive uses of water by alfalfa in Arizona and California (Depth of water in inches.)

Month	Mesa-Tempe	USDA Imperial Conservation R Center, Brawley 1972	San Joaquin Valley	Sacramento Valley
January	1.5	2.6	1.0	1.0
February	3.0	2.6	2.0	2.0
March	6.0	6.2	3.8	3.2
April	7.5	7.0	5.2	4.8
May	10.0	9.3	7.0	6.3
June	10.8	11.0	8.6	8.3
July	10.8	12.2	9.4	8.4
August	9.0	8.8	8.7	6.9
September	9.2	9.2	5.8	5.2
October	5.7	6.0	4.3	3.6
November	3.5	3.9	2.0	1.9
December	2.0	1.9	1.0	1.0
Total	79.0	80.8	58.8	52.6

2) Determine water holding capacity of your soil. Water available for plant use per foot of depth of soil varies according to soil texture as outlined in Table 1. By determining the texture of each foot of soil, and knowing the depth of root zone, the total water storage capacity in inches of water can be estimated.

3) Determine the soil root zone. Water is used from the soil in proportion to the distribution of the alfalfa roots. Root distribution increases with age of stand and in a warm climate. It is restricted by compaction and poor aeration, a high water table, impervious layers, destructive diseases and pests, and salinity. High root concentration may occur in the vicinity of needed fertilizer bands, textural layers such as hardpans, and in the moist soil above a water table. Significant root development has been noted in permeable soils at depths of six to ten feet. Rooting depth can be estimated by backhoeing an observation pit or by sampling soil at various depths with a soil auger.

More than 90 percent of total water extracted from the soil in most desert areas including sandy areas such as Yuma and clay hardpan areas in Imperial Valley, comes from the upper three to four feet of soil. Even deep permeable soils such as those located at Davis, California have more than 80 percent of their roots distributed in the upper three feet of a five year old alfalfa stand. In general, most irrigation specialists agree that about 40 percent of the extracted moisture comes from the upper quarter of the root zone, with 30, 20 and 10 percent for successive quarters. Recent studies in Imperial Valley (Lehman, et al., 1968, Volume 39, Hilgardia) on shallow clay and clay loam soils showed that alfalfa rooting was shallow in comparison to better drained sandy loam or sandy soils from the same area. In these studies 82 percent of the roots were found in the upper foot, 12 percent in the second foot, and only 6 percent in the third foot. Rooting depth can also be influenced by irrigation frequency. Tests at Yuma under hot conditions resulted in increased water extraction from the surface foot of soil by frequent irrigations. Trials in Yuma have also demonstrated that where deficient, applications of phosphorus in the upper parts of the root zone where high temperatures prevail also increased the root activity and water use from this very warm zone.

Overestimating the root zone and moisture holding capacity of soils will result in prolonged saturation which favor diseases such as Phytophthora root rot, Rhizoctonia root canker and scald.

4) Determine water intake rate for your different alfalfa soils. A soil probe (a four foot x  $\frac{1}{4}$  inch iron rod with a T handle) can determine the depth of water penetration after an irrigation since it stops when it meets dry dirt. By noting the time water was applied, an estimate of the infiltration in inches per hour can be made. A careful study of intake characteristics is necessary when selecting sites and designing irrigation systems. It is difficult to obtain rates in excess of 0.3 inches per hour in many desert soils, with the exception of sandy and sandy loam soils. Some practices have successfully assisted in aiding moisture penetration in low intake rate soils:

Don't work soils when too wet

- 2 Reduce traffic to a minimum or confine traffic to predesignated areas
3. Break plow soles and compacted layers with subsoiling.
- 4 Amend sodium soils with calcium or some amendment that will make calcium available.
- 5 Modify soil surface with organic matter or manure.
6. Applying two irrigations, closely spaced, in place of one

Some irrigators will keep soils saturated too long in an attempt to obtain deeper moisture penetration. Since alfalfa has very limited tolerance to poor surface and subsurface drainage conditions, such practices under the conditions of the desert result in rapid development of Phytophthora root rot in the cool months and scald and Rhizoctonia root canker in the warm summer months. Recent research at the Imperial Valley Field Station has indicated the value of irrigating soils with poor infiltration characteristics more frequently for shorter periods of time. In addition to greater yields from more frequent irrigations of shorter duration, additional benefits were no scald, greater plant populations, drastically fewer grassy weeds, less diseases that cause stand loss, and a satisfactory salinity level.

Some operators in the San Joaquin Valley have improved water penetration without serious stand loss by surface "scratching" in the fall or spring with one-half inch fertilizer shanks spaced 12 or 18 inches apart running at a depth of 5 to 7 inches. Low infiltration rates on shallow, dense or hardpan soils can seriously limit yields. By (1) decreasing the quantity of water released in each check, (2) decreasing the length of run by adding needed cross ditches, (3) increasing the application time, and (4) increasing the frequency of irrigation within the limits of cutting frequency requirements, more water can be made uniformly available to the root zone over a longer period of time, thereby improving alfalfa production. Since the balance between too little and too much irrigation is very small, irrigation of soils that accept water very slowly or which have a low water storage capacity becomes very critical and difficult.

5) Determine drainage requirements. During periods of active growth, alfalfa has comparatively low tolerance to wet soil conditions. During hot weather, alfalfa cannot take water standing on the surface longer than 12 hours without some stand loss. When soils are saturated up to 36 hours during these warm periods nearly the entire alfalfa stand will be lost due to scald. Both tile drains and surface drains will assist in eliminating this stand loss. One of the greatest stand reducing problems is the failure of many operators to provide for surface drains at the bottom of checks which if present, could remove surplus surface water and reduce plant loss due to scald (Figure 3).

If a producer is able to have an idea of the intake rate, the potential rooting depth, the water holding capacity of the soil, an estimate of the daily peak use for maintaining vigorous growth, and his efficiency he is in a good position to estimate how much, how often and how long he must irrigate to avoid moisture stress or over irrigation.

Irrigation frequency. The frequency is dependent on the capacity of soil to hold water and the water use requirements of the particular time of the year. During the winter, excess water should be applied to satisfy the leaching requirements to maintain the proper salt balance and to rewet the entire root zone. With adequate winter moisture, the root system becomes more extensive and is able to recover from previous accumulated harmful results of over irrigation.

Frequency of irrigation in the spring and summer in desert areas is much more critical. Too large or too frequent irrigations will cause scalding and the development of root rotting organisms, stimulate weeds, raise the water table, contribute to drainage and soil salinity problems, and aggravate the already overtaxed nitrogen fixing bacteria possibly contributing to a nitrogen deficiency. A minimum of two irrigations and often three are required per cutting in the summer months to support continuous growth over the 26 to 30 day cutting interval. Shallow clay soils will have to be irrigated three or four times per cutting in order to maintain growth. Continuous growth in the summer will be maintained if each irrigation can be scheduled when about 60-70 percent of the readily available moisture has been used from the active root zone. Soils should be sampled at every foot of depth, and an estimate made of the inches of water needed per foot, depending on soil texture. A brief description of the appearance of soil with two-thirds of the moisture removed is given in Table 1. A complete discussion of this method can be found in Bulletin A-20, Arizona Agricultural Experiment Station, 1970. An example may help illustrate. Assume that you cut on June 9th, each cutting is 30 days apart and you hope to be able to use two irrigations per cutting. Suppose that after irrigation on June 15th, the soil profile contains 6 inches of available water and we wish to irrigate when two-thirds of the available water, or 4 inches ( $6 \times \frac{2}{3} = 4$ ), is used. Average daily consumptive use for the last half of June is 0.36 inches (10.8 inches monthly use divided by 30 days = 0.36 inch per day). The 4 inches of water will be gone in 11 days ( $4 \text{ divided by } 0.36 = 11$ ), and irrigation should be scheduled on or before June 26. If your efficiency is estimated at 80 percent, then you must apply 5 inches ( $4 \text{ divided by } 0.80 = 5$ ). However, two irrigations each 11 days apart will put the second on June 26th, and with a cutting scheduled for July 9th a third irrigation should be applied on July 7th. This would force either (1) a delay or an early cutting, (2) an early irrigation on July 2nd, or else (3) delaying irrigation until after cutting. The latter will result in drought, poor recovery after harvest and reduced yield.

Plant symptoms are less reliable signs of when to irrigate. However, observing plants for wilting, color change to a blue-green color, and careful observance of growth rate should help. By using a soil auger to check the soil for moisture in the root zone, you can combine plant signs with soil conditions and help answer the question of when to irrigate.

One of the greatest limiting factors in alfalfa production is the extended time from the last irrigation before cutting until water can be reapplied after removing the bales.

Fine textured clay soils may require up to seven days after irrigation before equipment can safely enter an alfalfa field to begin harvest. This seven day period is extended to twelve to sixteen days before water can again be applied after removing alfalfa from the field. Many fields have no regrowth at all after cutting until the first irrigation. Four or five days of drought following several cuttings can eliminate one entire cutting per year. When water is available, new buds must be regenerated at the crown, which can delay recovery up to ten days. Fields that have restricted root development or which have a low water storage capacity will have to be irrigated closer to cutting than deeper soils. The danger of compacting moist soils and problems in curing alfalfa hay windrowed on damp soil may be less than the yield reduction suffered by allowing severe drought to occur during curing.

Alfalfa should not be irrigated after cutting until a canopy of leaves shade the ground. Fields irrigated without this canopy can expect an accelerated infestation of summer grassy weeds such as watergrass or pigeongrass which require light in addition to moisture to germinate. In addition, irrigation should be scheduled as long after cutting as possible (at least 5 days) to avoid stand loss from scald. Apparently newly clipped plants are more susceptible to flooding injury than plants that have had an opportunity to harden and develop new regrowth. Fields that are dry with no regrowth at cutting need to have their irrigation schedules reevaluated and changed so growth will not be stopped and yield lost during the hay making process.

Overirrigation. Overirrigation also reduces production. Its effects have been covered in the previous discussion in a general way, but it cannot be overemphasized that during the hot months of the summer in the southwest desert area, soils that remain saturated at or above field capacity for periods of time in excess of 24 to 30 hours will have many alfalfa plants die from asphyxiation due to the lack of oxygen. This phenomenon has been termed "scald" but is not due to the high temperature affect of the water but due to the high demand of oxygen by the plants during hot weather and the removal of oxygen from the soil due to flooding. The resulting effect, visible in about 5 to 8 days, is the yellow and brown discoloration of the woody tissues of the root followed by complete disintegration, with roots becoming soft and mushy and giving off a putrid odor. Tops of plants become yellow and wilted followed by rapid death.

#### Control Stand-Reducing Diseases With Proper Management and Varieties

The dry desert areas of the southwest are relatively free of diseases that attack leaves and stems such as common leaf spot, Stemphylium leaf spot, rust and Downy mildew. Most varieties developed in the southwest have little resistance to leaf diseases with the exception of Downy mildew. Diseases that attack the crown and root of alfalfa cause stand losses and are economically important. Phytophthora root rot occurs in the fall, winter and spring, and Rhizoctonia root rot and scald are involved with the summer decline of alfalfa stands. Anthracnose has been found in many fields in Arizona and southern California but its total damage has not yet been assessed. Likewise, it is very difficult to determine the overall damage caused by crown and crown-bud rots since many fungi are involved. Field traffic and animals are considered to be the origin of this complex since they open crowns and allow fungi to invade crown and bud tissue. For a more complex discussion of alfalfa diseases see U.C. Circular 485, 1971 Proceedings of the California Alfalfa Production Symposium and articles in this proceedings.

Phytophthora root rot is the most important disease in the southwest, causing rapid thinning of alfalfa stands, often in the first year of establishment. Water in excess of field capacity for several days, and mild temperatures under 85° F are necessary for the fungus to reproduce and attack alfalfa roots. It is specific to alfalfa and will not attack other crops. Usually the disease occurs on clay soils with poor internal drainage but also appears on sandy and sandy loam soils with compacted layers or lenses where there are textural differences that prevent rapid drainage. Many severe Phytophthora infections have been reduced by changing irrigation practices to minimize the amount of free water in the soil. This may involve reducing the quantity of water applied per irrigation, decreasing the number of irrigations, increasing the flow of water in an individual check, shortening the length of the runs, making drains at the end of checks, preplant subsoiling, or a combination of such practices. Until recently, the only varieties with some degree of resistance to Phytophthora root rot have been semidormant varieties, such as Lahontan, that have not been adapted to the desert areas. There are now available from private and University breeders, a few released varieties and many other experimental varieties that are being tested with a good level of resistance to Phytophthora root rot that are nondormant

and adapted to the desert areas. Hopefully, this disease can be controlled in a few years by continually increasing the level of resistance in new alfalfa varieties.

Rhizoctonia root canker and summer flooding injury (scald) cause early death of alfalfa plants in the hot desert area of the southwest. Although the cause of these two diseases are different, they can both be minimized by reducing the time roots are saturated during hot weather. They both occur during the hot months of July through September, with most damage occurring in August. Damage can be minimized or eliminated through a very careful water control program so soils are not saturated more than 24 hours. As time of saturation and temperatures increase, damage will increase. Newly mowed plants are also more susceptible to scald than those with one or two weeks regrowth. Crown damage from wheel traffic prior to irrigation causes death of plants in the tracks in less than a week after flooding. Recently, Dr. W. F. Lehman has released a new variety, UC Salton, with a moderate level of resistance to summer flooding (Figure 2). This variety and other experimental selections offer the possibility for increased summer production and stand life.

Crown and crown-bud rots are responsible for premature death of many alfalfa plants. Many fungus diseases are involved, but it is generally recognized that wheel traffic increases damage. Until breeding programs can provide resistance, or more broadly crowned alfalfa are developed with nonwinter dormant characteristics, minimizing traffic is the only practical control. Recent research in Fresno County has shown that at the end of the first harvest season, a traffic pattern at cutting and again 7 days after cutting reduced the number of live alfalfa plants in the wheel traffic area by 70 percent, and reduced yield in those same traffic patterns by 75 to 80 percent. Thus, it would appear that damage from the wheel is causing crown buds to be broken, especially the baler and bale pick up traffic, and invaded by fungi that cause crown rot and death of the alfalfa plants. All unneeded traffic should be eliminated. It is with this in mind that recent research was initiated at Davis to study the effect of cutting intervals on yield, alfalfa quality, and stand persistence. This research should be done in the desert area as well, since if one cutting can be eliminated per year, this will mean a certain percentage less traffic. Additionally, traffic could be concentrated in prescribed areas if wheel bases were standardized on all equipment. This would not result in yield loss since the compensating ability of the alfalfa plant would overcome yield loss from adjacent alfalfa-free areas.

There are other diseases that ought to be mentioned that reduce stand life and yield including bacterial wilt, alfalfa dwarf, and Anthracnose. Alfalfa mosaic virus is also being investigated as a possible cause of early stand decline when combined with diseases such as Phytophthora root rot and Rhizoctonia.

#### Select The Right Variety

Factors that are important for a grower to consider in choosing a variety will vary from area to area, depending on your soil texture, length of stand life desired, local climate and whether or not winter forage is desired. Anyone selecting a variety or giving variety recommendations should know as much as possible about the local conditions present on the particular piece of land where planting is intended, and have a complete knowledge of the different characteristics of the various varieties. Varieties do differ in their characteristics and yielding ability. Important varietal characteristics for the desert areas of the southwest will vary slightly from one area to the next, but should include:

A nonwinter dormant variety

2. A moderate to long stand life of three to four years
3. Resistance to the newer biotypes of the spotted alfalfa aphid
4. An adequate yield.
5. As many other "plus" factors as are available in pest and disease resistance considered necessary for your particular area.

Winter dormancy. Alfalfa varieties grown in the southwest may be divided into three rather broad groups: 1) those which are nonwinter dormant, capable of slow growth during the winter months in the mild, relatively frost-free winter areas of southern California and Arizona; 2) those with intermediate winter dormancy; and 3) those which are very winter dormant. Only varieties from the nonwinter dormant group should be considered for the desert

southwest, except those few locations where colder winters with distinct dormancy is possible due to elevation. Characteristics shared by varieties in the nonwinter group include lack of cold resistance, very little or no winter dormancy, quick recovery after cutting, narrow erect crowns, large, hollow stems and purple flowers. Classification of all varieties into this three category broad grouping is increasingly difficult to maintain since there are new varieties with variations in winter dormancy within all three groups. I prefer to classify alfalfas for the desert area into four groups with the addition of a "very nondormant group" which has more growth in the winter months in the low desert valleys of southern California and southern Arizona permitting grazing, green chopping and dehydration to continue throughout the winter months. A listing of all known public and private alfalfa varieties and brands sold in the desert area in the nondormant and intermediate dormant classifications includes:

#### Alfalfa varieties and brands

Very Nondormant	Nondormant	Semidormant
Abunda Verde Brand	AS-13 *	AS-49
Bonanza	DeKalb Brand 183	Caliverde 65
Caliente	DeKalb Brand 185 *	Cody
Converde 94 Brand	Diablo Verde	Condura 72 Brand
El Unico	El Camino Brand	DeKalb Brand 167
Hayden	8-19 Brand	Eureka Brand **
Imperial 70 Brand	El Camino Brand WL 450 *	Kanza
Mesa Sirsa	El Camino Brand WL 451 *	Lahontan
Niagara N-71 Brand	El Camino Brand WL 508	Mesilla **
Sonora	Germain's Eldorado *	Niagara N-78 Brand **
Sonora 70	Germain's Eldorado R	10-19 Brand
U.C. Salton	Joaquin 11	Resistador **
Val-Falfa Brand	Moapa	Washoe
WL 600	Moapa 69	
	919 Brand *	
	U.C. SW-44	

Known to be only slightly more winter dormant than Moapa.

\*\* Known to be less dormant than Lahontan, and will produce more fall growth than Lahontan.

(This listing is as complete as the author was able to determine.)

Semidormant varieties do not begin growth as early in the spring, do not grow as long into the fall, are slower recovering after cutting, and require two to four days longer interval between harvests to reach 1/10th bloom. Variety trials conducted in the desert areas in the past 15 years indicate a yield reduction for semidormant varieties of 15 to 30 percent over a three year period harvested on a 26 to 30 day cutting interval.

Stand Life. Most nondormant varieties are considered short lived, with stands ordinarily remaining two to three years and seldom exceeding four years. The University of California, University of Arizona, USDA and private companies are engaged in research to develop varieties with greater resistance to stand depleting diseases. Hopefully this effort will result in new varieties with greater persistence that will allow stands to be maintained for four years with greater yielding ability on problem soils. Short stand life costs southwestern producers millions of dollars annually. Most producers calculate a \$20-\$25 annual cost for replacing alfalfa stands. This high amortization cost make it absolutely necessary to continue this kind of research to find varieties with greater persistence. U.C. Salton is one step in this direction with many other varieties being developed and some almost ready for release.

Stand life is also affected by many other factors other than dormancy, but usually nondormant varieties are shorter lived because of the continuous cutting and resulting reduction of root carbohydrate reserves. Diseases such as Phytophthora root rot, Rhizoctonia root rot, scald, crown rot complex, bacterial wilt, stem and root knot nematodes, Southern Anthracnose, and alfalfa dwarf all reduce stand life. Cultural practices also influence

stand life. Continuous fall or winter grazing or dehydration reduce vigor and promote weediness. Even periodic harvest and grazing throughout the fall have an effect in reducing stand life because of depletion of root reserves during a time when growth is not vigorous and replacement is slow. Cutting intervals less than 26 days which harvest alfalfa in the bud stage and seriously reduce vigor will eventually result in weed invasion and death of many plants.

The selection of a variety involves a thorough knowledge of varietal characteristics, some of which are more important than yielding ability, combined with a thorough knowledge of your own soils and cultural practices you intend to impose on the variety. While the choice of a variety is important, and it can be vital for economic production on certain problems soils, attention to the important production practices outlined in this and past symposiums will be of greater influence on total production than will the choice of a variety. Until desert growers are producing at a much higher level than the approximately 6 tons per acre average indicate, production practices need more attention in order to obtain the 10 to 12 tons optimum yields that can be obtained from most of the varieties now being used.

For detailed information about varietal characteristics see the discussions involving varieties in this proceedings and the Proceedings of the 1971 Symposium.

### Stand Establishment

Preplant subsoiling, irrigation to settle the soil, and land planing will assist in improving the stand life of alfalfa in the desert areas. High spots that tend to accumulate salt, and low spots that have standing water (Figure 4) can be detected by a preirrigation followed by touch up land planing or leveling. High sodium spots should be treated before the preirrigation. (Figure 5) Hardpans should be broken with deep subsoiling before any operations commence. Fields with either clay or sand lenses which hold up water movement should be deep plowed.

The shape of the levee will depend upon the stream size intended for irrigation, but ordinarily an 8 foot wide levee with a maximum settled height of 4 to 6 inches is recommended for easy passage of equipment and for complete utilization by the growing crop. High, narrow levees ordinarily have from 1 to 3 feet of nonproductive surface which can mean up to 15 percent unplanted surface in a border check. More care in border shaping and in preirrigation in desert areas can eliminate this loss.

Drainage channels on each side of the levee are becoming increasingly popular to provide rapid surface drainage. This is especially true in large basins and in long, wide checks on clay soil. Another new trend on shallow clay soils is to make corrugations or beds from 2 to 8 feet wide which will permit both rapid drainage and easier germination from stands that must be irrigated up (see U.C. Circular 408, "The Border Method of Irrigation" for more details).

Seed Inoculation. Normally, alfalfa in the southwest depends upon a bacterium, *Rhizobium meliloti*, present in the soil to fix nitrogen from the air for use by the plant. They are tolerant to moderate levels of alkalinity, but are sensitive to acidity and grow very poorly at a pH of 5.5 or below. Mature effective nodules are large, elongated, often clustered on primary roots and have pink to red centers. If nodules change to green, this indicates a cessation of nitrogen fixation. Legume nodules are usually shed following cutting, and new nodules form when the plants renew growth. Ineffective nodules are small, usually numerous, with white or pale green centers, and are scattered over the entire root system. Both effective and ineffective nodules can occur simultaneously on a root system. A pale yellow coloration of foliage indicates a nitrogen deficiency of seedling alfalfa. Cultures of rhizobium can be purchased and inoculated in a variety of ways (Proceedings, 1972 California Alfalfa Symposium, page 39). Poor nodulation can also occur from compaction and waterlogging, soil temperature extremes (below 40° F if accompanied by favorable growth conditions and above 95° F), and phosphorus, sulfur and boron deficiencies. There is some recent evidence gathered at U.C. Davis that very little nodulation takes place when temperatures surrounding roots exceed 95° F. In desert areas these temperatures are approached at the 2 inch depth daily in midsummer. Higher temperatures no doubt occur for several days following cutting. In one trial where nitrogen fertilizers were used, known to have been conducted under controlled conditions in Imperial Valley, there was no response to applied nitrogen. The search continues at U.C. Davis for strains that will tolerate higher temperatures and fix nitrogen more abundantly. When this research is completed, regular inoculation may be worthwhile. For the present, inoculation is usually unnecessary in the desert areas if the field to be planted has a history of alfalfa planting. Inoculation

costs between 20¢ and 70¢ per acre making it advisable whenever the soil is suspected to have too few or poorly effective rhizobium. Seed pelleting and inoculation costs more (10¢ to 15¢ per pound of seed) but usually less seed per acre is required which can result in a net savings to the grower through pelleting due to the difference between the cost of pelleting and today's high seed price in excess of \$1.00 per pound.

What is an adequate seedling stand? Many seeding rate trials have been conducted in California which indicate no difference in final yield from seeding rates between 10 and 50 pounds per acre. If every seed germinated, 10 pounds per acre would establish 50 plants per square foot. Seeding 20-25 pounds per acre under average conditions will establish 30 to 60 plants per square foot one month after seeding. At the end of the first season, about 40 to 50 percent of the plants will remain. Lower seeding rates have up to an 80 percent survival and higher seeding rates may have only 30 percent. Stands should not be removed unless the number of seedlings established are less than 12 to 15 per square foot. Although such stands have severe competition from weeds, chemicals can assist in stand establishment. An adequate stand for optimum production would have 12 to 20 plants remaining at the end of the first production year, 10 to 15 at the end of the second, 8 to 12 at the end of the third, and 6 to 9 at the end of the fourth and subsequent years. Adequate stand density depends on cutting schedule. If a 1/10th bloom schedule is practiced, root, crown size, and stems per crown will increase yearly, compensating for the reduction in plants. Depending upon crown size, stands should be removed when 5 or less plants per square foot remain.

If a relatively fine, firm seedbed is provided, 15 pounds per acre have been successfully used to establish alfalfa when followed by cultipacking. Normally however, under conditions in the southwest where irrigation is needed to germinate the seeds, heavier seeding rates seem warranted, particularly on soils with high salinity. Sprinkling-up alfalfa will increase germination and seedling establishment by 200 percent on clay and clay loam soils that puddle and crack easily.

Fall versus Spring Planting. A planting period from late September through early November is favored in the desert. Advantages of early fall planting over spring planting include: 1) a 20-30 percent yield increase in the first year; 2) more rapid germination in establishment due to warmer temperatures; 3) increased vigor and ability to compete with winter weeds; 4) development of a more vigorous, deeper root system that may prevent stand loss during the next summer; 5) reduce likelihood of soil compaction from working wet soils.

Rainfall in the desert is not predictable enough to insure germination during any season. Therefore, the first irrigation of a fall planting in dry soil should be gentle, penetrate deeply, and cover the ground as completely as possible. Soils that crust easily should be irrigated rapidly one additional time before emergence. Irrigating after emergence when the plants are a few inches tall may stimulate rapid growth of damping off organisms and possibly buildup soil salinity on the surface. A good preirrigation and subsequent irrigations during germination should provide enough moisture to supply seedlings with enough water to develop three to five true leaves. After emergence, excessive irrigations should be avoided, but careful attention must be paid to the moisture status of the soil due to the prevalence of drying winds and warm temperatures during late summer and fall establishment.

Seeding with a companion crop is not recommended except where wind and sand may blow out unprotected seedlings. When necessary, use 30 pounds of grain per acre or less when planting with a new seeding. Severe cereal competition can be avoided by pasturing or green chopping or making hay from the cereal rather than allowing grain to mature.

#### Determine Fertilization Requirements

In the desert areas of the southwest, phosphorus is the most likely element to be deficient. Nitrogen is rarely required and never needed if soil conditions are satisfactory for the growth of bacteria supplying atmospheric nitrogen to the roots of alfalfa. Most desert soils are also well supplied with potassium, magnesium, sulfur and calcium. Rarely, sandy soils heavily fertilized with ammonium-type fertilizers for many years may have a pH low enough to require the addition of lime.

Diagnosing fertilizer requirements. Fertilizer needs can be best diagnosed by a combination of: 1) soil analysis; 2) plant analysis; 3) deficiency symptoms; and 4) field strips. Soil analysis, plant analysis, and plant symptoms may help tell us what nutrients are needed to add as fertilizers but as yet no substitute has been found for well laid out tests and demonstrations to show how much fertilizer may be profitably used. Where one or

more nutrients are limiting, the interaction in response of two or more nutrients in combination is extremely difficult to diagnose with anything but field strips.

Since phosphorus is limiting in many desert soils, the recommended practice is to plow down 300-400 pounds of  $P_2O_5$  ahead of seeding. This should last through the three year normal crop rotation. If additional phosphorus is needed, an annual topdressing of 100 pounds of  $P_2O_5$  per acre made in the late fall should be sufficient. A helpful diagnosis of growing alfalfa can be made with tissue analysis taken at 1/10th bloom stage. Either the whole plant or only the midstems may be analyzed. Critical levels below which a response to phosphorus would be normally expected are 0.18% phosphorus (whole plant) and 700 ppm of  $PO_4-P$  (midstem).

Soil analysis of desert soils can only be helpful in possibly determining what, not how much fertilizer should be used. Because of the great depth and exploration of the alfalfa root system, it is difficult to be certain that responses will occur even when a deficiency is indicated by soil analysis. Phosphorus, potassium, sulfur, and possibly zinc and boron are all possible to diagnose with soil analyses. If soil values for P ( $HCO_3-P$ ) are over 20 ppm, exchangeable K over 100 ppm, and  $SO_4-S$  over 20 ppm it is very unlikely that a response from P, K or S fertilizers will be obtained. Responses are likely at values below 10 ppm, 50 ppm and 10 ppm for P, K and  $SO_4-S$  respectively.

Plant analysis only reflects with certainty the nutrient that actually limits growth. Where multiple nutrient deficiencies occur, the major limiting factors must be corrected (P deficiency for example) before tissue values for S and K will reflect the supply of these nutrients. For further information consult Proceedings, 1971 California Alfalfa Symposium, AXT-376, "Alfalfa Analyst" and discussions in these proceedings on alfalfa fertilization.

#### Select Correct Harvesting Schedule

The number of cuttings per year in the desert areas of the southwest will influence hay quality, total seasonal yield, plant survival and hence number of years of a productive alfalfa stand, plant vigor and rate of recovery following cutting, weediness, and resistance to alfalfa diseases. Detailed information about cutting frequency can be obtained from Proceedings, 1971 California Alfalfa Production Symposium, and the article by Massengale, printed in these proceedings.

The important question that producers must answer is what harvesting program will return the most production of marketable quality hay per acre over a three or four year stand life. The answer to this question must be a compromise because quality is becoming more and more important in determining price. Research in Arizona has shown that over two harvest seasons, cutting hay in the 1/10th bloom to 1/4 bloom stage resulted in more total yield than when cut in the bud or full bloom stage or growth. Although stands decline in plant numbers continually through their life, cutting in the bud stage, particularly in the hot summer months of June through August, can reduce plant population by the end of the second year to only 20 percent of the original established plants. Plants cut in the bud stage before reaching bloom, continually lose root carbohydrates without sufficient regrowth time for replenishment. Such cutting frequencies reduce the plant vigor, increase the weed content, reduce total seasonal yield, as well as bring on the rapid decline of stand during the second summer. This information has resulted in the recommendation for the desert areas of the southwest that alfalfa be cut in the 25 to 35 percent bloom stage June through September, with earlier cuttings only permitted during late fall and early spring. The 50 percent bud stage for Moapa alfalfa occurs about 21 days after cutting from May through October, while the 25 percent bloom stage occurs in 29-31 days. Large operations must usually schedule harvests on a calendar basis to maximize use of irrigation labor and machinery. In the Imperial Valley, approximately 50 percent of the total seasonal yield is obtained from the three cuts in March, April and May. In order to maintain quality these three cuts can be made at about 30 day intervals which coincide with the 10 percent bloom stage in this period. The three cuttings in July, August and September normally total only about 25 percent of the seasonal yield and can be allowed to mature to the 25-35 percent bloom stage in order to help increase yield and preserve stand life, without seriously affecting total seasonal quality.

For any maturity stage, summer alfalfa is poorer quality than spring or fall due to the decreased percentage of leaves and greater production of stem tissue. Alfalfa produced on heavy clay and/or salty soils normally are under more stress than alfalfa planted on

sandy soils. This stress seems to produce a shorter, finer stemmed, leafier alfalfa that can be cut as late as the 1/2 bloom stage without seriously reducing quality. Alfalfa quality studies throughout all alfalfa growing areas in California have indicated that hay from these soils, such as Imperial Valley, is generally higher quality when cut at the same stage of maturity. Therefore, unless buyers are willing to pay for higher quality, it appears wise to consider wider cutting intervals which will result in more hay of an adequate quality, greater vigor and fewer weeds, and stands with more years of productive life.

Late fall and early spring harvesting. Total seasonal yield can be increased by delaying the date of the first cut in the spring by one or two weeks, provided lower leaves don't fall. A nine day delay in Fresno County increased yield of first cutting by 0.6 tons per acre. Frequent removal of late fall, winter and early spring growth less than 12 inches tall through dehydration or pasture can result in reduced vigor, more weeds, and lower yields the following year. Repeated harvesting or continuous grazing in the winter causes root reserves to be depleted very drastically at a time when they ought to be stored for later use in the summer months. Rational use of animals by rotational grazing with large numbers, and infrequent harvesting for dehydration in the winter time probably has very little effect on yield the next spring and summer while giving some income in the winter months.

How to determine percent bloom. The percent bloom stage is usually determined by counting the total stems and noting those with any flower showing at several locations through the field. Then a percentage bloom can be calculated. It is not always possible to use this method because of lack of bloom due to insect damage, disease, and short days of the spring and fall. For this reason, height of regrowth of newly developing crown buds found at the base of the alfalfa stem have been correlated with flower development. Many growers prefer to use crown bud development. When one-half of the crowns have buds just beginning to show (1/4 inch or less) this is equivalent to the flower bud stage of development. In 10 percent bloom alfalfa, crown buds are present on 60 percent of the crowns and regrowth averages 1/2 to 3/4 inches; at 1/2 bloom crown bud regrowth averages 1 to 2 inches on nearly all of the crowns; full bloom alfalfa has crown bud regrowth in excess of 2 inches on every crown. Many growers have found high yields and excellent vigor with good stand life from cutting alfalfa when the majority of the shoots from the crown buds are just under the cutting height of the swather, or approximately 2 inches tall. In this system, some shoots from earlier developing crown buds will be cut with no harmful effect.

#### Develop Integrated Insect Control Program

Resistance of varieties to insect pests is becoming a more effective means of insect control every year. Because of continuous breeding programs by public and private breeders, pests such as the spotted alfalfa aphid and the pea aphid have been controlled or at least damage minimized. Plant breeders, such as Bill Lehman here at the Imperial Valley Field Station, are developing resistance to the Egyptian alfalfa weevil. While many insects must be controlled chemically, biological control and varietal resistance will in the future reduce the insecticides that need to be used. Excellent and very timely information on integrated control is presented in the Proceedings of the 1971 and 1972 California Alfalfa Symposiums as well as in this symposium proceedings.

When insects such as the Egyptian alfalfa weevil reach damaging levels any neglect in timely control will cause an economic loss. Losses in the first cutting from the Egyptian alfalfa weevil in many parts of California have been documented as varying from 1/2 to 1 ton per acre. Pea aphid damage has reduced yields up to 1 ton per acre in late August and early September in the San Joaquin Valley, and in late winter and early spring in the desert areas.

Growers should be aware that varieties do differ in both the level of resistance and the type of insects a particular variety may be resistant to. Also, new strains or races of insects do develop that can attack previously resistant varieties. Recommendations on economic levels of insect control as well as information on chemicals that may be less harmful on beneficial insects are available from the Extension Service and chemical companies. Costs of insect control can be reduced by utilizing sources of plant resistance, biological control combined with essential chemical control in an integrated pest control system. Repeated demonstrations throughout California have shown that strip cutting in 300 or 400 foot blocks, or leaving alternate levees uncut will encourage beneficial insects and reduce insecticide costs.

## Maintain Good Weed Control Practices

Most weed problems are a result of poor management such as improper leveling in seedbed preparation, irrigation practices that bring on weed invasions, and cutting in the bud stage thereby reducing vigor and the competitiveness of the alfalfa plant. If your management practices favor weed growth rather than alfalfa development, the use of chemicals will only temporarily help control weeds. Management, including wise use of chemicals, is the key to successful weed control in seedling and established stands. For more detailed information on weed control in seedling and established alfalfa stands, see the Proceedings of the 1971 and 1972 California Alfalfa Symposiums as well as the information presented in this proceedings. In addition, most state extension services publish information on the control of specific weeds by specific chemicals.

Cultural control in seedling alfalfa. Establishing a thick, vigorous stand early in the fall is an effective weed control technique. Alfalfa seeded too early in the desert areas can have serious problems with summer-annual weeds. On the other hand, seeding too late in the fall reduces the rate of alfalfa development and often results in severe infestations with winter-annual weeds. Preirrigating seedbeds that have been prepared early bring up many weeds that can be disced under. Often several discings can take place before planting. Seedlings that germinate and develop rapidly due to shallow planting, warm temperatures and adequate irrigation are usually weed free. Poor conditions such as dry seedbed, crusting, compaction, all of which result in poor germination and establishment, result in thin weedy stands because of lack of alfalfa competition. Adequate soil fertility, particularly phosphorus is essential in providing good alfalfa competition. Many growers feel that a small quantity of complete fertilizer assists in establishing stands when it is placed under the seed. Experience in the desert areas indicate that very little benefit, if any, can be attributed to nitrogen or potassium in the fertilizer. If nitrogen is used, the application rate should not exceed 15 to 20 pounds per acre.

If weeds do become a severe competitive problem in new seedling stands, timely application of herbicides when the weeds are small will insure establishment. Many growers feel that mowing or shredding the weeds just above the young alfalfa plants will temporarily stunt the weeds and give the alfalfa a chance to compete. The use of chemicals will insure a weed free first cutting that should receive a premium price more than enough to pay for the application of the chemical.

Cultural control in established stands. Weak alfalfa plants brought on by compaction, disease, moisture stress immediately after cutting, irrigation when there is no cover from regrowth, and early cutting which depletes root reserves, reduces vigor and slows regrowth, all contribute to poor weed control in established stands. Stand loss from Phytophthora root rot and other diseases that kill alfalfa allow weeds to replace dead alfalfa plants and reduce quality. Most of the weed problems in established stands can be solved with proper management without excessive use of chemicals. Poor irrigation practices and improper cutting schedules together probably account for most of our weed problems. After three years of cutting at the schedules indicated, nearly half of the forage harvested in a 21 and 25 day schedules were weeds, only 8 percent in the 29 day schedule, and none in the 33 or 37 day cutting interval. Improper timing of irrigation can also bring infestations of watergrass in the summer months. Most watergrass establishes when alfalfa is stressed immediately before or during harvest and water is applied immediately after bales are removed when there is no regrowth to cover and shade the ground. Adjustment of the irrigation schedule to provide water closer to the cutting date and allow alfalfa plants to continue growth during the harvest period will minimize weed infestation. When such dry periods are combined with early cutting in the bud stage, the vigor of the alfalfa plants is reduced so much that they cannot compete against weed invasions.

Fall and winter grazing, can aggravate weed problems. If done in such a way as to minimize the time animals are on any particular piece of ground so a single rapid grazing similar to a cutting is done, alfalfa vigor is maintained and the competitiveness of the alfalfa plants in the winter and spring allow weed free alfalfa to develop. Never graze repeatedly, or continuously, or before there is at least 10 to 12 inches of regrowth.

### Summary

Alfalfa producers in the desert areas of the southwest can obtain higher yields than are now usually obtained on most soils. Those who are producing 9 to 12 tons per acre are those willing to invest management time, apply available technology, and reorganize and

change the important factors that limit alfalfa yield. The single most important management factor to be carefully watched by producers is their irrigation practices. Irrigation affects so many other parts of the alfalfa production scheme that its neglect can either reduce yield severely by failing to maintain a optimum soil moisture environment for continuous growth, or through overirrigation, cause diseases that reduce alfalfa stands very rapidly to the point of becoming unprofitable. More awareness of the need to prepare an irrigation system properly, constant attention to damaging insect infestations, potentially disastrous disease buildups that can be altered by changing irrigation schedules, more attention to stage of development of the alfalfa in relation to harvest schedules and general overall vigor, more knowledge about varietal characteristics, and awareness of the fertility status of your alfalfa can make the difference between success or failure, profitability or unprofitably, and the satisfaction that comes from knowing you have developed the best possible alfalfa production system available.

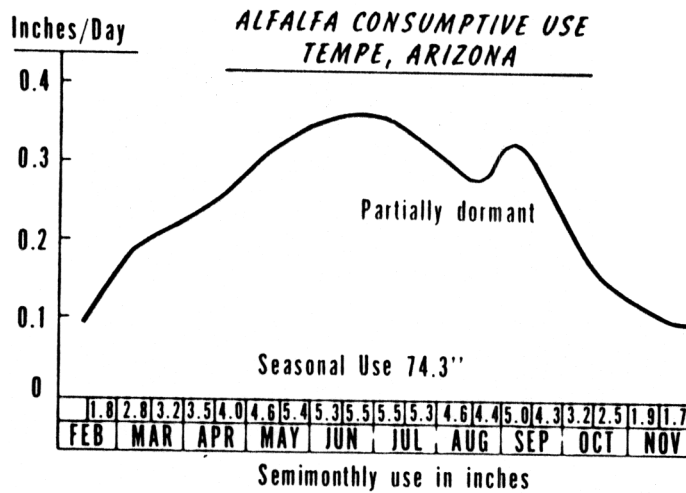


Figure 1. Daily and monthly water use at Tempe, Arizona.



Figure 2. Variety trial at Imperial Valley Field Station showing scald damage and the survival of UC Salton when irrigated in August.

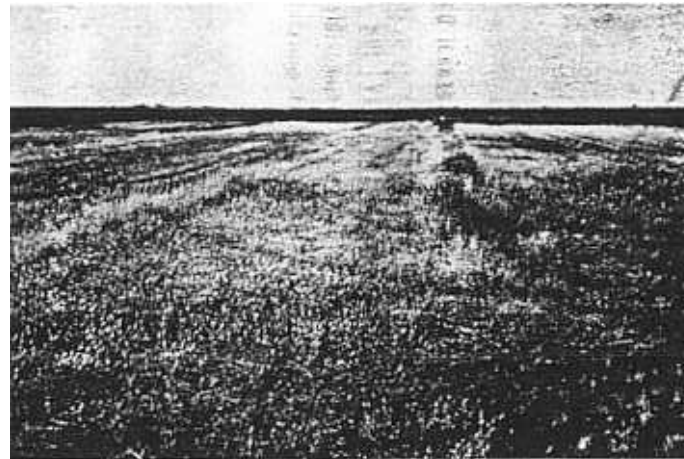


Figure 3. These stands were killed by scald from standing water after irrigation. A drain installed across the bottom of the field could prevent this damage.

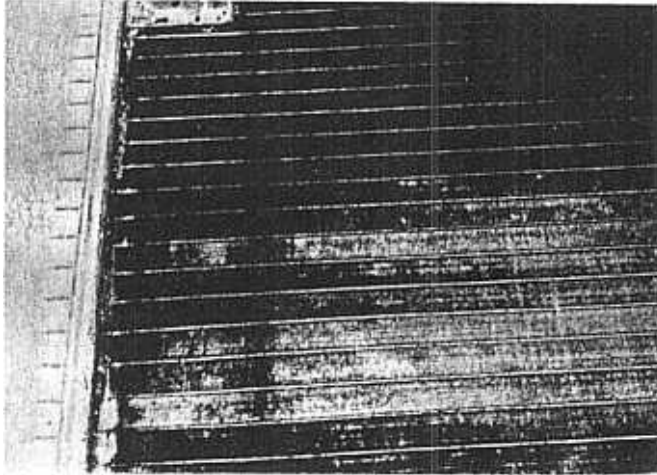


Figure 4. Scald occurred in this low spot and killed one-third of field. Note levees with 2-3 foot without alfalfa, further reducing yield by 10 percent.

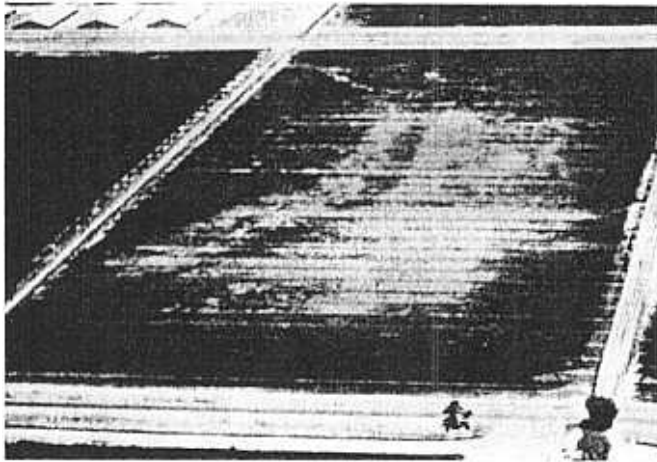


Figure 5. Failure to amend and leach this salty-alkali spot has reduced alfalfa yield from this field by at least 60 percent.