Principles of Irrigation for

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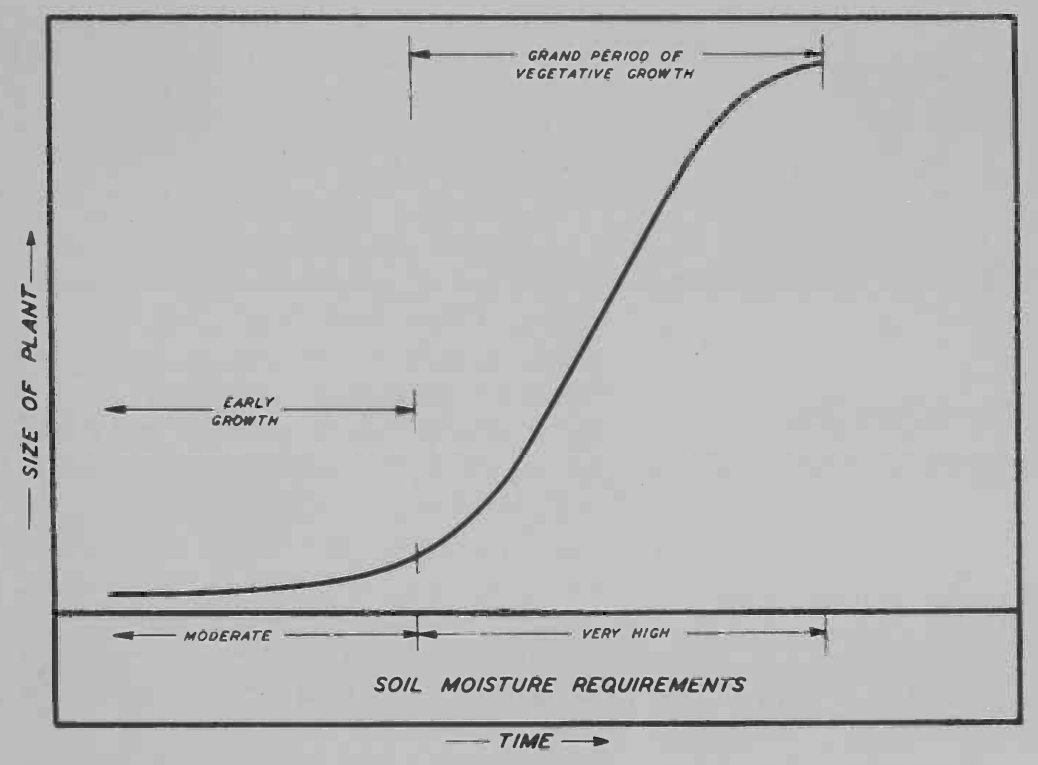

Figure 1. Diagram illustrating growth periods and soil moisture requirements for maximum vegetative yields.

The objective in all cultural practices is to bring about conditions most favorable for maximum yields. To accomplish this desired end, the farmer must adjust his cultural practices to the specific plant under consideration.

There are two distinct types of yields. First, the vegetative, unfruitful type illustrated by agricultural crops such as alfalfa and lettuce with yields being measured in the volume of plant growth. Second, the reproductive or fruiting type such as cotton, tomatoes, and small grains with yields being measured in terms of the amount of seeds or fruits produced.

Irrigation for Maximum VEGETATIVE Responses

To best understand vegetative production one must visualize the usual sequence of changes in the life cycle of an annual plant. A plant's life cycle consists of seed germination, vegetative growth, senescence (old age), and death. If one is interested in vegetative production, he must accentuate the vegetative growth period by preventing or delaying as long as possible the transition from the vegetative growth period to the subsequent period of flowering and fruiting. (Compare figures 1 and 2.)

There are many factors which influence vegetative growth in plants. The result of altering any one or more of these becomes most interesting and important when dealing with crops which respond markedly to such controlled environmental changes.

Cotton or tomato plants are excellent examples of this group. Either of these crops can easily be thrown into a vegetative unfruitful condition at the expense of the normal fruiting condition for which they are grown. On the other hand, alfalfa may be kept in a vegetative condition at the expense of fruiting merely by the proper manipulation of applied water.

Of the many factors, soil moisture—irrigation water—is one of the easiest and most effective methods to regulate in altering the course of growth. Beyond the period of more or less universal irrigation treatment for all crops, those crops intended for vegetative purposes should continue to have a high moisture level as contrasted with the decrease to a moderate level for fruiting plants. In vegetative production it is imperative that the plants never be allowed to suffer for need of water.

This does not infer, however, that such plants should receive excessive amounts of water. Excessive watering will reduce water intake due to lack of soil aeration.

A reduced root system of shallow penetration regardless of cause, makes maximum vegetative growth next to impossible. Under such conditions, the plant is incapable of taking advantage of deep moisture when the demand for water is greatest. Further, because of this limited root system, these plants are unable to take up enough water to meet the needs for rapid vegetative growth and rapid transpiration loss (water loss through the leaves) associated with later growth periods.

To provide the optimum condition or fruiting parts, it is necessary to know all plants and individual plant parts—low a universal pattern. At first the gr increases and becomes very rapid to p riod of Growth." After the maximum ra creases and finally stops.

With vegetative plants the growth of Growth" is of primary consideratio seed formation after the maximum gro portance. At this time the plant has a ing carbohydrates to supply the fruiting

Many factors such as temperature, l processes, but under Arizona conditions be controlled by the farmer.

To obtain maximum production fro vigorous strong plant must be insured and extensive root system. This requi by the root system of the plant be moi should wet the entire potential root zon

Subsequent irrigations depend upon soil temperature at this period freque seeds and young, slowly growing plant

Irrigations during this formativ temperatures as well as to supply regardless of cause, the plants will suf

It is toward the conclusion of th normal "Grand Period of Growth" ind cated on the accompanying graphs tha the irrigation requirements differ mar edly for the vegetative and reproducti cycles. During the entire "Grand Perio of Growth" and up to harvest time, is essential to provide the most favor able conditions possible for vegetati growth and to minimize fruiting tende cies. Therefore, during the period whe water is being reduced for good fruit ing, irrigation application should co tinue at its established high level f vegetative development. Allowing plant to wilt, even temporarily, will re duce vegetative growth.

In the matter of manufactured food rapid growth must be maintained to pre vent an accumulation of carbohydrate which is so essential in flower and fru formation and development. When th plants are kept in a vigorous growin condition, the manufactured carboh drates will be used to further root shoot development thus reducing the chances of the reproductive part of the cycle from being initiated.

laximum Production

Department of Horticulture

maximum yields of either vegetative growth habits of the plant. Growth in stems, leaves, flowers, and fruits—folrate is very slow. It then gradually e an interval known as the "Grand Pegrowth is attained, it gradually de-

the early part of the "Grand Period With fruiting plants the blossoming and rate is attained is of paramount ime number of leaves which are produc-ons.

and soil fertility influence these growth moisture is the chief factor which can

h vegetative and fruiting plants, a o this it is necessary to develop a large at the entire soil mass to be occupied herefore, irrigations at planting time

pecific requirements of the plant. The s the critical factor. The germinating ost instances require warm moist soil, be used to create favorable soil If a limited root system is developed, internal water shortage causing them

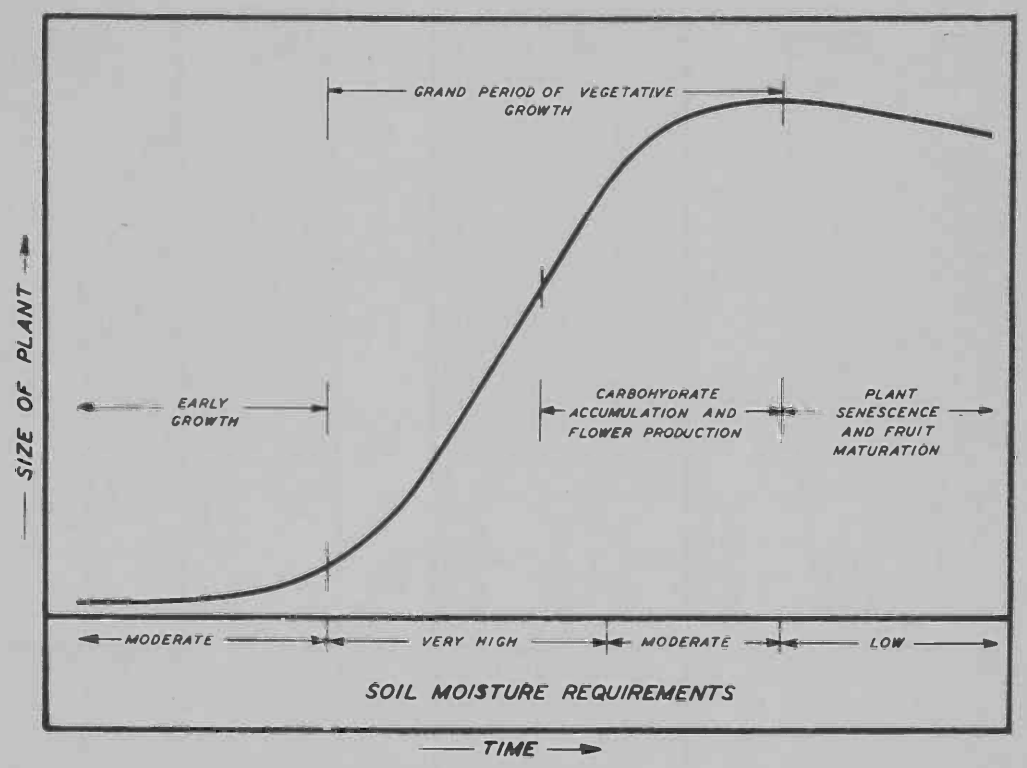

Figure 2. Diagram illustrating growth periods and soil moisture requirements for maximum fruiting yields.

to wilt and resulting in an accumulation of carbohydrates.

These principles can be illustrated by specific examples of successful field practices. When temperatures are critically high lettuce seeds are germinated by frequent though not excessive irrigations which reduce the temperature of the seed bed. Conversely, water is withheld from young, slowly growing cotton plants during cool spring weather because it chills the soil and checks growth. Cotton and alfalfa production has been shown to be closely related to the amount of water present in the subsoil.

After the young plant is established and the 'Grand Period of Growth" is initiated, irrigation practices must then be adjusted to insure either a vegetative or fruiting type of growth.

rigation for Maximum FRUITING Responses

Fundamental soil moisture requirents at different periods during the life cle of a fruiting plant are illustrated Figure 2.

With the onset of the "Grand Period Growth," according to the natural aracteristics of the plant, it is essenl to provide the most favorable conions for rapid growth. Accordingly, igations should be light and frequent h the object of maintaining free and dily available water throughout the tire soil area occupied by the roots.

With most plants under Arizona condins ample subsoil moisture is easily intained. The upper foot of soil, ere the major part of the feeder roots ually occur, however, frequently benes too dry for maximum water abption. With row crops, irrigation of ernate rows at one-half the usual inval for the plant in question may be to provide more uniform soil moisewith the same amount of water.

After the maximum rate of growth has n attained and the period of gradual reduction in rate begins, the need for large amounts of readily available water is over. The large vegetative leaves are now producing more carbohydrates than are required by the growing points so that reserve materials, such as starches, accumulate in the plant.

Unless environmental conditions are adverse, flower formation is initiated and vegetative growth is naturally retarded. At this time slight moisture stresses, not severe enough to produce serious wilting, cause an additional check to vegetative growth and promote the accumulation of carbohydrates and the formation of additional blossoms.

Irrigations should be less frequent. The value of a deep root system with ample subsoil moisture becomes evident at this time. As the surface soil drys, roots in this zone cannot obtain water, so less is supplied to the plant. When deep root development has occurred and moisture is present in the subsoils, sufficient water is obtained by the deep roots to allow the leaves to efficiently manufacture food for the developing fruit. At the same time insufficient water is present to stimulate vegetative development.

During the final stage of fruiting and plant senescence, the leaves are old and little water is used, so the soil may be allowed to become very dry without interfering with yields.

These basic principles are well illustrated with the cotton plant. If adequate water is not provided at the onset of the "Grand Period of Growth" the entire cycle is delayed with a consequent reduction in yield. Failure to maintain adequate water after the "Grand Period of Growth" has started interrupts growth and may induce premature blossoming. When ample soil moisture is again supplied, rapid vegetative growth occurs, squares fail to form, and a large, overdeveloped, vegetative, low producing plant is formed.

Accumulation of carbohydrates during moderate stress periods is utilized by grape growers to hasten the maturity of the fruit. As the fruit approaches maximum size, irrigations are withheld, vegetative growth is retarded, and more sugar accumulates in the maturing berries.