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Analyses of Agricultural Yield. Part I. The Spacing Experiment with Egyptian Cotton, 1912

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III. *Analyses of Agricultural Yield.* Part I.—*The Spacing Experiment with Egyptian Cotton*, 1912.

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General Introduction.

The aim of the investigations here entered upon is statistical analysis of the yield of agricultural crops in terms of the stages of the plant's development. When the yield is a fruit, then precedent stages determining the yield must be the flower and, before this, the development of flowering branches. In such a case, for full analysis of the final yield, careful records of these stages must first be taken all through the development season of the crop. The senior author has elaborated, during experiments on cotton in Egypt, the procedure for carrying out such analysis and the points to be attended to.

Armed with this method of analysis the effects of environmental conditions on the development of the crop can be satisfactorily distinguished. The chief factors of environment capable of control in field work are—the space allowed to each plant, the date of sowing, the supply of water, of manures, and the choice of the year in which the crop is grown.

The present series deals in three parts with the effects of spacing, sowing-time and season, on Egyptian cotton grown at Giza in Egypt.

Consequent upon such analysis the experiments have a secondary object, which is to appreciate the reasons underlying the conventional practices of agriculture, and possibly to improve these practices.

An indirect result of such experiments is the accumulation of precise data which are subsequently of value in providing constants for studying special cases and new problems.

The numerical data in the Appendices of this account may, at first sight, appear unduly large in comparison with the length of the text. The reason for this disparity is that conjectures as to accidental disturbing factors, which would necessarily form a large part of the discussion of any less complete set of experiments, are here almost entirely eliminated by the extent of the data. The records are, in fact, so complete as to be easily understood. Fully to realise the technical significance of this point would require citation of many contradictory statements from authorities on the agriculture of cotton, which statements, being based largely on subjectivity and on plot experiments of low precision, would serve for us no other useful purpose.

The presentation of these Appendices is further necessitated in that these analyses are the result of new and formerly unpublished methods, which are being extensively adopted in Egypt, and will before long be used in other parts of the world. The methods are subject to many sources of error, which can only be avoided when fully understood, and this understanding can only be attained by study of the actual original data.

Material.

The choice of Egyptian cotton as the material for these experiments was due solely to circumstance. The methods employed are essentially applicable to any other plant, provided that suitable modifications are introduced.

The cotton crop is peculiarly suitable in some respects, having a prolonged fruiting season, so that the yield is steadily built up, fruit by fruit, in an obvious way. The nearest parallel in English crops is provided by the tomato. In other respects cotton has marked disadvantages, and we were of opinion, before these experiments were conducted, that the analysis of yield in a cotton field would be more difficult than with a cereal crop.

The plants of Egyptian cotton are sown in March or April; the seed is sown on ridges from 60 to 80 cm. apart, and the clumps of seedlings are thinned out when well established, leaving two in each "hole" where seed had been sown; the plants grow to a height of 1 or 2 metres, and the flowers are carried on lateral sympodia arising either from the main stem or from lateral monopodia. Flowering begins in June and July according to district; the opening of the capsules, or "bolls," begins about 50 days later, and should continue until mid-November. Late in the season the fields are dotted with three-lobed flocks of pale brown or white cotton hanging from the open capsules. This "seed-cotton" is picked by hand, usually in three instalments, or "pickings," and is sent to factories, where the hairs of "lint" are stripped from the seed by the "ginning" machinery, and compressed into bales. The lint and seed are both exported, excepting for such seed as is held back for sowing; the lint constitutes about one-third of the seed-cotton by weight, and about five-sixths by value. The export of cotton provides about four-fifths of the income of modern Egypt.

The crop is, of course, grown entirely under irrigation.

Methods of Yield Analysis.

The methods employed may be grouped under the headings of sampling, arrangement of the variables to be studied, daily collection of data for constructing the life-history under each variation of the environment, together with computation and the graphic presentation of results.

Sampling.—The areas of land employed were sub-divided into plots not larger than 80 square metres each. Five or more plots of any one kind of spacing, etc., were scattered over the area. The actual observations were restricted to a group of plants demarcated in some convenient way in the centre of each plot; in the spacing experiment these plants had to be so chosen as to eliminate those which were being affected by abnormal causes; otherwise, the group is taken at random. The number of plants in each group should be about 150, so as to reduce the probable error caused by individual fluctuation from plant to plant, and by constitutional differences due to varietal impurity. The use of pure strains for such work would eliminate the latter source of error. Such groups are usually termed "Observation rows" in Egypt and the Sudan, where they are now being employed extensively for research on cotton. The average plant of an observation row is thus a fair sample of its plot, while the average of all five sets of rows from one kind of plot is a fair sample of the area, soil variations having been largely eliminated by the scatter of small plots.

Other considerations with regard to sampling, such as the recognition of real differences from one day to another, are discussed later.

Arrangement of the Variables investigated.—The variable whose effects were studied in each experiment was modified in as many steps as was possible. Thus the spacings employed were ten in number, ranging from 0·12 to 2·75 square metres per plant, and the sowing-time ran weekly from mid-February to mid-April. In this way each statistical number obtained had its place in at least two series, firstly in the time-series which makes the life-history of the average plant, and secondly in the series of variables for all the average plants.

The arrangement of series in this way permits of the plotting of curves, with consequent increased insight into the meaning of results. To determine the effect of a variable at three intensities only may produce the impression of a simple relation, expressible graphically by a straight line joining three points, whereas a fuller record may show the real relation to be more complex, as in the curve for total yield with various spacings (fig. 9, p. 179).

Daily Collection of Data.—For similar reasons to those just mentioned, all data with regard to the life-history of each group of plants, and consequently of the average plant under each condition, were taken daily wherever it was possible to do so. These continuous records of growth, flowering, fruiting, etc., form the distinctive feature of these experiments, and they will therefore be treated separately under the designations by which they are now commonly known in Egypt, *e.g.* the flowering-curve.

The original data for flowering,* on which this method of plant-development curves was built up, were taken personally by the senior author. A native gardener, subsequently headman of the native staff when the Giza Laboratory was founded, next took a share in the recording, and—in conjunction with the junior author—ultimately trained a staff of Plant Observers, who were recruited for their general intelligence from the ordinary Fellaheen; the only formal education required from these men was the ability to write numerals, preferably Roman as well as Arabic. They were seven in number in 1913, but the taking of the records embodied in these experiments formed only a small part of their duties. Their numerical records were made on filing-cards or in notebooks, and transferred daily to a card file in the laboratory by the headman.

Check counts were taken for safety's sake by the headman, and less frequently by the authors, but any flagrant error could be detected by the computer when plotting the daily averages, through the abnormal run of a curve. Such inexactitudes were very rare, and we are both indebted to our Plant Observers for the excellent work which they performed at the wage of ordinary labour, and at the cost of some trouble on our part in devising suitable methods for them. This experiment in organisation lasted two years, and was so completely successful that it deserves careful consideration.

Computations were made by the senior author until 1913, when a computing clerk was trained, and with his assistance it became practicable to bring figures up to date each day instead of allowing them to accumulate until the end of the season. They were, therefore, promptly plotted on wall diagrams, enabling us by noon of each day to see at a glance the exact condition of any series of plots.

A valuable means for avoiding any falsification is the labelling of all plots with serial numbers only, thus preventing bias in the observers' minds and restricting them to observation only.

Plant-development Curves (fig. 1, *et seq.*).

These methods of determining and presenting the life-history of a crop in the form of curves showing the daily behaviour of an average plant, were slowly developed by the authors from the first determination of flowering data in 1906. The experiments here described from observations made by our native plant observers in 1912

* 'Khed. Agric. Soc. Year Book,' 1909, p. 44, &c.

and 1913 were, in one sense, intended to be a demonstration of the capabilities of these methods for analytical purposes, and were also arranged so as to investigate the possible errors of the methods under the stringent test of application to field work.

Growth-curve.—The curve showing the daily rate of growth of the central axis is obtained, when required, by direct measurement with dividing compasses, or by a water-level. A better method is to fix a peg, with a notched top, in the ground by the side of each plant observed, and to measure the height of the axil of the youngest leaf to the nearest half-centimetre, by resting the end of a scale in the notch. Observations can thus be taken rapidly with unskilled labour, and the error of each separate measurement is smoothed out by the large number of plants which can be observed.

All data for plotting in the growth-curve are worked out to "millimetres growth per plant per day," or "mm.p.p.p.d."

The chief interest of this daily record was originally physiological, but in 1912 we found a direct connection between it and the flowering-curve, which will be discussed under the effect of season. For the moment it is sufficient to mention that the growth of the main stem and of the flowering branches are closely correlated during the early part of the season, so that the growth-curve may be used as an index to the rate at which the "scaffolding" of flowering branches is being laid down.

Flowering-curve.—This curve represents the rate of flowering, *i.e.* the number of flowers opening day by day throughout the season. The flower only remains open for a single day, so that counting is relatively simple. The observed data are computed in terms of the average plant and plotted as "flowers per plant per day," or "flowers p.p.p.d." The data from the experiments on spacing and sowing-time have been smoothed to weekly means in the Appendices to save space.

There are certain errors to which these determinations of flowering are subject. (*a*) Errors due to soil variation are partly eliminated by the scatter of plots, but a large number of plots or rows are required to avoid them completely. (*b*) Errors due to plant-to-plant fluctuation (or to constitutional differences between the plants of one commercial variety) may be reduced by increasing the number of plants observed; the probable error of the total number of flowers actually produced during a season by a single plant is about ± 30 per cent., so that a family of 100 plants is needed to give a reasonably accurate figure for total production; a further increase is required to obtain equal accuracy in the daily production, but since this increase begins to involve errors from soil variation, the proper size of group to observe is about 150 plants. (*c*) The third source of error is the daily change in rate of flowering, which is common to large areas, and would appear to be shown on some days at least by all the fields in Egypt, whatever their previous history; discussion of this will also be postponed till the account of seasonal effects, but for the moment it should be noted that a true flower-curve can only be obtained by counting the flowers every day; if one day or another is taken at random, the probable error of the deviation from the true mean rate is about $\pm$ 9 per cent. through this cause alone.

These three errors are illustrated in the appended table (p. 110), which is drawn from the data for nine pairs of rows of a commercial variety of cotton.

The rate at which the flowers open, on which the form of the flowering-curve depends, is really determined in the first instance by the rate at which the flower-buds were differentiated, as we shall show later; this rate is only slightly modified—in the Egyptian cotton crop—by subsequent environmental changes, excepting when these changes provoke bud-shedding. In this case, the bud having fallen off, the flower is not present when its turn comes to open.

Consequently, the form of the flowering-curve within the same kind of cotton is an indirect measure of the growth and dimensions of the flowering branches. These branches are sympodia, borne laterally on a main stem or on monopodial lateral branches of the same. The first determinant is, therefore, the number of flowering branches formed acropetally along the main stem, the second is the extent to which lateral monopodia behave in the same way, like subsidiary main stems, adding their quota to the first, and the third determinant is the number of flowers which each flowering branch produces.

All three are inter-related through growth, and differentiated through local senescence.

The flowering-curve may be curtailed quite abruptly by causes which not only check the growth of the branches but also cause the buds to be shed, such as root-asphyxiation in field crop by a rise of the water-table, or a scorching wind, or a cold night. If the cause is less severe in its action, checking growth, but not causing shedding of the buds, the curve is not curtailed until all the buds have opened as flowers.

It should here be mentioned that "shedding," to a certain degree, is a normal occurrence in the field crop of Egyptian cotton. If it were possible to plot a curve for the number of flower-buds differentiated it would be of slightly greater amplitude than the flowering-curve. Similarly, the open flower appears to be peculiarly susceptible to shedding, possibly for chemical reasons connected with transpiration, so that the amplitude of the fruiting-curve, or bolling-curve, is always less than that of the flowering-curve from which it is derived.

Bolling-curve.—This curve expresses the rate of production of ripe fruits, or bolling, per plant per day, in the same way as the previous curve expresses the flowers. The data should be obtained by daily counting, or picking, of the ripe cotton from the bolls opened, but—since the completion of boll-opening is not quite sharply defined—it is usually more convenient to make the count once a week. This weekly count embodies the total of all the bolls which have opened during the week, and is thus comparable with the expression of the flowering-curve in weekly mean rates, already mentioned as being convenient.

Observation Rows of One Variety. Daily Flowering during four weeks of a Season.

Row No.	No. of plants.	Flowers opening upon :—																															
		June.			July.				Flowers p.p.p.d.	July.							Flowers p.p.p.d.	July.							Flowers p.p.p.d.	July.							Flowers p.p.p.d.
		28.	29.	30.	1.	2.	3.	4.		5.	6.	7.	8.	9.	10.	11.		12.	13.	14.	15.	16.	17.	18.		19.	20.	21.	22.	23.	24.	25.	
{ 19	33	7	9	8	12	18	23	25		11	20	29	20	14	27	31	0·658	35	35	31	23	47	44	33		35	57	32	27	34	32	26	
{ 22	34	13	12	13	14	24	26	20		16	20	36	22	31	39	37	0·845	39	42	37	40	47	56	35		39	36	34	30	41	37	26	
{ 52	22	6	12	16	14	23	19	20		13	23	24	25	21	26	39	1·110	30	45	30	38	18	40	37		43	41	38	34	37	38	31	
{ 55	30	14	17	14	18	22	15	31		18	18	20	22	17	28	44	0·795	35	40	24	40	5	29	42		34	34	41	41	35	28	37	
{ 70	23	4	5	5	6	5	6	9		5	7	7	13	7	9	13	0·379	17	14	9	17	17	22	23		11	18	19	20	24	21	18	
{ 73	23	6	5	6	11	11	6	7		7	12	11	10	8	16	16	0·497	19	27	19	16	31	27	25		17	16	18	23	14	20	26	
{ 103	22	7	6	9	13	9	16	9		13	13	17	8	8	19	27	0·714	14	15	18	8	26	20	20		23	18	17	22	26	19	21	
{ 106	23	9	11	3	14	19	19	19		20	14	24	14	17	19	26	0·832	36	37	27	15	27	34	24		35	32	34	26	23	26	27	
{ 121	32	9	6	11	8	11	13	10		17	12	12	13	11	12	20	0·433	19	25	18	11	25	21	27		17	16	25	16	12	14	18	
{ 124	30	14	12	9	14	17	16	16		14	13	14	16	11	20	26	0·542	25	32	28	29	26	30	24		35	21	22	24	22	28	21	
{ 154	34	16	12	12	20	21	29	23		17	20	24	18	18	23	46	0·688	33	46	23	20	47	31	40		29	45	28	23	27	43	33	
{ 157	31	7	4	9	14	10	7	19		9	13	18	19	16	25	21	0·515	28	34	18	27	32	31	23		34	30	34	33	37	24	30	
{ 205	31	6	14	7	12	20	24	17		18	16	13	17	24	29	31	0·683	27	49	25	40	52	34	29		36	50	40	43	30	32	27	
{ 208	28	9	5	9	8	12	9	13		10	21	13	9	14	13	22	0·520	33	28	20	20	40	23	28		32	28	28	19	27	22	18	
{ 256	26	5	10	7	13	13	11	17		16	14	18	14	11	17	26	0·637	23	21	18	30	33	25	31		23	31	23	27	32	22	34	
{ 259	25	1	10	2	6	10	7	12		10	8	7	16	6	14	15	0·435	15	19	8	14	23	18	22		25	17	21	13	24	17	18	
{ 289	23	6	6	6	11	11	11	11		9	15	16	14	11	15	22	0·635	21	18	22	13	17	15	15		15	15	11	12	10	12	11	
{ 292	20	1	9	6	9	10	4	13		8	9	15	13	9	12	16	0·464	15	21	13	12	25	15	15		8	21	13	4	17	15	12	
SUMMARY.																																	
First row of pairs	246								0·441	119	140	160	142	125	177	255	0·650								0·970								0·960
Second row of pairs	244								0·429	114	138	158	141	129	186	223	0·631								0·989								0·951

Notes.—Variety, "Domains" Afifi. Each row 10 metres long. Scattered in pairs (with two intervening rows) over an area of ½ acre. Ordinary field-crop spacing and cultivation. Grown at the Giza Cotton Station, 1913.

The purpose of this table is to illustrate the various sources of error in field experiments with cotton, using for this purpose the very delicate test of daily flower-production.

(*a*) Each pair of rows occupies almost identically the same soil. The soil-variation error is thus reduced to a minimum. The slight differences between Rows 19 and 22. are due mainly to chance, and would be further reduced if the rows included more plants, *e.g.*, 150 instead of 33.

(*b*) Rows situated in other parts of the field (although the whole area was only 45 metres square) show differences which are due to soil-variation. Compare, *e.g.*, Rows 70–73 with 103–106, the latter pair being more prolific.

(*c*) The total daily flowering given for July 5–11 shows these two errors to have been satisfactorily eliminated. A third source of error appears in the daily changes of flowering rate, *e.g.*, July 8, 9 and 10. In the weekly totals this is also eliminated.

It should, however, be remembered that these weekly expressions are not suitable for precise work, a single day being the real time-unit. Changes of considerable importance may take place in the form of these curves during a week and yet be completely masked in the weekly means.

The bolling-curve is expressed in "number of bolls per plant per day," or "bolls p.p.p.d." Multiplying the data by the number of plants on the unit area we can plot the bolling curve per unit area per day, or, in other words, the yield-curve. If the weights of the contents of the boll are known we can plot the yield-curve in terms of seed cotton. If the ratios of lint obtained in ginning from the seed cotton are similarly know we can plot the yield-curve in terms of the final product, viz., the lint itself.

By addition of the mean rates on all the days of the bolling season we can obtain the total yield, either as number of bolls, weight of seed cotton, or weight of lint per plant or per area.

By adding these rates in successive groups, according to the days on which the conventional "pickings" would have been taken, we can obtain the pickings, and can also see how much they would have been affected by variations in the date of picking.

If the mean seed weight is known we can also compute the number of seeds produced per plant or per unit area.

Other Curves.—Statistics for the weight of seed cotton per boll, yield of lint from seed cotton, and seed weight during each week of the season, were taken in the spacing experiment only. It will there be seen that these components have only a subsidiary effect on the yield-curve, but the statistics for these characteristics have been included in the spacing experiment account because, although negative in so far as the demonstration of spacing effects is concerned, they not only represent an amount of detailed examination which is rarely practicable in applied botany, but they also demonstrate the untenable nature of many conjectures made in the past; as such, they should be useful for reference.

Other records, such as the length and strength of the lint, which can also be handled in conjunction with the curves already described, were not taken systematically in connection with these experiments, nor is it necessary to include the parallel records of meteorological conditions, soil-water content, water table, etc., which were obtained concurrently with these experiments, in part or completely, for special purposes.

In the two parts which follow, the senior author is more responsible for the design of the experiments and the presentation of the results, while the junior author more particularly undertook the administration of the experimental work.

The work was conducted at the Giza Botanical Laboratory and Cotton Experiment Station, during our tenure of the posts of Botanist and Assistant Botanist to the Egyptian Government Department of Agriculture, as a side issue of our work on pure-strain supply of cotton seed. The fundamental researches, on which our methods and interpretations are constructed, were effected when we were holding similar posts under the Khedivial Agricultural Society of Egypt. To both these bodies our thanks are due for those facilities which they willingly placed at our disposal.

The numerical data were made possible of attainment by the labour of our native staff of plant observers under their headman, Mohammed Sorure. Mr. O. Weinsteiner was in charge of all computation during the later stages of the experiments.

Our thanks are especially due to Dr. F. F. Blackman, F.R.S., for his interest and trouble in the presentation of this account.

NOTE.—The interpretations placed on the data obtained in these experiments are founded on the views outlined by one of us in 'The Cotton Plant in Egypt' (Macmillan, 1912), with such extensions as subsequent research has suggested.

Concurrently with these investigations we were conducting others which were necessitated by our official task of isolating, propagating, testing, and understanding pure lines of Egyptian cotton. Data drawn from these others have been made use of here, and conversely. Of those employed may be mentioned:—"Movements of Soil-water in an Egyptian Cotton Field," 'Journ. Agric. Sci.,' 1913; "A Study of some Water Tables at Giza," 'Cairo Sci. Journ.,' 1914; "Meteorological Conditions in a Field Crop," 'Roy. Met. Soc. Journ.,' 1913; investigations unpublished or in the press, on 'The Development of Raw Cotton,' 'Precise Forecasting of the Cotton Crop,' on carbon assimilation in field conditions, the testing of pure strains for their agricultural properties with very small quantities of seed, etc.

PART I.—THE SPACING EXPERIMENT WITH EGYPTIAN COTTON, 1912.

The aims of this experiment, in addition to the purposes already described in the General Introduction, of analysing "yield," were to ascertain the space which could with advantage be allowed to each plant for the rapid multiplication of pedigree seed, and also to ascertain the reasons which underlie the local native custom of very close planting,* which causes a struggle for existence between the plants composing the field crop.

A large area was divided into rectangular plots among which were distributed the different spacings which it had been decided to study. These are stated in detail on the chart (p. 114), and a plan of the area is added to show the scatter of the spacings.

* The Fellaheen custom of close planting has been condemned by many visitors to Egypt, and by most authorities, as being inimical to good cultivation and prejudicial to the yield. It has been stated that such planting delays maturity, prevents the access of light and air among the plants, and that wide planting is the first reform which should be introduced into Egyptian cotton cultivation. Early plot experiments had given contradictory results. The authors shared this condemnatory opinion until their spacing experiment had been conducted (fig. 2, p. 172). The point is a good illustration of the enormous subjective error involved in dealings with cotton.

Limitations.

The results as they stand are necessarily true for one variety, site, and season only, in respect to the agricultural bearings of the experiment. On the other hand, the dissection of the components which make up the yield is very much fuller than anything that has been carried out before, so that predictions for other sites and seasons may be made with reasonable certainty. To enter into details with regard to such possible modifications is scarcely necessary, and it may suffice to state that the conclusions would hold good under any ordinary conditions of cultivation in any part of Egypt.*

Limiting Factors of the Environment.

These may be grouped as those which affect any well cultivated plants in the Egyptian crop at some time in their life-history, and as those special ones which are correlated with the different spacings adopted in this experiment.

General Limiting Factors.—Absorption of water by the seed-coat, itself influenced by temperature, is followed by temperature control almost exclusively from germination until the first flowers appear, excepting for the "sunshine effect." Soil temperature limits the growth of the root system in the early stages, and hence of the stem also. Growth of the stem is restricted mainly to the hours of darkness, the intense insolation of each day necessitating rapid water-loss for cooling purposes. The amount of growth of the stem at night is dependent mainly on the night temperatures, when once a sufficient root system has developed.

In the early development of the lateral branches their growth follows that of the main stem. At about the time when the first flowers are opening the growth of the main stem ceases to follow the night temperature, and the branches successively do the same. This would appear to be due to some restricting form of autotoxic effect.

Throughout the greater part of the season the plants receive a check every afternoon, the stomata closing and growth and assimilation being stopped, on account of the inability of the soil to give up as much water as the root needs.

Later in the season, when the bolls are ripening, it would seem, from evidence drawn from fluctuations in lint-length, that with very good cultivation the water supply is the principal limiting factor. If water supply is deficient senescence follows, and recovery from it may require the lapse of several weeks.

On most permeable soils in Egypt the growth is checked ultimately by the rise of the water table, which varies in date with the arrival of the Nile flood and with the locality. At the time when this happens the crop may be transpiring nearly 50 tons of water per acre per day,† and the asphyxiation of the lower roots necessarily brings

* It is of course understood that in the cooler north of the Delta, and on poor land where the plants attain only half the size they reach at Giza, the planting should be closer, as it is actually made by the Fellaheen. The Giza custom represents almost the maximum space-allowance per plant which is permissible in Egypt.

† See Hughes, F., 'Cairo Sci. Journ.,' 1914, and W. L. B., 'Journ. Agric. Sci.,' 1913.

about a severe check.* The depth of the root system at this time is about 2 metres, and the plants can thus only escape the effects in impermeable soils or where drainage can keep the water table below this level. Crops growing on impermeable soils may suffer in the same way, however, through excessive watering.

Apart from the general history of a plant under good cultivation, there are detailed local factors, of which the commonest are: variations in soil texture down to the 2-metre depth, which are extremely frequent in deltaic soil; deficiency in available nitrogen; excess of salt; presence of weeds which have an indirectly toxic result on the cotton plant, and insect pests.

Water supply in Egypt is, or should be, under complete control.

LIST OF SPACINGS.

Designation of arrangement.		Distances between		Thousands of holes per acre.	Area available per hole.	Angle subtended by two nearest plants on the next ridge.
		Sown ridges.	Holes on ridge.			
		cm.	cm.		square metres.	°
1a	1b	75	30	18	0·23	20
2a	2b	—	45	12	0·34	30
3a	3b	—	60	9	0·46	40
4a	4b	—	90	6	0·68	60
5a	5b	—	120	4	0·88	90
6a*	6b*	150	30	9*	0·46*	10
7a*	7b*	—	60	4*	0·88*	20
8a	8b	—	90	3	1·36	30
9a	9b	—	135	2	2·00	45
10a	10b	—	180	1½	2·75	60

* Duplicating density of Nos. 3 and 5, but with different arrangement.

For description see p. 116. Each spacing employed involves two components, viz., the "density" of the population on a given area, and the "arrangement" or relative geometrical position of the individuals.

The "**a**" series consists of plants standing singly, or one to every "hole"; the "**b**" series, of paired plants, or two to every hole, as in the conventional field practice. Thus 1*a* is half the density of 1*b*, and so forth. See also the diagrams attached to fig. 9.

Limiting Factors Controlled by Spacing.—Variations in soil texture, composition, weeds, salt, etc., were eliminated by plot scatter in this experiment, and controllable insect pests were suppressed, while the uncontrollable *Earias insulana* did relatively little damage.

In progressing from closely crowded plants to wide sowings, the incidence of the limiting factors would appear to be affected in the following ways:—

Increasing volume of soil allowed to each plant lessens the proportion of soil particles

* The water-table effect is of more than academic interest in Egypt. An exceptionally early flood in 1909 brought about a catastrophic failure of a very promising crop. We shall deal with its seasonal effects in Part III, and also point out how a rough computation of the percentage of permeable soils in Egypt may be made by means of the flowering-curve.

actually in contact with the root system, and hence lessens the proportionate loss of water from the soil by transpiration. On the other hand, since the soil is less shaded by foliage, the water loss from the surface soil by direct evaporation is much higher in wide spacings after flowering has begun.

PLAN OF PLOTS.

1 *a* **4** *b*	2 *a* **6** *b*	3 *a* **9** *b*	4 *a* **3** *b*	5 *a* **7** *b*	6 *a* **2** *b*
7 *a* **9** *b*	8 *a* **7** *b*	9 *a* **8** *b*	10 *a* **5** *b*	11 *a* **1** *b*	12 *a* **10** *b*
13 *a* **5** *b*	14 *a* **1** *b*	15 *a* **2** *b*	16 *a* **10** *b*	17 *a* **4** *b*	18 *a* **5** *b*
19 *a* **8** *b*	20 *a* **10** *b*	21 *a* **4** *b*	22 *a* **9** *b*	23 *a* **8** *b*	24 *a* **7** *b*
25 *a* **6** *b*	26 *a* **9** *b*	27 *a* **7** *b*	28 *a* **4** *b*	29 *a* **6** *b*	30 *a* **1** *b*
31 *a* **7** *b*	32 *a* **2** *b*	33 *a* **1** *b*	34 *a* **8** *b*	35 *a* **3** *b*	36 *a* **9** *b*
37 *a* **3** *b*	38 *a* **8** *b*	39 *a* **5** *b*	40 *a* **2** *b*	41 *a* **10** *b*	42 *a* **4** *b*
Reserved for physiological records.		45 *a* **10** *b*	46 *a* **6** *b*	47 *a* **5** *b*	48 *a* **3** *b*
		51 *a* **3** *b*	52 *a* **1** *b*	53 *a* **2** *b*	54 *a* **6** *b*

W
E

Small numbers—Reference numbers of plots. Large numbers—Spacing, as in preceding list.
a, one plant. *b*, two plants.

The lessened occupation of the surface soil by roots implies less "root interference"; hence any limitation due to available soil water, or to nutrient salts dissolved therein, should take place at a later date in wide sowings. On the other hand, the free circulation of wind and the hot dry surface soil around wide-sown plants increases their transpiration, but it has seemed to us that the self-regulation of the plant as between the functions of root and shoot tends to minimise these differences. Thus, wilting and stomatal closure on a hot afternoon appear to set in at nearly the same time in all spacings.

The principal limiting factor controlled by spacing is thus the amount of nutrient salts in soil water solution at the disposal of each plant. The aërial spacing appears to be of less importance, contrary to accepted belief; it is almost impossible to differentiate between the two components, but the light in Egypt is so intense that obvious shade adaptations are not developed until fairly late in the season, and then on the lower branches alone.

Arrangement of the Experiment.

The area of 2 acres was divided into 50 plots, each 10 × 16 metres, the respective spacing on each of them being shown on the chart on p. 114. Adjacent ridges in any one plot were sown *en échelon* throughout (see diagrams in fig. 9). A plan was made to show the position and seedling condition of every plant on the area, and the planting was very carefully done, so that every plant on the 2 acres was within 2 cm. of its correct place.

The observation rows were marked with tall stakes and their positions demarcated on the plan. Abnormal or stunted plants were excluded from these observed groups. The small size of some of these observed groups (see Tables I–XX in the Appendix) was due to accidental causes which are explained under "Agricultural Details, Stunting," below.

All spacings were duplicated in two series; series *a* consisted of plants standing singly, series *b* of two plants growing together in one "hole," as in the conventional field cultivation. The use of two plants standing together is almost peculiar to Egypt. It has formerly been thought to be merely an insurance against accidental damage; our results show that the reason lies deeper. These separate series, *a* and *b*, were obtained by dividing each plot into two halves, the southern half being thinned to single plants to make the *a* series, while the northern half was thinned to two plants to make the *b* series.

The spacings employed (see p. 114) were arranged from Spacing 1, which was the densest sowing, and closer than conventional practice in the Giza district, up to Series 10, which was the widest sowing, and was similar to the arrangement we had, employed for investigations in genetics.

To this progression were added Spacings 6 and 7, which provided duplicate densities of other spacings but with different spatial arrangement, the plants being closer set on the ridge, but the ridges farther apart. The sequence of spacings thus runs in both the *a* and *b* series as follows:—

1	2	3	4	5			
		6		7	8	9	10

As between the *a* and *b* series some further duplication of densities should be noted; thus 5*b* and 7*b* were of the same density of population as 6*a* and 3*a*, though differently arranged.*

Perfect symmetry of arrangement, so that each plant of every spacing should occupy the vertical axis of an imaginary regular hexagonal prism of soil, was not practicable on account of the exigencies of irrigation. It will be seen later that such arrangement would probably be ideal.

Scatter of reduplicated plots is even more necessary with cotton than with some other crops, owing to the practical impossibility of obtaining soil which is uniform to the full depth of the cotton root. The scatter employed in this experiment is shown on the plan (p. 115).

There is no evidence that neighbouring plots affect one another, at least as regards their respective observation rows, though one might have expected the humidity of the air in a wide sown plot to have been raised by the proximity of a close sown plot. If any effects of this kind were present at the edges they have been satisfactorily eliminated by the use of observation rows, which were taken from the centre of each plot when possible. In addition, the scatter was so arranged that each plot of one kind was not merely in a different part of the area, but also was in juxtaposition with different neighbours.

The identity of similar plots of cotton on even such a small area as 2 acres is really little more than nominal. In fig. 3 we have plotted three sets of "bolling-curves" of five such plots each to illustrate this.† The variations among the close-sown plots are the largest, probably on account of the more severe water strain; two of the plots in 1*a* begin to degrade nearly a month before their normal curtailment by the water table, presumably through water shortage; yet these plots received as nearly equal irrigations as was possible without actual measurement over weirs, and the differences must be primarily due to deep-seated patches of sand and clay which we know existed in the area.

Agricultural Details.

The land employed was a square of 95 metres side, lying to the west of the laboratory building, with well No. 5 in its centre (see map, 'Cairo Sci. Jour.,' May, 1914).

* It may be noted here that while our Spacing 2*b* is that of conventional practice in the Giza district of Egypt, our Spacing 6*a* is nearly the conventional practice with American Upland cotton in the U.S.A.

Our 6*a* was spaced at 30 × 150 cm. as against 30 × 120 cm. in the States. This width between the rows is there necessary, in order to permit of the use of horse-hoes, hand labour being too expensive.

Our 6*a* gave 59 bolls per square metre; correcting to the U.S.A. spacing, this would not be more than 74 bolls, as against 95 bolls from our 2*b*. Thus it would appear that the yield per area might be increased in the U.S.A. by quite 25 per cent. if the cost of labour would permit of hand cultivation. Our experience of Upland cottons leads us to think that the difference in species would not affect the general principle of this deduction.

† This fig. 3 provides a demonstration of the way in which these plant-development curves serve almost entirely to eliminate the probable error of any one plot. An error which can thus be recognised is not a "probable error."

There were no divisions other than the usual irrigation furrows and ridges, except one path of 50 cm. wide traversing it from east to west. There was no thoroughfare through or round the area. Irrigation ditches bordered it on the north and south, along which margins a belt of five ridges was excluded from the experiment in case seepage should take place from the ditches.

The area was sub-divided into 54 plots, each 10 × 16 metres; Nos. 43, 44, 49, and 50 were excluded from the experiment and used for physiological research. The remaining 50 were sown as shown on p. 115.

Preparatory Cultivation.—Ploughed and rolled January 25, after a winter fallow. Cross ploughed February 12. Rolled and ridged up February 27. Ridges made up at 75 cm. apart.

Sowing.—From March 16 to 20, using dry seed of the Assili variety, treated with naphthalene dressing. Correct spacing ensured by sowing along 4-metre gauge rods, with coloured wool bound round at the correct intervals; rods aligned on a stretched string in starting each plot. All plots sown *en échelon* from ridge to ridge.

Watering followed on March 21, which is thus the effective sowing date. This is near the "critical date" for the land in question, as shown by the Sowing Date experiments.

Seedlings appeared above ground on March 28, the stand of seedlings being almost perfect. A little re-sowing was done on April 9.

Map.—A map was made in May to show every plant on the area, noting its condition as stunted, normal, or re-sown. A set of observation rows was then selected in the centre of each half plot, containing as nearly 200 plants as was possible without including re-sown or stunted plants. Each row was marked out by a 2-metre stake at each end, to which was nailed a cardboard label bearing in pencil the serial number of each plot (not the spacing number) and the letter *a* or *b*, accordingly as one or two plants had been left in each hole.

Stunting.—The laboratory was newly built, having been first occupied on April 1, and the land taken over from poor cultivation. It was full of "negeel" grass (*Cynodon dactylon*) which exercises a severe indirect toxic effect on cotton, and is as difficult as couch grass to deal with. The observation rows were so chosen as to eliminate this toxic soil almost completely, though often at the cost of serious reduction in the number of plants included in the rows (see Appendix, Tables I–XX).

Thinning.—The clumps of seedlings in each hole were thinned by cutting out with scissors, and not by pulling, to two plants per hole on April 22, and in the *a* half plots were further thinned to one plant on May 1.

Waterings.—March 21 at sowing, April 27, May 30, June 23, July 17, August 13, September 11, and October 17.

Hoeings.—The usual three were given after the first three waterings, and then desultory hoeing in those plots where the spacing of the plants was sufficiently wide.

Insect Pests.—The cotton worm (*Prodenia littoralis*) first appeared on June 5, and a very severe brood descended during the night of June 23, following the irrigation of that day. It was entirely eradicated by hand picking, assisted after the first day or two by deaths from natural causes. Counts of the number of egg masses from each plot gave some useful information on the "psychology" of the moth. Aphides appeared as usual on a few marginal plots and were sprayed with kerosene emulsion. Boll worm (*Earias insulana*) was slight, as the figures for boll weight show (Appendix I, Table XLI).

Flowering.—Began on June 8. Numbers per plot counted every day until the observation rows were completely arranged. From June 23 to August 17 the counts were taken on the observation rows only, every day. After the latter date a part of the available labour had to be diverted to boll picking and counting; the flower counts were thenceforward taken on alternate days, namely: Tuesday, Thursday, and Saturday for Plots 1–24; Sunday, Wednesday, and Friday for Plots 25–54. This left Monday as a free day for special work.

Bolling.—The number of bolls open on the observation rows were counted and picked each week. The work, being more than it was convenient to do on a single day, was similarly halved; Plots 1–24 were picked on Monday, 25–54 on Tuesday. The first 100 bolls picked (or the counted number if less than 100) from each plot were put into boxes and removed to the laboratory.

Boll Weight, etc.—These bolls from each week were weighed to obtain the mean boll weight. Each lot was then ginned on the 12-inch roller hand gin, and the lint weighed to determine the ginning out-turn. Ten grammes of seed from each ginning were then weighed and counted out to obtain the mean seed weight. These operations began on August 12 and ended on November 5, taking two days in each week, and making a total of 1300 pickings and ginnings, nearly 4000 weighings, and the counting of 150,000 seeds.

The weighings for ginning out-turn were all made immediately after ginning, and are thus comparable *inter se* although no correction is made for humidity; hence the actual values are rather low, aided by the fact that Giza is rather too far south for the Assili variety.

Counting seeds in a known weight is both faster and safer than weighing a counted number when native labour is employed.

Grading.—About 500 grm. of seed cotton were picked in conventional pickings from the plants of each plot which were not included in the observation rows.

Yield.—Plot No. 44 was picked to check the yields computed from the observation rows. It gave 6 kantars as against a computed yield of 6·15 kantars.

Cost of Experiment.—The details of the time table have been given above because the conduct of the experiment was only an item in a very heavy season's work, so that a regular routine was necessary. It may also be stated that the cost, when properly organised, was not great; £30 included every expense over and above the cost of conducting an ordinary cultivation of the area.

The Data Recorded.

The primary data recorded are presented in full in Appendix I, with the following condensations :—Daily flowering is condensed to the weekly totals to save space; boll weight, out-turn, and seed weight, are condensed to the means of each spacing, instead of presenting the separate determinations for each plot. These last show no features of interest for our present purpose.

The secondary data computed from these recorded data are given in Appendix II.

Graphic presentations have been made of sufficient data from these two appendices to allow the reader to follow the discussion of results, without necessarily consulting the actual numbers. The discussion therefore treats of the data as curves, and not as numbers. These curves are set out as figs. 1–11, in Appendix III.

The Flowering-curve.

We were unable, from accidental causes, to mark out all the observation rows before flowering began. Counts were therefore taken on the entire plots up to June 22, on which date the flowering-curve proper begins. Since early flowering is an important factor in yield, some data from these plot counts are given to amplify the systematic data embodied in the curves.

We have taken the total flowers for the first five days after the beginning of flowering on June 8, and also the number open on another day taken at random, viz., June 15. In columns parallel to these we have placed expectation numbers, which are merely ratio numbers proportional to the density of plants on equal areas of each spacing. It will be seen that in each spacing the early flower-production per plant is the same, within the probabilities, except the last plots of Spacings 1 and 2. These two plots were adjacent, being Nos. 52 and 53 (see Tables I–XX in Appendix I), and their precocity was certainly due to some local soil difference.

Spacing.	Flowers on first five days.		Expectation by density.	Flowers on June 15.		Expectation by density.
	Each plot.	Total.		Each plot.	Total.	
1	1.2.0.0.14	17	25	5.6.1.4.35	51	60
2	7.2.0.6.23	38	17	14.4.4.13.23	62	40
3	3.0.2.2.1	8	12	7.6.4.6.4	27	30
4	0.2.0.0.3	5	8	4.4.1.0.6	15	19
5	0.0.0.2.1	3	6	0.1.2.4.6	13	13
8	0.0.0.0.0	0	4	1.1.0.0.4	6	10
9	0.0.0.0.1	1	3	0.0.3.0.1	4	7
10	3.0.0.2.0	5	2	1.1.0.4.0	6	5

The counts made on the observation rows from June 23 onwards are plotted in figs. 2 and 9 from the data in Tables I–XX of Appendix I.

Our remarks on these flowering-curves will deal successively with the beginning of the curve, the rise of the curve, the maximum, and the decline of flowering.

The earliest beginning of the curve for all spacings is the same, as we have seen in the foregoing table. Such differences as exist are not regular and are due to accident. Consequently, there can have been no functional interference between the roots of even the closest sown plants at the time when they differentiated their first flower-buds. This fact is of primary importance in the analysis of yield. The greater the number of plants on the area the greater will be the early yield, other things being equal. With a crop which gives one almost simultaneous "yield," such as wheat, the root-interference effect should be very important.

The rise of the curve in this particular experiment is slightly abnormal, as we had delayed our irrigation rather too long in early June. We shall see when dealing with the effects of season that the true daily flowering-curve tends to smooth during its rise to an approximately straight line. These spacing experiment curves, on the contrary, all show a slight check during this rise, but this difference from the ideal form merely decreases the definiteness of our final results, and does not alter them qualitatively.

The rise is, of course, due to the successive steady increase in the number of later flowering branches on which flowers are ready to open. This part of the flowering-curve is, in fact, a reduplication of the growth-curve of the central axis during the time when the latter was producing the flowering branches.*

* A conception of the branching system of the plant as a kind of scaffolding upon which bud after bud is formed, each to open as a flower after a well defined time, has been found very useful. It has led to

Comparison of the curves in fig. 2 shows that this rise of the curve comes to an end later and later with wider spacings. Further, whereas the curve of 1*b* ceases to rise in the week ending on July 12, that of 1*a*—which represents a spacing of half the 1*b* density—does not stop until the following week. Thus, the date at which root-interference begins, with consequent limitation of growth rate by the available soil water and nutrient salts, depends on the volume of soil available, as one would expect.* In the widest sowing the curve is still rising when the curtailing effect of the water table comes into operation; with such spacings there is no rest at a maximum, but in the close sowings the curve remains horizontal under the control of this soil water limiting factor for several weeks. That this arresting factor is not aërial may be further deduced from the fact that, on June 30, it is still possible to see the soil between the plants in photographs taken from above; since the flower-bud takes not less than three weeks to develop into a flower, it follows that the horizontal position which the curve of 1*b* takes up in the week ending July 12 was determined in the week ending June 21, before aërial interference had begun.

Comparison between the *a* and *b* series introduces a further complication. The closest sowings of *a* and *b* may be explained as above, but in the wider sowings it is evident that this explanation will not suffice. Comparing, for example, the curves of 8*a* and 8*b*, they both have the same form, the maximum being attained at the same time and lasting for the same time. The only difference is in the amplitude of the curve, which is nearly twice as great in 8*a* as in 8*b*. Here we appear to be dealing with a factor which is akin in its incidence to a toxin rather than to an ordinary limiting factor, it being continuous in its action and "depressing the vitality" of the plant; actually there can be little doubt that it is in reality the same limiting factor of soil water, but that it is brought into play each afternoon of the season at an earlier hour when two root systems are interlaced in the same spot. This would give it the appearance of a continuous action. Here, again, it would seem that the effect of aërial interference between branches has been overrated.

As regards the maximum of the curve, its height is partly dependent on the number of lateral monopodial branches produced, which branches in their turn bear flowers to augment those produced on the main stem. The height of the latter was the same in all spacings at all times of the season, so that the flower production of all the main

developments of these methods, in which the behaviour of the crop is not merely recorded, but *forecasted* through records of the building up of the scaffolding. The point will be dealt with more fully in Part III.

* We have been unable to disentangle the effects of soil-water as such from the effects of the nutrient salts dissolved therein. A standard set of experiments was conducted by Mr. F. Hughes in many different sites in Egypt ('Khed. Agric. Soc. Year Book,' 1909), which showed that, under the accepted methods of cultivation, there were no recognisable effects from manurial treatment. This conclusion applies nevertheless to the final yield only, and it is still possible that nutrient effects may be involved for short periods and may ultimately be recognisable by these curves.

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stems in all the spacings was initially the same, but in the closest sowings practically no lateral monopodia were developed, whereas in wide spacings the plants branched extensively.

The initiation, rise, and maximum of the flowering-curve having been discussed, it remains to consider its fall, or curtailment. This might result from growth limitation by temperature as the winter comes on, but such is rarely the case under Egyptian conditions. It might also happen that the growth of the main stem and its monopodia had been prematurely checked by senescence, in which case no more flowering branches could be formed, and the flowering-curve would tail off gradually, as the existing flowering branches opened their last flowers; this is an unusual phenomenon in modern Egypt. It is, however, shown regularly by American Upland plants growing under the climatic conditions of Giza.

The commonest cause which curtails the flowering-curve is the rise of the water table. In this experiment it is the sole regular cause. Details as to its action may be relegated to the subsequent account of seasonal effects, and it suffices to note here the effect on the various spacings. In the closest sowings the flowering responded almost immediately to the immersion of the root system up to 170 cm. from the surface, as is shown by the curve of 1*b*, which is practically of the same form as the curve of the level in the water wells would be if turned upside down. Wider sowings show a less and less marked effect, but even the widest are suddenly curtailed four weeks later. We have, unfortunately, no statistical records of bud-shedding to prove our interpretation of this delay, but the explanation would appear to be very simple. In very close sowings the roots are so completely occupying the available soil by the autumn that its upper layers are partially exhausted, and—as we know from independent investigations already quoted—the layers at 150 cm., and even lower, are then much the most important source of soil water, and probably also of nutrient salts. Asphyxiation of the roots in these lower layers entirely destroys the water equilibrium between root and shoot, and extensive shedding is the result, both of open flowers and also of buds. The buds being shed flowering must stop immediately. In the widest spacings, on the other hand, the lower layers are not of the same proportionate importance, nor even of the same relative size, since the non-interference of laterals leaves the functional root system in its natural conical form, instead of compressing it to a cylinder or prism. Consequently, the disturbance is less sudden and does not provoke shedding, so that no immediate effect is shown by the flowering-curve. Nevertheless, growth of the flowering branches is checked by the diminution of the root supply, and flowering must come to an end when all the buds on the branches have unfolded. Since the bud takes three to four weeks to unfold from its first differentiation, the flowering-curve in these wide sowings is not curtailed until a month after root asphyxiation has taken place. Intermediate spacings show a mixture of the two effects in varying proportions, part of the curtailment of the curve taking place immediately through bud-shedding, and part taking place a month later through cessation of growth; the result is that these curves appear to present a steady progression (see, *e.g.*, fig. 11).

Before passing on to the bolling-curve, it may with advantage be noted that the statements just made with regard to the effects of such an obvious modification of the environment as a sudden rise of the water table are equally good for less obvious and sudden modifications. A slightly hotter or drier day may act thus, doing more damage to the close sowings than to the wide sowings, unless duly counteracted by such attention to the soil-water contents as is not possible under field conditions of cultivation. Hence, the closer the plants are sown, the more skilful must the cultivation be, until further skill becomes impossible of application in actual practice.

The Bolling-curve.

The curves for boll production per plant, expressed by the number of ripe bolls per plant per day in each weekly period, are plotted in fig. 5 from the data in Tables XXI–XL of Appendix I.

They do not present many new features, being identical with the flowering-curves from which they were derived, as to their form, but differing in amplitude. The difference is due to the shedding of about 40 per cent. of the flowers after they have opened. This difference is practically constant throughout all varieties of cotton in any part of Egypt, though some suffer more in the south, where it is hotter. The fact that all spacings are equally affected has a direct bearing on our former conclusion, that the automatic self-regulation of the plant is sufficient to compensate for the different environmental conditions. It also indicates that the cause of this comparative constancy in shedding is one which acts at regular intervals over a short period, and there can be little doubt that the condition of water-strain which occurs every afternoon is this cause.

Although the average amount of shedding in good cultivation is practically constant, there are fluctuations from the average with which we shall deal later.

That there should be such a marked resemblance between the curves of flowering and of bolling is important in the analysis of yield, since it indicates that flowering is the principal determinant; and since flowering in its turn can be traced back to branching, it follows that the yield may be determined long before it is obtained.

The Bolling-curve per Unit Area.—By taking the number of plants per square metre, or any other unit area, as the basis of computation, instead of taking the individual plant, we obtain curves showing the time distribution of yield. On changing the scale in this way, certain peculiarities become obvious which were not very noticeable in the curves per plant (fig. 6).

Since all the spacings begin with equal rates of flowering, and since there is equal shedding in all, it results that the greatest yield per area for the first few weeks is given by the spacing which contained most plants per area. This would be described conventionally by stating that close planting hastened maturity; actually it does not affect maturity in the least, as a plant function, but simply gives more early bolls because there are more plants to produce them.*

The next differentiation between the spacings appears as each curve reaches its maximum and becomes horizontal in the way discussed when dealing with the flowering-curve. The closer the spacing the sooner the maximum is reached, so that the period of maximum yielding is earliest in the closest spacings and latest in the widest.

The effects of the water table having been most severe in the closest sowings, the curve of yield per unit area falls more rapidly in Spacing 1 than in Spacing 2, and this again more rapidly than in Spacing 3. The result is that the total "area" of the yield-curve of 2*b* is greater than that for any other spacing, since although it does not begin so well as 1*b*, it finishes better. This Spacing 2*b* is the conventional arrangement practised by the Fellaheen of the district in which the experiment was performed.

Provided that the contents of the bolls in 2*b* are equal in weight, ginning out-turn, and quality with those from the other spacings, the custom of the Fellah is remarkably justified. His convention balances the chances of loss from various causes with great exactitude.

It remains to examine the contents of the bolls in order to see whether boll counting gives a true expression of the yield.

The Weight of the Boll Contents, or Boll Weight.

The data for these determinations are not given plot by plot, but the means for each spacing are presented in Table XLI of Appendix I.

Determinations were made by weighing the seed cotton picked from 100 open bolls each week, or if less than a hundred were available from any plot, then of all those available.

The weight of the seed cotton in the boll is the aggregate expression of a number of different features, which features may be determined at various times beforehand. The boll grows to its full dimensions in about 25 days from flowering, and in the remaining half of the period of maturation it undergoes various secondary processes. The number of seeds in each boll has been computed and shows no features of interest.

It will be seen from the table that there are no marked effects to be recorded from

* There may be a real effect on maturity through close planting, in that the water-shortage which is likely to ensue from unskilful cultivation brings about autotoxic effects in the tissues of the boll, so shortening the periods of growth. The effect from very severe water-shortage was found by the senior author in other experiments to alter a certain period from 23 to 21 days. Thus the boll itself, normally requiring about 50 days to open, would open five days sooner. Such acceleration of maturity is highly undesirable, as it implies incomplete or insufficient growth, with consequent short or weak lint.

various spacings, except that bolls opening after September 19 in the closest sowings would appear to have been reduced in weight by the action of the water table.

Thus, in this experiment, boll weight proves to be an unimportant component of the yield. Since an increase in boll weight would be directly projected as an increased yield, it may be advisable to comment briefly on its nature.

No variety of Egyptian cotton at Giza has yet produced more than about 2 grm. of seed cotton per boll under any treatment or in any season. On the other hand, boll weight was determined, at our instance, in an experiment by the Egyptian Survey Department in the Middle Delta, where the weather is cooler, and it was found that the boll weight there rose higher in soil with a deep water table; from 2 grm. with shallow soil it rose nearly to 3 grm. in deep soil resembling our land at Giza.* It would seem from this and from other considerations that the afternoon water strain acts as the limiting factor on the growth of the boll also. With deep soil in the Middle Delta the boll becomes larger, while with deep soil at Giza it does not. Severe root asphyxiation is needed at Giza to exceed the limiting effect of this daily water strain. Investigations into the development of the boll and its contents were carried on concurrently with these analyses, and showed that fluctuations in the length and breaking strain of the lint which the boll contains were almost exclusively limited by the soil water available, or in other words, by the diurnal water strain.

It should be noted that as we progress through these successive stages the probable error of the determination of yield is steadily increasing. Fluctuations in boll weight are now added to fluctuations in shedding.

Seed Weight.

The data set out in Table XLII were obtained by counting the number of seeds weighing 10 grm. from each plot each week. They are plotted for the *a* series in fig. 10.

Seed weight is less compound in origin than boll weight, and hence the curves are more definite. Indications of specific influences are provided by the sudden and simultaneous variations from week to week, but there are no very definite effects from various spacings. One of us is discussing this matter elsewhere.

The curve for Spacing 8*a* in fig. 10 is noticeably separate from the other spacings. This is due to impurity of the commercial variety, there having been an excessive number of large-seeded plants in the observation rows of this spacing.

The variety employed in this experiment was Assili, introduced in 1910, as a purified form of the deteriorated Afifi variety, by a commercial firm. Our analysis of its composition in 1911, from plant to plant, had led us to conclude that it was extremely impure from the beginning, but since our methods were new and the weight of opinion against us, we employed this variety in the spacing experiment while

* Ferrar, H. T., and Hurst, H. E., Survey Department Paper, No. 24, p. 34; W. L. B., 'The Development of Raw Cotton' (in course of publication).

waiting for the results of a second year's analysis. It may be added that our subsequent analyses of its composition amply confirmed the first one; the only other variety which is equally impure with Assili is the Afifi which it was designed to replace (see the Report of the International Federation of Master Cotton Spinners' Egyptian Congress, 1913, pp. 199 and 200, etc.).

Lint Weight.

The weight of the lint per single seed is determined by computation from the ginning out-turn (Table XLIII), and is presented in Table XLIV of Appendix II.

It shows no features due to spacing.

It might here be added that the appearance of lint produced on wide-sown plants is distinctly inferior. It tends to be less regular than the normal field-sown lint, and is woolly and "staring," though the breaking-strain is normal.* This makes the estimation of the value of new cottons for fine spinning extremely difficult, since they must be grown wide sown for pedigree culture and for propagation; whereas their commercial value can only be tested by their behaviour in field crop over several acres, with ordinary commercial handling, ginning, and baling.

Summary and Conclusions.

We may conveniently summarise the effect of the various spacings upon the final yield by working backwards from the yield through the various stages of analysis.

We have seen that the weight of lint per boll is not appreciably affected by any alteration of spacing, so that the final yield is expressed with fair accuracy by a simple count of the number of bolls ripening (fig. 11, and Tables XLV and XLVI).

The number of bolls ripening is primarily determined by the number of flowers which open, subject to alteration by shedding to a degree which should be effectively constant in good cultivation. The automatic balance which the plant maintains between water intake and water loss prevents spacing from affecting shedding.

The flowering is dependent on the development of flowering branches, either directly on the main stem, or on lateral monopodia as well. Hence, it is dependent on the growth of the plant some three weeks previously to the actual opening of the flower, with a correction for bud-shedding. The effect of varying the spacing of the plants is to vary the development of the branches, but this effect does not appear to be due to aërial interference, but rather to subterranean competition between adjacent root systems.

The yield may thus be discussed primarily on the flowering data, being regarded as the product of the number of plants per area multiplied by the yield per plant.

The chief effects of the various spacings employed are distinguishable as resulting from the number of plants in each "hole," whether one or two, from the area of soil allowed per plant, and from the arrangement of the plants.

* Breaking-strains of 50 single hairs were determined for each spacing.

We have seen that the Fellah's custom of leaving two plants standing together is a good one; the habit is not a mere insurance against possible damage to one plant, but in all circumstances (fig. 7) it gives about 10 per cent. higher yield, since each one of the pair produces a little more than half the crop which a single plant would give, and not one-half exactly.

The area allotted to each plant affects the date at which flowering ceases to increase, and also influences the severity of the effects of root asphyxiation by the water table. The widest spacing employed in this experiment allowed 2·75 metres of superficies per plant, and this gave a higher yield per plant than the spacing of 2·00 metres, confirming previous evidence as to the enormous extent of the root system. The maximum yield per area, however, is obtained with the conventional close spacing used by the native cultivators (see fig. 4).

As regards the effect of arrangement there would appear to be possible improvements in the native custom of planting in parallel ridges, by using a symmetrical space distribution of the plants over the surface of the ground, but practical difficulties in irrigation and cultivation would make such spacing very difficult to handle. If we compare those groups of arrangements in this experiment which gave the same density per unit area, the most symmetrical arrangement of each group always gives the most ample flowering-curve per plant. Three such comparisons are presented graphically in fig. 9, as flowering-curves, a plan of the spatial arrangements being appended to the curves.

The first noticeable feature in this figure is the way in which all the curves coincide during their fall under the influence of the water table, the most powerful limiting factor in the plant's life-history. Spacing 1*a* is an apparent exception to this, but only on account of its severe bud-shedding. With regard to the marked superiority of, *e.g.*, 3*a* over 6*a*, the explanation can only be a geometrical one; root interference begins in 6*a* along the line of the ridge, and further extension of the effective root system can only take place, therefore, at right angles to the ridge. In 3*a* there is no root interference until it takes place in all directions at once. It is not possible to elucidate the details with exactitude on account of the slight deformation of the flowering-curves from their normal rise along a straight line, already mentioned on p. 120.

Conclusion.

A full investigation of the effect of different spacings in the planting of cotton has been carried out.

For each of 20 different spacings the number of flowers, number of bolls or fruits, mean weight of the boll contents, of the seed, and of the lint cotton per seed, have been recorded, and it is shown to what extent each of these components enters into the building up of the total yield.

The statistics of these stages of analysis are recorded in the Tables I–XLIII and XLIV–LI of the two Appendices. These numbers serve to check one another, and

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we thus possess for the first time a body of data, of determined probable error, upon which trustworthy conclusions can be established, free from subjective bias.

When such data are entered up day by day and plotted graphically, it is possible to present the whole course of the building up of the yield in the form of plant-development curves, by which it is clear in what direction the phenomena are simple and in what direction complex.

The following conclusions may be formulated :—

a. The experiment shows that the yield of a cotton crop is primarily dependent on the number of flowers which it forms.

b. The normal extension of the root system of an isolated cotton plant can utilise more than 2 square metres of soil surface in soil which is more than 2 metres deep.

c. The plants in the field crop have only 0·18 square metre each allowed them, or less. Most of the phenomena of field crop physiology in the fruiting season are traceable to the consequent interference of one root system with another.

d. The yield per unit area of the conventional spacing of the Egyptian Fellah is the maximum obtainable under the limitations of field cultivation.

e. The sources of error in field experiments with cotton can be traced to—

1. Soil variation, especially below 1 metre depth.
2. Insufficient frequency of observation, whereby accidental episodes cannot be distinguished from normal sequences.
3. Fluctuation of single plants, heterogeneity of commercial varieties, and normal physiological variations from day to day.

Technical Bearings of the Spacing Experiment.

A few points of special interest may be mentioned which do not concern our primary purpose of yield analysis.

The use of bolling-curves shows that the conventional "pickings" are purely arbitrary and misleading now that the Nile is under control.

It would be useful to repeat this experiment with about ten spacings interpolated between our 1*b* and 3*b*, to determine the detailed form of the curve of total yield at its mode, and to do so in several sites.

Close planting offers a way for avoiding those insect pests which attack the late bolls. It is more effective than breeding quickly-maturing varieties, unless such varieties are early as well as quick. On the other hand, the closer cotton is planted the more skilful must cultivation be, and the more damage will result from hot weather, water-shortage, or water-logging. This damage not only stops the flowering, but also reduces the length and strength of the lint in bolls already formed.

The only improvement which can be suggested on the Fellah's conventional spacing is that the pairs of plants should be symmetrically distributed over the area. To do this, while keeping the same density as at present, would necessitate the use of very narrow ridges (57 cm. on good land, and less on poor land), and access among the plants would be practically impossible.

It should be noted that our Spacing 6*a* is similar to the spacing employed in the United States of America. It would be interesting to know whether this arrangement has any merits of its own in the cultivation of Upland cotton, or whether—as seems more probable—its employment is solely due to the compulsory use of horse-hoes instead of expensive hand-labour. If the latter, cotton may be described not merely as a "cheap-labour crop," but also as a "hand-labour crop."

The yield of seed per plant can be enormously increased by wide sowing. In the year following this experiment we obtained 1400 seeds per plant on 13,000 plants, including many stunted and late-sown individuals. We thus raised 2 tons of seed in 1913 from two seeds sown in 1911. Five times this quantity is easily practicable.

The errors in comparison of nominally identical plots of cotton are very serious. In future computation of the significance of ordinary plot-experiment results, the probable error of a total yield from any ordinary plot should be assessed at not less than $\pm$ 7 per cent.,* even when conducted under the most favourable conditions.

When daily or weekly series of observations on flowering and bolling are taken weekly from observed groups of plants in each plot by the senior author's methods, there is practically no fear of error in the comparison, since accidents and abnormalities are shown up at once by the run of the curves.

The various sources of error detected by the employment of these continuous records explain why previous published statements as to the best spacing for Egyptian cotton are contradictory, and often misleading.

Several side issues of the spacing experiment serve to illustrate the very great subjective error of opinions on the cotton crop. Our wide-sown plants were considered to be late in flowering, closer planting would have given better results per plant, etc.; the obvious reason for these mistakes is that the abundant leafage of the lateral monopodial branches helps to hide the flowers and bolls from direct view. Similarly, it is very difficult to believe, in the light of these results, that a checking of growth can be beneficial under any circumstances; nor is it easier to accept the converse, that a renewal of growth is necessarily prejudicial. Benefit or harm may well result in either case through secondary causes, unless an intelligent control

* In expansion of this evaluation we may cite the actual deviations of one set of plots from Table XXIV, Appendix I. The observation rows of 2*b*, representing the normal Egyptian field crop, were composed of selected individuals, chosen to eliminate any stunted plants, and the number of plants observed was high. The yields work out as follows, in bolls per square metre, the mean being 17·37 bolls:—

Yield	19·98	12·25	18·48	20·58	15·68
Deviation	2·51	−5·12	1·11	3·21	−1·69
Or	+14 per cent.	−29 per cent.	+6 per cent.	+18 per cent.	−10 per cent.

A deviation of 29 per cent. necessitates a probable error of 9 per cent. to account for it on accidental grounds.

is exerted. Thus, an unwise watering after partial drought is said to cause the bolls which were near opening to fall off; as a matter of fact, the shedding of a boll which is more than 25 days old is a relatively rare occurrence; what actually happens is that the new leafy shoots hide the bolls already formed. Similarly, the use of manures is said to make the plant "run to wood" and lessen the yield; it is probable that the greater part of such decrease in yield is simply due to shedding, resulting from insufficient water-supply to cope with those demands which the increased leaf surface would make upon the root system on hot days.

APPENDIX I.

Statistical Tables of the Data directly recorded during Cultivation of the Crop.

Tables I–XX.—*Daily Flowering Records of the Twenty different Spacings.*

These records were obtained by counting the number of flowers opening each day on a group of plants chosen for observation in each plot. The daily numbers are not given in this account, but only the totals for seven days *ending* on the dates given in the Tables.

The totals for the five plots of one kind in each week are then divided by a factor, to obtain the average rate of flowering "per plant per day" during the seven-day period.

This factor is the number of plants in each observed group (or "observation row") multiplied by the number of days on which observations were taken. Up to August 16 observations were made each day of the week; after that date they were made on three days only (see p. 118). The factor is thus three-sevenths of the factor for the early part.

Flowers "per square metre per day," representing the yield of the land in terms of flowers, are obtained by multiplying flowers "p.p.p.d." by the number of plants in a square metre.

Total production per plant and per square metre are both determined by addition of the weekly velocities per day and multiplying the total by seven.

Computed figures are in leaded type; observed figures are in ordinary type.

Reproduced graphically in fig. 2 without spacings 6 and 7. The latter spacings are represented in fig. 9.

Daily Flowering Records for the Different Spacings. Tables I–XX.

Spacing 1. 30 cm. × 75 cm.; 18,000 holes per acre.

TABLE I.—Series *a*: One plant per hole; 0·23 m.^{2} per plant; 18,000 plants per acre. (Factors 2380 and 1020.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
11	29	52	114	103	90	82	90	53	50	23	18	19	8
14	52	98	162	197	201	220	200	119	69	21	14	11	12
30	53	54	149	198	209	204	225	164	166	46	34	10	11
33	102	153	273	426	545	623	565	307	168	47	33	13	5
52	104	213	264	385	386	456	502	238	199	91	33	16	12
Totals . .	340	600	962	1309	1431	1585	1582	881	652	228	132	69	48
Flowers p.p.p.d. . .		0·25	0·40	0·55	0·60	0·66	0·66	0·37	0·27	0·22	0·13	0·07	0·05
Flowers p.m.^{2}p.d. . .		1·09	1·74	2·39	2·61	2·88	2·88	1·61	1·17	0·96	0·57	0·30	0·22

Total production per plant = **29·6** flowers; total production per square metre = **128·9** flowers.

TABLE II.—Series *b*: Two plants per hole; 0·12 m.^{2} per plant; 36,000 plants per acre. (Factors 5350 and 2290.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
11	73	287	393	237	130	147	114	115	108	47	38	22	11
14	83	284	406	467	472	385	329	149	81	21	23	8	9
30	42	75	138	170	157	195	204	175	138	50	42	44	25
33	86	209	341	421	447	416	261	129	58	22	28	4	8
52	108	403	547	598	639	490	393	147	103	58	17	14	17
Totals . .	392	1258	1825	1893	1845	1633	1301	715	488	198	148	92	70
Flowers p.p.p.d. . .		0·23	0·34	0·35	0·34	0·30	0·24	0·13	0·09	0·08	0·06	0·04	0·03
Flowers p.m.^{2}p.d. . .		2·00	2·96	3·13	2·96	2·61	2·08	1·13	0·78	0·70	0·52	0·34	0·26

Total production per plant = **15·6** flowers; total production per square metre = **136·29** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 2. 45 cm. × 75 cm.; 12,000 holes per acre.

TABLE III.—Series *a*: One plant per hole; 0·34 m.² per plant; 12,000 plants per acre. (Factors 2548 and 1092.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
6	49	135	186	219	173	187	246	372	424	177	158	106	91
15	63	140	288	348	340	350	346	268	194	65	38	10	9
32	77	140	302	382	478	533	491	460	437	158	87	57	22
40	87	176	309	453	473	632	796	557	361	123	52	11	11
53	88	216	337	486	521	463	603	390	274	111	70	12	20
Totals . .	364	807	1422	1888	1985	2165	2482	2047	1690	634	405	196	153
Flowers p.p.p.d. . .		**0·32**	**0·56**	**0·74**	**0·78**	**0·85**	**0·97**	**0·80**	**0·66**	**0·58**	**0·37**	**0·18**	**0·14**
Flowers p.m.²p.d. . .		**0·94**	**1·65**	**2·18**	**2·29**	**2·50**	**2·85**	**2·35**	**1·94**	**1·73**	**1·08**	**0·53**	**0·41**

Total production per plant = **48·6** flowers; total production per square metre = **143·1** flowers.

TABLE IV.—Series *b*: Two plants per hole; 0·17 m.² per plant; 24,000 plants per acre. (Factors 4690 and 2010.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
6	47	123	217	258	244	338	318	349	365	155	179	112	80
15	74	309	469	463	466	406	375	192	156	48	25	11	23
32	86	218	327	509	575	693	706	688	470	156	84	38	28
40	74	223	315	468	518	573	597	346	215	69	37	15	7
53	63	194	297	422	460	418	470	301	268	90	79	19	29
Totals . .	344	1067	1625	2120	2263	2428	2466	1876	1474	518	404	195	167
Flowers p.p.p.d. . .		**0·23**	**0·35**	**0·45**	**0·48**	**0·52**	**0·53**	**0·40**	**0·31**	**0·11**	**0·09**	**0·04**	**0·04**
Flowers p.m.²p.d. . .		**1·35**	**2·06**	**2·65**	**2·82**	**3·06**	**3·12**	**2·36**	**1·82**	**0·65**	**0·52**	**0·24**	**0·23**

Total production per plant = **2·48** flowers; total production per square metre = **146·1** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued*.

Spacing 3. 60 cm. × 75 cm.; 9000 holes per acre.

TABLE V.—Series *a*: One plant per hole; 0·46 m.^{2} per plant; 9000 plants per acre. (Factors 2163 and 927.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
4	48	123	195	195	187	211	300	283	275	97	59	35	35
35	56	165	305	356	312	437	485	416	325	107	62	26	27
37	59	159	242	318	373	440	532	516	463	179	103	43	29
48	87	243	416	627	773	750	676	578	334	105	43	11	19
51	59	156	228	248	262	275	394	380	442	147	161	86	74
Totals . .	309	846	1386	1744	1907	2113	2387	2173	1839	635	428	201	184
Flowers p.p.p.d. . .		**0·39**	**0·64**	**0·81**	**0·88**	**0·98**	**1·10**	**1·01**	**0·85**	**0·69**	**0·46**	**0·22**	**0·20**
Flowers p.m.^{2}p.d. . .		**0·85**	**1·39**	**1·76**	**1·90**	**2·13**	**2·39**	**2·20**	**1·84**	**1·50**	**1·00**	**0·48**	**0·43**

Total production per plant = **57·6** flowers; total production per square metre = **125·0** flowers.

TABLE VI.—Series *b*: Two plants per hole; 0·23 m.^{2} per plant; 18,000 plants per acre. (Factors 4180 and 1793.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
4	44	147	213	157	138	220	323	398	402	143	102	57	38
35	56	168	257	423	508	665	697	623	397	146	81	29	20
37	61	190	329	373	363	503	618	692	699	206	180	76	48
48	86	332	517	759	852	758	688	548	322	90	53	17	16
51	59	171	320	381	388	363	404	250	219	145	75	44	30
Totals . .	306	1008	1636	2093	2249	2509	2730	2511	2039	730	491	223	152
Flowers p.p.p.d. . .		**0·24**	**0·39**	**0·50**	**0·54**	**0·60**	**0·65**	**0·60**	**0·49**	**0·41**	**0·27**	**0·12**	**0·08**
Flowers p.m.^{2}p.d. . .		**1·04**	**1·69**	**2·16**	**2·35**	**2·60**	**2·82**	**2·60**	**2·12**	**1·78**	**1·17**	**0·52**	**0·35**

Total production per plant = **34·2** flowers; total production per square metre = **148·4** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 4. 90 cm. × 75 cm.; 6000 holes per acre.

TABLE VII.—Series *a*: One plant per hole; 0·68 m.² per plant; 6000 plants per acre. (Factors 1281 and 549.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
1	48	87	161	198	212	291	405	558	681	265	206	140	105
17	18	56	103	145	146	183	223	214	267	87	110	21	5
21	50	139	291	374	475	532	518	382	279	86	45	16	12
28	20	54	99	114	82	117	180	125	133	72	83	34	25
42	47	146	256	371	390	380	368	378	414	150	63	45	15
Totals . .	183	482	910	1202	1305	1503	1694	1657	1774	660	507	256	162
Flowers p.p.p.d. . . .		**0·37**	**0·71**	**0·94**	**1·02**	**1·17**	**1·32**	**1·29**	**1·38**	**1·14**	**0·93**	**0·47**	**0·30**
Flowers p.m.²p.d. . .		**0·54**	**1·04**	**1·38**	**1·50**	**1·72**	**1·94**	**1·90**	**2·03**	**1·68**	**1·37**	**0·69**	**0·44**

Total production per plant = **77·2** flowers; total production per square metre = **113·6** flowers.

TABLE VIII.—Series *b*: Two plants per hole; 0·34 m.² per plant; 12,000 plants per acre. (Factors 2563 and 1100.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
1	49	163	279	367	313	447	489	492	529	197	115	73	47
17	26	117	203	223	273	282	293	261	227	106	95	43	50
21	60	214	415	498	519	613	617	452	310	118	63	32	17
28	19	47	110	124	136	149	203	168	191	85	61	38	41
42	34	175	265	328	327	409	356	310	257	113	81	18	30
Totals . .	188	716	1272	1540	1568	1900	1958	1683	1514	619	415	204	185
Flowers p.p.p.d. . . .		**0·28**	**0·50**	**0·60**	**0·61**	**0·74**	**0·76**	**0·66**	**0·59**	**0·56**	**0·38**	**0·18**	**0·17**
Flowers p.m.²p.d. . .		**0·82**	**1·47**	**1·76**	**1·79**	**2·18**	**2·23**	**1·94**	**1·74**	**1·65**	**1·12**	**0·53**	**0·50**

Total production per plant = **42·2** flowers; total production per square metre = **124·1** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 5. 120 cm. × 75 cm.; 4000 holes per acre.

TABLE IX.—Series *a*: One plant per hole; 0·88 m.^{2} per plant; 4000 plants per acre. (Factors 1176 and 504.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
10	31	76	145	163	151	171	293	374	423	158	144	78	60
13	27	54	107	109	124	180	249	388	454	222	183	89	78
18	22	61	99	94	122	190	222	312	299	113	120	68	110
39	56	116	213	288	345	405	583	561	833	300	226	60	48
47	32	107	180	320	324	421	499	447	479	126	76	15	16
Totals . .	168	414	744	974	1066	1367	1846	2082	2488	919	749	310	312
Flowers p.p.p.d. . . .		**0·35**	**0·63**	**0·83**	**0·90**	**1·16**	**1·57**	**1·77**	**2·12**	**1·83**	**1·49**	**0·62**	**0·62**
Flowers p.m.^{2}p.d. . .		**0·39**	**0·72**	**0·95**	**1·02**	**1·32**	**1·78**	**2·01**	**2·41**	**2·08**	**1·69**	**0·70**	**0·70**

Total production per plant = **97·2** flowers; total production per square metre = **110·4** flowers.

TABLE X.—Series *b*: Two plants per hole; 0·44 m.^{2} per plant; 8000 plants per acre. (Factors 2455 and 1052.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
10	36	122	222	238	227	263	366	493	582	222	205	138	88
13	31	98	180	221	231	252	306	303	389	127	137	62	66
18	23	74	151	167	256	242	324	434	442	199	144	75	78
39	35	123	223	279	291	282	375	395	373	133	104	41	41
47	55	293	519	643	747	686	649	586	544	192	128	36	40
Totals . .	180	710	1295	1548	1752	1725	2020	2211	2330	873	718	352	313
Flowers p.p.p.d. . . .		**0·29**	**0·53**	**0·63**	**0·71**	**0·70**	**0·82**	**0·90**	**0·95**	**0·83**	**0·68**	**0·34**	**0·30**
Flowers p.m.^{2}p.d. . .		**0·66**	**1·20**	**1·43**	**1·61**	**1·59**	**1·86**	**2·04**	**2·16**	**1·89**	**1·54**	**0·78**	**0·68**

Total production per plant = **53·7** flowers; total production per square metre = **122·0** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 6. 30 cm. × 150 cm.; 9000 holes per acre.

TABLE XI.—Series *a*: One plant per hole; 0·46 m.² per plant; 9000 plants per acre. (Factors 2450 and 1050.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
2	86	151	256	293	226	303	444	518	608	213	221	133	89
25	62	105	180	212	193	216	301	355	407	165	182	103	89
29	60	70	116	132	147	157	172	140	132	35	31	11	11
46	92	155	256	381	371	396	622	698	632	199	96	22	15
54	50	133	188	151	176	173	260	282	328	153	96	54	29
Totals . .	350	614	996	1169	1113	1245	1799	1993	2107	765	626	323	233
Flowers p.p.p.d. . . .		0·25	0·41	0·48	0·46	0·51	0·73	0·81	0·86	0·72	0·59	0·31	0·22
Flowers p.m.²p.d. . .		0·54	0·89	1·04	1·00	1·11	1·58	1·76	1·87	1·57	1·28	0·67	0·48

Total production per plant = **44·4** flowers; total production per square metre = **96·5** flowers.

TABLE XII.—Series *b*: Two plants per hole; 0·23 m.² per plant; 18,000 plants per acre. (Factors 4930 and 2112.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
2	103	225	370	431	395	477	551	566	676	266	248	119	92
25	65	104	197	240	221	276	339	411	436	162	96	53	64
29	60	163	250	276	246	309	326	356	375	120	83	42	31
46	93	280	372	423	563	617	731	592	578	186	114	14	23
54	40	122	104	52	59	116	172	231	333	114	114	45	40
Totals . .	361	894	1293	1422	1484	1795	2119	2156	2398	848	655	273	250
Flowers p.p.p.d. . . .		0·18	0·26	0·29	0·30	0·36	0·43	0·44	0·49	0·40	0·31	0·13	0·12
Flowers p.m.²p.d. . .		0·78	1·13	1·26	1·30	1·56	1·86	1·91	2·12	1·74	1·35	0·56	0·52

Total production per plant = **25·9** flowers; total production per square metre = **112·6** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 7. 60 cm. × 150 cm.; 4000 holes per acre.

TABLE XIII.—Series *a*: One plant per hole; 0·88 m.² per plant; 4000 plants per acre. (Factors 896 and 384.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
5	20	45	87	85	104	158	210	225	197	83	43	21	17
8	9	18	24	35	38	40	81	111	94	41	29	23	14
24	19	38	54	83	102	99	142	182	234	133	109	59	36
27	37	95	185	218	251	279	309	343	393	163	113	27	35
31	43	80	164	173	195	250	380	518	534	272	175	142	101
Totals . .	128	276	514	594	690	826	1122	1379	1452	692	469	272	203
Flowers p.p.p.d. . . .		**0·31**	**0·58**	**0·67**	**0·78**	**0·92**	**1·26**	**1·54**	**1·62**	**1·80**	**1·22**	**0·71**	**0·53**
Flowers p.m.²p.d. . .		**0·35**	**0·66**	**0·76**	**0·89**	**1·05**	**1·43**	**1·75**	**1·84**	**2·05**	**1·39**	**0·80**	**0·64**

Total production per plant = **83·5** flowers; total production per square metre = **95·2** flowers.

TABLE XIV.—Series *b*: Two plants per hole; 0·44 m.² per plant; 8000 plants per acre. (Factors 2310 and 990.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
5	22	93	126	99	117	211	303	266	191	45	13	0	5
8	29	87	173	188	202	191	212	298	294	113	93	69	49
24	28	105	149	212	244	289	302	355	425	167	152	70	71
27	40	125	208	225	249	312	324	336	354	137	121	30	36
31	50	134	226	326	448	443	659	771	697	292	175	71	44
Totals . .	169	544	882	1050	1260	1446	1800	2026	1961	754	554	240	205
Flowers p.p.p.d. . . .		**0·24**	**0·38**	**0·45**	**0·55**	**0·63**	**0·79**	**0·88**	**0·85**	**0·76**	**0·56**	**0·25**	**0·21**
Flowers p.m.²p.d. . .		**0·55**	**0·86**	**1·02**	**1·25**	**1·43**	**1·80**	**2·00**	**1·93**	**1·73**	**1·27**	**0·57**	**0·48**

Total production per plant = **45·8** flowers; total production per square metre = **104·2** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 8. 90 cm. × 150 cm.; 3000 holes per acre.

TABLE XV.—Series *a*: One plant per hole; 1·36 m.² per plant; 3000 plants per acre. (Factors 651 and 279.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
9	12	37	71	68	80	93	127	168	172	88	76	50	38
19	28	36	72	92	99	99	150	189	294	142	144	116	126
23	14	17	50	66	72	97	146	160	185	86	30	10	5
34	10	17	31	32	48	67	95	113	134	46	53	35	19
38	29	65	146	197	256	294	372	471	584	235	266	121	96
Totals . .	93	172	370	455	555	650	890	1101	1369	597	569	332	284
Flowers p.p.p.d. . . .		0·26	0·57	0·70	0·85	1·00	1·37	1·70	2·11	2·14	2·04	1·19	1·04
Flowers p.m.²p.d. . .		0·19	0·42	0·52	0·62	0·73	1·00	1·25	1·55	1·57	1·50	0·87	0·76

Total production per plant = **104·8** flowers; total production per square metre = **76·8** flowers.

TABLE XVI.—Series *b*: Two plants per hole; 0·68 m.² per plant; 6000 plants per acre. (Factors 1430 and 615.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
9	21	74	126	75	100	131	205	330	331	142	105	60	64
19	26	61	106	168	169	214	278	341	415	193	172	107	85
23	19	84	122	155	186	217	268	202	211	89	65	48	36
34	8	16	37	42	43	47	72	151	137	64	40	29	18
38	31	95	214	293	345	399	487	568	726	224	197	74	44
Totals . .	105	330	605	733	843	1008	1310	1592	1820	712	579	318	247
Flowers p.p.p.d. . . .		0·23	0·42	0·51	0·59	0·71	0·92	1·11	1·27	1·16	0·94	0·52	0·40
Flowers p.m.²p.d. . .		0·29	0·54	0·65	0·76	0·91	1·18	1·42	1·63	1·48	1·20	0·67	0·51

Total production per plant = **61·4** flowers; total production per square metre = **78·6** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 9. 135 cm. × 150 cm.; 2000 holes per acre.

TABLE XVII.—Series *a*: One plant per hole; 2·00 m.^{2} per plant; 2000 plants per acre. (Factors 658 and 282.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
3	26	45	90	107	132	239	381	476	566	231	216	134	86
7	19	4	17	27	50	63	80	149	178	104	147	96	97
22	12	27	52	56	38	41	68	112	196	109	103	71	60
26	19	37	97	120	126	159	243	255	384	160	158	101	97
36	18	50	79	103	140	149	196	267	329	161	164	116	64
Totals . .	94	163	335	413	486	651	968	1259	1653	765	788	518	404
Flowers p.p.p.d. . . .		0·25	0·51	0·63	0 74	0·99	1·47	1·91	2·51	2·71	2·80	1·84	1·43
Flowers p.m.^{2}p.d. . .		0·12	0·25	0·31	0·74	0·49	0·73	0·95	1·25	1·35	1·40	0·92	0·71

Total production per plant = **124·5** flowers; total production per square metre = **65·4** flowers.

TABLE XVIII.—Series *b*: Two plants per hole; 1·00 m.^{2} per plant; 4000 plants per acre. (Factors 929 and 398.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
3	12	38	56	58	60	116	208	300	352	127	143	66	41
7	11	35	51	64	68	75	77	182	225	141	137	100	96
22	14	41	58	79	85	103	126	208	318	161	172	107	93
26	16	47	90	122	112	151	194	262	333	173	139	71	63
36	15	86	143	159	166	304	249	301	340	130	113	56	56
Totals . .	68	247	398	482	491	749	854	1253	1568	732	704	400	349
Flowers p.p.p.d. . . .		0·26	0·43	0·52	0·53	0·81	0·92	1·35	1·69	1·83	1·77	1·00	0·88
Flowers p.m.^{2}p.d. . .		0·26	0·43	0·52	0·53	0·81	0·92	1·35	1·69	1·83	1·77	1·00	0·88

Total production per plant = **83·9** flowers; total production per square metre = **83·9** flowers.

Daily Flowering Records for the Different Spacings. Tables I–XX—*continued.*

Spacing 10. 180 cm. × 150 cm. ; 1500 holes per acre.

TABLE XIX.—Series *a* : One plant per hole ; 2·75 m.² per plant ; 1500 plants per acre. (Factors 483 and 207.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
12	9	35	52	48	39	64	88	150	194	81	100	94	57
16	18	39	68	64	79	131	223	310	363	138	152	94	70
20	15	40	62	89	80	81	111	192	275	129	161	163	139
41	13	38	66	74	89	98	173	248	299	100	132	90	61
45	14	35	63	70	97	114	195	264	326	134	131	83	73
Totals . .	69	187	311	345	384	488	790	1164	1457	582	676	524	400
Flowers p.p.p.d. . . .		**0·39**	**0·64**	**0·71**	**0·79**	**1·01**	**1·64**	**2·41**	**3·01**	**2·81**	**3·51**	**2·53**	**1·93**
Flowers p.m.²p.d. . .		**0·14**	**0·23**	**0·26**	**0·29**	**0·37**	**0·60**	**0·88**	**1·09**	**1·02**	**1·27**	**0·92**	**0·70**

Total production per plant = **149·6** flowers ; total production per square metre = **54·4** flowers.

TABLE XX.—Series *b* : Two plants per hole ; 1·37 m.² per plant ; 3000 plants per acre. (Factors 888 and 380.)

Plots.	No. of holes.	June 28.	July 5.	July 12.	July 19.	July 26.	Aug. 2.	Aug. 9.	Aug. 16.	Aug. 23.	Aug. 30.	Sept. 6.	Sept. 13.
12	11	35	71	79	78	123	195	269	316	147	157	55	82
16	14	43	80	72	73	108	165	260	380	176	184	120	93
20	14	34	74	79	89	80	128	210	320	103	155	112	111
41	12	57	87	99	144	183	271	274	351	135	177	62	64
45	14	40	99	108	132	182	202	271	397	160	140	58	48
Totals . .	65	209	411	437	516	676	961	1284	1764	721	813	407	398
Flowers p.p.p.d. . . .		**0·23**	**0·46**	**0·49**	**0·58**	**0·76**	**1·08**	**1·45**	**1·98**	**0·81**	**0·91**	**0·46**	**0·45**
Flowers p.m.²p.d. . .		**0·17**	**0·33**	**0·36**	**0·42**	**0·55**	**0·78**	**1·05**	**1·44**	**0·59**	**0·66**	**0·33**	**0·33**

Total production per plant = **67·6** flowers ; total production per square metre = **49·0** flowers.

TABLES XXI–XL.—*Weekly Bolling Records for the different Spacings.*

These records were obtained by counting the number of ripe bolls (or open capsules) on the same group of plants in each plot as for the flowering records. Counts were made once a week, and therefore comprise the total number of bolls ripening during the week.

The totals in each week for five plots of one kind are then divided by seven times the number of plants included in the five groups. This gives the average rate of "bolling per plant per day" during the week *ending* on the given date.

The "bolling per square metre per day" is obtained by multiplying the "p.p.p.d." figures by the number of plants in a square metre.

Total yield, expressed as the number of ripe bolls, is obtained by addition of the weekly rates per day and multiplying by seven.

Computed figures as above are in leaded type; observed figures in ordinary type.

Italics.—These are employed for a separate computation, in which each plot is given equal weight, independently of the number of plants in its "Observation Rows," and is computed separately. The mean bolling "p.p.p.d." thus obtained is only slightly different from the other figures.

Reproduced graphically in figs. 5 and 6. Extracts also in fig. 3. Total yields only in figs. 7 and 8.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL.

Spacing 1. 30 cm. × 75 cm.; 18,000 holes per acre.

TABLE XXI.—Series α: One plant per hole; 0·23 m.^{2} per plant; 18,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
11	29	*0·20* 40	*0·27* 54	*0·28* 57	*0·34* 69	*0·27* 54	*0·19* 39	*0·12* 24	*0·07* 15	*0·19* 38	*0·17* 34	*0·06* 13	*0·05* 10	*0·03* 6
14	52	*0·13* 46	*0·23* 82	*0·36* 132	*0·34* 123	*0·40* 147	*0·29* 106	*0·21* 78	*0·12* 45	*0·09* 32	*0·06* 21	*0·07* 27	*0·04* 15	*0·02* 8
30	53	*0·04* 15	*0·17* 62	*0·21* 76	*0·41* 151	*0·38* 139	*0·32* 118	*0·33* 123	*0·24* 90	*0·16* 61	*0·27* 102	*0·17* 63	*0·09* 32	*0·06* 24
33	102	*0·06* 42	*0·15* 110	*0·29* 209	*0·39* 278	*0·56* 400	*0·54* 383	*0·49* 348	*0·27* 196	*0·12* 84	*0·16* 113	*0·11* 76	*0·02* 13	*0·01* 8
52	104	*0·08* 61	*0·04* 27	*0·22* 163	*0·28* 205	*0·36* 261	*0·41* 296	*0·40* 293	*0·26* 190	*0·16* 113	*0·14* 100	*0·09* 67	*0·06* 46	*0·06* 49
Totals .	340	204	335	637	826	1001	942	866	536	328	370	246	116	95
Bolls p.p.p.d. . .		*0·10* **0·08**	*0·17* **0·14**	*0·27* **0·27**	*0·35* **0·35**	*0·39* **0·42**	*0·35* **0·40**	*0·31* **0·36**	*0·19* **0·23**	*0·14* **0·14**	*0·16* **0·16**	*0·10* **0·10**	*0·05* **0·05**	*0·04* **0·03**
Bolls p.m.^{2}p.d. .		**0·35**	**0·61**	**1·17**	**1·52**	**1·83**	**1·74**	**1·57**	**1·00**	**0·61**	**0·70**	**0·43**	**0·22**	**0·13**

Total yield per plant = **19·1** bolls; total yield per square metre = **83·1** bolls.

TABLE XXII.—Series *b*: Two plants per hole; 0·12 m.² per plant; 36,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
11	73	*0·15* 148	*0·21* 210	*0·23* 231	*0·16* 156	*0·10* 105	*0·06* 58	*0·05* 54	*0·05* 54	*0·06* 56	*0·08* 84	*0·04* 40	*0·03* 28	*0·02* 18
14	83	*0·09* 107	*0·18* 209	*0·26* 291	*0·25* 287	*0·28* 319	*0·25* 286	*0·15* 170	*0·08* 92	*0·05* 51	*0·02* 17	*0·04* 41	*0·01* 3	*0·01* 9
30	42	*0·01* 7	*0·02* 14	*0·04* 23	*0·17* 98	*0·19* 107	*0·22* 128	*0·24* 136	*0·20* 113	*0·10* 57	*0·18* 105	*0·17* 100	*0·12* 71	*0·06* 33
33	86	*0·04* 49	*0·10* 112	*0·20* 235	*0·21* 243	*0·25* 289	*0·24* 283	*0·15* 171	*0·07* 87	*0·02* 28	*0·03* 35	*0·03* 30	*0·01* 14	*0·01* 4
52	108	*0·03* 48	*0·18* 263	*0·23* 333	*0·28* 413	*0·28* 419	*0·29* 423	*0·18* 258	*0·10* 147	*0·03* 47	*0·04* 57	*0·04* 60	*0·02* 23	*0·03* 41
Totals .	392	359	808	1113	1197	1239	1178	789	493	239	298	271	139	105
Bolls p.p.p.d. . .		*0·06* **0·07**	*0·14* **0·15**	*0·19* **0·21**	*0·21* **0·22**	*0·22* **0·23**	*0·21* **0·22**	*0·15* **0·15**	*0·10* **0·09**	*0·05* **0·04**	*0·07* **0·06**	*0·06* **0·05**	*0·04* **0·03**	*0·03* **0·02**
Bolls p.m.²p.d. .		**0·61**	**1·30**	**1·82**	**1·91**	**2·00**	**1·91**	**1·30**	**0·80**	**0·35**	**0·50**	**0·43**	**0·26**	**0·17**

Total yield per plant = **10·7** bolls; total yield per square metre = **93·5** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 2. 45 cm. × 75 cm.; 12,000 holes per acre.

TABLE XXIII.—Series α: One plant per hole; 0·34 m.² per plant; 12,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
6	49	*0·25* 86	*0·26* 88	*0·32* 110	*0·36* 122	*0·32* 110	*0·29* 101	*0·49* 167	*0·69* 236	*0·86* 297	*0·75* 256	*0·51* 176	*0·51* 175	*0·16* 54
15	63	*0·24* 105	*0·30* 130	*0·49* 215	*0·45* 197	*0·46* 203	*0·38* 167	*0·32* 140	*0·23* 102	*0·20* 89	*0·10* 42	*0·15* 65	*0·02* 10	*0·04* 19
32	77	*0·06* 34	*0·14* 74	*0·23* 124	*0·47* 256	*0·40* 216	*0·61* 330	*0·74* 401	*0·56* 301	*0·32* 174	*0·46* 246	*0·28* 149	*0·17* 90	*0·05* 28
40	87	*0·09* 57	*0·13* 77	*0·24* 146	*0·40* 241	*0·57* 346	*0·62* 378	*0·48* 294	*0·39* 235	*0·38* 234	*0·35* 214	*0·14* 83	*0·06* 38	*0·03* 17
53	88	*0·11* 67	*0·23* 144	*0·35* 214	*0·39* 239	*0·63* 390	*0·46* 282	*0·47* 292	*0·31* 189	*0·17* 107	*0·15* 90	*0·09* 57	*0·11* 66	*0·12* 71
Totals .	364	349	513	809	1055	1265	1258	1294	1063	901	848	530	379	189
Bolls p.p.p.d. . .		*0·15* **0·14**	*0·21* **0·21**	*0·33* **0·33**	*0·41* **0·43**	*0·48* **0·51**	*0·47* **0·51**	*0·50* **0·53**	*0·44* **0·43**	*0·39* **0·37**	*0·36* **0·34**	*0·23* **0·22**	*0·17* **0·15**	*0·08* **0·08**
Bolls p.m.²p.d. .		**0·41**	**0·62**	**0·97**	**1·26**	**1·50**	**1·50**	**1·56**	**1·26**	**1·09**	**1·00**	**0·65**	**0·44**	**0·24**

Total yield per plant = **29·7** bolls; total yield per square metre = **87·5** bolls.

TABLE XXIV.—Series *b*: Two plants per hole; 0·17 m.² per plant; 24,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
6	47	*0·06* 41	*0·07* 43	*0·13* 85	*0·20* 127	*0·32* 208	*0·30* 190	*0·31* 199	*0·29* 184	*0·32* 205	*0·30* 195	*0·25* 163	*0·22* 142	*0·07* 42
15	74	*0·15* 153	*0·15* 153	*0·26* 262	*0·29* 292	*0·25* 249	*0·21* 210	*0·14* 143	*0·09* 89	*0·09* 91	*0·05* 46	*0·05* 54	*0·01* 10	*0·01* 15
32	86	*0·04* 42	*0·07* 82	*0·16* 188	*0·21* 250	*0·35* 413	*0·37* 435	*0·33* 391	*0·44* 512	*0·26* 300	*0·21* 244	*0·12* 145	*0·06* 75	*0·02* 25
40	74	*0·04* 41	*0·08* 83	*0·15* 160	*0·22* 234	*0·31* 329	*0·32* 347	*0 32* 347	*0·26* 278	*0·12* 124	*0·12* 127	*0·05* 51	*0·04* 42	*0·01* 12
53	63	*0·04* 37	*0·14* 117	*0·23* 199	*0·25* 211	*0·35* 304	*0·28* 243	*0·28* 244	*0·22* 190	*0·12* 107	*0·15* 127	*0·06* 52	*0·08* 70	*0·04* 38
Totals .	344	314	478	894	1114	1503	1425	1324	1253	827	739	465	339	132
Bolls p.p.p.d. . .		*0·07* **0·07**	*0·10* **0·10**	*0·19* **0·19**	*0·23* **0·24**	*0·32* **0·32**	*0·30* **0·30**	*0·28* **0·28**	*0·26* **0·27**	*0·18* **0·18**	*0·17* **0·16**	*0·11* **0·10**	*0·08* **0·07**	*0·03* **0·03**
Bolls p.m.²p.d. .		**0·41**	**0·59**	**1·12**	**1·41**	**1·88**	**1·76**	**1·65**	**1·59**	**1·06**	**0·94**	**0·59**	**0·41**	**0·17**

Total yield per plant = **16·1** bolls; total yield per square metre = **95·0** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued*.

Spacing 3. 60 cm. × 75 cm.; 9,000 holes per acre.

TABLE XXV.—Series α: One plant per hole; 0·46 m.² per plant; 9,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
4	48	*0·38* 129	*0·37* 124	*0·41* 139	*0·35* 119	*0·32* 106	*0·31* 103	*0·38* 126	*0·27* 91	*0·46* 155	*0·34* 113	*0·20* 68	*0·17* 56	*0·05* 16
35	56	*0·17* 67	*0·19* 76	*0·38* 148	*0·50* 196	*0·68* 268	*0·61* 240	*0·64* 251	*0·37* 145	*0·39* 154	*0·62* 242	*0·25* 97	*0·11* 45	*0·04* 15
37	59	*0·04* 16	*0·20* 81	*0·31* 129	*0·48* 197	*0·55* 226	*0·60* 249	*0·77* 317	*0·84* 348	*0·62* 254	*0·63* 258	*0·37* 151	*0·18* 76	*0·10* 41
48	87	*0·22* 134	*0·11* 69	*0·30* 181	*0·86* 523	*0·70* 427	*0·66* 401	*0·56* 342	*0·33* 200	*0·30* 185	*0·19* 113	*0·10* 60	*0·06* 37	*0·05* 33
51	59	*0·16* 65	*0·12* 51	*0·37* 151	*0·37* 152	*0·36* 147	*0·30* 123	*0·43* 178	*0·52* 214	*0·68* 281	*0·45* 187	*0·58* 238	*0·35* 145	*0·20* 83
Totals .	309	411	401	748	1187	1174	1116	1214	998	1029	913	614	359	188
Bolls p.p.p.d. . .		*0·19* **0·19**	*0·20* **0·19**	*0·35* **0·34**	*0·51* **0·55**	*0·52* **0·54**	*0·50* **0·52**	*0·56* **0·56**	*0·47* **0·46**	*0·49* **0·47**	*0·45* **0·42**	*0·30* **0·28**	*0·17* **0·17**	*0·09* **0·09**
Bolls p.m.²p.d. .		**0·41**	**0·41**	**0·74**	**1·20**	**1·17**	**1·13**	**1·22**	**1·00**	**1·02**	**0·91**	**0·61**	**0·37**	**0·20**

Total yield per plant = **33·4** bolls; total yield per square metre = **72·7** bolls.

TABLE XXVI.—Series *b*: Two plants per hole; 0·23 m.[2] per plant; 18,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
4	44	*0·23* 136	*0·21* 124	*0·15* 87	*0 20* 117	*0·21* 124	*0·25* 147	*0·32* 192	*0·35* 213	*0·38* 226	*0·24* 144	*0·15* 87	*0·16* 94	*0·05* 28
35	56	*0·04* 31	*0·11* 81	*0·17* 126	*0·35* 270	*0·46* 350	*0·51* 393	*0·59* 448	0·55 418	*0·27* 207	*0·36* 275	*0·16* 120	*0·08* 63	*0·03* 24
37	61	*0·03* 24	*0·02* 18	*0·15* 125	*0·17* 142	*0·25* 209	*0·38* 316	*0·47* 394	*0·44* 368	*0·40* 336	0·35 292	*0·33* 279	*0·15* 126	*0·11* 90
48	86	*0·07* 79	*0·21* 249	*0·19* 224	*0·42* 497	*0·40* 466	*0·32* 373	*0·22* 255	*0·20* 234	*0·12* 141	*0·10* 117	*0·06* 67	*0·03* 41	*0·04* 44
51	59	*0·03* 22	*0·17* 137	*0·22* 179	*0·32* 258	*0·29* 237	*0·14* 111	*0·22* 179	*0·18* 147	*0·12* 98	*0·15* 121	*0·15* 124	*0·07* 57	*0·11* 86
Totals .	306	292	609	741	1284	1386	1340	1468	1380	1008	949	677	381	272
Bolls p.p.p.d. . .		*0·08* **0·07**	*0·14* **0·14**	*0·18* **0·18**	*0·29* **0·31**	*0·32* **0·33**	*0·32* **0·32**	*0·36* **0·35**	*0·34* **0·33**	*0·26* **0·24**	*0·24* **0·23**	*0·17* **0·16**	*0·10* **0·09**	*0·07* **0·06**
Bolls p.m.[2]p.d. .		**0·30**	**0·61**	**0·77**	**1·34**	**1·43**	**1·39**	**1·52**	**1·43**	**1·04**	**1·00**	**0·69**	**0·39**	**0·26**

Total yield per plant = **19·6** bolls; total yield per square metre = **85·2** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 4. 90 cm. × 75 cm.; 6000 holes per acre.

TABLE XXVII.—Series *a*: One plant per hole; 0·68 m.² per plant; 6,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
1	48	*0·24* 81	*0·28* 94	*0·43* 144	*0·49* 163	*0·52* 174	*0·56* 188	*0·64* 216	*0·99* 331	*1·09* 368	*0·89* 300	*0·58* 195	*0·71* 237	*0·29* 98
17	18	*0·33* 41	*0·48* 61	*0·55* 70	*0·97* 122	*0·98* 123	*0·88* 111	*0·99* 125	*0·96* 121	*1·16* 146	*0·55* 70	*0·74* 93	*0·29* 36	*0·18* 23
21	50	*0·24* 85	*0·39* 136	*0·46* 162	*0·72* 254	*0·74* 258	*0·55* 191	*0·59* 208	*0·26* 91	*0·29* 102	*0·44* 155	*0·08* 27	*0·15* 53	*0·03* 10
28	20	*0·21* 30	*0·27* 38	*0·42* 59	*0·46* 65	*0·39* 55	*0·53* 74	*0·54* 75	*0·53* 74	*0·55* 77	*0·99* 139	*0·74* 104	*0·48* 67	*0·21* 29
42	47	*0·36* 120	*0·15* 49	*0·47* 154	*0·66* 216	*0·67* 219	*0·55* 182	*0·49* 162	*0·50* 164	*0·63* 209	*0·68* 223	*0·25* 83	*0·19* 61	*0·09* 29
Totals .	183	357	378	589	820	829	746	786	781	902	887	502	454	189
Bolls p.p.p.d. . .		*0·28* **0·28**	*0·31* **0·29**	*0·47* **0·46**	*0·66* **0·64**	*0·66* **0·65**	*0·61* **0·58**	*0·65* **0·61**	*0·65* **0·61**	*0·71* **0·70**	*0·71* **0·69**	*0·48* **0·39**	*0·36* **0·36**	*0·16* **0·15**
Bolls p.m.²p.d. .		**0·41**	**0·43**	**0·68**	**0·94**	**0·95**	**0·87**	**0·90**	**0·90**	**1·03**	**1·02**	**0·57**	**0·53**	**0·22**

Total yield per plant = **44·8** bolls; total yield per square metre = **66·1** bolls.

TABLE XXVIII.—Series *b* : Two plants per hole ; 0·34 m.^{2} per plant ; 12,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
1	49	*0·17* 112	*0·22* 144	*0·34* 229	*0·36* 239	*0·36* 240	*0·35* 233	*0·43* 287	*0·37* 246	*0·44* 293	*0·39* 261	*0·26* 172	*0·24* 161	*0·05* 35
17	26	*0·19* 66	*0·31* 110	*0·34* 121	*0·38* 136	*0·43* 151	*0·44* 156	*0·34* 121	*0·30* 105	*0·39* 140	*0·28* 100	*0·41* 145	*0·23* 83	*0·10* 37
21	60	*0·15* 126	*0·25* 207	*0·29* 241	*0·30* 299	*0·40* 331	*0·27* 222	*0·32* 259	*0·23* 186	*0·16* 134	*0·22* 179	*0·05* 40	*0·07* 54	*0·02* 19
28	19	*0·07* 19	*0·09* 23	*0·22* 57	*0·42* 109	*0·34* 87	*0·40* 104	*0·41* 106	*0·51* 131	*0·82* 212	*0·60* 156	*0·46* 119	*0·44* 114	*0·20* 52
42	34	*0·15* 72	*0·29* 136	*0·34* 160	*0·48* 221	*0·51* 238	*0·45* 207	*0·34* 159	*0·36* 167	*0·32* 148	*0·38* 178	*0·23* 108	*0·14* 63	*0·07* 32
Totals .	188	395	620	808	1004	1047	922	932	835	927	874	584	475	175
Bolls p.p.p.d. . .		*0·15* **0·15**	*0·23* **0·24**	*0·31* **0·31**	*0·39* **0·39**	*0·41* **0·41**	*0·38* **0·36**	*0·37* **0·36**	*0·35* **0·33**	*0·42* **0·36**	*0·37* **0·34**	*0·28* **0·23**	*0·22* **0·18**	*0·09* **0·07**
Bolls p.m.^{2}p.d. .		**0·44**	**0·70**	**0·91**	**1·15**	**1·20**	**1·06**	**1·06**	**0·97**	**1·06**	**1·00**	**0·67**	**0·53**	**0·21**

Total yield per plant = **26·1** bolls ; total yield per square metre = **76·7** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 5. 120 cm. × 75 cm.; 4000 holes per acre.

TABLE XXIX.—Series a: One plant per hole; 0·88 m.[2] per plant; 4,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
10	31	*0·33* 71	*0·38* 83	*0·47* 102	*0·53* 118	*0·48* 103	*0·68* 148	*0·72* 156	*1·09* 237	*0·97* 219	*1·08* 235	*0·60* 131	*0·48* 104	*0·09* 20
13	27	*0·16* 31	*0·35* 67	*0·43* 82	*0·49* 92	*0·60* 114	*0·59* 112	*1·00* 189	*1·30* 246	*1·53* 288	*1·10* 207	*1·24* 235	*0·66* 125	*0·32* 60
18	22	*0·31* 48	*0·23* 35	*0·33* 51	*0·42* 64	*0·58* 90	*0·77* 119	*0·97* 150	*1·03* 159	*1·36* 210	*0·76* 117	*1·15* 178	*0·47* 73	*0·20* 31
39	56	*0·22* 85	*0·04* 16	*0·37* 146	*0·48* 186	*0·58* 226	*0·54* 214	*0·71* 278	*0·92* 362	*0·75* 294	*1·10* 432	*0·72* 281	*0·39* 152	*0·14* 56
47	32	*0·34* 76	*0·11* 24	*0·43* 96	*1·53* 342	*0·75* 168	*0·74* 166	*0·88* 198	*0·88* 198	*0·95* 213	*0·49* 109	*0·45* 110	*0·10* 23	*0·16* 36
Totals .	168	311	225	477	802	701	759	971	1202	1224	1100	925	477	203
Bolls p.p.p.d. . .		*0·27* **0·26**	*0·22* **0·19**	*0·41* **0·40**	*0·69* **0·68**	*0·60* **0·60**	*0·66* **0·65**	*0·85* **0·83**	*1·04* **1·02**	*1·11* **1·04**	*0·92* **0·94**	*0·83* **0·79**	*0·42* **0·41**	*0·18* **0·17**
Bolls p.m.^{2}p.d . .		**0·30**	**0·22**	**0·45**	**0·77**	**0·68**	**0·74**	**0·94**	**1·16**	**1·18**	**1·07**	**0·90**	**0·46**	**0·19**

Total yield per plant = **55·8** bolls; total yield per square metre = **63·4** bolls.

TABLE XXX.—Series *b* : Two plants per hole ; 0·44 m.² per plant ; 8000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
10	36	*0·22* 110	*0·22* 108	*0·28* 136	*0·32* 160	*0·34* 168	*0·33* 163	*0·38* 186	*0·62* 302	*0·73* 356	*0·59* 289	*0·41* 202	*0·36* 176	*0·07* 32
13	31	*0·08* 77	*0·24* 100	*0·36* 151	*0·36* 151	*0·43* 181	*0·31* 131	*0·33* 142	*0·47* 198	*0·41* 176	*0·39* 167	*0·54* 231	*0·24* 101	*0·13* 57
18	23	*0·08* 24	*0·16* 49	*0·35* 111	*0·41* 129	*0·38* 152	*0·66* 208	*0·64* 200	*0·77* 243	*0·81* 254	*0·70* 221	*0·86* 271	*0·33* 105	*0·19* 60
39	35	*0·12* 59	*0·19* 90	*0·27* 131	*0·38* 183	*0·36* 174	*0·34* 164	*0·32* 153	*0·36* 174	*0·32* 152	*0·48* 229	*0·26* 123	*0·20* 94	*0·06* 28
47	55	*0·15* 111	*0·26* 197	*0·36* 272	*0·59* 446	*0·51* 384	*0·39* 292	*0·50* 373	*0·35* 260	*0·31* 232	*0·22* 162	*0·16* 117	*0·16* 121	*0·09* 67
Totals .	180	381	544	801	1069	1059	958	1054	1177	1170	1068	944	597	244
Bolls p.p.p.d. . .		*0·15* **0·15**	*0·21* **0·22**	*0·32* **0·33**	*0·41* **0·44**	*0·40* **0·43**	*0·41* **0·39**	*0·43* **0·43**	*0·51* **0·48**	*0·52* **0·48**	*0·48* **0·44**	*0·45* **0·39**	*0·26* **0·24**	*0·11* **0·10**
Bolls p.m.²p.d. .		**0·34**	**0·50**	**0·75**	**1·00**	**0·98**	**0·89**	**0·98**	**1·09**	**1·09**	**1·00**	**0·89**	**0·55**	**0·23**

Total yield per plant = **31·6** bolls ; total yield per square metre = **72·0** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 6. 30 cm. × 150 cm.; 9000 holes per acre.

TABLE XXXI.—Series a: One plant per hole; 0·46 m.^{2} per plant; 9000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
2	86	*0·19* 116	*0·22* 135	*0·31* 187	*0·29* 175	*0·30* 178	*0·30* 179	*0·40* 239	*0·60* 364	*0·61* 369	*0·53* 320	*0·31* 184	*0·40* 243	*0·10* 58
25	62	*0·05* 23	*0·18* 77	*0·20* 89	*0·29* 126	*0·32* 139	*0·32* 137	*0·34* 153	*0·41* 180	*0·59* 258	*0·59* 256	*0·55* 238	*0·50* 216	*0·23* 99
29	60	*0·09* 38	*0·10* 41	*0·12* 52	*0·25* 106	*0·15* 63	*0·22* 93	*0·17* 70	*0·18* 75	*0·14* 59	*0·15* 64	*0·13* 55	*0·05* 21	*0·02* 9
46	92	*0·10* 62	*0·11* 72	*0·18* 117	*0·58* 372	*0·40* 255	*0·39* 253	*0·38* 243	*0·48* 309	*0·54* 348	*0·41* 263	*0·22* 144	*0·07* 46	*0·05* 32
54	50	*0·20* 70	*0·09* 31	*0·29* 100	*0·30* 106	*0·33* 116	*0·33* 117	*0·34* 120	*0·48* 166	*0·78* 271	*0·50* 176	*0·50* 177	*0·17* 60	*0·07* 24
Totals .	350	309	356	545	885	751	779	825	1094	1305	1079	798	586	222
Bolls p.p.p.d. . .		*0·13* **0·12**	*0·14* **0·15**	*0·22* **0·22**	*0·34* **0·36**	*0·30* **0·31**	*0·31* **0·32**	*0·33* **0·34**	*0·43* **0·45**	*0·53* **0·53**	*0·44* **0·44**	*0·34* **0·33**	*0·24* **0·24**	*0·09* **0·09**
Bolls p.m.^{2}p.d. .		**0·26**	**0·33**	**0·48**	**0·78**	**0·67**	**0·70**	**0·74**	**0·98**	**1·15**	**0·96**	**0·72**	**0·52**	**0·19**

Total yield per plant = **27·3** bolls; total yield per square metre = **59·3** bolls.

Table XXXII.—Series *b*: Two plants per hole; 0·23 m.^{2} per plant; 18,000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
2	103	*0·11* 161	*0·13* 190	*0·19* 273	*0·24* 342	*0·25* 354	*0·19* 265	*0·26* 368	*0·23* 322	*0·26* 373	*0·28* 388	*0·17* 237	*0·19* 268	*0·04* 50
25	65	*0·02* 17	*0·03* 30	*0·10* 85	*0·20* 181	*0·19* 167	*0·20* 180	*0·21* 185	*0·28* 249	*0·19* 171	*0·34* 304	*0·18* 163	*0·14* 122	*0·08* 74
29	60	*0·04* 35	*0·06* 47	*0·15* 122	*0·25* 201	*0·22* 178	*0·25* 204	*0·26* 216	*0·30* 243	*0·25* 203	*0·30* 246	*0·20* 165	*0·14* 115	*0·05* 45
46	93	*0·03* 32	*0·06* 82	*0·15* 194	*0·25* 315	*0·32* 404	*0·38* 480	*0·37* 470	*0·31* 394	*0·24* 307	*0·27* 337	*0·14* 176	*0·03* 34	*0·06* 70
54	40	*0·10* 55	*0·12* 63	*0·13* 73	*0·06* 31	*0·10* 58	*0·08* 45	*0·14* 78	*0·30* 162	*0·40* 218	*0·30* 161	*0·22* 119	*0·12* 65	*0·05* 29
Totals .	361	300	412	747	1070	1161	1174	1317	1370	1272	1436	860	604	268
Bolls p.p.p.d. . .		*0·06* **0·06**	*0·08* **0·08**	*0·14* **0·15**	*0·20* **0·22**	*0·29* **0·24**	*0·22* **0·24**	*0·25* **0·27**	*0·28* **0·28**	*0·27* **0·26**	*0·30* **0·29**	*0·18* **0·17**	*0·12* **0·12**	*0·06* **0·05**
Bolls p.m.^{2}p.d. .		**0·26**	**0·35**	**0·65**	**0·95**	**1·04**	**1·04**	**1·17**	**1·21**	**1·13**	**1·26**	**0·74**	**0·52**	**0·22**

Total yield per plant = **17·0** bolls; total yield per square metre = **73·7** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 7. 60 cm. × 150 cm. ; 4000 holes per acre.

TABLE XXXIII.—Series a : One plant per hole ; 0·88 m.^{2} per plant ; 4000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
5	20	*0·42* 59	*0·29* 41	*0·36* 51	*0·56* 78	*0·56* 79	*0·54* 75	*0·74* 104	*0·70* 98	*0·84* 118	*0·61* 86	*0·27* 38	*0·19* 27	*0·06* 9
8	9	*0·16* 10	*0·15* 9	*0·46* 29	*0·52* 33	*0·33* 21	*0·43* 27	*0·86* 54	*1·01* 64	*1·10* 69	*0·94* 59	*0·63* 40	*0·57* 36	*0·62* 39
24	19	*0·09* 12	*0·20* 27	*0·42* 56	*0·46* 61	*0·71* 94	*0·50* 66	*0·56* 74	*0·67* 89	*1·31* 174	*1·49* 198	*0·97* 129	*0·58* 77	*0·25* 33
27	37	*0·26* 67	*0·24* 63	*0·43* 112	*0·55* 143	*0·67* 173	*0·66* 170	*0·56* 145	*0·68* 176	*0·64* 167	*1·06* 274	*0·47* 121	*0·29* 76	*0·10* 25
31	43	*0·08* 24	*0·18* 54	*0·26* 77	*0·42* 127	*0·44* 132	*0·51* 153	*0·80* 241	*0·93* 281	*0·94* 283	*1·31* 394	*0·94* 282	*0·58* 176	*0·36* 108
Totals .	128	172	194	325	442	499	491	618	708	811	1011	610	392	214
Bolls p.p.p.d. . .		*0·20* 0·19	*0·21* 0·22	*0·39* 0·37	*0·50* 0·50	*0·54* 0·56	*0·53* 0·55	*0·70* 0·69	*0·80* 0·79	*0·97* 0·91	*1·08* 1·13	*0·66* 0·68	*0·44* 0·44	*0·28* 0·24
Bolls p.m.^{2}p.d. .		0·22	0·25	0·42	0·57	0·64	0·62	0·79	0·90	1·03	1·29	0·77	0·50	0·27

Total yield per plant = **50·9** bolls ; total yield per square metre = **57·8** bolls.

TABLE XXXIV.—Series *b* : Two plants per hole ; 0·44 m.^{2} per plant ; 8000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
5	22	*0·45* 134	*0·28* 84	*0·22* 67	*0·31* 92	*0·40* 119	*0·41* 123	*0·42* 126	*0·24* 72	*0·20* 59	*0·21* 62	*0·07* 21	*0·02* 7	*0·01* 3
8	29	*0·17* 69	*0·25* 100	*0·27* 106	*0·37* 145	*0·32* 126	*0·28* 112	*0·26* 102	*0·43* 168	*0·43* 169	*0·43* 172	*0·25* 100	*0·20* 79	*0·04* 14
24	28	*0·09* 36	*0·15* 56	*0·37* 140	*0·30* 116	*0·49* 187	*0·47* 178	*0·51* 194	*0·47* 181	*0·43* 165	*0·78* 299	*0·28* 106	*0·37* 143	*0·09* 33
27	40	*0·07* 37	*0·14* 74	*0·24* 131	*0·37* 203	*0·30* 162	*0·32* 177	*0·19* 102	*0·31* 168	*0·35* 192	*0·37* 200	*0·25* 135	*0·13* 71	*0·07* 39
31	50	*0·04* 30	*0·13* 86	*0·22* 148	*0·32* 222	*0·45* 311	*0·50* 345	*0·70* 480	*0·70* 480	*0·54* 371	*0·65* 447	*0·40* 274	*0·20* 140	*0·10* 67
Totals .	169	306	400	592	778	905	935	1004	1069	956	1180	636	440	156
Bolls p.p.p.d. . .		*0·16* **0·13**	*0·19* **0·17**	*0·26* **0·26**	*0·33* **0·34**	*0·39* **0·39**	*0·40* **0·40**	*0·42* **0·43**	*0·43* **0·46**	*0·39* **0·41**	*0·49* **0·51**	*0·25* **0·28**	*0·18* **0·19**	*0·06* **0·07**
Bolls p.m.^{2}p.d. .		**0·30**	**0·39**	**0·59**	**0·77**	**0·89**	**0·91**	**0·98**	**1·05**	**0·93**	**1·16**	**0·64**	**0·43**	**0·16**

Total yield per plant = **28·2** bolls ; total yield per square metre = **64·4** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 8. 90 cm. × 150 cm.; 3000 holes per acre.

TABLE XXXV.—Series α: One plant per hole; 1·36 m.^{2} per plant; 3000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
9	12	*0·44* 37	*0·44* 37	*0·54* 45	*0·63* 53	*0·77* 65	*0·68* 57	*0·89* 75	*1·29* 108	*1·50* 126	*1·44* 121	*1·20* 101	*0·88* 74	*0·14* 12
19	28	*0·06* 11	*0·19* 37	*0·29* 56	*0·40* 79	*0·32* 62	*0·46* 90	*0·45* 89	*0·60* 118	*1·11* 217	*1·28* 251	*0·87* 170	*0·96* 188	*0·35* 69
23	14	*0·18* 18	*0·14* 14	*0·25* 25	*0·50* 49	*0·61* 60	*0·54* 53	*0·57* 56	*0·92* 91	*1·23* 120	*1·52* 149	*0·41* 40	*0·10* 10	*0·10* 10
34	10	*0·13* 9	*0·10* 7	*0·27* 19	*0·39* 27	*0·67* 47	*0·47* 33	*0·57* 40	*1·04* 73	*0·87* 61	*0·93* 65	*0·73* 52	*0·70* 49	*0·26* 18
38	29	*0·22* 45	*0·12* 24	*0·59* 120	*0·57* 116	*0·74* 151	*0·73* 149	*0·80* 162	*1·18* 239	*1·77* 359	*1·79* 363	*1·34* 272	*0·74* 151	*0·31* 63
Totals .	93	120	119	265	324	385	382	422	629	883	949	635	472	172
Bolls p.p.p.d. . .		*0·20* **0·18**	*0·20* **0·18**	*0·39* **0·41**	*0·50* **0·50**	*0·62* **0·59**	*0·58* **0·59**	*0·66* **0·65**	*1·00* **0·97**	*1·30* **1·36**	*1·39* **1·46**	*0·91* **0·98**	*0·68* **0·73**	*0·23* **0·26**
Bolls p.m.^{2}p.d. .		**0·13**	**0·13**	**0·30**	**0·37**	**0·43**	**0·43**	**0·48**	**0·76**	**1·00**	**1·07**	**0·72**	**0·54**	**0·19**

Total yield per plant = **62·0** bolls; total yield per square metre = **45·8** bolls.

TABLE XXXVI.—Series *b*: Two plants per hole; 0·68 m.^{2} per plant; 6000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
9	21	*0·22* 65	*0·21* 61	*0·22* 63	*0·23* 66	*0·27* 78	*0·28* 81	*0·40* 121	*0·66* 192	*0·61* 178	*0·54* 156	*0·43* 127	*0·28* 110	*0·07* 21
19	26	*0·07* 27	*0·18* 66	*0·26* 92	*0·40* 143	*0·40* 143	*0·42* 133	*0·53* 192	*0·62* 223	*0·67* 241	*0·88* 318	*0·39* 141	*0·59* 212	*0·14* 52
23	19	*0·26* 69	*0·20* 52	*0·29* 76	*0·48* 127	*0·66* 173	*0·39* 103	*0·32* 84	*0·40* 105	*0·52* 137	*0·40* 106	*0·26* 67	*0·24* 61	*0·17* 45
34	8	*0·07* 8	*0·09* 10	*0·23* 26	*0·36* 39	*0·23* 26	*0·32* 35	*0·43* 46	*0·57* 63	*0·72* 80	*0·96* 107	*0·77* 85	*0·57* 64	*0·24* 27
38	31	*0·02* 10	*0·18* 78	*0·33* 141	*0·36* 154	*0·51* 216	*0·50* 212	*0·52* 224	*0·73* 312	*0·83* 349	*0·79* 338	*0·45* 193	*0·35* 149	*0·11* 47
Totals .	105	179	267	398	529	636	564	667	895	985	1025	613	596	192
Bolls p.p.p.d. . .		*0·13* **0·12**	*0·17* **0·19**	*0·27* **0·28**	*0·37* **0·37**	*0·41* **0·44**	*0·38* **0·39**	*0·44* **0·47**	*0·60* **0·63**	*0·67* **0·69**	*0·71* **0·72**	*0·46* **0·43**	*0·41* **0·42**	*0·15* **0·13**
Bolls p.m.^{2}p.d. .		**0·18**	**0·28**	**0·41**	**0·54**	**0·65**	**0·57**	**0·69**	**0·93**	**1·01**	**1·06**	**0·63**	**0·62**	**0·19**

Total yield per plant = **36·9** bolls; total yield per square metre = **54·3** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 9. 135 cm. × 150 cm.; 2000 holes per acre.

TABLE XXXVII.—Series *a*: One plant per hole; 2·00 m.^{2} per plant; 2000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
3	26	*0·26* 47	*0·28* 52	*0·46* 85	*0·72* 132	*0·73* 135	*1·19* 219	*1·59* 292	*1·09* 200	*2·19* 403	*1·53* 281	*0·75* 138	*0·90* 166	*0·12* 23
7	19	*0·02* 2	*0·07* 9	*0·10* 14	*0·28* 37	*0·33* 44	*0·22* 29	*0·54* 72	*0·74* 98	*1·41* 187	*1·28* 170	*1·23* 164	*0·99* 131	*0·65* 87
22	12	*0·18* 15	*0·24* 20	*0·36* 30	*0·38* 32	*0·39* 33	*0·27* 23	*0·65* 55	*1·11* 93	*1·36* 114	*1·75* 147	*0·78* 66	*1·15* 97	*0·55* 46
26	19	*0·17* 22	*0·46* 61	*0·50* 67	*0·77* 102	*0·75* 100	*0·88* 117	*0·75* 100	*1·53* 204	*1·07* 143	*2·08* 276	*1·39* 185	*1·18* 157	*0·46* 61
37	18	*0·13* 16	*0·64* 81	*1·02* 129	*1·56* 197	*1·79* 226	*1·97* 249	*2·51* 317	*2·76* 348	*2·01* 254	*2·05* 258	*1·19* 151	*0·60* 76	*0·34* 43
Totals .	94	102	223	325	500	538	637	836	943	1101	1132	704	627	260
Bolls p.p.p.d. . .		*0·15* **0·15**	*0·34* **0·34**	*0·49* **0·50**	*0·74* **0·76**	*0·80* **0·82**	*0·91* **0·97**	*1·21* **1·27**	*1·45* **1·43**	*1·61* **1·68**	*1·74* **1·72**	*1·07* **1·06**	*0·96* **0·95**	*0·42* **0·40**
Bolls p.m.^{2}p.d. .		**0·7**	**0·17**	**0·25**	**0·38**	**0·41**	**0·48**	**0·63**	**0·71**	**0·84**	**0·86**	**0·53**	**0·47**	**0·20**

Total yield per plant = **84·3** bolls; total yield per square metre = **42·0** bolls.

TABLE XXXVIII.—Series *b* : Two plants per hole ; 1·00 m.² per plant ; 4000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
3	12	*0·24* 40	*0·18* 30	*0·25* 41	*0·30* 49	*0·28* 46	*0·67* 109	*0·87* 143	*1·26* 207	*1·23* 201	*0·92* 151	*0·50* 82	*0·60* 99	*0·13* 22
7	11	*0·09* 13	*0·19* 28	*0·31* 47	*0·31* 46	*0·34* 51	*0·25* 37	*0·43* 64	*0·60* 90	*1·34* 202	*1·52* 228	*1·03* 154	*0·89* 134	*0·33* 49
22	14	*0·25* 24	*0·25* 24	*0·70* 68	*0·63* 61	*0·47* 46	*0·65* 63	*0·79* 77	*1·66* 161	*2·24* 217	*2·92* 283	*1·45* 141	*2·09* 203	*0·71* 69
26	16	*0·04* 8	*0·21* 45	*0·35* 76	*0·39* 84	*0·39* 86	*0·42* 91	*0·62* 136	*0·76* 166	*0·85* 186	*1·04* 226	*0·70* 153	*0·61* 132	*0·26* 57
36	15	*0·37* 76	*0·18* 36	*0·47* 97	*0·49* 101	*0·79* 162	*0·69* 141	*0·67* 138	*0·86* 177	*0·96* 197	*1·04* 214	*0·63* 130	*0·49* 100	*0·18* 37
Totals .	68	161	163	329	341	391	441	558	801	1003	1102	660	668	234
Bolls p.p.p.d. . .		*0·20* **0·17**	*0·20* **0·18**	*0·42* **0·35**	*0·42* **0·37**	*0·45* **0·42**	*0·54* **0·48**	*0·68* **0·60**	*1·03* **0·86**	*1·32* **1·08**	*1·49* **1·19**	*0·86* **0·71**	*0·94* **0·72**	*0·32* **0·25**
Bolls p.m.²p.d. .		**0·17**	**0·18**	**0·35**	**0·37**	**0·42**	**0·48**	**0·60**	**0·86**	**1·08**	**1·19**	**0·71**	**0·72**	**0·25**

Total yield per plant = **51·6** bolls ; total yield per square metre = **51·6** bolls.

Weekly Bolling Records for the Different Spacings. Tables XXI–XL—*continued.*

Spacing 10. 180 cm. × 150 cm. ; 1500 holes per acre.

TABLE XXXIX.—Series *a* : One plant per hole ; 2·75 m.^{2} per plant ; 1500 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
12	9	*0·62* 39	*0·32* 20	*0·67* 42	*0·63* 40	*0·89* 56	*0·64* 40	*1·29* 81	*2·31* 145	*2·65* 167	*2·67* 168	*1·72* 108	*1·67* 105	*0·41* 26
16	18	*0·24* 30	*0·29* 37	*0·40* 51	*0·53* 67	*0·79* 100	*0·99* 124	*1·35* 170	*1·78* 224	*1·61* 203	*1·46* 184	*1·23* 155	*0·81* 102	*0·13* 13
20	15	*0·21* 22	*0·20* 21	*0·61* 64	*0·49* 51	*0·44* 46	*0·51* 54	*0·63* 66	*1·09* 115	*1·15* 121	*2·44* 256	*1·18* 124	*1·83* 192	*0·51* 54
41	13	*0·36* 33	*0·31* 28	*0·56* 51	*0·69* 63	*0·95* 86	*0·76* 69	*1·33* 121	*1·68* 153	*1·42* 129	*1·89* 172	*1·68* 153	*1·41* 128	*0·48* 49
45	14	*0·20* 20	*0·26* 26	*0·50* 49	*0·80* 78	*0·74* 73	*0·56* 55	*0·82* 80	*1·68* 165	*1·68* 165	*1·75* 171	*1·40* 137	*1·19* 117	*0·74* 73
Totals .	69	144	132	257	299	361	342	518	802	785	951	677	644	215
Bolls p.p.p.d. . .		*0·32* **0·30**	*0·28* **0·27**	*0·55* **0·53**	*0·63* **0·62**	*0·76* **0·75**	*0·69* **0·71**	*1·08* **1·07**	*1·71* **1·66**	*1·70* **1·62**	*2·04* **1·96**	*1·44* **1·40**	*1·38* **1·33**	*0·45* **0·45**
Bolls p.m.^{2}p.d. .		**0·11**	**0·10**	**0·19**	**0·23**	**0·27**	**0·26**	**0·39**	**0·60**	**0·59**	**0·71**	**0·51**	**0·48**	**0·16**

Total yield per plant = **88·7** bolls ; total yield per square metre = **32·2** bolls.

Table XL.—Series b : Two plants per hole ; 1·37 m.² per plant ; 3000 plants per acre.

Plots.	No. of holes.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
12	11	*0·18* 27	*0·31* 46	*0·35* 53	*0·51* 77	*0·55* 82	*0·67* 100	*0·84* 126	*1·11* 167	*1·21* 182	*0·92* 139	*0·95* 143	*0·68* 102	*0·20* 30
16	14	*0·09* 17	*0·21* 41	*0·32* 61	*0·28* 53	*0·35* 67	*0·43* 82	*0·57* 109	*1·07* 205	*1·16* 221	*1·14* 217	*1·19* 228	*0·86* 164	*0·24* 46
20	14	*0·10* 19	*0·26* 49	*0·32* 62	*0·36* 69	*0·28* 54	*0·27* 52	*0·43* 83	*0·79* 152	*0·72* 137	*1·20* 229	*0·58* 110	*0·79* 151	*0·28* 53
41	12	*0·13* 22	*0·34* 56	*0·48* 79	*0·68* 111	*0·87* 143	*0·78* 127	*0·91* 149	*1·17* 192	*1·24* 204	*1·50* 246	*1·23* 202	*0·76* 125	*0·32* 52
45	14	*0·12* 23	*0·25* 48	*0·41* 78	*0·61* 117	*0·59* 113	*0·66* 136	*0·82* 157	*1·00* 190	*0·93* 177	*1·29* 247	*0·73* 140	*0·54* 104	*0·35* 66
Totals .	65	108	240	333	427	459	497	624	906	921	1078	823	646	247
Bolls p.p.p.d. . .		*0·12* **0·11**	*0·27* **0·27**	*0·38* **0·38**	*0·49* **0·48**	*0·53* **0·51**	*0·56* **0·56**	*0·71* **0·70**	*1·03* **1·02**	*1·05* **1·04**	*1·21* **1·21**	*0·94* **0·93**	*0·73* **0·74**	*0·28* **0·23**
Bolls p.m.²p.d. .		**0·08**	**0·20**	**0·28**	**0·35**	**0·37**	**0·41**	**0·51**	**0·74**	**0·76**	**0·88**	**0·68**	**0·54**	**0·17**

Total yield per plant = **57·2** bolls ; total yield per square metre = **41·8** bolls.

PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY B BIOLOGICAL SCIENCES

TABLES XLI–XLIII.—*Boll-weight, Seed-weight, and Out-turn Records.*

Determinations of these data were made separately each week on each plot, making 3300 separate determinations in all, averaging about three minutes each with three plant observers at work. The results are chiefly negative, and therefore the figures for individual plots are not given (as they were for flowering and bolling), but only the means for each set of five. Since series 2*b* represents the ordinary field crop of Egypt, the separate plot data for this series are appended as an example.

The three curves for spacing 2*b* only are plotted in fig. 1.

The seed-weight curves for all spacing of one plant per hole are plotted in fig. 10.

TABLE XLI.—*Boll-weight Records.*—Actually the mean weight of the contents of the ripe boll, *i.e.* the seed cotton picked from the open capsule.

The first 100 bolls picked each week (or less if not 100 were ripe, as shown in bolling records) were weighed and the mean weight for the week *ending* on each date entered in grammes.

The bolls of the last two or three weeks are subject to accidental diminution of weight through the attacks of *Earias insulana* larvæ. The damage done was not serious till the last week.

Determinations based on less than 200 bolls total for the series are marked with a note of interrogation.

TABLE XLII.—*Seed-weight Records.*—Actually the mean weight of a single seed in grammes.

After the seed of a weekly picking from each plot had been thoroughly mixed in the process of "ginning," 10 grm. were weighed out to the nearest whole seed and subsequently counted. The mean weight of one seed thus obtained is entered on the date of picking, *i.e.* the date *ending* the week in which they were determined.

Since the only source of appreciable error lies in the sampling, the same notes of interrogation are applied as in the boll weight.

TABLE XLIII.—*Ginning Out-turn Records.*—The process of "ginning" consists of feeding the seed cotton (produced in the capsule) into a machine called a "gin," whereby the lint is stripped from the seed. In commerce the ratio of lint to seed is expressed indirectly by the weight of lint obtained in the gin from a standard weight of seed cotton.

We have used 100 as the standard, instead of the local Egyptian unit, so that the figures given in the records are *percentages* of lint from seed cotton.

Computation from this and from the previous record gives the most expeditious and most accurate method of determining the mean lint weight per seed (Table XLIV).

All determinations were made on samples of 50 grm. of seed cotton.

Notes of interrogation and dating to *end* of week as in the previous records.

TABLE XLI.—Weekly Mean Boll Weights for the Different Spacings (in Grammes).

Series.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.
1a	1·836	1·790	1·772	1·628	1·498	1·482	1·508	1·670	1·744	1·678 ?	1·600 ?
1b	1·936	1·822	1·704	1·706	1·574	1·516	1·576	1·680	1·538	1·486 ?	1·494 ?
2a	1·856	1·864	1·906	1·810	1·588	1·564	1·562	1·696	1·586	1·814	1·572 ?
2b	1·848	1·924	1·922	1·848	1·688	1·748	1·640	1·668	1·556	1·526	1·642 ?
3a	1·754	1·724	1·766	1·768	1·596	1·526	1·560	1·566	1·682	1·684	1·750 ?
3b	1·736	1·788	1·882	1·894	1·696	1·584	1·644	1·616	1·612	1·616	1·602 ?
4a	1·778	1·704	1·828	1·760	1·770	1·738	1·666	1·774	1·768	1·840	1·664 ?
4b	1·668	1·660	1·690	1·646	1·670	1·618	1·576	1·708	1·744	1·712	1·692
5a	1·706	1·790	1·846	1·868	1·826	1·862	1·822	1·800	1·768	1·730	1·780
5b	1·722	1·692	1·814	1·760	1·728	1·840	1·810	1·812	1·786	1·640	1·774
6a	1·642	1·672	1·714	1·774	1·708	1·736	1·712	1·814	1·712	1·860	1·756
6b	1·654	1·504	1·642	1·642	1·546	1·534	1·574	1·578	1·562	1·622	1·576
7a	1·688 ?	1·748 ?	1·764	1·860	1·798	1·780	1·634	1·802	1·730	1·780	1·700
7b	1·616	1·664	1·740	1·712	1·672	1·604	1·636	1·730	1·670	1·648	1·682 ?
8a	1·550 ?	1·788 ?	1·898	1·892	1·996	1·978	1·944	1·956	1·850	1·904	1·864 ?
8b	1·622 ?	1·694	1·804	1·878	1·836	1·748	1·762	1·808	1·894	1·942	2·002 ?
9a	1·578 ?	1·732	1·850	1·892	1·836	1·902	1·798	1·900	1·840	1·946	1·858
9b	1·662 ?	1·632 ?	1·868	1·970	1·824	1·836	1·874	1·890	1·802	1·862	1·816
10a	1·712 ?	1·826 ?	1·966	1·854	1·918	1·946	1·882	2·000	2·020	1·886	2·002
10b	1·680 ?	1·748	1·898	1·956	1·926	1·898	1·872	1·910	1·786	1·668	1·682
Addenda.											
2b. Plot 6 . .	1·45	1·59	1·59	1·60	1·57	1·64	1·76	1·68	1·68	1·59	1·38
,, 15 . .	1·90	1·60	1·43	1·37	1·24	1·23	1·21	1·34	1·32	1·25 ?	1·90 ?
,, 32 . .	2·12	2·25	2·13	2·12	2·03	2·00	1·65	1·74	1·61	1·63	1·58 ?
,, 40 . .	1·96	2·30	2·54	2·25	2·03	1·84	1·74	1·75	1·50	1·43	1·60 ?
,, 53 . .	1·81 ?	1·88	1·92	1·90	1·57	2·03	1·84	1·83	1·67	1·73	1·75 ?
Mean . .	1·848	1·924	1·922	1·848	1·688	1·748	1·640	1·668	1·556	1·526	1·642 ?

TABLE XLII.—Weekly Mean Seed Weights for the Different Spacings (in grammes).

Series.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.
1*a*	0·0892	0·0916	0·0910	0·0876	0·0780	0·0812	0·0854	0·0864	0·0862	0·0866 ?	0·1024 ?
1*b*	0·0944	0·0940	0·0902	0·0858	0·0794	0·0770	0·0822	0·0820	0·0756	0·0800	0·0830 ?
2*a*	0·0870	0·0910	0·0918	0·0874	0·0774	0·0754	0·0834	0·0806	0·0766	0·0886	0·0766 ?
2*b*	0·0914	0·0898	0·0912	0·0882	0·0826	0·0848	0·0854	0·0814	0·0794	0·0818	0·0808 ?
3*a*	0·0862	0·0876	0·0906	0·0868	0·0806	0·0784	0·0850	0·0788	0·0796	0·0886	0·0868 ?
3*b*	0·0830	0·0898	0·0916	0·0888	0·0832	0·0800	0·0820	0·0852	0·0790	0·0844	0·0800 ?
4*a*	0·0838	0·0876	0·0932	0·0856	0·0806	0·0818	0·0836	0·0832	0·0816	0·0900	0·0834
4*b*	0·0804	0·0832	0·0884	0·0814	0·0764	0·0786	0·0804	0·0810	0·0834	0·0870	0·0814
5*a*	0·0846	0·0912	0·0898	0·0878	0·0822	0·0806	0·0814	0·0838	0·0786	0·0812	0·0870
5*b*	0·0814	0·0894	0·0894	0·0882	0·0838	0·0832	0·0832	0·0802	0·0778	0·0826	0·0820
6*a*	0·0800	0·0810	0·0898	0·0856	0·0824	0·0836	0·0888	0·0880	0·0818	0·0900	0·0852
6*b*	0·0818	0·0838	0·0836	0·0800	0·0730	0·0752	0·0826	0·0792	0·0760	0·0832	0·0786
7*a*	0·0846 ?	0·0872 ?	0·0838	0·0816	0·0828	0·0804	0·0810	0·0800	0·0794	0·0774	0·0782
7*b*	0·0778	0·0846	0·0868	0·0826	0·0812	0·0792	0·0828	0·0820	0·0762	0·0822	0·0804 ?
8*a*	0·0868 ?	0·0946 ?	0·0908	0·0920	0·0904	0·0920	0·0918	0·0862	0·0808	0·0924	0·0860 ?
8*b*	0·0864 ?	0·0902	0·0890	0·0840	0·0850	0·0850	0·0868	0·0852	0·0856	0·0828	0·0862 ?
9*a*	0·0866 ?	0·0898	0·0914	0·0842	0·0838	0·0836	0·0820	0·0842	0·0812	0·0838	0·0822
9*b*	0·0818 ?	0·0864 ?	0·0918	0·0892	0·0824	0·0842	0·0838	0·0830	0·0760	0·0822	0·0818
10*a*	0·0810 ?	0·0884 ?	0·0884	0·0830	0·0828	0·0802	0·0852	0·0848	0·0846	0·0864	0·0906
10*b*	0·0816 ?	0·0886	0·0862	0·0862	0·0840	0·0822	0·0850	0·0810	0·0768	0·0782	0·0774
Addenda.											
2*b*.											
Plots 6 . .	0·072	0·074	0·078	0·078	0·074	0·080	0·083	0·077	0·076	0·077	0·075
,, 15 . .	0·098	0·082	0·081	0·070	0·070	0·064	0·074	0·070	0·070	0·077 ?	0·081 ?
,, 32 . .	0·100	0·100	0·086	0·095	0·095	0·088	0·084	0·086	0·082	0·077	0·081 ?
,, 40 . .	0·098	0·099	0·109	0·099	0·089	0·092	0·091	0·086	0·082	0·086	0·083 ?
,, 53 . .	0·089 ?	0·094	0·102	0·099	0·085	0·100	0·095	0·088	0·087	0·092	0·084 ?
Mean . .	0·0914	0·0898	0·0912	0·0882	0·0826	0·0848	0·0854	0·0814	0·0794	0·0818	0·0808 ?

TABLE XLIII.—Weekly Mean Ginning Out-turn Records, giving Percentage of Lint per Intact Seed.

Series.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.
1*a*	29·90	29·12	29·06	31·04	31·42	30·60	31·10	30·90	30·76	30·72 ?	29·02 ?
1*b*	33·16	31·60	30·70	31·62	32·12	31·66	31·84	31·82	31·92	32·10 ?	29·50 ?
2*a*	29·78	29·42	29·94	31·00	31·70	31·62	30·92	31·62	31·66	30·64	31·64 ?
2*b*	31·20	29·82	31·46	32·12	31·70	31·28	31·62	30·84	31·06	30·68	29·80 ?
3*a*	29·06	29·52	30·10	32·20	31·50	31·94	31·54	31·86	31·44	30·64	30·62 ?
3*b*	30·52	29·94	30·32	30·94	31·84	32·14	31·78	31·04	31·58	30·54	30·46 ?
4*a*	27·84	27·38	28·96	30·88	31·58	31·90	32·28	31·94	32·36	30·68	31·32 ?
4*b*	29·14	28·18	30·10	31·30	32·64	32·06	32·52	32·46	32·54	31·60	30·94
5*a*	27·10	28·10	29·68	31·16	31·80	31·48	33·00	32·16	31·70	31·72	29·94
5*b*	27·72	28·22	29·78	30·98	31·74	32·14	33·42	33·38	32·48	32·08	30·28
6*a*	26·98	27·62	28·52	31·30	31·58	31·78	31·84	31·44	30·80	31·48	31·72
6*b*	29·12	28·62	29·54	31·76	31·82	32·60	32·22	32·42	32·06	31·96	31·00
7*a*	29·04 ?	28·60 ?	30·14	32·02	31·26	31·04	32·32	32·30	32·26	31·44	30·97
7*b*	28·46	29·18	30·44	32·10	32·06	31·70	32·28	32·20	32·46	31·44	30·42 ?
8*a*	27·92 ?	28·52 ?	29·54	31·02	30·74	30·62	31·38	32·24	31·70	31·30	30·70 ?
8*b*	27·72 ?	27·82	29·18	30·94	31·76	31·10	32·44	31·36	30·82	30·62	29·17 ?
9*a*	28·12 ?	28·44	31·16	32·06	32·68	32·42	32·64	32·56	31·92	31·84	30·42
9*b*	27·24 ?	27·66 ?	29·58	30·48	31·04	31·76	32·18	32·52	31·34	31·60	29·82
10*a*	23·12 ?	28·30 ?	30·78	31·64	32·22	31·42	32·54	32·32	30·80	31·12	28·70
10*b*	27·52 ?	27·70	30·70	31·96	32·70	32·02	32·68	33·04	30·64	32·40	30·20
Addenda.											
2*b*.											
Plot 6. .	29·9	29·8	31·8	32·4	31·3	31·8	33·3	33·6	33·8	30·5	30·7
,, 15. .	33·7	30·7	31·2	32·2	31·4	30·3	32·7	31·3	31·4	32·3	30·6
,, 32. .	32·5	32·7	33·7	32·9	32·1	32·4	32·4	29·4	28·2	28·7	29·2
,, 40. .	30·8	26·4	30·1	31·7	32·0	30·8	28·4	28·0	29·9	30·1	27·3
,, 53. .	29·1	29·5	30·5	31·4	31·7	31·1	31·3	31·9	32·0	31·8	31·2
Mean. .	31·20	29·82	31·46	32·12	31·70	31·28	31·62	30·84	31·06	30·68	29·80

APPENDIX II.

Computed Statistics of Yield Ratios.

Table XLIV.—*Lint-weight Records* (*indirect*).—The figures represent in grammes the mean weight of the lint (or hairs of cotton) borne on a single seed in each of the weekly pickings.

This weight is computed from Tables XLII and XLIII :—

$$\text{Lint weight} = \frac{\text{Seed weight} \times \text{ginning out-turn}}{100 - \text{ginning out-turn}}.$$

The same notes of interrogation are applied as in Tables XLI, XLII, and XLIII.

Tables XLV and XLVI.—*Distribution of Total Yield* (*indirect records*).—The total yield per unit area, as given in Tables XXI–XL and XLVII, is taken as 100 in each series treated, and subdivided into the weekly percentages.

Thus is shown up the geometrical alteration in the form of the yield-curve with various spacings, and the superposition of the bolling- and lint-curves gives a quick demonstration of the validity of determining yield by boll-counting, instead of picking, ginning, and weighing.

The computation is restricted to the *b* series, with two plants per hole, since these represent the ordinary field crop custom.

Spacings 6*b* and 7*b* are omitted in these records, as also in Tables XLVII, L, and LI, so as to leave only the steady progression of spacing from dense to wide.

A portion of these computed records is plotted in fig. 11.

Table XLVII.—*Yield of Lint Cotton* (*indirect records*).—Computed from the number of bolls, multiplied by the boll weight and by the ginning out-turn, divided by 100.

This table represents the final yield of the crop. The commercial value of the seed also obtained is much less than that of the lint.

Totals plotted in fig. 4.

Tables XLVIII–LI.—*Computed Yields for the Three Conventional Pickings.*—In ordinary agricultural practice the cotton crop is harvested in three separate pickings only. The data in these Tables XLVIII–LI are obtained by summation of the original analytical data of the previous tables, for comparison on the part of agriculturists, and as a final demonstration of the composite nature of yield.

The dates selected by us for pickings are those conveniently employed for ordinary farm practice in the district where the experiment was performed, viz., September 10, October 1, and November 5.

The yield of bolls per square metre is given for all series, while only the "one plant per hole," or Series 1*a*–10*a*, are given for the rest.

Table L is the table of primary interest for purposes of seed-propagation, just as Table XLVII was of primary interest to the farmer seeking a large crop.

TABLE XLIV.—Mean Weight of Lint per Seed at each Weekly Picking.

Spacing.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.
1*a*	0·0380	0·0376	0·0375	0·0394	0·0358	0·0358	0·0384	0·0386	0·0381	0·0384	0·0422
1*b*	0·0468	0·0476	0·0400	0·0397	0·0378	0·0357	0·0384	0·0383	0·0352	0·0374	0·0346
2*a*	0·0369	0·0379	0·0392	0·0392	0·0360	0·0349	0·0372	0·0373	0·0356	0·0392	0·0356
2*b*	0·0420	0·0382	0·0419	0·0418	0·0383	0·0386	0·0395	0·0362	0·0312	0·0362	0·0341
3*a*	0·0353	0·0366	0·0395	0·0412	0·0370	0·0368	0·0391	0·0369	0·0366	0·0392	0·0382
3*b*	0·0364	0·0384	0·0398	0·0398	0·0388	0·0379	0·0382	0·0384	0·0366	0·0370	0·0352
4*a*	0·0324	0·0330	0·0380	0·0382	0·0372	0·0383	0·0398	0·0391	0·0390	0·0398	0·0380
4*b*	0·0331	0·0327	0·0380	0·0371	0·0370	0·0373	0·0387	0·0389	0·0401	0·0401	0·0364
5*a*	0·0314	0·0356	0·0379	0·0398	0·0383	0·0371	0·0401	0·0397	0·0364	0·0376	0·0372
5*b*	0·0312	0·0351	0·0379	0·0396	0·0390	0·0394	0·0417	0·0402	0·0374	0·0390	0·0356
6*a*	0·0296	0·0308	0·0358	0·0390	0·0378	0·0390	0·0414	0·0407	0·0364	0·0412	0·0396
6*b*	0·0336	0·0336	0·0350	0·0372	0·0341	0·0364	0·0392	0·0380	0·0358	0·0392	0·0354
7*a*	0·0346	0·0351	0·0362	0·0384	0·0376	0·0362	0·0386	0·0382	0·0378	0·0356	0·0256
7*b*	0·0311	0·0348	0·0378	0·0392	0·0384	0·0368	0·0394	0·0386	0·0366	0·0376	0·0258
8*a*	0·0336	0·0377	0·0380	0·0414	0·0401	0·0406	0·0420	0·0411	0·0371	0·0422	0·0381
8*b*	0·0332	0·0347	0·0366	0·0376	0·0395	0·0383	0·0417	0·0389	0·0382	0·0366	0·0355
9*a*	0·0339	0·0357	0·0413	0·0397	0·0407	0·0406	0·0397	0·0407	0·0381	0·0415	0·0359
9*b*	0·0306	0·0330	0·0385	0·0391	0·0372	0·0391	0·0396	0·0400	0·0346	0·0379	0·0348
10*a*	0·0301	0·0348	0·0393	0·0393	0·0394	0·0367	0·0411	0·0405	0·0377	0·0391	0·0365
10*b*	0·0310	0·0339	0·0382	0·0405	0·0408	0·0388	0·0413	0·0400	0·0340	0·0374	0·0334

TABLE XLV.—Distribution of Total Yield as Percentage per Week—by Number of Bolls.

Spacing.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Nov. 5.
1*b*	4·56	9·73	13·62	14·30	14·97	14·30	9·73	5·98	2·62	3·74	3·22	1·94	1·27
2*b*	3·02	4·34	8·24	10·38	13·84	12·96	12·15	11·70	7·80	6·92	4·34	3·02	1·25
3*b*	2·46	5·01	6·32	11·01	11·74	11·42	12·49	11·74	8·54	8·21	5·67	3·20	2·13
4*b*	4·01	6·38	8·30	10·49	10·94	9·67	9·67	8·85	9·67	9·12	6·11	4·83	1·91
5*b*	3·30	4·86	7·29	9·72	9·53	8·65	9·53	10·60	10·60	9·72	8·65	5·32	2·23
8*b*	2·31	3·60	5·28	6·95	8·37	7·34	8·89	11·98	13·01	13·65	8·11	7·99	2·44
9*b*	2·30	2·43	4·74	5·01	5·69	6·50	8·13	11·65	14·64	16·12	9·62	9·75	3·38
10*b*	1·34	3·35	4·69	5·86	6·19	6·86	8·54	12·39	12·90	14·74	11·39	9·04	2·84

TABLE XLVI.—Distribution of Total Yield as Percentage per Week—by Weight of Lint.

Spacing.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.
1*b*	5·52	11·75	14·77	14·08	15·22	13·51	8·77	5·81	2·64	3·46	2·89	1·47
2*b*	3·23	4·63	8·76	11·63	15·21	12·85	12·30	11·24	7·44	6·19	3·76	2·74
3*b*	2·51	5·11	6·52	12·10	13·25	11·86	12·23	11·80	8·22	8·05	5·46	3·00
4*b*	3·81	6·07	7·59	10·44	11·04	10·32	9·82	8·88	10·49	10·13	6·46	4·96
5*b*	2·92	4·29	6·44	9·71	9·57	8·78	10·41	11·86	11·84	10·43	8·42	5·31
8*b*	2·12	2·97	4·56	6·71	8·91	7·84	8·85	12·56	13·53	14·60	8·86	8·55
9*b*	1·90	2·01	3·91	5·05	6·24	6·73	8·65	12·60	16·43	16·64	10·32	9·65
10*b*	1·11	2·77	4·05	6·14	6·96	7·77	9·34	13·61	14·44	14·49	11·06	8·25

TABLE XLVII.—Total Yield of Lint-cotton with Selected Spacings.

Per square metre per day in grammes with two plants per hole.

Viz. : $\frac{\text{Boll Weight} \times \text{Number of Bolls} \times \text{Out-turn}}{100}$.

N.B.—Shift decimal point one place to left to obtain approximately kantars per feddan.

Spacings.	Aug. 13.	Aug. 20.	Aug. 27.	Sept. 3.	Sept. 10.	Sept. 17.	Sept. 24.	Oct. 1.	Oct. 8.	Oct. 15.	Oct. 22.	Oct. 29.	Total yield, grammes per square metre.
1*b*	0·391	0·893	1·047	0·998	1·079	0·965	0·622	0·412	0·187	0·245	0·205	0·105	49·63
2*b*	0·236	0·340	0·642	0·852	1·175	0·942	0·902	0·824	0·546	0·454	0·276	0·201	51·31
3*b*	0·159	0·323	0·412	0·765	0·837	0·750	0·773	0·746	0·520	0·509	0·345	0·190	44·24
4*b*	0·214	0·340	0·425	0·585	0·618	0·578	0·550	0·497	0·588	0·568	0·362	0·278	39·20
5*b*	0·162	0·239	0·358	0·540	0·532	0·488	0·579	0·660	0·659	0·580	0·468	0·295	38·92
8*b*	0·090	0·126	0·193	0·284	0·377	0·332	0·375	0·532	0·572	0·618	0·375	0·362	29·61
9*b*	0·077	0·081	0·158	0·204	0·252	0·272	0·349	0·509	0·663	0·672	0·417	0·390	28·28
10*b*	0·037	0·092	0·135	0·204	0·231	0·258	0·310	0·452	0·479	0·481	0·367	0·274	23·24

Computed Yields for the Three Conventional Pickings.

TABLE XLVIII.—Bolls per Plant for Spacing-series *a*.

Spacing *a*.	1*a*.	2*a*.	3*a*.	4*a*.	5*a*.	6*a*.	7*a*.	8*a*.	9*a*.	10*a*.
First picking .	8·82	11·34	12·67	16·24	14·91	8·12	12·88	13·02	17·99	17·29
Second picking .	6·93	10·29	10·78	12·60	17·50	7·77	14·21	15·47	25·69	24·08
Third picking .	3·36	8·12	10·01	16·03	23·45	11·41	23·80	33·53	40·67	47·32
Totals . .	19·11	29·75	33·46	44·87	55·86	27·30	50·89	62·02	84·35	88·69

First picking, September 10; second picking, October 1; third picking, November 5.

TABLE XLIX.—Bolls per Square Metre for Spacing-series *a* and *b*.

Spacing *a*.	1*a*.	2*a*.	3*a*.	4*a*.	5*a*.	6*a*.	7*a*.	8*a*.	9*a*.	10*a*.
First picking .	38·36	33·32	27·51	23·87	16·94	17·64	14·70	9·52	8·96	6·30
Second picking .	30·17	30·24	23·45	18·69	19·88	16·94	16·17	11·69	12·74	8·75
Third picking .	14·63	23·94	21·77	23·59	26·60	24·78	27·02	24·64	20·30	17·15
Totals . .	83·16	87·50	72·73	66·15	63·42	59·36	57·89	45·85	42·00	32·20
Spacing *b*.	1*b*.	2*b*.	3*b*.	4*b*.	5*b*.	6*b*.	7*b*.	8*b*.	9*b*.	10*b*.
First picking .	53·48	37·87	31·15	30·80	24·99	22·75	20·58	14·42	10·43	8·96
Second picking .	28·07	35·00	30·38	21·63	20·72	23·94	20·58	15·33	13·58	11·62
Third picking .	11·97	22·19	23·66	24·29	26·32	27·09	23·24	24·57	27·65	21·21
Totals . .	93·52	95·06	85·19	76·72	72·03	73·78	64·40	54·32	51·66	41·79

First picking, September 10; second picking, October 1; third picking, November 5.

Computed Yields for the Three Conventional Pickings.

Table L.—Seeds per Plant for Spacing-series *a*.

$$\text{Viz.}: \frac{\text{Boll-weight} \times \text{Ginning Out-turn}}{100 \times \text{Lint-weight}} \times \text{Bolls per plant per picking.}$$

Spacing *a*.	1*a*.	2*a*.	3*a*.	4*a*.	5*a*.	6*a*.	7*a*.	8*a*.	9*a*.	10*a*.
First picking .	121	166	176	233	216	—	—	180	250	261
Second picking .	88	141	142	180	268	—	—	230	383	380
Third picking .	43	113	138	229	345	—	—	504	622	749
Totals . .	252	420	456	642	829	—	—	914	1255	1390

First picking, September 10; second picking, October 1; third picking, November 5.

Table LI.—Composition of the Seed-cotton from each Conventional Picking.

Spacing . .	1*a*.	2*a*.	3*a*.	4*a*.	5*a*.	6*a*.	7*a*.	8*a*.	9*a*.	10*a*.
No. 13.—Boll-weight (grammes).										
First picking .	1·756	1·859	1·753	1·767	1·802	—	—	1·782	1·763	1·839
Second picking .	1·496	1·571	1·560	1·724	1·836	—	—	1·972	1·845	1·915
Third picking .	1·673	1·667	1·670	1·761	1·769	—	—	1·893	1·886	1·977
No. 14.—Ginning Out-turn (per cent.).										
First picking .	29·78	30·03	32·22	28·76	29·01	—	—	29·25	29·94	29·46
Second picking .	31·04	31·41	31·66	31·92	32·09	—	—	30·91	32·58	32·06
Third picking .	30·35	31·39	31·14	31·57	31·38	—	—	31·48	31·68	30·73
No. 15.—Lint-weight (grammes).										
First picking .	0·0381	0·0383	0·0381	0·0354	0·0361	—	—	0·0376	0·0376	0·0358
Second picking .	0·0367	0·0360	0·0376	0·0384	0·0385	—	—	0·0409	0·0403	0·0390
Third picking .	0·0393	0·0369	0·0377	0·0389	0·0377	—	—	0·0396	0·0390	0·0384

First picking, September 10; second picking, October 1; third picking, November 5.

APPENDIX III.

Graphic Figures of Selected Records.

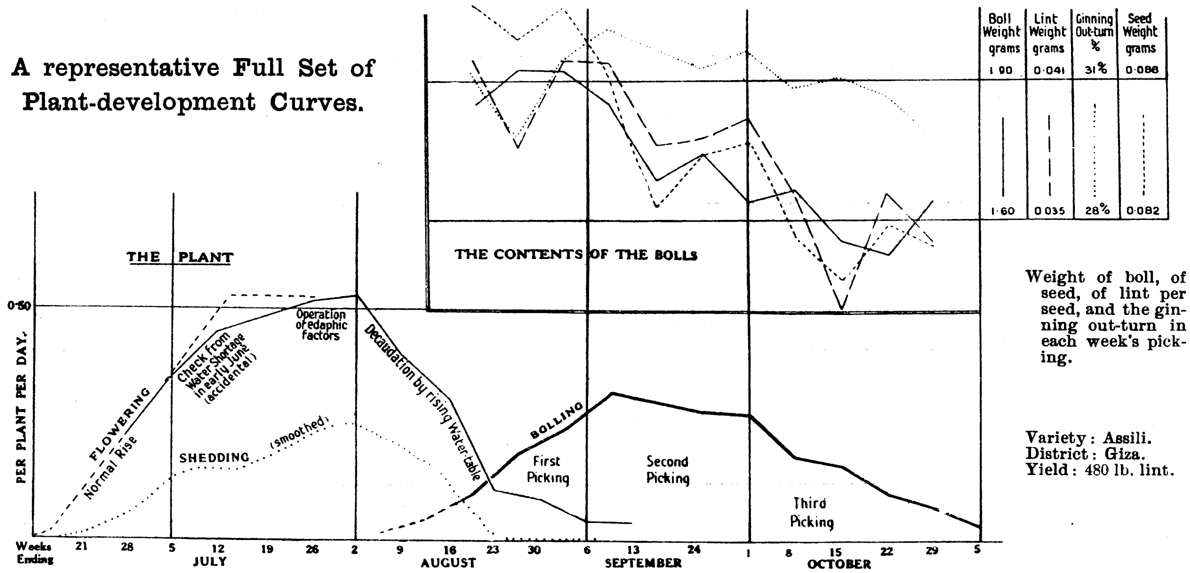


Fig. 1.—This diagram represents the life-history of an average field crop of Egyptian cotton, viz., the arrangement designated as **2b** in the Spacing Experiment (Table, p. 114).

The ordinates erected at weekly intervals to represent the various values have been joined by lines to form the various curves.

The flowering-curve and bolling-curve show the changes from week to week in the rates at which flowers and bolls (fruits) are being opened on an average plant.

The approximate shedding-curve shows those flowers which were shed in each week, and is obtained here by subtraction of bolling from the flowering of 50 days previously.

On the bolling-curve are indicated approximately the areas of this curve which would be gathered into the three conventional pickings, while the inset diagram above the bolling-curve shows the characteristics of the seed-cotton gathered in each of our weekly pickings.

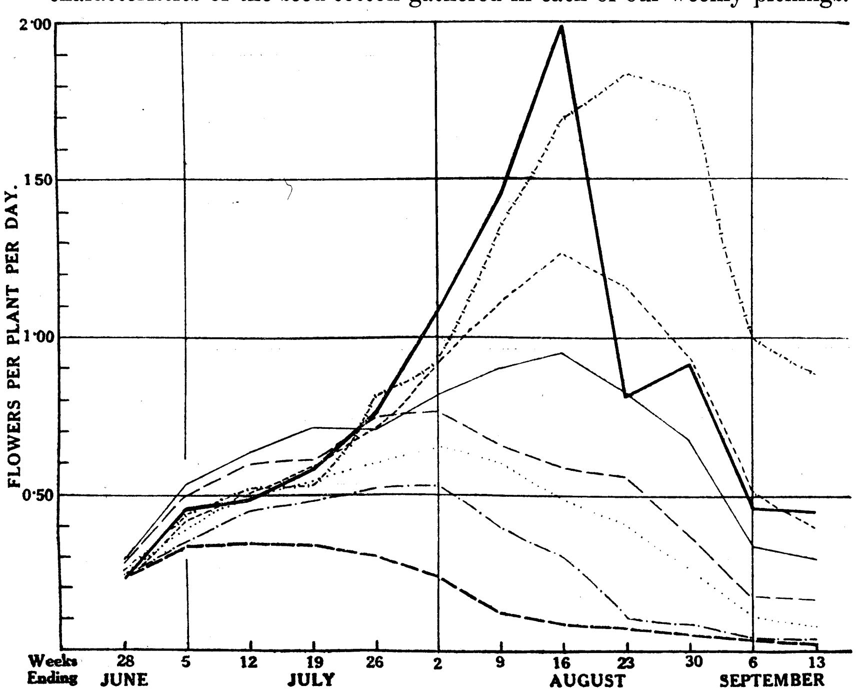


Fig. 2 (**b**).—*Flowering Curves per Plant.* These curves show the average rate of flowering in successive weeks of the season, as determined by the average of all the plots of each spacing designated (on p. 114) as the *b* series (having paired plants as in conventional cultivation), except Spacings 6*a* and 7*a*.

All spacings produce the same number of flowers per plant in mid-June, but the wider spacings successively rise to higher rates of flowering afterwards. The curve for Spacing 10*b* is deformed by accidental causes.

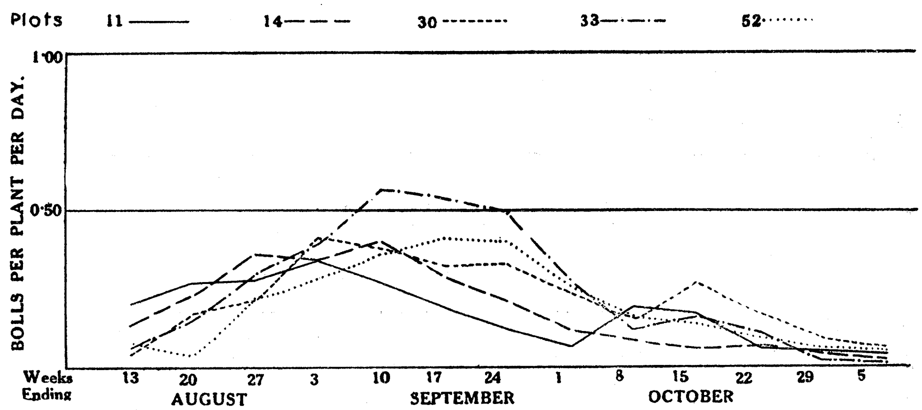
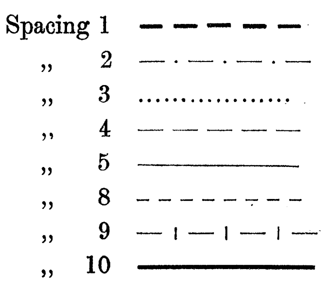
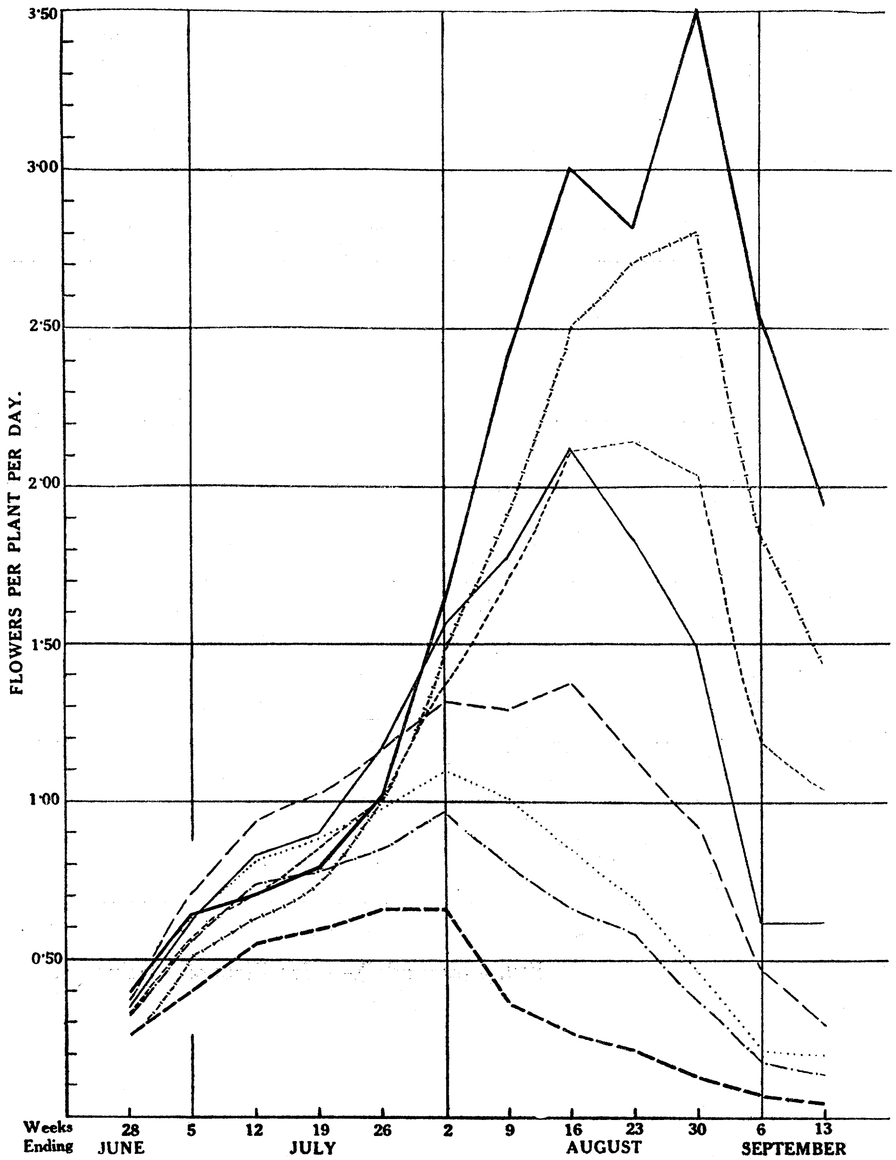


FIG. 3 (1*a*).—*Comparison of Plots which are nominally identical.* Five plots of Spacing 1*a*, compared by weekly boll-production.

FIG. 2 (**a**).—*Flowering Curves per Plant.* This figure is a companion to fig. 2 (**b**), but represents the flowering rates for those spacings with single plants, as against the paired arrangement of **b**.

The curves are of the same form as in fig. 2 (**b**), but their height at any given point is almost doubled.





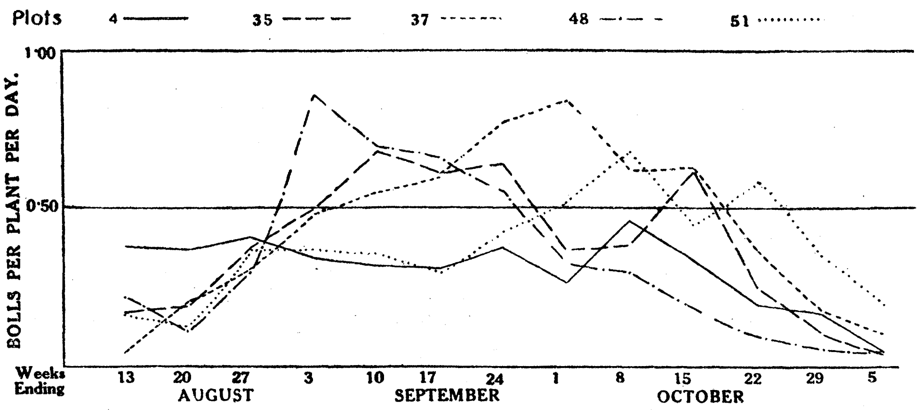


FIG. 3 (*continued*).—Five Plots of Spacing 2*a*.

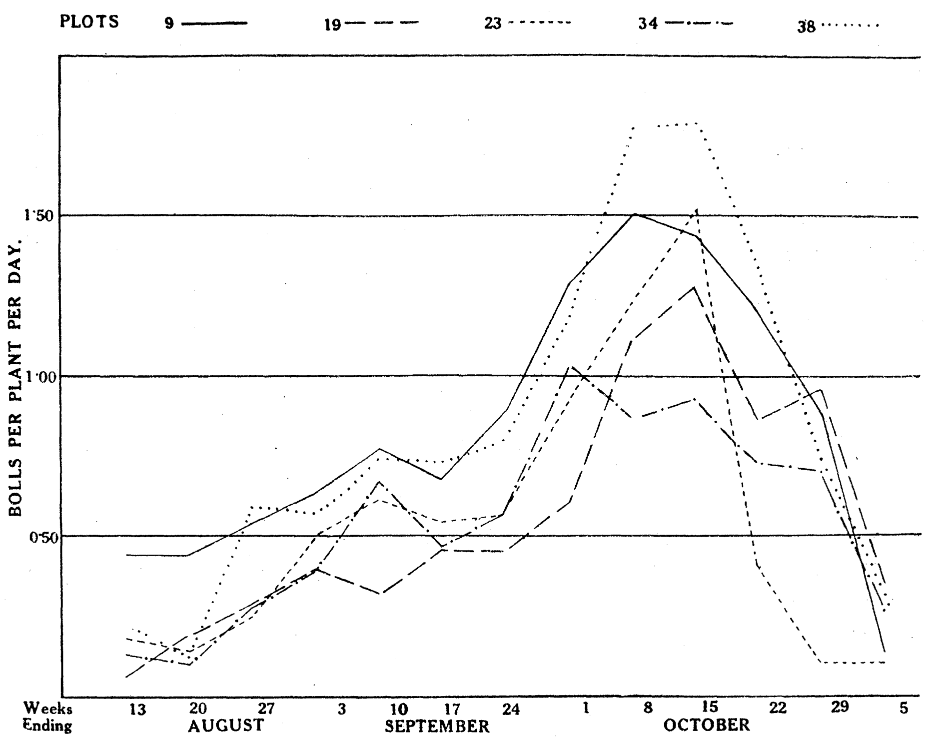


FIG. 3 (*concluded*).—Five Plots of Spacing 8*a*.

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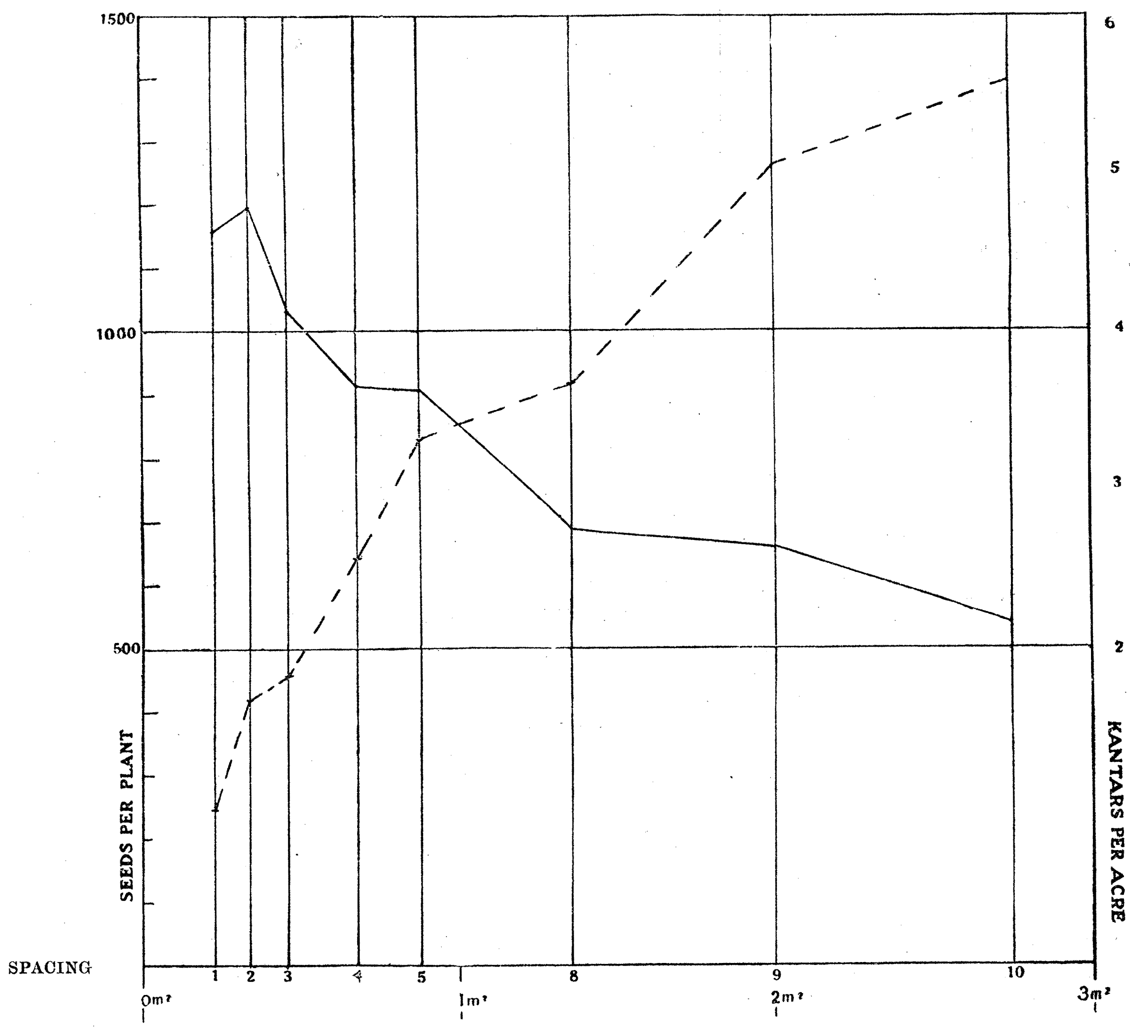

FIG. 4.—*Total Yield Summarised.*

Lint per acre with two plants per hole (**b** series).
Seeds per plant with one plant per hole (**a** series).

Spacing 2*b* gives the highest yield per acre, while Spacing 10*a* gives the highest yield per plant.

— — — — Seeds per plant. ———— Lint per acre.

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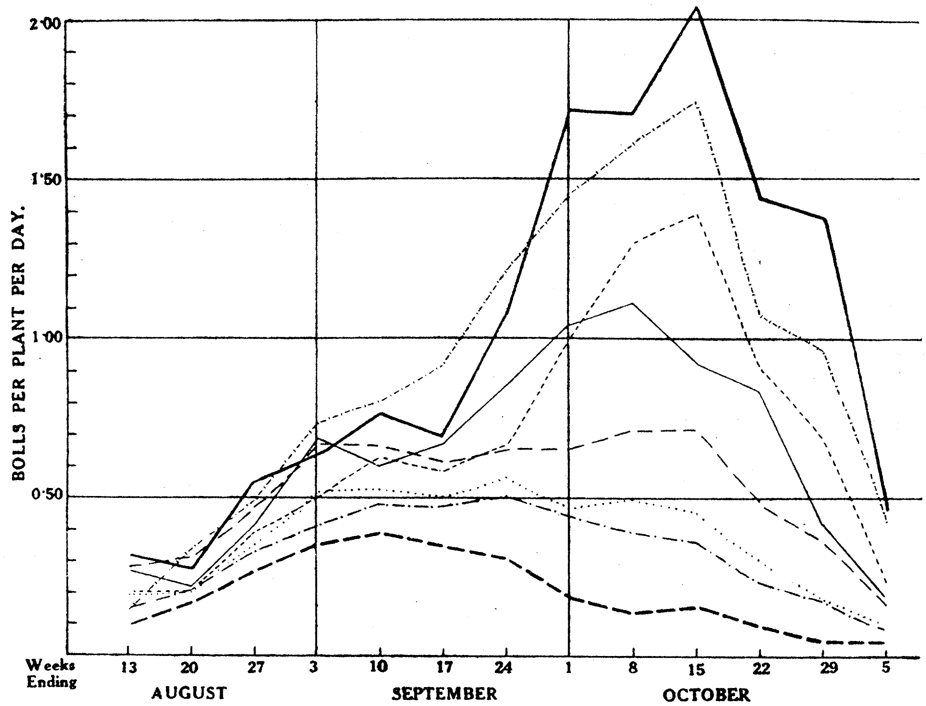
Series a.



Series b.

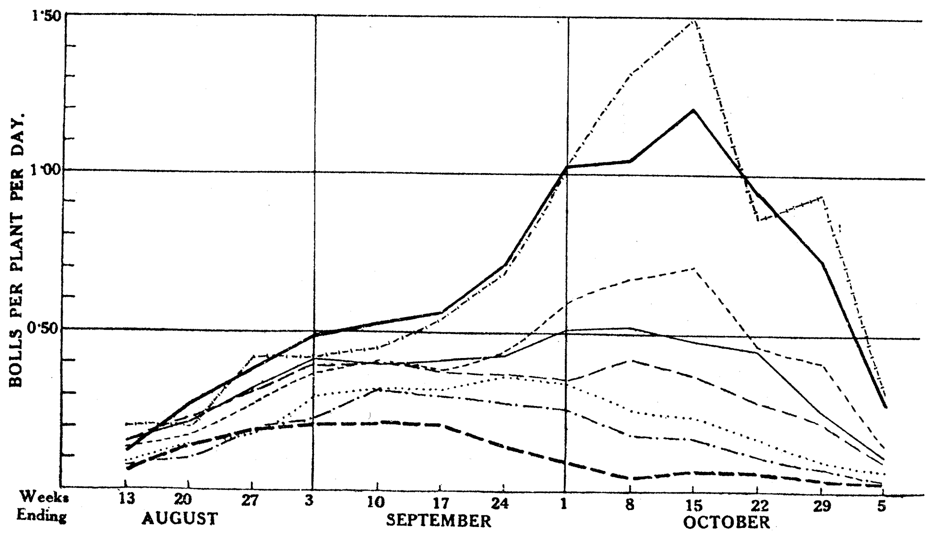
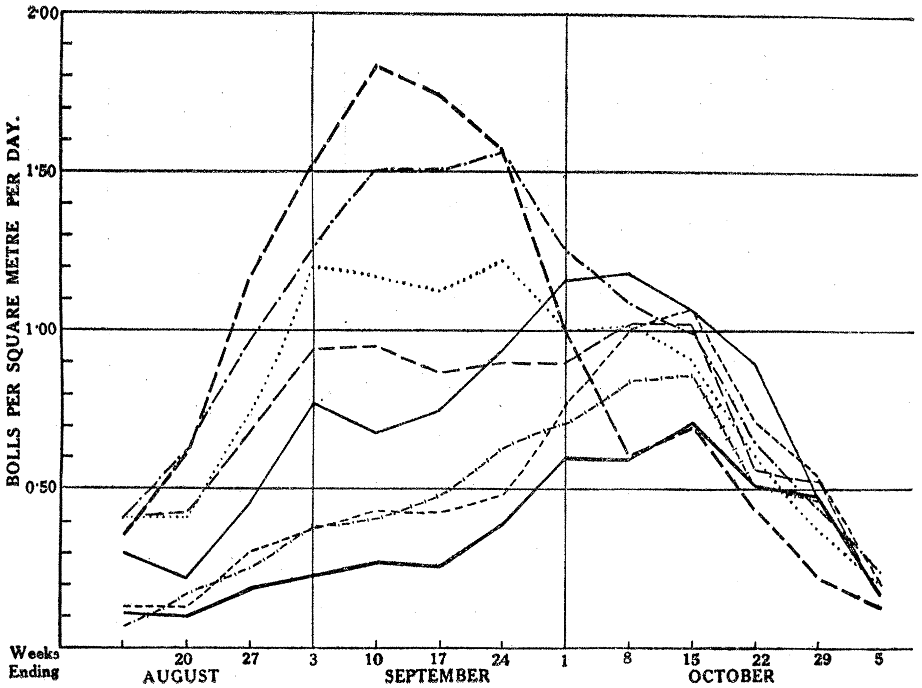


FIG. 5.—*Bolling curves per Plant.*

These curves show the weekly rates of boll production per plant, exactly as fig. 2 shows the rate of flowering. The scale is the same in both, and also in fig. 6. Notation as in fig. 2.

Series a.



Series b.

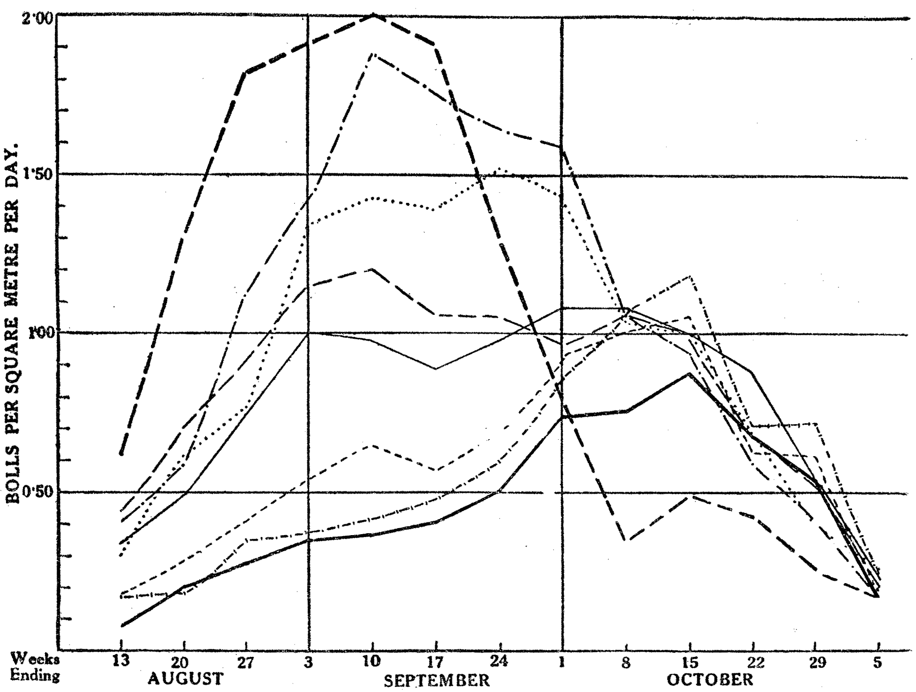


FIG. 6.—*Bolling curves per Unit Area.*

These curves show the weekly rates of boll production per square metre. They thus are yield-curves showing for each spacing the distribution of the yield in time. Compare with fig. 5. Notation as in fig. 2.

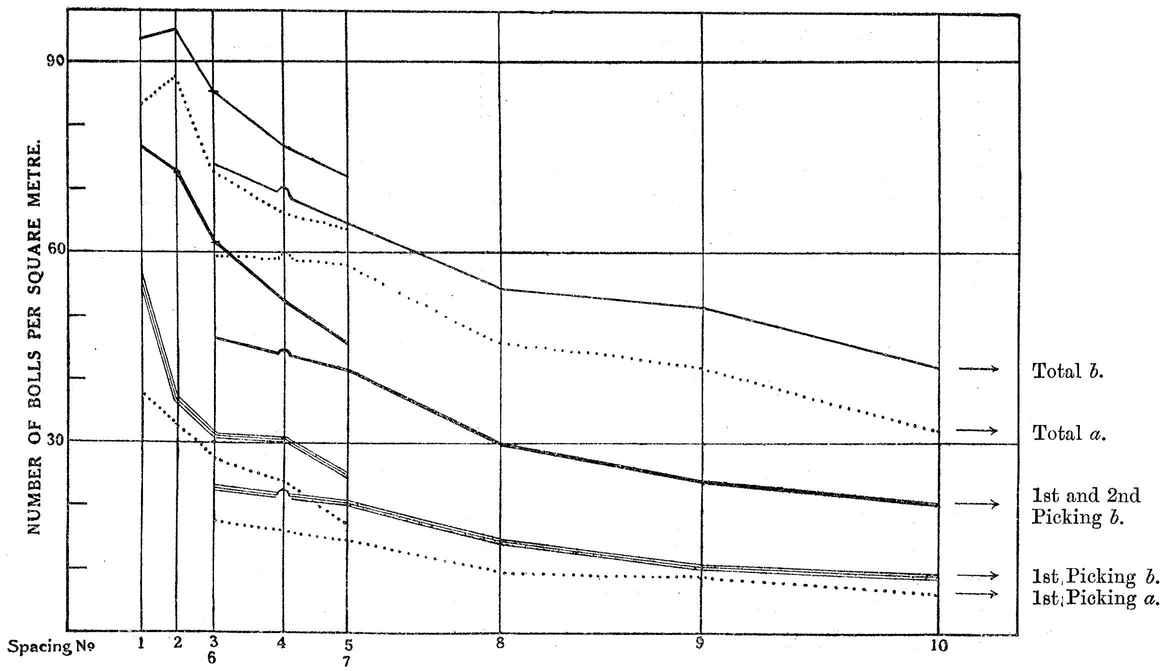


FIG. 7.—*Total Yield per Unit Area*, as obtained in the three conventional pickings, for the sowings with two plants per hole (Series *b*). Dotted lines show first picking and total for Series *a*.

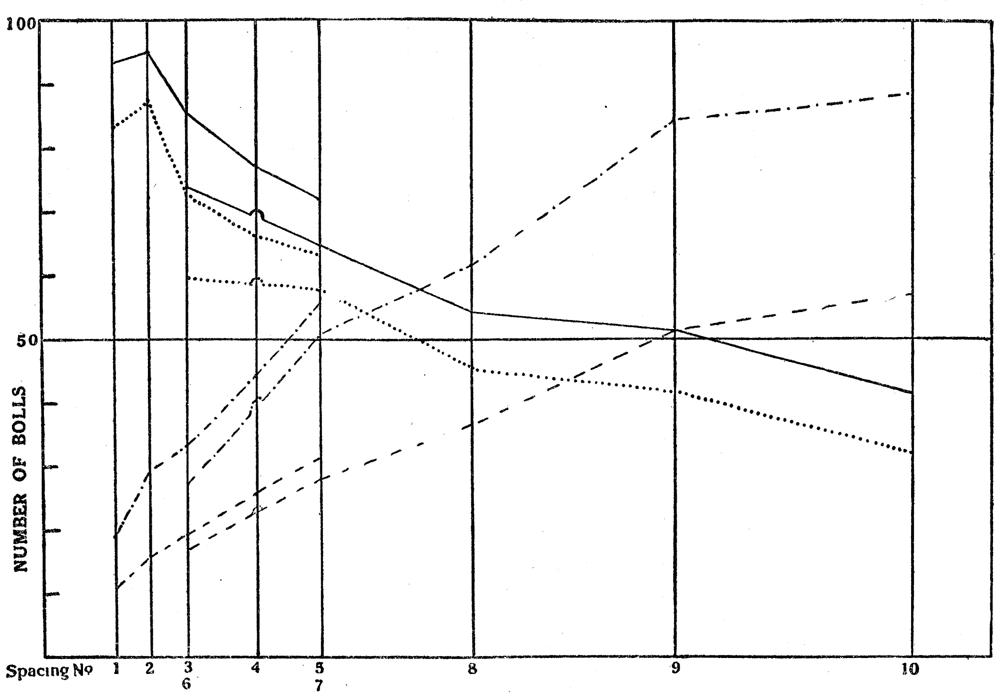


FIG. 8.—*Total Yield per Plant and per Unit Area*, with one and two plants per hole (Series *a* and *b*).

. . . . Per area, Series *a*. — · — · — Per plant, Series *a*.
———— Per area, Series *b*. — — — — Per plant, Series *b*.

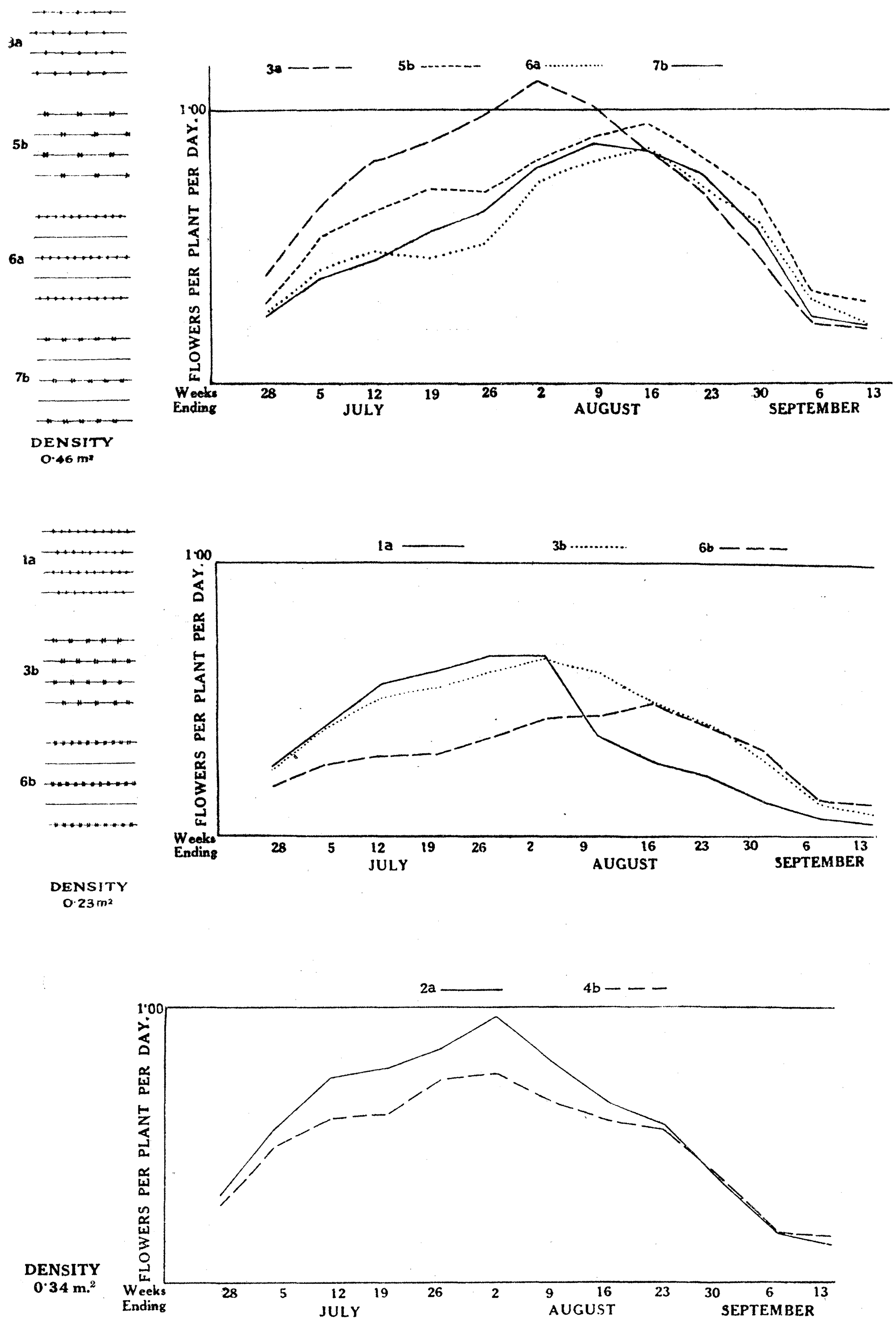


FIG. 9.—*Effects of Varying Arrangement with Uniform Density.* Flowering curves per plant (equally per unit area) for three densities.

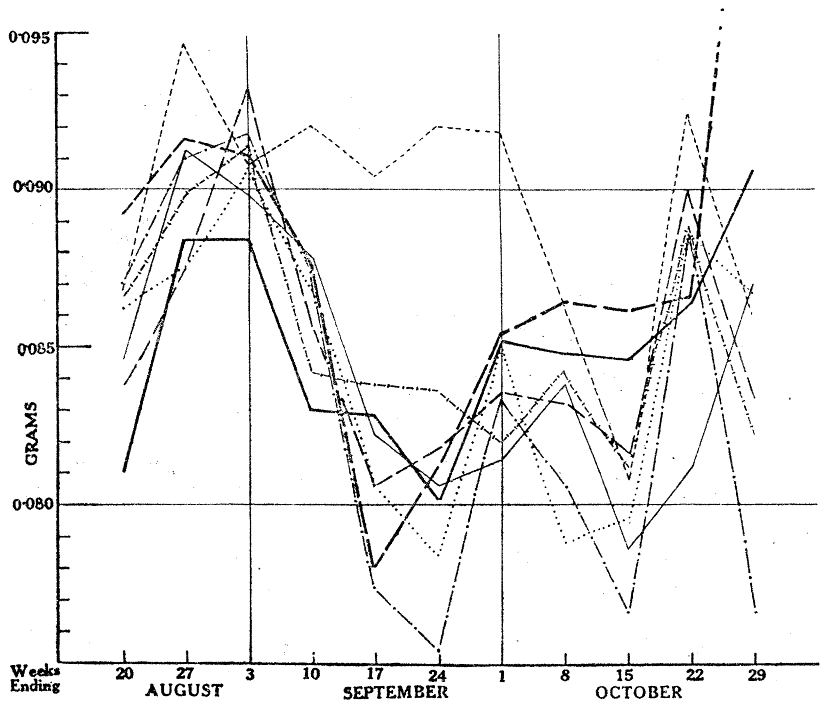


FIG. 10.—*Seed Weight.* Variations from week to week in mean weight of seed produced on spacings with single plants, or Series *a*. The various lines employed are the same as for the various spacings in figs. 2, 5, 6.

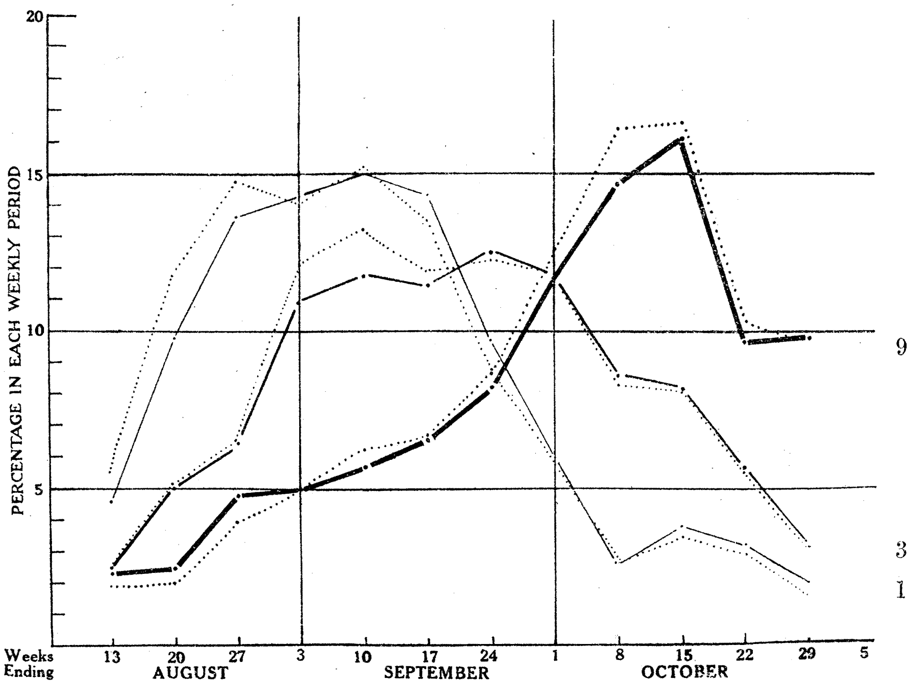


FIG. 11.—*Percentage Distribution of Yield.* For Spacings 1*b*, 3*b*, and 9*b*. To illustrate the differential effect of root interference in altering the form of the yield curve. Also, to demonstrate the fact that the yield of ginned lint is closely similar to the yield expressed as number of bolls. Continuous lines show results of observations expressed as Number of Bolls, and the adjacent dotted lines as Weight of Lint.