

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

SOME OBSERVATIONS ON SUNN HEMP.

Submitted

by

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I. INTRODUCTORY.

A. Introduction.

The sugar industry in Trinidad has for a number of years suffered severely from the depredations of the Sugar-cane Froghopper (*Tomaspis saccharina*). The loss due to the ravages of this insect varies greatly from year to year and is difficult to estimate with any degree of exactitude, but it is sufficiently great to warrant the attention which is being given to it. Urich estimated the loss from 1907-1912 to be about £55,000 per annum, and as much as £300,000 in 1916-17.

The factors influencing the severity of the attack are many, including the amount and distribution of the rainfall, type of soil, cultural methods, and the general condition of the plant. Investigations carried out up to the present time indicate that indirect methods in the form of a general improvement in the cultural methods applied to the growing of sugar-cane must play a large part in the effectual control of the froghopper. It is generally recognised that the continuous system of growing sugar-cane is favourable to the development of the pest, and that some form of rotation should be introduced. There is a definite need in Trinidad for "a crop, preferably leguminous, which can be grown in rotation with cane, to be used as a green dressing. It should be a good cover crop, to keep down weeds, and when turned into the soil should be sufficiently woody to decay slowly and leave air channels, thus assisting in the aeration of the soil." (Withycombe, C.L.). Experiments have been carried out with several crops, including Sunn Hemp. At the end of

1925 40 lbs. of Sunn Hemp seed was handed to Mr. G.A. Jones to be grown by peasants on the Oropouche Lagoon lands in the dry season, to increase the quantity of seed, but the attempt was a failure owing to the dryness of the season. Wet season crops had been prevented from seeding by the larvae of a moth (*Utethesia ornatatrix*). Quotations for Sunn Hemp seed from India were prohibitive, and the provision of seed was the chief difficulty in the way of experimenting with the crop on a field basis. In 1926 four acres of Sunn Hemp were grown by Mr. Brunton at the St. Augustine Experiment Station on which he reported, in comparison with Pidgeon Pea, *Stizolobium aterrimum*, and *Canovalia* that Sunn Hemp "is pre-eminent in possessing the indispensable qualities for a cover crop of quick germination and rapid growth. It easily smothers all weeds, only nut grass, if it gains an appreciable start, is capable of checking its growth; it affords an effective cover for 5 months."

This experiment was designed as a further study of the crop, with particular reference to the production of seed.

B. Sunn Hemp.

Sunn Hemp is a member of the natural order Leguminosae. It is described as a herbaceous or semi-shrubby annual with numerous ascending branches. The leaves are $1\frac{1}{2}$ -4 inches long borne on short thickened petioles, lanceolate-oblong or linear, and pubescent on both sides. The large conspicuous yellow flowers are borne on long terminal racemes, the first bloom appearing when the plants have attained their full height. Those buds which show slits in their calyxes in the late afternoon with the yellow corolla showing through open the following morning about 9-10 a.m., at which time the glands begin to secrete nectar freely. As a rule the flowers remain fully open for two days. The lowest flowers of each inflorescence opens first and flowering proceeds regularly towards the growing point and is complete in the whole plant in about a month. The pods are oblong and cylindrical, not stalked and tipped with a short style base.

Under Indian conditions cross pollination is general but self-pollination may occur where the flowers are not visited by insects.

Two varieties are commonly grown in India, a tall variety with a weaker fibre, and a short variety. The former is recognised as a great fertiliser of the soil.

As a crop Sunn Hemp is widely cultivated in India, Ceylon, Java and Borneo for fibre. The fibre, consisting of the bast fibres of the stem, is used for cheap grade ropes, boxcord, canvas, fish nets, etc. It varies considerably in quality, being coarse when grown on rich soils, which, however, give a very vigorous growth. The

preparation consists of ploughing and harrowing, and the seed is broadcast (70-100 lbs. per acre) or drilled (12-15 lbs.), the common spacing being 3 x 4 inches. No further attention is required until harvesting in four to five months. It is usually sown from April to June and harvested in September-October, or sown in September-October and harvested in February. It may be cut when in flower or after seeding and either stacked to dry for some time before "retting" or "retted" almost immediately. Opinions differ as to the best time to cut. Methods of retting vary considerably. The stalks may be immersed in stagnant or running water for about 5 days and then stripped, or the action of rain and dew may be made use of. In some parts of the world a process of dry scutching is employed.

As a leguminous crop Sunn Hemp is recognised by cultivators as a renovator of soils, and as a good crop to grow before valuable crops such as sugar-cane, tobacco, jute and others. It is extensively used as a green manure crop in India. In Mauritius it is grown in between young canes and "develops splendidly without the least injury to the smallest canes....It may easily be grown between canes forming a mass probably superior to that obtained from any other Leguminosae." (P. de Sornay). It has been experimented with recently in Southern Rhodesia and East Africa where it is reported on as growing more luxuriantly than in India. Its lack of need for intensive preparation before planting, its rapid growth, the way in which it smothers weeds, and the amount of plant food it gives when ploughed in go towards making it a green manure cover crop very suitable for the tropics. It may be ploughed in at six weeks, by which time it has made rapid growth and is

green and juicy, or be left for a much longer period and turned in when more woody.

Results in Mauritius indicated that a total yield of green matter when ploughed in as a green manure during florescence would be 14-15 tons per acre.

Analyses from the same station give the composition of the green matter as follows:-

Total mineral matter	1.880 %
Water	79.3 %
Dry matter	20.7 %
Nitrogen	0.36 %

Assuming Nitrogen at 0.31% (an average figure) a yield of 14-15 tons per acre would give 92 lbs. Nitrogen per acre.

II. EXPERIMENTAL.

A. Plan of the Experiment.

The experiment was designed as a study of the crop under field conditions and at the same time to provide material for a number of observations on individual plants.

The variable factors throughout the experiment were the time of planting and the rate of sowing, the object being to determine:-

1. The best time for planting the crop.
2. The correct spacing of the plants to give maximum yields of fibre, or seed, or of green matter to be ploughed in as a green manure, at different times of planting.

These determinations, in addition to the collection of yield figures, involved a study of the behaviour of selected individual plants under the controlled conditions, and their relation to their environment, including rainfall and the incidence of insect pests.

The field observations made consisted of the following:-

1. Rate of growth of selected plants.
2. Height of lowest lateral branch.
3. Time of flowering.
4. Numbers of flowers formed.
5. Numbers of pods formed.
6. Number of seeds per pod.
7. Pollination of flowers.
8. Incidence of pests.

Estimation of yields were made as follows:-

1. Total yield of green matter.
2. Yield of fibre.
3. Yield of seed.

The land available for this experiment was a rectangular strip approximately 8640 sq.ft. in extent on the eastern boundary of the College estate lying alongside the road. The land had not previously been cultivated and had formed part of a savannah in the vicinity of the old sugar factory. Native huts had been situated on or near the plots, and a considerable amount of refuse and broken up masonry was present in the upper layer of soil. Much of this had been removed but the gravelly components of the soil was made up largely of this type of material.

The soil may be described as Trinidad Red Silt with an admixture of gravel decreasing to the north from Plot 1 to Plot 8.

Owing to the filling in of the holes with vegetable and other rubbish, the proximity of the plots to human habitations, and its probable use as rough grazing the fertility of the soil varied considerably and was very patchy in places.

The preliminary cultivation consisted of one plowing a month or so before, and one hoeing a few days before sowing.

It was decided to make eight separate sowings at fortnightly intervals from October 2nd (1926) to January 8th (1927), each sowing to include spacing at four different intervals.

For this purpose the land was divided into 32 plots 15 ft. x 18 ft. with narrow lanes 6" wide between each. Four plots were sown each fortnight, and numbered I A, I B, I C, I D; II A, II B, etc. In each case A represents the thickest rate of seeding, down to D, the thinnest. It was originally intended to broadcast at the rate of 100, 60, 25 and 12 lbs. per acre respectively, but on Plot I the two lower rates of seeding gave such uneven stands that they were abandoned, and afterwards formed part of Plot II. I A and I B gave even stands apparently similar in all respects and were retained as an observation plot. The following fortnight all four plots (II A, II B, II C, and II D) were sown at an even rate of 100 lbs. per acre. When the plants were 2-3 inches high B, C and D were thinned out to a spacing of 6, 9 and 12 inches respectively. This system was followed throughout in succeeding sowings.

Thus in Plots II.-VIII.

- | | |
|------------------------------|----------------------------------|
| A - spacing:(approx.) 3 ins. | - seed rate 100 lbs./acre |
| B - spacing: 6 ins. | - seed rate (approx.) 60 lb/acre |
| C - spacing: 9 ins. | - seed rate (approx.) 25 lb/acre |
| D - spacing:12 ins. | - seed rate (approx.) 12 lb/acre |

The stand secured depends on the percentage germinations as well as the rate of seeding, so the seed rate per acre is only given approximately in the case of B, C, and D.

The seed was a mixed lot originally obtained from India and the U.S.A. which had been grown together in Trinidad for one year previous to this experiment.

For the purpose of observation on individual plants five plants were selected at random from each division (A, B, C, and D) of each plot(II - VIII). In addition 20 plants were selected from the observation plot (Plot I) and divided into four groups of five. These latter, however, were all growing

under the same conditions and are not to be confused with the A, B, C and D groups of Plots II - VIII.

These plants were labelled when they had attained a height of 3-4 ins. and measurements of their height taken three times a week until the appearance of the first flowers. At this point growth had virtually ceased, any further increase in height being due to a development of the inflorescence or the vertical growth of branches. In addition to the growth rates, height of branching, and the dates of flowering and setting seed flower counts were made on all these plants, also the number of pods per plant and the number of seeds per pod.

Yield figures were obtained of total green matter and fibre from two separate yard blocks of Plot I, and 2 sq. yds. from each of A, B, C, D, in the case of Plots II - VIII. These cuttings were made as representative as possible. The remaining portion of each plot was harvested for seed.

The process of retting consisted of allowing the stalks to dry in the field for half a day, after which they were tied up in bundles and immersed in standing water for five days. At the end of this period they were taken out and the separated fibre dried in the sun.

B. Growth Characteristics.

The data obtained from the studies of the growth rate of the selected plants is given in Figs.1-10 and in the Table.

The graphs show the daily growth rate from the time the plants reach the height of 3-4 ins. until the time of flowering. The green, red, mauve and black lines indicate respectively the averages of the five selected plants in the A, B, C & D divisions of the plot, i.e. the average growth rate of the plants spaced at approximately 3, 6, 9 and 12 ins. The time of flowering of individual plants is indicated by the small numerals along the graphs, and the period from sowing to flowering is also given in the table. The average heights at the commencement of flowering are given in the histograms accompanying each graph, and in the Table. The shaded portion in each column of the histogram shows the height of stem below the lowest lateral branch, and is thus an indication of the proportion of stem available for fibre.

Plotted above the growth rate graphs is the daily rainfall. The graphs commence at about two weeks after sowing, rainfall during germination and early growth can be seen by reference to the previous graph. The rainfall during the germination period of Plot I is not given as Messrs. Macdonald and Newman's figures which are used throughout were not available previous to October.

Although Mr. A. L. Brunton gives one day as the germination period of Sunn hemp seed at St. Augustine, it was found in this experiment that germination was in 2-4 days and longer. Germination tests were carried out on five separate lots of seed in Petrie dishes filled with damp sand, 50 seeds in each lot. It was found that 60% had germinated in four

days, 90% in six days, and a few others took as long as ten days to germinate, bringing the total to 92%.

On the plots germination appeared to take place within four days.

During the first ten days plants at different spacings made equal growth but after this those in A shot up above the others, those in D developing thicker stems and a more bushy habit at the expense of height. The average diameter of the stem 18 inches from the ground was $\frac{3}{8}$ " in the case of A, and $\frac{1}{2}$ "- $\frac{5}{8}$ " in the case of D. The height at which the lowest branches were thrown out varied considerably from plant to plant but spaced at 3" about $\frac{5}{6}$ of the stem would be clear of laterals and only $\frac{1}{2}$ or less when spaced at 12". The growth rate increased with the height of the plants to within 14 days of florescence at which time growth slackened and practically came to a standstill, further growth being confined to development of the inflorescence and the throwing out of branches. The maximum daily growth recorded (average of five plants) was $3\frac{1}{2}$ ". The tendency was for the closely-spaced plots to come into flower at a later date than the others. The difference recorded between A and D vary from 0-12 days, but the actual difference seemed more, D often being a mass of yellow when only a few isolated blooms were visible in A. The difference in height of flowering between closely and widely spaced plants is effectively shown in the histograms.

The variation in the growth rate from day to day was marked. This is clearly shown in the graphs. So far as can be judged by comparing this with the rainfall chart during the same period a general acceleration of the growth rate usually follows closely on a fall of rain.

The dependence of the crop for its greatest development on a regular rainfall is shown by a comparison of Figs.1-8 and in Fig.9 in which the heights of flowering of Plots II - VIII are given. Plot V was remarkable in that germination was very poor and early growth slow, resulting in stunted, bushy plants which came into flower prematurely - the Plot was well into flowers before Plot IV, planted a fortnight before Plot V - and at half the normal height. Plot V experienced a dry spell during germination and early growth and subsequent rains evidently did not compensate for this initial handicap. Plots VI, VII, and VIII, sown December 11th - January 8th, all came into flower at a less height than II, III, or IV, sown October 16th - November 13th. The rains during the growing period of the later sown plots were evidently not suited to the best growth of the plants, they consisted for the most part of heavy, isolated showers between dry spells, as compared with a steady succession of lighter showers, and the atmospheric humidity was much lower.

It is interesting to note that in the later sowings the widely spaced plants appeared to do better than those closely planted (Fig.9). This may be partly accounted for by inequalities in the soil, but the widely spaced plants suffered less from competition due to crowding, and would be more able to make use of the soil moisture.

The time taken to the ripening of seed is given in the Table. It will be seen that there is little variation except in the case of Plot V.

Normally the plant may be described as flowering in 7-8 weeks at a height of 4'-6', the seed ripening in 15 weeks.

C. Flower Counts.

The flowering of each plant extends over a period of two to three weeks, fully formed green pods and flowers being present on a plant at the same time. In order to estimate the total number of flowers produced per plant, all the flower scars and pods were counted at the completion of florescence.

The number of flowers per plant showed great variation, from one to as many as four hundred. This appeared to be determined largely by the degree of crowding. Plants in D produced large numbers of flowers whilst those in A had less, though there were many exceptions to the latter. This is not always borne out by the counts obtained from the selected plants, due to the relatively small number of plants examined from each plot, but it was quite evident from an examination of the plots as a whole.

The most interesting point arising out of the flower and pod counts is the fact that only 20% to 30% of the flowers ever produce pods which remain to be harvested. In some cases plants with as many as 300 flowers produced no pods.

This loss must be made up as follows:-

1. Shedding of flowers for physiological reasons.
2. Shedding of flowers due to insect attack.
3. Infestation of pods by insect pests.

It is difficult to arrive at the relative importance of these factors, but the shedding of flowers due to physiological reasons (adverse soil or climatic conditions, or non-pollination) must play a fairly large part, because the loss per cent in the later sown plots was as large as in the earlier sown plots, whereas the incidence of insect pests had dwindled to 1% at most. The number of pods showing insect attack which remained on the plant (as shown in the Table) is of little significance, and only goes to indicate that most of the damaged pods are shed. In connection with the possibility of the non-pollination of flowers

it may be stated that large numbers of bees were observed to visit the flowers, and also that A. & G. Howard hold that in the case of non-cross fertilization of Sunn hemp the flowers self automatically.

The number of seeds per pod varied from four to fourteen. The normal number probably varies from eight to fourteen, depending on the variety, but plants growing under adverse conditions, as in Plot V., showed a very low number of seeds per pod. In making these counts no pods showing signs of insect attack were included.

D. Yields.

1. Total Green Matter.

The yield figures are given in the Table. They show a marked diminution in those plots sown after November 13th., particularly in the thinly sown plots. In Plot II. there is a difference of eight tons per acre between the thickest and thinnest sown plots. The more bushy nature of the plants in the latter evidently does not compensate for the greater number of plants in the former. In this connection it should be noted that weed growth was effectively controlled by rapid growth of the Sunn hemp in A, and usually in B, but that in the case of C & D weeding had to be done to enable the plants to establish themselves.

The effect of a dry period during early growth is shown by the yields from Plot V. which are extremely low. The yields obtained from Plots I and II compare very favourably with those obtained in Mauritius of 14-15 tons per acre.

2. Fibre.

The yields of fibre, as would be expected, follow closely the yield of green matter in a comparison of thickly seeded with thinly seeded plots. The yields from the later sown plots are much higher in proportion to the yields of total green matter. This is due to the fact that fibre yields are more in proportion to the number of stems per acre, whereas in the yield of total green matter other factors such as branching habit and leafiness are concerned.

In India yields of fibre of from 200 to 1200 lbs. are obtained, the average being about 640 lbs. This experiment shows that yields of from 400-600 lbs. can be relied on when sowing not later than October at the rate of 100 lbs. per acre.

With regard to quality of fibre no actual tests were carried out but each lot was examined and judged for fineness and general appearance. It was evident that rate of sowing was an important factor, the fibre from closely spaced plants being finer, cleaner and longer than the fibre from other spacings. There was also an apparent deterioration in quality with successive sowings. Normal development of plants was prevented by the uncertainty of rain and this evidently had an effect on the fibre.

The plants from Plot V. were so low and woody that no fibre was obtained from them. The fibre from Plot I. was unfortunately lost owing to a misunderstanding in connection with the process of retting.

3. Seed.

No data of seed yields from Sunn hemp in other countries was available.

The yields of seed were surprisingly high due to the appearance of insect pests in smaller numbers than had been anticipated. Yields of from 640 to 1360 lbs. per acre were obtained from the thickly seeded plots sown before November 13th, after which the yield decreased rapidly, in spite of the fact that infestation of the pods by caterpillars had decreased to about 1% of what it had been. This is difficult to account for, but flowers were produced in smaller numbers on the plots owing to poor germination of those sown later and to poor development of individual plants. Large numbers of flowers were shed for no apparent reason, so it can only be concluded that climatic conditions at this time were not favourable to the production of seed. It should also be pointed out that in the case of Plots I - IV. the period of florescence was of longer duration than in the case of the other plots,

necessitating the harvesting of a number of pods in the green stage. This would tend to give a slightly higher yield. The seed from Plots VI.-VIII. were dead ripe and noticeably smaller than seeds of similar ripeness from the earlier plots.

The smallness of the yields of seed from the thinly sown plots was unexpected. It was anticipated that the more bushy habit of these plants due to the absence of overcrowding would result in a more profuse setting of seed which would compensate for the greater number of plants in the other plots. That this is not so is evidenced by a comparison of the yields.

It is also evident that the plant to plant variation is too great for any correlation to be established between yield of seed and the average number of pods per plant, etc., from only five plants in the plot.

From the results obtained it must be concluded that where sown later than October climatic conditions are of greater importance than insect attack in the production of seed and also that bushy habit does not compensate for closer spacing.



Plutethesia ornatrix.
attacking Sann Hemp.
X7/8.

E. Pests and Diseases.

Considerable damage was done on the first four plots by two types of insect. The most important of these was the larva of a moth, *Utethesia ornatrix*. This moth is almost identical with *U. pulchella* which attacks Sunn hemp in India. *U. ornatrix* is found in Trinidad on wild crotalarias.

The moth lays its eggs on flowers and leaves singly or in packets and one female may lay 200-300 eggs. The egg hatches in 3-4 days and the larval stage is about 30 days. It is in the larval stage that the insect does most damage. The caterpillar attacks the leaves of young plants and the leaves and flowers of larger plants. However, most damage is done when they attack the green pods, eating their way in and remaining there to demolish the young seeds. Most of the pods attacked fall to the ground, but some remain on the plant. The life cycle is repeated continuously throughout the rainy season.

At the time this experiment was started (October 2nd., 1926) there were several rows of Sunn hemp on the College plots planted as protection for a plot of jute. These were then well advanced in flower and some green pods were also present. These few rows were very badly infested with the caterpillars and it was the exception to find an undamaged pod. Plot I. of this experiment appeared to be badly infested and large numbers of moths were observed laying on the flowers and leaves. In spite of this a fairly good yield of seed was obtained. On Plot II. the infestation was considerably less, and decreased rapidly with successive plantings. The later plots were hardly attacked at all, and the insect could be considered a negligible factor.

Another insect pest which at one time appeared to be doing serious damage was the Flea beetle - *Diabrotica* spp., - which was also present in large numbers on the sweet potato,

canovalia, and other adjacent plots. These beetles attack the young leaves of the plant voraciously, especially when the plant is small. Plot II., especially II.A, was badly attacked by this pest, the plot having the appearance of being riddled with shot. However, growth at this time was very vigorous and the plants rapidly outgrew the infestation. When the plants had attained the height of 3 ft. the pest seemed to have disappeared entirely. On Plot IV. these beetles again appeared in large numbers and did a lot of damage while the young plants were held back by insufficient rains. With the advent of several showers, however, the plants sprang up rapidly and outgrew the pest, which again disappeared. No further trouble with these beetles was experienced.

A third pest was present - pentatomid bugs which attacked the flowers. These were identified as *Nezeda viridula* (which also attacks canoalia) and *Dinocoris* spp. *N. viridula* was also observed to attack green pods, but this appeared to be unusual, and was confined to a slight injury of the outer skin of very young pods. The greatest damage was done by the eating of flowers, which were shed in most cases. These bugs may be a factor in the shedding of flowers, but as the infestation was never serious its importance cannot be very considerable. This pest was absent on Plots IV. - VIII.

An examination of the roots of plants which were pulled up for examination after they had been harvested for seed showed the presence of nematode worms which were eating into the roots. These were only found on fully matured plants, and although a number of green plants were pulled up no trace of them was found, so they are probably of no importance as a pest.

Disease conditions on the plants were absent except for the widespread prevalence of chlorosis or mozaic. This was first noticed on the above mentioned windbreak which was in flower at the time this experiment was started. It took the form of the yellow spotting of the leaves on a number of plants and seemed to be confined to one section of the windbreak. This condition was absent in Plot I, and Plot II. of the experiment. When the latter had made about four weeks growth (on Nov. 11th.) a culture, obtained by macerating the leaves of some of the infected plants of the windbreak in distilled water, was sprayed onto half a dozen plants in Plot II.A, after several leaves had been removed to provide a channel of infection. No signs of an infection appeared until December 11th., when a number of plants in Plot II.A, including the sprayed plants and those adjoining them, developed a marked yellowing of the leaves, in the form of spots. Later it was observed that these conditions had been developed independently on the other plots, and were observed to develop on all the plots after about four weeks growth. This condition appeared to be favoured by hot, dry weather, and was more marked in some of the later sown plots, notably Plots VI. - VIII., but were completely absent from Plot V. Two plants were observed which were entirely yellow.

From the evidence available it is difficult to say whether these conditions were the result of a definite infection of mozaic, or chlorosis, due to soil conditions. Except in the case of a few individual plants the intensity of the yellowing was not sufficient to affect the stand to an appreciable extent.

It was noticed that the entry of *U. ornatrix* larvae into pods was usually followed by the appearance of a black mould, which was suggested to be *Aspergillus niger*, or of another mould which formed a white mycelium.

F. Pollination.

A. & G. Howard working in India found the principal pollinating agents to be 'heavy insects', which are not specified. The two small Indian bees, *Apis indica* and *A. florea*, also visit the flowers but are considered too small and light to effect pollination.

During this experiment the flowers were visited by insects in great numbers. These insects were mostly hymenopterous, though one large beetle was fairly common. The hymenopterous insects consisted for the most part of the common bees, which may or may not be considered 'heavy insects'. Probably they are heavy enough to effect pollination, as the typical Indian bee described above is small. The common 'Jack Spaniard' was also a frequent visitor to the flowers.

A. & G. Howard state that in the event of cross-fertilization by insects not being effected self-fertilization takes place, though it is interesting to note that this does not occur if the plants are protected from insects.

The visitation of flowers was noticed to fall off on those plots planted after November 27th. It is possible that this may be a factor in the production of low yields of seed on the last three plots, and for the slightly lower number of seeds per pod in spite of the decreased activities of the various insect pests.

III. CONCLUSIONS.

Before proceeding to a general summary of results it must be emphasised that weather conditions during the greater part of the experiment were unusual.

A comparison of the rainfall for the first four months of 1927 with the average of the previous four years shows how the rainy season extended into what is usually regarded as the 'dry season'.

	Jan.	Feb.	March	April.
Av. 1923-1926	2.54 in.	1.25 in.	1.16 in.	.53 in.
1927	7.30 "	7.94 "	1.65 "	9.10 "

The unusual character of the season, together with undoubted variations in the fertility of the soil from plot to plot, render it necessary to consider the results as having been obtained under somewhat abnormal conditions. They must be regarded in general, therefore, as being indicative rather than conclusive.

In the first place this experiment has confirmed the results obtained in previous experiments in showing that under Trinidad conditions Sunn hemp is a fast growing vigorous cover crop which will effectually smother weed growth (except perhaps nut grass) and in six or seven weeks provide a heavy growth suitable for plowing in as a green manure. [If sown not later than October at the rate of from 70-100 lbs. per acre yields of green matter of from 14-20 tons per acre can be expected with only a rough preparation of the soil] which is equal to yields obtained in Mauritius after two cultivations. No weeding is necessary under these conditions, nor is any further attention needed after sowing. Even if laid by wind

and heavy rain no permanent damage results, and growth is sufficiently rapid to outgrow the attacks of flea beetles and caterpillars even if in large numbers.

A seed rate of less than 60 lbs. per acre will give a poorer stand of somewhat coarser plants which will not keep down weed growth.

If the crop is sown after October yields would be lower and definitely uncertain on account of the probable scarcity of rain. Sufficient moisture is particularly essential for germination and early growth. In the event of there being little rain at this period germination will be poor and the stand obtained inconsiderable. The plants are likely to be small, bushy and coarse.

If grown as a fibre crop in addition to high yield length and fineness of fibre are desirable. [Length of fibre is attained by ensuring a good length of stem which must be free from laterals for the first $3\frac{1}{2}$ to 4 ft. from the ground. This condition is obtained by sowing when sufficient rainfall can be relied on to give a good vigorous growth, that is not later than October, and by seeding at the rate of 80-100 lbs. per acre to discourage the production of laterals. Too rank growth such as would be given by growing the crop on a rich soil should be avoided, however, in the interest of fibre quality. Wider spaced plants are more sturdy in habit and give a coarser type of fibre.

The yields of fibre obtained from plots grown in October varied from 710-764 lbs. per acre where sown at a rate of 100 lbs. per acre. These compare favourably with the average Indian yield of 600 lbs.

The difficulty of producing seed in sufficient quantity is likely to be the limiting factor in the cultivation of Sunn hemp in Trinidad. Although this experiment included only the latter end of the rainy season observations on other plots of Sunn hemp seem to indicate fairly conclusively that during the time when the most vigorous growth may be expected, that is during the rainy season proper from June to October, the yield of seed is likely to be very poor owing to the ravages of the larvae of *U. ornatrix*. The results of this experiment also show that where sown after October growth conditions are such that only very low yields can be expected, and these would be more uncertain in normal years when the limit of the rainy season would be more definite.

Contrary to expectations it was found that [the best yields were obtained from closely sown plots.] Taking the yields then from the 100 lb. per acre seeded plots it is seen that the yield of seed rises from 640 and 740 lb. where sown on October 2nd. to 1162 lb. (Oct.16th), 1360 lb. (Oct.30th), and 1344 lb. (Nov.13th), and then drops to 322 lb. (Nov.27th), 290 lb. (Dec.11th), 172 lb. (Dec.27th) and 408 lb. (Jan.8th). Even allowing for the unusual rains experienced during January and February, 1927, it seems that at the end of the rainy season there may be a short period, say the last two weeks in October, when Sunn hemp can be sown with the reasonable expectation of fair seed production, together with a marked decline in the incidence of insect pests. Under the conditions of the experiment this would be the only means of obtaining a satisfactory yield of seed. During the course of the experiment other factors were observed which may be of importance in seed production. The shedding of flowers, for no apparent cause, must affect the yield very considerably, but its importance can only be gauged by further experiment in which the possibility of insect damage is eliminated. With

this object in view the following tentative suggestions are put forward in connection with a further study of seed production in Sunn hemp:

1. Experimental control of insect pests, particularly *U. ornatrix*, by dusting or spraying with arsenicals.
2. The provision of optimum soil conditions in the experiment by:
 - a. A more thorough preparation of the seed bed.
 - b. Treatment of the soil for possible deficiencies in plant food. Potash is suggested in view of the chlorotic condition of many of the plants.

An experiment conducted along these lines would throw light on the relative importance of insect attack and soil conditions in seed production. If these methods proved effective a basis for common cultural practice would be provided which would enable Sunn hemp to be generally adopted in Trinidad as a valuable cover crop.

IV. BIBLIOGRAPHY.

1. Minutes and Proceedings of the Froghopper Investigation Committee, Trinidad, 1926. Parts III. & IV.
2. Report on the Froghopper Blight of Sugar Cane in Trinidad.
C.B.Williams, M.A., F.E.S. 1921.
3. Studies on the Aetiology of Sugar-cane Froghopper Blight in Trinidad. 1. Introduction and General Survey.
C.L.Withycombe, Ph.D., D.I.C. 1926.
4. Green Manures and Manuring in the Tropics.
P. de Sornay.
5. Handbook of Flora in Ceylon.
H. Trimen.
6. Cotton and Other Vegetable Fibres.
E. Goulding.
7. Handbook of Indian Agriculture.
N. G. Mukerji.
8. Empire Cotton Growing Report.
H. C. Sampson, C.I.E.
9. Studies on the Pollination of Some Indian Crops.
A. & G. Howard.

Fig. 1

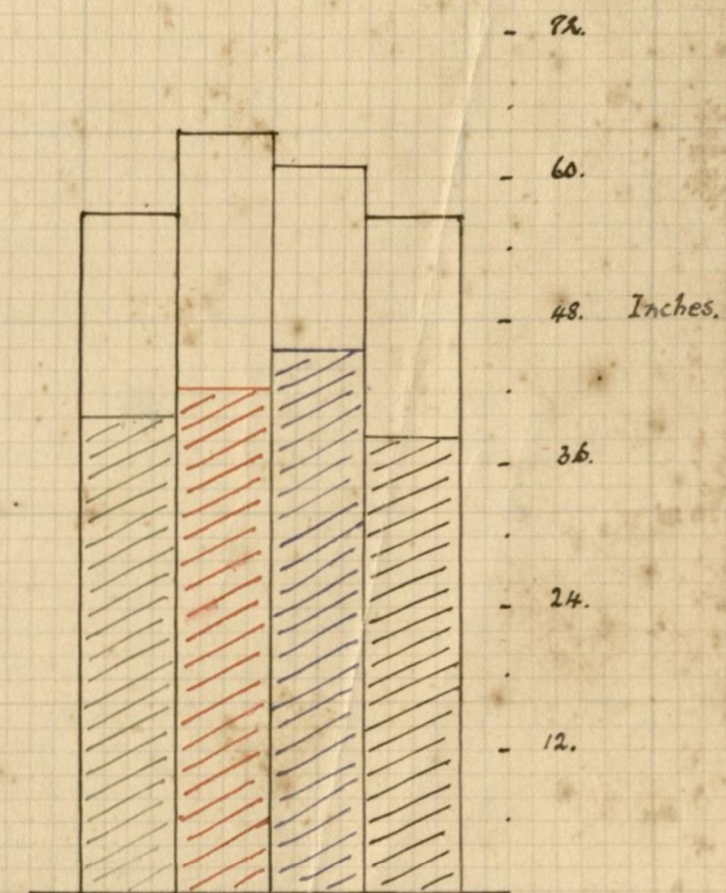
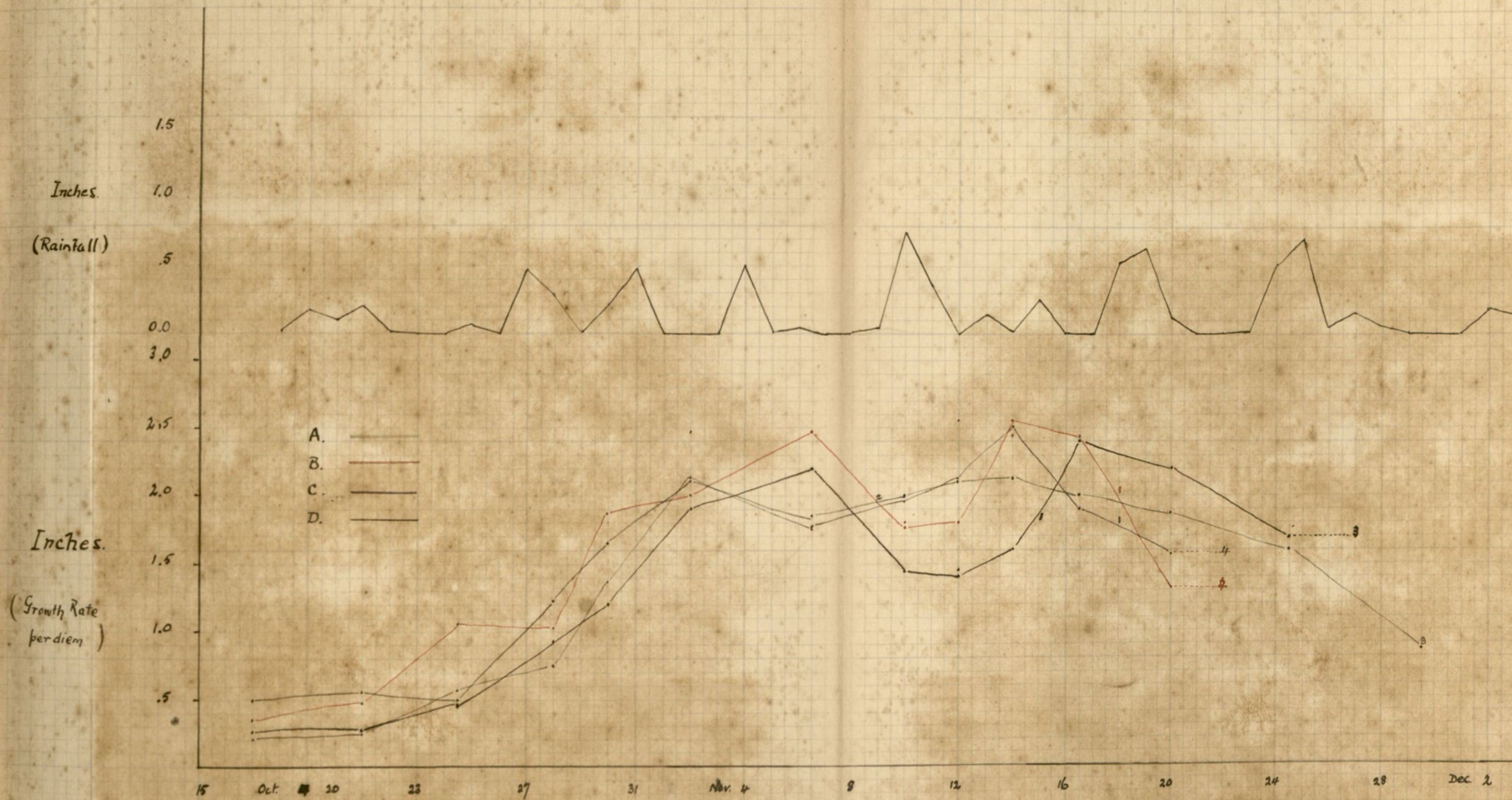


Fig. 2.

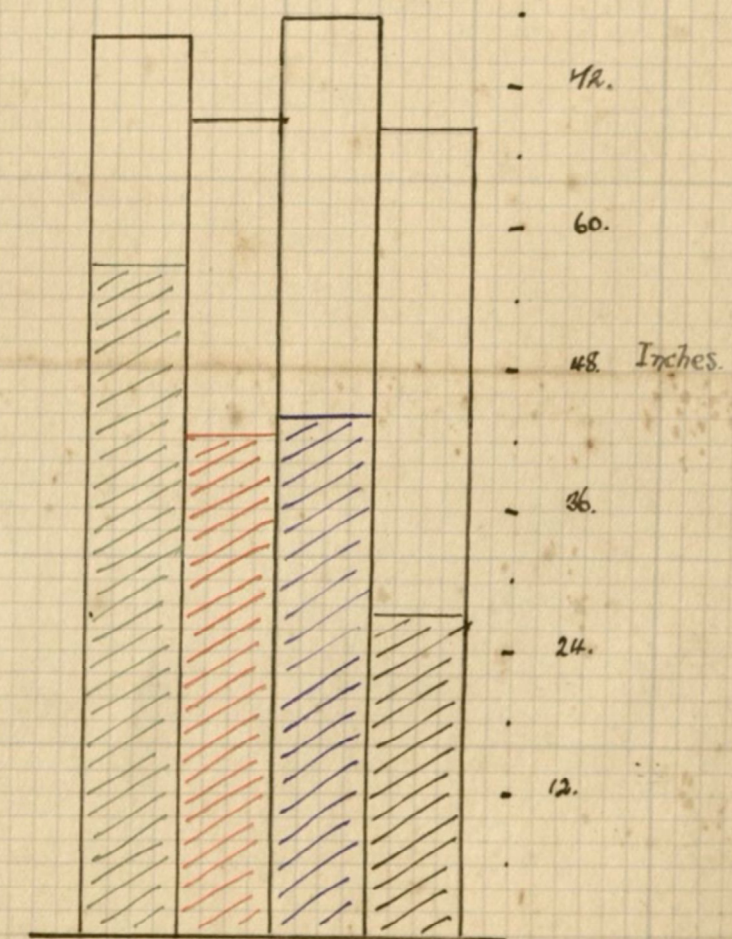
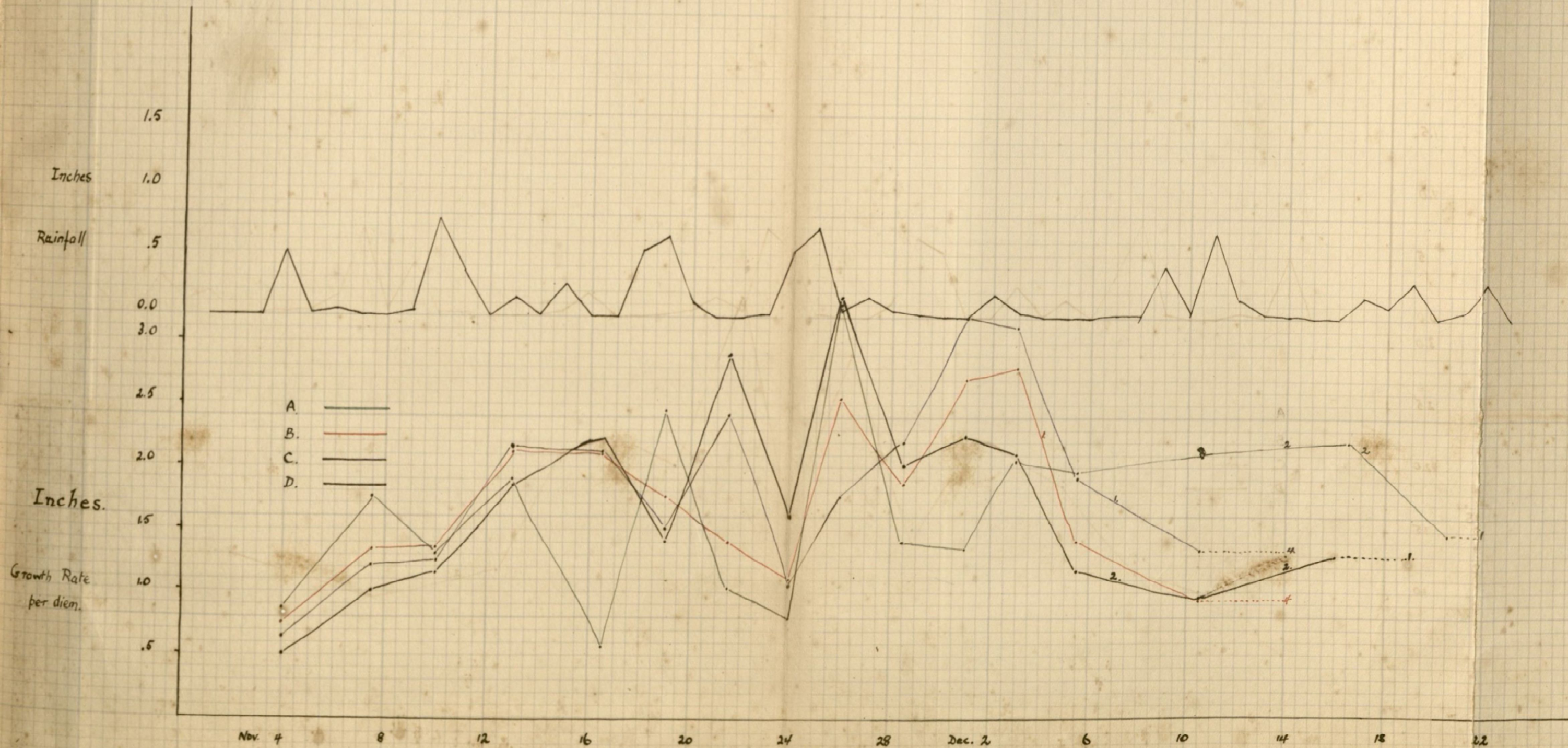


Fig. 3.

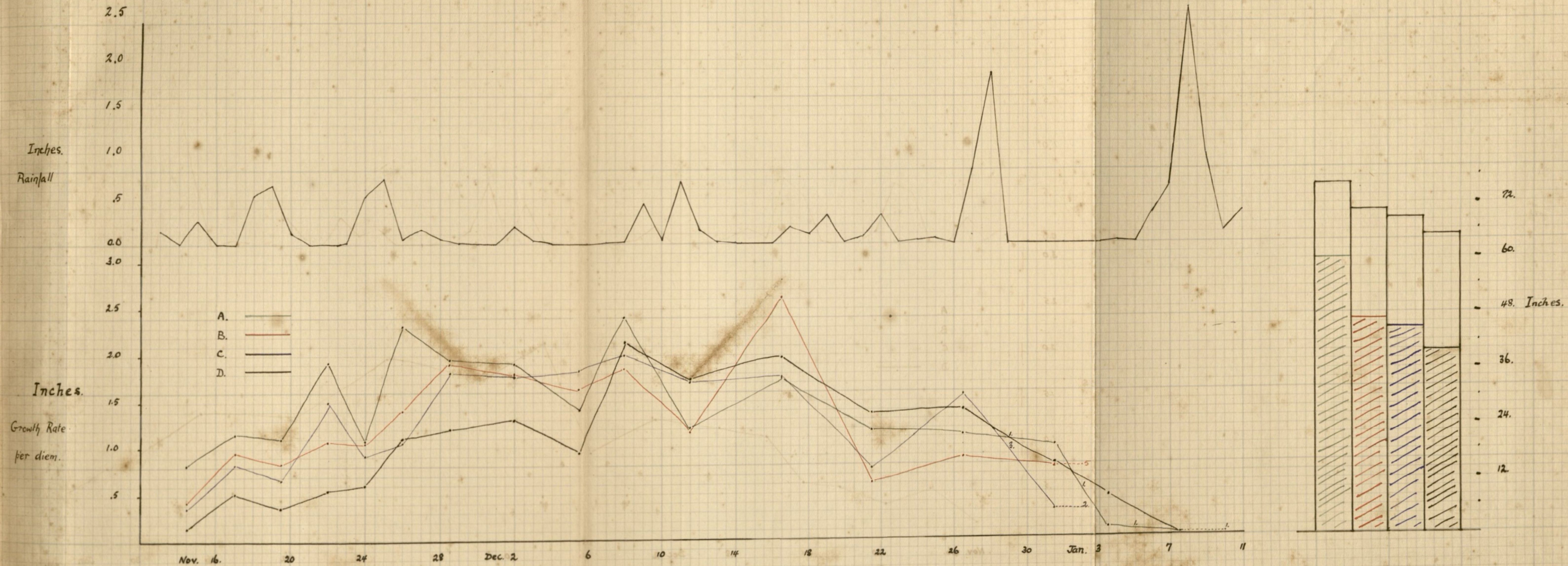


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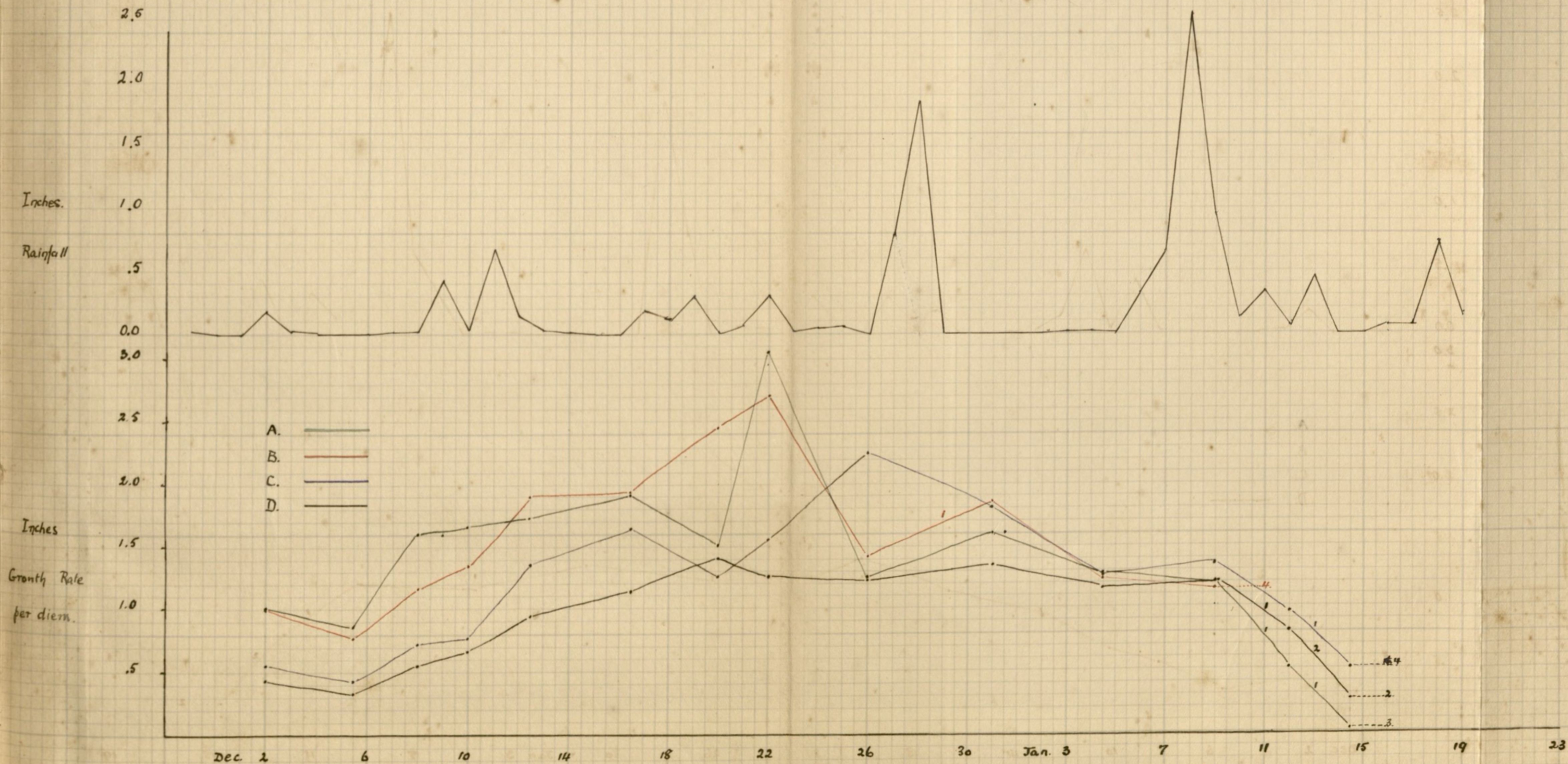


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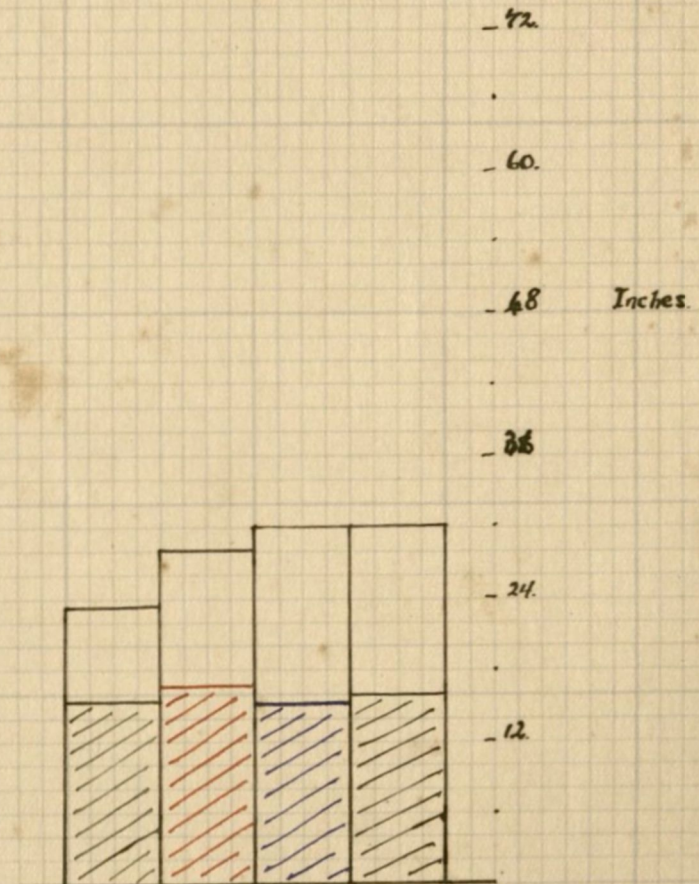
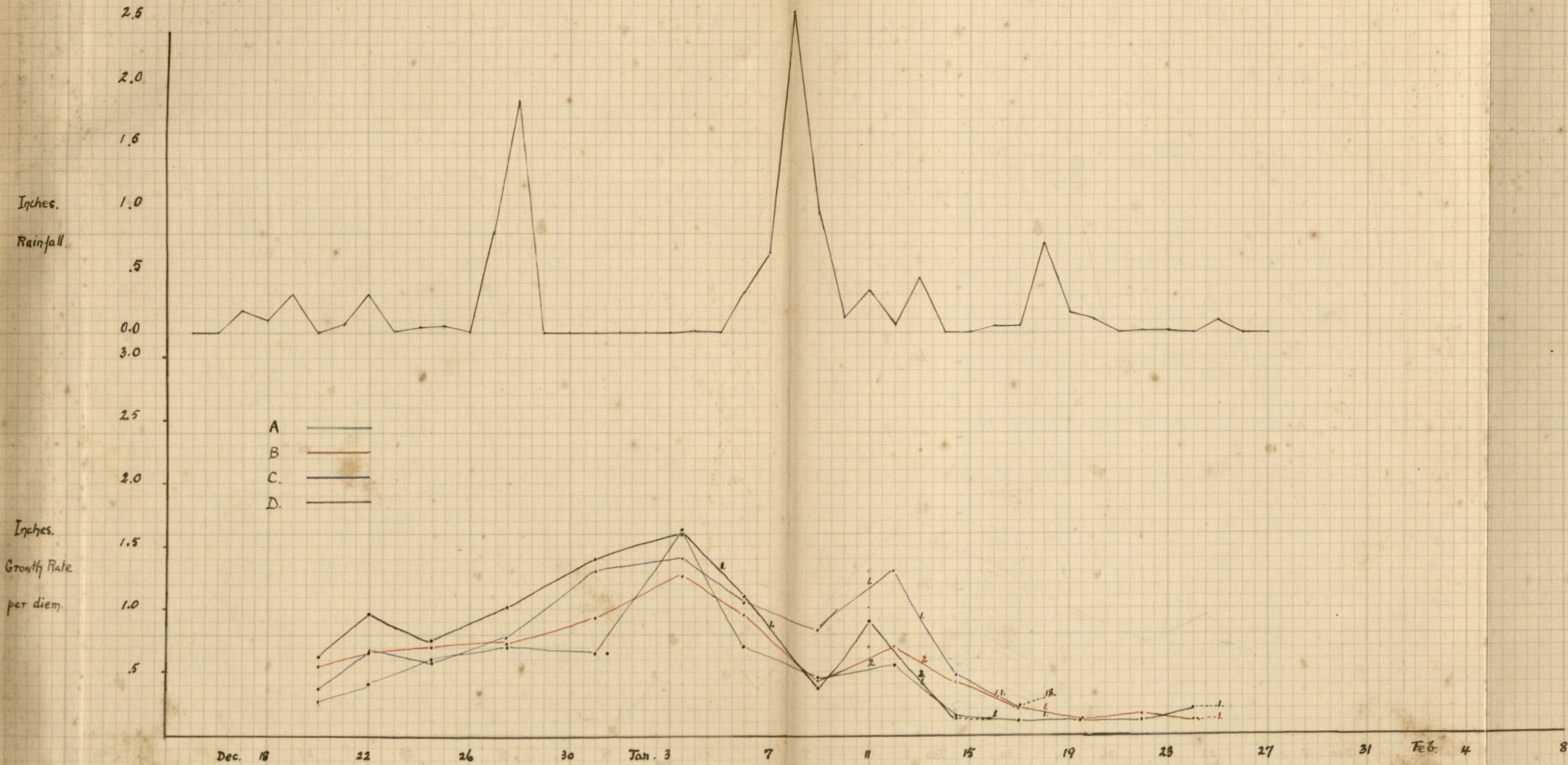


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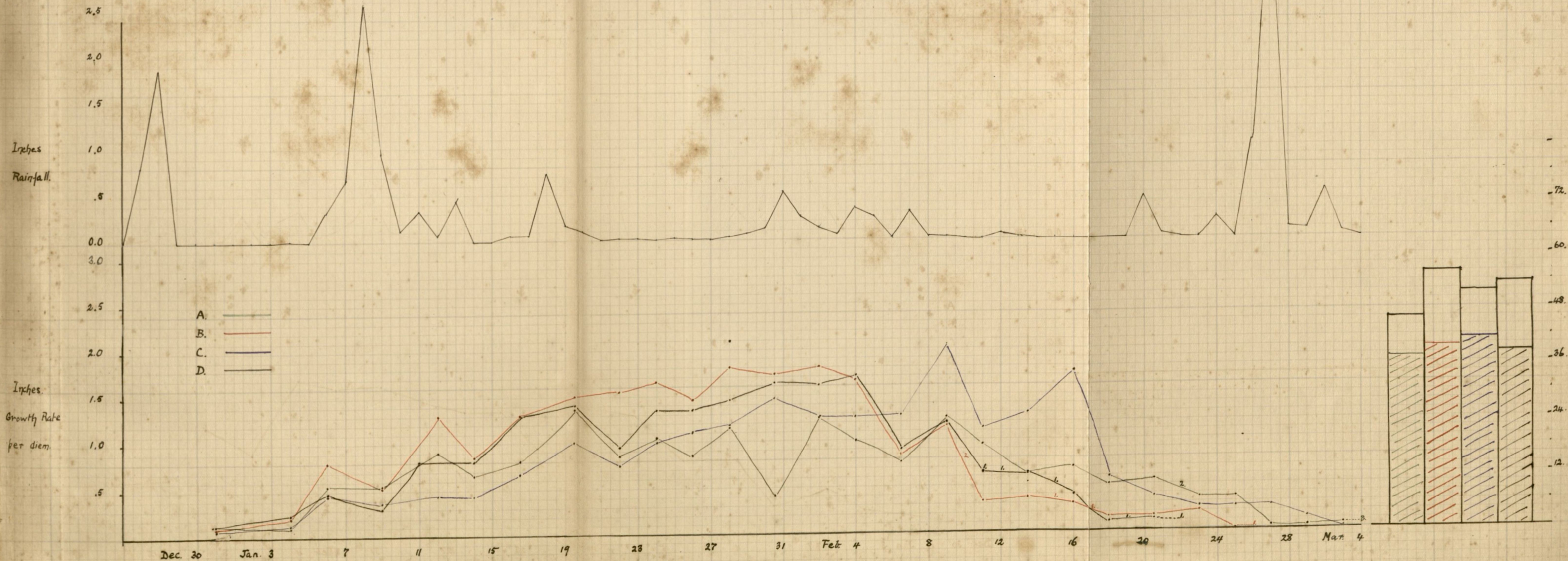


Fig. 7.

Inches
Rainfall.

Inches
Growth Rate
per diem.

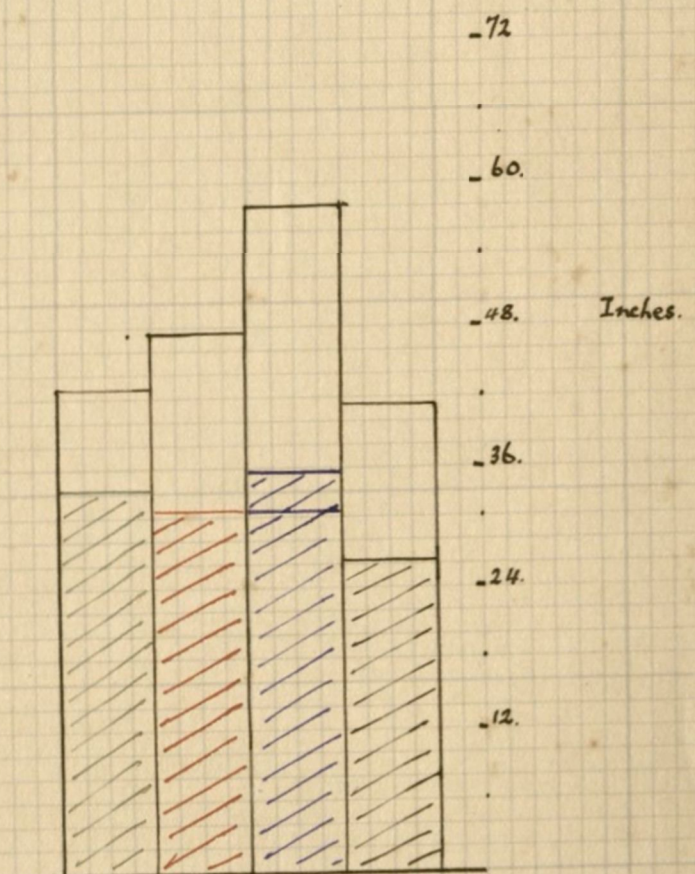
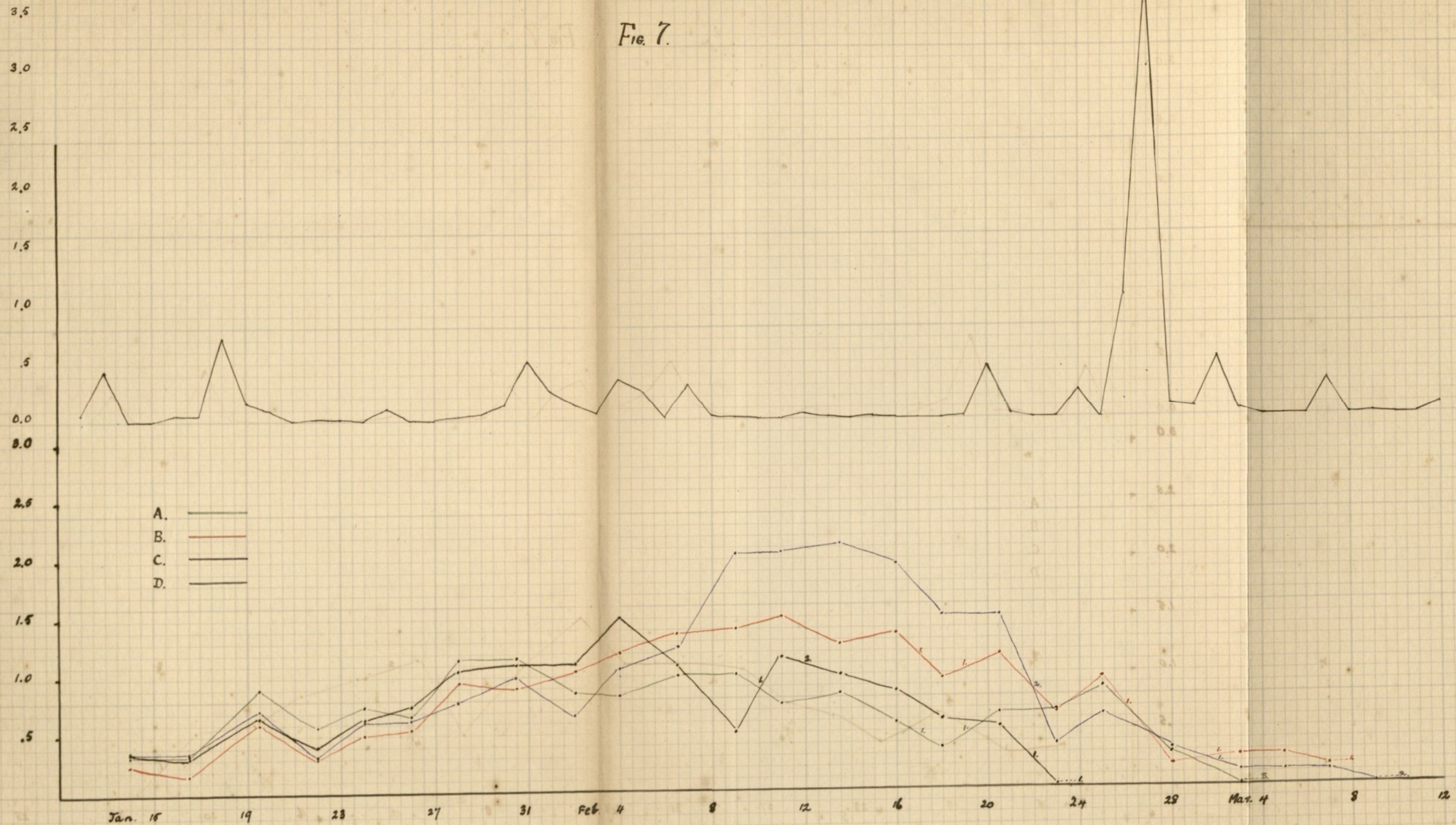


Fig. 8.

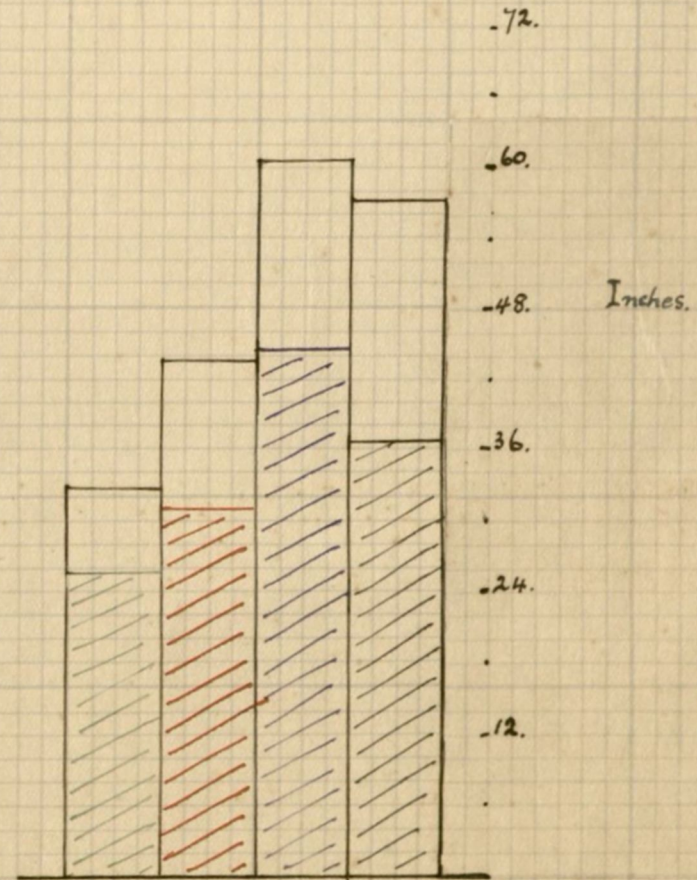
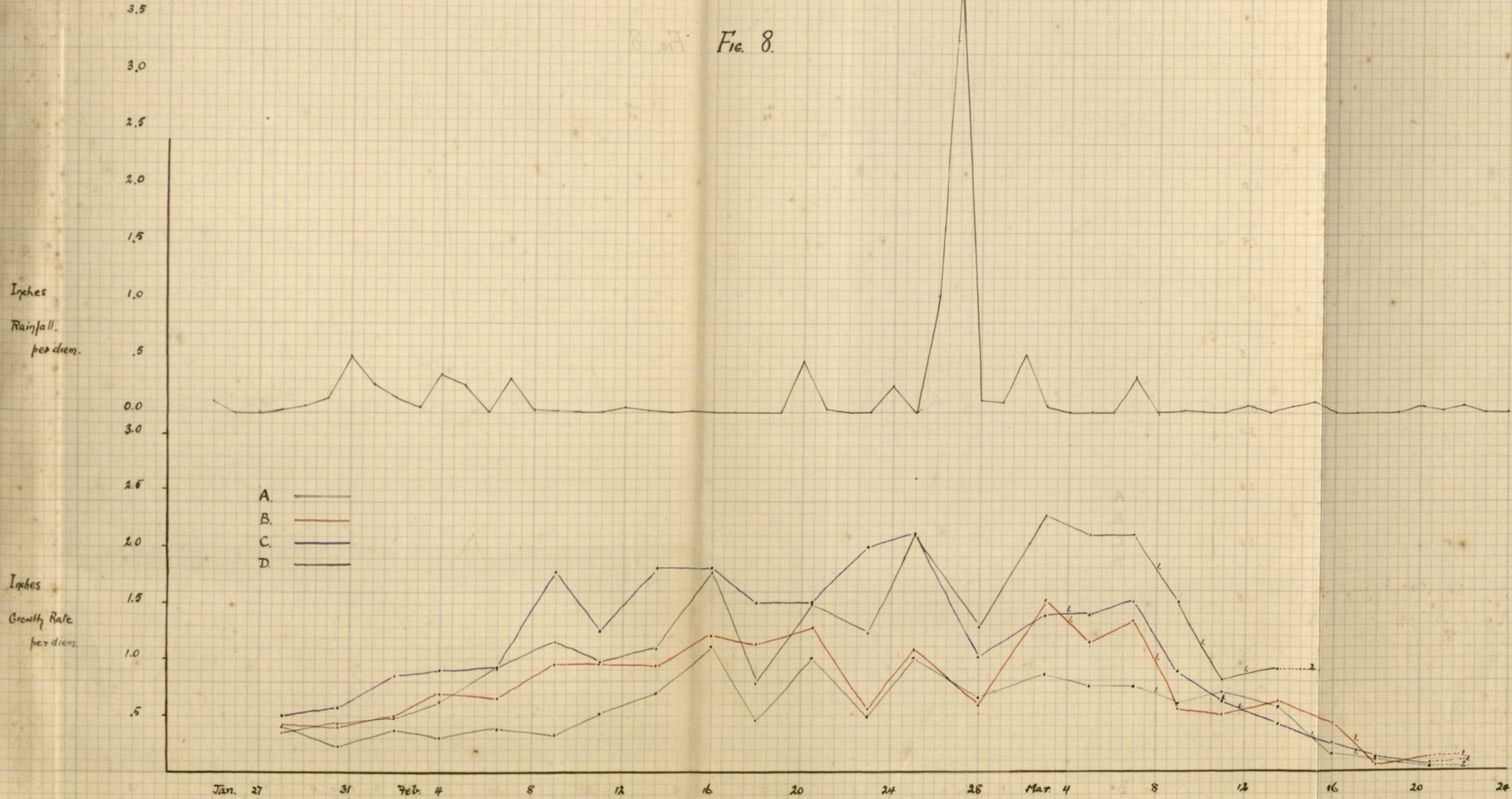
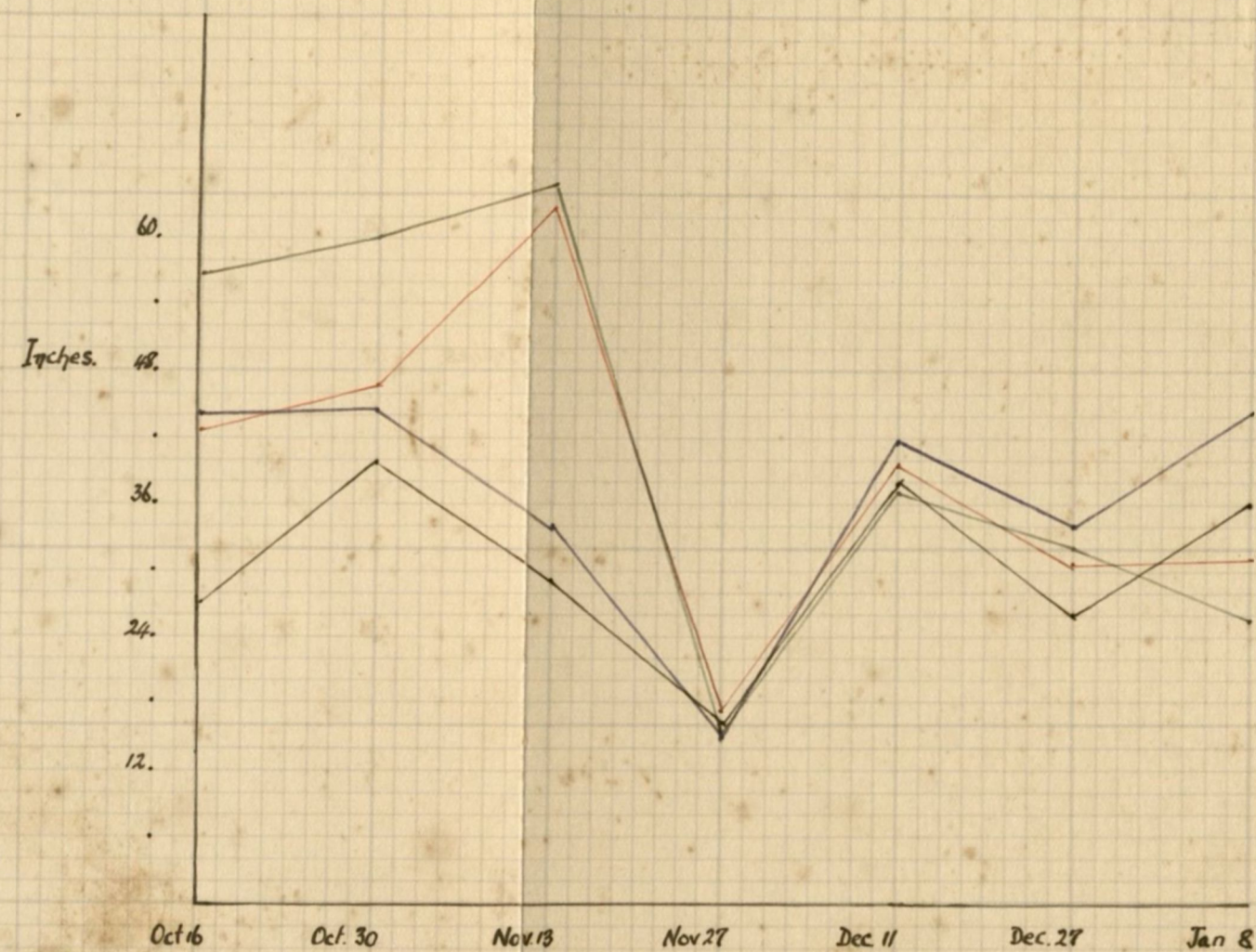


Fig. 9.



A. —
B. —
C. —
D. —

Fig. 10.



Plot No. DATE OF SOWING	Div. OF PLOT (SPACING)	TIME TO FLOWERING DAYS.	TIME TO SETTING RIPE SEED DAYS.	HEIGHT OF PLANT INS.	HEIGHT OF LOWEST BRANCH INS.	No. OF FLOWERS PER PLANT.	No. OF PODS PER PLANT	% FLOWERS SETTING PODS.	Av. No SEEDS PER POD.	No. PODS SHOWING INSECT ATTACK.	YIELD TOTAL GREEN MATTER TONS PER ACRE.	YIELD FIBRE LBS. PER ACRE.	YIELD SEED LBS. PER ACRE.
I OCT 2 1926	+	52	104	57.1	40.0	90	17	19	9.2	1	16.74	-	649.
	-	50	102	63.8	42.4	89	28	31	8.3	3			
	-	48	104	61.0	45.7	119	34	28	10.2	3	16.74	-	700.
	-	51	104	56.8	38.2	95	16	17	8.5	2			
II OCT 16 1926	A	63	112	76.0	56.7	101	16	16	9.6	1	22.65	764.7	1162.
	B	57	117	69.0	42.4	162	34	22	9.4	1	19.5	828.0	660.
	C	58	109	77.7	44.0	152	35	23	8.4	1	19.5	710.5	743.
	D	57	113	68.4	27.3	256	46	20	9.1	1	14.65	451.7	250.
III OCT. 30 1926	A	66	113	76.5	60.0	14	8	57	9.1	0	14.05	710.0	1360.
	B	65	117	70.4	46.7	24	12	50	9.0	1	7.9	349.5	1020.
	C	62	115	68.5	44.8	105	21	20	8.5	3	4.3	138.7	460.
	D	65	120	64.9	39.8	51	7	14	8.8	1	1.6	54.5	212.
IV NOV 13 1926	A	63	120	72.3	65.0	31	7	23	9.5	2	14.65	710.0	1344.
	B	57	119	71.8	62.3	55	12	22	10.0	1	13.5	484.5	1291.
	C	62	112	62.3	34.0	203	6	3	8.8	3	2.15	86.0	425.
	D	62	117	47.4	29.0	166	11	7	7.7	2	.85	34.0	85.
V NOV 27 1926	A	50	95	23.4	15.3	21	3	14	4.7	2	1.05	-	322.
	B	51	92	28.0	16.6	21	3	14	4.3	2	2.4	-	453.
	C	49	93	30.0	15.3	47	8	17	5.6	2	1.05	-	347.
	D	45	93	30.0	16.0	142	50	35	6.6	2	.54	-	153.
VI DEC. 11 1926	A	79	119	45.9	37.1	13	2	15	6.5	0	4.05	345.0	290.
	B	67	117	56.0	39.7	44	8	18	7.0	1	2.4	197.0	129.
	C	74	117	51.6	41.3	28	5	18	7.9	0	.5	67.25	32.
	D	67	110	53.5	38.3	47	7	15	7.9	2	.5	29.25	16.
VII DEC 27 1926	A	60	109	42.8	34.2	171	27	16	8.8	1	7.9	477.5	172.
	B	61	111	47.5	32.6	73	11	15	7.0	1	6.35	283.0	102.
	C	61	109	58.0	35.7	82	13	16	8.2	1	2.15	149.5	107.
	D	51	103	41.3	26.2	62	11	17	8.0	2	6.05	77.5	118.
VIII JAN 8 1927.	A	72	123	32.8	25.6	127	18	14	8.7	1	6.5	376.0	408.
	B	64	115	43.6	31.0	94	13	14	8.0	1	5.9	283.0	311.
	C	63	106	60.7	44.4	63	15	24	7.0	1	2.58	117.7	290.
	D	63	112	57.1	36.7	41	6	15	5.3	1	.85	45.25	161.

Figures in black are averages of five plants.

Figures in red are actual yields calculated on an acre basis.