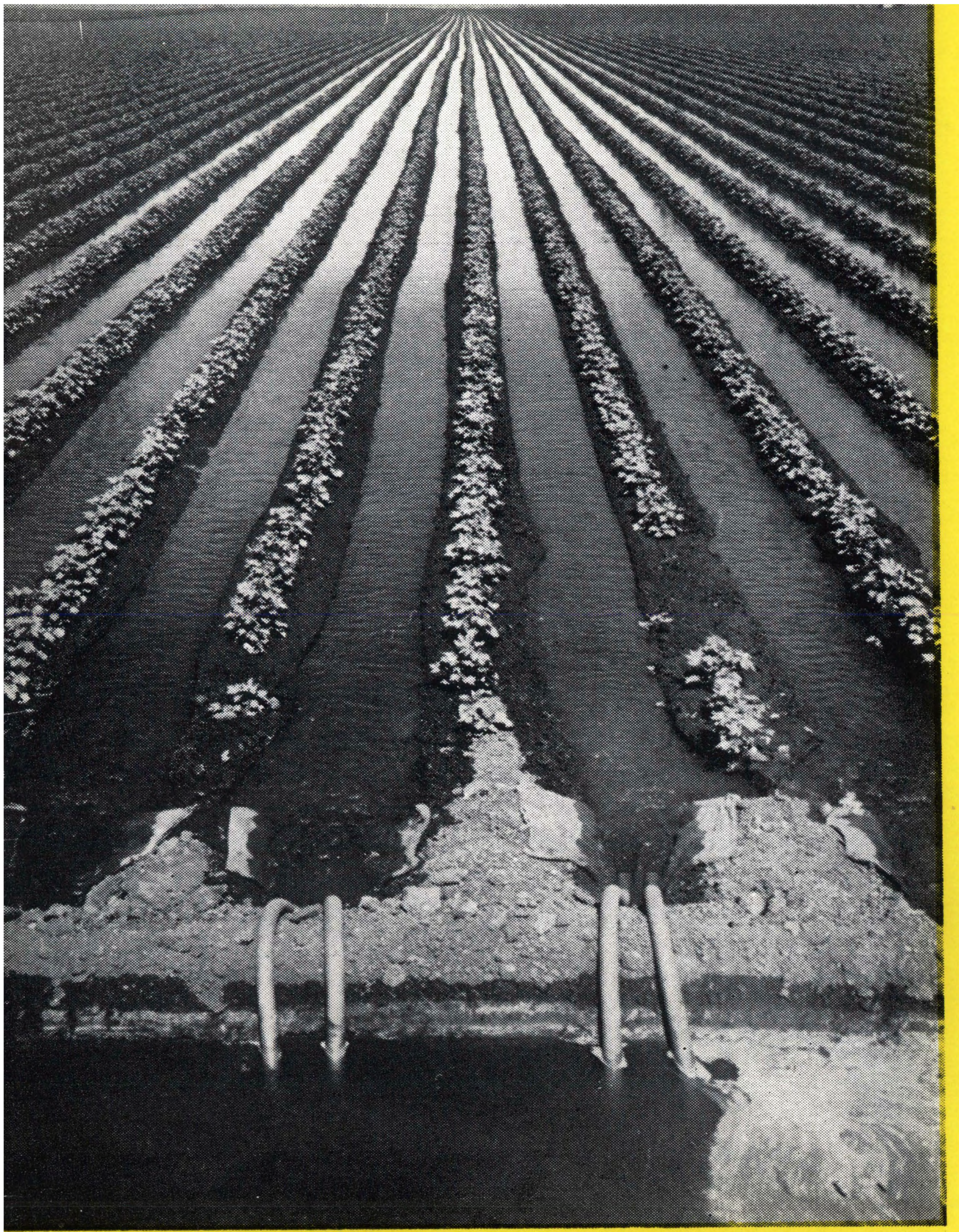

- ALFALFA
- COTTON
- PEANUTS
- SORGHUMS
- CORN
- WHEAT

OKLAHOMA STATE UNIVERSITY
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CROP IRRIGATION in Oklahoma

CONTENTS

CROP IRRIGATION IN OKLAHOMA

By Wesley Chaffin, Robert Duffin, Gaylord Hanes and Elmo Baumann*

The rapid development of irrigation is one of the most notable advancements in Oklahoma agriculture in recent years. More than 300,000 acres are now under irrigation, and the acreage is steadily increasing each year.

There are extensive underground water supplies, particularly in the western part of the state. Water from lakes and streams is also available in some areas.

Irrigation reduces drought hazards and tends to stabilize crop production. It increases income potential, but likewise increases production costs. Successful irrigation farming requires efficient management. The operator must be willing to acquire and apply sound information as determined by research and practical experience. An adequate and well designed irrigation system is essential, but even the best system cannot assure success if other production factors are not duly considered.

It is the purpose of this circular to present basic information which can be used as a guide in the successful development of irrigation farming.

LAND PREPARATION

Regardless of whether surface or sprinkler irrigation is used, some land preparation is usually necessary for more uniform application of water, and to provide adequate drainage. An experienced irrigation engineer can determine the best method of preparing the land and give an estimate of the cost.

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Surface methods of irrigation require more careful land preparation than the sprinkler method; however, some land preparation is usually desirable with sprinkler irrigation.

Uniform water application is easier on nearly level land. Even the minor high and low spots need to be smoothed out with some type of land plane.

The surface of crop land that was most uniform under natural conditions has been disturbed by ridges and dead furrows resulting from the use of one-way types of disc and moldboard plows. Little is gained by preparing a smooth, uniform surface if one-way types of plows are later used to destroy it.

For best results, land should be prepared with a uniform slope of 1 to 3 inches per hundred feet in the direction of water flow, and with little or no side slope.

Irrespective of the method of irrigation chosen, good drainage is is essential and should be provided in the original plans for land leveling.

For best results, land should be prepared with a slope of 1 to 3 inches per 100 feet in direction of flow.

IRRIGATION PRACTICES

General Irrigation Rules

When seed is germinating and the seedling plants are becoming established, an adequate level of available soil mositure is needed near the surface.

The rate at which water is removed from the soil will rapidly increase with larger plants, higher temperatures, greater wind velocity, lower humidity, and longer days.

The time to apply water and amount of water to apply will vary with the moisture holding capacity of the soil and the root zone area of the particular crop.

Plants of any crop will need about the same amount of water, regardless of depth or texture of the soil.

Generally speaking, a given soil has a fixed capacity to take in and hold moisture.

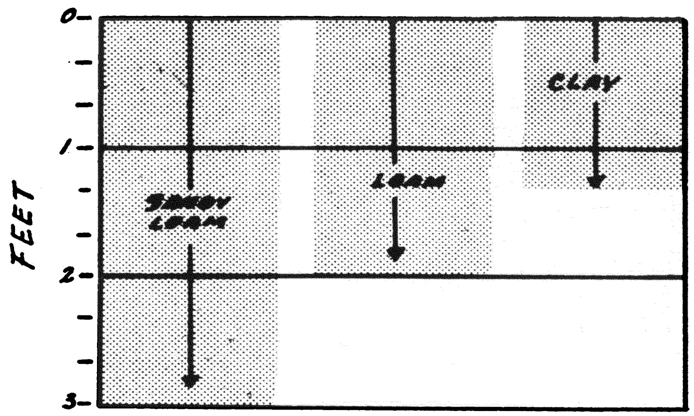
If pre-season irrigation is necessary, do it before planting—not during germination and early growth.

The most common tendency of the new irrigator is to apply water too late. Check the soil moisture level at various depths by using a spade and soil auger. Apply water to meet plant needs—not by the calendar.

Influence of the Soil

The soil is the greatest single factor in determining when to irrigate and how much water to apply on a particular crop. Soil may be considered a reservoir capable of holding a certain amount of moisture available for plant use.

Soil texture, structure, and depth affect moisture intake rates and available storage, and thus help determine the irrigation practices which should be followed. When these soil characteristics are known on a particular farm, they can be a helpful guide in determining good irrigation practice.



Soil is a reservoir, capable of holding various amounts of water, depending on the type of soil.

A 3-inch application of water will wet different textured soils to the depths shown.

Sandy soils take water rapidly but hold very little of it. Water wastage and plant nutrient leaching will frequently occur in irrigating sandy soils. These soils require more frequent and lighter water applications than fine textured soils. Thus, they are better adapted to sprinkler irrigation.

Moisture Holding Capacity of Soils

Soil Texture	Available Water Per Foot Depth of Soil Range Inches	Available Water Per Foot Depth of Soil Average Inches	Inches Water Required to Wet Soil One Foot in Depth Average Inches
Sandy	0.5-1.1	0.75	0.5
Sandy Loam	0.6-2.0	1.30	1.0
Loam and Silt Loam	1.0-2.5	2.00	1.5
Clay Loam and Clay	0.7-3.6	2.00	2.0

Medium textured (loam) soils present the least difficulty in good irrigation water management. They take water more slowly than sandy soils and hold a larger amount of it available to plants.

Fine textured (clay) soils often present a difficulty in obtaining the desired penetration. Compared to sands, heavy clay soils store relatively large amounts of water, but slow penetration rates often make it difficult to take full advantage of the higher storage capacity.

When to Irrigate

There is no precise method of determining exactly when to irrigate; however, the soil "feel" test and crop appearance can serve as practical guides. It is important that irrigation be started early enough to water the entire acreage before crops suffer from moisture deficiency. The table below contains the basic information necessary in making the "feel" test. A spade and soil auger can be used in obtaining soil samples from various depths to determine when to irrigate and how much water to apply.

Guide for Estimating Plant Available Moisture in Soils

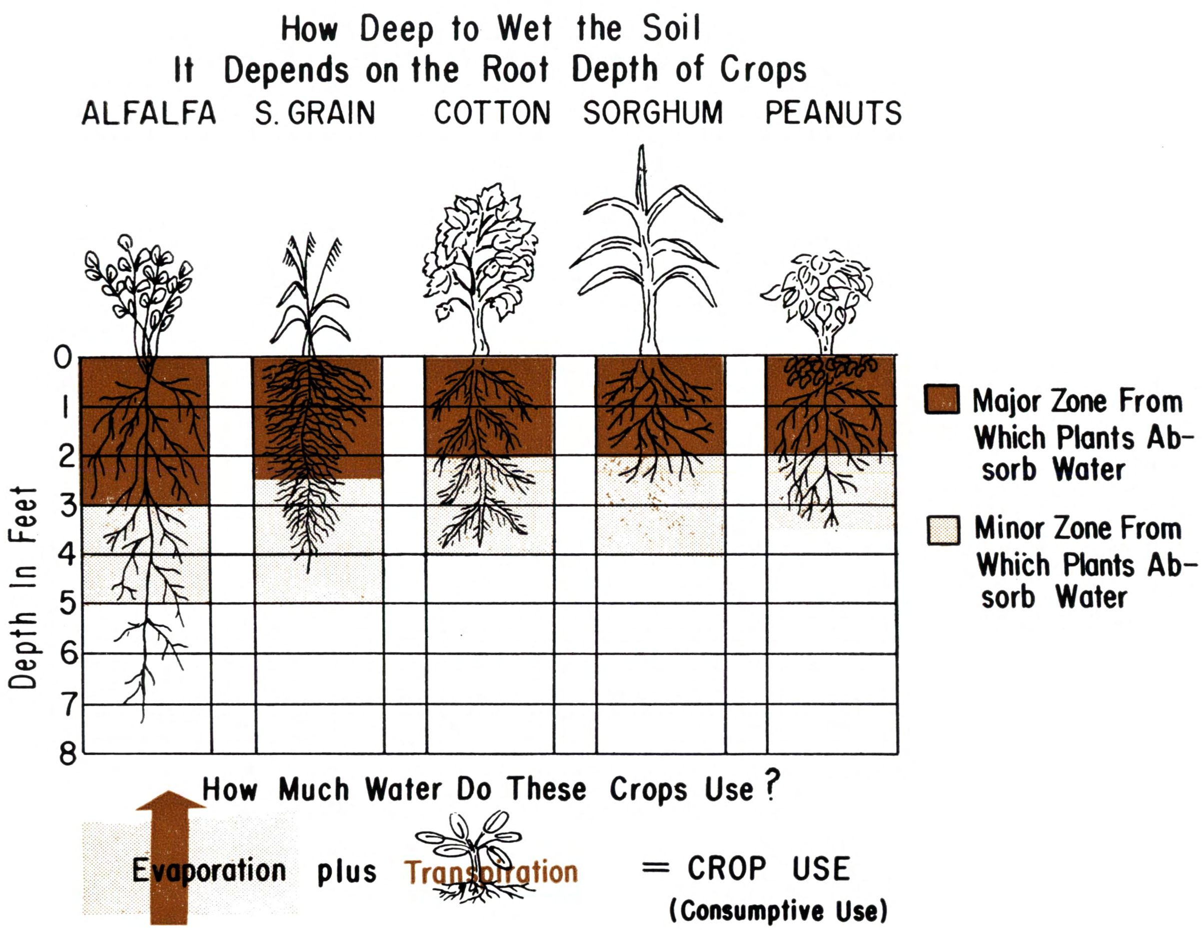
Range of moisture in soils	Feel or appearance of soils with varying moisture		
Percent*	COARSE TEXTURE (Sandy loams and loamy sands)	MEDIUM TEXTURE (Silts, silt loams, loams and very fine sandy loams)	FINE TEXTURE (Silty clay and clay loams)
0-25	Dry, loose, flows through fingers.	Crumbles easily, tends to hold together from hand pressure.	Crumbles readily, will hold together but "balls" with difficulty and breaks easily.
25-50	Looks dry, will not hold together from pressure.	Somewhat crumbly, will hold together in hand with pressure.	Does not crumble, forms readily. Will "ball" with pressure.
50-75	Will form loose ball under pressure, will not hold together with handling.	Forms "ball" readily. Will "slick" slightly with pressure.	Forms "ball" readily. Will "ribbon" out between thumb and forefinger. Somewhat slick feeling.
75-100	Forms weak ball, breaks easily, will not "slick."	Forms "ball" easily, fairly pliable, "slicks" readily.	Easily "ribbons" out. Has "slick" feeling.
100-field capacity	No free water appears on soil when squeezed, but wet outline of ball is left on hand. Soil will stick to thumb when rolled between thumb and forefinger.		

*Percent of plant available water in the soil.

The Root Zone

Rooting habits of different crops vary greatly, but the crops under consideration (cotton, sorghum, peanuts, alfalfa) will, on most soils, take approximately 70 percent of their required moisture from the upper two feet of soil depth. The following chart gives the approximate effective root zone depths for different crops in a deep, permeable soil:

Crop	Effective Root Zone Depths	Crop	Effective Root Zone Depths
Alfalfa	6 feet	Sorghum	3-4 feet
Cotton	3-4 feet	Peanuts	3 feet



When applying water according to the root zone of a particular crop, the penetration should be checked during and after the water application. This can be done by using a soil probe (1½-inch rod with rounded end and T-handle).

Quality of Irrigation Water

The kinds and quantities of salts present in water affect its situability for irrigation use, crops irrigated, and irrigation practices. To determine the quality of water and whether it is safe to use for irrigation purposes, a good water analysis is necessary.[1] The analysis should include: (1) sodium content and ratio of sodium to calcium and magnesium; (2) electrical conductivity of the water; (3) total concentration of soluble salts[2]; (4) amount of carbonates and chlorides; (5) approximation of the sulfates; and (6) the presence of elements, such as boron in toxic concentrations.

The use of poor quality water for irrigation usually results in salt accumulations in the soil. Excessive quantities of soluble salts in the soil profile may seriously affect crop production by inhibiting or reducing seed germination and preventing plants from obtaining adequate water and nutrients for normal growth. An excess of sodium salts will adversely affect the physical condition of soils, reducing water intake and air circulation. Such soils are puddled when wet and crusted when dry.

Water quality evaluated in relation to soil characteristics (texture, depth, permeability, and salt content), ground water level, and the salt tolerance of crops to be grown, will determine to a large extent the feasibility of irrigation development and the design of the system to be used. Management practices, including cropping systems and fertilization, are also influenced by water quality.

CROPPING SYSTEMS

The use of soil management practices to maintain a favorable physical condition for moisture penetration, aeration, and root development is an essential part of successful irrigation farming.

In medium and fine textured soils, a granular or "crumb" structure is desirable. This permits more rapid infiltration of water into the soil, increases the amount of water available for plant use, and promotes internal drainage. It also permits air circulation in the soil which is essential for normal plant growth. The addition of organic material will improve the water-holding capacity of sandy soils and thus increase the efficiency of irrigation water.

[1] For information on where a water analysis can be obtained, contact your county agent.

[2] This can be approximated by calculation from electrical conductivity.

SOIL MANAGEMENT AND FERTILIZATION

The use of legumes solely as a means of maintaining soil nitrogen may not be practical. However, when legumes or legume-grass mixtures fit into the cropping system, they provide an excellent means of maintaining or improving soil structure, increasing water penetration and providing a more favorable environment for efficient irrigation.

The legume most commonly grown on irrigated land is alfalfa. A combination of alfalfa and bromegrass is used on many farms. Other legumes, such as sweet clover and winter peas, are likewise suitable for this purpose. Rye-vetch mixtures are excellent for sandy soils. Each grower should select the legume or legume-grass mixture best suited to his soil and crop conditions and which will give highest returns from the land.

Fertilizers

Irrigation alone will not insure high crop yields. Even under dry land conditions many soils are too low in natural fertility to produce maximum yields. On irrigated land where adequate moisture is available, the need for plant nutrients is greatly increased.

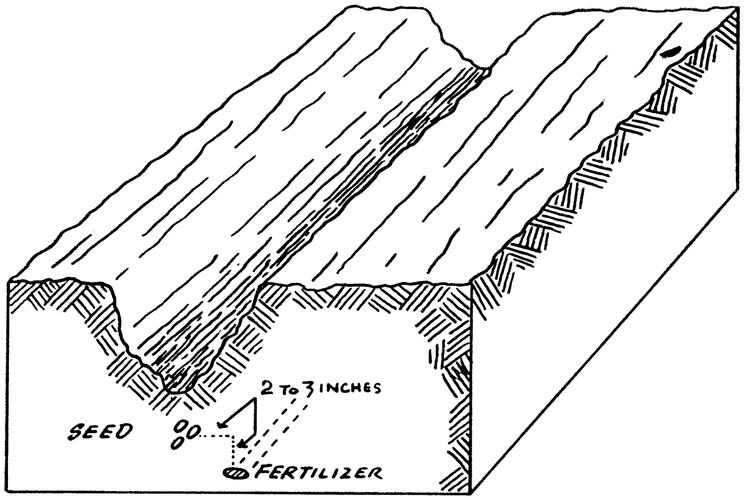
High yields of crops remove large quantities of plant nutrients which must be replaced if yields are to be maintained at a satisfactory level.

Of the 16 elements necessary for plant growth, nitrogen, phosphorus and potassium are most often lacking in soils. Fertilizers are intended to supplement the limited soil supply of any or all of these elements in order to produce maximum crop yields under the existing environmental conditions. Adequate fertilization may also help maintain soil structure by producing larger quantities of plant residues which, if left on the land, will maintain organic matter.

Fertilizer Placement

All fertilizer elements do not act the same in the soil. Nitrate nitrogen is easily soluble and moves freely with soil water, but there is very little movement of phosphorus in the soil. Potash moves rather easily with soil water until it combines with the clay, after which there is no further movement except as it is absorbed by plant roots or replaced by other elements.

Fertilizers containing nitrogen or potash may cause injury to



Best fertilizer placement is 2 to 3 inches below and to one side of seed.

germination if applied at high rates and in direct contact with the seed. The crop to be planted and the kind and amount of fertilizer to be used will help determine the placement for best results.

Alfalfa—It is advisable to work the major portion of the phosphorus and potash into the surface soil during seedbed preparation. A complete fertilizer can then be banded one or two inches below the seed at planting time as a starter for the young plants.

Maintenance applications of phosphate and potash may be applied on established stands of alfalfa during the winter. The fertilizer can be drilled one or two inches deep, or broadcasted and worked into the soil with a springtooth harrow or a regular alfalfa renovator.

Cotton—The best placement of fertilizer for cotton is in continuous bands, two to three inches to one side, and two to three inches below the level of the seed. Avoid placing the fertilizer in direct contact with seed, or less than six inches deep if directly below the seed.

Side-dressing applications of nitrogen should be placed in bands within 12 inches of the rows when the cotton is in the early square stage. Anhydrous and acqua ammonia can be applied before planting or as a side-dressing if the soil contains sufficient moisture and clay to adsorb the ammonia.

Peanuts—At low rates of application, the fertilizer for peanuts can be placed in bands, three inches to one side and two or three inches below the level of the seed.

When high rates of applications are used, two-thirds of the fertilizer can be worked into the soil and the remaining one-third placed below and to the side of the seed at planting time.

The best method is to apply the peanut fertilizer with a cover crop in the fall, to be turned under three or four weeks before peanut planting time. Limited research indicates portions of the fertilizer applied to the peanut crop may well be placed 6 to 8 inches directly below the seed.

Sorghums—Starter fertilizers for sorghums should be placed in bands three to four inches on one side of the row and two to four inches below the seed level at planting time.

Nitrogen side-dressings can be made after the sorghums are up to a stand and before the plants are 10 inches high. Placement is about the same as for cotton.

Wheat—Phosphate and potash fertilizers, when used, can be drilled with the wheat at planting time. Nitrogen can be applied before planting, at the time of planting, or as a top-dressing after planting. Top dressings of nitrogen fertilizer may be applied anytime during late fall, winter or early spring. For best results, spring applications of nitrogen should be made before wheat begins jointing.

Corn—When high rates of starter fertilizer are used for corn, one-half of the application should be plowed down during seedbed preparation.

The remaining portion can be applied in bands, two or three inches to the side and two to four inches below the level of the seed at planting time.

Additional nitrogen, needed for high yields, should be applied as a side-dressing after the corn is up to a good stand and before the plants are more than 18 inches high. An attachment on the second shank of the cultivator can be used to place the fertilizer 10 to 12 inches to the side of the rows and two to three inches deep.

PRODUCTION PRACTICES FOR FIELD CROPS

Alfalfa

The Oklahoma Common, Buffalo and Cody varieties of alfalfa are recommended in Oklahoma.

Seedbed preparation for irrigated alfalfa is the same as for dry land conditions. On irrigated land, the usual rate of seeding is 18 to 20 pounds per acre.

Alfalfa has a higher water requirement than any other crop grown in Oklahoma.

When irrigating alfalfa, an adequate supply of available moisture must be maintained in the upper 2 to 3 feet of soil, if maximum yields are to be expected. Alfalfa is a deep rooted crop and if subsoil moisture is maintained below the 2- to 3-foot level, this will enable the plants to better withstand the stress of dry periods when available water must be used for other crops.

Both field experience and research show that without rainfall, two applications of water between clippings will usually result in the most economical return. The water should penetrate the soil to a depth of at least 3 to 4 feet. In establishing new stands of alfalfa, more frequent and lighter applications are necessary.

For maximum alfalfa seed production, soil moisture should be kept at a somewhat lower level than for hay production. When the second crop is saved for seed, irrigation following the first mowing is desirable to carry the plants into the peak of flowering in good condition. On deep, medium to fine-textured soils, one 5- to 6-inch application is usually needed to make a good seed crop.

Cotton

Several varieties of cotton have proved satisfactory for lint production in Oklahoma. Among these, there is considerable variation in plant type and storm resistance. For this reason, the method of harvest is of prime importance in selecting a variety to grow on irrigated land.

If the plan is to use a mechanical picker, Stoneville 62, Deltapine 15, and Paymaster 54 are desirable varieties. Acala 44 is also adapted to the mechanical picker. This variety is showing considerable promise for irrigation in the state.

If mechanical strippers are to be used for the last harvest operation, varieties possessing storm resistance are preferred. Varieties of this type that have performed best in Oklahoma are Lankart 57, Lankart 611, Parrott, Lockett No. 1, and Western Stormproof.

Close spacing of plants—two or three plants per foot—is desirable for machine harvesting. With wider spacing, yields are usually about the same, but plants are larger and have more branches; this lowers the efficiency of machine harvesters.

The new plateau profile seedbed for cotton has many advantages. It provides a firm soil in which to place the seed; it conserves moisture for quick germination and rapid early growth; it gives some protection against washing of soil and surface crusting, often caused by hard,

Cotton is Oklahoma's Number 1 irrigated crop. The variety you select to grow should be suited to the harvest method you plan to use.

dashing rains. This method of planting has been very dependable in giving good stands from the first planting, thus eliminating the expense of replanting and the delay in getting a stand established.

A specially designed planter is used to plant the seed and form the seedbed profile. Several equipment companies now have this type of planter available. Some standard type planters can be adapted for the new method of planting by making certain modifications.

Satisfactory land preparation consists of flat-breaking, or listing and dragging down the ridges to form a relatively smooth surface.

A hollow, rubber-tired press wheel, available as an attachment for most planters, can be used to press the seed into firm, moist soil. This is more desirable than pressing the soil over the seed. Fish tail drags are then used to cover the seed with loose soil.

The first irrigation after planting should be applied as soon as most of the readily available moisture is exhausted but before plants show any sign of moisture stress. Research has shown that cotton plants making rapid growth before blooming begins, will out-yield those making slow growth during this period due to inadequate moisture.

Cotton planted on sandy soils will need the first application of water after planting earlier than cotton planted on fine-textured soils. Quite often the pre-irrigation on a deep, medium textured soil may supply adequate moisture up to the blooming period.

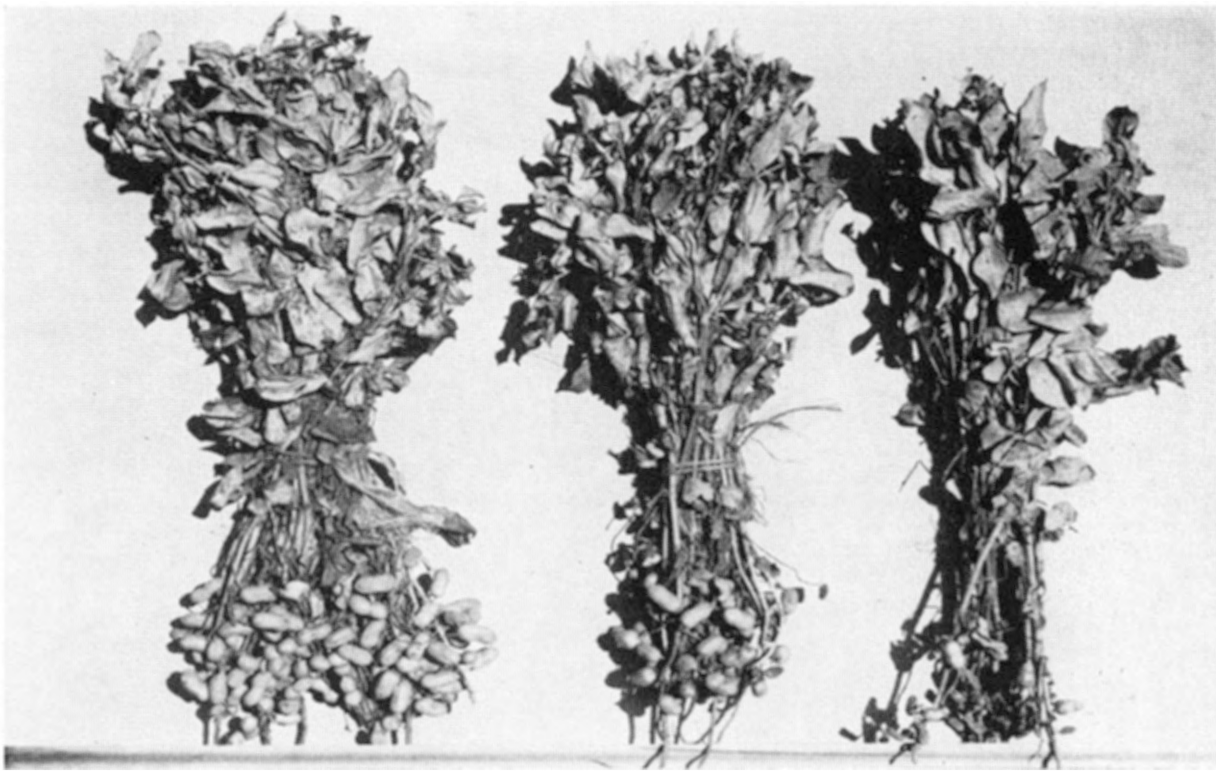
The cotton plant consumes more water in the early blooming and boll development stages than at any other time. During this critical growth period, water applications must be timed so that the plants will have a constantly available supply of moisture. Yields are often greatly reduced by delayed irrigation during this time.

A continued high level of soil moisture tends to encourage vegetative growth at the expense of boll set. Consequently, it is a good practice to time water applications with a view of allowing available soil moisture to reach a slightly lower level during the late fruiting period.

Peanuts

Peanuts grown commercially in Oklahoma are of the white Spanish type. The recommended varieties are Argentine, Dixie Spanish, and Spantex.

Planting in rows approximately 28 inches apart and adjusting



Peanuts on left, irrigated to supply high water level (9%) yielded 2,121 lbs. per acre; center sample with medium water level (5%) yielded 892 lbs.; right, no irrigation yielded only 215 lbs. per acre.

the planter to drop four or five seeds per foot of row is recommended. This will require 60 to 70 pounds of seed per acre and, under favorable conditions, will provide a plant population of 100,000 to 110,000 plants per acre.

Research studies indicate that planting on a clean, level seedbed will give better results than deep furrow planting.

The total water requirement of peanuts is about 25 inches. Considering the benefit from average effective rainfall, 13 to 16 inches of irrigation water will usually be needed. If soil moisture is adequate at planting time, the first irrigation can be delayed until the plants start blooming. Available moisture is needed during the critical period of blooming and nut development.

Because of the sandy textured soils on which they are normally grown and the medium depth rooting habit of the plants, peanuts require more frequent irrigation than most crops. Applications of approximately 3 to 3½ inches of water are needed at 7- to 11-day intervals in late July through August. The best time for the last application will generally be about September 15; however, this may vary slightly, depending on the soil and weather conditions. Applications made too late will result in immature nuts and excessive moisture at harvest time.

Sorghums

The recommended grain sorghum hybrids are suitable for growing on irrigated land in their respective areas of adaptation.

The varieties of grain sorghums recommended for growing under irrigation are Redlan, Kafir 44-14, and Hegari.[3] In the west central and southwestern areas, Plainsman Milo also may be grown. In the Panhandle, if planting is delayed until after June 10, an early variety such as Westland or Martin should be used.

Where irrigated grain sorghums are planted in rows of standard width, the recommended rate of planting is 6 to 8 pounds of seed per acre. If a larger plant population is desired, this can be accomplished by planting in rows spaced 14 to 21 inches apart, using 8 to 10 pounds of seed per acre.

[3] On irrigated land, standard or regular Hegari may grow too tall for combine harvesting, particularly if planted in wide rows.

Irrigation boosted forage sorghum yield from 4.4 to 34.4 tons per acre.

Grain sorghum responds to irrigation, uses less water than alfalfa or cotton.

The forage varieties of sorghums for irrigation are Sugar Drip, Atlas, and Sumac 1712. Under adequate moisture conditions, Sugar Drip is potentially the highest yielding variety. It has stronger stalks and is less likely to lodge than other varieties. Sugar Drip is late maturing and should be planted early. If later planting is necessary, Atlas or Sumac 1712 is preferable.

Forage sorghums on irrigated land should be planted at the rate of 8 to 10 pounds of seed per acre. When the crop is drilled for hay, 30 to 40 pounds of seed per acre will be required for best results.

Sorghum yields, like those of other crops, are increased by maintaining available moisture during the entire growing season. However, research shows that the yield is not materially reduced if the plants are allowed to wilt one or two days before each irrigation. The late boot through soft dough stage is the most critical time and the plants need adequate moisture during this period.

Where crops of higher value are being grown and there is a shortage of water, grain sorghum can be irrigated in a limited way.

Good irrigation practice calls for both surface and subsoil moisture to be at an adequate level at planting time.

Corn

Adapted, late maturing hybrids have generally produced the highest yields of corn on irrigated land.[4]

A full stand of plants is essential for high yields. When adequate water is available for irrigation, it is advisable to drop the kernels 8 to 10 inches apart in the row to provide an average of 16,000 to 18,000 plants per acre.

It is important to check the planter for accuracy in handling the particular size and shape of kernels to be planted. A good method is to set the dropping mechanism for the desired rate of planting and then drive the tractor a short distance, letting the kernels fall on the surface of the ground. Make adjustments, if necessary, to secure the desired spacing in the rows.

Research in Oklahoma has shown that corn has a slightly higher total water requirement than grain sorghum. If corn shows signs of

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[4] Recommended corn hybrids are listed in Ext. Service Leaflet No. 3, *Higher Corn Yields,* and Ext. Cir. No. 643, *Crop Varieties for Oklahoma.*

drouth, yield possibilities are reduced. It is important that both the surface and subsoil be well supplied with moisture at planting time. Generally, however, rainfall is adequate at this time.

Adapted, late maturing hybrids have generally produced the highest yields of corn on irrigated land in Oklahoma. Soil should be well supplied with water at planting.

Corn has its highest moisture requirement during the critical period extending from just before tasseling through the silking stage. If high yields are to be expected, one water application will likely be necessary during later stages of growth also. Corn continues to use water until it is well dented; consequently, the soil should furnish some available moisture until that time.

Wheat

With adequate moisture, wheat tends to grow tall, and the danger of lodging is increased. Consequently, strength of straw is very important in selecting varieties for planting on irrigated land. Of the varieties recommended in Oklahoma, Comanche, Kaw, Ponca, and Triumph seem to have the best straw, particularly under conditions of abundant moisture.

Seedbed preparation for wheat on irrigated land is about the same as for dry land conditions. A firm, weed-free seedbed is essential.

A seeding rate of 45 to 50 pounds per acre is adequate, if clean seed of good germination is used.

In preparing for irrigation, surface corrugations with proper equipment can be made after the wheat is seeded. If the land is listed before seeding, a monitor or a harrow can be used to smooth the tops of the ridges and at least partially fill the lister furrows for more uniform drilling of the wheat.

Wheat normally has a light irrigation requirement in Oklahoma, since the crop makes most of its growth during the months which have the highest average rainfall. Wheat is not grown extensively with irrigation, because other crops are generally more profitable. Moisture, however, is often a limiting factor at seeding time and some growers irrigate wheat to assure early growth for fall and early winter grazing.

When surface and subsoil moisture is low at seeding time, preplanting irrigation is a better practice than seeding in dry soil and then following with a water application during germination and early growth. Harmful effects of crusting and poor aeration usually result from the latter practice.

Pre-planting irrigation should be early enough to allow the soil to become sufficiently dry for completing seedbed preparation before planting time. Yields will be greatly reduced if moisture is not available during the critical period extending from early booting to the soft dough stage. Wheat uses about 0.3 inches per day during this period. Water applications past the soft dough stage are generally detrimental, since they will adversely affect both yield and grain quality.

If wheat is used as a companion crop for alfalfa or some other legume, the moisture needs of the legume should determine the time and frequency of water applications.

Irrigation practices for oats and barley are about the same as for wheat.

Soybeans

In preliminary tests, irrigation of soybeans has been somewhat less profitable than it has with some other crops. However, irrigation of soybeans is regarded as a good practice when water is available and not needed for more profitable crops such as peanuts, cotton and alfalfa. Irrigation is often planned to include both corn and soybeans since the two crops normally need supplemental water at different periods.

There will usually be adequate moisture from rainfall for soybeans during the early part of the growing period. If plants are not wilting, it seems to make little difference in grain yield whether irrigation is started when the soybeans are in bloom or delayed until the early seed-setting period. Irrigation should be continued throughout the remainder of the growing season, with applications timed to provide adequate soil moisture and to avoid wilting of the soybean plants.

FOR FURTHER INFORMATION

On related subjects, ask your County Agent for these publications:

E478—Sorghums for Grain and Forage

E497—Alfalfa Queen of Forage Crops

E659—Growing Wheat in Oklahoma

E552—Castor Bean Production

E560—Improved Tillage Practices for Better Farming

E566—Your Soil: Know What It Needs

E625—Liming Soils for Better Farming

E620—Crops for Silage

E635—Know Your Fertilizers

E582—Control of Weeds in Oklahoma

E410—Peanuts

E638—Our Soil and Its Care

E613—Methods of Applying Fertilizers

E472—Vetch for Soil Improvement

E615—Seed Treatment for Plant Disease Control

E668—Bindweed Control in Oklahoma

Leaflet No. 8—Control of Weeds on Irrigated Land

Leaflet No. 5—Soybeans

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