RELATION OF WEATHER CONDITIONS TO GROWTH AND DEVELOPMENT OF COTTON.

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GENERAL REMARKS.

The peculiar adaptability of the climate of the South to the production of cotton, the great clothing staple of the world, has made this the “money crop” of those States lying within what is known as the Cotton Belt of the United States. This belt includes the States of North and South Carolina, Georgia, Alabama, Mississippi, Louisiana, Arkansas, and Texas, and portions of Tennessee, Florida, Virginia, and Oklahoma. In the present study of the subject the last four States have been left out of consideration, since the output from each is relatively small and data from the sections of those States devoted to the cultivation of cotton are difficult to obtain.

Cotton, though a sensitive plant, is of all summer-growing crops of the South about the least affected by ordinary changes in the weather. Its long period of growth, fruiting, and maturity affords it ample opportunity to recover from a number of temporary setbacks. During the protracted season from planting in April to the completion of its harvest in November it is exposed to many varieties of weather, and it seems to endure the bad as well as enjoy the good. Such a thing as “half a crop” is unknown. Statistics show that the crop is seldom curtailed by more than one-fourth or one-third.

It being a well-established fact that the temperature and the amount and distribution of rainfall are vital factors in the growth and maturity of all crops, a careful study of these elements in conjunction with the average yield of cotton per acre for each year since 1893 has been made, and the following results deduced as to the weather conditions most favorable for the growth and development of this important crop.

INFLUENCE OF MOISTURE IN DEVELOPMENT OF COTTON.

During April, the month of planting, there should be frequent but comparatively light showers to keep the soil in good moist condition, favorable for germination. Should the soil become heavily charged
with moisture while the seeds are in the stage of transformation just prior to germination, decay will result; on the other hand, should the ground become dry and baked, the seeds will not obtain the required nourishment to start growth and but few plants will come up. If the nights are cold, even though the moisture element is just right, germination and growth are seriously retarded. Long experience has taught the planter not to put the seed in until the soil has become warmed by the spring sun, when the warm days far outnumber the cool ones. While temperature and precipitation are each prominent factors in the growth of all plant life, the latter seems to be the stronger influence in the development of the cotton plant. Well-distributed showers during the spring months serve to keep the soil in a condition well suited for the best development of the young plant and to cause the roots to sink deep into the earth, thus enabling the plant to maintain itself against the dry periods of the following summer. A very wet spring causes the development of a large number of surface roots to the sacrifice of those roots which naturally tend downward, and the droughty conditions which prevail frequently during the summer soon cause the plant to wilt and shed its foliage and fruit, since the dry surface soil does not furnish sufficient nourishment for its growth. The following extract on the importance of moisture in the life of the plant is taken from Johnson's "How crops feed:"

Let us suppose dew or rain to have saturated the ground with moisture for some depth. On the recurrence of a dry atmosphere with sunshine and wind, the surface of the soil rapidly dries; but as each particle of water escapes (by evaporation) into the atmosphere, its place is supplied (by capillarity) from the stores below. The ascending water brings along with it the soluble matters of the soil, and thus the roots of the plants are situated in a stream of their appropriate food. The movement proceeds in this way so long as the surface is drier than the deeper soil. When, by rain or otherwise, the surface is saturated there is no longer any ascent of water; on the contrary, the water, by its own weight, penetrates the soil, and if the underlying ground be not saturated with moisture (as can happen where the subterranean fountains yield a meager supply) then capillarity will aid gravity in its downward distribution. * * * It is easy to see how, in good soil, capillarity thus acts in keeping the roots of plants constantly immersed in a stream of water or moisture that is now ascending, now descending, but never at rest, and how the food of the plant is thus made to circulate around the organs fitted for absorbing it. The same causes that maintain this perpetual supply of water and food for the plant are also efficacious in constantly preparing new supplies of food. * * * The more extensive and rapid the circulation of water in the soil, the more matters will be rendered soluble in a given time; and, other things being equal, the less will the soil be dependent upon manures to keep up its fertility.
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INFLUENCE OF SUNSHINE ON YIELD OF CROP.

The charts for April and May (figs. 1 and 2) reveal the fact that both months are comparatively dry, the normal precipitation of neither being as much as 4 inches—just sufficient moisture to nourish the plant to healthy growth without an abnormal development. A small amount

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**Fig. 1.**—Comparison of precipitation during April and yield of cotton for the years 1893-1903, and normal precipitation and yield.

**Fig. 2.**—Comparison of precipitation during May and yields of cotton for the years 1893-1903, and normal precipitation and yield.
of rain during May enables the farmer to clean out the weeds, and at
the same time promotes a healthy, but not too rapid, growth of the
cotton plant. This plant is a great lover of warm sunshine, needing
during its entire life plenty of warm, sunny days and warm nights.
It is said to thrive best in a climate where the rays of the sun strike
the earth almost vertically.

The time required for the full development of cotton is about seven
months from the time the seed is placed in the ground to the time the
staple is ready for the gin. This period should have a large percent-
age of sunshine and be free from damaging frosts. The growing period
of cotton is from about the 1st of June to the middle of August. The
blooms, as a rule, begin to appear early in June and the first bolls form
about the first decade in August. During June and part of July
there should be plenty of sunshine, interspersed with only sufficient
rain to furnish nourishment to the plant without causing a rapid multi-
plication of surface roots or a too rapid development of the stalk and
limbs to the detriment of the bloom and fruit. The air should be
rather dry, since a large percentage of the moisture needed is sup-
plied by the heavy deposits of dew at this season.

If the first three months have been favorable, the plant can stand
considerable rain during the latter part of July and the first half of
August; and, if there is plenty of warm sunshine during the last half
of August and much of September, the staple will mature rapidly and
a large yield will result. This is shown very plainly on the chart
(fig. 7), where the rainfall for both July and August is much in excess
of normal, but the records show that the rains were followed by pro-
tracted warm periods of sunshine. It was under the conditions pre-
vailing during the year 1898 that the largest yield of cotton in the
history of the South was produced, up to the close of the period
covered by this article.

During the blooming period it is best that there should be no more
than the normal amount of rain—about ten rainy days per month—
since too much rain is likely to cause decay of the fruit and shedding.
The bloom of the cotton plant opens during the early morning and
remains open to the sun until late in the afternoon; the petals then
close until the next morning, when they open again. The color of this
flower undergoes a change from a delicate ecru to light red, and when
the petals fall off a small boll is left. It is at this stage that very lit-
tle rain and plenty of sunshine are required. Continuous cloudiness
at this stage is very nearly as disastrous as constant rains.

The normal conditions of temperature and rainfall throughout the
cotton belt are, as a rule, most favorable for the proper development
of this delicate plant. April and May, with less than 4 inches of rain
each, cause the tap root to sink deep into the soil, so that sufficient
moisture is brought up from below to satisfy the demands of the plant
later in the season, when the weather is dry and sunshine prevails. The temperature during June and July (figs. 3 and 4) is also a very important factor, averaging about 78° for the former month and 80° for the latter. There is a marked uniformity in the average temperature among all the States in the cotton belt.
August (fig. 5) may be considered a most important period in the life of the cotton plant. About the first week in this month the bolls begin opening. From the first bloom to the first boll is a period of about

seven weeks. The plant continues growing and blooming until the new growth is killed by frost, but it does not bloom so luxuriantly as earlier in the season, since much of its vitality is needed to carry the bolls
already formed to maturity. During this period of its life an abundance of light, well-distributed showers and warm sunshine is needed. If too much rain falls, the results are peculiarly disastrous; the weed will begin to grow rapidly, to the detriment of the fruit; the plant will cease to make new blooms and the squares already formed will drop; the bolls will decay on account of the accumulated moisture which they absorb; the fiber in the open bolls will be either beaten out or discolored.

September and October are the months for picking, and, of course, dry weather is needed. Only sufficient moisture is then required to nourish the growing bolls and opening flowers, and much of this can be secured through the roots, provided the weather early in the season has been such as to cause the roots to penetrate deep into the soil. Under normal conditions the rainfall is very light during the months of September (fig. 6) and October throughout the major portion of the cotton belt, affording fine opportunity for securing the matured crop.

WEATHER CONDITIONS THROUGHOUT THE COTTON BELT.

YEAR OF GREATEST YIELD.

Figure 7 shows the yield of cotton for 1898—the year of greatest yield—together with the rainfall for each month during the season.

From this chart it will be seen that April had just about the normal amount of rain, while May was a dry month, its rainfall being 1.1 inches less than the normal. June had just about the normal amount, and it was well distributed throughout the month. July had more
than the average amount, as had also both August and September; but, coming after the plant had gotten a good start and was well worked, and being accompanied by a goodly number of sunshiny days, this proved rather a benefit to the crop. A summary of the conditions is as follows: During the first decade of April it was rather cool, freezing temperatures occurring in the northern portions of the belt and damaging frosts down to central Florida. Cotton made very little growth during the month, but the roots seemed to penetrate deep into the soil. May was particularly favorable for a rapid development of the plant. Rains were just sufficient to furnish the required amount of moisture and not to interfere with the thorough cultivation and cleaning of the fields. During June cotton made steady growth under the most favorable conditions. There was about the normal amount of rain, with just normal temperature. Considerable rain fell early in July, causing a rapid growth of the stalk, but these conditions changed before the 10th, and the dry weather following afforded ample opportunity to kill out the grass and weeds. Abundant sunshine gave renewed energy to the plant. Excessive rains early in August caused considerable apprehension among the planters, but more favorable conditions prevailed during the latter part of the month and most of September, and the result was the largest yield ever recorded.

YEAR  OF  SMALLEST  YIELD.

Figure 8 shows the relation between the precipitation and the yield per acre in 1901, the year of smallest output. The rainfall curve for April shows that it was a very wet month, nearly 1 inch more than
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The average. In addition to this the temperature was abnormally low, averaging 5° below normal. Preparation for planting was delayed on account of the chilled condition of the soil. May was somewhat cooler than normal, with the rainfall over an inch above the average. Cotton that was planted made very slow growth; the fields could not be worked and became overrun with grass and weeds. The early part of June was wet, interrupting work and growth; the last half of the month was more favorable, with plenty of warm sunshine, but it was not until late in the month that the work of cleaning the fields was completed. July had about the normal amount of rain, but it came in the form of heavy downpours, followed by excessive heat, causing rapid shedding, rust, and bloom at the top. August had about normal temperature, but more than 2 inches above the normal rainfall. The accumulated excess of rainfall caused cotton to grow too much to weed, and the stalk was watery and unhealthy and the bolls failed to mature. Contrary to the rule, September was a cool, wet month, interrupting the ripening and gathering of the staple. On the whole there was a decided excess in rainfall and a deficiency of sunshine. From April to September there was a total excess of 7 inches in precipitation and a deficiency in temperature of 5°.

SUMMARIES FOR COTTON SEASONS.

The year 1893 gave a normal yield of 0.39 bale per acre. The weather during April was most favorable; its temperature averaged only 3° above normal, while the precipitation was just about the seasonal average. May was favorable as to temperature, but there was rather too much rain, about 2.5 inches in excess of the average; this rendered the soil too wet for cultivation and the fields became foul. The same was true as to most of June, while July had over an inch less than its normal amount of rain. The plant grew rapidly during May and June. Work was rushed and the fields were freed from grass early in July, and the abundant sunshine caused a rapid development of the bolls. August had more than the average amount of precipitation, but it was so distributed and interspersed with warm sunshine as to prove rather beneficial. Picking was interrupted many times by rain during September, but killing frosts did not occur until late and an average crop was harvested.

The year 1894 yielded more than the normal per acre, and, as is revealed by the charts, was a comparatively favorable season. April was warm, with about the usual amount of rain. May and June followed with less than the average. During these three months cotton developed rapidly and was in a condition to be benefited by the generous rains which came during July and August. September gave about the usual amount of sunshine and rain.

With the exception of 1901, 1895 gave the smallest yield per acre;
April was favorable, with about normal weather conditions, but from May to August, inclusive, the rainfall was far in excess of the normal, while the number of sunshiny days was small; as a consequence it was impossible to keep the fields free from weeds and grass, and the plant made too rank growth.

Another poor year was 1896, the yield being 0.02 bale less than the average. This shortage was evidently due to the accumulated deficiency in rainfall throughout the entire season, April being the only month with precipitation equaling the normal. The damage from lack of moisture was supplemented by excessive sunshine and abnormally high temperature. The growth of the plant was stunted early in its life and never recovered.

The yield for 1897 was practically the same as that for 1898, and the weather conditions during these two years were very similar, except that the amount of rain during the latter was somewhat greater.

A normal crop was produced in 1899. The temperature averaged slightly above normal, and the rainfall somewhat below each month. The dry weather during April and May gave the plant such a start that it was enabled to withstand the drought later in the season. Its roots were forced down into the soil, from which moisture was secured during July and August.

The crop of 1900 was slightly below that of the preceding year. The heavy rainfall and low temperatures during much of April retarded planting until late. May had about the usual amount of rain, followed by what may be termed a wet June and July. August was drier than usual, with an average temperature and plenty of sunshine.

In 1902 the yield was 0.03 bale per acre more than normal. April and May were about normal both as regards temperature and rainfall. June, July, and August followed with deficiencies in precipitation, but the rains were fairly well distributed.

The year 1903 was only fairly favorable. Too much rain during May interrupted work at a critical period. There was about an average during each of the remaining months, but unevenly distributed. The crop became very grassy in many sections early in the season, and could not be properly worked and cleaned in time to make a full crop.